
Basic Tutorials

T1**Ultrasound physics and knobology***L. Olah*University of Debrecen, Department of Neurology, Debrecen,
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To be a qualified neurosonologist, it is essential to understand the physics of ultrasound and be able to apply it on a daily basis. The lecture will review the basics of ultrasound transmission, characteristics of sound waves, behaviour of ultrasound at acoustic boundaries, as well as the resolution and penetration of ultrasound beam in body tissues. The Doppler effect and the Doppler principle, as well as the time-based gating method and pulse-echo approach in the pulsed-wave Doppler mode will be discussed. The sonographer should be aware of a relationship between dependent variables, like pulse-repetition-frequency, insonation depth and the measurable highest flow velocity. The lecture will cover the basic principles of image acquisition. Since multiple ultrasound modes are used during the examination, the examiner has to be familiar with the advantages and disadvantages of these modalities in order to accurately use this diagnostic method. Besides understanding the basic physics of ultrasound, a sonographer must understand pitfalls and artifacts to interpret properly the ultrasound results.

In the second part of the lecture types of transducers, proper setting of ultrasound machine, use of different knobs will be highlighted. Efficient use of ultrasound requires understanding of functions of different knobs, which serve to shift between different ultrasound modes as well as to produce a clear image of the structure of interest and to improve the image quality.

T2**TCD examination protocol***Z. Garami*Vascular Ultrasound Laboratory
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Transcranial Doppler (TCD) is the “doctor’s stethoscope for the brain”. It is a non-invasive, safe, and cost-effective bedside test for evaluating the cerebrovascular circulation. TCD shows the

blood flow direction and velocity in the intracerebral vessels, adding physiologic information to the anatomical images obtained with other imaging modalities. TCD can also detect potential collateral flow signals in the ophthalmic, anterior communicating, and posterior communicating arteries caused by hemodynamically significant carotid stenosis. TCD remains the only method for detecting asymptomatic embolization, but does even more. TCD provides essential “real time” hemodynamic information about the intracranial circulation compared to “static” brain imaging modalities.

TCD detection of embolic particulate matter and gas bubbles have been validated in laboratory and animal models. The Doppler signal intensity of an embolus traveling in blood depends on its size and acoustic impedance. Air, for example, has a much lower acoustic impedance than blood and, therefore, reflects sound waves to a greater extent. The minimum detectable diameter of gaseous emboli has been reported at 10 microns, while particulate emboli can be detected from 40 microns. Based on Consensus Committee guidelines, certain technical criteria must be met to qualify as microembolic signals (MES) by TCD. If MES are observed on both the side of the carotid stenosis and the contralateral side, the origin of the embolus may be from a central source, e.g., the heart or aorta. Unilateral MES more likely result from carotid lesion or plaque.

Two major limitations exist with TCD impeding its widespread use. It is a true operator-dependent, hand-held technique requiring detailed knowledge of the intracranial arterial anatomy. More critically, TCD is hampered by the 10-15% rate of inadequate temporal windows most commonly seen in elderly female patients. A newer technology called Power Motion-mode TCD (PMD/TCD) appears to improve window detection and simplifies the operator dependence of TCD by providing multi-gate flow information simultaneously in the Power M-mode display.

During carotid endarterectomy (CEA), when an intact Circle of Willis is not present and there are insufficient collateral pathways to maintain adequate MCA flow, a significant mean flow velocity (MFV) drop is seen after placing the arterial clamps and can be accompanied by a dramatic decrease in pulsatility index (PI). In cases where sufficient collaterals exist, CEA without shunting can be performed, because there is a minimal drop in MFV after the arterial clamp is applied to the carotid artery. If MFV remains >50% of baseline, shunt placement can be safely avoided, and by increasing mean arterial pressure (MAP) to 75-90% of the baseline, flow can be restored during clamping. Unlike CEA, sudden flow velocity and waveform changes are not generally seen in carotid artery stenting (CAS), except briefly during balloon angioplasty. CAS cannot be performed without MES, because microemboli are detected with the wire and catheter manipulations and our current filters and cerebral protections do not eliminate these embolizations during stent placement.

T3

TCCS examination protocol

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TCCS is the current state-of-the-art ultrasound approach for transcranial insonation as it comprises direct structural information derived from B-mode and color-mode images as well as information on blood flow of intracranial vessels. For instance in arterial analysis, TCCS allows to exactly identify more than 20 different vessel segments in excellent correspondence with the angiographic or radiological nomenclature. Three routine TCCS access paths are being used, the transtemporal bone window, the transforaminal and the transorbital bone window.

TCCS usually starts with a transtemporal insonation. There, five axial insonation planes (lower pons, upper pons, midbrain, thalamus, cella media) and two coronal planes (anterior and posterior) are can be identified using B-mode landmarks like bone, parenchyma, vessel sheaths and ventricles. In the midbrain plane the following vessel segments can be visualised: M1- and M2-MCA, A1- and A2-ACA, P1- and proximal P2-PCA and the head of the basilar artery. In the upper pons plane, the carotid siphon, ophthalmic artery and the posterior communicating artery are visualised. In the lower pons plane, the petrosal segment of the carotid artery (C6) is identified paralleling the course of the petrosal bone. Within the thalamic plane the pineal gland, the third ventricle and lateral to both thalami M2- and M3-MCA branches are accessible. More posteriorly the P2- and P3-PCA are accessible. The coronal transtemporal planes are of particular value to differentiate the proximal M1-MCA from the distal ICA (anterior) to analyse the distal BA and to differentiate the PCA from the superior cerebellar artery (posterior).

