



ESNCH

BELGRADE 2020/21

25th Conference of the European Society of Neurosonology and Cerebral Hemodynamics

Confluence of East and West

Belgrade, Serbia | October 15-17th, 2021



ABSTRACT BOOK

TEACHING COURSES AND PROGRAMME OVERVIEW

www.neurosonology2021.esnch.org



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Official Title

25th Conference of the European Society of
Neurosonology and Cerebral Hemodynamics

Dates

October 15–17, 2021

Friday, October 15, 2021

Teaching Courses

ESNCH Examination
Opening and Welcome Words
Gala Dinner

Friday, October 16, 2021

Scientific Sessions

Poster Presentations
Lecturers Dinner

Friday, October 17, 2021

Scientific Sessions

Poster Presentations
Closing Ceremony & Awards

Venue

Hilton hotel Belgrade

Kralja Milana 35, 11000 Belgrade, Serbia
www.hilton.com/Belgrade

Website

www.neurosonology2021.esnch.org

ESNCH Virtual Platform:

<https://esnch2021.digitalevents.rs>

Congress Organisers

**European Society of Neurosonology and Cerebral
Hemodynamics** (www.esnch.org)

Society of Serbian Neurologists

(www.drustvoneurologasrbije.org)

Neurology Clinic, University Clinical Center of Serbia

(www.neurologija.bg.ac.rs)

Astra Travel d.o.o. (www.astratravel.rs)



Congress Co-Organisers

National Society of Neuroangiography of Serbia

(www.drustvoneurologasrbije.org)

National Society of Neuroangiography of Serbia

Faculty of Medicine, University of Belgrade

(www.mfub.bg.ac.rs)



Dear Colleagues and Friends,

On behalf of the European Society of Neurosonology and Cerebral Hemodynamics (ESNCH), we are honored to welcome you to the jubilee 25th ESNCH Conference in Belgrade, Serbia.

Due to the Covid-19 pandemic, the conference initially planned for April 2020 has been postponed for October 2021 and we finally meet live in Belgrade during three days of October 15-17th. After closely monitoring the epidemiological situation, the meeting is organized as hybrid (live and virtual) with more than 250 registered participants and guests, more than 50 speakers in 6 Teaching Courses and 14 Scientific Sessions with almost 80 oral and poster presentations. The organizers put their best efforts to follow all general and local pandemic restrictions and to keep all participants safe. A special effort has been invested in making the experience of the virtual conference as live and dynamic as possible via the use of a dedicated Conference platform.

The 25th ESNCH Conference has been organized in cooperation with the National Society of Neuroangiography of Serbia, Society of Serbian Neurologists, Neurology Clinic of the University Clinical Center of Serbia, and Faculty of Medicine of the University of Belgrade, and endorsed by the European Academy of Neurology, European Stroke Organization and European Federation of Neurorehabilitation Societies.

The ESNCH Conference is aimed at providing a very high level of scientific and practical knowledge in the fields of neurosonology, cerebral hemodynamics, and related disciplines. These topics of scientific and clinical importance will be presented by the leading European and local experts.

In addition to the training, comradeship, exchanging of ideas, fruitful collaborations, and the forging of new ties, all participants will have the opportunity to enjoy the hospitality, history, and beauty of Belgrade (White City) – one of the oldest cities in Europe.

On behalf of the Organizing Committee, we wish all our participants to stay healthy and also hard yet rewarding work for our conference.

Sincerely,

Milija D. Mijajlović
Chair of the Conference

Aleksandra M. Pavlović
Chair of the Teaching Courses

Claudio Baracchini
President of the ESNCH

Endorsed by

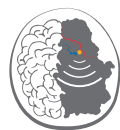
European Academy of Neurology
(www.ean.org)

European Federation of Neurorehabilitation Societies
(www.efnr.org)

European Stroke Organisation
(www.eso-stroke.org)

**European Society for Cardiovascular
and Endovascular Surgery**
(www.es cvs.com)



**ESNCH**

BELGRADE 2020/21

**25th Conference of the European Society of
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Confluence of East and West

Belgrade, Serbia | October 15–17, 2021

**Chair of the Meeting**

Milija Mijajlovic, Belgrade, Serbia

**Chair of the Teaching Courses**

Aleksandra Pavlovic, Belgrade, Serbia

Scientific Committee

Milija Mijajlovic, Belgrade, Serbia
 Claudio Baracchini, Padova, Italy
 Massimo Del Sette, Genova, Italy

Natan Bornstein, Tel Aviv, Israel
 Nadezda Covickovic-Sternic, Belgrade, Serbia
 Zagorka Jovanovic, Belgrade, Serbia
 Ranko Raicevic, Belgrade, Serbia

Petar Slankamenac, Novi Sad, Serbia
 Ljiljana Beslac Bumbasirevic, Belgrade, Serbia
 Aleksandra Pavlovic, Belgrade, Serbia

Djordje Radak, Belgrade, Serbia
 Lazar Davidovic, Belgrade, Serbia
 Marjana Vukicevic, Belgrade, Serbia

Dejana Jovanovic, Belgrade, Serbia
 Toplica Lepic, Belgrade, Serbia
 Manfred Kaps, Giessen, Germany

Fabienne Perren, Geneva, Switzerland
 Marija Žarkov, Novi Sad, Serbia
 Vlado Djajic, Banja Luka, Bosnia and Herzegovina

Anita Arsovska, Skopje, Macedonia
 Branko Malojcic, Zagreb, Croatia
 Laszlo Csiba, Debrecen, Hungary

Ekaterina Titianova, Sofia, Bulgaria
 Bojana Zvan, Ljubljana, Slovenia
 Dzevdet Smajlovic, Tuzla, Bosnia and Herzegovina

Ljiljana Radulovic, Podgorica, Montenegro
 Danijela Zamaklar Trifunovic, Belgrade, Serbia
 Kurt Niederkorn, Graz, Austria
 Mathias Sturzenegger, Bern, Switzerland

David Russell, Oslo, Norway
 Erich Bernd Ringelstein, Muenster, Germany
 Elsa Azevedo, Porto, Portugal

Milan Vosko, Linz, Austria
 Eva Bartels, Munich, Germany
 João Sargento Freitas, Coimbra, Portugal

Cornelia Brunner, Tulln, Austria
 Piergiorgio Lochner, Homburg/Saar, Germany
 Laszlo Olah, Debrecen, Hungary

Dafin Muresanu, Cluj-Napoca, Romania
 Vida Demarin, Zagreb, Croatia
 Janja Pretnar-Oblak, Ljubljana, Slovenia

Arijana Lovrencic-Huzjan, Zagreb, Croatia
 Cristina Tiu, Bucharest, Romania
 Georgios Tsivgoulis, Athens, Greece

Honorary Committee

Zlatibor Loncar, HE Minister of Health
 of the Republic of Serbia

Vladimir S. Kostic, President of the
 Serbian Academy of Sciences and Arts

Zoran Radojicic, Major of the city
 of Belgrade, Serbia

Lazar Davidovic, Dean of the Faculty of
 Medicine University of Belgrade,
 Belgrade, Serbia

Milika Asanin, Head of the University
 Clinical Center of Serbia, Belgrade

Dragoslav Sokic, Head of the Neurology
 Clinic of the University Clinical Center
 of Serbia, Belgrade

Ranko Raicevic, President of the Society
 of Serbian Neurologists

Radoje Colovic, President of the Serbian
 Medical Society

Milan Dinic, President of the Serbian
 Medical Chamber

Local Organizing Committee

Milija Mijajlovic, Belgrade, Serbia (Chair)
 Aleksandra Pavlovic, Belgrade, Serbia
 Dragoslav Sokic, Belgrade, Serbia

Jasna Zidverc-Trajkovic, Belgrade, Serbia
 Dejana Jovanovic, Belgrade, Serbia
 Predrag Stanarcevic, Belgrade, Serbia

Ranko Raicevic, Belgrade, Serbia
 Zeljko Zivanovic, Novi Sad, Serbia
 Tamara Svabic, Belgrade, Serbia
 Nataša Stojanovski, Belgrade, Serbia

Zeljko Krsmanovic, Belgrade, Serbia
 Maja Stefanovic Budimkic, Belgrade, Serbia
 Olivera Tamas, Belgrade, Serbia

Mihailo Mirkovic, Valjevo, Serbia
 Mirjana Zdraljevic, Belgrade, Serbia
 Aleksa Pejovic, Belgrade, Serbia

Ivo Bozovic, Belgrade, Serbia
 Visnja Padjen, Belgrade, Serbia
 Ivana Ilic, Belgrade, Serbia

Awards Committee

Live poster presentations
 Elsa Azevedo, Portugal
 Claudio Baracchini, Italy
 Uwe Walter, Germany

Virtual poster presentations
 Joao Sargento Freitas, Portugal
 Branko Malojcic, Croatia
 Aleksandra Pavlovic, Serbia

Oral communications
 Piergiorgio Lochner, Germany
 Nathalie Nasr, France
 Dzevdet Smajlovic, Bosnia and Herzegovina

Poster Presentations Instructions

VIRTUAL POSTER session presenters are kindly asked to pre-record their presentation(s), duration of presentation up to 5 minutes, via narrated pptx (in the Slide Show choose Record Slide Show) or via Zoom or mp4.

Virtual posters will be posted on the Conference virtual platform: www.esnch2021.digitalevents.rs. The conference virtual platform with posted pre-recorded posters, oral presentations, teaching courses, hands-on sessions, and lectures will be available On-demand only for registered participants for the whole duration of the Congress and three months after the Conference days. Registered participants will receive personalized credentials to access the virtual platform of the Conference.

In preparing your presentation please follow the strict respect of terms and permissions related to copyright and plagiarism, include the disclosure slide at the beginning of your presentation, and label all slides that include unpublished data with a title: “unpublished data – do not copy or distribute”. All authors are considered responsible for any Content that they create, transmit, or display in their presentations during the 25th ESNCH Conference and for patients’ privacy in the presentations.

For the final version of the virtual and live program of the conference, please follow the updated information at the conference website: <https://neurosonology2021.esnch.org/> as well as at the Conference virtual platform: esnch2021.digitalevents.rs.

Virtual poster session Chairs will look at all posted virtual poster presentations and will award one best virtual poster presentation.

Winner will be announced on the conference website, virtual poster platform, ESNCH website as well as in the ESNCH newsletter.

LIVE POSTER presenters are also asked to pre-record their presentation(s), duration of presentation up to 5 minutes, via narrated pptx (in the Slide Show choose Record Slide Show) or via Zoom or mp4. Live (on-site) presented posters will be also posted on the Conference virtual platform:

esnch2021.digitalevents.rs

Besides, live poster presenters will also present their posters posted on the posters boards, maximal dimensions of the poster boards, length 120cm, width 90cm.

Posters could be placed from October the 16th, starting 8am, and should be removed until October 17th, 3pm at latest. Posters mounting material will be provided on-site.

During the final program designated poster viewing time, Chairs of the live posters session will guide live posters presentations in the poster area (3 minutes presentation+2 minutes for discussion). Live posters session Chairs will award one best live poster presentation.

One additional prize will be provided for a local poster presenter.

Prizes consist of:

1. Certificate
2. Free ESNCH membership for 1 year
3. Free Teaching Courses (full day) registration for the 26th ESNCH Conference in Lisbon, Portugal, 2022.

Winners will be announced on the conference website, virtual poster platform, ESNCH website as well as in the ESNCH newsletter.

Oral Presentations Instructions

Oral communication presenters are kindly asked to pre-record their presentation(s), duration of presentation up to 10 minutes, via narrated pptx (in the Slide Show choose Record Slide Show) or via Zoom or mp4.

All oral presentations either presented virtual or live will be posted on the Conference virtual platform: www.esnch2021.digitalevents.rs.

The conference virtual platform with posted pre-recorded posters, oral presentations, teaching courses, hands-on sessions, and lectures will be available On-demand only for registered participants for the whole duration of the Congress and three months after the Conference days.

Registered participants will receive personalized credentials to access the virtual platform of the Conference.

In preparing your presentation please follow the strict respect of terms and permissions related to copyright and plagiarism, include the disclosure slide at the beginning of your presentation, and label all slides that include unpublished data with a title: “unpublished data – do not copy or distribute”. All authors are considered responsible for any Content that they create, transmit, or display in their presentations during the 25th ESNCH Conference and for patients’ privacy in the presentations.

For the final version of the virtual and live program of the conference, please follow the updated information at the conference website: <https://neurosonology2021.esnch.org/> as well as at the Conference virtual platform: esnch2021.digitalevents.rs.

Oral communication presenters will give their lectures as per final program, either on-site or will be provided with a special link to give their lecture through live streaming in real time.

Oral presentations sessions (virtual+live) Chairs will award one best oral presentation/communication.

Winner will be announced on the conference website, virtual poster platform, ESNCH website as well as in the ESNCH newsletter.

Prize consist of:

1. Certificate
2. Free ESNCH membership for 1 year
3. Free registration for the 26th ESNCH Conference in Lisbon, Portugal, 2022.

Winner will be announced on the conference website, virtual poster platform, ESNCH website as well as in the ESNCH newsletter.

25th ESNCH Conference Organizing Committee

General Information

Venue

Hilton hotel Belgrade
Kralja Milana 35, 11000 Belgrade, Serbia
Tel: +381-11-7555700
Fax: +381-11-7555701
(GPS 20.4659330000 Longitude;
44.8043500000 Latitude)
www.hilton.com/Belgrade

Language

Official language of the course is English.

Badges

All registered participant are required to wear the badges during entire scientific and social activities of the teaching course.

Dress code

Smart casual.

Accreditation and certification

25th ESNCH Conference will be accredited by the Serbian Health Council.

Those participants who successfully pass the international certification in neurosonology exam will receive a separate certificate from the ESNCH office.

Visa formalities to enter Republic of Serbia

Serbia is an EU candidate and visas are not required for EU citizens.

All EU and non-EU citizens are required to have a passport to enter Serbia.

Some citizens may need an appropriate visa to visit Serbia. For more information on the visa regime for entering Serbia please check the information at the Ministry of Foreign Affairs of the Republic of Serbia's website: <http://www.mfa.gov.rs/en/consular-affairs/entry-serbia/visa-regime>



Visa requirements

It is the sole responsibility of the attendee to take care of his/her visa requirements. Attendees who require an entry visa must allow sufficient time for the application procedure. Attendees should contact the nearest embassy or consulate to determine the appropriate timing of their visa applications. It is recommended to apply for a visa at least 3 months in advance of the conference.

Local currency

The local currency in Serbia is the Serbian Dinar (RSD). Currency exchange is possible in all banks and exchange offices. To check the current exchange rates please visit the official site of the National Bank of Serbia: <http://www.nbs.rs/internet/english/index.html>

Official letter of invitation

Registered participants who need an official letter of invitation for visa and travel purposes should send a requirement to the organizer and indicate it during the registration process. Official letter of invitation does not include any financial support except registration for the course.

Insurance

Participants are responsible to personally provide valid travel and health insurance during stay in Serbia.

Climate

The average temperature in Belgrade in October is 12°C (8–20°C). For more details please visit: <http://www.serbia.climateemps.com/october.php>

About Belgrade

Belgrade (Beo-grad, meaning white city) is the capital and the largest city of Serbia. It is situated in South-Eastern Europe, at the confluence of the Sava and the Danube rivers, where the Pannonian Plain meets the Balkans. The city has a population of about 1.8 million people and its territory is divided into 17 municipalities. Today it is the capital of Serbian culture, education, science and economy. As a result of its tumultuous history, Belgrade has for centuries been home to many nationalities.

Local transportation

Belgrade city public transport is provided through a network of bus, trolleybus and tram routes run by GSP "Beograd" and bus services operated by private bus companies, on around 130 routes.

Information on official local taxi providers could be found here: <http://belgrademyway.com/taxi/>

History

With its history of 7000 years, Belgrade is one of the oldest cities in Europe and has since ancient times been an important focal point for traffic, an intersection of the roads of Eastern and Western Europe, an important strategic location. The area around the two great rivers, the Sava and the Danube, has been inhabited as early as the Palaeolithic period. Ancient sources provide the oldest known name for Belgrade – Singidunum – and the first written documents date back to the 3rd century B.C. The name of the settlement was preserved throughout the Roman rule. With the division of the Roman Empire in 395, Singidunum passed over to the Eastern Empire, i.e. Byzantium, and the name of the city gained a Greek sound: Singidon. Favoured by the weaknesses

in the defence of the Byzantine border, the Slavs started frequently crossing the Danube in the 6th century and gradually settled the area. The stone-built fortress rising above the rivers was dubbed *Beli grad* (White City). The first record of the Slavic name *Beograd* dates back to 878, during the rule of the First Bulgarian Empire. Between the 16th and 19th century Belgrade is referred to with various names in different languages: *Alba Graeca*, *Alba Bulgarica*, *Bello grado*, *Nandor Alba*, *Griechisch Weissenburg*, *Castelbianco*... All these names, however, are translations of the Slavic word *Beograd*.

There are over 5,500 streets, 32 squares and 16 plazas in the inner area of the City of Belgrade. The development of the street network started in 1867, after the Turks had departed, when the regulatory plan of Belgrade, drawn up by engineer Emilijan Josimović, was adopted. The oldest streets that have retained their original routes in the city are Vase Čarapića, Kralja Petra, Cara Dušana, Jevrejska, Narodnog fronta,

Knez Mihailova Street



Kalemegdan





Gavril Principa and Karađorđeva streets. The oldest one is the Students Square, while the most famous one is the Republic Square. Knez Mihailova Street (the street of Prince Mihailo) is a pedestrian zone and a shopping area – protected by law as one of the oldest and most valuable monument complexes of the city, with a large number of representative buildings and urban houses built at the end of 1870s.

The first electric light was switched on in Belgrade in 1882, while the first train took off towards Niš (a Serbian city in the southern part of the country) from the Belgrade railway station in 1884. The first telephone rang in 1890, while the first cinema projection was held in 1896, just six months after the first projection by the Lumière brothers in Paris.

High above the Sava and the Danube confluence, on the rocky ridge which gives view of Novi Beograd (*New Belgrade*), Zemun and the wide plains of Pannonia, there lies Kalemegdan Fortress, the former historical and urban centre of Belgrade. This spatial complex consists of the Fortress (divided into Upper Town and Lower Town), and the Kalemegdan Park, the most beloved promenade by the people of Belgrade. Kalemegdan, the biggest and most beautiful park in Belgrade, is also the most important cultural and historical complex. The name *Kalemegdan* applies only to the spacious plateau surrounding the Fortress, which was turned into a park in 1880s. When the Fortress served as Belgrade's chief military stronghold, the plateau was a place from which the enemy was kept under observation and where preparations were made for combat. Its name derives from the Turkish words *kale* (fort) and *megdan* (battlefield).

Discover Belgrade

To its visitors, Belgrade offers a rich programme of cultural, arts and sports events, many museums and parks and cultural and historical mon-

Church of Saint Sava



Nikola Tesla Museum



Yugoslav Drama Theatre



The White Palace



Rose Church



Brankov Bridge



Skadarlija



uments. With its height of 79 meters in total, the Church of Saint Sava in Vračar represents one of the largest churches in the world and the largest one in the Balkans. Other significant areas and buildings include the National Museum and the National Theatre, Terazije area, the Serbian Academy of Sciences and Arts, the House of the National Assembly, the White Palace, the House of the Royal Family Karađorđević and the nearby Josip Broz Tito's Mausoleum, "The House of Flowers", which documents the life of the former Yugoslav president. Also worth visiting are the Residence of Prince Miloš, the Residence of Princess Ljubica, Captain Miša's Mansion and "?" Café.

Ada Ciganlija is a former island in the Sava River, today an artificial lake and Belgrade's biggest sports and recreational complex with about 8 kilometres of long beaches, cafés and sports facilities.

Nightlife

The city also has a good reputation for offering a rich nightlife. Many clubs that are open until early morning hours can be found all over the city. One of the most recognisable nightlife features of Belgrade are the barges spread along the banks of the Sava and the Danube rivers. A more traditional Serbian nightlife experience, accompanied by traditional music known as *starogradska* (roughly translated as *old town music*), can most commonly be gained in Skadarlija, the city's old bohemian neighbourhood, where the poets and artists of Belgrade gathered in the 19th and the early 20th century. Skadarlija Street and the surrounding neighbour-

Belgrade by night



hood are lined with some of Belgrade's best and oldest traditional restaurants (called *kafana* after the Serbian word *kafa*, meaning coffee), which date back to that period.

Last year Belgrade was visited by over three million tourists from all around the world. We hope you will enjoy your stay and come back to see us again!

Sources: Tourist Organisation of Belgrade, www.beograd.rs, www.avalaskitoranj.rs, www.hramsvetogsava.com, AstraTravel

River at night



Online Registration

REGISTRATION FEES AND DEADLINES

Registration can be done online until October 8th, 2021. After this date only on-site registration is possible.

REGISTRATION FEE INCLUDES

- admission to scientific sessions and poster presentations
- admission to the industrial exhibition
- printed material for the conference
- online access to abstracts
- conference bag and other conference material
- coffee breaks and business lunches
- opening ceremony and welcome reception

| | Early Bird Fee by January 20th | Regular Fee until October 8th, 2021 | Onsite Fee (October 15th) |
|--|-----------------------------------|--|------------------------------|
| Full registration | | | |
| Member* | € 400.- | € 450.- | € 450.- |
| Non-Member | € 500.- | € 550.- | € 550.- |
| Nurses & Technicians | € 200.- | € 250.- | € 250.- |
| Participants from low, lower middle and upper middle economy countries** | € 300.- | € 300.- | € 300.- |
| Undergraduate Students*** | Free admission | Free admission | Free admission |
| Day tickets | | | |
| Saturday or Sunday | € 200.- each | € 200.- each | € 200.- each |

* Member fees include members of the ESNCH with paid membership fees

** Based on World Bank list:

<https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>

*** To purchase undergraduate student admission, you must be under 30 years old at the date of the conference. Furthermore it will be necessary to send a confirmation letter about student status to email address: esnch.confirmation@gmail.com

TEACHING COURSES

| | Early Bird Fee by January 20th | Regular Fee until October 8th, 2021 | Onsite Fee (October 15th) |
|--|-----------------------------------|--|------------------------------|
| 1 Teaching Course (morning or afternoon) | € 95.- | € 110.- | € 110.- |
| Teaching Course combination (2 courses morning & afternoon) | € 180.- | € 210.- | € 210.- |

Teaching Courses are limited in the number of participants. Course registration is obligatory and takes place within the normal registration process (first come, first served)

VIRTUAL CONFERENCE PARTICIPATION – ESNCH 2021 VIRTUAL PARTICIPATION FEE INCLUDES:

- Open access to presentations and session recordings allowing you to create your own schedule, attend any and all of the sessions whenever and wherever.
- Opportunity to present your poster or oral communication in virtual sessions
- Network with colleagues including opportunity to browse a list of participants and click on their name to contact them.
- Earn CME credits.
- Certificate of attendance
- Access all the E-posters.
- Join the debate. Attend a session recorded and streamed live to allow participation delegates from all over the world to participate in live conversations.
- Visit the virtual exhibition hall. Journey through the exhibition booths, explore the displayed materials, contact exhibitors directly, and chat with other visitors.

| | |
|--|---------|
| Virtual conference participation | € 300.- |
| Virtual teaching courses participation | € 120.- |
| CERTIFICATION IN NEUROSONOLOGY EXAM | |
| Certification in neurosonology exam | € 50.- |
| OPENING CEREMONY AND GALA DINNER | |
| October 15th, 2021 | € 50.- |

SOCIAL ACTIVITIES

*Informations and reservations at registration desk

ACCREDITATION

25th ESNCH Conference is accredited by the Serbian Health Council as INTERNATIONAL CONGRESS with 15 CME credits for lecturers, 10 CME credits for participants, 13 CME credits for oral presentation and 11 CME credits for poster presentation.

Accreditation number of program: A-1-971/20.

Accreditation Decision No. 153-02-301/2020-01, from 02.03.2020. 17.10.2021

Those participants who successfully pass the international certification in neurosonology exam will receive a separate certificate from the ESNCH office.

COVID-19 and the 25th ESNCH conference in Belgrade

Attendees take full responsibility for following epidemiological measures currently implemented in Serbia. All attendees are expected to wear masks at all times while attending the conference. The meeting organisers are not liable for transmission or treatment of individuals infected with COVID-19 while attending the 25th ESNCH conference and do not take the responsibility to cover costs of testing, assessment, or treatment for COVID-19. Participants are expected to self-monitor for signs and symptoms of COVID-19 and in the unfortunate case that any of these are noticed during the meeting, please immediately isolate yourself and inform Hilton hotel staff or the organisers as soon as possible. It is each attendee's personal responsibility to follow current terms and conditions for entering Serbia during the COVID-19 pandemic as well as for returning to your country of residence or your final destination. The organisers cannot guarantee that meeting participants and attendees will not become infected with COVID-19. By attending the 25th ESNCH conference in Belgrade on-site, you are deemed to have given a full release of liability to the organisers to the fullest extent.

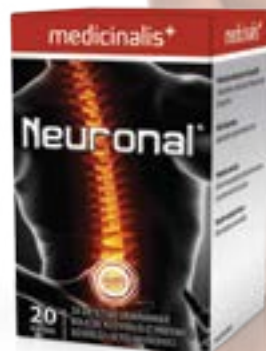
**FACE MASK
IS REQUIRED**



CORONAVIRUS
PROTECT YOURSELF & OTHERS

Neuronal®

ZA BRZ OPORAVAK OŠTEĆENIH NERAVA



**NEURONAL® SADRŽI NCFR-6
JEDINSTVENU KOMBINACIJU
NUKLEOTIDA I VITAMINA.**

| Sastav | Tableta |
|-----------------|---------|
| Nukleotid (UMP) | 50 mg |
| Niacin | 20 mg |
| Vitamin B6 | 4,2 mg |
| Vitamin B1 | 3 mg |
| Folati | 400 µg |
| Vitamin B12 | 9 µg |

- ✓ PODRŠKA TRETMANU KOMPRESIVNIH NEUROPATIJA
- ✓ UBRZAVA PROCESE OBNOVE I REGENERACIJE OŠTEĆENIH NERAVA
- ✓ SMANJUJE POTREBU ZA KORIŠĆENJEM ANALGETIKA
- ✓ JEDNOSTAVNO DOZIRANJE - JEDNA KAPSULA DNEVNO

CombiNERV®

**INOVATIVNA ČETVOROSTRUKA KOMBINACIJA
ZA PODRŠKU TRETMANU PERIFERNIH NEUROPATIJA**

SUPEROKSID-
DISMUTAZA
(SOD)

ALFALIPOIČNA
KISELINA

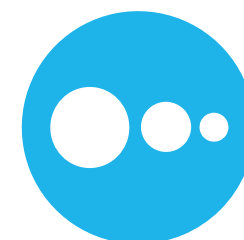
ACETIL- L
KARNITIN

VITAMIN B12

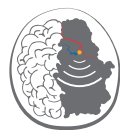
INOVATIVNA ČETVOROSTRUKA KOMBINACIJA

Preporučena dnevna doza: 1 tableta

| Sastav | Tableta | % PDD |
|----------------------------------|---------|-------|
| ALPHA LIPOIC ACID MATRIS® RETARD | 570 mg | |
| ACETYL-L-CARNITINE | 300 mg | |
| SOD GLISODIN® | 10 mg | |
| VITAMIN B12 | 2,5 µg | 100 |



NovaSignal™



OCTOBER 15th

DAY 1 - Friday

| | Room 1 | Room 2 | Room 3 | Room 4 |
|-------------|--|--------------------------------|--|--|
| 8.30–10.30 | TC1: Extracranial Arteries Examination | TC2: B mode Brain Sonography | TC3: Echocardiography for Neurosonologists | Meeting of the International Commission for Certification in Neurosonology |
| 10.30–11.00 | Coffee Break, Exhibition | | | |
| 11.00–13.00 | Demonstration & Hands-on (TC1) | Demonstration & Hands-on (TC2) | Demonstration & Hands-on (TC3) | Certification Exam Theoretical Exam |
| 13.00–14.00 | Lunch Break, Exhibition | | | |
| 14.00–16.00 | TC4: Intracranial Vascular Examination | TC5: Nerves and Muscles | TC6: Ocular and Orbital Ultrasound | Certification Exam Practical Exam |
| 16.00–16.30 | Coffee Break, Exhibition | | | |
| 16.30–18.30 | Demonstration & Hands-on (TC4) | Demonstration & Hands-on (TC5) | Demonstration & Hands-on (TC6) | Angels Initiative Satellite Symposium |
| 18.30–19.00 | | | | Special Lecture |
| | Opening Ceremony • Gala Dinner | | | |

Teaching Course 1

Extracranial Arteries Examination

Chairs: Nathalie Nasr (France), Toplica Lepic (Serbia)

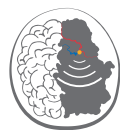
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|-------------|--|---|---|
| 8.30–9.00 | Carotid and Vertebral Artery Insonation Protocol (Normal Finding) | Laszlo Olah Hungary | V |
| 9.00–9.30 | Cervical Arteries Atherosclerosis: Carotid Wall Imaging, Plaque Morphology, Stenosis Grading | Nathalie Nasr France | L |
| 9.30–10.00 | Neurosonology Testing in Non-Atherosclerotic Carotid Disease | Arijana Lovrencic Huzjan Croatia | V |
| 10.00–10.30 | Extracranial Vascular Examination in Acute Stroke | Claudio Baracchini Italy | L |
| 10.30–11.00 | Coffee Break | | |
| 11.00–13.00 | Demonstration and Hands-On | Nathalie Nasr, Claudio Baracchini, Dragan Vasic, Toplica Lepic, Tanja Stricevic, Zeljko Krsmanovic, Aleksandar Jovanovic, Predrag Stanarcevic | |

TEACHING COURSES TIMETABLE AND PROGRAMME OVERVIEW

Friday, 15th October 2021 Day 1

Saturday, 16th October 2021 Day 2

Sunday, 17th October 2021 Day 3



Teaching Course 2

B-mode Brain Sonography

Chairs: Uwe Walter (Germany), Aleksandra Pavlovic (Serbia)

| | | | |
|-------------|---|--|---|
| 8.30–9.00 | Brain Parenchyma Imaging Basis and Protocol | Aleksandra Pavlovic Serbia | L |
| 9.00–9.30 | Transcranial Sonography in Parkinsonian Syndromes | David Skoloudik Czech Republic | R |
| 9.30–10.00 | Transcranial Sonography is Useful not only in Parkinsonian Syndromes | Dzevdet Smajlovic Bosnia and Herzegovina | L |
| 10.00–10.30 | New applications: TCS in Deep Brain Stimulation, Medial Temporal Atrophy Assessment | Uwe Walter Germany | L |
| 10.30–11.00 | Coffee Break | | |
| 11.00–13.00 | Demonstration and Hands-On | Aleksandra Pavlovic, Dzevdet Smajlovic, Uwe Walter, Nikola Veselinovic | |

Teaching Course 3

Echocardiography for Neurosonologists

Chairs: Jorge Pagola (Spain), Danijela Zamaklar Trifunovic (Serbia)

| | | | |
|-------------|--|---|---|
| 8.30–9.00 | The Basis of Stroke Focused Echocardiogram | Iria Lopez Dequidt Spain | V |
| 9.00–9.30 | How to detect Ventricular Akinesia and Systolic Dysfunction | Aleksandra Ilic Serbia | L |
| 9.30–9.45 | Coffee Break | | |
| 9.45–10.15 | Focused Echo Helps to Detect AF and Related Valvulopathies | Jorge Pagola Spain | V |
| 10.15–10.45 | Embolic Source of Stroke Uncovered by Focused Echocardiography | Radim Licenik UK | V |
| 10.45–11.15 | Cardiologist perspective in imaging patients with PFO and stroke | Vlatka Reskovic Luksic Croatia | L |
| 11.15–11.30 | Coffee Break | | |
| 11.30–13.00 | Demonstration and Hands-On | Aleksandra Ilic, Danijela Zamaklar Trifunovic, Vlatka Reskovic Luksic | |

Teaching Course 4

Intracranial Vascular Examination

Chairs: João Sargento Freitas (Portugal), Zsolt Garamy (USA/Hungary)

| | | | |
|-------------|---|-----------------------------------|---|
| 14.00–14.30 | Transcranial Insonation Protocol (TCCS/TCD) | João Sargento Freitas Portugal | L |
| 14.30–15.00 | Intracranial Stenosis/Occlusion | Eva Bartels Germany | L |
| 15.00–15.15 | Coffee Break | | |

| | | | |
|-------------|--------------------------------------|--|---|
| 15.15–15.45 | Collateral Pathways | Marek Jauss Germany | R |
| 15.45–16.15 | Challenging TCD Cases | Zsolt Garamy USA/Hungary | L |
| 16.15–16.45 | TCD in Right-to-Left Shunt Diagnosis | Dmitar Vlahovic Serbia | L |
| 16.45–17.00 | Coffee Break | | |
| 17.00–18.00 | Demonstration and Hands-On | Eva Bartels, Zsolt Garamy, Toplica Lepic, Nevenka Zaric, Bojana Solunac, Maja Stefanovic Budimkic, Janja Pretnar Oblak, Zeljko Zivanovic | |

Teaching Course 5

Muscle and Nerve

Chairs: Ekaterina Titianova (Bulgaria), Olivera Jovanikic (Serbia)

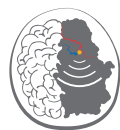
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| 14.00–14.30 | Basic Principles of Muscle and Nerve Ultrasonography | Olivera Jovanikic Serbia | L |
| 14.30–15.00 | Ultrasound of the Muscles | Ekaterina Titianova Bulgaria | V |
| 15.00–15.30 | Ultrasound-Guided Botulinum Toxin Injections in Neurology: Technique And Indications | Uwe Walter Germany | L |
| 15.30–16.00 | Muscle and Nerve Ultrasound in Motor Neuron Disorders | Daniele Coraci Italy | V |
| 16.00–16.30 | Coffee Break | | |
| 16.30–18.00 | Demonstration and Hands-On | Uwe Walter, Olivera Jovanikic | |

Teaching Course 6

Ocular And Orbital Ultrasound

Chairs: Branko Malojcic (Croatia), Piergiorgio Lochner (Germany)

| | | | |
|-------------|--|---|---|
| 14.00–14.30 | Why Do We Perform Ultrasound Neuro-ophthalmological Examination? | Piergiorgio Lochner Germany | L |
| 14.30–15.00 | Optic Nerve Sheath Diameter and the Diagnosis of Increased Intracranial Pressure | Fillipo Farina Italy | V |
| 15.00–15.30 | Vascular Orbital Sonography | Jelena Potic Serbia | L |
| 15.30–16.00 | Temporal Artery Examination | Branko Malojcic Croatia | L |
| 16.00–16.30 | Coffee Break | | |
| 16.30–16.45 | Transbulbar ultrasound: a useful tool in multiple sclerosis? | Fabienne Perren Switzerland | L |
| 16.45–18.00 | Demonstration and Hands-On | Piergiorgio Lochner, Branko Malojcic, Jelena Potic, Ana Podgorac, Tamara Svabic | |