Transforaminal axial TCCS allows to analyse the V3- and V4-VA and the posterior inferior cerebellar artery (lower plane) as well as the proximal two thirds of the BA, sometimes even the anterior inferior cerebellar artery (upper plane).

Transorbital insonation permits insonation of the OA, and if a high-frequency ultrasound probe is used also of the optic nerve including the papilla and the central retinal artery and vein.

Insonation power, gain and filter settings, size of the color-window and the applied pulse repetition frequency of the ultrasound system should specifically be adjusted to achieve the best possible imaging results. As hardly any intracranial vessel segment runs a true straight course for more than 1 to 1,5cm, intracranial flow velocities are generally measured without angle correction to avoid additional measurement errors.

T4

Carotid arteries: Classification of stenosis

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The classification of internal carotid artery (ICA) stenosis is of great impact. The degree of stenosis is the main criterion for the decision between an invasive or non-invasive treatment of extracranial ICA stenoses. By now the NASCET criteria have been internationally approved for ICA grading. According to NASCET the stenosed lumen is compared with the lumen of the distal ICA. All ultrasound criteria do have limitations and can therefore cause pitfalls in determining the degree of stenosis using one criterion exclusively. The approach of peak systolic velocity (PSV) – for many reasons and no matter what threshold-PSV was chosen – is of limited value if taken as the primary and only criterion (Vasc Endovascular Surg 2012;46:466-74). Therefore a multi-parametric grading of stenoses should be favoured. The multi-parametric “DEGUM” ultrasound criteria have been revised and a novel differentiation between main (primary) and additional (secondary) criteria has been proposed. Recently a similar consensus was reached by the “Neurosonology Research Group (NSRG) of the WFN” (Stroke 2012; 43: 916-21). The differentiation between main and additional criteria is caused by their different reliability. Main criteria include the following: Imaging of the stenosis in B-mode sonography; visualization of the stenosis by color-coded imaging of flow; measurement of PSV in the area of greatest narrowing of the lumen; measurement of PSV in the poststenotic segment; assessment of the collateral supply. Additional criteria include the following: Prestenotic flow velocity deceleration in the common carotid artery; evidence of poststenotic flow disturbances; end-diastolic flow velocity in the area of greatest narrowing of the lumen; the so-called confetti-sign; the carotid ratio. The main advantage of a multi-parametric grading of ICA stenoses is the synergetic effect of the different single criterion. Combining these ultrasound criteria, neurosonography allows reliable and reproducible grading of carotid stenoses as a basis for decision making.

T5

Estimating the degree of intracranial stenosis

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Ultrasound criteria for estimating the degree of intracranial stenosis include direct and sometimes indirect hemodynamic effects on cerebral blood flow. Direct criteria for intracranial artery stenosis include: 1) a color aliasing phenomenon seen only with transcranial color-coded Doppler sonography; 2) a progressive focal increase of blood flow velocities in $\geq 50\%$ stenosis. As a general rule for a vessel with straight walls, a 50% diameter reduction doubles the velocity,

and a 70% stenosis may triple the velocity at the end of the stenosis compared with a pre-stenotic segment. Noteworthy, in certain vessel segments (eg. P1-PCA, A1-ACA) there might be no significant flow velocity increase, despite the presence of a stenosis, due to efficient collateralization (via ipsilateral ICA and PcomA, and via contralateral A1 and AcomA, respectively); 3) a paradoxical velocity decrease with very severe stenosis, near-occlusion or diffuse intracranial disease; 4) a significant ($\geq 30\%$) side-to-side difference of velocity; however, this criterion can only be applied to symmetrical vessel segments after accurate angle correction. In case of severe stenosis, additional frequent findings are: 5) co-vibrations (i.e. high intensity signals at the zero line), 6) musical murmurs, which have a visual correlate called 7) mirror-image parallel strings.

In severe stenosis ($>80\%$), in addition to the direct criteria described above, there are indirect hemodynamic criteria which include proximal or distal flow alterations: 1) a diastolic velocity drop and high resistance in the feeding vessel or in the proximal segment of the stenotic vessel; 2) a delayed systolic flow rise and velocity drop (tardus et parvus) downstream; 3) flow diversion and 4) signs of collateralization.

In patients with recurrent symptoms despite best medical therapy, ultrasound can detect a progression of the stenosis. In patients who have undergone cerebral artery angioplasty and/or stenting, ultrasound can verify the efficacy of endovascular treatment.

T6

Posterior vs. anterior cerebral circulation

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The neurosonologic approach to vascular pathology in anterior and posterior circulation presents different challenges requiring knowledge of their anatomical, pathological and even embryological specificities across extra and intracranial segments.

In the assessment of extracranial supra-aortic vessels the first difference arises from the anatomical construct of both circulations. The Vertebral arteries stem from a short, initial segment of the Subclavian arteries and then progress in a longitudinal anastomosis of segmental metameric arteries. After a cervical segment (V1) they advance in a relatively fixed path through the transverse processes of cervical vertebrae. This conditions pathological susceptibility to different disease mechanisms in each segment.

Intracranially, the posterior circulation is united in the midline through the course of the Basilar artery, branching into numerous vessels with anatomical and pathological specificities that need to be taken under consideration during ultrasound assessment.

The aim of this lecture will be to address the physiological differences and pathological implications that must be appreciated during the neurosonological study of cervicocephalic arteries in the anterior and posterior circulation.