Certification in Neurosonology exam

| | | |
|-------------|--|--|
| 11.00–13.00 | CERTIFICATION EXAM: Theoretical Exam | Eva Bartels, Germany Claudio Baracchini, Italy |
| 13.00–14.00 | Lunch Break | |
| 14.00–16.00 | CERTIFICATION EXAM: Practical Exam | Eva Bartels, Germany Claudio Baracchini, Italy Branko Malojcic, Croatia Elsa Azevedo, Portugal Joao Sargento Freitas, Portugal Milija Mijajlovic, Serbia Aleksandra Pavlovic, Serbia |

ANGELS Initiative Satellite Symposium

Chair: Natan Bornstein (Israel), Thomas Fischer (Germany), Milija Mijajlovic (Serbia)



| | | | |
|-------------|---|--|---|
| 16.30–16.40 | Welcome and Introduction | Natan Bornstein Israel | V |
| 16.40–17.20 | Angels Initiative Global Overview on Strategy and Achievements | Thomas Fischer Germany | V |
| 17.20–17.50 | The Implementation of Quality Monitoring with RES-Q | Natan Bornstein Israel | V |
| 17.50–18.15 | How to implement Angels in Serbia | Tatjana Golubovic, Marjana Vukicevic Savicevic, Milija Mijajlovic Serbia | L |
| 18.15–18.30 | Discussion | | |

Special Lecture

Chairs: Claudio Baracchini (Italy), Natan Bornstein (Israel), Milija Mijajlovic (Serbia)

| | | | |
|--------------------|------------------|---------------------|---|
| 18.30–18.50 SL1 | SHARP-SVDs Trial | Alastair Webb UK | L |
| 18.15–19.00 | Discussion | | |

Opening Ceremony – Welcoming words • Gala Dinner

| | | |
|-------------|-------------------------------------|--|
| | Opening ceremony Welcoming Words | Milija Mijajlovic & Aleksandra Pavlovic Claudio Baracchini Vladimir S. Kostic Ranko Raicevic Lazar Davidovic Milika Asanin Dragoslav Sokic |
| 21.00–24.00 | Gala Dinner | |

OCTOBER 16th

DAY 2 - Saturday

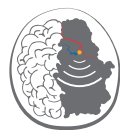
| | Plenary Hall Tsar Dusan | Poster Hall Danube | Room Belgrade |
|-------------|--|--------------------|----------------------|
| 8.00–9.00 | Scientific Session 1: Special Session with Vascular Surgeons | | |
| 9.00–10.45 | Scientific Session 2: Joint Session with ESO: Stroke/Cerebrovascular Diseases | | |
| 10.45–11.00 | Coffee Break, Exhibition | | |
| 11.00–12.30 | Scientific Session 3: Novel Methods: Neuroophthalmology and Focused Echocardiography | | |
| 12.30–13.30 | | Guided Poster Tour | ESNCH EC Meeting |
| 13.00–14.00 | Lunch Break, Exhibition, Poster Viewing | | |
| 14.00–15.30 | Scientific Session 4: Emerging Topics in Neurosonology | | |
| 15.30–17.00 | Scientific Session 5: Brain Parenchyma Sonography | | |
| 17.00–18.00 | | | Industry Round Table |
| 17.00–17.30 | Coffee Break, Poster Viewing | | |
| 17.30–19.00 | Scientific Session 6: Young Investigators Studies | | |
| 19.00–19.30 | Takeda Special Lecture | | |
| 19.30–20.30 | ESNCH General Assembly | | |
| 21.30–24.00 | Lecturers Dinner | | |

Scientific Session 1

Special Session with Vascular Surgeons

Chairs: Natalie Nasr (France), Lazar Davidovic (Serbia)

| | | | |
|-------------------|---|-----------------------------------|---|
| 8.00–8.15 S1L1 | Non-stenotic Carotid Plaques And Ischemic Stroke: How Strong Is The Association? | Tatjana Boskovic Matic Serbia | L |
| 8.15–8.30 S1L2 | When To Treat Asymptomatic Carotid Stenosis? | Lazar Davidovic Serbia | L |
| 8.30–8.45 S1L3 | Ultrasound Follow-up of Carotid Stenosis (Pre-and Post-revascularization) | Anita Arsovska North Macedonia | V |
| 8.45–9.00 S1L4 | Highlights on Ultrasound Diagnosis of Cervical Arteries Dissection | Nathalie Nasr France | L |



Scientific Session 2

Joint Session with ESO: Stroke/Cerebrovascular Diseases

Chairs: Georgios Tsivgoulis (Greece), Kurt Niederkorn (Austria), Aleksandra Pavlovic (Serbia)

| | | | |
|---------------------|---|--------------------------------------|---|
| 9.00–9.15 S2L1 | The Value of Ultrasound After Stroke Reperfusion Therapies | Kurt Niederkorn Austria | V |
| 9.15–9.30 S2L2 | Perfusion Augmentation in Acute Stroke Using Mechanical Counter-Pulsation | Matthias Reinhard Germany | V |
| 9.30–9.45 S2L3 | Update on Sonothrombolysis | Georgios Tsivgoulis Greece | V |
| 9.45–10.00 S2L4 | Gender Differences in Vascular Ultrasound in Prevention, Treatment and Prognosis of Ischemic Stroke: Does Gender Matter in Vascular Ultrasound? | Christine Kremer Sweden | V |
| 10.00–10.15 S2L5 | The Value of Microembolic Signals After Endovascular Stroke Treatment | Claudio Baracchini Italy | L |
| 10.15–10.25 S2O1 | Ischemic Stroke in Patient with Congenital Agenesis of Internal Carotid Artery with Ipsilateral Horner's Syndrome and Hypochromia Iridis | Magdalena Konieczna-Brazis Poland | L |
| 10.25–10.35 S2O2 | Indices of Carotid Plaque Embologenicity, Juxtaluminal Echodensity, Global Echodensity and Heterogeneity | Thomas Tegos Greece | V |
| 10.35–10.45 S2O3 | What's Persistent Primitive Trigeminal Artery Got To Do With It? - An Ultrasound Approach | Caterina Kulyk Austria | L |

Scientific Session 3

Novel Methods: Neuroophthalmology and Focused Echocardiography

Chairs: Branko Malojcic (Croatia), Jorge Pagola (Spain)

| | | | |
|---------------------|--|-----------------------------------|---|
| 11.00–11.15 S3L1 | Neuroophthalmological Examination and Transorbital Sonography in Neurology | Piergiorgio Lochner Germany | L |
| 11.15–11.30 S3L2 | Ultrasound in Giant Cell Arteritis: News, Tips and Tricks | Branko Malojcic Croatia | L |
| 11.30–11.45 S3L3 | Automatic Optic Nerve Measurement (AUTO-NOMA): A New Tool to Standardize the Optic Nerve Assessment by Transorbital Sonography | Andrea Naldi Italy | V |
| 11.45–12.00 S3L4 | The Basis of Focused Echocardiography for Neurologists | Jorge Pagola Spain | V |
| 12.00–12.15 S3L5 | Cardiac Sources of Embolism | Vlatka Reskovic Luksic Croatia | L |
| 12.15–12.25 S3O1 | Shutting the Door on Migraine | Klaudia Duka Glavor Croatia | L |

Scientific Session 4

Emerging Topics in Neurosonology

Chairs: Daniele Coraci (Italy), Susanna Horner (Austria), Zeljko Zivanovic (Serbia)

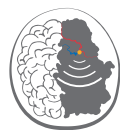
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| 14.00–14.15 S4L1 | Ultrasound Guided Interventions (Steroid Injections, Lumbar Puncture, Muscle Biopsy) & Evaluation of Less Common Nerves and Muscles | Daniele Coraci Italy | V |
| 14.15–14.30 S4L2 | The Treatment of Resistant Chronic Peripheral Neuropathic Pain: Investigation of Various Local Anesthetics Applied by Ultrasound-Guided Perineural Blocks | Olivera Jovanikic Serbia | L |
| 14.30–14.45 S4L3 | Tele-neurosonology | Bojana Zvan Slovenia | V |
| 14.45–15.00 S4L4 | The Role of TCD in PFO Diagnosis and Management | Susanna Horner Austria | V |
| 15.00–15.15 S4L5 | Review of Myosonology in the Field of Neurosonology | Ekaterina Titianova Bulgaria | V |
| 15.15–15.25 S4O1 | Hemodynamic Changes After Carotid Endarterectomy – a Detailed Analysis with Correction for Age of Middle Cerebral Artery Flow Velocity | Arjen Schaafsma The Netherlands | V |

Scientific Session 5

Brain Parenchyma Sonography

Chairs: Uwe Walter (Germany), David Skoloudik (Czech Republic)

| | | | |
|---------------------|---|---|---|
| 15.30–15.45 S5L1 | Digital Image Analysis in Transcranial Sonography | David Skoloudik Czech Republic | V |
| 15.45–16.00 S5L2 | Fusion Imaging Technique | Uwe Walter Germany | L |
| 16.00–16.15 S5L3 | Transcranial Brain Sonography in Parkinsonism and Dementia | Dzevdet Smajlovic Bosnia and Herzegovina | L |
| 16.15–16.30 S5L4 | Transcranial Brain Sonography in Psychiatric Diseases and Pain Conditions | Milija Mijajlovic Serbia | L |
| 16.30–16.40 S5O1 | Characteristics of Transcranial Brain Parenchyma Sonography in Patients with Myotonic Dystrophy Type 1 And 2 | Ivo Bozovic Serbia | L |
| 16.40–16.50 S5O2 | Mesencephalic Raphe nucleus and third ventricle diameter changes in patients with non-psychotic bipolar mood disorder | Mohammad Malakooti Iran | V |
| 16.50–17.00 S5O3 | An Ultrasonography-Guided Approach Improves Treatment Efficiency in Dystonia Patients | Gilberto Pereira Portugal | V |



Scientific Session 6

Young Investigators Studies

Chairs: Eva Bartels (Germany), Claudio Baracchini (Italy), Aleksandra Pavlovic (Serbia)

| | | | |
|---------------------|---|-------------------------------|---|
| 17.30–17.45 S6L1 | TCS Fusion Imaging in the Detection of Cerebral White Matter Lesions | Cornelia Brunner Austria | L |
| 17.45–18.00 S6L2 | Carotid Sonography Findings in Patients with Cerebral Small Vessel Disease | Stefan Stojavljevic Serbia | L |
| 18.00–18.15 S6L3 | Transcranial Brain Parenchyma Sonography of Basal Ganglia in the Evaluation of the Clinical Course of Juvenile Myoclonic Epilepsy | Ivana Djordjevic Serbia | L |
| 18.15–18.30 S6L4 | Transcranial Brain Parenchyma Sonography in Primary Burning Mouth Syndrome-Nigrostriatal Dopaminergic System Matters | Natasa Stojanovski Serbia | L |
| 18.30–18.45 S6L5 | Evaluation of Carotid Intima-Media Thickness in Systemic Rheumatic Disease Patients | Viktor Pasovski Serbia | L |
| 18.45–19.00 S6L6 | Endovascular Treatment of Acute Ischemic Stroke - a Single Comprehensive Stroke Center Experience | Dragan Dragicevic Croatia | L |

Takeda Special Session

Chairs: Marjana Vukicevic (Serbia), Milija Mijajlovic (Serbia)



| | | | |
|---------------------|--|-----------------------------|---|
| 19.00–19.20 SSL1 | Neuroimaging in Fabry Disease-Focus on Neurosonology Methods | Milija Mijajlovic Serbia | L |
| 19.20–19.30 | Discussion | | |

OCTOBER 17th

DAY 3 - Sunday

| | Plenary Hall Tsar Dusan | Poster Hall Danube | Room Belgrade |
|-------------|--|--------------------|-----------------|
| 8.30–10.00 | Scientific Session 7: Joint Session with EAN: New Techniques/Neurorehabilitation | | |
| 10.00–11.30 | Special Session: Neurosonology In our Region and Oral Presentations | Guided Poster Tour | ERNSono Meeting |
| | Graba Coffee Break, Exhibition | | |
| 11.30–13.00 | Scientific Session 8: Neurosonology in ICU | | |
| 13.00–14.30 | Scientific Session 9: Miscellaneous | | |
| 14.30–15.00 | Awards, Closing Ceremony and Introduction of the 26th ESNCH Conferenc | | |
| 15.00–16.00 | Exhibition, Lunch and Farewell | | |

Scientific Session 7

Joint Session with EAN/EFNR: New Techniques/Neurorehabilitation

Chairs: Elsa Azevedo (Portugal), Dafin Muresanu (Romania)

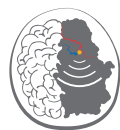
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| 8.30–8.45 S7L1 | Functional TCD in Aquired and Genetic Cerebrovascular Disease and in Precerebral Hypoperfusion | Elsa Azevedo Portugal | L |
| 8.45–9.00 S7L2 | Functional TCD - Update | Janja Pretnar-Oblak Slovenia | L |
| 9.00–9.15 S7L3 | Role of Ultrasound in Neurorehabilitation | Dafin Muresanu/Adina Stan Romania (EFNR) | V |
| 9.15–9.30 S7L4 | Acute stroke Hemodynamics | Joao Sargento Freitas Portugal | L |
| 9.30–9.45 S7L5 | Assessment of Collateral Flow with Ultrasound and MRA – Complementary Findings | Marek Jaus Germany | L |
| 9.45–9.55 S7O1 | Intracranial Pulsatility and Cerebral White Matter Hyperintensity Burden in a Community-Dwelling Elderly Population | Markus Kneihsl Austria | V |

Special Session

Neurosonology in Our Region and Oral Presentations

Chairs: Vida Demarin (Croatia), Zagorka Jovanovic (Serbia)

| | | | |
|----------------------|--|---------------------------------|---|
| 10.00–10.30 SpSL1 | Past, Present and Future of Neurosonology in Our Region | Vida Demarin Croatia | V |
| 10.30–10.40 SpSO1 | Effects of Acute Alcohol Consumption on Neuronal Activity and Cerebral Vasomotor Response | Eszter Balogh Hungary | V |
| 10.40–10.50 SpSO2 | Refining the Concept of ESUS – A Longitudinal 5-Year Follow-Up Study | Carolina Fernandes Portugal | L |
| 10.50–11.00 SpSO3 | Bilateral High-Grade Stenosis of Intracranial Internal Carotid Artery in Patient with Multiple Myeloma | Jurgita Valaikiene Lithuania | V |
| 11.00–11.10 SpSO4 | Successful Embolization of Giant Basilar Aneurysm: Follow-Up by Transcranial Color-Coded Duplex Sonography | Jurgita Valaikiene Lithuania | V |
| 11.10–11.20 SpSO5 | Middle Cerebral Artery Pulsatility Index and Serum Inflammatory Markers in Lacunar Stroke – a Preliminary Report | Grzegorz Kozera Poland | V |
| 11.20–11.30 SpSO6 | The Role of Carotid Duplex Sonography in The Evaluation of Patients with Tinnitus and in the Detection of Dural Arteriovenous Fistulas | Catarina Caldeiras Portugal | V |

**ESNCH**

BELGRADE 2020/21

25th Conference of the European Society of Neurosonology and Cerebral Hemodynamics**Scientific Session 8****Neurosonology in ICU**

Chairs: Milan Vosko (Austria), Dejana Jovanovic (Serbia)

| | | | |
|---------------------|---|----------------------------|---|
| 11.30–11.45 S8L1 | Scientific Evidence and Enhancing Safety in Ultrasound Assisted procedures in ICU | Milan Vosko Austria | L |
| 11.45–12.00 S8L2 | Transcranial Doppler in Subarachnoid Haemorrhage | Zeljko Zivanovic Serbia | L |
| 12.00–12.15 S8L3 | The Normal Mean Values of ONSD and OND and the Issue of Different Cut-off Values: Application In Neurology and Critical Care Patients | Andrea Naldi Italy | V |
| 12.15–12.30 S8L4 | Ultrasound in Brain Death | Dejana Jovanovic Serbia | L |
| 12.30–12.45 S8L5 | Validation of a New Non-Invasive Technique for Cerebral Compliance Assessment | Sergio Brasil Brazil | V |
| 12.45–12.55 S8O1 | Intraoperative Ultrasonography in Adult Neurosurgery: our Experience and Literature Review | Vuk Aleksic Serbia | L |

Scientific Session 9**Miscellaneous**

Chairs: Laszlo Csiba (Hungary), Joao Sargento Freitas (Portugal)

| | | | |
|---------------------|--|-------------------------------------|---|
| 13.00–13.15 S9L1 | Do We Overlook Fibromuscular Dysplasia on Ultrasound Images? | Arijana Lovrencic-Huzjan Croatia | V |
| 13.15–13.30 S9L2 | Effect of 2 Types of Antihypertensive Therapy on Cognition and Vessel Wall | Laszlo Csiba Hungary | V |
| 13.30–13.45 S9L3 | Optic Nerve Sheath Diameter and Diagnosis of Increased Intracranial Pressure | Nicola Carraro Italy | V |
| 13.45–14.00 S9L4 | Transcranial Detection of Microemboli Signals (MES) In Patients with Antiphospholipid Syndrome and Stroke | Zagorka Jovanovic Serbia | L |
| 14.00–14.10 S9O1 | Evolution of Blood-Brain Barrier Permeability and Impact on Clinical Outcome Throughout the Pathological Phases of Ischemic Stroke: an Observational Study and Meta-Analysis | Joao Sargento Freitas Portugal | L |
| 14.10–14.20 S9O2 | Enhanced Hemodynamic and Clinical Response to aCGRP in Migraine Patients – a TCD Study | Bojana Zvan Slovenia | V |

Awards, Closing Ceremony and Farewell

| | | | |
|-------------|--|---|--|
| 14.30–15.00 | Awards, Closing Ceremony and Introduction of the 26th ESNCH Conference | Milija Mijajlovic Aleksandra Pavlovic Claudio Baracchini Branko Malojcic | João Sargento Freitas Victor Oliveira Elsa Azevedo |
| 15.00–16.00 | Exhibition, Lunch and Farewell | | |

A Wearable Robotic TCD

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Innovative Transcranial Doppler (TCD) Technology



Evaluation for Critical assessment



Assessment and evaluation for cerebral auto regulation function



Prof Marek Czosnyka, University of Cambridge

- « Application of robotic transcranial Doppler for extended duration recording in moderate/severe traumatic brain injury: first experiences » Zeller and Smielewski Crit Ultrasound J (2018) 10:16
- « Optimal cerebral perfusion pressure via transcranial Doppler in TBI: application of robotic technology » Zeller and Marek-Peter Acta Neurochirurgica (2018)
- « Non-Invasive Pressure Reactivity Index Using Doppler Systolic Flow Parameters: A Pilot Analysis » Frederick A. Zeller, Peter Smielewski, JOURNAL OF NEUROTRAUMA 35:1-8 (2018)



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ABSTRACTS

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Online Publication of all ESNCH 2021 abstracts
(available after the conference)

For further information see page
<https://esnch2021.digitalevents.rs>

FACULTY ABSTRACTS

Teaching Course 1

Title: CAROTID AND VERTEBRAL ARTERY INSONATION PROTOCOL (NORMAL FINDING)

Author: Laszlo Olah, Hungary

Title: CERVICAL ARTERIES ATHEROSCLEROSIS: CAROTID WALL IMAGING, PLAQUE MORPHOLOGY, STENOSIS GRADING

Author: Nathalie Nasr, France

Title: NON-ATHEROSCLEROTIC CERVICAL ARTERY DISEASE

Author: Prof. Arijana Lovrencic-Huzjan, MD, PhD, FESO, FEAN¹
1 University Hospital Center Sestre milosrdnice, Zagreb, Croatia

Abstract

Non-atherosclerotic cervical artery disease are not rare. They include vasculopathies like fibromuscular dysplasia that can cause cervical artery dissection, vasculitis, genetically mediated arteriopathies and anatomic variants.

Fibromuscular dysplasia is a non-atherosclerotic vascular disease, frequently underdiagnosed due to diverse clinical picture that ranges from non-specific symptoms like headache, migraine, dizziness, tinnitus, to more severe picture of ischemic stroke as a result of cervical artery dissection. Neurosonological findings range from subtle changes or changes of increased intima-media thickness (carotid marker), to focal, multifocal or long tubular stenosis, or aneurysm. Frequent finding is vessel tortuosity, but it is a nonspecific finding. Recognition of the disease is limited by localization of the disease in the distal, sub petrosal part of the internal carotid artery.

In craniocervical artery dissection neurosonology has high sensitivity in diagnosis of the disease, and enables decision of antithrombotic treatment. It also has a prognostic role. Neurosonology enables monitoring of the disease, morphologic and hemodynamic features, high intensity transient signals, and recanalization and recurrence rate, what is important in decision of the duration of antithrombotic treatment. Pitfalls are in acute setting, and localization of the disease.

If the vasculitis is located in the craniocervical arteries it becomes a diagnostic challenge, but other diagnostic modalities may solve the dilemma.

Genetically mediated arteriopathies may have diverse neurosonological finding ranging from tortuous vessels to fusiform dilatation of the vessel.

Anatomical variants like hypoplasia, aplasia or fenestration may pose a diagnostic challenge.

Non-atherosclerotic cervical artery disease are not so rare and should be included in the daily routine differential diagnosis.

Title: EXTRACRANIAL VASCULAR EXAMINATION IN ACUTE STROKE

Author: Claudio Baracchini MD, FESO¹

¹Stroke Unit and Neurosonology Lab, Department of Neurological Sciences, University of Padua School of Medicine

Abstract

In general, it is essential to assess the etiopathogenesis of an acute ischemic stroke in order to tailor and monitor appropriate treatment and determine prognosis. About 15-20% of all ischemic strokes are caused by an arteriopathy of the cervical vessels. Therefore, an early diagnosis of a hemodynamically significant stenosis or occlusion of these arteries is pivotal for acute treatment strategies such as thrombolysis and mechanical recanalization, and subsequent procedures such as carotid endarterectomy or stenting. Digital subtraction angiography (DSA) represents the gold standard, but it is too invasive and expensive as a first-line method. Magnetic resonance angiography (MRA) is not available in every hospital or 24/7; it is also time consuming and contraindicated in several patients. Computed tomographic angiography (CTA) is the most widely used technique; however, radiation exposure and potential allergic or renal side effects due to the contrast medium should be considered. Duplex ultrasound (DUS) has several advantages, being a low-cost, non-invasive bedside tool, with high temporal and spatial resolution that can also assess patients with contraindications to angiographic methods. A fast-track cervical DUS protocol can be performed in the emergency room and yields information on the status of the carotid and vertebral arteries without a significant delay, when performed by an experienced sonographer. In particular, it provides morphologic characteristics of the atherosclerotic plaque, the degree of stenosis and its hemodynamic effects. Cervical DUS may also support the diagnosis of non-atherosclerotic lesions including dissections and arteritis. The specificity of "fast-track" ultrasound for steno-occlusive disease is excellent, while the sensitivity is higher in the anterior compared with the posterior circulation, due to frequent anatomic variants of the vertebro-basilar system and limited insonation settings. The feasibility of pre-hospital DUS in identifying vessel occlusion, using a portable ultrasound system in the emergency helicopter or ambulance, has already been proven. In light of the COVID-19 pandemic, the ESNCH has recently issued practice recommendations for the use of clinically oriented ultrasound evaluation during transport to reveal large vessel occlusion strokes and indicate the most suitable destination for the patient. Furthermore, therapeutic decisions on systemic or endovascular reperfusion therapies for COVID-19-positive and presumed positive patients presenting with acute stroke symptoms may rely on ultrasound to avoid potential time delays related to CTA or MRA. This teaching course will outline the applications of cervical DUS in acute stroke management and its potential therapeutic implications.

Teaching Course 2

Title: BRAIN PARENCHYMA IMAGING BASIS AND PROTOCOL

Author: Aleksandra M. Pavlović¹

¹Faculty for Special Education and Rehabilitation, University of Belgrade, Belgrade, Serbia

Abstract

Transcranial B-mode sonography (TCS) of the brain parenchyma has developed in the last two decades into an important diagnostic tool with high sensitivity and specificity for detecting basal ganglia abnormalities in different conditions. Unilateral or asymmetric substantia nigra hyperechogenicity has been recognized as a biomarker of idiopathic Parkinson's disease and is increasingly used in the differential diagnosis of parkinsonism. Brain stem raphe hypoechogenicity has been identified in various depressive disorders. The increased width of the third ventricle indicates subcortical atrophy or hydrocephalus. In addition, this method enables the assessment of the echogenicity of other midline structures as well, with several specific patterns for different diseases reported in recent years. There is the emerging use of the TCS with expanding spectrum of indications, such as deep brain stimulation and medial temporal atrophy assessment, for other neurodegenerative conditions beyond movement disorders but also in vascular conditions and neurocritical care.

The scanning is performed at several axial levels through the brain stem and thalami. Assessment starts in the axial scanning plane parallel to the orbitomeatal line, at the level of the midbrain. In this plane, the butterfly-shaped mesencephalic brainstem, and the echogenicity of the ipsilateral SN, ipsilateral red nucleus, and median midbrain raphe are assessed. The ultrasound beam is then tilted 10–20° upwards through the section



of the thalami. At this plane, the transverse diameter of the third ventricle and the frontal horn of the contralateral lateral ventricle can be measured. Furthermore, echogenicity of the contralateral thalamus, lenticular nucleus, and caudate nucleus is rated semiquantitatively at this level.

This method offers new approach to the visualization of brain structures compared to other neuroimaging methods due to different physical imaging principles with high-resolution imaging of echogenic deep brain structures. The consensus guidelines for uniform TCS scanning procedures for midbrain and basal ganglia structures, as well as the ventricular system, have been established. The TCS technique proved to be a dependable, non-invasive, available, and easily applicable method, which provides novel information on the morphology of the central brain structures for different clinical indications.

Title: TRANSCRANIAL SONOGRAPHY IN PARKINSONIAN SYNDROMES

Author: David Skoloudik, Czech Republic

Title: TRANSCRANIAL SONOGRAPHY IS USEFUL NOT ONLY IN PARKINSONIAN SYNDROMES?

Author: Prof.dr. Dzevdet Smajlović, MD, PhD¹

¹ Department of Neurology, University Clinical Centre Tuzla, Bosnia and Herzegovina

Abstract

Transcranial sonography (TCS) of brain parenchyma is a relatively new ultrasound modality which could display echogenicity of human brain tissue through the intact skull. Becker and colleagues (1995) first observed hyperechogenicity of the substantia nigra in patients with Parkinson's disease (PD) using TCS. Since then, TCS of brain parenchyma in patients with movement disorders has developed with increasing dynamics during the past two decades. Based on the convincing evidence available, the EFNS accredited the method of TCS a level A recommendation for supporting the diagnosis of PD and its differential diagnosis from secondary and atypical parkinsonism.

In this lecture, we will try to give the answer is TCS can be used to evaluate changes in other diseases characterized by movement disorders (Wilson's disease, Huntington's chorea, spinocerebellar ataxia, dystonia and restless leg syndrome), in some neurodegenerative diseases (amyotrophic lateral sclerosis, dementia with Lewy bodies), demyelinating diseases (multiple sclerosis), cerebrovascular and psychiatric diseases. Furthermore, we will give enough scientific data that TCS can be useful and helpful not only in diagnosis and differential diagnosis of Parkinsonian syndromes, but also in other neurological and psychiatric diseases.

Title: NEW APPLICATIONS: TCS IN DEEP BRAIN STIMULATION, MEDIAL TEMPORAL ATROPHY ASSESSMENT

Author: Prof. Uwe Walter, MD¹

¹ University of Rostock, Department of Neurology, Gehlsheimer Str. 20, 18147 Rostock, Germany, D-18147 Rostock, Germany

Abstract

Transcranial B-mode sonography (TCS) is a non-invasive neuroimaging method that allows high-resolution imaging of deep brain structures, especially substantia nigra and basal ganglia. In the guidelines of the European neurological societies (EAN, MDS-ES) TCS of substantia nigra is included as a biomarker for the early and differential diagnosis of PD. A growing number of studies suggest that TCS of substantia nigra, basal ganglia, and temporal lobe can also be helpful in the diagnosis of neurodegenerative dementia disorders. Especially, TCS can be used to detect and monitor medial temporal lobe atrophy in Alzheimer disease. Meanwhile there are a number of novel technologies allowing for the automatic structure detection and digitized image analysis of distinct brain structures depicted with TCS. These digitized analysis technologies are now being tested for its value in the assessment of therapeutic effects in PD and other disorders. An elegant application of TCS is the intra- and postoperative localization of deep brain stimulation electrodes. Especially the location of deep brain stimulation electrodes in the subthalamic nucleus can be precisely and exactly performed with TCS alone. The increasingly available technology of TCS-MRI fusion imaging and volume navigation is currently being tested for the peri- and postoperative location of deep brain electrodes, but also with other new diagnostic applications.

Teaching Course 3

Title: THE BASIS OF STROKE FOCUSED ECHOCARDIOGRAPHY

Author: Iria A. López Dequidt¹

¹ Clinical Hospital of Santiago de Compostela. Spain.

Abstract

Background: Stroke is a major cause of mortality in Europe. Causes of stroke vary, although it is thought that about 20% of ischemic stroke are cardioembolic. In cryptogenic stroke an important part of the unknown causes are from cardioembolic sources too. Cardiac sources including diseases from left atrium and left atrial appendage, left ventricular, heart valve diseases, cardiac tumors and thoracic aorta pathologies.

Echocardiography is essential for the evaluation, diagnosis, and management of stroke and systemic embolism. Nowadays neurologists are receiving specific training to perform echocardiograms by themselves.

Objectives: Review the guidelines and recommendations to date to determine the most appropriate echocardiography diagnostic management strategy for stroke patients.

Methods: Review the specific recommendations regarding echocardiography in 1) 2021 guideline for the prevention of stroke in patients with stroke and transient ischemic attack from American Heart Association; 2) Guideline for the use of echocardiography in the evaluation of a cardiac source of embolism from the American Society of Echocardiography published in 2016; 3) Systematic review and economic evaluation of routine echocardiography in the management of stroke published in Health technology assessment in 2014.

Results: Transthoracic echocardiography is the most appropriate test and it is a cost effective tool. Transesophageal echocardiography is appropriate in some circumstances and specific guidelines are provided for each category of embolic sources.

Title: HOW TO DETECT VENTRICULAR AKINESIA AND SYSTOLIC DYSFUNCTION

Author: Aleksandra Ilic, Serbia

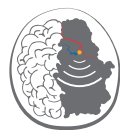
Abstract

Assessment of the left ventricular (LV) systolic function is the most common indication for echocardiography. According to the Recommendations by the American Society of Echocardiography and the European Association of Cardiovascular Imaging, there are currently conventional echocardiographic methods - two-dimensional echocardiography (2DE) and Doppler echocardiography, and advanced techniques such as real-time three-dimensional echocardiography (3DE), myocardial deformation imaging and microbubble contrast agents that can be used in this assessment.

Accurate measurement of the LV function is important and necessary for the evaluation of cardiac disease. Decreased systolic function is associated with worse prognosis after myocardial infarction, increase in the relative risk of death, causes decreased organs perfusion, including the brain, and the possibility of thrombus formation with subsequent embolization. LV size should be routinely assessed on 2DE by calculating volumes using the biplane method of disks summation technique. LV volumes should be measured from the apical four- and two-chamber views and indexed to the BSA. Modified Simpson's rule is recommended 2D method to assess LV ejection fraction (EF). EF <52% for men and <54% for women is considered as abnormal.

There are several limitations of this technique: suboptimal endocardial definition, inadequate interpretation of apical structures due to foreshortening, arrhythmias. In these circumstances, if there are technical conditions and experience, it should be done 3DE or microbubble contrast agents may be used for image optimization. These techniques allow more accurate measurement of volumes, myocardial mass and systolic function when they compared to cardiac magnetic resonance, which is considered the reference standard for assessing LV volumes and function.

For the assessment of LV regional function, LV is divided into segments, which reflect coronary perfusion territories, and allow comparison with other imaging modalities. Regional myocardial function is assessed on the basis of the observed endocardial thickening. Each segment has to be analyzed in multiple views. The following scoring system is recommended: (1) normal or hyperkinetic, (2) hypokinetic, (3) akinetic and (4) dyskinetic. Regional abnormalities are often caused by myocardial infarction and ischemia. But, may also occur in the absence of coronary artery disease. Speckle-tracking is recommended for the assessment of regional myo-



cardial function. Myocardial deformation, termed strain, was reported as a percentage change in length. On 2DE, peak global longitudinal strain (GLS) describes the relative length change of the LV myocardium between end-diastole and end-systole. 2DE GLS appears to be reproducible and feasible for clinical use and offers incremental prognostic data over LV EF in a variety of cardiac conditions. A peak GLS in the range of -20% can be expected in a healthy person.

Assessment of the LV function plays an important role in the diagnosis of cardiac disease, but also for prediction morbidity and mortality. 2D and 3D strain imaging and microbubble contrast agents allow more accurate evaluation of LV systolic function, particularly for patients with borderline LV function, because of the potential to identify subclinical disease, which may improve prognosis.

Title: FOCUSED ECHO HELPS TO DETECT AF AND RELATED VALVULOPATHIES

Author: Jorge Pagola Pérez de la Blanca, MD, PhD.¹

¹ Stroke Unit, Neurology Department, Vall d'Hebron University Hospital. Stroke Research Group, Vall d'Hebron Research Institute.

Abstract

Cardiac Focused Echocardiography (FOCUS) is an examination performed by non cardiologist based on several expert recommendations. In stroke setting, the main sources to evaluate with cardiac focused echo are: Ventricular akinesia, aortic plaques and PFO.

Ventricular akinesia is the lack of wall segment movement that can be observed by this protocol. FOCUS echo may help suspect plaques by supraesternal echographic window. The sensitivity and specificity of FOCUS to detect PFO is excellent. Moreover, FOCUS can detect relevant information regarding complex PFO like Atrial Septal aneurism, prominent Eustachian Valve or Chiari Network reticula.

FOCUS echo is being improving by new protocols and devices. Accordingly, WHOLE POCUS is defined as the examination of heart-carotid vessels and intracranial circulation in only one step. With the use of POCUS devices connected to smartphone we can evaluate the source of stroke anywhere anytime. A proper education and formal practice by a certification is required to perform FOCUS echo. In Spain there is a Consensus that include a protocolo to certificate non cardiologist in this technique.

Title: EMBOLIC SOURCE OF STROKE UNCOVERED BY FOCUSED ECHOCARDIOGRAPHY

Author: Radim Licenik, UK

Title: CARDIOLOGIST PERSPECTIVE IN IMAGING PATIENTS WITH PFO AND STROKE

Author: Vlatka Reskovic Luksic, MD, PhD¹

¹ Department for Cardiovascular Diseases, University Hospital Center Zagreb, Croatia

Abstract

Patent foramen ovale (PFO) is a rather common finding in the general population (25%), increasing to over 50% in patients with cryptogenic stroke. PFO is not a true deficiency of the atrial septum, but a potential separation between the septum primum and septum secundum in the anterosuperior part of the fosa ovalis. In patients with PFO usually small left-to-right shunt is observed. Right-to left shunting is associated with paradoxal embolisation and can be provoked by maneuvers that increase right atrial pressure, such as cough and Valsalva maneuver. Presence of the PFO is associated with stroke, decompression sickness, platypnea-orthodeoxia syndrome and migraine headache. Atrial septal aneurysm is a common finding in patients with PFO, and is associated with increased prevalence of cryptogenic stroke and other embolic events.

Transthoracic echocardiography (TTE) is used for initial evaluation in patients with cryptogenic stroke, and if contrast TCD study is positive, contrast TOE should be performed before transcatheter PFO closure. Detailed anatomic TOE study should provide measurements important for both patient and device type and size selection. Important features are tunnel length, atrial septal aneurysm, septum primum deviation, additional multi-

ple small defects on the fossa ovalis, thick septum secundum, large Eustachian valve and excessive redundant Chiari network. During the percutaneous PFO closure, TOE is of most importance for guiding intervention (device position, stability, relation to surrounding structures, early complications...). After patient discharge, regular echocardiography follow-up is required after 1,6,12 months and afterwards regularly every 1-2years. Complications are rather rare but can be fatal. Residual shunt is a significant predictor of stroke recurrence. Following 6-12 months after PFO closure, contrast study should be performed to exclude residual shunt and confirm complete closure.

Careful patient selection and multidisciplinary approach are very important to select good candidates for PFO closure and to minimize the rate of re-events and complications. Echocardiography is an irreplaceable tool in diagnosing, managing and follow-up.

Teaching Course 4

Title: TRANSCRANIAL INSONATION PROTOCOL (TCCS/TCD)

Author: João Sargento-Freias, Coimbra, Portugal

Abstract

The ultrasonographic study of intracranial vessels has revolutionized in many ways the way physicians see, approach and treat neurovascular disorders.

As in any diagnostic strategy, its accuracy will be directly dependent on the use of correct technical acquisition. In this lecture we will approach the theoretical principles involved in acquiring and interpreting the main anatomical vessels of the intracranial vascularization using the most relevant ultrasonographic windows, namely the transtemporal, suboccipital and transorbital.

The main objective of this lecture is to provide the trainees with the theoretical background required for the correct performance of a transcranial ultrasonographic assessment.

Title: INTRACRANIAL STENOSIS/OCCCLUSION

Author: Eva Bartels, Germany

Title: COLLATERAL PATHWAYS

Author: Marek Jauss, Germany

Abstract

Assessment of collateral pathways are important in clinical decision making in vascular neurological disease in acute as well as in chronic conditions. The author gives illustrative examples of difficult findings in patients with intracranial and extracranial findings as well. ultrasound examination protocols are presented and limitations of assessment with ultrasound are addressed. It will be commented on complementary methods such as CTA and MRA. Sophisticated examination sequences situations are illustrated on a stepwise base. Also non-everyday situations such as examination of an EC-IC bypass is presented.

Title: CHALLENGING TCD CASES

Author: Zsolt Garamy, USA/Hungary

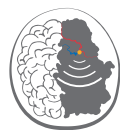
Title: TCD IN RIGHT-TO-LEFT SHUNT DIAGNOSIS

Author: Dmtar Vlahović¹

¹ Neurology Clinic, Clinical Center of Vojvodina; Faculty of Medicine, University of Novi Sad, Serbia

Abstract

Up to 30% of all ischemic strokes are cryptogenic. Under that umbrella, one of the potential causes is right-



to-left shunt (RLS), a non-physiological gateway. One of those is patent foramen ovale (PFO), which is present in 20-30% of the adult population. Right-to-left cardiac shunts usually remain undetected. Because they are associated with ischemic strokes, especially in younger population, diagnosing RLS is of cardinal importance. Passing blood clots and other potential emboli through the shunt is called paradoxical embolization. TCD bubble study is a procedure which is used for diagnosis of possible presence of RLS. It is well recognized and verified procedure, with excellent safety profile and low-cost. This method uses contrast agent, an agitated saline solution. By positioning TCD probes over both medial cerebral arteries, we can register micro embolic signals (MES), soon after injection of contrast. Also, number of MES is well correlated with the size of the shunt, with a sensitivity 90-100% and specificity >95%. It can be easily repeated and done by the bedside. TCD is useful tool for selecting patients who need further invasive investigations like transesophageal echocardiography (TEE). Studies comparing transthoracic echocardiography (TTE) or TEE to TCD have shown that 15-25 % of patients test positive for right-to-left shunt on TCD but are negative on TTE or TEE. TCD is nowadays first step in diagnosis of RLS and essential tool for further treatment planning for patients with ischemic stroke and other conditions, like migraine with aura.

Teaching Course 5**Title: BASIC PRINCIPLES OF MUSCLE AND NERVE ULTRASONOGRAPHY****Author:** Olivera Jovanikic, Serbia**Title: ULTRASOUND OF THE MUSCLES****Author:** Acad. Prof. Ekaterina Titianova, MD, PhD, DSc¹¹ Clinic of Functional Diagnostics of Nervous System, Military Medical Academy, 3 Georgi Sofijski str., 1606 Sofia, Bulgaria**Abstract**

In the past decade the multimodal 2D/3D/4D myosonology has become the most appropriate non-invasive and bedside method for real-time evaluation of structural and functional properties of the muscle tissue in normal and pathological conditions. Using high-resolution B-mode ultrasound the physiological and pathological muscle structure and the positioning of needle electrodes for biopsy or injections (e.g., botulinum toxins or local anesthetics) can be easily imaged. By tissue velocity imaging (TVI) the muscle motion can be better detected and quantified in terms of velocity, accelerations, and synchronicity of muscle contraction. It can be used for assessment of orthostatic antigravity adjustment using the measurement of pennation angle of triceps surae muscle contraction at rest and during maximal active plantar flexion. Recently, an M-mode tremorogram has been introduced for registration of tremor frequency. Thus, the myosonology seems to become a powerful tool for neurologists and physiotherapists in their everyday clinical practice.

**Title: ULTRASOUND-GUIDED BOTULINUM TOXIN INJECTIONS IN NEUROLOGY:
TECHNIQUE AND INDICATIONS****Author:** Prof. Uwe Walter, MD¹¹ University of Rostock, Department of Neurology, Gehlsheimer Str. 20, 18147 Rostock, Germany, D-18147 Rostock, Germany**E-mail:** uwe.walter@med.uni-rostock.de**Abstract**

Botulinum neurotoxin (BoNT) injection has been increasingly used for treating muscular spasticity and dystonia. Unlike other techniques of precision targeting such as electromyography or computed tomography, B-mode ultrasound allows immediate and high-resolution imaging of the injection needle position and injected fluid within the target region. Visual identification of muscles or glands and depth control of needle placement are the key features of ultrasound-guided injection that lead to improved targeting and safety of BoNT injections. Ultrasound may be helpful to validate already established injection techniques or when learning

the correct injection technique. Ultrasound-guided BoNT injection has been recommended as a standard procedure in treatment of lower leg spasticity in children with cerebral palsy. In recent years, this technique has been increasingly used also for the exact targeting of BoNT injection in single forearm muscles (e.g. the flexor digitorum superficialis or the flexor digitorum profundus muscle of single fingers) of patients with writers or musicians cramp, or with mild post-stroke spasticity. An emerging application is the ultrasound-guided BoNT injection into deep cervical and nuchal muscles in patients with cervical dystonia, such as the scalene muscles, the longissimus capitis muscle, and the obliquus capitis inferior muscle. Distinct targets for BoNT infiltration such as the omohyoid muscle, as well as the submandibular or sublingual glands can practically only be sighted with ultrasound. This applies also for the piriformis muscle in patients with painful piriformis syndrome. The upcoming real-time MRI-ultrasound or CT-ultrasound fusion imaging techniques promise the repeated ultrasound-guided targeting also of deep muscles such as the longus colli muscle in patients with antecollis, and the lumbar portion of the psoas muscle in patients suffering from severe painful spastic hip bending.

Title: MUSCLE AND NERVE ULTRASOUND IN MOTOR NEURON DISORDERS**Author:** Daniele Coraci, MD, PhD, Assistant Professor¹¹ Department of Neuroscience, University of Padua, Italy**Abstract**

Motor neuron disorders include a group of different diseases characterized by progressive degeneration of the motor neurons. The clinical evaluation is fundamental for the diagnosis and it is based on the search of upper motor neuron signs, lower motor neuron signs, bulbar involvement, neuropsychiatric alterations. Electrophysiological evaluation is part of the evaluation because it is able to reveal the axonal damage and it can help to exclude other diseases. Among the conditions mimicking the motor neuron, immune-mediated neuropathies may be assessed by ultrasound. Usually, in these, nerve enlargements are visible. On the other side, in motor neuron diseases, some authors found a reduction of motor nerve dimensions. For this reason, ultrasound may support the differentiation between motor neuron diseases and immune-mediated neuropathies. Considering the muscles, ultrasound can quantify their dimension and can evaluate the echogenicity and the fasciculations. Finally, the function of the diaphragm can be assessed. Hence, the technique can improve the diagnostic power if associated with electrodiagnosis.

Teaching Course 6**Title: WHY DO WE PERFORM ULTRASOUND NEUROOPHTHALMOLOGICAL EXAMINATION?****Author:** Piergiorgio Lochner¹¹ Department of Neurology, Saarland University Medical Center, Homburg, Germany**Abstract**

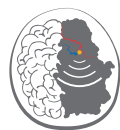
The eye represents a sensory extension of the central nervous system whose main function is vision. The easy accessibility of the eye to ultrasound, given the superficiality and the absence of bone, makes it a real window on the brain.

The aim of this lecture is to bring the reader closer in the transorbital ultrasound technique and to stimulate him to apply it daily to the patient's bed as an extension of clinical examination.

Optic nerve sheath diameter (ONSD) measurement is simple, easy to learn and has several applications. We describe the technique and the main parametric settings. ONSD has utility for estimating ICP in several clinical conditions such as intracranial haemorrhage and ischaemic stroke, in meningitis and encephalitis, and in idiopathic intracranial hypertension. Less known is the usefulness of ONSD studies in symptomatic intracranial hypotension.

The identification of the main arteries of the eyes helps to diagnose or exclude a central retinal artery occlusion allowing to distinguish different etiologies.

The collateralisation through ophthalmic artery is a positive prognostic factor in cases of haemodynamic stenoses of the extracranial part of internal carotid artery.



No, at least ultrasound pupillometry is a new and feasible tool for the bedside pupillary function assessment in patients with periorbital hematoma or carotid artery dissection.

In conclusion transorbital sonography is a bedside, easy to learn tool with the potential to screen patients in need of other neuroimaging or needs acute reperfusion therapies and those who may require an invasive ICP measurement.

Title: OPTIC NERVE SHEATH DIAMETER AND THE DIAGNOSIS OF INCREASED INTRACRANIAL PRESSURE**Author:** Filippo Farina, MD¹¹ Ospedale dell'Angelo Mestre-Venezia, Department of Neurosciences, Venice (Italy)**Abstract**

Elevated Intracranial Pressure (ICP) is a challenging and potentially fatal complication of various neurological diseases, like space occupying lesions (tumors, hemorrhagic or ischemic stroke, abscesses) or idiopathic intracranial hypertension syndromes. Invasive ICP measurement devices which represent the gold standard, but may lead to important collateral effects, non-invasive techniques have been developed. The optic nerve (ON) and its sheaths (ONS) are an easily accessible part of the central nervous system. Since a striking correlation between the dilation of the ONS and ICP rise was observed in experimental settings, ONS diameter (ONSD) measurement was proposed. Ultrasound-based ONSD represent a reliable and reproducible system to high-light ICP rise almost in real time. Anyway, due to particular features of ultrasound eye examination, specific echographic settings needs to be respected in order to avoid retinal or lens damages.

Title: VASCULAR ORBITAL ULTRASOUND**Author:** Jelena Potic¹¹ Clinic for Eye Diseases, University Clinical Centre of Serbia, School of Medicine, University of Belgrade**Abstract**

Ultrasound (US) is a simple, safe, non-invasive, highly informative diagnostic procedure for both, intraocular and intraorbital lesions. Although CT scan and NMR are being used for orbital lesions more often, US, being easily accessible, has kept its important role. The orbit contains different tissues, such as extraocular muscles, sensory and motor nerves, the optic nerve, excretory glands, the eyeball. Only the anterior part of the orbit can be accessed by echography examination, with the main acoustic lines in the anterior-posterior direction. The examination of the orbit should always involve: detecting the normal anatomical features in orbit, detecting the pathological lesions and their localization in the relation to other normal structures, evaluation of the echogram and measuring the size of the lesion. The structures being always examined during the orbital US are the optic nerve (the most important landmark), the extraocular muscles, the orbital adipose tissue (high acoustic reflectivity) and the structures not visible by US under normal conditions such as Tenon's space, the orbital vessels (except the veins of crying child), the lacrimal gland, the paranasal sinuses. If these features are detected by the orbital US examination, they should be regarded as pathological, and they should undergo further evaluation. The characteristics of main intraorbital lesions and differential diagnostics will be explained during the talk.

Title: TEMPORAL ARTERY EXAMINATION**Author:** Branko Malojcic, MD, PhD, FESO, FWSO¹¹ University Hospital Center Zagreb, Department of Neurology, TIA Center, Zagreb, Croatia**Title: TRANSBULBAR ULTRASOUND: A USEFUL TOOL IN MULTIPLE SCLEROSIS?****Author:** Fabienne Perren, Switzerland**Scientific Session 1****Title: NON-STENOTIC CAROTID PLAQUES AND ISCHEMIC STROKE: HOW STRONG IS THE ASSOCIATION?****Author:** Tatjana Boskovic Matic, Serbia**Title: WHEN TO TREAT ASYMPTOMATIC CAROTID STENOSIS?****Author:** Lazar B. Davidovic MD, PhD.

School of Medicine, University of Belgrade

Clinic for Vascular and Endovascular Surgery, University Clinical Center of Serbia.

Abstract

The treatment of patients with asymptomatic carotid stenosis (ACS) is one of the most important controversies in vascular surgery. I will try to explain that these patients can benefit from the surgery. The first reason for their surgical treatment is a silent brain infarction. According to some studies, the prevalence of the silent brain infarction ranges between 14 and 18% at patients with ACS higher than 70%. However, results of ACST-1 are of a particular significance regarding the treatment of ACS. According to this trial CEA performed in asymptomatic phase has significantly decreased the incidence of perioperative stroke and death outcomes in comparison to patients treated after the onset of symptoms. Moreover, the incidence of stroke occurrence in this group was significantly lower even 5 and 10 years after the surgery. However, besides that the answer on question: can a patient with ACS benefit from the intervention is not quite simple. We need to speak for it having in mind age and life expectancy, gender, comorbidity, risk factors, contralateral disease, carotid plaque morphology, concomitant operations as well, surgeon volume.

Numerous significant papers emphasized that the rate of perioperative stroke, grows in patients older than 75 during CEA. Due to this CEA is not recommended at elderly patients with ACS. However, my Clinic's study with more than 1500 patients with surgically treated ACS, did not find a significant difference regarding perioperative stroke rate between patients younger and older than 75. Probably that is a result of very good selection of our patients. Namely, the biologic preservation of the patient does not depend only on the aging. Some other studies did not also find significant differences in combined stroke and death outcome after CEA between octogenarians and other patients. Moreover, CEA in nonagenarians was followed with reasonably low 30-day rates of ischemic stroke and myocardial infarction. However, very elderly patients with ACS may not live enough to benefit from CEA.

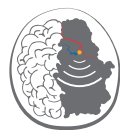
According to some studies (including ours) female gender increases, while according to others, it does not increase the rate of perioperative stroke.

Extremely significant comorbidity increases stroke rate after CEA. Due to this, CEA is not recommendable in patients with ACS that have life limiting conditions.

We have found that the obesity increases significantly stroke occurrence during CEA performed at patients with ACS. However according to some previous studies an obesity is independent risk factor for cardiac complications and even for death after CEA.

Bearing in mind the natural course of disease, the impact of ACS depends also on the contralateral carotid condition. We believe that contralateral carotid disease is an additional reason for the treatment of ipsilateral ACS. At the sometime in our study contralateral carotid disease including even an occlusion, did not increase significantly perioperative stroke occurrence during CEA of ipsilateral ACS. However, some other studies found that contralateral carotid occlusion increases risk of perioperative complications during CEA on ipsilateral side.

The presence of unstable plaque increases the risk of stroke occurrence because of higher incidence of distal embolization. Therefore, the presence of unstable plaque is an additional reason for an intervention in patients with ACS.



According to some articles, there is no evidence to justify routine prophylactic CEA of ACS before major cardiovascular and other surgeries. For instance, a current ESVS guidelines dedicated to AAA does not recommend routine prophylactic CEA, as well as routine screening for ACS prior to AAA repair. I do not totally agree with previous recommendations. Namely, ESVS guidelines committee members had in their mind EVAR that is not followed with significant peri-procedural changes of blood pressure, as well as with significant blood loss. Due to this untreated ACS is not significant predictor of stroke occurrence during EVAR. However the situation is completely different regarding an OR of abdominal, thoracic and thoracoabdominal aneurysms, regarding CABG, as well as regarding other major surgeries. Due to this we recommend prophylactic CEA for ASC prior major upcoming surgeries if patients have associated significant contralateral carotid stenosis or an occlusion. What is a better for these patients simultaneous or staged procedure? Recommendations from the current ESVS guidelines dedicated to carotid artery diseases are not clear. We recommend simultaneous CEA with CABG, only at patients with triple vessels coronary artery disease, as well as in those with left main trunk stenosis or occlusion.

Surgical treatment of ACS is recommended at non-obese patients with no significant comorbidity and with life expectancy at the least 5 years. Reasons are even more obvious when a patient has unstable plaque, contralateral disease, or a major upcoming surgery. Surgical treatment of ACS requires very high level of safety. Very experienced professionals can perform it in high volume centers. In our study with 1567 surgically treated ACS, cumulative perioperative death rate was 0.38% while total stroke/TIA rate was 2.81%.

Title: ULTRASOUND FOLLOW-UP OF CAROTID STENOSIS (PRE-AND POSTREVASCLARIZATION)

Author: Prof. Anita Arsovska^{1,2}

¹ University Clinic of Neurology, University "Ss. Cyril and Methodius", Skopje, N. Macedonia

² Faculty of Medicine, Skopje, N. Macedonia

Abstract

Carotid artery stenosis is a prevalent disease, caused predominantly by atherosclerosis. The reported prevalence of carotid artery stenosis is dependent on the population screened, investigative tool used, and which criteria are employed. In the Framingham Study cohort, the prevalence of significant carotid artery stenosis was 7% in women and 9% in men. Treatment for atherosclerotic carotid stenosis consists in a surgical approach, either by endarterectomy or by angioplasty with stent placement in patients with significant stenosis (>70%), asymptomatic and symptomatic. Widely varying protocols exist for the follow-up of patients after carotid revascularization. Carotid duplex scanning for surveillance is a common indication, given the restenosis rates associated with CEA and carotid artery stenting. Generally it is recommended that patients with <50% stenoses are followed once a year; and those with >50% disease are followed twice a year. There were some studies that identified several clinical risk factors in the development of ISR: older age, female sex, dyslipidemia, diabetes, tobacco, and peripheral artery occlusion disease. Technical and postprocedural risk factors included multiple stents implantation, postprocedural residual stenosis, and previous CEA. Close DUS follow-up is therefore appropriate in patients with these ISR risk factors. Patients should be investigated with B-mode, color mode and power mode. In patients with stents, PSV criteria should be adjusted. A PSV value of 300–350 cm/s may be used as the threshold criterion of high grade restenosis. Restenosis is generally a benign condition that does not require revascularization except in selected cases, such as when restenosis progresses to preocclusive grade or determinates neurological symptoms. Under these circumstances, it may be justifiable to repeat revascularization, either by CEA in the hands of an experienced surgeon or by CAS in the case of hostile neck anatomy.

Title: HIGHLIGHTS ON ULTRASOUND DIAGNOSIS OF CERVICAL ARTERIES DISSECTION

Author: Nathalie Nasr, France

Scientific Session 2

Title: THE VALUE OF ULTRASOUND AFTER STROKE REPERFUSION THERAPIES

Author: Kurt Niederkorn MD, Markus Kneihsl MD, Susanna Horner MD, Thomas Gattringer MD

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Abstract

Endovascular stroke treatment (Mechanical Thrombectomy) achieves successful recanalization rates (TICI 2b-3) of about 90%. However, good clinical outcome at 3 months after Thrombectomy (mRS 0-2) ranges between 40 and 50%. Among main complications post thrombectomy are reocclusion and hemorrhage and edema. The value of Transcranial color-coded duplex sonography (TCCS) for predicting diagnosing and preventing post-interventional complications has been described by Demchuk and al (Stroke 2001;32:89–93).

Using their Thrombolysis in Brain Ischemia (TIBI) Transcranial Doppler Flow Grades, Kneihsl et al (Stroke. 2018;49:2780–2782) showed in 215 patients with large vessel occlusions that in patients with successful angiographic recanalization TIBI grades 0-4 within 72 hours after Mechanical Thrombectomy were an independent predictor of poor clinical outcome at 90 days after the stroke.

To prospectively assess the value of TCCS and other methods the "DYNASTROKE Study-Cerebral Hemodynamics After Stroke Thrombectomy: A Prospective Multicenter Study" (Principal Investigator: Thomas Gattringer MD, PhD) has been designed and started in Graz/Austria, in cooperation with Departments of Neurology in Linz, Salzburg and Munich.

The study hypotheses are:

Patients with increased MCA velocity index have a higher risk for (symptomatic) cerebral bleeding complications after mechanical thrombectomy and Laboratory biomarkers (matrix metalloproteinases, interleukines) indicating blood-brain-barrier disruption are increased in such patients.

Besides the clinical assessment, Neurosonography with a defined protocol will be performed immediately after thrombectomy, at 24-48 hours after thrombectomy and at 7 days after thrombectomy as well as at the 90 days follow-up.

Blood biomarkers and Multimodal MRI will be performed at 0-48 hours post thrombectomy, Blood biomarkers also at the 90 days follow-up. The study is ongoing- those who want to join or receive detailed information please contact markus.kneihsl@medunigraz.at

Title: PERFUSION AUGMENTATION IN ACUTE STROKE USING MECHANICAL COUNTER-PULSATION

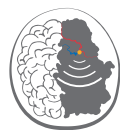
Author: Matthias Reinhard¹

¹ Department of Neurology and Clinical Neurophysiology, Department of Neurology, University of Freiburg, Germany

Abstract

Background and Purpose: External counterpulsation (ECP) is a non-invasive technique for diastolic blood flow augmentation to the heart and the brain. It uses pneumatic cuffs around the lower legs which are sequentially inflated during diastole. It is mainly used in chronic refractory coronary artery disease so far. This talk reviews the possibility of using ECP in acute and chronic cerebrovascular diseases.

Findings: Diastolic blood pressure augmentation during ECP does not lead to increased mean cerebral blood flow velocity (CBFV) in healthy adults because the effects of ECP are counter-acted by intact cerebral autoregulation. In patients with subacute stroke, ECP leads to an increase of mean CBFV both ipsi- and contralateral to the infarcted side. This is probably because cerebral autoregulation is impaired in this situation. In patients with subacute stroke, ECP may thus potentially increase periinfarct perfusion and probably enhance neuroplasticity and functional recovery. Small studies have shown positive clinical effects on functional recovery in this situation, but larger randomized trials are missing. In hyperacute stroke, ECP has not been used to augment perfusion to the penumbra so far. A further attractive field of application of ECP may be chronic occlusive cerebrovascular disease. In the coronary artery circulation, ECP can induce collateral angiogenesis due to increased shear stress. Such an effect on cerebral microcollaterals may also be present but has not been investigated in detail so far. In a pilot study, we have shown that in patients with severe internal carotid artery



stenosis or occlusion, mean ipsilateral CBFV increases significantly during ECP, as does ipsilateral cerebral oxygenation.

Conclusions: ECP effects on cerebral circulation are not present in healthy persons because of their intact cerebral autoregulation. Application of ECP in hyperacute ischemic stroke is not sufficiently investigated and no realistic scenario. ECP has probably positive effects in subacute ischemic stroke on clinical function and recovery. Larger scale studies are, however, necessary, as well as more detailed studies on its direct hemodynamic effects using perfusion measurements. In chronic occlusive cerebrovascular disease, ECP may be a future method for improving hemodynamic compensation, but more basic studies on ECP effects are needed first.

Title: UPDATE ON SONOTHROMBOLYSIS

Author: Georgios Tsivgoulis, Greece

Title: GENDER DIFFERENCES IN VASCULAR ULTRASOUND IN PREVENTION, TREATMENT AND PROGNOSIS OF ISCHEMIC STROKE: DOES GENDER MATTER IN ULTRASOUND?

Author: Assoc. Prof. Christine Kremer¹

¹ Head Ultrasound, Neurology Department, Skåne University Hospital, Department of Clinical Sciences University of Lund, Jan Waldenströms Gata 15, 20502 Malmö/Sweden

Abstract

The presentation covers the aspects of sex and gender differences regarding cerebrovascular ultrasound. As introduction several examples of sex differences regarding the treatment chain of stroke are given including at admission, and acute treatment. Regarding the differences in stroke etiology, and modifiable vascular risk factors, there are some implications for ultrasound. Men show more large artery atherosclerosis and women have a higher risk of stroke from atrial fibrillation. The risk of lacunar stroke in men is higher. Anterior circulation strokes are more common in women, and posterior circulations strokes in men. In large artery atherosclerosis plaque composition in men and women can differ, as well as outcome after carotid endarterectomy or stenting. In women a higher percentage of cardiac embolic sources can be expected and monitoring, and follow-ups and eventual additional measurements (atrial diameter?) are recommended.

A higher association with a stroke in women with diabetes, metabolic syndrome, and smoking is observed. As well as stroke risk in women with migraine, and atrial fibrillation. Apart from closely monitoring this risk factors, ultrasound could help to identify risk populations (, Blood flow velocities, IMT- measurements?).

During pregnancy the stroke risk is increased due to pre- and eclampsia, posterior reversible encephalopathy syndrome (PRES), reversible cerebral vasoconstriction syndrome (RCVS), and postpartum due to cerebral venous thrombosis (CVT). Cerebral ultrasound has the advantage of being non-invasive and it can be used repetitively, therefore it can be used in pregnancy for the monitoring of eg blood flow velocities in PRES or RCVS, and even venous flow in CVT.

Regarding stroke prognosis, and recurrency women have more severe strokes, worse outcome and can show a higher recurrency of stroke due to atrial fibrillation. This might be due to less aggressive treatment in women. It is even speculated that women can be “underscreened”.

More sex-specific analyses are needed, and sex as a variable should be introduced prospectively. There is an underrepresentation of women in randomized clinical trials, with a lack of inclusion of older women. Although we have to avoid generalizing and sex-specific treatment algorithms follow-up including more individualized and also directed ultrasound examinations could help to optimize stroke prevention, and therefore outcome.

Title: THE VALUE OF MICROEMBOLIC SIGNALS AFTER ENDOVASCULAR STROKE TREATMENT

Author: Claudio Baracchini MD, FESO¹

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Abstract

Mechanical thrombectomy (MT) is the most effective treatment for patients with acute ischemic stroke due to large vessel occlusion (LVO) in the anterior circulation. However, MT does not guarantee successful recanaliza-

tion to all patients, and about half of treated patients do not experience a significant clinical improvement at 3 months despite successful recanalization of the occluded artery. Poor collateralization and hyperperfusion are known causes of poor outcome, but other possible causes are incomplete microvascular reperfusion, distal microembolization from endothelial damage secondary to MT, and continuous embolization from the same source that caused the index stroke. Microembolic signals (MES) detection by transcranial ultrasound is associated with a higher risk of cerebrovascular events in various stroke etiologies, and it is currently used to monitor the safety and efficacy of different vascular therapeutic approaches. In stroke patients who underwent MT, MES are a common finding regardless of the recanalization strategy (MT alone or combined with intravenous thrombolysis). They are more frequent in patients with specific factors, such as a relevant carotid stenosis or occlusion, incomplete vessel recanalization, proximal intracranial site of occlusion, inadequate or no collaterals; however, they are also very common after successful endovascular therapy. MES represent a predictor of worse prognosis in terms of residual disability and mortality and increase the risk of recurrent ischemic stroke or systemic embolization during 90 days of follow-up. All these findings highlight the important role of MES monitoring after endovascular treatment for identifying patients at higher risk of poor outcome and recurrent embolic events. This might have a significant implication in risk stratification and patient management.

Scientific Session 3

Title: NEUROOPHTHALMOLOGICAL EXAMINATION AND TRANSORBITAL SONOGRAPHY IN NEUROLOGY

Author: Piergiorgio Lochner¹

¹ Department of Neurology, Saarland University Medical Center, Homburg, Germany

Abstract

Ultrasound has been used for almost 30 years in a wide variety of clinical applications. Over the past few years neurosonology has been undergoing a significant expansion of its modalities, including atherosclerotic plaque perfusion, elastography, fusion imaging, and multimodal monitoring in intensive care unit. Among these applications we describe transorbital sonography (TOS) measuring optic nerve sheath diameter (ONSD). Several studies have shown that ONSD is a valid and reliable indicator of intracranial pressure (ICP). Estimation of intracranial pressure (ICP) may be helpful in the management of neurological critically ill patients and patients with chronic increase of ICP. TOS can be performed fast everywhere: at prehospital setting, at hospital admission or in neurological and neurointensive care units.

We briefly discuss the technique and the novel approach of ONSD measurement. ONSD measurement is simple, easy to learn, and has a wide variety of applications, where an increase of ICP is presumed: intracranial hemorrhage and ischemic stroke, meningitis and encephalitis, and idiopathic intracranial hypertension, acute mountain sickness and posterior reversible encephalopathy syndrome. A thickening of ONSD can develop even in inflammatory lesions of the optic nerve.

A application of TOS could happen in in some neurological complications in not-neurological setting including pregnancy: eclampsia and preeclampsia. Moreover ONSD could be a prognostic indicator of hypoxic encephalopathy. It's application can be useful in some laparoscopic surgery where a pneumoperitoneum is performed with application of a CO₂ and often a concomitant steep head-down position (up to 45°, Trendelenburg position), together increasing the risk for decreased venous return, hypercapnia, and therefore an increase of ICP or in aortic surgery operation. In case of a central retinal artery occlusion

In the diagnostic workup of acute arterial occlusions of the eye, TOS can recognise a hyperechoic structure depicted in the optic nerve head: „spot sign“.

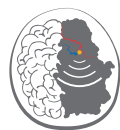
Finally another new field of application is continuous measurement and monitoring of the pupils, allowing analysis of the fine details of their constriction and dilation.

TOS is a safe and low-cost bedside tool with the potential of screening patients who need other neuroimaging and those who may need an invasive measurement of ICP.

Title: ULTRASOUND IN GIANT CELL ARTERITIS: NEWS, TIPS AND TRICKS

Author: Branko Malojcic, MD, PhD, FESO, FWSO¹

¹ University Hospital Center Zagreb, Department of Neurology, TIA Center, Zagreb, Croatia



Abstract

Giant cell arteritis (GCA) is the most common form of arteritis in adults. When it spreads to the temporal arteries, it is called temporal arteritis (TA). Its classical presentation appears in the patients with 50 or more years of age, headache and increase of ESR over 50 mm/h. At the level of vessel wall histology, GCA is a granulomatous panarteritis with mononuclear cell infiltrates and giant cell formation causing swelling of intima and media. The swelling is visible in an ultrasound examination as segmental hypoechoic areas, while inflammation changes in adventitia are not that clearly distinguishable from the surrounding tissue. Because of potential serious complications of GCA, like stroke, myocardial infarction and blindness, it is essential to establish the diagnosis in a fast and efficient way. Although biopsy of the superficial temporal artery (STA) is considered as a golden standard, it is often delayed and may carry a risk of complications like hematoma, infection and facial paresis. Ultrasound (US) examination of STA is a non-invasive, widely available and cheap method in cases of suspected TA. High resolution probes can display the vessel wall even in superficially located small diameter arteries. If performed properly, its high sensitivity and even higher specificity, allow rapid selection of patients which should be considered as highly probable TA (clinical suspicion + positive US) or exclusion of the TA diagnosis (low clinical suspicion + negative US).

The limitations of US for the diagnosis of TA are the operator dependency which can be minimized by a proper training and the influence of corticosteroid therapy on the vessel wall inflammation which causes typical US signs of TA to disappear within 1-2 weeks of treatment.

Title: AUTOMATIC OPTIC NERVE MEASUREMENT (AUTONOMA): A NEW TOOL TO STANDARDIZE THE OPTIC NERVE ASSESSMENT BY TRANSORBITAL SONOGRAPHY

Authors: Andrea Naldi^{1,2}, Kristen Meiburger³, Nicola Michielli³, Lorenzo Coppo⁴, Claudia Montabone⁴, Filippo Molinari³, Alessandro Vercelli^{1,5}, Mauro Bergui⁶, Roberto Cavallo², Piergiorgio Lochner⁷

1 Department of Neuroscience "Rita Levi Montalcini", University of Turin, Turin, Italy

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Abstract

Background: Transorbital sonography is a reliable tool for the noninvasive estimation of intracranial pressure by measuring the optic nerve sheath diameter (ONSD), while the optic nerve (ON) diameter (OND) may detect ON atrophy in multiple sclerosis patients. The manual OND and ONSD evaluation is subjected to operator's experience and inter-rater variability, leading to potential misunderstanding in the results interpretation. Therefore, a standardization of OND and ONSD measurements are required. Here, an AUTOMATIC Optic Nerve Measurement (AUTONOMA) system for OND and ONSD assessment in ultrasound B-mode images based on deformable models is presented.

Methods: Seventy-five ON images of both healthy subjects and patients with intracranial hypertension were analyzed. OND and ONSD were measured by the AUTONOMA system and compared to manual ones obtained by two operators (expert and inexperienced). Agreement between operators was tested.

Results: AUTONOMA correctly segmented the ON and its sheath in 95% of images. There were no significant differences between AUTONOMA and the operators for the OND values and the expert operator for the ONSD. Compared to the expert operator, the mean error was 0.06 ± 0.52 mm for the ONSD and 0.06 ± 0.35 mm for the OND. The agreement between AUTONOMA and the operators was good. The AUTONOMA evaluation was faster than manual ones.

Conclusions: AUTONOMA is a reliable and faster system for the assessment of both ONSD and OND compared to manual evaluation. The AUTONOMA system may favor a standardization of OND and ONSD measurements, reducing the manual inter-rater variability and allowing a higher reproducibility across studies.

Title: THE BASIS OF FOCUSED ECHOCARDIOGRAPHY FOR NEUROLOGISTS

Author: Jorge Pagola Pérez de la Blanca, MD, PhD¹

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Title: CARDIAC SOURCES OF EMBOLISM

Author: Vlatka Reskovic Luksic, MD, PhD¹

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Abstract

Cardiac embolism is a rather common cause of the ischaemic stroke (15-30%). Establishing cardiac embolism as the cause of the stroke has important therapeutical implications (oral anticoagulation, device implantation etc.). Multimodality cardiac imaging is often required (echocardiography, cardiac CT and cardiac MR). Left atrial thrombi represent primary source of cardiac embolism, so rigorous search for atrial fibrillation should be performed (especially in older population and patients at risk), including prolonged monitoring (Holter, implantable cardiac monitoring). Left ventricular thrombi are most frequently found in patients with cardiomyopathies (i.e. dilated, non-compaction cardiomyopathy) and after acute myocardial infarction (MI) with large zone of necrosis (4-39% of patients in the first 3 months after anterior MI).