Advanced Tutorials

T7

Ultrasound contrast agents applications

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Since the 1960' ultrasound contrast agents have been applied for ultrasound imaging. These agents are composed of air microbubbles, according to the principle that the tissue/air interface is a strong ultrasound reflector. At first, air saline shaken solutions were used by cardiologists to enhance the visualization of the right heart chambers and then, being these bubbles stopped by the pulmonary filter, to detect right-to-left shunt with both echocardiography and transcranial Doppler Sonography: the observation of the bubbles in the left heart chambers or in the middle cerebral artery shortly after peripheral contrast injection was indicative of the shunt. Later, second and third generations of ultrasound contrast agents were developed and they are composed of more stable, very small microbubbles of either low soluble gas covered with a shell of proteins, polymer or surfactant (second generation), or of a sulphur hexafluoride gas encased in a phospholipid shell (third generation). These last generation microbubbles are of a diameter smaller than that of the red blood cells and they are therefore able to pass the pulmonary filter and distribute to arterial blood flow up to the capillary level and microcirculation, lasting for several minutes after the injection. From initial applications to obtain a better visualization through Color Doppler imaging, contrast ultrasound specific modalities has been developed to visualize specifically the signal of the microbubbles, thus depicting microvasculature and organs perfusion. From the first use in liver cancers, this technique has proven useful in several organs, including the study of cerebral perfusion in ischemic and hemorrhagic strokes and cerebral tumors as well as for a better definition of plaque morphology and to investigate pathophysiology of the atherosclerotic unstable plaque, detecting plaque angiogenesis and vascularization. These methods are reviewed in the presentation.

T8

Functional transcranial doppler sonography (fTCD)

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Functional transcranial Doppler sonography (fTCD) is a neuro-imaging tool for measuring cerebral blood flow velocity changes due to various stimulations. fTCD uses pulse-wave Doppler technology to record blood flow velocities in the anterior, middle, and posterior cerebral arteries. fTCD can be used to assess the physiologic health

of a particular vascular territory by measuring blood flow responses to changes in blood pressure (cerebral autoregulation), changes in end-tidal CO₂ (cerebral vasoreactivity), cognitive and motor activation (neurovascular coupling), application of L-arginine (endothelial function) etc. In comparison to other neuroimaging techniques TCD offers an excellent temporal resolution, it is noninvasive and easy to apply. Blood flow velocity measurements are robust against movement artifacts. Overall fTCD is a very sensitive tool but requires some knowledge for the interpretation of the results. The changes of blood flow velocity reflect blood flow changes only in stable conditions. The position of the probe has to be in the same spot during the whole recording in order to avoid changes due to the vessel diameter. End tidal CO₂, mean arterial pressure and heart rate have to be monitored during all recordings.

TCD has become the most commonly utilized tool to study cerebral blood flow regulation in humans. The sudden changes in arterial pressure can be induced by a variety of techniques such as deflation of bilateral thigh cuffs, postural alteration, Valsalva maneuver etc. Abnormalities in cerebral autoregulation are thought to occur in a number of clinical disorders such as stroke, subarachnoid hemorrhage, postpartum angiopathy, eclampsia, syncope, and traumatic brain injury.

TCD has also been used to test cerebral vasoreactivity. Changes in ventilation (hyper- and hypoventilation or breathholding) and use of drugs such as acetazolamide can be used in order to induce CO₂-mediated changes on cerebral blood flow velocity. Cerebral vasoreactivity describes the ratio of the percentage changes in cerebral blood flow velocity to changes in PaCO₂. Diseases such as sleep apnea, congestive heart failure, carotid artery stenosis, and cerebral ischemia are associated with impaired vasoreactivity.

fTCD can be used to measure neurovascular coupling by recording cerebral blood flow velocity 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. Neurovascular coupling is disrupted in diseases such as hypertension and ischemic stroke.

TCD can also be used to assess cerebral endothelial function. Intravenous application of L-arginine induces vasodilatation through enhanced production of nitric oxide in the cerebral endothelium. Cerebrovascular reactivity to L-arginine (CVR-L-Arg) seems to show specific cerebral endothelial function. So far CVR-L-Arg has been used to study cerebral endothelial function in many pathological conditions such as in patients with cardiovascular risk factors, stroke, migraine etc.

T9

Optic nerve sheath diameter

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Raised intracranial pressure (ICP) is frequent in conditions like stroke, liver failure, meningitis, meningococcal meningitis and postre-

suscitation syndrome. It may be associated with increased mortality and poor neurological outcomes. Therefore, early detection and treatment of raised ICP is critical but often challenging. Invasive ICP monitoring is not routinely undertaken in these settings. Magnetic resonance imaging (MRI) is often undertaken in such patients, and may provide a noninvasive method of estimating ICP. As a non-invasive method transcranial Doppler is sometimes impossible.

The optic nerve is a part of the central nervous system, surrounded by a subarachnoid space and experiences the same pressure changes as the intracranial compartment. The intraorbital part of the sheath, and particularly its retrobulbar segment, can distend when ICP (and hence cerebrospinal fluid pressure) is elevated. The dural sheath surrounding the optic nerve communicates with the subarachnoid space and distends when intracranial pressure is elevated. Assessing the optic nerve sheath diameter (ONSD) by transbulbar sonography and MRI is a useful tool for the non-invasive evaluation of patients with increased ICP (cut off values of 5.7-5.9 mm) with a high intra- and interobserver reliability. It can be applied in patients with raised ICP like traumatic brain injury, hemorrhagic stroke, benign intracranial hypertension and brain death.

T10

Transcranial B-mode sonography

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Transcranial B-mode sonography (TCS) is a non-invasive, low-cost, short-duration neuroimaging method that allows high-resolution imaging of deep brain structures in patients with inflammatory and degenerative brain diseases. Hyperechogenicity of the substantia nigra (SN), a TCS findings present in about 90% of patients with idiopathic Parkinson's disease (PD), is already present in presymptomatic disease stages. The results of recent longitudinal studies suggest that TCS of SN may serve as a screening tool for detecting subjects at risk of later developing PD. Studies of our and other groups show that the combination of TCS with simple olfaction and motor tests already at very early disease stages discriminates PD from other parkinsonian disorders. In turn, normal SN echogenicity in combination with lenticular nucleus hyperechogenicity indicates an atypical Parkinsonian syndrome rather than PD with a specificity of more than 95%. TCS detects characteristic basal ganglia changes also in other movement disorders such as lenticular nucleus hyperechogenicity in idiopathic dystonia and caudate nucleus hyperechogenicity in Huntington's disease. Lenticular nucleus hyperechogenicity in Wilson's disease has been proven histochemically to be caused by copper accumulation, while the same TCS finding is caused by iron accumulation in hereditary disorders with brain iron accumulation such as PKAN and MPAN. Reduced echogenicity of midbrain raphe is frequent in depressive disorders and correlated with both, suicidal ideation and responsiveness to serotonin reuptake inhibitors. An elegant application of TCS is the intra- and postoperative localization of deep brain stimulation electrodes in patients with movement disorders. Upcoming technologies such as digitized image analysis and TCS-MRI fusion imaging will promote novel diagnostic applications of TCS.

Opening and the Lecture of Excellence

L1

Development of ultrasound diagnostics in Croatia and the region

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Doppler ultrasound investigation of cerebral circulation has developed from simple zero-crossing detector technique to sophisticated color and power doppler flow imaging enabling non-invasive assessment of carotid and vertebral arteries.

After its introduction in Japan and USA its use started in several European countries, and in former Yugoslavia, as well. The first world congress on ultrasound (US) was held in 1969. in Vienna. In 1971. eight European countries had established national ultrasound societies, and in 1972. delegates of 13 European societies met in Basel and founded European Society for Ultrasound in Medicine. Neurologists played a key role, and one of them was from Zagreb. In Zagreb the national ultrasound society was also founded, with neurologist being the first president. From that time, Zagreb conducted the central role in implementation, development and training of neurosonology in the region. Increased sophistication of ultrasound, in particular Doppler probes, has allowed direct interrogation of the neck vessels to detect stenotic lesions first with duplex machines in 1974., and later on with color duplex equipment. Besides plaque morphology, stability and degree of stenosis, intima-media thickness can be assessed as a noninvasive surrogate marker of atherosclerosis. In 1982., low frequency probes enabled assessment of intracranial hemodynamic, and they were first applied for monitoring of blood flow velocities in basal cerebral arteries in subarachnoid hemorrhage. The equipment was quickly adopted in Europe, and in Croatia as well. The development of Transcranial Doppler (TCD) enabled information on intracranial vascular structures and intracranial hemodynamic, vasoreactivity testing and emboli detection. Functional evaluations of brain structures became also possible. With the improvements and development of machines and techniques, indications and applications of US are constantly expanding.

Croatia had a leading role in implementation, development and training of neurosonology in the region.

L2

Determine etiology and find reasons to treat: Ultrasound driven vascular neurology

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Vascular Neurology became recognized subspecialty after systemic thrombolysis with tissue plasminogen activator (tPA) proved to be effective therapy to reduce disability after stroke and neurologists realized the need to support disease-specific systems of care.

Before sub-specialization, neurologists with interest in cerebrovascular diseases pioneered vascular ultrasound tests to advance our understanding of stroke mechanisms and dynamics. Current Vascular Neurology training programs are supposed to include cerebrovascular ultrasound into teaching curriculum but availability of hands on and in depth physics, fluid dynamics and interpretation training varies greatly between the continents and programs.

What makes a neurologist specialist in vascular disorders? Among many aspects, this requires advanced studies into imaging diagnosis of stroke. This has been largely delegated to multi-modal CT and MRI, and vascular neurologists commonly limit their diagnostic armamentarium to these tests. Fewer become proficient in ultrasound testing such as carotid duplex and transcranial Doppler. It is imperative that experts in cerebrovascular ultrasound continue educational programs and advance research to stay current with the future generations of vascular neurologists.

Finally, vascular neurologists have to be able to determine stroke etiology, pathogenic mechanisms and therapeutic targets in most stroke patients, not just a few super-selected by snapshot CT or MRI. This is where the knowledge and ability of performing and interpreting a variety of cerebrovascular ultrasound tests and real time monitoring becomes paramount. Ultrasound tests are an extension of the neurological examination, making our assessments truly neurovascular. In my opinion, the ability to use ultrasound complimentary to advanced imaging tests, answer the question why stroke is happening, and find reasons to treat (instead of excuses not to treat) – all of this makes Vascular Neurologist.

Session I: Comprehensive assessment of atherosclerosis by ultrasound

L3

The acute symptomatic carotid artery plaque

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Backgrounds: in one third of cases, ischemic stroke is caused by an artery-to-artery embolism from an unstable carotid plaque. Sonographic features of plaque instability have been described over years, varying from morphological structural aspects to more complex pathophysiological mechanisms, such as increased angiogenesis at contrast ultrasound. We present the experience of our neurosonology laboratory in assessing carotid plaques in stroke patients.

Methods: standard neurosonological evaluation of carotid vessels and intracranial arteries has been performed in stroke patients admitted to our ward, as well as in asymptomatic patients during their vascular work-up. Plaques have been evaluated according to the echogenicity, surface, stenosis degree, plaque motion and ultra structural aspects with high-resolution B-Mode ultrasonography. Ultrasound contrast agents were also applied in selected patients to better define plaque morphology and to detect plaque angiogenesis and vascularization.