Cardiac tumors are rare (0,1-0,3%) and mostly benign, but may show malignant behavior. The most prevalent among benign tumors are atrial myxomas, while cardiac sarcomas represent the most frequent type among malignant cardiac tumors. Tumor dimension and localization are the main determinant factors for embolization. Among patients with infective endocarditis, 15-30% are complicated with cerebral embolization, often silent, so active search for cerebral embolization should be routinely performed. Size (10mm) and mobility of the vegetations are the most potent independent predictors of embolic events, and embolization most often occurs before the initiation and two weeks after the initiation of antibiotic therapy.

The prevalence of PFO in the general population is about 25%, increasing to over 50% in patients with cryptogenic stroke. In those patients, small left-to-right shunt turns into right-to-left shunt during elevation of right atrial pressures (i.e. during cough or Valsalva maneuver), causing paradoxical embolization. About 60% of the patients with ASA also have PFO. Patient who are at risk for stroke and recurrent events are those with large PFO, ASA, long length of the tunnel and large right-to-left shunt (>30 bubbles on contrast echocardiography). Echocardiography is the first and most important imaging tool for diagnosis of all the above-mentioned potential causes of cardiac embolization. Beyond establishing diagnosis, it is also important for appropriate therapeutical decision making, guiding interventions and follow-up. However, inappropriate exams should be avoided. Heart-brain multidisciplinary team and individual patient approach are of the most importance.

Scientific Session 4

Title: ULTRASOUND GUIDED INTERVENTIONS (STEROID INJECTIONS, LUMBAR PUNCTURE, MUSCLE BIOPSY) & EVALUATION OF LESS COMMON NERVES AND MUSCLES

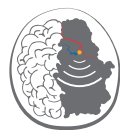
Author: Daniele Coraci, MD, PhD, Assistant Professor¹

1 Department of Neuroscience, University of Padua, Italy

Abstract

Ultrasound shows high usefulness in evaluating the soft tissue. Additionally, it is very beneficial to guide the intervention, in particular drug injections, lumbar puncture and muscle biopsy. With ultrasound, the physician can see the target to treat/evaluate and the needle. This can extremely reduce the possible side effects of the blind procedure. In fact, the target can be better injected and the vessel and the other structures can be avoided. Furthermore, in cases of biopsy, ultrasound can help the selection of the best muscle area.

Ultrasound can evaluate the small nerves and the anatomical variants of nerves and muscles. The small nerves represent a challenge, but they can be visualized considering their anatomy. In cases of small nerve branches arising from the main trunks, the sonographer should follow the major nerve and pay attention to the divisions. In cases of "isolated" small nerves, the use of proper landmarks should be considered.



Future development, like the application of ultra-high-frequency ultrasound may help in the identification and assessment of these structures.

**Title: THE TREATMENT OF RESISTANT CHRONIC PERIPHERAL NEUROPATHIC PAIN: INVESTIGATION OF
VARIOUS LOCAL ANESTHETICS APPLIED BY ULTRASOUND-GUIDED PERINEURAL BLOCKS**

Author: Olivera Jovanikic, Serbia

Title: TELENEUROSONOLOGY

Author: Prof. Bojana Žvan, MD, PhD, Senior advisor, FESO¹

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Abstract

Medical service is one of the crucial policies and decent medical service is required by the population in every country. There are three main obstacles which prevent people from obtaining proper medical cares and treatments. First, the deficiency of medical staffs especially physicians. Second, an increase in the number of the elderly makes the medical services more demanding and broader. Finally, geographical aspect also plays a major role in healthcare inequality. Information and communication technologies have become an important infrastructure upon which several domains can build in order to achieve more effective solutions. Integrating such technologies into the medical discipline results in telemedicine which is currently available across the globe.

A neurosonographer performs ultrasounds on the brain and nervous system of patients of all ages. Also called neurosonology or neurosonoimaging, that utilizes specialized beam shapes and frequencies from a Transcranial Doppler (TCD) and neck vessels neurosonoimaging. The TCD and color coded duplex sonography machines are a non-invasive ultrasound option which can also be portable. The overall goal of neurosonography is to detect or help prevent abnormalities and conditions involving the central nervous system and brain. There may be instances where prevention cannot occur, but neurosonography might determine the extent of damage. However, pertaining to strokes, neurosonography might help to save lives. A neurosonographer usually works directly with patients and physician. Today we are facing a shortage of neurosonologists, but sonographers could help diagnose brain arterial and vein diseases, as well as other neurological conditions through telemedicine, the so-called teleneurosonology.

Key Words: teleneurosonology, neurosonographer, neck vessels, transcranial Doppler sonography

Title: THE ROLE OF TCD IN PFO DIAGNOSIS AND MANAGEMENT

Author: Susanna Horner, Austria

Abstract

Patent foramen ovale (PFO) is implicated in the pathogenesis of clinical conditions such as cryptogenic stroke. Only recently have large-scale data suggested a benefit of PFO closure for secondary stroke prevention in selected patients. The diagnosis of PFO is required for deciding on a treatment. Different imaging modalities can be used to diagnose a cardiac or pulmonary right-to-left shunt (RLS). Contrast transesophageal echocardiography (cTEE) is required in all cryptogenic stroke patients, particularly in those of younger age, to confirm the site of the shunt (cardiac or extracardiac) and allows grouping into simple PFO and complex lesions („high-risk PFO“) by assessment of the PFO size, presence of an atrial septal aneurysm and other cardiac abnormalities. Based on recent data, contrast transcranial Doppler (cTCD) has the highest sensitivity for indirectly detecting RLS compared to transthoracic echocardiography and cTEE. Standardized technique cTCD is recommended as the first-line test to detect a RLS and should be performed according to the instructions of international consensus conferences. cTCD can be used as a screening test during the acute phase of ischemic stroke workup and routine ultrasonography in order to identify the pathogenic mechanism of stroke and to make timely decisions to perform cTEE. cTCD adds functional aspects, allows assessment of permanent or functional shunting and semiquantitative estimation of the shunt size by using the so-called „microembolic signals grading score“.

It also serves as an alternative method for RLS detection and diagnosis of successful interventional treatment if cTEE is not available or applicable. cTCD contributes to therapeutic decision making and complements cTEE for the management of suspected paradoxical cerebral embolism. However, in the management of PFO mediated stroke TCD is still underutilized in clinical practice. Further effort is required to teach and practice a proper TCD examination technique. Cardiologists and stroke physicians should communicate closely and the interdisciplinary approach for a rational PFO management based on the best available evidence is required.

Title: REVIEW OF MYOSONOLOGY IN THE FIELD OF NEUROSONOLOGY

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Abstract

In the past decade the multimodal 2D/3D/4D myosonology has become the most appropriate non-invasive and bedside method for real-time evaluation of structural and functional properties of the muscle tissue in normal and pathological conditions. Using high-resolution B-mode ultrasound the physiological and pathological muscle structure and the positioning of needle electrodes for biopsy or injections (e.g., botulinum toxins or local anesthetics) can be easily imaged. By tissue velocity imaging (TVI) the muscle motion can be better detected and quantified in terms of velocity, accelerations, and synchronicity of muscle contraction. It can be used for assessment of orthostatic antigravity adjustment using the measurement of pennation angle of triceps surae muscle contraction at rest and during maximal active plantar flexion. Recently, an M-mode tremorogram has been introduced for registration of tremor frequency. Thus, the myosonology seems to become a powerful tool for neurologists and physiotherapists in their everyday clinical practice.

Scientific Session 5

Title: DIGITAL IMAGE ANALYSIS IN TRANSCRANIAL SONOGRAPHY

Author: David Skoloudik, Czech Republic

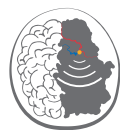
Title: FUSION IMAGING TECHNIQUE

Author: Prof. Uwe Walter, MD¹

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Abstract

Transcranial sonography (TCS) is a non-invasive neuroimaging method that can display echogenic deep brain structures with high spatial and temporal image resolution. Important advantages of TCS are unlimited repeatability, mobility, and low corruption by patients' movements which is of high value especially in subjects with movement disorders. Its main limitations are the affection of image quality by bone structures and low resolution of basal ganglia. Conversely, MRI visualizes the intracranial structures with high tissue contrast and spatial resolution but is largely affected by patients' movements. Using real-time fusion imaging, the shortcomings of MRI and TCS can be offset by putting the spatial, contrast or temporal resolution advantage of each modality to good use. The image displayed during the fusion imaging procedure allows for either side-by-side display or for an image overlay where TCS overlaps MR images. Clinical applications of MRI-ultrasound fusion imaging in the head region published so far are the assessment of intracranial vessels and orbital structures, the postoperative location of deep brain stimulation electrodes, and intra-operative neuronavigation in brain tumour surgery. Real-time MRI-TCS fusion imaging also allows the exact comparison of small deep brain structures easily identified on MRI with the referring region on TCS if it less clearly identifiable on TCS alone. A very promising clinical application is the intra-operative location of deep brain stimulation electrodes and other brain implants.



Title: TRANSCRANIAL BRAIN SONOGRAPHY IN PARKINSONISM AND DEMENTIA

Author: Dzevdet Smajlović¹

¹ Department of Neurology, University Clinical Centre Tuzla, Bosnia and Herzegovina

Abstract

Transcranial sonography (TCS) of brain parenchyma is a relatively new ultrasound modality which could display echogenicity of human brain tissue through the intact skull. Becker and colleagues (1995) first observed hyperechogenicity of the substantia nigra in patients with Parkinson's disease (PD) using TCS. Since then, TCS of brain parenchyma in patients with movement disorders has developed with increasing dynamics during the past two decades. Based on the convincing evidence available, the EFNS/ENS accredited the method of TCS a level A recommendation for: a) supporting the diagnosis of PD and its differential diagnosis from secondary and atypical parkinsonism; b) early diagnosis of PD; and c) detection of subjects at risk for PD.

In many neurodegenerative disorders there are no specific CT or MRI features which underline a proposed clinical diagnosis or help to differentiate the disorder from clinically similar entities. In this lecture, we will try to give the answer is TCS can be used to evaluate changes in other diseases characterized by movement disorders (Huntington's chorea, Wilson's disease, Essential tremor), as well as in dementias (Dementia with Lewy bodies, Parkinson's disease dementia). TCS provides supplementary information to other neuroimaging techniques, it is helpful in differential diagnosis of different forms of parkinsonism and dementias, and enables new insights into pathophysiological processes. Finally, we will give enough scientific data that TCS is useful and helpful not only in diagnosis and differential diagnosis of Parkinsonian syndromes, but also in other neurodegenerative diseases.

Title: TRANSCRANIAL BRAIN SONOGRAPHY IN PSYCHIATRIC DISEASES AND PAIN CONDITIONS

Author: Milija Mijajlović¹

¹ Neurology Clinic, University Clinical Center of Serbia and Faculty of Medicine University of Belgrade, Serbia

Abstract

Changes in the echogenicity of subcortical brain structures were detected in different disorders, such as obsessive-compulsive disorder, autism spectrum disorder, schizophrenia, panic disorder, attention-deficit/hyperactivity (ADHD), bipolar disorder and depressive disorder. Transcranial sonography (TCS) revealed reduced echogenicity of the brainstem raphe (BR) as a characteristic finding in unipolar depression and in depression associated with Parkinson's or Wilson's disease, but not in healthy adults, schizophrenia, multiple sclerosis with depression or Parkinson's disease without concomitant depression. Similar findings were shown also for adjustment disorder with depressed mood. In contrast to unipolar depression, sonographic findings of bipolar patients may generally indicate preserved structural integrity of mesencephalic raphe structures. If bipolar disorder is associated with hypoechogenic BR, depressive symptoms are more severe. BR hypoechogenicity could be caused by a modification of tissue cell density, the interstitial matrix composition or an alteration of fiber tracts integrity representing involvement of the basal limbic system in the pathogenesis of unipolar depression and depression associated with certain neurodegenerative diseases.

Recently it was shown that nigrostriatal dopaminergic system is abnormal in children with attention-deficit hyperactivity disorder which was expressed by significantly larger echogenicity of substantia nigra.

TCS also revealed certain structural brain changes in several pain conditions like burning mouth syndrome or migraine.

Scientific Session 7

Title: FUNCTIONAL TCD IN ACQUIRED AND GENETIC CEREBROVASCULAR DISEASE AND IN PRECEREBRAL HYPOPERFUSION

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Abstract

Our brain is especially sensitive to a decrease of perfusion, and a very fine-tuned cerebrovascular regulation is needed to maintain an adequate global brain perfusion, but also to distribute it according to the local specific needs. The neurovascular unit provides a perfect articulation between the neurons and the microvessels. This neurovascular coupling (NVC) allows a regional reactive hyperemia to local cortical activation, and functional transcranial Doppler (fTCD) evaluates this phenomenon measuring the variation of blood flow velocities in the regional distributing cerebral artery.

In individuals with cerebrovascular risk, fTCD may detect dysfunction of the neurovascular unit, even previously to open cerebrovascular disease (CVD). This is the case of the hypertensive diabetic patients, that may have a precocious impairment of NVC, already occurring without symptomatic CVD. Also in individuals with intracranial stenosis, either symptomatic or not yet, NVC was shown to be associated with severe stenosis, higher than 70%.

In monogenic causes of CVD, fTCD can also detect cerebral neurovascular unit problems even before any serious clinical neurological expression. In pre-dementia CADASIL patients, we found a selective disturbance of NVC performance, with no significant changes in cerebral autoregulation nor in CO₂ vasoreactivity. Also, male patients with Fabry disease classic phenotype and absence of clinical expression of CVD already show impairment of NVC. It supports the notion of an early dysfunction of cerebral microvascular in a presymptomatic stage of these diseases, and that fTCD could be useful in its assessment.

Patients with familial amyloidotic polyneuropathy type I have a progressive autonomic failure and orthostatic hypotension with cerebral hypoperfusion. Also the autonomic failure could interfere with the cerebrovascular regulation. In patients that could still sit without a significant decrease of blood pressure, we could find that they had a dysfunction of NVC, that was worse in sitting than in supine conditions.

An acquired example of precerebral hypoperfusion is the patient with heart failure. Unlike cerebral autoregulation, NVC is significantly impaired in heart failure patients with reduced ejection fraction, revealing that neurovascular unit of subjects with chronically reduced heart pumping capability is severely dysfunctional.

In conclusion, fTCD has proved to be an early, non-invasive, biomarker of both acquired and genetic CVD, and a biomarker of precerebral hypoperfusion. As it allows the monitoring of changes, it might be a useful tool to evaluate the result of therapeutic strategies in the future.

Title: APPLICATIONS OF FUNCTIONAL TRANSCRANIAL DOPPLER SONOGRAPHY

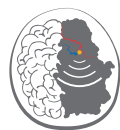
Author: Assoc. prof. Janja Pretnar Oblak, MD, PhD¹

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Abstract

Functional transcranial Doppler sonography (fTCD) is a neuroimaging tool for measuring cerebral perfusion changes due to neural activation. Namely, relative cerebral blood flow and relative blood flow velocity (BFV) changes seem to correlate well under strictly monitored conditions such as CO₂ and hemodynamic parameters. Transcranial Doppler (TCD) ultrasonography provides non-invasive monitoring of BFV in large intracranial arteries. High temporal resolution, safety and accessibility are some of the advantages of TCD in comparison to other functional imaging methods, such as functional magnetic resonance imaging, single-photon emission computed tomography, and positron emission tomography. On the other hand, low spatial resolution determined by the size of the cortical area supplied by the investigated artery seems to be a relative disadvantage. fTCD has been used to measure neurovascular coupling by recording cerebral BFV during visual stimulation, as well as cognitive and motor tasks. fTCD has been particularly useful for the study of cerebral lateralization of major brain functions such as language, facial processing, color processing etc. Some cognitive tasks (phonemic verbal fluency test, trail making test) have shown great potential for TCD monitoring. Recent studies have shown a difference between fTCD responses to a cognitive task in patients with schizophrenia compared to healthy controls. It seems that fTCD is predestinated for follow-up investigations, especially in individuals with diminished ability to cooperate, like patients or children. Its role should be emphasized in clinical practice as well as in research studies.

In conclusion, fTCD is an inexpensive, noninvasive method that enables real time monitoring of BFV with excellent temporal resolution. In the hands of an experienced ultrasonographer it is a reliable tool in clinical practice and even more so a research tool.



Title: ROLE OF ULTRASOUND IN NEUROREHABILITATION

Authors: Dafin Muresanu/Adina Stan, Romania (EFNR)

Title: ACUTE STROKE HEMODYNAMICS

Author: João Sargento-Freias, Coimbra, Portugal

Abstract

An acute ischemic stroke is, in its essence, the clinical translation of a cerebral hemodynamic event. Moreover, most of the approved therapeutic interventions address directly or indirectly hemodynamic features of the patient's pathology.

In the timecourse of a stroke, brain perfusion often suffers severe dynamic changes, that in many situations have antagonistic effect, even for the same patient in different hours of the day. These changes may include spontaneous thrombolysis, therapeutic recanalization, hyperperfusion, reocclusion, microembolism, thrombus propagation, or collateralization. The intricate complexity of these mechanisms help understand the impact of one of the first and more efficacious treatments approved for stroke: admission to a stroke unit. A key determinant for the impact of stroke units is the precise contextualization of the individual patient's hemodynamic in each phase of his/her condition. Neurosonology offers the tools to precisely assess patients' hemodynamic status routinely, bedside and with the possibility of serial repetitions of the exam.

The main objective of this lecture is to review what neurosonological methods can offer in the assessment and management of acute stroke hemodynamics.

Title: ASSESSMENT OF COLLATERAL FLOW WITH ULTRASOUND AND MRA – COMPLEMENTARY FINDINGS

Author: Marek Jauss, Germany

Abstract

Assessment of collateral pathways are important in clinical decision making in vascular neurological disease in acute as well as in chronic conditions. The author gives illustrative examples of difficult findings in patients with intracranial and extracranial findings as well. ultrasound examination protocols are presented and limitations of assessment with ultrasound are addressed. It will be commented on complementary methods such as CTA and MRA. Sophisticated examination sequences situations are illustrated on a stepwise base. Also non-everyday situations such as examination of an EC-IC bypass is presented.

Special Session

Title: PAST, PRESENT AND FUTURE OF NEUROSONOLOGY IN OUR REGION

Author: Vida Demarin¹

¹ Croatian Academy of Sciences and Arts, Zagreb, Croatia

Abstract

Neurosonology, with its array of different methods has been present in our region since about fifty years ago. Being noninvasive, functional and accurate, giving the insight of brain's circulation as well as partly of brain's morphology as well, neurosonologic methods are indispensable diagnostic tool. Echoencephalography was the first ultrasound method introduced in neurology, with the possibility to show eventual midline echo shift. With the introduction of CT scanner, it was not used any more.

On the other hand, ultrasound methods based on Doppler's principle, quickly found their way in examining cerebral circulation and based upon new technology, they developed in the important noninvasive diagnostic tool with increasing number of applications. The first Doppler method was a simple, zero-crossing detector, using compression tests in evaluation of carotid circulation. It was followed by color doppler mapping, having possibility of mapping carotids based upon blood velocity changes. The introduction of duplex scanner was a kind of „revolution“ in diagnostics of cerebral circulation, but only the invention of color doppler enabled the complete evaluation of cerebral circulation, including vertebrobasilar system as well. Further on, power doppler was introduced with more detailed visualization.

Transcranial doppler (TCD) was introduced about 25 years after carotid as skull bones, precluded the penetra-

tion of ultrasound waves. It enables the insight in intracranial circulation in basic conditions while vasoreactivity is investigated by use of different stimuli. Special software enabled emboli detection and TCD monitoring is used during thrombolysis. Transcranial color-coded system gives data on brain parenchyma, what is especially important in patients with extrapyramidal disorders, and with depression.

Recently, ultrasound sonography is used for detection of peripheral nerves lesions.

Ultrasound methods are widely used in all countries in our region, in many institutions, from university departments to private practice. Many different indications for neurosonologic methods are contributing to more precise evaluation, prevention and management of patients with stroke, with cognitive decline, with traumatic brain injury, with headache and migraine, peripheral nerves impairment and many more.

Education is very important and it is very well organized in all countries of our region, theoretical and practical with hands on sessions, with final exams and certification. Several Doppler laboratories are certified by EAN and ESNCH becoming the European Reference Center in Neurosonology.

Scientific Session 8

Title: SCIENTIFIC EVIDENCE AND ENHANCING SAFETY IN ULTRASOUND ASSISTED PROCEDURES IN ICU

Author: Milan Vosko, Austria

Title: TRANSCRANIAL DOPPLER IN SUBARCHNOID HAEMORRHAGE

Author: Željko Živanović^{1,2}

¹ Faculty of Medicine, University in Novi Sad, Serbia; ²Clinic of Neurology, Clinical Centre of Vojvodina, Novi Sad, Serbia

Abstract

Transcranial Doppler (TCD) ultrasonography is a noninvasive tool used for monitoring of intracerebral hemodynamic changes. Aneurysmal subarachnoid hemorrhage (SAH) and its accompanying sequelae are management challenges for the neurosurgeon and neurointensivist. TCD extensively use for the monitoring of vasospasm after aneurysmal SAH. Vasospasm following SAH is a very important source of morbidity and mortality. Vasospasm occurs most intensely adjacent to the subarachnoid clot. A typical course for vasospasm is increase on the fourth day after SAH with declining trend following the 14th day. The incidence of vasospasm after SAH has been estimated to occur in 50% to 70% of patients, with 50% of those exhibiting symptoms. Patients with vasospasm may progress from focal neurologic deficits suggestive of infarction to diffuse neurologic signs such as confusion, increasing somnolence. The impact of clinical vasospasms on outcome, with both morbidity and mortality ranges from 10% to 20%.

The gold standard for the diagnosis of cerebral vasospasm is DSA. However it is impractical for use as a frequent monitor of vasospasm, expense, and may have severe complications. CTA is helpful tool in the evaluation of vasospasm, with relatively good sensitivity and specificity. MRA is a technology limited by logistics, acquisition time, motion, and hardware artifact. TCD has become the most common screening tool for vasospasm monitoring due to its portability, bedside monitoring, and ease of repeat testing.

Many studies have established TCD threshold velocities for vasospasm diagnosis. The velocity of blood flow in artery is inversely related to the diameter of that artery. As the diameter of a blood vessel decreases, the blood velocity will increase. The Lindegaard index (LI) is an important method of correcting for increases in hyperdynamic systemic flow velocities, either physiologic or induced, in patients with SAH. To calculate the LI, the mean flow velocity (MFV) of the middle cerebral artery (MCA) is compared with an ipsilateral internal carotid artery (ICA). This ratio helps to distinguish global hyperemia from vasospasm. Many advocate frequent TCD monitoring starting on the first day after SAH onset, with schedules ranging from every other day to twice daily, and ending with resolution of vasospasm. Limitation of TCD is operator dependent, and inability to insonate to inadequate acoustic windowing in about 8% of patients.



**Title: THE NORMAL MEAN VALUES OF ONSD AND OND AND THE ISSUE OF DIFFERENT CUT-OFF VALUES.
APPLICATION IN NEUROLOGY AND CRITICAL CARE PATIENTS**

Author: Andrea Naldi, M.D.^{1,2}

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2 Neurology Unit, San Giovanni Bosco Hospital, Turin, Italy

Abstract

Ultrasonography of the optic nerve sheath diameter (ONSD) is a valuable method for the non-invasive evaluation of intracranial pressure. Due to the numerous advantages related to the ultrasound assessment, the interest for transorbital sonography has remarkably increased with a crescent number of studies in this field. As a consequence, different ONSD techniques of measurement and have been proposed, leading to a heterogeneity among studies that risks to limit the reproducibility of results. Therefore, to date there is still no consensus about a unique cut-off value to delineate normal ONSD from pathological one. Despite this, current clinical application of the ONSD assessment vary from neurological diseases with intracranial hypertension or hypotension, optic nerve pathology, brain death and, more recently, for the monitoring and decision-making in critically ill patients with serial evaluation.

Conversely, measurements of the optic nerve diameter (OND) seems to be more homogeneous probably reflecting a unique model of assessment. However, application field are restricted to multiple sclerosis patients by detecting optic nerve atrophy.

In this lecture, current potential cut-off values for the ONSD-OND assessment are considered. In addition, factors that contributed to the heterogeneity of the OND and ONSD measurements are analysed, emphasizing the current role of these useful techniques and their potentiality in neurological and critical care setting.

Title: ULTRASOUND IN BRAIN DEATH

Author: Prof. Dejana Jovanovic^{1,2}

1 Neurology Clinic, University Clinical Centre of Serbia, Belgrade

2 Faculty of Medicine, University of Belgrade

Abstract

The diagnosis of brain death is based on clinical criteria. However, ancillary testing is required when it is impossible to complete a minimum of clinical criteria or when it is required by the law. Pathophysiological basis of brain death means the existence of cerebral circulatory arrest (CCA) which can be detected with transcranial Doppler (TCD). Compared to other complementary methods, benefits of TCD in confirming brain death are that it is a cheap, safe, and noninvasive method, without contrast media, which can be easily performed at the bedside of patients, and most importantly the TCD findings are not affected by the sedation, metabolic disorders or hypothermia. Typical TCD records in the presence of CCA are bi-directional (oscillating, reverberating) signals with antegrade and retrograde flow component or presence of systolic spikes, sharp unidirectional signals in early systole without diastolic signal in other parts of the cardiac cycle. The absence of a TCD signal is not a reliable finding for the diagnosis of CCA, as it may be due to difficulties in the transmission of ultrasound through the temporal bone. CCA may be confirmed in the presence of typical TCD records, bilaterally or over 3 arteries of different vascular territories, mandatory in the anterior and posterior circulation. TCD has a high degree of specificity (97-100%) and sensitivity (86-91%) in the confirmation of brain death. The disadvantage of this method is that it can show cerebral blood flow only in some segments of the great arteries.

Title: VALIDATION OF A NEW NON-INVASIVE TECHNIQUE FOR CEREBRAL COMPLIANCE ASSESSMENT

Author: Sergio Brasil, Brazil

Abstract

Background: We validated a new noninvasive tool (B4C) to assess intracranial pressure waveform (ICPW) morphology in a set of neurocritical patients, correlating the data with ICPW obtained from invasive catheter monitoring.

Materials and Methods: Patients undergoing invasive intracranial pressure (ICP) monitoring were consecutively evaluated using the B4C sensor. Ultrasound-guided manual internal jugular vein (IJV) compression was performed to elevate ICP from the baseline. ICP values,

amplitudes, and time intervals (P2/P1 ratio and time-to-peak [TTP]) between the ICP and B4C waveform peaks were analyzed.

Results: Among 41 patients, the main causes for ICP monitoring included traumatic brain injury, subarachnoid hemorrhage, and stroke. Bland-Altman's plot indicated agreement between the ICPW parameters obtained using both techniques. The strongest Pearson's correlation for P2/P1 and TTP was observed among patients with no cranial damage ($r = 0.72$ and 0.85 , respectively) in detriment of those who have undergone craniotomies or craniectomies. P2/P1 values of 1 were equivalent between the two techniques (area under the receiver operator curve [AUROC], 0.9) whereas B4C cut-off 1.2 was predictive of intracranial hypertension (AUROC 0.9 , $p < 0.001$ for ICP > 20 mmHg).

Conclusion: B4C provided biometric amplitude ratios correlated with ICPW variation morphology and is useful for noninvasive critical care monitoring.

Scientific Session 9

Title: DO WE OVERLOOK FIBROMUSCULAR DYPLASIA ON ULTRASOUND IMAGES?

Author: Arijana Lovrencic-Huzjan¹

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Abstract

Fibromuscular dysplasia (FMD) is a non-atherosclerotic, non-inflammatory vascular disease with strong female preponderance. However neurosonological diagnosis of the disease is low.

FMD affects medium-sized muscular arteries, predominantly renal arteries, but equally carotid and vertebral arteries. It leads to artery stenosis, occlusion, aneurysm or dissection. The clinical picture depends on the affected blood vessels. It is most commonly recognized as a cause of hypertension in young female patients. In the case of involvement of cranial and cervical arteries, the clinical picture is mostly nonspecific, with headache, migraine and tinnitus. Usually, it becomes recognized after ischemic symptoms due to craniocervical artery dissection. However, ultrasound detection of FMD is low, due to multiple reasons. Low awareness of the disease, localization in distal, inaccessible parts of internal carotid or vertebral arteries, FMD mimics like atherosclerosis, arteritis, external compression, hypoplasia and chronic lesions secondary to dissection are challenging to set the diagnosis.

Ultrasound can show diversity of findings like tortuosity as kinks, coils, S curve, increased intima-media thickness, focal stenosis or aneurysm. String of beads are challenging when analyses of freeze images is performed. Carotid web is an unusual form. Single patient can exhibit diverse findings, and since they are nonspecific, they can mimic other disease.

The challenges in FMD ultrasound diagnosis can be overcome by awareness of the disease, online analyzes and knowledge of the ultrasound findings.

Title: EFFECT OF 2 TYPES OF ANTIHYPERTENSIVE THERAPY ON COGNITION AND VESSEL WALL

Author: Laszlo Csiba, Hungary

Title: OPTIC NERVE SHEATH DIAMETER AND DIAGNOSIS OF INCREASED INTRACRANIAL PRESSURE

Author: Nicola Carraro, Italy

Abstract

In adults, the skull is a non expansible structure and contains brain, blood and cerebrospinal fluid (CSF). The intracranial fluids are: CSF (10%), blood (10%) and the remaining 80% consists of intracellular (68%) and interstitial (12%) fluids.

The CSF flows in the brain ventricles, in the cerebral and spinal sub arachnoidal cisterns and in sub arachnoidal spaces.



CSF is mainly produced by the choroid plexus, but intracellular fluid and interstitial bulk flow account for some of it; it is absorbed through the arachnoid villi into the venous circulation, but a significant amount also flows into dural lymphatic vessels located around the cranial cavity and spinal canal and the cranial nerves.

CSF is renewed about four times every 24 hours. The CSF space is a dynamic pressure system. CSF pressure determines intracranial pressure with physiological values ranging, in adults, between 10 and 15 mmHg. Cranial and spinal arachnoid villi have been considered for a long time to be the predominant sites of CSF absorption into the venous outflow system. Experimental data suggest that cranial and spinal nerve sheaths, the cribiform plate and the adventitia of cerebral arteries constitute substantial pathways of CSF drainage into the lymphatic outflow system.

CSF circulation from sites of secretion to sites of absorption largely depends on the arterial pulse wave; additional factors such as respiratory waves, the subject's posture, jugular venous pressure and physical effort also modulate CSF flow dynamics and pressure. The absorption rate correlates, moreover, with the CSF pressure.

The 3rd Cranial nerve leaves the chiasmatic cistern to reach the ophthalmic bulb, it is surrounded by the dura mater, arachnoid and pia mater and between the latter two there is the subarachnoid space.

There is a relationship between optic nerve sheath diameter (ONSD), endocranial hypertension and other conditions that change the modulation of the brain/eye pressure gradient, (microgravity and excursions in high mountains). Intracranial hypertension leads to nervous structures compression, dislocation (midline shift, intratentorial herniation), CSF reallocation and its turnover, blood flow reduction, and finally ONSD dilation and optic disc swelling (ODS).

The US investigation of the ONSD and the ODS, have good reproducibility, measurement accuracy and observer agreement; although the cut-offs for pathological values are likely affected by many factors (age, ethnicity, equipment used and measurement accuracy). It has a certain sure value also for the follow-up of this life-threatening condition.

Title: TRANSCRANIAL DETECTION OF MICROEMBOLI SIGNALS (MES) IN PATIENTS WITH ANTIPHOSPHOLIPID SYNDROME AND STROKE

Authors: Zagorka Jovanović MD PhD¹

¹ Faculty of Medicine, University of Belgrade

Abstract

Background: Stroke is a severe manifestation of antiphospholipid syndrome (APS). The aim is to estimate importance of microemboli signals (MES) detection to confirm thromboembolic mechanism of stroke.

Method: The study included 36 patients with APS+stroke and 26 stroke-free APS patients (control group-CG). The ultrasound examination included neurosonologic examination, including MES detection and echocardiographic examination.

Results: Color doppler flow imaging showed 5.5% patients with unstable plaque and appositional thrombus on carotid arteries, without unstable plaques in CG ($p > 0.05$). Pathological heart conditions with embolic potential (thrombus in the left auricle, patent foramen ovale, Libman Sacks endocarditis, mitral valve prolapse) were more frequently (22.2%) observed in the APS+stroke group compared to the CG and this result reached statistical significance ($p = 0.043$). MES were detected in 8.0% of patients only, ($p > 0.05$). The paradoxical thromboembolism was not detected.

Conclusion: MES were detected in a non-significant number of patients with APS, although cardiac potentially embolic lesions were present in a significant number. More reliable results would be obtained using long-term MES detection of all cerebral arteries on the first day of stroke.

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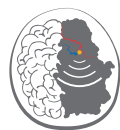
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ORAL COMMUNICATION ABSTRACTS

LIVE PRESENTATION

| Number | Title | First author | Country |
|--------|--|---------------------|----------|
| 1. | The treatment of resistant chronic peripheral neuropathic pain: investigation of various local anesthetics applied by ultrasound-guided perineural blocks | Jovanikić O. | Serbia |
| 2. | Evolution of blood-brain barrier permeability and impact on clinical outcome throughout the pathological phases of ischemic stroke: an observational study and meta-analysis | Sargento-Freitas J. | Portugal |
| 3. | Refining the concept of ESUS – a longitudinal 5-year follow-up study | Martins E. | Portugal |
| 4. | What's persistent primitive trigeminal artery got to do with it?" An ultrasound approach. | Kulyk C | Austria |
| 5. | Ischemic stroke in patient with congenital agenesis of internal carotid artery with ipsilateral Horner's syndrome and hypochromia iridis | Konieczna-Brazis M. | Poland |
| 6. | Intraoperative ultrasonography in adult neurosurgery. Our experience and literature review | Aleksić V. | Serbia |
| 7. | Transorbital sonography in neurology | Lochner P. | Germany |
| 8. | Characteristics of transcranial brain parenchyma sonography in patients with myotonic dystrophy type 1 and 2 | Božović I. | Serbia |
| 9. | Shutting the door on migraine | Duka Glavor K. | Croatia |

Abstract category: Original research**Scientific topic:** Navigation & Guidance**Abstract title:** THE TREATMENT OF RESISTANT CHRONIC PERIPHERAL NEUROPATHIC PAIN: INVESTIGATION OF VARIOUS LOCAL ANESTHETICS APPLIED BY ULTRASOUND-GUIDED PERINEURAL BLOCKS**Authors:** Jovanikić O.¹, Lepic T.¹, Raicevic R.¹, Veljancic D.¹, Pavlicevic G.¹, Mirkovic D.¹**Institution:**

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Background: We investigated efficacy of the neuropathic pain treatment with ultrasound – guided nerve blocks.

Methods: In prospective, randomized and double-blinded study, 108 patients with the resistant, chronic, peripheral neuropathic pain in the lower extremities were treated with a series of ultrasound-guided peripheral nerve blocks. The conventional treatment was exhausted. The pain was confirmed by the Leeds Assessment of Neuropathic Symptoms and Signs, the Dolour Neuropathic 4 questions and the pain DETECT scale. Other therapies were not applied. The nerve blocks were daily performed until the pain relief (VAS<30), and two additional nerve blocks were given. During patient treatment, one local anesthetics was given at the same dose: 1% procaine-chloride solution or 1% lidocaine-chloride solution or 0,25% levobupivacaine-chloride solution. The efficacy was measured with the percent reduction in pain intensity (VAS scale) before and after the therapy and one month after the treatment: excel-

lent (>50%) and good results (31-49%), or the therapy does not work (<30%). The side effects, complications, the procedure duration, the onset time of numbness, the number of needle corrections were recorded as well.

Results: For all three groups: nerve blocks took 5,04±1,48 minutes, the numbness occurred within 3,75±2,62 minutes, and the needle corrections was minimal (1,03±0,17). All the patients experienced the loss of pain: the number of blocks with long-acting anesthetic was the significant smallest (4,33±0,63), and the pain reduction was the significant highest (73,13%) than in other two group(p<0,001). The pain relief lasted one month after the therapy without any other therapy. Neither complications nor side effects were observed.

Conclusions: This is a safe, efficient and easy-to-perform procedure. The pain relief is achieved effectively and rapidly with long-acting anesthetics, maintained a months without of any additional therapy.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: EVOLUTION OF BLOOD-BRAIN BARRIER PERMEABILITY AND IMPACT ON CLINICAL OUTCOME THROUGHOUT THE PATHOLOGICAL PHASES OF ISCHEMIC STROKE: AN OBSERVATIONAL STUDY AND META-ANALYSIS

Authors: Sargento-Freitas J., Bernardo-Castro S., André Sousa J., Martins E., Silva F., Donato H., Nunes C., d'Almeida O.C., Castelo-Branco M., Abrunhosa A., Ferreira L.
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Background: Blood-brain barrier permeability (BBBP) is a core determinant of hemodynamic evolution and clinical outcome after ischemic stroke. However, BBBP shows a time-sensitive evolution, with animal models suggesting hypoxia as the main pathological substrate in the hyperacute phase, inflammation in acute and regenerative vasculogenic mechanisms in the late subacute phase. This heterogeneity and unclear evolution in humans limits standardized approaches. With this study we aimed to perform an observational study of BBBP in different timepoints and pool the results with existing data in a meta-analysis.

Methods: We performed a cohort study of consecutive patients with non-lacunar acute ischemic stroke in the territory of a middle cerebral artery and assessed BBBP in the first 24 hours and seven days (+2) of the infarct tissue and contralateral brain parenchyma using MRI with Dynamic Contrast-enhancement. For the meta-analysis we included all human studies that quantitatively assessed BBBP in non-lacunar stroke reporting contralateral values. Stroke

phases were defined as Hyperacute (< 6 hours); Acute (6-48hours); Subacute (3-9 days) and Chronic (\geq 30 days). BBBP was evaluated by a random effect model based on the standardized difference between lesion and contralateral brain and compared by meta-regression.

Results: We included 45 patients in the cohort study and 1385 patients in the meta-analysis (from 21 eligible studies). All phases were associated with increased permeability, reaching a peak in the subacute phase [SMD (95% CI): 0.74 (0.48-0.99) $p < 0.0001$], 1.68 (0.94-2.42) $p < 0.0001$, 1.98 (0.96-3.00) $p < 0.0001$ and 1.37 (0.73-2.02). BBBP was associated with haemorrhagic transformation only in the hyperacute phase, with bad clinical outcome in the acute phase and good clinical outcome in the subacute phase.

Conclusions: BBBP is persistently elevated after stroke, peaking in the subacute phase, and showing heterogeneous associations with clinical and hemodynamic features

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: REFINING THE CONCEPT OF ESUS – A LONGITUDINAL 5-YEAR FOLLOW-UP STUDY

Authors: Martins E.¹, Faustino P.¹, Gomes F.¹, Fernandes C.¹, Rodrigues B.¹, Machado C.¹, Santo G.¹, Almendra L.¹, Sargento-Freitas J.¹, Silva F.¹
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Background: ESUS is generically defined as non-lacunar ischemic stroke without a clear embolic source. The best secondary prevention strategy for ESUS is still unclear. Recent clinical trials failed to show efficacy of anticoagulation over antiplatelet therapy. Many causes for these results have been proposed, however the heterogeneity of the population seems to contribute to the results. Therefore, it is paramount to define sub-groups within the ESUS population that might benefit from different secondary prevention strategies. We aimed to identify sub-groups of ESUS patients and evaluate differences in clinical outcomes after a 5-year follow-up.

Methods: We included all patients with ischemic stroke admitted in our tertiary centre in 2015, identified ESUS patients and recorded clinical features, imaging, complementary studies (carotid and vertebral ultrasound, ECG-Holter, echocardiogram, cervical angio-CT), recurrence of vascular events and complications until 2020. Patients were divided in “probably atherothrombotic” (ESUS-Athero) defined by the presence of irregular/heterogeneous plaques

in ultrasound/angio-CT not causing > 50% stenosis and “probably not-atherothrombotic” (ESUS-NonAthero) when not meeting the prior criteria.

Results: We identified 861 patients with ischemic stroke, 16% ESUS, 9% undetermined etiology due to incomplete evaluation, 46% cardioembolic, 11% atherothrombotic. Within ESUS, 22% were subclassified as “ESUS-Athero” and the rest as “ESUS-NonAthero”. “ESUS-NonAthero” had atrial fibrillation detected more often during follow-up (18,4% vs. 3.3%, $p = 0.044$) but no significant differences in mortality (20,8% vs. 12,5%, $p = 0.295$) or stroke recurrence (14,9% vs. 23,3%, $p = 0.235$).

Conclusions: The characteristics of the ESUS population and the best secondary preventive strategy remain elusive. Our study emphasizes the existence of different sub-groups within the ESUS definition, that may be identified by carotid and vertebral ultrasound or by angio-CT. A non-atherothrombotic ESUS sub-group probably exist that might benefit from a different diagnostic and prevention strategy.

Abstract category: Original research
Scientific topic: Teaching Cases & Pitfalls

Abstract title: "WHAT'S PERSISTENT PRIMITIVE TRIGEMINAL ARTERY GOT TO DO WITH IT?"
AN ULTRASOUND APPROACH

Authors: Kulyk C.¹, Funk S.², Brunner C.^{1,3}, Maria Farina F.⁴, Röper-Kelmayer J.^{5,6}, Fellner A.F.⁵, Ransmayr G.⁷, Vosko M.¹

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Background: Persistent Primitive Trigeminal Artery (PPTA) is the most common of the fetal carotid-basilar anastomosis that persists in adulthood. The aim of our study was to assess the hemodynamic repercussions of PPTA on cerebral circulation.

Methods: Four patients with PPTA (diagnosed with MRA) were included in the study (mean age: 61 years, 50% male). All underwent an extensive ultrasound assessment, including Color-Coded Duplex Ultrasonography of the cervical vessels and TransCranial Color Doppler of the intracranial circulation; VasoMotor Reactivity (VMR) was assessed using Breath Holding Index (BHI). Data were compared with the radiological and ultrasound findings of ten healthy controls (mean age 53 years, 50% male).

Results: Patient 1 and Patient 2 presented with clinical and radiological signs of vertebrobasilar insufficiency and had severe hypoplasia of both vertebral arteries and proximal segment of basi-

lar artery. Both had an impaired VMR in the vascular bed downstream of the carotid artery ipsilateral to the PPTA, hinting to the presence of a steal of blood flow from the anterior towards the posterior circulation. Interestingly, Patient 2 also had a tinnitus homolateral to PPTA. Patient 3 presented with recurrent unexplained episodes of long-lasting singultus; though no hypoplasia was present, the patient had deficient VMR homolateral to the PPTA. Patient 4 came to medical attention because of recurrent vertigo attacks and hypoacusis ipsilateral to the PPTA; neither hypoplasia of the vertebrobasilar system nor significant asymmetries in VMR were found. No significant side difference in VMR was reported in the healthy control subjects.

Conclusions: Although often regarded as a clinically meaningless finding, our preliminary data indicate that PPTA could represent a hallmark of hemodynamic instability of the posterior circulation, especially in the presence of vertebrobasilar hypoplasia.

Abstract category: Clinical case study
Scientific topic: Vascular Anomalies and Veins

Abstract title: ISCHEMIC STROKE IN PATIENT WITH CONGENITAL AGENESIS OF INTERNAL CAROTID ARTERY WITH IPSILATERAL HORNER'S SYNDROME AND HIPOCHROMIA IRIDIS

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Background: Agensis, aplasia and hypoplasia of the internal carotid artery (ICA) are very rare congenital vascular anomalies of which occurrence has been reported less than 0.01%. In literature there are a few case reports which have described a coexistence of absence of the ICA with Horner's syndrome (HS) and even less with hypochromiairidis. We report a case of patient with agensis of the left ICA with ischemic stroke of right brain hemisphere, ipsilateral Horner's syndrome and hypochromiairidis.

Case report: A 81-years-old female with comorbidities: hypertension and hypercholesterolemia, presented to the Stroke Unit with left hemiparesis and dysarthria due to acute ischemic stroke of the right brain hemisphere. Neurological examination also performed left Horner's syndrome and hypochromiairidis. She was treated with an intravenous recombinant tissue plasminogen activator (IV-rtPA) with almost full recovery. Imaging findings: The assessment by Duplex scanning of extracranial arteries showed a relatively small left common

carotid artery (CCA) caliber. There was demonstrated the absence of the LICA as well as significant increase in flow velocity in both vertebral arteries (VAs). Transcranial color-coded duplex ultrasonography (TCCD) revealed blood flow through an enlarged left posterior communicating artery (PCoA). Unenhanced skull base CT showed the absence of left bony carotid canal. The absence of the LICA was detected by CT angiography. The left anterior cerebral artery (LACA) was found to receive collateral circulation from the contralateral ICA via the anterior communicating artery (ACoA); the left middle cerebral artery (LMCA) received collateral circulation from the basilar artery (BA) via the enlarged LPCoA. These findings confirm agensis of the ICA with type A according to Lie and Quint's classification of collateral blood flow.

Conclusions: Color-coded duplex ultrasonography and CT imaging may precisely clarify agensis of the ICA which was responsible for insufficiency of cerebral circulation.

Abstract category: Review article
Scientific topic: Other/Miscellaneous

Abstract title: INTRAOPERATIVE ULTRASONOGRAPHY IN ADULT NEUROSURGERY.
OUR EXPERIENCE AND LITERATURE REVIEW

Authors: Aleksić V.¹, Mihajlović M.¹, Stanić M.¹, Bulatović M.¹, Mandarić A.¹, Ilić R.¹, Popović I.¹,
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Background: Intraoperative ultrasonography (IOUS) has been used a useful tool in cranial and spinal neurosurgery for several years. During recent years, advances in image data processing have led to improvements in ultrasound image quality. IOUS is used to navigate towards deep brain lesions, to define the extent of resection, and to visualize remnants of tumor. Different tumors and other well-delineated lesions are displayed with clear margins. However, the boundaries of diffuse infiltrating tumors (mostly gliomas) with the surrounding brain tissue cannot be distinguished properly. Also, edema impairs the contrast line.

Methods: We performed literature review about IOUS in adult cranial neurosurgery, and also we present results of our ongoing study. In the Neurosurgical department of Clinical Hospital Center Zemun, IOUS is used in the last 3 years. We used Toshiba, Aplio 500® with sector (5MHz) and linear (7,5MHz) probes. So far, 20 patients have been operated with the assistance of IOUS. Demographical, clinical and pathological characteristic are presented and discussed.

Results: All operated tumors in our series were clearly displayed and visualized during surgery. All of them were hyperechogenic relative to the surrounding brain tissue, regardless of tumor pathohistological type and preoperative neuroimaging finding on CT and MRI. Hyperechogenicity increased with higher grades of malignancy.

Conclusions: Our results are in accordance with the findings of other similar studies. IOUS can be a useful operative tool in the hands of neurosurgeon.

Abstract category: Review article
Scientific topic: Other/Miscellaneous

Abstract title: TRANSORBITAL SONOGRAPHY IN NEUROLOGY

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Background: Transorbitalsonography (TOS) provides information for specific central nervous system (CNS) or systemic diseases. It has been demonstrated that the estimation of intracranial pressure (ICP) may be helpful in the management of critically ill patients. The optic nerve sheath diameter (ONSD) is a reliable tool for non-invasive estimation of increased (ICP) at hospital admission, in neurological wards, or in intensive care. Furthermore, in the last years some studies provided the application of optic nerve diameter (OND) detecting optic nerve atrophy in multiple sclerosis. The aim of this review was to elucidate both prevailing and novel applications of ONSD and OND for neurologists and critical-care physicians and neuro-ophthalmologists.

Methods: In this review we discuss the technique and novel approach of ONSD and OND measurement and its clinical applications.

Results: Both OND and ONSD are used to study neurological conditions that imply variations in their value. An increase of ICP can be shown in acute mountain sickness and posterior reversible encephalopathy syndrome as well as in intracranial hemorrhage and malignant ischemic stroke, meningitis and encephalitis, and idiopathic intracranial hypertension. ONSD changes develop in inflammatory or ischemic optic neuropathies. Some articles demonstrate the usefulness of ONSD studies in symptomatic intracranial hypotension. Future applications could be in the prehospital setting and the development of automated measurement of ONSD. Little is known about the usefulness of OND in multiple sclerosis and neurodegenerative diseases.

Conclusions: TOS is simple, easy to apprehend, with diverse applications. ONSD and OND are a safe and low-cost bedside tool with the potential of screening patients in neurointensive and neurological care and for neuro-ophthalmological purposes.

Abstract category: Original research
Scientific topic: Muscle and Nerves

Abstract title: CHARACTERISTICS OF TRANSCRANIAL BRAIN PARENCHYMA SONOGRAPHY IN PATIENTS WITH MYOTONIC DYSTROPHY TYPE 1 AND 2

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Background: Myotonic dystrophy type 1 and 2 (dystrophia myotonica, DM), is an autosoma dominant genetically determined progressive muscular dystrophy associated with multiple organs involvement. The application of molecular genetic tests contributed to the accuracy in diagnosing DM1 and DM2, confirming the mutation by using PCR and Southern blot analysis. Neuroimaging techniques allow better visualization and quantification of pathoanatomic changes, by using the parenchymal transcranial ultrasound (TCS), which allows accurate visualization of deep brain structures (basal ganglia, raphe nuclei, and the chamber system). Determining the echogenicity change of basal ganglia (substantia nigra-SN, n. raphe-BR, n. Ruber-NR, n. Lentiformis-NL) and diameter of third ventricle (DTI) by using TCS in DM1 and DM2 patients and to correlate the ultrasonography results with the clinical manifestation.

Methods: The study was conducted on 163 patients with DM1 and DM2, aged 30 to 62 years, at Department of Neurology, Clinical Center of Serbia, Belgrade. Statistical analysis was conducted in SPSS program.

Results: Borderline statistical significance ($p=0.05$) is determined by comparing the right SN surface in DM1 patients ($0.14 \pm 0.06 \text{ cm}^2$) and is lower than the right SN average size in DM2 patients ($0.16 \pm 0.07 \text{ cm}^2$). There are no statistically significant data comparing the echogenicity of other basal ganglia and DTK patients with DM1 and DM2. BR hypoechogenicity in DM1 patients was more common in older (32–53 years) and in patients with depression ($p<0.05$). Enlarged DTK present at DM1 patients correlated with age ($P<0.01$). Borderline statistical significance was determined by comparing the BR hypoechogenic images of DM1 patients with fatigue ($p=0.05$). Daytime sleepiness is more frequent in correlation with hypoechogenic BR and hyperechogenic SN ($p<0.05$) and enlarged DTK at DM2 patients ($p<0.01$).

Conclusions: TCS is a practical, easily applicable, highly sensitive and useful neuroimaging method of great importance in the diagnosis and treatment of patients with DM1 and DM2.

Abstract category: Clinical case study
Scientific topic: Other/Miscellaneous

Abstract title: SHUTTING THE DOOR ON MIGRAINE

Authors: Duka Glavor K.¹, Kalanj S.¹, Mrđen A.¹, Bakotić Z.², Stipčević M.²
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Background: We present the case of a 23-year-old man with a history of migraine with aura since the age of eleven. There was no family history of headaches. In 2016, he was referred to our Neurology Department. In the last five years, he had two attacks of migraine with aura monthly, usually lasting 2–3 hours often associated with nausea and vomiting, phono and photophobia. The intensity was severe (7/10 according to the Numeric Pain Rating Scale). In the last year it had become a therapy-resistant migraine. He had more frequent absences from school, decreased concentration, fatigue, and less physical activity which worsened his quality of life. At that time, he had been examined by a neuropediatrician and cardiologist (TTE: thinner layer of the basal part of the IAS).

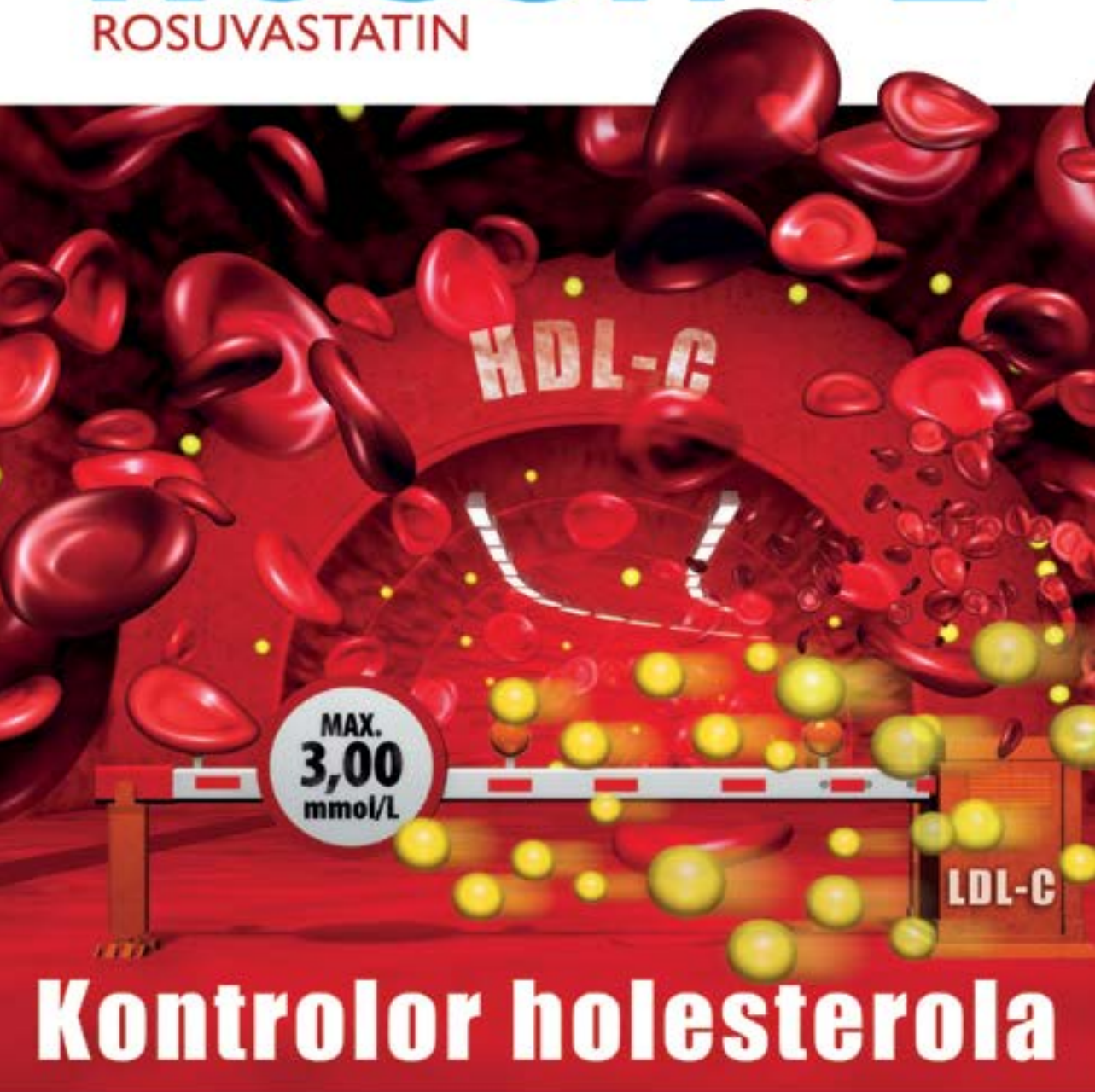
Methods: Neurological examination was unremarkable. We performed a complete extracranial and intracranial ultrasound evaluation (US), transcranial ultrasound (TCD) with right-to-left shunt (RLS) detection followed by brain magnetic imaging (MRI) and angiography (MRA), cardiac workup with transthoracic echocardiogram (TTE) and transesophageal echo (TEE), genetic and laboratory evaluation.

Results: Cervical vessel and transcranial ultrasound, brain MRI and MRA showed no pathological findings. TCD saline contrast study revealed a large RLS, while the TEE showed a defect of the interatrial septum (ASD) type ostium secundum 5 mm in the upper part of the fossa ovalis. Coagulopathy and immunological screening tests were normal. In 2016, transcatheter closure of ASD with an Amplatzer septal occluder device was performed. Since then, the patient had regular clinical and ultrasound evaluations with complete migraine cessation and significant improvement of health and quality of life.

Conclusion: Studies have reported a significant association between migraine with aura and the presence of Patent Foramen Ovale. Pooled analysis showed that percutaneous closure of PFO in migraine with aura is safe and significantly reduced the attacks. TCD confirmed its pivotal role in the diagnosis of RLS and especially in post-procedural monitoring during follow-up.

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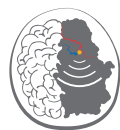
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ORAL COMMUNICATION ABSTRACTS

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Abstract category: Original research**Scientific topic:** Original research**Abstract title:** INDICES OF CAROTID PLAQUE EMBOLOGENICITY. JUXTALUMINAL ECHODENSITY, GLOBAL ECHODENSITY AND HETEROGENEITY**Authors:** Tegos T.J.¹, Zilakaki M.¹, Papagiannis I.¹, Poulidou V.¹, Stefanou G.², Arnaoutoglou M.¹, Tsolaki M.¹**Institution:**

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Background: Previous ultrasound studies suggested that echolucent carotid plaques are embologenic, whereas echogenic ones are non-embologenic. The aim of the present study was to determine whether juxtaluminal echodensity and heterogeneity constitutes a better discriminator of embologenic and non-embologenic status, as compared to global plaque echodensity.

Methods: Analysis performed on images of 154 carotid plaques with 50%-99% stenosis (121 patients, 65 symptomatic and 89 asymptomatic plaques). The global (100%) plaque Grey Scale Median (GSM100) and also the juxtaluminal 10%, 25%, 50% plaque area GSM (GSM10, GSM25, GSM50) were evaluated in a computer software. The heterogeneity of a plaque was defined as the difference of maximum and the minimum value of those GSMs per plaque. Low values of heterogeneity corresponded to homogeneous plaques, whereas high values to heterogeneous ones. The embolic count (EC) was calculated in the ipsilateral middle cerebral artery to the plaque under study for 30 minutes on transcranial Doppler. Carotid plaque stenosis was also evaluated.

Results: Embologenic plaques (EC>0) were associated with median GSM10 of 2, median GSM100 of 8.5 and median heterogeneity of 5.5, whereas the non-embologenic ones (EC=0) of 29, 39 and 18 respectively ($p=0.0001$ for all analyses). Carotid plaque stenosis failed to separate the embologenic from non-embologenic plaques (median stenosis for embologenic plaques of 80% and for non-embologenic ones of 70%, $p=0.09$). ROC curves demonstrated a trend for more adequate ability of GSM10, over GSM100 and heterogeneity in separating the embologenic from the non-embologenic plaques (areas under the curve: 0.742 for GSM10, 0.710 for GSM100, 0.666 for heterogeneity, $p=0.22$ for GSM10-GSM100 comparison, $p=0.02$ for GSM10-heterogeneity comparison, $p=0.16$ for GSM100-heterogeneity comparison).

Conclusions: Our results suggested a trend for juxtaluminal plaque echodensity to be a more adequate index, compared with global plaque echodensity and heterogeneity, in the separation of embologenic and non-embologenic carotid plaques.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: THE ROLE OF CAROTID DUPLEX SONOGRAPHY IN THE EVALUATION OF PATIENTS WITH TINNITUS AND IN THE DETECTION OF DURAL ARTERIOVENOUS FISTULAS

Authors: Caldeiras C.¹, Pereira G.¹, Ferreira C.¹, Santos R.¹, Azevedo E.¹

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Background: Dural arteriovenous fistulas (DAVF) commonly present with tinnitus. Carotid duplex sonography (CDS) is a non-invasive and readily available exam, with recognized utility in the screening of DAVF but still marginally used to this end. We aimed to evaluate the performance of CDS in the detection of intracranial fistulas.

Methods: We performed a retrospective observational study (Jun/2000-Jun2021). We included individuals whose CDS report mentioned "fistula" or "tinnitus". For DAVF mostly nourished by the external carotid artery (DAVF-ECA), we included cases with ECA resistance index (RI) < 0.7; increased ECA velocity and/or RI between the internal carotid artery (ICA) and the ECA > 0.9. For carotid-cavernous fistulas (CCF) we considered increased ICA velocity, diminished ICA RI, and/or flux reversal at the superior ophthalmic vein. We reviewed the database from the Neurosonology Unit and patients' electronic chart data.

Results: We identified 123 patients, 17 (13.8%) were diagnosed with fistula – 11 DAVF-ECA and 6 CCF [12 females (71%), median age of 55 years-old (47-70)]. CDS displayed indirect signs of fistula in 13 patients (sensitivity 77%). When analyzed separately, CDS detected 10 DAVF-ECA (91% sensitivity) and 3 CCF (50% sensitivity). Clinical information included the terms "fistula", "tinnitus" or "bruit" in 10 (77%). CDS was the first exam raising fistula suspicion in at least 9 cases (the remaining 6 with previous vascular exam, 2 unknown). In one case, CDS raised the hypothesis of DAVF, and posterior clinical information mentioned endovascular embolization, however, we did not have access to the angiography and the diagnosis was, therefore, uncertain. Apart from this dubious case, there were no secure false positives in the present series.

Conclusions: CDS performed well in the present sample, with high sensitivity in the detection of hemodynamic parameters consistent with fistula, particularly in DAVF-ECA. ECA's hemodynamic data ought to be evaluated in all patients, especially in those with tinnitus.

Abstract category: Original research
Scientific topic: Therapeutic applications

Abstract title: AN ULTRASONOGRAPHY-GUIDED APPROACH IMPROVES TREATMENT EFFICIENCY IN DYSTONIA PATIENTS

Authors: Pereira G.¹, Dias L.¹, Oliveira A.¹, José Rosas M.¹, Azevedo E.¹

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Background: Dystonia treatment is usually defined by clinical features and, intramuscular botulinum neurotoxin (BoNT) injections are used to improve patient's quality of life. Usually, these injections are guided by anatomical landmarks. To maximize the efficacy of BoNT, an accurate selection of muscles is critical. In this setting, ultrasonography (US) provides the means to unequivocally identify target muscles for BoNT therapy. We retrospectively evaluated the benefits of an US-guided approach to BoNT treatment, in comparison to the manual needle placement, by evaluating the dosage of BoNT applied and the frequency of injections.

Methods: We included mainly cervical dystonia patients, from an outpatient clinic in a tertiary university hospital. Considering the time of the first US-guided BoNT injection (T0), two moments before (T-2 and T-1), and after (T+1 and T+2), were assessed by reviewing the serotype and dosage of the BoNT injected, its cost, and the time interval between sessions. Statistical comparisons were made between sessions, using Friedman and Wilcoxon tests.

Results: From the 43 patients included, 42% (n=22) were injected with abobotulinumtoxinA, 32,6% (n=42) with onabotulinumtoxinA and 11,6% (n=5) with incobotulinumtoxinA. We observed a significant reduction tendency of the BoNT dosage per patient (p=0.006), particularly between T-2 and T+1 (p=0.003), T-1 and T+1 (p=0.031), and T-2 and T+2 (p=0.032). A significant reduction in cost per session was also observed (p<0.001). Major differences in the time intervals between sessions were not detected (p=0.430).

Conclusion: In our sample, the usage of ultrasonography to identify target muscles allowed for a reduction of the BoNT applied to patients with dystonia. This not only leads to a subsequent therapy cost reduction but may also lower the risk of iatrogenic effects.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: MIDDLE CEREBRAL ARTERY PULSATILITY INDEX AND SERUM INFLAMMATORY MARKERS IN LACUNAR STROKE- A PRELIMINARY REPORT

Authors: Kozera G.¹, Pawluk H.², Piec K.³, Kołodziejka R.¹, Kozakiewicz M.⁴, Grzechowiak E.³, Grześ G.⁵, Wojczal J.⁶, Woźniak A.², Bieniaszewski L.¹

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Background: Inflammatory response in ischemic stroke may occur both, in acute ischaemia, and chronic phase of cerebral microangiopathy. Increase of Pulsatility Index (PI) reflects a dysfunction of brain microvasculature, however its associations with inflammatory markers remains unclear. Thus, we aimed to evaluate a relationship between PI of middle cerebral artery (MCA) and pro-inflammatory cytokines in patients with lacunar stroke treated with iv-thrombolysis.

Methods: Study group consisted of 25 patients (mean age 68,9 years, 18 males) with lacunar stroke treated with iv-thrombolysis. Serum concentrations of interleukin 6 (IL-6), high sensitivity C-reactive protein (hs-CRP) and tumor necrosis factor (TNF) have been obtained within 4,5 hours from the stroke onset, MCA PI was mea-

sured bilaterally by TCD (Viasys, Companion III device) after 24 hours from stroke onset.

Results: There were significant correlations between averaged MCA PI and IL-6 ($R=0,54$; $p=0,005$), hs-CRP ($R=0,42$; $p=0,04$) and TNF ($R=0,53$; $p=0,008$). PI was also associated with 3-month functional outcome ($R=0,53$; $p=0,01$). Subgroup of patients with favorable outcome showed lower PI values ($p=0,04$) than those with poor long time outcome. No differences regarding pro-inflammatory markers between subgroups existed.

Conclusions: Cerebral pulsatility in acute stroke may be related to pre-treatment inflammatory state markers. Post-treatment PI may also impact functional prognosis after cerebral iv-thrombolysis.

Abstract category: Clinical case study
Scientific topic: Teaching Cases & Pitfalls

Abstract title: BILATERAL HIGH-GRADE STENOSIS OF INTRACRANIAL INTERNAL CAROTID ARTERY IN PATIENT WITH MULTIPLE MYELOMA

Authors: Valaikiene J.¹, Ryliskiene K.¹, Beliak L.¹, Jatuzis D.¹

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Background: Multiple myeloma (MM) is a lymphoid malignancy, accounting for 1% of all cancers. A recent cohort study showed an increased risk of a stroke in MM patients with a kappa light chain isotype. We described a clinical case of a newly diagnosed lambda light chain MM with multiple cerebral infarctions and vasculopathy, predominantly in the intracranial internal carotid artery (ICA).

Case report: A 50-year-old woman was admitted to a hospital for anaemia in 2018 and was diagnosed with MM, a lambda light chain isotype, III stage, and mild renal insufficiency. She had induction chemotherapy with bortezomib, thalidomide, dexamethasone (VTD) regimen. An acute right-sided weakness occurred 2 weeks after the end of treatment. The neurological evaluation showed mild right hemiparesis. Brain CT and magnetic resonance imaging (MRI) demonstrated multiple brain infarctions, involving bilateral cortical, subcortical, watershed regions and cerebellar hemispheres. Transcranial color-coded sonography (TCCS) revealed stenotic lesions >70 % in C1-2 segments of ICA bilaterally, and in middle ce-

rebral, vertebral and basilar arteries. Microembolic signals were registered in middle cerebral artery bilaterally. Conventional angiography confirmed high-grade left ICA stenosis. Thalidomide was discontinued, cyclophosphamide administered, CyBorD regimen was activated. Additionally the patient was treated low-molecular-weight heparin for the presumable embolization. Eight months later an autologous bone marrow stem cell transplantation was successfully performed. The remission of MM was achieved. However, repeated TCCS revealed no regress of stenotic lesions in the distal ICA. High-resolution MRI showed contrast enhancement in the walls of the distal ICA. Genetic testing of COL4A1, 2, CTC1, GLA, HTRA1, N3ECD, NEMO, NOTCH3, TREX1 was normal. No cerebrovascular events occurred within two years of the follow-up.

Conclusions: Lambda light chain MM may present with multiple cerebral infarctions and vasculopathy of non-atherosclerotic origin. TCCS is a reliable method for initial diagnosis and follow-up of stenotic lesions of intracranial ICA.

Abstract category: Clinical case study
Scientific topic: Vascular Anomalies and Veins

Abstract title: SUCCESSFUL EMBOLIZATION OF GIANT BASILAR ANEURYSM:
THE FOLLOW-UP BY TRANSCRANIAL COLOR SONOGRAPHY

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Background: Giant aneurysm of the basilar artery is a rare life-threatening condition, which poses a difficult therapeutic challenge.

Case report: A 37-year-old woman was urgently admitted due to a temporary loss of consciousness after a neck flexion. The medical history included intermittent double vision, dizziness, headache and numbness of the left arm two days before. Neurological examination revealed no focal and meningeal signs. Head computed tomography (CT) excluded haemorrhage, but demonstrated brain stem compression by a giant basilar aneurysm (~41×30 mm), partially thrombosed. Transcranial duplex sonography (TCCS) with the transtemporal and transforaminal approach was performed to visualize the aneurysm. Magnetic resonance (MR) imaging showed no ischemic lesions. Conventional angiography confirmed CT and MR data. Successful placement of a flow-diverter "Surpass" for basilar aneurysm embolization and additio-

nally putting a neurostent to posterior cerebral artery/proximal basilar artery for the stability of the system were performed. Aggressive steroid therapy to prevent the rupture of the basilar aneurysm, including clopidogrel 75mgx1 for 6 months and aspirin 100 mgx1 for 2 years was administered. Conventional angiography after one year showed no more flow in the basilar aneurysm. →Repeated TCCS was used for a follow-up period of 3 years. The patient remained asymptomatic and neurologically normal.

Conclusions: The presented case proved that the embolization of a giant basilar aneurysm using a flow-diverter implant with an additional neurostent may be highly successful. TCCS, being a non-invasive and inexpensive diagnostic tool for the visualization of a giant basilar aneurysm, may provide important additional information in order to perform follow-up examinations before and after the embolization.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: TRANSCRANIAL DOPPLER PULSATILITY INDEX AND INTIMA MEDIA THICKNESS
CORRELATION WITH THE CD4 /CD8 RATIO IN HIV PATIENTS

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Background: The use of new antiretroviral therapies (ARVT) turned HIV infection into a chronic disease with an increasing life expectancy while keeping the state of persistent inflammation with an immune activation ("inflammaging") and a predisposition for complications not directly related to the infection. A few studies suggested CD4 / CD8 ratio as a possible accurate marker to predict future non-AIDS events such as those associated with cardiovascular manifestations. We intended to correlate the very low CD4 / CD8 ratios (<0.4), despite ARVT with neurovascular ultrasound parameters: TCD pulsatility index (PI), and carotid intima-media thickness (IMT).