Results: severe stenosis and plaque echographic heterogeneity with hypoechoic areas and surface ulcerations are universally considered “at risk”. Acute symptomatic plaques, even of moderate degree, show particular aspects of low echogenicity with altered motion, and with the frequent presence of superimposed thrombi or fibrin strands on the plaque surface. When plaque rupture is acutely correlated with clinical symptoms, no reendotelization or fibrous cap can be detected on the base of the ulceration. Contrast ultrasound can help in the definition of plaque morphology with increased sensitivity in detecting plaque surface fissuration and pseudoclosures identification. Moreover, contrast ultrasound shows a different pattern of vascularization in symptomatic plaques, varying from increased overall angiogenesis to localized spots of contrast enhancement nearby the sites of plaque rupture.

Conclusions: ultrasonography, a real-time technique with high resolution, has a high sensitivity in detecting plaque morphological changes related with higher instability, thus helping to discriminate whether the plaque is responsible of the clinical symptoms in stroke patients and thus characterizing the “acute symptomatic plaque”.

L4

Carotid IMT: From vascular risk assessment to genetic discoveries

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Carotid intima-media thickness (CIMT) is an ultrasound imaging measure of subclinical atherosclerosis and a predictor of future stroke, myocardial infarction and death. It has been used as a surrogate marker of subclinical vascular disease in large population-based longitudinal studies and as an outcome in numerous randomized multi-center clinical trials of different classes of anti-atherosclerotic medications worldwide. Regardless, the use of CIMT in clinical practice has been extremely limited by a lack of recognition of its value as a screening tool by medical communities and health care policy makers. Furthermore, there is a lack of reimbursement for CIMT in vascular clinics by the third-party payers engaged in the delivery of vascular imaging services in the U.S. and beyond. Therefore, the use of CIMT has been reserved predominantly for research. CIMT has been challenged recently by the negative outcomes of several lipid-lowering clinical trials. This presentation will address the role of CIMT in vascular disease risk prediction and discuss the net clinical benefit of CIMT for vascular risk prediction in the communities. In addition, the value of using CIMT in genetic research will be presented. The study of CIMT provides a powerful approach to elucidate genetic contribution to complex vascular disease at a stage that precede clinical disease onset. CIMT is highly heritable trait, but yet the genetic variants affecting CIMT remain largely unidentified. Several CIMT GWAS have been conducted in general populations but none produced genome-wide significant results after correction for multiple testing. A recent CHARGE meta-analysis reported several important genomic regions associated with CIMT. This presentation is intended to provide a practical guide for use of CIMT in clinical practice and epidemiology research and to promote the use of CIMT in genetic research for discovery of novel anti-atherosclerotic therapies in the future.

L5

Carotid atherosclerosis: New examination methods

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Thromboembolic strokes have been shown to be effectively preventable by carotid endarterectomy. In current clinical practice patient selection for revascularization primarily involves assessment of the severity of luminal stenosis. It has, however, become increasingly clear that the degree of luminal stenosis alone is not the best predictor of stroke risk. The composition of an athero-

sclerotic plaque and a thin or ruptured fibrous cap may be more important.

New methods are therefore being developed which may in the future enable a more accurate and objective identification of CAD patients with an increased stroke risk.

The Oslo Toshiba Ultrasound Research Group is currently assessing new ultrasound methods which include:

1. Elastography which uses strain images of soft tissue to determine plaque content. Soft and hard tissue respectively shows a larger and smaller strain. This is being used to determine plaque content such as calcification, lipid content and hemorrhage.
2. FlyThru volume rendering technology which uses 4D data to produce a perspective view from within the lumen similar to an endoscopic image. This is being used to detect plaque surface irregularities and possible ulceration or rupture.
3. Superb Microvascular Imaging (SMI) with a high density beam former architecture allows for very high frame rates and a proprietary algorithm which isolates and removes clutter (e.g. flash artifacts). This provides unparalleled visualization of hemodynamics especially when imaging low flow velocities. This is being used to assess plaque revascularization.

MRI may be used to detect intraplaque hemorrhage, lipid-rich necrotic core, and thinning/rupture of the fibrous cap. The use of a contrast agent improves quantification of total plaque burden, and contrast between fibrous cap and lipid core. Dynamic contrast-enhanced MRI allows assessment of plaque neovascularization.

Currently, there are few *in vivo* human studies on functional imaging of carotid plaques: these initial studies have shown the potential of USPIO-enhanced MRI and 18F-FDG PET to identify inflammation. More research is needed to determine their value in risk stratification.

Biomarkers have been shown to improve prediction independent of conventional risk factors. Matrix metalloproteinase 7 (MMP-7), the calcium-binding proteins calgranulins (S100A12) and are two such candidates.

It is at present undecided whether one imaging modality or a multimodality approach is most effective. Prospective clinical trials are needed to demonstrate if imaging methods do indeed result in an improvement in defining unstable carotid artery plaques and if they can predict patient outcomes, particularly in asymptomatic subjects.

Session II: Heart and Brain

L6

The heart's effect on the brain atrial fibrillation and stroke prevention-update

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Approximately 20%-25% of all ischemic strokes are cardioembolic stroke.

Non-Valvular Atrial fibrillation (NVAF) is the most frequently found arrhythmia with a prevalence of 0.4 – 0.7% in the general population. The prevalence of AF rises to approximately 6% in population older than 65 years, and up to 10% in people older than 75 years.

AF related stroke comprises approximately 45% of all cardioembolic strokes.

AF is a well-established independent risk factor for stroke, leading to 5.6-fold increase of risk. Risk for recurrent stroke in AF patients without antithrombotic treatment is 12% per year. An ischemic stroke will occur during lifetime of about 35% non-anticoagulated AF patients.

According to Class I evidence, adjusted-dose warfarin reduces risk of stroke in AF patients by about 70% and aspirin by only 20%. Treatment with warfarin is recommended with target INR of 2.5 (range 2.0-3.0). However, treatment with warfarin is problematic, only about 50% of AF subjects are taking warfarin and of those only 50% are on target INR. Therefore, newly developed anticoagulant were approved as a replacement for warfarin (NOACs).

Three novel anticoagulants (NOACs)-dabigatran etexilate, rivaroxaban, apixaban- have been approved in many countries for stroke prevention in atrial fibrillation, because they are associated with the same or lower rates of stroke, bleeding (particularly intracranially) and death compared with warfarin; and unlike warfarin, they can be given in fixed doses without routine coagulation monitoring. The effects of NOACs compared with warfarin are consistent in almost all populations and patients subgroups studied. The lack of antidote to the NOACs in patients who experience major bleeding has not yet been associated with worse outcome among patients treated with NOACs compared with warfarin in secondary analysis. Multiple guidelines for the management of AF now recommend the NOACs for stroke prevention among atrial fibrillation (AF) patients at risk for stroke.

L7

Cryptogenic stroke, the chameleon among stroke etiologies

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Cryptogenic stroke (CryS) is defined by the TOAST classification as cases where the origin is unclear despite extensive investigations, or where multiple causes are possible and a definite cause cannot be determined. This accounts for 20% up to 30% of all ischemic strokes. Guidelines regulate that CryS has to be treated with ASA, however, if AF were detected, oral anticoagulation would be the treatment of choice. This is why doctors are obliged to carefully work-up CryS. We have to consider a broad spectrum covering extracranial occlusive disease (carotid, vertebral), Intracranial occlusive disease (carotid distrib., VB), small artery disease, and rare types of CV disease like dissection, inflammation, radiation-induced, genetical, and FMD, etc. Of particular interest is „cardioembolism“ which includes not only Intracardiac sources of embolism (AF, with or without thrombus in LAA, ventricle, valve, acute MI, etc.), but also extracardiac sources of embolism, namely precardiac (PFO and other shunts, DVT, pulmonary fistulas) and postcardiac locations of thrombotic processes (aortic arch, ascending/descending). Many of these conditions can be pinpointed with refined ultrasound techniques but some require MRI techniques and intelligent long-time ECG recordings. A comprehensive diagnostic program will be presented.

L8

Facing the burden of AF with ageing

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Atrial fibrillation (AF) is undoubtedly one of the major hazards of contemporary medicine. Its prevalence is increasing, especially in the elderly, and AF-related cardioembolism is becoming the most frequent cause of stroke in this age group. This scenario is aggravated by the fact that cardioembolic stroke is frequently associated with a high morbimortality. AF also contributes to the vascular cognitive impairment, either through symptomatic acute ischemic cerebral infarcts, and/or through the multiple small, only apparently silent, cardioembolic ischemic lesions.

It is well settled that with appropriated treatment AF cardioembolic risk decreases significantly. Anticoagulation therapy is particularly effective in reducing the cardioembolic risk after a stroke and when administered to aged people. However, the ideal is to use it for preventing a first stroke, in primary prevention.

Upon the diagnostic work-up of an acute stroke patient the use of ultrasound techniques may add great clinical significance. Firstly, the absence of significant arterial extra and intracranial pathology (such as atherosclerotic plaques, arterial dissection or oth-

er) in the setting of a patient with a non-lacunar stroke is highly suggestive of an upstream (cardiac) source of an emboli. Moreover, initial occlusion of a vessel at a bifurcation followed by spontaneous recanalization or documentation of active embolization through detection of microembolic signals by transcranial Doppler is also indicative. Lastly, even if the exam is not performed in the first day, Doppler hemodynamic signs of post-ischemia hyperaemia in a symptomatic territory suggest a recent revascularization of an embolic occlusion.

In order to deal with the burden of this enormous disease, each country warrants a multidisciplinary approach, involving correct identification of AF, even if paroxysmal, individual patient risk assessment, and an adequate stroke preventive treatment.

Fortunately, there have been important scientific breakthroughs on diagnosis and treatment of AF. Paroxysmal AF presents the same cardioembolic risk as the continuous AF, although it is often difficult to diagnose. Particularly in the case of a cryptogenic stroke with embolic characteristics, paroxysmal AF has to be exhaustively searched and might require long-term cardiac rhythm monitoring systems, which have been recently developed. Other new achievements are the therapeutic advances in oral anticoagulation treatment, allowing increased efficacy and safety, along with a better convenience to the patient.

All these new approaches are changing the paradigm of the acute stroke management, challenging the stroke unit neurologist.

Session III: Treatment decisions guided by ultrasound

L9

Cerebral vasomotor reactivity testing and functional TCD in cardiac sources of stroke

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Many factors influence cerebral vasomotor reactivity (VMR), which reflects cerebral small vessels functional status, including morphological and functional parameters of large and small brain blood vessels. Autoregulation of cerebral blood flow (CBF) ensures delivery of oxygenated blood to the brain commensurate with cerebral O₂ demand. Intact autoregulation protects the brain from ischaemia caused by acute arterial pressure fluctuations. In contrast, disturbed autoregulation has been found to be independently associated with mortality after brain Injury. It is generally accepted that cerebral autoregulation may become impaired after stroke by damage to cerebral arterioles and capillaries during ischemia or other chronic insults (like hypertension).

Significant alterations in autonomic nervous system (ANS) function, VMR, and CBF may also develop from damage to brain ANS regulatory areas in heart failure.

Impaired VMR is usually affected by a presence of carotid stenosis. However, in some cases it can be impaired in the absence of carotid stenosis due to several poorly characterized mechanisms. One of the potential reasons could be atrial fibrillation that is known to be one of the major risk factors for ischemic stroke. Stroke could also occur in approximately 2% to 3% of adult cardiac surgery patients due to impaired VMR/CBF.