Methods: 79 HIV1 men aged < 65 years, under ARVT for more than 2 years, with no history of cardiovascular events, were selected by a convenience sampling from our immunodeficiency clinic during 2019. Our cohort was evaluated by both carotid ultrasound imaging and TCD. The CD4 and CD8 values of the previous 5 years were collected and the CD4 / CD8 ratio was

obtained. The patients were then divided into 2 groups according to that ratio in < 0.4 ("very low" group) and >1.0 (immunological normalization). Possible associations were statistically sought.

Results: Only 49 individuals (62%) attended the ultrasound evaluation. The subgroup analysis of CD4 / CD8 ratio < 0.4, presented a significant correlation between the CD4 / CD8 ratio and PI (p <0.05). The association between IMT with very low ratio and the immunologically normalized was not statistically significant.

Conclusions: The association between lower CD4 / CD8 ratio and higher PI on TCD suggests an increased cardiovascular risk possibly caused by the persistence of immune dysfunction. Because this dysfunction causes predominantly inflammation so atherosclerosis may presents as less important. This may explain this association with PI values not seen in carotid IMT. A larger sample may be necessary to confirm our findings.

Abstract category: Original research
Scientific topic: Neurointensive Care

Abstract title: VALIDATION OF A NEW NON-INVASIVE TECHNIQUE FOR CEREBRAL COMPLIANCE ASSESSMENT

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Background: Early and continuous detection of intracranial hypertension (ICH) is essential to guide the installation of therapeutic measures capable of preventing cerebral compliance impairment (CCI) harmful effects. However, Intracranial pressure monitoring (ICP) is an invasive, costly, and therefore restricted technique. Transcranial Doppler, in a controlled environment is able to indirectly assess cerebrovascular resistance by the measure of pulsatility index (PI). Likewise, a new recently developed cranial pulse sensor (B4C) features compatible graphic record with cerebral compliance, as this sensor registers waveforms with definite ICP peaks (P1, P2 and P3), but still under study. The main objective of the present study was to evaluate the accuracy of the variation of the PI and the cranial pulse sensor as indicators of CCI.

Methods: A prospective observational controlled study is ongoing with neurocritical patients monitoring invasive arterial pressure and ICP, bilaterally middle cerebral arteries velocities and B4C recording. First, a basal recording of 5 minutes, followed by a second record of 4 minutes with ultrasound guided internal jugular veins (IJVs) manual compression for one minute. All parameters able to influence TCD and/or ICP recording (i.e. arterial blood pressure and pCO₂) were controlled to assure suitability of comparison between recordings. Analytic data report (P2/P1 ratio, time to peak and pulse detection) and correlation with the same ICP features, as well as PI variation were correlated. Data of 40 patients has been collected to the date.

Results, discussion and conclusions of preliminary data will be presented in the 25th meeting of the ESNCH 2021 in Belgrade.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: INTRACRANIAL PULSATILITY AND CEREBRAL WHITE MATTER HYPERINTENSITY BURDEN IN A COMMUNITY-DWELLING ELDERLY POPULATION

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Background: Previous studies suggested an association between increased intracranial arterial pulsatility and cerebral small vessel disease including white matter hyperintensities (WMH). However, possible confounders such as age and hypertension were rarely considered, and longitudinal data are lacking. We hypothesized that in community-dwelling stroke-free subjects an increased middle cerebral artery (MCA) pulsatility index (PI) measured by transcranial Doppler sonography (TCD) relates to baseline WMH severity and progression over 5 years follow-up.

Methods: The study population consisted of elderly participants without stroke and dementia from the community-based Austrian Stroke Prevention Study. Baseline and follow-up assessment comprised TCD, brain MRI and clinical/laboratory examination of vascular risk factors. Individuals TCD PI was averaged from baseline PIs of both MCAs and was correlated with baseline WMH severity and WMH progres-

sion over a median follow-up of 5 years in uni- and multivariable analyses. WMH severity was rated by the Fazekas scale and quantified by semi-automated volumetric assessment.

Results: The final study cohort comprised 491 participants (mean age: 60.7±6.9 years; female: 48.5%). TCD PI was increased in participants with more severe WMH at baseline ($p<0.001$) but was not associated with WMH progression during follow-up ($rs: 0.097$, $p=0.099$). In multivariable analyses, only arterial hypertension ($p<0.05$) remained significantly associated with baseline severity and progression of WMH, while TCD PI was not predictive ($p>0.1$, respectively).

Conclusions: In this large community-based cohort, MCA PI on TCD was neither associated with microangiopathic WMH severity at baseline nor predictive of WMH progression during follow-up after adjustment for important co-variables.

Abstract category: Original research
Scientific topic: Vascular Surgery

Abstract title: HEMODYNAMIC CHANGES AFTER CAROTID ENDARTERECTOMY- A DETAILED ANALYSIS WITH CORRECTION OF MIDDLE CEREBRAL ARTERY FLOW VELOCITY

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Background: Transcranial Doppler (TCD) measuring middle cerebral artery flow velocity (MCAFV) is an important technique to monitor patients during and after carotid endarterectomy (CEA). In 2012 (Ultrasonography 38(8): 1451-9) new TCD parameters were introduced which represent the MCAFV more accurately: the first (Sys1) and second (Sys2) systolic peak and the diastolic flow velocity at a fixed time of 560ms after stroke onset (D560). Since flow velocities are known to decrease with age, it was proposed to use Z-scores as method for age correction (2018 JNeurosciMeth 307:1-7). This retrospective study aimed to provide normal values for changes in Z-scores of the new parameters on postoperative days 0-3.

Methods: In a retrospective study preoperative data on ipsilateral MCAFV could be retrieved in 224 out of 318 patients undergoing CEA. Follow up data on postoperative day 3 was available in 196 patients.

Results: Compared to preoperatively, the Z-scores of the first systolic peak (Sys1) and second systolic peak (Sys2) were increased on postoperative day 3 (both $p < 0.001$), with a stronger rise of Sys1. The Z-score for D560 only showed a temporary increase with a maximum on postoperative day 1 ($p < 0.001$). The systolic and diastolic blood pressure decreased with 8 and 7 mmHg resp. (both $p < 0.001$) whereas heart rate increased with 9 BPM ($p < 0.001$).

Conclusions: Describing the normally occurring changes in Z-scores for the new MCAFV parameters after CEA improves our understanding of the underlying hemodynamic mechanisms and enables a more accurate follow up for future patients undergoing surgery.

Abstract category: Original research
Scientific topic: Functional Testing/Contrast imaging

Abstract title: EFFECTS OF ACUTE ALCOHOL CONSUMPTION ON NEURONAL ACTIVITY AND CEREBRAL VASOMOTOR RESPONSE

Authors: Balogh E.¹, Ároksszállási T.¹, Körtefői K.¹, Nagy V.¹, Csiba L.¹, Oláh L.¹
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Background: Alcoholism is a global problem nowadays. Our aim was to study the effects of acute alcohol consumption on neuronal activity, cognitive functions, neurovascular coupling and cerebral vasoreactivity.

Methods: Thirty young healthy adults (15 men) were included in our study. Neuronal activity was evaluated by visual evoked potential (VEP) examination. Cognitive functions were investigated by neuropsychological tests. By using a visual cortex stimulation paradigm, visually evoked flow velocity response during reading was measured by transcranial Doppler in both posterior cerebral arteries (PCA). Cerebral vasoreactivity was investigated by analysing the effect of breath holding on the flow velocity increase (breath holding index, BHI) in both middle cerebral arteries. The examinations were evaluated before and 30 minutes after drinking alcohol. The target blood alcohol content was 1 ‰.

Results: The blood pressure didn't change, but the heart rate increased after alcohol consumption. Alcohol increased the latency of

the VEP P100 wave compared to the control period (110.81 ± 3.39 ms vs. 107.96 ± 2.40 ms, $p < 0.01$). The resting absolute flow velocity values increased, whereas the pulsatility indices in the PCA decreased after alcohol ingestion. Although the visually evoked PCA flow velocity time courses were similar ($p = 0.29$), the visually evoked maximum relative flow velocity increase in the PCA ($125.58 \pm 7.07\%$ vs. $127.30 \pm 7.60\%$; $p = 0.02$), as well as the steepness of rise of the flow velocity curve were smaller (3.24 ± 1.03 cm/s² vs. 4.73 ± 1.42 cm/s², $p < 0.01$) after than before alcohol consumption. The BHI (34.88 ± 14.28 %/40s vs. 44.09 ± 11.42 %/40s, $p < 0.01$) was also smaller after than before alcohol ingestion.

Conclusions: Our measurements prove that acute alcohol consumption inhibits the neuronal activity evoked by visual stimulus, results in dilation of cerebral arterioles, and thus interferes with cerebral vasoreactivity. These effects might contribute to the disturbance of the visually evoked flow response after alcohol consumption.

Abstract category: Original research

Scientific topic: Neurodegeneration and transcranial parenchyma sonography

Abstract title: MESENCEPHALIC RAPHE NUCLEUS AND THIRD VENTRICLE DIAMETER CHANGES IN PATIENTS WITH NON-PSYCHOTIC BIPOLAR MOOD DISORDER.

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Background: Bipolar disorders include mood disorders associated with severe mood swings, changes in energy, sleep, perception, and behavior. Transcranial sonography (TCS) is a non-invasive and valuable measure for assessing brain parenchyma. The Mesencephalic raphe nuclei are closely associated with the dorso-caudal limbic system and are essential in many psychiatric disorders. In this study, we compared the echogenicity of the raphe nuclei in patients with nonpsychotic Bipolar Mood Disorder type1 (B1D) and the control group.

Methods: Eighty participants, including 27 patients in the B1D group and 53 in the control-group with similar age and sex, were analyzed. The DSM-V criterion confirmed the Medical diagnosis in the samples in psychiatrist interviews. The echogenicity of the Mesencephalic raphe nuclei and diameter of the third ventricle was assessed by a trained neurologist using TCS. The Mean and standard deviation (SD) represented

quantitative and qualitative variables, respectively. Mean difference, CHI-Square, and p-value of decreased Raphe echogenicity and increased DTV were calculated separately in pairs for each group.

Results: The echogenicity of the brainstem raphe nuclei was significantly decreased in B1D patients (33.33%) in comparison with the control group (9.4%) (P-value of CHI-square: 0.008). Also, The DTV was significantly increased in B1D patients (25.9%) in comparison with the control group (5.6%) (P-value of CHI-square: 0.010).

Conclusion: In this study, The Echogenicity of the Mesencephalic raphe nuclei in patients with Bipolar disorder is significantly lower, and the Diameter of the third ventricle is significantly higher than the average population. We recommend a meta-analysis considering previous articles' results and series of TCS evaluations in each episode of the disease.

Abstract title: AGRP-INDUCED CHANGES IN CEREBRAL AND SYSTEMIC CIRCULATION; A TCD STUDY

Authors: Prof. Bojana Žvan, MD, PhD, Senior advisor, FESO¹, Darja Visočnik, MD¹, Matija Zupan, MD, PhD¹, Marjan Zaletel, MD, PhD, Senior advisor¹

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Calcitonin gene-related peptide (CGRP) has been proven to play an important role in migraine and it has therefore become a target molecule in headache migraine research and treatment. There is growing evidence that alpha CGRP (αCGRP) importantly affects clinical and physiologic state. Therefore, an αCGRP response should be regarded as an important predictive factor for selecting patients who are responders to anti-CGRP preventive treatment. It is known that perivascular application of CGRP induces cerebral vasodilatation. However, it is unclear whether intravenous alpha CGRP (αCGRP) induces changes in cerebral and systemic hemodynamics. Therefore, we studied the influence of an αCGRP intravenous infusion at a rate of 1.5 mcg/min in 20 min on mean arterial velocity in the middle cerebral artery (vm MCA) and in the posterior cerebral artery (vm PCA) in twenty healthy subjects using transcranial Doppler (TCD). We found out that αCGRP decreased vm MCA (p<0.001), vm PCA (p < 0.001), mean arterial pressure (MAP) (p< 0.001) and end-tidal CO₂ (Et-CO₂) (p=0.030). The heart rate (HR) increased during αCGRP infusion (p<0.001). In addition, we found a positive relationship between Et-CO₂ and vm MCA (p=0.001) as well as vm PCA (p=0.043). In our view, αCGRP induces changes in cerebral and systemic circulation in healthy volunteers. It might cause vasodilatation of MCA and PCA and a compensatory decrease of Et-CO₂ to αCGRP related hemodynamic changes.

ty healthy subjects using transcranial Doppler (TCD). We found out that αCGRP decreased vm MCA (p<0.001), vm PCA (p < 0.001), mean arterial pressure (MAP) (p< 0.001) and end-tidal CO₂ (Et-CO₂) (p=0.030). The heart rate (HR) increased during αCGRP infusion (p<0.001). In addition, we found a positive relationship between Et-CO₂ and vm MCA (p=0.001) as well as vm PCA (p=0.043). In our view, αCGRP induces changes in cerebral and systemic circulation in healthy volunteers. It might cause vasodilatation of MCA and PCA and a compensatory decrease of Et-CO₂ to αCGRP related hemodynamic changes.

Key Words: calcitonin gene-related peptide, cerebral arteries, transcranial Doppler sonography, migraine



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LIVE PRESENTATION

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| 2. | Carotid Sonography Findings in Patients with Cerebral Small Vessel Disease | Stoisavljevic S. | Serbia |
| 3. | Transcranial Brain Parenchyma Sonography in the Evaluation of the Clinical Course of Juvenile Myoclonic Epilepsy | Djordjević I. | Serbia |
| 4. | Transcranial Brain Parenchyma Sonography in Primary Burning Mouth Syndrome- Nigrostriatal Dopaminergic System Matters | Stojanovski N. | Serbia |
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| 6. | Endovascular Treatment of Acute Ischemic Stroke – A Single Comprehensive Stroke Center Experience | Dragičević D. | Croatia |

Abstract category: Original research

Abstract title: TCS FUSION IMAGING IN THE DETECTION OF CEREBRAL WHITE MATTER LESIONS

Authors: Brunner C.^{1,2,3}, Schreiber S. J.³, Bokemeyer M.³, Ransmayr G.², Struhal W.¹, Olbert E. D.¹, Alhani N.¹, Vosko MR.²

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Introduction: Cerebral small vessel disease (CSVD) is a common neurological disease and causes about 20% of all strokes worldwide and up to 45% of dementia, mood disturbance and gait problems. Small vessels per se cannot be currently visualized in vivo. The diagnosis of CSVD has relied on imaging findings. The leading imaging techniques to visualize brain white matter lesions (WMLs) are magnetic resonance imaging (MRI) or computed tomography (CT). Another, not routinely applied brain parenchyma imaging method is ultrasound (US). With high-end ultrasound systems a very high image resolution is achieved. Ultrasound fusion imaging (UFI) is a relatively novel approach to evaluate brain tissue.

Subjects and Methods: 29 Patients with various degree of WMLs quantified according to Fazekas grading scale (n=13 °I; n=9 °II; n=7 °III) and 11 subjects with normal MRI findings were investigated using UFI technique. Additionally, inter-rater-agreement (IRA) between two independent raters was determined. UFI was conducted with US Esaote – MyLab

twice machine. Brain tissue was visualized transcranially using a sector transducer with an operating frequency of 2.0–3.5 MHz in B-Mode, followed by fusion of imported MR pictures (FLAIR sequence, DICOM format, performed with 1.5 Tesla MRI system, slice thickness 5mm, 10% gap). Electromagnetic (EM) tracking-based fusion imaging was performed.

Results: In 91% the periventricular white matter lesions verified on MRI could be visualized using UFI technique. The detection rate increases with higher WMHs burden (°I:85%, °II:94%, °III:97%). The highest visualizable detection rate of white matter lesions was found at the contralateral central part (CPC) (97%). The IRA between 2 independent raters indicated an 86% agreement with an overall moderate strength of agreement (κ : 0.489, $p < 0.0005$) for all localizations.

Conclusion: This explorative study describes prospectively the ultrasound detection of periventricular WMHs corresponding to MRI lesions using UFI.

Abstract category: Original research

Abstract title: CAROTID SONOGRAPHY FINDINGS IN PATIENTS WITH CEREBRAL SMALL VESSEL DISEASE

Authors: Stoisavljevic S.¹, Stojanovski N.¹, Pavlovic A.¹, Zidverc-Trajkovic J.¹, Mijajlovic M.¹

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Background: Cerebral small vessel disease (CSVD) includes pathologies that affect small arteries, arterioles, venules, and capillaries of the brain. Today, atherosclerosis is considered to be the most dominant pathology in CSVD. Most commonly, the disease presents with ischemic lesions (lacunar stroke LS and white matter hyperintensities WMH). Even though large and small cerebral arteries have a clear morphological and functional connection, the role of large vessel atherosclerosis in CSVD is not fully understood.

Methods: The population included 99 patients treated at the Neurology Clinic of the University Clinical Center of Serbia from November 2018 to August 2021. CSVD was confirmed clinically and by neuroimaging methods in all patients. The following data was collected: LS/WMH on neuroimaging and localization (right, left or both hemispheres), ultrasonographic properties of the carotid and vertebral arteries (caro-

tid plaques, carotid diameter stenosis, sum of plaques, intima-media thickness-IMT, IMT sum, arterial anatomy malformations, peak systolic velocity PSV, end-diastolic velocity EDV, vertebral artery findings). Information about age, sex and cerebrovascular risk factors (hypertension, hyperlipidemia, diabetes, and smoking) were also noted.

Results: In our group of patients the most prominent finding was a correlation between age and a type of lesion. Combined LS and WMH were more often found in older patients. There was no correlation between other risk factors/carotid ultrasonography findings and CSVD.

Conclusions: Based on the results, we can conclude that there is a clear correlation between aging and CSVD. We believe that additional research is required to find a cause of CSVD.

Abstract category: Original research

Abstract title: TRANSCRANIAL BRAIN PARENCHYMA SONOGRAPHY IN THE EVALUATION OF THE CLINICAL COURSE OF JUVENILE MYOCLONIC EPILEPSY

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Background: Abnormal neural networks in the thalamus, limbic areas, brainstem and cerebellum seem to be associated with juvenile myoclonic epilepsy (JME). Cognitive and behavioral difficulties in JME are suggested to relate with alterations in basal ganglia. These structures are implicated in the modulation of epileptic spike-wave discharge generalization in patients with idiopathic generalized epilepsy. The aim of our study was to evaluate the influence and potential clinical significance of abnormal findings in subcortical structures associated with JME.

Methods: This retrospective study included 40 JME patients who were followed-up from January 1985 to December 2016 at the Clinic of Neurology and Psychiatry for Children and Youth in Belgrade. All patients received transcranial parenchymal sonography (TPS). Relation of clinical parameters (seizure control, cognitive functioning, and behavior) with TPS results was assessed.

Results: Duration of remission for at least one year was achieved in 71% of patients, while 10% had pseudo-resistant epilepsy. Dysexecutive syndrome and psychiatric comorbidities were noted in 30.4% and 25% of patients, respectively. Pathologically hyperechoic substantia nigra (SN) and red nucleus (RN) on TPS were found in 35% and 32.5% of patients, respectively. There was no statistically significant difference in the incidence of pathologic echogenicity of these structures between different patient groups. However, compared to the control group, hyperechoicity of the right-sided SN and both right- and left-sided RN was significantly more common in the patient group.

Conclusions: To our knowledge, this is the first study to demonstrate structural changes of SN and RN in JME. Our results suggest additional non-lesional abnormalities of BG and midbrain structures in JME patients.

Abstract category: Original research

Abstract title: TRANSCRANIAL BRAIN PARENCHYMA SONOGRAPHY IN PRIMARY BURNING MOUTH SYNDROME- NIGROSTRIATAL DOPAMINERGIC SYSTEM MATTERS

Authors: Stojanovski N.¹, Zidverc Trajković J.¹, Zoric B.¹, Jankovic LJ.¹, Sternic N.¹, Mijajlovic M.¹

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Background: Primary burning mouth syndrome (BMS) is chronic intraoral burning sensation without medical or dental cause. Potential causes are neuropathic dysfunction and central mechanisms with involvement of the nigrostriatal dopaminergic system (NDS). BMS could also be premotor symptom of Parkinson's disease (PD). The aim of this study was to determine the frequency of NDS dysfunction in BMS using TCS.

Methods: 120 patients with BMS, 120 with PD and 74 healthy individuals are included. Using standardized transcranial sonography (TCS) protocol, basal ganglia echogenicity as well as ventricular system diameter and brainstem raphe echogenicity were measured. Degree of intraoral burning sensation and affective status were also determined.

Results: Frequency of substantia nigra (SN) echogenicity was the highest in PD, also significantly higher in BMS in comparison to controls (90% vs. 62% vs. 10%; $p < 0.01$ respectively), while there were no differences in other basal ganglia echogenicities. The third ventricle diameter was significantly higher in PD and BMS compared to controls (8.4 ± 2.2 vs. 8.2 ± 2.1 vs. 5.3 ± 1.9 ; $p < 0.01$). Frequency of brainstem raphe hypoechogenicity was significantly higher in both patients groups compared to controls (75% vs. 74% vs. 10%; $p < 0.01$ for PD and BMS vs. controls). Significant correlation was found between raphe and substantia nigra echogenicity and the degree of depression ($r = 0.351$; $p = 0.012$).

Conclusions: TCS is noninvasive method to identify BMS patients with NDS damage that in some could be early premotor PD symptom. This finding could have important therapeutic implications.

Abstract category: Original research

Abstract title: EVALUATION OF CAROTID INTIMA- MEDIA THICKNESS IN SYSTEMIC RHEUMATIC DISEASE PATIENTS

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Background: Study intention was to determine factors associated with increased intima-media thickness (IMT) and potential cardiovascular risk of rheumatoid arthritis (RA) patients. Carotid IMT of the carotid arteries is a marker of subclinical atherosclerosis.

Methods: The insonation was performed in 42 non-diabetic, normotensive, female RA patients and 32 matched healthy controls (age 45.3 ± 10.0 vs. 45.2 ± 9.8 years) at common carotid artery to determine the IMT. Mean and maximal IMT were calculated from 3 measurements at each site. Clinical work-up included laboratory analyses, determination of the disease activity and evaluation of treatment. vWF activity was used as rheumatoid arthritis confirmation.

Results: RA patients had increased IMT (mm) in comparison with controls (IMTmax: 0.764 ± 0.148 vs. 0.703 ± 0.100 , IMTmean: 0.671 ± 0.119 vs. 0.621 ± 0.085 . Parameters associated with IMT

in RA patients were: age, body-mass index, smoking, rheumatoid factor concentration, erythrocyte sedimentation rate, and duration of methotrexate+chloroquine therapy (inverse correlation). Multivariate regression analysis revealed that RA is an independent risk factor for increased IMT. vWF activity was significantly higher in participants with subclinical as well as in participants with atherosclerotic plaques than in those without. Factors correlating with IMT in the controls were: age, BMI, total cholesterol, LDL-cholesterol, total/HDL cholesterol, triglycerides and glycaemia.

Conclusions: Despite a favorable risk profile, our female RA patients had significantly enlarged carotid IMT than controls. RA itself was an independent risk factor for increased IMT. Impact of chronic inflammation on atherosclerosis was confirmed by negative correlation of IMT and duration of anti-inflammatory treatment.

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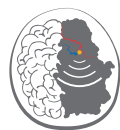
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**25th Conference of the European Society of
Neurosonology and Cerebral Hemodynamics****Abstract category:** Original research**Scientific topic:** Vascular Anomalies and Veins**Abstract title:** ENDOVASCULAR TREATMENT OF ACUTE ISCHEMIC STROKE – A SINGLE COMPREHENSIVE STROKE CENTER EXPERIENCE**Authors:** Dragičević Dragan¹, Sablić Sara¹, Kraljević Ivan¹, Štula Ivana¹, Sekovski Budimir¹, Cambj-Sapunar Liana¹, Repić-Buličić Ana², Čaljkusić Krešimir², Pijerov Terezija², Matijaca Meri², Dolić Krešimir¹
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Country: Croatia**E-mail:** dragandragicevic1@gmail.com**Purpose:** The aim of this study is to show how we treat patients with acute ischemic stroke in UHC Split combining endovascular approach (mechanical thrombectomy) with intravenous thrombolysis.**Materials and Methods:** We present 356 consecutive patients who underwent thrombectomy in a single center between 01.01.2018. and 30.06.2021. Demographics, comorbidities, National Institute of Health Stroke Scale (NIHSS), rtPA administration, localisation of vessel occlusion, onset to skin puncture time, onset to recanalization time, recanalization rates (mTICI), recanalization technique (only aspiration vs use of stentriever combined with distal aspiration) were presented for patients with various 90-day outcomes (mRS).**Results:** A total of 356 patients were studied. Median baseline NIHSS score was 15. The occlusion site was MCA in 73% of all cases, ICA-MCA tandem occlusion in 5%, T-occlusion in 12%, and basilar artery in 10% of all patients. 64% received intravenous thrombolysis. Super selective catheterization of the occluded vessel was not feasible in 13%. Successful revascularization was achieved in 60% of all patients. The median NIHSS score at the end of hospitalization was 10. After 3 months 51% showed good functional outcome (mRS 0-2).**Conclusions:** Endovascular techniques (mechanical thrombectomy) for treatment of acute ischemic stroke, which commonly use stentriever in addition with distal aspiration and only mechanical aspiration as well, especially in combination with intravenous thrombolysis are the gold standard for patients with large vessel occlusions of anterior and posterior cerebral circulation, in the 6-hours window, and even for the late-window patients.**Taita**[®]
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Abstract category: Original Research
Scientific topic: Cerebrovascular Diseases

Abstract title: HEADACHE PREVALENCE IN PATIENTS WITH SPORADIC CEREBRAL SMALL VESSEL DISEASE

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Background: Cerebral small vessel disease (CSVD), a common finding in patients with vascular risk factors, is associated with motor, cognitive and affective disorders. Magnetic resonance imaging (MRI) findings in patients with CSVD include lacunar infarcts, white matter hyperintensities (WMH), and microbleeds. Aside from rare familiar forms of CSVD, patients with chronic headache, migraine in particular, have an increased risk for developing such lesions, although this relationship is rather complex and yet to be fully elucidated. The aim of the study was to determine the frequency and type of headache in patients with CSVD.

Methods: This retrospective study included 115 patients with CSVD diagnosis admitted at the Clinic of Neurology, Clinical Center of Serbia in the period January 1st, 2015 - December 31st, 2017. Baseline demographic data, headache type, and MRI findings (ischemic lacunar infarctions, WMH, and overall lesion severity) were

obtained. Data were compared between CSVD patients with headache and headache-free CSVD cases, with the use of standard statistical methods.

Results: Headache was reported in 44.0% of included patients. MRI findings included lacunar infarcts in 86.1% and WMH in 46.1% cases. Correlation between headache symptoms and lacunar infarcts showed a trend towards statistical significance ($p = 0.072$) whereas headache-free patients more frequently had WMH, also approaching statistical significance ($p = 0.065$).

Conclusions: A large number of arteriosclerotic CSVD patients complain of different types of headaches. Based on MRI findings, lacunar infarcts are related to headache symptoms, and WMHs are more frequently present in patients with a negative history of headache.

Abstract category: Clinical case study
Scientific topic: Teaching Cases & Pitfalls

Abstract title: THE BRACHIAL PLEXUS ULTRASONOGRAPHY:
THREE CASES WHEN IS SURGICAL STRATEGY CHANGED

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Background: We represent three cases when we changed surgical plan after brachial plexus ultrasound performed.

Methods: The first one is 17 years old girl with bilateral congenital C8 radix pressure by the medial scalenus muscle (MSM) and the neck rib. The brachial plexus ultrasound examination discovered very long and wide arterial vessel from the right side, just anteriorly from the MSM. From the other side, we discovered double crush syndrome (the another hard C8 radix compression in the ulnar canal, at two places). The second one, is 34 years old man, who had, after vehicle accident as a motocyclist, diagnosis of the avulsion of the C8, C7 and C6 brachial plexus radices. After the ultrasound examination, we modified this diagnosis in to contusion and haemathoma of the MSM and contusion of the C4, C5 radices under of it. The third case is case of 58 years man, who suffer from flagrant pain after surgical and hemothrapy treatment of larynx carcinoma. The pain is

localised around the right shoulder. Before the ultrasound examination, this patient treated as neuropathic pain after lateral surgical dissection of the neck. This specially, because after surgical procedure the hypoglossal and accessory nerves were paralysed, and shoulder girdle muscles were atrophied. The ultrasound identified subcutaneous position of the suprascapular nerve, who is additionally compressed by fibrous band- rest of the muscles.

Results: In the first case, we additionally threat canalulnarissy, include vascular surgeon in our surgical team, during brachial plexus approach. In the second case conservative treatment with hyperbaric oxygen treatment was a play. In the third case, we apply the free fat graft between the nerve and this fibrous band: pain completely resolved.

Conclusions: The brachial plexus ultrasound is easy to perform, and very valuable method for surgery planning.

Abstract category: Clinical case study
Scientific topic: Neurointensive Care

Abstract title: CAN OPTIC NERVE SHEATH DIAMETER HELP US IN THE ASSESSMENTS
OF INTRACRANIAL PRESSURE?

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Background: 'Gold' standard for measuring of intracranial pressure (ICP) is still an invasive way. For doing that, you have to exchange that opportunity for a moderate risk of infections and other complications. Even today, invasive ICP measuring is not widely available. Optic nerve sheath diameter (ONSD) is a low-cost, safe and reliable method for recognizing those patients who have ICP > 20 mmHg and requiring specific treatment for lowering ICP. It can be done by the bed, very fast, and can be repeated several times during the day. We wanted to report an illustrative case of a young patient with malignant cerebral edema and utilization of ultrasound ONSD for further management and treatment decisions.

Case report: We present a case report of a male patient 19 years old. He was admitted to the ICU because of epileptic seizure and postictal coma. He was previously treated conservatively with antibiotics for brain abscess. After urgent

surgical treatment, the patient was sedated and mechanically ventilated. On control CT, diffuse cerebral edema was noted. Decompressive craniotomy was done next. ICP could not be measured invasively at that time, due to technical issues, but ICP assessment was necessary, so optical nerve sonography was performed. ONSD was acquired on both sides, with visible bilateral papillary edema and ONSD which was 6.9 mm on the right, and 6.4 mm on the left. Based on that report, barbituric sedation with thiopental was induced for further neuroprotection and lowering ICP. Unfortunately, the patient died because of extreme hypernatremia and prolonged malignant cerebral edema.

Conclusions: ONSD is a safe and reliable method to assess ICP with the capability to recognize those patients who are at risk of major neurological deterioration and with death following. It is a new tool not just for neurocritical care physicians, but for all neurosonologists.

Abstract category: Clinical case study
Scientific topic: Cerebrovascular Diseases

Abstract title: METASTATIC CAROTID OCCLUSION: IS ULTRASOUND SUPERIOR TO CT ANGIOGRAPHY? A CASE REPORT

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Background: Tumor embolism is recognized as a possible mechanism of cancer-related stroke. Excluding systemic tumor emboli caused by left atrial myxomas, tumor emboli large enough to cause symptomatic cerebral ischemia are quite uncommon. Lung carcinoma may form an embolus after invading blood vessels via 2 mechanisms: spontaneous embolization or secondary to surgical manipulation, which is more frequent. The most frequent sites of tumor emboli reported are aortic bifurcation of femoral vessels (50%) and cerebral circulation (30%).

Case report: We report a 60-year-old woman with a history of lung adenocarcinoma, without diagnosis of active metastatic disease, who presented to our clinic with acute right middle cerebral artery syndrome, characterized by conjugate gaze deviation to the right, left hemiparesis, and dysarthria; the NIH stroke scale score was 11. Head CT scan showed early signs of ischaemia with ASPECT score of 8 in the right hemisphere. Head and neck CT angiography showed occlusion of right internal carotid artery after which our patient received intravenous tissue plasminogen activator for acute ischaemic stroke treatment.

On the next day routine carotid ultrasound was performed and showed atypical and uncommon heterogeneous mass on posterior wall resembling probable metastatic embolus, and neither with power or color signal within the mass. Stenosis was not significant. Distal to the stenosis, an artery was occluded with homogenous hypoechogenic formation, a thrombus. Ultrasound findings in our case led us to consider existing tumor embolic complication of already known lung cancer.

Conclusion: Ischaemic stroke in our patient was a consequence of spontaneous internal carotid artery occlusion by tumor embolus spreading from the lung cancer. Our therapy decision would probably have been different if we had suspected of tumor embolus as the origin for ischaemic stroke and performed the ultrasound at the same time as CT angiography. Understandably, our patient had no benefit from thrombolytic therapy. This case may indicate that in similar situations carotid ultrasound exam should not be overlooked since it could be superior to CT angiography and may lead to different decisions regarding the therapy.

Abstract category: Original research
Scientific topic: Functional Testing/Contrast imaging

Abstract title: NEUROVASCULAR COUPLING IMPAIRMENT AND COGNITIVE DEFICIT IN HEART FAILURE PATIENTS WITH REDUCED AND RECOVERED EJECTION FRACTION

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Background: Heart failure (HF) is a prevalent disease but there is a lack of knowledge regarding its repercussion in cerebral hemodynamics mechanisms and in cognitive decline. Aim: To evaluate neurovascular coupling (NVC) in HF patients with reduced and recovered ejection fraction and healthy subjects, through a battery of dynamic transcranial Doppler (TCD) tests. We also aimed to explore if NVC parameters are associated with cognitive decline.

Methods: We performed a cross-sectional observational study of TCD vasoregulation tests in HF patients with reduced (HFrEF) and recovered ejection fraction (HFrecEF) and healthy controls, monitoring cerebral blood flow velocity (CBFV) in right middle and left posterior cerebral arteries. NVC was assessed by the CBFV response to visual stimulation. MoCA test was performed to assess cognitive status. Results: We recruited 23 patients with HFrEF, 8 with HFrecEF and 13 healthy controls. No differences were detected in CA. NVC was significantly impaired in HFrecEF patients with reduced augmentation of CBFV during stimulation (overshoot systolic CBFV 19.116.92 vs 22.61 7.78 vs 27.92 6.84, $p = 0.04$), slower upright of CBFV (rate time to overshoot: 1.19-3.0 vs. 3.06 (4.30) vs. 2.90-3.84, $p = 0.02$); $p = 0.023$) and reduced arterial oscillatory properties (natural frequency 0.17 0.06 vs. 0.20 0.09 vs. 0.24 0.07, $p = 0.03$; attenuation 0.34-0.24 vs. 0.48-0.35 vs. 0.50 0.23, $p = 0.05$). Logistic regression for MoCA score (normal vs cognitive deficit) according to NVC parameters did not show significant differences between groups.

Conclusions: Our results show that HF may have an impairment of the neurovascular unit. NVC parameters do not seem to be associated with MoCA score compatible with cognitive deficit. Further prospective studies are needed to explore if NVC parameters may predict cognitive decline.