In a meta-analysis of stroke incidence after myocardial infarction, the risk of stroke was estimated to be approximately 1.1% during hospitalization and 2.1% at 1 year usually caused by systemic embolisation, including mural thrombus, cardiac arrhythmias and impaired left ventricular ejection fraction. Many asymptomatic patients with potential sources of cardiac embolism have signs of cerebral embolism on brain imaging studies and transcranial Doppler monitoring. It remains unclear whether impaired cerebral vasomotor reactivity also reflects more systemic vascular damage.

L10

Unstable carotid artery plaque

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To date the decision for invasive therapy in carotid artery stenosis is mainly driven by symptoms and the degree of stenosis. However, this approach does not reflect our current understanding of plaque pathology. The main diagnostic challenge is to define specific plaque vulnerability besides simple definition of luminal narrowing.

Ultrasound offers the opportunity to depict the vessel wall itself. It further allows to account for hemodynamic features and to detect embolic signals deriving from the plaque. Detection of plaque vascularization might also play a prominent role in the near future.

In this lecture the capabilities and limitations of ultrasound techniques to define vulnerable plaques and trigger therapeutic decisions will be critically discussed.

L11

Treatment decisions in craniocervical artery dissection

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Spontaneous craniocervical artery dissection (sCAD) is a common etiology of ischemic stroke in young adults. However, it remains often unrecognized. Accurate diagnosis of sCAD and

monitoring are crucial for adjusting medical management and affecting overall disease outcomes.

Imaging of sCAD plays a major role in diagnosis and follow-up of patients with sCAD. Catheter angiography may reveal luminal narrowing, tapered, flame-like occlusion, pseudoaneurysm, intimal flap, double lumen or distal branch occlusion. MR images the periarterial rim of intramural hematoma. Neurosonological techniques are useful in the assessment of patients with sCAD, but confirmatory radiological testing is almost always indicated. The extent of the dissection is important in management of patients for therapeutic decisions on selection of antithrombotic treatment.

Besides diagnostic potential, neurosonological techniques enable monitoring of the course of the dissection, recanalization and recurrence rate and presence of embolic signal. Microembolic signals on transcranial doppler indicate higher stroke risk and require stronger antithrombotic therapy. Duplex sonography may also display asymptotically involvement of other arteries that may occur simultaneously or sequentially within a short time frame. Daily monitoring of patients with sCAD showed high rate of recurrence, especially in previously unaffected arteries, suggesting that recurrence of early cerebral ischemia and late sCAD may be underestimated. Monitoring the course of the dissection is important in duration of antithrombotic treatment.

In patients with sCAD neurosonological tests may also show overlap with other vascular diseases of low incidence in which the recurrence rate is higher, thus enabling prognostic information.

Recent data of patients with sCAD have been helpful in improving the understanding of the pathophysiology, risk factors, clinical picture and course of sCAD. However, the molecular mechanisms underlying this disease are still poorly understood and treatment decisions are empirical and not evidence based. Neurosonological tests may be helpful in clinical guiding management of patients with sCAD.

L12

Right-to-left shunt detection by TCD - is it still necessary for the routine clinical workup?

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The patent Foramen ovale (PFO) is present in approximately 25% of the general population. Studies conclude that the PFO is not an independent predictor of stroke. However, there is evidence for an increased prevalence of PFO in cryptogenic young stroke patients. Other possible causes of right-to-left shunting (RLS) leading to embolic stroke, such as shunting at the pulmonary level, are often neglected in cryptogenic stroke patients. The impact of RLS detection has been studied also in other diseases considered to be associated with paradoxical embolism such as migraine and decompression sickness.

Determination of the cause after index stroke is essential in guiding diagnostic and therapeutic strategies. Therefore, in younger stroke patients studies that can identify RLS may be consid-

ered for prognostic purposes. Transesophageal echocardiography (TEE) is required in cryptogenic stroke patients with suspected paradoxical embolism. TEE is usually considered a safe diagnostic device. However, contraindications from TEE exist and TEE-associated complications have been reported in up to 3.5% of patients. TEE is not always applicable and depends on the patient's cooperation, negative test results might occur due to inability to the adequate performance of a Valsalva maneuver.

Contrast-enhanced transcranial Doppler sonography (cTCD) cannot replace echocardiography in the workup of stroke patients. However, cTCD has efficacy comparable to TEE for detecting RLS. Moreover, of patients with negative TEE but positive cTCD shunting, angiographic proven pulmonary RLS due to arteriovenous malformation had been reported. cTCD serves as an ideal, non-invasive bedside screening method for the detection of RLS, as a follow up method to exclude residual shunting after PFO closure and as an alternative method if TEE is not applicable or available. It can be useful during the acute phase of routine ischemic stroke workup in order to identify the pathogenic mechanisms of stroke and to make timely decisions to perform TEE.

Session IV: Neurosonology of cognitive impairment

L13

Ultrasound and cognition

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The interpretation of TCD findings in studies on how cognitive tasks activate different parts of the brain in pathological and physiological conditions is based on presumption of adequate and highly organized neurovascular coupling or functional hyperemia and acceptance of approximative estimate that the changes of mean blood flow velocity reflect changes of cerebral blood flow. Coupling between increased neuronal activity and increased blood flow can be studied in the context of time and the context of space. Studies interested in spatial distribution and in examining activation of the whole brain use functional MRI or PET, while TCD as a continuous method with high frequency sampling provides excellent temporal resolution capable of recording activation in selected brain areas. Very important advantages of TCD to other imaging techniques is its non-invasiveness, relative freedom of movement for subjects and the price. There are different paradigms used to activate different parts of the brain and, consequently, increase blood flow velocities in corresponding arteries. However, as there is compelling evidence that the theory of

neurovascular coupling has its shortcomings and that cognitive functions interrelate in complex ways it would be most appropriate to consider all of the mentioned methods a surrogate marker for exploring changes in neural activity.