Abstract category: Original research
Scientific topic: Functional Testing/Contrast imaging

Abstract title: NEUROVASCULAR REACTIVITY IN PATIENTS WITH MULTIPLE SCLEROSIS WITH OR WITHOUT OPTIC NERVE INVOLVEMENT

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Background: Increased neurovascular reactivity have been shown in patients with relapsing-remitting multiple sclerosis (RRMS) in our previous studies. In this study, we investigated the effect of optic nerve involvement on neurovascular reactivity.

Methods: Eighty-five patients with RRMS (77 patients with ON and 8 patients without ON) were examined by transcranial Doppler sonography. Blood flow velocities were recorded from the P2-segments of both posterior cerebral arteries simultaneously during simple visual stimulation. The NV reactivity was defined as a relative increase of the blood flow velocities during visual stimulation.

Results: The neurovascular reactivity was found to be significantly higher in patients with optic nerve involvement ($53.3 \pm 12.1\%$ and $52.7 \pm 12.2\%$; $p < 0.001$, right and left sides, respectively) with ON and ($38.8 \pm 11.7\%$ and $37.4 \pm 12.2\%$; $p < 0.002$, right and left sides, respectively) without ON.

Conclusion: Since axonal degeneration of the optic nerve strongly correlated with cortical glial degeneration, our results support the theory that inhibition due to glial degeneration causes high activity.

Abstract category: Original research
Scientific topic: Functional Testing/Contrast imaging

Abstract title: THE CORRELATION BETWEEN FATIGUE, COGNITIVE DYSFUNCTION, AND VISUAL REACTIVITY IN MULTIPLE SCLEROSIS

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Background: Fatigue and cognitive dysfunction are important parameters for multiple sclerosis (MS)-related disability and they affect most patients. This process is thought to be related to cerebral hypometabolism, but the underlying pathophysiological mechanisms are not fully known. Our aim in this study was to describe the relationship between cerebral metabolism, fatigue, and cognition, and to determine cerebrovascular reactivity in the posterior cerebral arteries accompanied by neuronal activity in the occipital cortex.

Methods: Our study included 50 patients diagnosed with MS according to the 2017 revised McDonald Criteria and 50 healthy controls. Brief International Cognitive Assessment (BICAMS) and Fatigue Assessment Scale (FAS) were administered for MS, and visual reactivity was assessed by TCD.

Results: Fatigue and cognitive dysfunction were significantly higher in MS patients compared to healthy controls. Increased visual reactivity was also associated with fatigue. We observed that as the SDMT (Symbol Digit Modalities Test) score decreased, cerebral reactivity increased and blood flow velocities decreased significantly. Similarly, when BVMTR (Brief Visuospatial Memory Test-Revised) scores decreased, blood flow velocities decreased significantly and reactivity increased, but it was not statistically significant.

Conclusion: We think that cerebrovascular reactivity is activated to provide sufficient blood flow to neurons to prevent chronic hypoxia caused by cerebral perfusion failure in MS patients with fatigue and cognitive dysfunction.

Abstract category: Original research
Scientific topic: Therapeutic applications

Abstract title: STENT RESTENOSIS PREDICTORS AFTER CAROTID ARTERY STENTING

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Background: The long-term efficacy of carotid artery stenting is debated. Predictors of stent restenosis are not fully investigated. Our aim was to assess the incidence of long term restenosis after CAS and to identify some predictors of restenosis.

Methods: We retrospectively selected 251 treated patients and we study the overall survival, for freedom from stroke or death and from restenosis. To correlate clinical, radiological, and procedural variables to stent restenosis, an univariate analysis was performed while to determine independent predictors of restenosis, a multivariate analysis was applied.

Results: We obtained 251 patients, 82.5% male and with a mean of 70 ± 9 years of age. All patients had carotid duplex ultrasound immediately after the procedure and at 1, 6 and every 6 to 12 months thereafter. Outcomes of interest included freedom from in-stent restenosis of

at least 50%, freedom from reintervention, survival, stroke and transient ischemic attack. Mean follow-up was 7 ± 3.42 years. Late carotid in-stent restenosis was observed in 16 patients (6.37%). 23.9% suffered a major vascular event at 5 years and, of the remaining, 17.2% presented it more than 5 years after stent placement; the mortality rate from vascular causes was 3.2% and 6.4% respectively. The following were analyzed as determining factors: hypertension, dyslipidemia, smoke and alcohol, ischemic heart disease, cardiac arrhythmias, valve disease, DM, episodes of repeated TIA or stroke, chronic renal disease, cervical radiation therapy, use of ASA, clopidogrel or anticoagulants, and chronic venous disease. Only the existence of the latter was significant in a future stenosis.

Conclusions: In our CAS experience, encouraging long-term results seem that peripheral arteriopathy has to be considered to facilitate restenosis.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: CEREBRAL VASOMOTOR REACTIVITY AND ITS CORRELATION WITH MORPHOLOGICAL AND HEMODYNAMIC PARAMETERS OF CAROTID ARTERIES

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Background: Cerebral vasomotor reactivity (VMR) plays an important role in maintaining cerebral autoregulatory mechanism. There are many risk factors that can influence VMR, which reflects morphological and functional parameters of large and small cerebral vessels. Aim of our study was to investigate correlation between VMR, and morphological and hemodynamic parameters of carotid arteries.

Methods: Retrospective cross sectional study included 285 individuals, treated at Neurology Clinic CCS in Belgrade. VMR was evaluated measuring breath holding index (BHI), whilst morphological and hemodynamic parameters of carotid arteries were obtained via a carotid artery ultrasound (intima-media complex thickness (IMT); presence and character of carotid plaques; degree of stenosis; peak systolic velocity (PSV); end diastolic velocity (EDV)). We also evaluated middle cerebral artery (MCA) hemodynamic parameters: mean flow velocity (MFV) and pulsatility indexes (PI). Hypertension; dia-

betes mellitus; atrial fibrillation; cardiomyopathy; blood lipid profile; smoking habits were taken from patients' medical history records.

Results: Out of entire sample, 160 were females and 125 males, average age of 54.6. We found the correlation between BHI and age ($r = -0.242$, $p < 0.01$), dyslipidemia ($p < 0.05$) and hypertension ($p < 0.05$). We also found negative correlation between BHI and presence of carotid plaques, as well as BHI and IMT ($r = -0.203$, $p < 0.01$). Positive correlation was found between BHI in the left MCA and EDV in the left internal carotid artery ($r = 0.121$, $p < 0.05$). We also found negative correlation between BHI and PI of MCA on both sides ($r = -0.268$, $p < 0.01$).

Conclusion: Our study showed correlation between cerebral VMR, and morphological as well as hemodynamic parameters of carotid arteries with a higher influence of morphological than hemodynamic parameters on cerebral VMR.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: THE ROLE OF MICROEMBOLIC SIGNALS AND THROMBOPHILIA IN PREDICTING COGNITIVE OUTCOME IN YOUNG ISCHEMIC STROKE

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Background: The objectives of our study were to describe the neuropsychological status after AIS in the young, its correlation with prothrombotic alterations and Microembolic Signals (MES), and its role in resuming normal work activity.

Methods: A retrospective analysis of patients aged 18-60 admitted for their first AIS to the Stroke Unit of our Hospital (January 2015 – September 2018) was performed. Then, we conducted a prospective investigation on the same population at two centers: our Hospital (September 2018 – September 2019) and the Kepler Universitätsklinikum of Linz, Austria (June – September 2019). Patients underwent a thrombophilic screening and neurocognitive assessment with the Oxford Cognitive Screen (OCS); MES were detected using Transcranial Ultrasound. After three months, patients were reassessed for neurological outcome and cognitive deficits; information about resumption of work activity was recorded.

Results: Eighty percent of patients had cognitive difficulties in the acute phase of AIS, with only 25% showing full recovery after three months. Half of the population did not resume work after three months, especially in the presence of attention and/or executive function deficits in the acute phase ($p = 0.015$) and language and number processing impairment after three months ($p = 0.041$ and $p 0.032$). MES detection was not associated with cognitive outcome nor the presence of thrombophilia. Coagulation factors were not predictive of motor outcome, but Factor XI and Factor VIII were associated with cognitive impairment.

Conclusions: Cognitive impairment is very common after juvenile ischemic stroke and is a major cause of inability to resume work. Therefore, early post-stroke cognitive assessment is essential to reveal a patient's dysfunction and offer adequate rehabilitation.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: INTIMA-MEDIA THICKNESS IN RHEUMATOID ARTHRITIS PATIENTS

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Background: Carotid intima-media thickness (IMT) of the carotid arteries is marker of subclinical atherosclerosis in patients with rheumatoid arthritis (RA). Study intention was to determine factors associated with increased IMT and potential cardiovascular risk of RA patients.

Methods: IMT was measured by ultrasonography in 42 non-diabetic, normotensive, female RA patients and 32 matched healthy controls (age 45.3 ± 10.0 vs. 45.2 ± 9.8 years) at common carotid (CCA). Mean and maximal (max) IMT were calculated from 3 measurements at each site. Clinical work-up included laboratory analyses, determination of the disease activity and evaluation of treatment.

Results: RA patients had increased IMT (mm) in comparison with controls (IMTmax: 0.764 ± 0.148 vs. 0.703 ± 0.100 , IMTmean: 0.671 ± 0.119 vs.

0.621 ± 0.085 . Parameters associated with IMT in RA patients were: age, body-mass index, smoking, rheumatoid factor concentration, erythrocyte sedimentation rate, and duration of methotrexate+chloroquine therapy (inverse correlation). Multivariate regression analysis revealed that RA is an independent risk factor for increased IMT. Factors correlating with IMT in the controls were: age, BMI, total cholesterol, LDL-cholesterol, total/HDL cholesterol, triglycerides and glycaemia.

Conclusions: Despite a favourable risk profile, our female RA patients had significantly enlarged carotid IMT than controls. RA itself was an independent risk factor for increased IMT. Impact of chronic inflammation on atherosclerosis was confirmed by negative correlation of IMT and duration of anti-inflammatory treatment.

Abstract category: Clinical case study

Scientific topic: Neurodegeneration and transcranial parenchyma sonography

Abstract title: NEUROIMAGING IN C-ANCA POSITIVE GRANULOMATOSIS WITH POLYANGIITIS

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Background: C-ANCA positive granulomatosis with polyangiitis (GPA) is a necrotizing vasculitis involving small vessels that causes multi-systemic granulomatous inflammation and can affect the central nervous system. It requires radiological diagnosis but there are not pathognomonic findings in the neuroimaging. We aim to present the unusual case of a GPA patient whose intracranial duplex showed characteristic changes.

Case report: A 52 year old woman is admitted to the emergency room presenting right facial palsy, motor aphasia and right hemiparesis. NIHSS 8. CT scan shows intracerebral haemorrhage in right basal ganglia. Transcranial duplex:

cerebral parenchyma shows hyperechogenic-echostructure around the basal ganglia due to the presence of multiple perivascular spaces dilatations. MRI: Multiple T2-hyperintense basal ganglia lesions, presented as hypointense areas on T1-weighted and FLAIR sequences in relation to prominent perivascular spaces.

Conclusions: GPA can provoke dilated perivascular spaces that can be detected not only in MRI but also in transcranial duplex. The usefulness of neurosonology in extracranial vasculitis is well known, however; transcranial duplex had generally only been used to measure velocimetric parameters.

Abstract category: Original research

Scientific topic: Cerebrovascular Diseases

Abstract title: ULTRASOUND SURVEILLANCE AFTER CAROTID STENTING TO DETECT RESTENOSIS

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Background: Clinical studies on carotid artery stenting (CAS) efficacy and security have shown good results on the reduction of periprocedural adverse events and during the first 12-24 months. However, long-term evidence on in-stent restenosis (ISR) is limited and therefore, duplex ultrasound (DUS) surveillance intervals are not unified amongst centres. Our purpose is to determine long-term ISR rate after CAS implantation in order to analyse the usefulness of close DUS surveillance after the procedure.

Methods: Retrospective observational study based on clinical history of patients that have undergone endovascular carotid stent intervention.

Results: 250 patients were included, mean age was 70.18 years (SD 8). 82.5% were male. 188 were followed-up for 5 years or more (mean follow-up 7 years). All patients had carotid DUS immediately after the procedure and at 1, 3, 6 and every 6 to 12 months thereafter. 16 (6.4%) patients suffered ISR, 3 of which (18.8%) occurred during the first year and 2 (12.5%) during the first 6 months. Mean ISR time was 34.5 months (range 5- 120).

Conclusions: We did not detect ISR in the first 4 months so it would be reasonable to postpone DUS to the 6th month after the procedure.



Abstract category: Clinical trial
Scientific topic: Cerebrovascular Diseases

Abstract title: THERE IS A CLINICAL BENEFIT OF SONOTHROMBOLYSIS

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Background: Sonothrombolysis (intravenous thrombolysis + TCD or TCCD), presents a promising method for treating the patients with acute cerebral infarction compared to mere intravenous thrombolysis with alteplase from the aspect of safety and therapeutic effect.

Methods: The patients who fulfilled criteria were treated with sonothrombolysis or intravenous thrombolysis. The efficacy was being estimated based on the Modified Rankin Scale (mRS) three months after the stroke. A favourable outcome – the mRS values ranging from 0-2. Safety was estimated based on the existence of symptomatic intracerebral hemorrhage. CT of the brain with CT angiography was performed up to 48 hours following the therapy. If the hemorrhage that could cause the increase in the NIHSS score by ≥ 4 , existed, it was considered to be symptomatic.

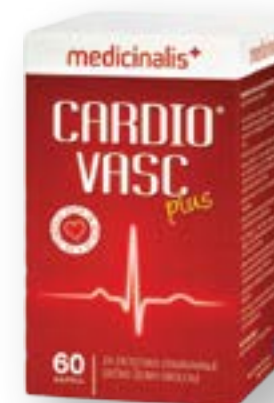
Results: There were 26 patients who were treated with sonothrombolysis and 84 patients who were treated with thrombolysis. The age (66,3 vs 68), initial neurological finding (NIHSS 14,1 vs NIHSS 14,5), did not show statistical differences. The patients who were treated with sonothrombolysis were statistically more often functionally independent relative to the patients treated with thrombolysis (61,5 % vs 39,2% ; OR 2,47; 95% CI: 1.0020 to 6.1022; P = 0.0495). There were no statistically significant differences related to symptomatic intracerebral hemorrhage between the examined groups (8% vs 7.5 %; P = 0.925).

Conclusion: Sonothrombolysis is considered to be safe and it increases considerably the percentage of patients that are functionally independent three months following the stroke compared to the patients that were treated only with intravenous thrombolysis.

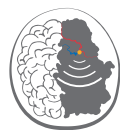
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**JEDINSTVENA FORMULA 10 AKTIVNIH SASTOJAKA
ZA TRETMAN KARDIOVASKULARNIH
I CEREBOVASKULARNIH OBOLJENJA**



1. Omega 3 iz ulja račića (Krill oil)
2. Fosfolipidi
3. Astaksantin
4. Koenzim Q10- prirodnog porekla
5. Magnezijum
6. Gvožđe
7. Vitamin B6
8. Vitamin B12
9. Selen
10. Cink



POSTER ABSTRACTS

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Abstract category: Clinical case study

Scientific topic: Cerebrovascular Diseases

Abstract title: **SUCCESSFUL TREATMENT OF SYSTEMIC AND CEREBRAL VENOUS THROMBOSIS COMPLICATING ANTITHROMBIN III DEFICIENCY WITH NON-VITAMIN K ANTAGONIST ORAL ANTICOAGULANTS (NOAC)**

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Background: Antithrombin III deficiency is a rare disease and results in condition of increased coagulation which can lead to venous thrombosis. The most frequent localizations are known in the veins of the legs, mesenteric veins, superficial periumbilical veins. A decreased activity of AT III may be resolved by the heparin or low molecular weight heparin administration. We report a case of systemic, including cerebral venous sinus thrombosis which was treated with NOAC successfully.

Case report: A 39-year-old woman visited emergency department with aphasia. She was nonsmoker and denied any previous disease including stroke, and familial history of vascular disease. She had no recent pregnancy, childbirth, medical history of oral contraceptives or hormone replacement therapy. On neurological examinations, she showed dysarthria and transcortical motor aphasia. NIH stroke scales were 2. Diffusion weighted MRI showed high signal intensity in left temporo-parietal subcortical and cortical areas without ADC restriction. SWI depicted petechial hemorrhages in the same areas. TOF and carotid enhanced neck MRA were normal. In MR venography, showed occlusion of left internal jugular vein, sigmoid sinus and transverse sinus. Abdominal & pel-

vic CT showed thromboses in right iliac and left renal veins. In laboratory findings, D-dimer and FDP increased to 1048 and 7.53, respectively, and antithrombin III decreased to 11%. SERPINC 1 gene analysis showed no deletion/duplication variant. After two weeks of low molecular-weight heparin(LMWH) and hypertonic saline, we switched to non-vitamin K antagonist oral anticoagulant, edoxaban. After 4 months, she had no headache and her aphasia improved to normal status. Follow-up MR venography depicted occlusion of sinus, however, abdominal & pelvic CT showed improved renal and iliac vein thrombosis.

Conclusion: There is a growing interest about NOAC in using to long term maintenance therapy for CVT. NOAC have several advantages over vitamin K antagonists including rapid onset of action, predictable pharmacokinetic properties and few drug interactions. Many recent studies reported that the outcomes of treatment with NOAC for CVT have been shown to be similar to those achieved with vitamin K antagonist and NOAC does not increase the risk of intracranial hemorrhage. However, there is no definite guideline yet, so further research is needed to show the efficiency of NOAC.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: DOLICHOARTERIOPATHIES OF INTERNAL CAROTID ARTERIES AND CEREBRAL PERFUSION

Authors: Golovin D.¹, Rostovtseva T.¹, Kudryavtsev I.¹, Berdalin A.¹, Lelyuk S.¹, Lelyuk V.¹

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Background: Dolichoarteriopathies of the internal carotid arteries (DICA) are thought to have the potential to affect cerebral perfusion. Existing ultrasound methods do not fully reflect the perfusion of brain tissue. The most reliable method for assessing the blood supply to the brain is perfusion computed tomography (CT). In this work, we performed perfusion CT in patients with lengthening of the internal carotid arteries revealed by echography.

Methods: MRI and perfusion CT angiography of the brain were performed in 31 patients with DICA and ischemic stroke of the contralateral hemisphere, as well as 14 patients in the control group with ischemic stroke in the hemisphere without DICA. In all patients, according to the results of duplex scanning of the brachiocephalic arteries, different types of dolichoarteriopathies were identified.

Results: A statistically significant decrease ($p < 0.05$) in the parameters of cerebral perfusion was found within the normal range in the

territories of elongated carotid arteries. We noted a correlation between the length of the convoluted carotid arteries and the age of the patients, but did not find a correlation between age and white matter disease (WMD). A statistically significant ($p < 0.005$) decrease in cerebral perfusion indices was recorded in the vascular areas of the anterior cerebral arteries and lenticulostriatal arteries on the side of the DICA. We also found a correlation between the degree of lengthening of the carotid arteries and the age of the patients, as well as the WMD of the brain. The association between the severity of the increase in blood flow velocity, and perfusion parameters has not been proven. We obtained similar results in an earlier pilot study.

Conclusions: The revealed decrease in the parameters of cerebral perfusion in the vascular areas of the anterior cerebral arteries and lenticulostriatal arteries in patients with DICA requires further research.

Abstract category: Original research
Scientific topic: Heart & Brain

Abstract title: THE STRUCTURE OF CARDIAC ARRHYTHMIAS IN PATIENTS WITH CARDIOEMBOLIC STROKE. HOLTER ECG MONITORING RESULTS

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Background: Cardioembolism is the leading cause of transient ischemic attacks and ischemic stroke. Sources of emboli can be not only walls and valves but also the formation of blood clots in the chambers when the rhythm is disturbed. Verification of potentially embologenic arrhythmias requires the use of long-term ECG monitoring.

Methods: In the period from January to August 2021, 956 people with suspected cardioembolic (according to TOAST) mechanism of development of acute focal cerebral ischemia treated with medical rehabilitation procedures in the early recovery period of ischemic stroke underwent 3-channels Holter ECG monitoring. The duration of the monitoring was at least 24 hours. The group of patients consisted of 330 (34.5%) women (64 ± 13 years old, 27-95 years old) and 626 (65.5%) men (60 ± 11 years old, 21-90 years old).

Results: Among the identified variants of cardiac arrhythmias, the proportion of long-stan-

ding persistent atrial fibrillation was 8.37% (80 people CI: 6.69-10.31%); paroxysmal atrial fibrillation 1.36% (13 people CI: 0.73-2.31%), supraventricular extrasystole (<1000 episodes) – 49.06% (469 people CI: 45.84-52.28%), supraventricular extrasystole (>1000 episodes) – 6.9% (66 people CI: 5.38-8.70%); ventricular extrasystoles (<1000 episodes) – 42.89% (410 people CI: 39.72-46.09%); ventricular extrasystoles (>1000 episodes) – 6.8% (65 people CI: 5.29-8.58%), supraventricular tachycardia 23.43% (224 people, CI: 20.78-26.25%), ventricular tachycardia 3.97% (38 people CI: 2.83-5.42%), AV block ≥ 2 nd-degree 0.94% (9 people CI: 0.43-1.78%).

Conclusions: As a result of the analysis of 24-hour Holter ECG data, the most frequent variant of a rhythm disturbance in the patients examined, who have a potentially high risk of ischemic stroke of the cardioembolic type, is supraventricular extrasystole (49.06%). The rate of the most embologenic atrial fibrillation was 9.73%.

Abstract category: Original research
Scientific topic: New Methods

Abstract title: TRANSCRANIAL TISSUE DOPPLER (TCTD) MEASUREMENT OF BRAIN TISSUE MOTION; SOFTWARE DEVELOPMENT

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Background: Ultrasound measurement of cardiac-induced brain tissue motion using transcranial tissue Doppler (TCTD) has potential to inform the development of medical devices aimed at diagnosis and monitoring of patients with brain injury. The aim of this project was to create versatile software package to support future analysis of TCTD data across a range of research projects.

Methods: A Graphical User Interface (GUI) and TCTD analysis package was developed in MATLAB (Mathworks, Natick, MA) to display and analyse continuous ultrasound brain tissue motion measurements acquired using a single-element 2 MHz TCD. Doppler sample depths selected for analysis ranged from ~2 to 8 cm beneath the probe's surface with a pulse repetition frequency of 500 Hz.

Results: A GUI was developed to enable researchers to review continuous TCTD recordings displaying either velocity or displacement estimates as well as backscattered signal intensity. The software automatically adds markers to indicate cardiac R-R intervals measured u-

sing a three-lead electrocardiogram (ECG), as well as facilitating the removal of artefacts, and enabling comparisons between TCTD data and other continuous physiological measurements (such as blood pressure, intracranial pressure, accelerometer, and capnography data). The GUI allows automated extraction of TCTD features (such as pulsation amplitude and 'time-to-peak') for future statistical analysis or use with machine learning algorithms. The GUI comes with an instruction manual and is suitable for use by non-experts with minimal training.

Conclusions: Our TCTD analysis software provides a powerful tool for future research. The software is currently being tested for analysis of clinical and healthy volunteer physiological measurement data and has been successfully used to explore the relationship between the amplitude of brain tissue pulsations and Et-CO₂, blood pressure, and heart rate. Future applications will focus on analysis of brain tissue pulsations measured in acute stroke patients to establish whether brain biomechanics are disturbed in the presence of stroke.

Abstract category: Original research
Scientific topic: New Methods

Abstract title: IMPROVED ENVELOPE DETECTION AND FIT FOR PATHOLOGICAL TCD WAVEFORMS

Authors: Thibeault C.M.¹, Jalaieddini K.¹, Elliott J.¹, Dorn A.Y.¹, Radhakrishnan S.¹, Hamilton R.B.¹

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Background: Transcranial Doppler (TCD) ultrasonography is a well-established, guideline-supported modality for the evaluation of cerebral hemodynamics. The TCD spectrogram envelope represents the maximal cerebral blood flow velocity (CBFV) and is used as the basis to indicate hemodynamically significant metrics including the systolic, diastolic, and mean velocities, Pulsatility index, systolic upstroke, and other waveform morphological metrics. The accuracy of these metrics; however, relies upon the accuracy of the envelope trace. Industry-standard envelope trace uses a modified geometric mean (MGM) method, which often fails in cases of low end-diastolic, high peak-systolic velocities, poor signal (signal-to-noise-ratio) and in instances of multiple flows (e.g. stenotic flow). We introduce and validate a novel envelope trace algorithm that accurately traces spectrograms in the aforementioned cases.

Methods: The new envelope trace is an adaptive algorithm that utilizes the interquartile signal range as follows:

1. Time-domain smoothing to pre-process signal
2. Signal to noise ratio assessment
3. Statistical modeling of noise to determine

highest velocities and subsequent envelope detection

4. Time-domain smoothing post-processing
For validation, 50 exams of 10s images with known envelope traces were used spanning the cases where MGM fails. The improvement in accuracy (difference in % variance accounted for) and improvement in percentage error in estimate of clinical parameters (systolic/diastolic velocity/pulsatility index) are reported.

Results: Compared to traditional envelope tracing (MGM algorithm), the new envelope trace demonstrated 14-56% improvement in trace accuracy, 12-71% improvement in diastolic velocity accuracy, 6-16% improvement in systolic velocity accuracy, and up to 211% improvement in accurate determination of pulsatility index.

Conclusions: A new adaptive envelope trace algorithm is demonstrated, showing significant performance improvement over state-of-the-art envelope trace algorithm based on clinically relevant metrics. Based on the technique, this algorithm could potentially be used for applications beyond transcranial pulsed wave Doppler as well.

Abstract category: Original research
Scientific topic: Other/Miscellaneous

Abstract title: ASSESSMENT OF RECOVERY AFTER MILD TRAUMATIC BRAIN INJURY WITH CEREBRAL HEMODYNAMICS: AGE MATTERS

Authors: Thibeault C.M.¹, Radhakrishnan S.¹, LeVangie J.¹, Sheridan C.², Brown A.², Bickart K.², Rafe D.², Choe M.C.², Giza C.C.², Hamilton R.B.¹

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Background: Altered cerebral hemodynamics after mild traumatic brain injury (mTBI) represent a significant diagnostic and therapeutic target. Previous studies have found increases in cerebrovascular reactivity (CVR) in adolescent athletes after mTBI; this conflicts with studies of older athletes that have demonstrated a decrease in CVR. Here, we compare the cerebral hemodynamic changes after an mTBI in injured adolescent and college-aged athletes across different time points.

Methods: Subjects were adolescent (N=69, 40% female, 15.6±1.2 years) and college-aged athletes (N=141, 49.6% female, 20.2±1.1 years), with cases assessed at multiple points following mTBI (N=30, 23.3% female, adolescent; N=46, 50% female, college-aged). These were contrasted with controls (N=39, 51% female, adolescent; N=74, 47.3% female, college-aged). Bilateral measurements of the MCA were recorded during a 5-minute baseline, followed by two 60-second hypercapnia challenges (CO₂ gas). Self-reported symptom scores were collected.

Analysis was completed using Linear Mixed Effects models.

Results: In the adolescent cohort, significantly increased CVR was observed across days 2-6, and days 8-9 post-injury. The college-aged cohort exhibited decreased CVR over a similar period. A significant fixed effect was only found on day 3. Fixed effects of gender in both cohorts were observed to reach significance for mean velocity (F>M), pulsatility index (M>F), and P2R (F>M), but not CVR. For both cohorts, significant effects were observed for symptoms indicating elevated reporting in the initial 7 days post-injury. Importantly, there was no significant effect of cohort in the combined population symptom model.

Conclusions: These results suggest that the different responses to the hypercapnia challenge cannot be directly attributed to a difference in injury severity as measured by self-reported symptoms, and that a critical period of hemodynamic development occurs between these two age cohorts.

Abstract category: Original research
Scientific topic: New Methods

Abstract title: ALGORITHM FOR IDENTIFICATION OF SHOWERS AND CURTAINS ON TCD ULTRASOUND

Authors: Thibeault C.M.¹, Elliott J.¹, Dorn A.Y.¹, Zhao A.¹, Canac N.¹, Thorpe S.G.¹, Radhakrishnan S.¹, Hamilton R.B.¹

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Background: The identification of emboli curtains, or an un-countable shower of emboli, on TCD has applications in bubble studies for Patent Foramen Ovale (PFO)/Right-to-Left (RLS) shunt assessment and for intra-operative monitoring. During a bubble study, the number of microembolic signals (MES) displayed is quantified to grade the size of the shunt. Identification of emboli showers/curtains is imperative for the assessment of pathology and requires expert interpretation. This introduces subjectivity that can be problematic for non-expert users and ultimately harmful to the patient. We present an objective metric that identifies regions of interest (ROI) in the exam with MES showers/curtains to increase diagnostic confidence from TCD.

Methods: The Shunt Grade Assist (SGA) algorithm creates signal and noise models from the power MMode. Regions of high activity in the signal are then found by comparing these models over a moving window. SGA was validated with clinical data collected using our fully autonomous NovaGuide robotic TCD. ROIs were manually labeled, and SGA was scored as a binary classifier and by a matching score that ranged from -1 (no match) to 1 (complete match).

Results: The performance of SGA algorithm was 226 true positives, 307 true negatives, 48 false positives, and 1 false negative out of 582 total patient exams collected. This yielded a sensitivity of 99.6% and specificity of 86.5%. The grading scheme resulted in a positive region grade of 0.68, control grade of 0.95, and an overall grade of 0.84.

Conclusions: The automated identification of ROIs for showers/curtains demonstrates the utility of advanced algorithms to aid in the identification of significant events, increasing diagnostic confidence for non-expert users. This suggests that SGA algorithm is a useful tool for the identification of embolic ROI and can be used to improve confidence in detecting emboli, especially among naïve TCD users and for longer exams.

Abstract category: Original research
Scientific topic: New Methods

Abstract title: DEEP LEARNING ALGORITHM FOR GRADING RIGHT-TO-LEFT SHUNTS

Authors: Thibeault C.M.¹, Ung A.¹, Zhao A.¹, Dorn A.Y.¹, Dayanim D.¹, Radhakrishnan S.¹, Hamilton R.B.¹

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Background: The utility of transcranial Doppler ultrasound (TCD) in identifying right-to-left shunts (RLS) is well established. However, the interpretation of the results can be a barrier for naive users. In this work we demonstrate a method for simplifying this process, by employing deep learning techniques to automate the interpretation of TCD bubble studies and the grading of an RLS called auto shunt grade (ASG). In addition, we are proposing a three grade scale that further simplifies the identification of shunts.

Methods: Three grades of RLS were defined based on the number of emboli counted unilaterally (Negative: no bubbles, Minor: 1-10 bubbles, Significant: >10 bubbles).

The training data for ASG was created through computationally simulating the Doppler shifted ultrasound response to blood cells and gaseous emboli in pulsatile flow. The data was created in 60-second Power M-Mode segments with 33 depths. A total of 100,284 segments were generated for training (80%) and validation (20%).

For testing, healthy subjects were scanned with a NovaGuide 2 Intelligent Ultrasound for 60 seconds bilaterally (n=110, 39.7±14.7 years, 40% female). This dataset was then further enriched using segments from a flow-phantom with automatic bubble injection. ASG employs a stereotypical image classification network configuration. The bottom layers consist of convolutions of increasing filter size, with two fully connected dense layers feeding a softmax activated output.

Results: The ASG algorithm had an overall accuracy of 97% with individual grades having precision, recall, and F1-score of Negative: 0.97, 0.99, 0.98, n=220; Minor: 0.96, 0.87, 0.91, n=86; Significant: 0.97, 0.99, 0.98, n=177.

Conclusions: ASG provides both naive and experienced users more confidence when identifying an RLS. Furthermore, the high sensitivity for the Significant grade illustrates that clinically meaningful shunts are seldom missed.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: TCD WAVEFORM ANALYSIS FOR DIFFERENTIATING LARGE-VESSEL AND DISTAL OCCLUSIONS

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Background: Traditional transcranial Doppler (TCD) ultrasound metrics in the acute phase of large-vessel occlusion (LVO) diagnosis have been shown to provide complementary value to current standard-of-care triage modalities. In addition to these metrics, pulse-level morphological features have also begun to show diagnostic utility. This study explores Velocity Curvature Index (VCI), one such morphological feature. VCI is an application of curvature, which quantifies the degree to which a beat morphologically deviates from normal. This reduces the dimensionality of a pulse, and has shown discriminatory power when comparing LVO subjects (ICA, M1, M2, MCA segments) to controls. This study extends beyond that binary case to explore how VCI changes in subjects with distal occlusions (M3, M4, MCA segments, and lacunar).

Methods: The three cohorts were confirmed by CTA imaging and were comprised of LVO (n=36, 70±20.4 years, 52% male), Distal occlusion (n=7, 67±14.6 years, 77% male), and Controls

(n=35, 57±16.5 years, 61% male). In addition to standard imaging, bilateral TCD measurements of the middle cerebral artery were collected. TCD waveforms were sampled at 30-s intervals and further processed by extracting the corresponding beats and resulting VCI for each subject.

Results: A one-way ANOVA revealed a significant effect of cohort on VCI [F(2, 75) = 41.76, p<0.001]. Post-hoc analysis using Bonferroni correction, found significant differences between LVO (2.83 ±0.92) and Controls (5.09±1.14) [p<0.001], Distal (3.97±1.13) and controls [p<0.05], as well as Distal and LVO [p<0.05] groups.

Conclusions: In this case the distal occlusion group had VCI values between the LVO and control groups — supporting VCI as a continuous estimate of vascular dysfunction. Furthermore, the extension beyond binary discrimination illustrates the use of VCI as a complementary measure of ischemic stroke severity.

Abstract category: Clinical case study
Scientific topic: Cerebrovascular Diseases

Abstract title: INTRACRANIAL ARTERY DISSECTION (IAD) AND POSSIBLE ALTERNATIVE TREATMENT HYPOTHESIS

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Background: IAD is an uncommon and under-diagnosed disease, the aim is to identify its pathophysiological mechanisms and possible alternative therapies.

Methods: Eight patients (pts.), referred to the Emergency Department with focal signs, were studied. Work-up: neurological examination, brain CT-MRI/AG, Digital-Angiography (DA), Ultrasounds.

Results: All pts. were diagnosed with cerebral ischemia. AG highlighted intradural internal carotid artery (ICA) dissection in three pts. and both intra- and extracranial ICA dissection in one pt. In one subject subarachnoid haemorrhage from rupture of intradural ICA dissecting aneurysm, treated with embolization, was observed; in another pt. dissection of the basilar artery (BA) was detected. The other pts. were found to have vertebral artery dissection (VAD). Ultrasounds monitoring, given in all pts. during Stroke Unit hospitalization, detected intradural ICA occlusion in two subjects; a pt. with fibrodysplasia showed a typical finding of both intra-extracranial bilateral ICA dissection and

vicarious external carotid arteries plus intracranial anterior and posterior compensation. Ultimately VA occlusion in 2 pts. and post-ricanalization stenosis in three cases were observed. Four pts. were given Actilyse, followed by mechanical thrombectomy (MT) in two subjects; one pt. underwent only BA MT. The thrombolytic was administered in all pts. with confirmed diagnosis of vessel occlusion prior to the dissection finding. Subsequent and alternative therapy: aspirin. The three-month outcome was good.

Conclusions: The thrombolytic therapy didn't cause bleeding in small sample of examined pts., thus suggesting that it acts on the thrombotic process, without affecting the integrity of the vessel wall, although the latter is poorly equipped with elastic fibers and easily vulnerable to any noxa, probably more traumatic than pharmacologic. The study of these few cases highlights the role of ultrasound in confirming dissection diagnosis and provides ideas to reflect on alternative treatments that could envisage, after specific trials, the use of thrombolysis also in intracranial vessels dissections.

Abstract category: Clinical case study
Scientific topic: Cerebrovascular Diseases

Abstract title: THROMBY ANALYSIS: FURTHER IN STROKE PHISYOPATHOLOGY, HAEMODYNAMICS AND POSSIBLE THERAPEUTIC PERSPECTIVE

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Background: Recent studies reported the questionable utility of bridging therapy with intravenous thrombolysis versus mechanical thrombectomy (MT) in acute ischemic stroke (AIS) with large vessel occlusion (LVO). This study focuses on the composition of extracted thrombi and the resulting haemodynamic repercussions on the cerebral circulation.

Methods: Thirty-seven LVO AIS patients (pts.) who were given either bridging therapy or MT, were studied.

Results: Twenty-three pts. underwent combined treatment and 14 isolated treatment (MT). Recanalization was achieved in all, but two pts., with a good outcome in 29 pts. The length of thrombi was difficult to assess, as they rupture during the procedure; the morpho-histological analysis highlighted the presence of fibrin, red blood cells (RBC), platelets, leukocytes. An almost similar amount of white and red thrombi was observed with a nearly overlapping distribution in both procedures. vWF expression was higher in pts. treated with combined treatment, in line with fibrin load.

The lower thrombus porosity seemed to promote collateral circulation.

Statistics: Both procedures led to a favourable outcome: $P < 0.001$; no association between fibrin load, RBC load, hyperemia and type of treatment, either isolated or combined, was found: $P > 0.05$ (MWT); an association trend between fibrin and atherosclerotic load: $P = 0.1$ and a correlation between collateralization and MT: $P = 0.037$ (χ^2 test) was also detected; almost total agreement between AG and Ultrasound was evident.

Conclusions: The study reveals the poor fibrinolytic efficacy of r-tPA against the thrombotic mechanism activation, especially in concurrence with a large atherosclerotic load. Without the proven superiority of MT, our investigation suggests that further research on thrombi, to supplement those already in progress, are required to identify alternative thrombolytics, a successful "cocktail" of thrombolytic combined with antiplatelet agents or anticoagulants, at different doses, antibodies neutralizing pro-thrombotic factors, ADAMTS-13 enzymes and Nets, nanobodies and novel ultrasounds.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: ISCHEMIC STROKE WITH DOLICHOECTASIA OF THE BASILAR ARTERY, RADIOLOGY EXAMINATION

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Background: Dolichoectasia of the cerebral arteries, which is nonsaccular intracranial aneurysm, is considered rare vascular pathology, most often affecting the arteries of posterior circulation (in particular – basilar artery). Clinical manifestations of basilar artery dolichoectasia (BADE) are very diverse, most often BADE is accompanied by development of ischemic stroke (IS) of the brain stem. The aim of this study was a comprehensive radiology assessment of patients with BADE who underwent IS.

Methods: Retrospectively, we recruited 10 patients (8 men and 2 women aged 67±8 years) with BADE and IS. The comparison group (patients after IS without BADE) consisted of 1000 patients (588 men and 412 women aged 60±13 years). MRI and MSCT of the brain and intracranial arteries, ultrasound DS were performed. 2 patients with BADE underwent contrast-enhanced (CE) MRI of the vascular wall.

Results: In patients with BADE, the infarction focus was localized in anterior circulation in

70% cases (left MCA – 4 patients, right MCA – 2, borderzone MCA/PCA – 1), in posterior – 30%. The diameters of all intracranial arteries (ICA, MCA, ACA, BA, and PCA) in patients with BADE were significantly larger ($p < 0.05$), and blood flow velocity in them was significantly lower than in control group. For example, with BADE, the diameter and peak systolic blood flow velocity in right MCA/M1 was 3.7 ± 0.6 mm, 55 ± 14 cm/s (2.8 ± 0.5 ; 97 ± 35 in control group respectively), in left MCA/M1 – 3.5 ± 0.7 , 66 ± 30 (2.9 ± 0.8 ; 94 ± 31), in BA – 5.9 ± 1 , 32 ± 12 (3.6 ± 0.7 ; 56 ± 23). MRI of vessel wall in patients with BADE revealed areas of CE accumulation not only in the BA wall, but also in the vascular wall of other cerebral arteries.

Conclusions: In elderly patients with BADE, changes are revealed not only in BA, but also in other cerebral arteries, which may indicate the generalized nature of the pathological process.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: MICROEMBOLIC SIGNALS IN PATIENTS AT RECOVERY PERIOD OF ISCHEMIC STROKE

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Background: Transcranial doppler embolodetection is a non-invasive, reproducible method for emboli detection in the cerebral arteries bloodstream. Prevailing opinion is that microemboli usually do not cause the clinical symptoms, but are markers and predictors of macroembolism. Another point of view: prolonged massive microembolization has a cumulative effect and leads to vascular dementia. Detection of microemboli within three months after a stroke may be a predictor of recurrent stroke and death. Despite the prognostic value of recorded microembolic signals (MES), their pathogenetic role is not fully understood. The aim of this study was to compare patients with and without MES in the late recovery period of IS to identify clinical and diagnostic parameters, associated with MES.

Methods: We include 515 patients with ischemic stroke. MES in MCA or PCA was observed in 48 (9.3%) patients, in 467 (90.7%) MES were not detected. All patients underwent: brachiocephalic arteries duplex scanning, echocardiography, microembolodetection, brain MRI, brain MSCT.

Results: According to brain MRI data in patients with MES, the limbic system atrophy on the right side (MTA scale) was significantly greater than in patients without MES ($p = 0.017$). On the left side, a similar picture was observed ($p = 0.13$). In patients with MES, the frequency and severity of deep microbleeds were significantly higher ($p = 0.045$). Vascular wall thickness (atherosclerotic plaque height) according to MSCTA was higher in patients with MES, for example: brachiocephalic trunk 4.00 ± 1.48 mm and 1.88 ± 1.49 mm, respectively ($p = 0.002$); right CCA – 2.90 ± 2.18 mm and 1.18 ± 1.30 mm ($p = 0.006$); left CCA – 2.23 ± 1.50 mm and 1.33 ± 1.13 mm ($p = 0.072$); left ICA bulb 3.49 ± 1.76 mm and 1.79 ± 1.32 mm ($p = 0.003$).

Conclusions: MES in our patients was associated with wall thickness in the CCA and ICA, atherosclerosis in the ascending aortic arch. There was no connection with cardiac pathology, concomitant diseases, defects in the plaque lining. The main cause of MES in our cohort is atherosclerosis, possibly aortic.

Abstract category: Original research
Scientific topic: Other/Miscellaneous

Abstract title: DEVELOPMENT OF A FLOW-PHANTOM FOR TRANSCRANIAL DOPPLER
ULTRASOUND QUALITY ASSURANCE

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Background: Transcranial Doppler (TCD) ultrasound estimates of blood flow have potential to vary due to differences in methods for calculating 'mean velocity' and the absence of angle correction. Here we describe a Middle Cerebral Artery (MCA) flow phantom aimed at clarifying the interpretation of TCD velocity estimates and for use in assessing whether estimates vary between manufacturers.

Method: Our MCA flow phantom comprised 3 mm internal diameter c-flex tubing embedded within a validated tissue-mimicking material at an angle of 30°. A programmable pump circulated blood mimicking fluid (BMF) in a closed loop to generate a typical 'textbook' MCA waveform with a "mean TCD velocity" of ~55 cm/s. Time-averaged velocity estimates were then obtained using two TCD devices (Spencer Technologies, USA, and DWL, Germany), a B-mode scanner (Zonare, USA), and with timed collection as the gold standard.

Results: TCD machines displayed reproducible time-averaged MCA velocity estimates, with an

average of 57.3 ± 0.43 cm/s for the DWL TCD and 57 ± 0.21 cm/s for the Spencer system. Timed collection confirmed that TCD devices display the "mean of the peak velocity envelope", which is around twice the mean velocity. Assuming laminar flow, 57 cm/s corresponds to a mean velocity or 28.5 ± 0.2 cm/s, or 33.25 ± 0.2 cm/s after correcting for a 30° Doppler angle. Following this conversion, mean TCD velocity estimates were in good agreement with the 33.25 cm/s found on imaging and true mean flow velocity of 33 cm/s confirmed by timed collection.

Conclusion: Our phantom provides a useful tool for exploring confusion surrounding TCD blood flow estimates, including differences between devices. The TCD machines we tested provided reassuringly similar velocity estimates, but care should be taken when comparing velocity estimates between TCD and imaging systems, remembering that TCD displays the "mean peak velocity" which will be roughly twice the non-angle corrected time-averaged mean velocity displayed by imaging devices.

Abstract category: Clinical case study
Scientific topic: Cerebrovascular Diseases

Abstract title: IN VIVO INTERNAL CAROTID "TAIL" EMBOLIZATION DIAGNOSED BY
TRANSCRANIAL DOPPLER

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Background: Internal carotid artery (ICA) occlusion presents a risk for ischemic stroke from distal embolization. Proposed source(s) of emboli include the "stump" (proximal aspect of occlusion) through ipsilateral external carotid artery (ECA) collaterals, the "tail" (distal aspect of occlusion), or via collaterals, especially the contralateral ICA and retrograde anterior cerebral artery (ACA) ipsilateral to the occluded ICA. There are no reports demonstrating a "tail" origin of embolization in vivo, which we demonstrate here using transcranial Doppler (TCD).

Results: A 55-year-old Caucasian male had left leg weakness and numbness from a right hemisphere ischemic stroke. CT angiography (CTA) revealed right ICA occlusion from origin to the distal intracranial segment with short segment of preserved terminus and left ICA stenosis of

60% by NASCET criteria. TCD demonstrated antegrade right MCA flow, turbulence at the right ICA terminus, anterior crossflow (left-to-right) via retrograde right ACA, antegrade ophthalmic artery (OA) on the right and absent right ICA siphon signal. There were four microembolic signals (MES) meeting consensus criteria for spontaneous emboli in the right MCA distribution. Each arose in the same location – the sonographically turbulent terminal R-ICA. No MES were noted in the left MCA, left ACA or right ACA that were all simultaneously monitored in real time with the right MCA.

Conclusion: TCD can isolate the source of MES by combining the results of a complete study and real-time monitoring of all relevant arterial segments, and thereby TCD can provide in vivo evidence of ICA "tail" embolization.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: COGNITIVE DECLINE AND CAROTID ARTERIES ATHEROSCLEROSIS IN PATIENTS WITH ESSENTIAL HYPERTENSION

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Background: To determine the association between cognitive function, parameters of carotid arteries structure and cerebral blood flow in patients with essential hypertension (EH).

Methods: In 148 pts with EH (average age 59,25±1,65; 89 males) we measured ultrasonographically diameter (D) of common carotid arteries (CCA), carotid intima-media thickness (IMT) value at the carotid bifurcations and at the level of CCA, blood flow velocities (BFV) in media(MCA), anterior(ACA), posterior(PCA) cerebral arteries. Cognitive function was assessed in all pts by Montreal cognitive assessment (MoCA) test. All patients were divided into 2 groups depending on the MoCA results: group I (n = 71) – MoCA score<26, group II (n =77) – MoCA score≥26.

Results: There was not significant difference in age between two groups. Pts with cognitive impairment had significantly greater carotid structural changes: pts of gr.I had DCCA 8,53±0,02

mm, IMT at the carotid bifurcation 1,69±0,02 mm, IMT at the level of CCA 1,16±0,02 vs pts of gr.II accordingly: 7,59±0,02 mm (p<0,05), 1,31±0,02 mm, 1,01±0,02mm (p<0,05) and significantly lower end diastolic BFV in MCA, ACA, PCA (accordingly: MCA – 0,49±0,02 vs 0,62±0,02m/s, p<0,05, ACA – 0,41±0,02 vs 0,50±0,02m/s, p<0,05, PCA – 0,30±0,01 vs 0,38±0,01m/s, p<0,05). Peak systolic BFV were not significantly different. MoCA results were related to IMT at the carotid bifurcation value (r = -0,53; p < 0,01), MCA end diastolic BFV (r = -0,63; p < 0,01). The same relations were between MoCA results and end diastolic BFV parameters of ACA and PCA.

Conclusions: Cognitive impairment in patients with essential hypertension is more closely associated with atherosclerotic changes of the carotid arteries rather than their hypertensive remodulation and increased vascular resistance of the cerebral arteries, which is manifested by a decrease in their diastolic blood flow velocity.

Abstract category: Clinical case study
Scientific topic: Cerebrovascular Diseases

Abstract title: REPERFUSIVE STRATEGIES IN THE ACUTE STROKE: OUR EXPERIENCE AND FUTURE WORKING HYPOTHESES

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Background: Thrombolysis is the approved treatment of the acute ischemic stroke, not always successful, the aim is understanding the ischemia pathophysiology to suppose adjuvant therapeutic strategies.

Methods: 223 patients (pts.), age range 18-93, referred to the Stroke Unit, underwent intravenous thrombolysis (IV-TL) and/or endovascular treatment (EVT). Work-up: brain CT/CT-Angiography, DW-PW-Flair-MRI/PW-CT in selected cases, diagnostic and therapeutic Digital Angiography (DA), Ultrasound Monitoring.

Results: DA confirmed the steno-occlusions detected by CT-AG showing active collaterals in 55 pts. (72.3%). 147/223 (65.9%) pts. received EVT; 76/223 (34%) pts. isolated EVT (42%) or associated with IV-TL (57.8%); average time since symptoms onset to IV-TL and EVT was 1-2 hours. 30 pts. (39%) exhibited complete (TICI 3) and early recanalization. Favourable outcome at three months (0-2 mRS) in 137/223 (61.4%) pts., moderate outcome (mRS: 3) in 21 (9.4%) pts., unfavourable in 66/223 (29.5%) pts.; the latter being often affected by TACS, having a greater atheromatic load, poor collateralization and more haemorrhagic complications.

Statistics: tendency to favourable outcome in pts. with primary compensations and higher Careggi Collateral Score, a higher TICI correlates with a better outcome at three months (p < 0.005); correlation between shorter procedure and lesser disability at three months (p<0.001), correlation between lysis or compensation-induced recanalization and favourable outcome (p< 0.005).

Conclusions: Reperfusion is achieved through thrombolysis and/or collateral flow with a better outcome when both events occur. Ineffective congenital collateralization or macro and microcirculation damage may impair any compensation, with slower flow, thrombosis and haemorrhagic complications. Hence, far from inducing reperfusion, recanalization procedures can result in re-occlusion. This study shows that, while providing satisfactory results, the above strategies are not always successful. Therefore, additional and alternative therapies should be considered encouraging studies and trials on sonothrombolysis with magnetically or otherwise targeted microbubbles, alternative thrombolytics, nanomolecules that support thrombolysis and strengthen the rete mirabile.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: ARE NON-DOMINANT VERTEBRAL ARTERIES MORE PRONE TO DISSECTION?

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Background: Arterial dissections are characterized by the tearing of the wall layers of the vessel and in the case of vertebral arteries they may be responsible for about 2% of all vertebro-basilar strokes. The diameter of the vertebral arteries (VA) varies widely being considered hypoplastic if < 2 mm. There is some evidence that VA dissections occur more frequently in the hypoplastic ones but no studies looked for an association with the dominants.

Methods: A retrospective analysis of VA dissection was performed at a neurovascular ultrasound unit where patients were evaluated for initial diagnosis or follow-up. The criterion for VA dominance was a difference in width ≥ 1 mm compared to the contralateral vessels. Hypoplastic VA were defined as difference in lumen diameter of < 2 mm. Clinical files were reviewed by a neurologist and the diagnostic images were evaluated independently by two senior neuroradiology residents who agreed with the presence of both direct signs of dissection (wall

hematoma, double lumen or intimal flap) and indirect signs (arterial stenosis or occlusion). A discriminative analysis was performed using the SPSS 22.2 software (2016).

Results: Thirty-three patients were identified and 4 of them were excluded because of missing relevant data. The mean age of the remaining 29 patients was 47.4 years (SD = 13.01 years) being 21 (72.4%) males. A total of 22 (75.9%) patients were classified as spontaneous and in 5 (24.1%) cases as traumatic according to their history. In 15 (51.7%) cases, VA dominance was found and in 2 (6.9%) cases the criteria of hypoplasia was met. In the group of VA dominance, dissection occurred in non-dominant arteries in 13 (86.7%) cases. This was statistically significant ($p=0.01$).

Conclusions: VA dissections were more frequent in the non-dominant vessels, Ultrasound examiners should be aware of this possible vulnerability in adequate clinical setting.

Abstract category: Original research
Scientific topic: New Methods

Abstract title: DIAGNOSTIC ACCURACY OF THE SUBOCCIPITAL APPROACH IN THE DIAGNOSIS OF RIGHT-LEFT SHUNT BY TRANSCRANIAL DOPPLER

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Background: Patent Foramen Ovale (PFO) is a congenital cardiac hole persisting in about 25% of the adults. Albeit most patients with PFO remain asymptomatic, there is a growing evidence that this may be responsible for ischemic events, mainly in young individuals. Transcranial Doppler with injection of saline contrast medium (TCD-c) via transtemporal window is currently used for detection of right-left shunt (RLS), identifying PFO and even non-cardiac sources. However, anatomical characteristics may limit this path in about 10% of the cases. We hypothesized that suboccipital insonation of the posterior circulation could be an alternative approach to detect RLS, however, there are no data validating this method. We aimed to compare the diagnostic accuracy of the suboccipital versus transtemporal approaches using TCD-c in the detection of RLS.

Methods: A prospective cohort of patients with the diagnosis of TIA or stroke was evaluated at a Neurosonology Laboratory from September 2019 to February 2020 to investigate RLS. The

evaluations were performed by TCD-c using the bilateral transtemporal approach (MCA's) and the suboccipital approach (Basilar Artery) with and without the Valsalva Maneuver (VM). The microembolic signals (MES) were quantified as: 0 = negative; 1-25 MES = isolated; > 25 MES = "shower"; countless = "curtain". The number of MES in both approaches, were compared using the Kappa-Cohen test.

Results: 61 patients (males = 45.9%) were included with a mean age of 53 years, (SD = 10.2). The Kappa-Cohen test value for concordance without VM was 0.85 with standard error 0.06. The agreement with the VM was 0.86 with standard error 0.06.

Conclusions: We found an almost perfect agreement between transtemporal and suboccipital approaches. So, suboccipital approach appears to be an accurate alternative to identify RLS, when the transtemporal one is not available.

Abstract category: Original research
Scientific topic: New Methods

Abstract title: COMPARISON OF TRANSCRANIAL DOPPLER SIGNAL TO NOISE IN HUMAN AND ROBOTICALLY ACQUIRED CLINICAL CONTROL GROUPS

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Background: High training requirements for ultrasound technicians have long been an obstacle to widespread adoption of TCD for acute stroke assessment, despite its status as a noninvasive, inexpensive, and conveniently portable imaging technology. In this work we compare TCD signal quality measured in a clinical control population by an expert human sonographer to that acquired robotically with the Lucid Robotic System (LRS), a device which automates TCD data acquisition.

Methods: Subjects were enrolled at Erlanger Medical Center (Chattanooga, TN, USA), as part of an ongoing TCD study of large vessel occlusion (LVO). To ensure the presence of LVO did not impact signal quality, only CTA-confirmed non-LVO control subjects were included in the current analysis. CBFV waveforms were recorded in 30 second intervals at multiple depths along the left/right Middle Cerebral Arteries of 105 total subjects: 71 via LRS, and 34 via manual examination by the same expert sonographer. To assess signal quality for each recording, both

Signal to Noise Ratio (SNR), and the proportion of each recording rejected as artifact, were computed and subsequently compared across groups via bootstrapped empirical p-values, with a critical level of 0.05 specified for significance.

Results: An average SNR of 10.57 (SD=4.23) was observed for LRS exam recordings, compared to an average of 10.29 (SD=4.68) observed for manual recordings. Observed group differences ($p=0.086$) did not reach the threshold for significance. However, the proportion of rejected signal averaged 12% (SD=9%) for LRS recordings, compared to 14% (SD=10%) for manual recordings, with observed group differences exceeding threshold significance ($p<0.01$).

Conclusions: These preliminary results suggest LRS is capable of measuring TCD in a clinical setting with signal quality which does not significantly deviate from an expert human sonographer, with a smaller proportion of signal rejected as artefact.

Abstract category: Original research
Scientific topic: Therapeutic applications

Abstract title: FULLY AUTOMATED ROBOTIC CONTROLLED TRANSCRANIAL DOPPLER ULTRASOUND MEASUREMENTS OF CEREBRAL BLOOD FLOW VELOCITY: IMPLICATIONS FOR ASSESSMENT OF INTRACARDIAC RIGHT-TO-LEFT SHUNT

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Background: Presence of cardiac Right-to-Left Shunt (RLS), usually through a patent foramen ovale (PFO), is shown to be a contributing factor to stroke and migraine. Contrast Transcranial Doppler (TCD) has proven excellent diagnostic accuracies that makes it a safe, non-invasive and cost-efficient test for detecting RLS [1]. However, TCD is underutilized due to lack of expertise. Insonation of at least one middle cerebral artery (MCA) is the minimum requirement for a diagnostic contrast TCD exam. Automated robotic signal acquisition could vastly improve ease of use and level of expertise required on site. We did a retrospective analysis to evaluate the efficacy of the investigational Lucid Robotic System (LRS) system in insonating MCA blood flow to be used for contrast examination.

Methods: Data from 86 healthy volunteers who underwent robotically conducted TCD scans by LRS is analyzed. Subjects were consented under IRB, with average age 38 ± 12 , 66% male. Performance indication is defined as percentage of successful scans to insonate the MCA at 1, and 3 min after starting the LRS search.

Results: On average, unilateral MCA signals are located for 86% (95% CI: 80-93%) of subjects after 1 min search and 94% (95% CI: 89-98%) of subjects under 3 min search.

Conclusions: In this retrospective analysis, we showed that investigational LRS is highly efficient in insonating MCA as the first requirement for contrast TCD examination. Autonomous TCD removes the need for experts and facilitates use of TCD as an efficient test for RLS diagnosis.

Abstract category: Original research
Scientific topic: Neurointensive Care

Abstract title: VALIDATION OF A NEW NON-INVASIVE TECHNIQUE FOR CEREBRAL AUTOREGULATION ASSESSMENT

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Background: Cerebral autoregulation (CAR) impairment is observed when intracranial hypertension (ICH, >20 mmHg), systemic or focal injuries to the brain are present. Hence, Intracranial pressure monitoring (ICP) and transcranial Doppler (TCD) are techniques used to assess CAR indexes (PRx and Mx respectively). A new recently developed cranial pulse sensor (B4C) features compatible graphic record with cerebral compliance, as this sensor registers waveforms with definite ICP peaks (P1, P2 and P3), theoretically could permit the study of CAR combined with TCD in an exclusively non-invasive fashion (B4Cx), and even the evaluation of resistance area product (RAP) and critical closing pressure (CrCP). The main objective of the present study was to evaluate correlation of CAR features assessed by different techniques.

Methods: A prospective observational controlled study was carried out in neurocritical patients with invasive arterial pressure and ICP monitoring, bilaterally middle cerebral arteries velocities and B4C monitoring were obtained in a basal recording of 5 minutes, followed by a second record of 4 minutes with ultrasound guided internal jugular veins (IJVs) manual compression for one minute. All parameters able to influence TCD and/or ICP recording (i.e. arterial blood pressure and pCO₂) were controlled to assure suitability of comparison between recordings. Analytic data report (P2/P1 ratio, time to peak and pulse detection) and correlation with the same ICP features, as well as PRx, Mx and B4Cx variation were correlated. Data of 40 patients has been collected to the date.

Results, discussion and conclusions of preliminary data will be presented in the 25th meeting of the ESNCH 2021 in Belgrade.

Abstract category: Original research
Scientific topic: Neurointensive Care

Abstract title: A NEW NON-INVASIVE TECHNIQUE FOR BRAIN DEATH ASSESSMENT

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Background: In clinical practice, some situations may challenge diagnosing brain death (BD), as those conditions that might mimic compromised cortical or brain stem function per example. Ancillary testing is needed in these situations, especially imaging tests. Recently, a strain gauge sensor device (B4C) has been developed, which only maintains contact with the skull skin and therefore eliminates the need for perforation of the skull, being able to obtain recordings of cranial dilatation at each heartbeat, and consequently reflecting brain compliance. As the latter reaches its limit when BD is established, because of extreme elevation of intracranial pressure (ICP), there is a possibility of B4C to detect maximum skull dilatation.

Methods: The present research assessed neurocritical patients (Glasgow coma score <5) with and without BD signs, to evaluate whether the B4C sensor is able to make distinction between BD and no-BD patients. Transcranial Doppler (TCD) was used as proof of intracranial arterial

collapse. Both assessments (TCD and B4C) were performed concomitantly to avoid timing bias.

Results: Preliminary data about no-BD and BD samples will be presented in the 25th ESNCH meeting in Belgrade. We observed significant differences concerning pulse amplitude and analytic data report (P2/P1 ratio, time to peak and pulse detection). In some BD cases, ICP was also monitored, and similarity correlation of ICP and B4C waveforms were observed. Discussion: We present a new non-invasive technique able to register intracranial compliance. In BD, TCD is a method to confirm the absence of intracranial flow, whereas arterial pulsatility remains producing systolic spikes. This pulsatility is transmitted to cranial bone and detected by the B4C sensor.

Conclusions: The maximum skull dilatation observed in BD may be assessed non-invasively. Broader studies in this subject may add more evidence to this insight.

Abstract category: Original research
Scientific topic: Cerebrovascular Diseases

Abstract title: TRANSCRANIAL DOPPLER AND CT ANGIOGRAPHY ACCURACY FOR BRAIN DEATH DIAGNOSIS

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Background: Conventional transcranial Doppler (TCD, blind technique) has been applied for brain death (BD) diagnosis support. The present study evaluated accuracy of TCD and computed tomography angiography (CTA) for this purpose, since well-designed and reliable studies were lacking for both techniques.

Methods: A unicenter prospective, observational controlled study was undertaken. Comatose patients (Glasgow Coma Scale ≤ 5), even subjects presenting with first signs of BD, were included. CTA scanning of arterial and venous vasculature and TCD were performed. A neurological determination of BD and consequently determination of case (BD group) or control (no-BD group) was conducted. All personnel involved with assessing patients were blinded to further tests results. CTA accuracy was calculated based on the criteria of bilateral no visualization of the internal cerebral veins and the distal middle cerebral arteries, the 4-point score (4PS), and an exclusive criterion of absence of deep brain venous drainage exclusively, the venous score (VS), considering only the internal cerebral veins bilaterally.

Results: A total of 106 patients were enrolled in this study; 52 patients did not have BD, and none of these patients had circulatory arrest observed by CTA or TCD (100% specificity). Of the 54 patients with a clinical diagnosis of BD, 33 met the 4PS (61.1% sensitivity), whereas 47 met the VS (87% sensitivity), and 52 had TCD positive results (96% sensitivity). The accuracy of both techniques was time-related, with greater accuracy when scanning was performed less than 12 hours prior to the neurological assessment, as CTA reached 95.5% sensitivity with the VS. For both false negatives found by TCD, sonographic assessment was conducted more than 12 hours prior to clinical definition of BD.

Conclusions: TCD and CTA can reliably support a diagnosis of BD. CTA criterion of absence of deep venous opacification can confirm the occurrence of cerebral circulatory arrest.

Abstract category: Clinical case study
Scientific topic: Heart & Brain

Abstract title: IS IT HERETICAL NOWADAYS TO DISCUSS ABOUT PRIMARY PREVENTION IN ATRIAL SHUNT PATIENTS? STORY FROM MY TCD LAB ABOUT A FAMILY WITH PFO

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Background: Official opinion regarding current guidelines about PFO (patent foramen ovale) and ASD (atrial septal defect) has remained inconclusive for a long time. According to present knowledge, atrial shunt (PFO or ASD) is not inherited. However, some population based studies suggest that atrial shunt is probably maternally inherited.

Methods: Nine years ago, we observed 39 year old female patient who had cryptogenic ischemic stroke with PFO. We investigated past medical history (migraine with aura, varicose veins) and family history (she has 2 maternal aunts with history of stroke in their 50s). She was examined neurologically, TCD, TTE, TEE, brain MRI with MRA. She was administrated by intravenous t-PA, because she had top of the basilar artery thrombus. After complete clinically improvement she underwent transcatheter closure of PFO. Five years later, her son, aged 16, also had a cryptogenic stroke with tunnel-shaped PFO with ASA (atrial septal aneurysm), which was transcatheter closed. Her daughter is 14 now and suffers from migraine. She also has PFO.

Results: Our adult female patient and her son had ischemic stroke, while she and her daughter have migraine. All of them had PFO which was confirmed by TEE. Also all of them had findings on TCD bubble test. All of them had no occurrence of MES (micro-embolic signals) at rest. With Vasalv maneuver mother had 20 MES, son had 5 MES and daughter had 2 MES. Mothers' and sons' MR of brain showed residual small cortical lesions and poststroke normal MRA findings. Daughters' MR of brain with MRA is without pathology.

Conclusions: We wanted to pay attention to this aspect due to a small number of published studies concerning PFO inheritance. The latest studies about the safety of device closure tend to introduce primary stroke prevention because PFO closure is safe and effective.

Abstract category: Clinical case study

Scientific topic: Heart & Brain

Abstract title: A CASE OF BRAIN DEATH AFTER CARDIAC ARREST UNACCOMPANIED BY CEREBRAL CIRCULATORY ARREST

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Background: Transcranial Doppler (TCD) is an useful ancillary test for brain death diagnosis with high level of sensitivity and specificity. The characteristic findings of cerebral circulatory arrest on TCD are mainly based on increased intracranial pressure (IICP). However, TCD has several limitations including false negatives. We present a brain death case after cardiac arrest with preserved cerebral blood flow on TCD.

Case report: A 67-year-old man was admitted after cardiac arrest. He had a history of non-ST segment elevation myocardial infarction and coronary artery stenting. He had return of spontaneous circulation in 23 minutes. At 5th days after cardiac arrest, he was unresponsive coma without brainstem reflexes. The electroencephalography (EEG) showed flat for 30 minutes and apnea test was positive, suggesting brain death. The brain CT revealed preserved

grey-white matter differentiation and diffuse cerebral edema was not obvious. An initial TCD examination also showed preserved cerebral blood flow with normal waveform. On the 8th day, TCD showed decreased MCA diastolic flow that was not compatible with cerebral circulatory arrest, and cerebral blood flows were still observed in intracranial major arteries. A follow-up CT showed aggravation of diffuse brain swelling.

Conclusions: In our brain death case caused by cardiac arrest, TCD showed a false negative finding despite compatible clinical examination and EEG findings. Brain death in this case may be caused by extensive cerebral cytotoxicity before IICP occurred. TCD findings should be cautiously interpreted with consideration of an underlying pathophysiology of brain death.

Abstract category: Original research

Scientific topic: Cerebrovascular Diseases

Abstract title: THE EFFECT OF CEREBROVASCULAR RISK FACTORS ON CAROTID INTIMA-MEDIA THICKNESS

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Background: Carotid intima-media thickness (CIMT) can be used for predicting patient's vascular age. The correlation of CIMT as an independent predictor of stroke and myocardial infarction with different cerebrovascular risk factors has already been studied, but with different methods of CIMT measurement across studies.

Methods: We conducted an observational cross-sectional study in obese patients in a weight reduction program under medical supervision. CIMT was measured according to the Mannheim protocol in both common carotid arteries and carotid bifurcations. The effect of cerebrovascular risk factors on CIMT was analyzed.

Results: The total number of patients was 111, 72% of which were female. Their average age was 49 ± 12 years. We found statistically significant higher values of CIMT in the groups of patients with diabetes and prediabetes com-

paring with the group without diabetes. There was no difference in CIMT when patients were divided according to their HOMA index or insulin levels. We also found statistically significant higher values of CIMT in patients with arterial hypertension comparing to those normotensive. CIMT values were dependent on hypertension duration, being higher in those with longer history of hypertension. Patients with hyperlipidemia, especially with triglyceride and cholesterol elevation had statistically significant higher values than those without hyperlipidemia. There was no difference in measured CIMT comparing smokers and non-smokers or in groups of patients divided according to their obesity level.

Conclusions: CIMT was higher in patients with arterial hypertension, diabetes, prediabetes and hyperlipidemia than in patients without those cerebrovascular risk factors present. The level of obesity didn't seem to affect CIMT.

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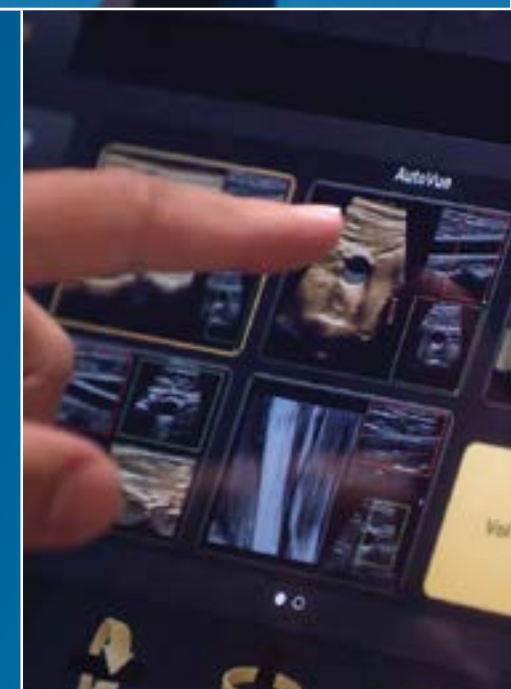
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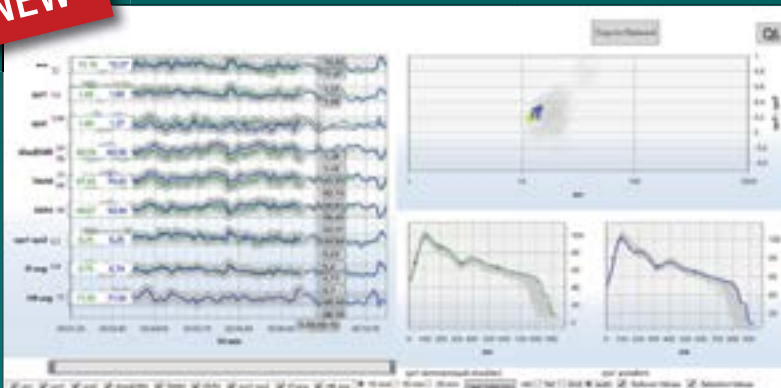
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