L14

Recent experiences with antihypertensive drugs – cognition and ultrasound

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The lecture deals with the pathogenesis of cognitive changes in hypertension, the impact of antihypertensive treatment on the cognition and the role of ultrasound. The chronic hypertension results in white matter lesions, cerebral hypoperfusion and the findings correlate with the decline of attention and executive functions.

The majority of the previous trials studied the white matter changes, while cognitive decline is more closely related to grey matter alterations than to white matter changes. Up till now, there is no evidence that hypertension treatment accelerates the progression of grey matter changes. Inappropriate blood pressure lowering in hypertensives may also accelerate the risk of cerebral hypoperfusion because of the impaired cerebral blood flow autoregulation. This vicious circle worsens the cognition especially in patients with more vascular risk factors. The role of antihypertensive therapy in preventing dementia or cognitive impairment in hypertensives is still a matter of debate. The efficient therapy of hypertension might prevent dementia, however, the results of the previous studies are not conclusive. It is a controversial question whether some antihypertensives improve while others worsen the cognitive performance. Three randomised controlled trials, found positive results on cognitive function, while other four ones did not find any significant effects. The author summarizes his pilot observations with two different ACE inhibitors (enalapril vs lisinopril) on the cognition of hypertensive patients and the role of ultrasound in the follow up.

L15

L16

Neurovascular coupling in the occipital cortex of blind people

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Background – Although the occipital cortex serves for processing of visual input, its activity was also shown in blind people during Braille reading, demonstrating that visual cortex might be recruited and adapted for other function, namely for processing of

sensory input. Our aim was to investigate the measure and dynamics of flow velocity changes in the posterior cerebral artery (PCA), evoked by tactile stimulus (Braille reading) in blind people.

Methods – By using a visual cortex stimulation paradigm in sighted subjects (n=10) and Braille reading in blind people (n=10), the flow velocity response was measured by transcranial Doppler sonography in both posterior cerebral arteries. The stimulation protocol consisted of 10 cycles with a resting phase of 20 seconds and a stimulation phase of 40 seconds for each cycle. During the resting periods, volunteers were instructed to close their eyes; during the stimulation phases, sighted people read silently, while blind people read Braille text of the same content.

Results – Although the flow velocity increased significantly in both groups during the stimulation phase, repeated measures analysis of variance detected significant difference in flow velocity response between the sighted and blind people. The mean and peak systolic flow velocities increased by 11±7% and 11±8% in blind people, and by 23±5% and 24±6% in sighted subjects, respectively (p<0.001).

Conclusions – Our preliminary results proved that flow velocity in the posterior cerebral artery increased significantly during Braille reading, indicating activation of occipital cortex evoked by sensory stimulus. The measure of the flow velocity increase, however, was less in blind people during Braille reading than in sighted subjects during visual stimulation (normal reading).

The study was supported by the Hungarian National Brain Research Program, NAP_13-1-2013-0001.

Session V: Acute stroke and endovascular procedures

L17

Combined lysis of thrombus with ultrasound and systemic tissue plasminogen activator (tPA) for emergent revascularization in acute ischemic stroke (CLOTBUST-ER)

A. V. Alexandrov, P. D. Schellinger, A. Barreto, A. M. Demchuk, L. Soinne, M. Kohrmann, G. Howard, C. A. Molina

On behalf of the Steering Committee and CLOTBUSTER Investigators

Background: Continuous exposure of intracranial arterial occlusions to pulsed wave ultrasound enhances tissue plasminogen induced recanalization. Our hypothesis is that sonothrombolysis can improve functional outcomes of stroke patients receiving tPA therapy.

Methods: The primary objective is to evaluate the efficacy of a novel transcranial ultrasound device and systemic tPA (Target group) compared to systemic tPA alone (Control group) in sub-

jects with acute ischemic stroke and NIHSS scores 10 or greater. This is a randomized (1:1), placebo-controlled, multi-site, phase 3 clinical trial to evaluate the efficacy and safety of CLOTBUST-ER transcranial ultrasound device, as an adjunctive therapy to tPA treatment in subjects with acute ischemic stroke. A total of 824 patients will be enrolled with interim analyses at 1/3 and 2/3 of enrollment.

Current Status: CLOTBUST-ER is closed to enrollment. Approximately 70 sites participated in 14 countries worldwide. Currently centers are completing follow-ups. Functional outcomes are assessed via modified Rankin Scores at 90 days. Data will be analyzed using ordinal shift statistical analysis.

Conclusions: CLOTBUST-ER final results will be presented at ISC 2016. ClinicalTrials.gov Trial Registry ID: NCT01098981

L18

Ultrasound in selection of patients for endovascular procedures

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New therapeutic options have been considered after the encouraging results of recent endovascular treatments trials in acute stroke patients. The rapid development of endovascular procedures and the evolution of new stent and thrombectomy devices have made the careful evaluation of the vessel patency and hemodynamics in acute ischemic patients even more necessary.

The usefulness of including ultrasound examination into the Emergency Department admission procedures consists of the rapid detection and location of extracranial and intracranial artery stenosis or occlusion to select high risk patients for ineffective recanalization and poor functional outcome.

Intravenously administered TPA remains the “first line” therapy of the acute phase but not all patients benefit from this solution. Large vessel occlusions, such as in M1 or M2 MCA tract, intracranial ICA or in tandem stenosis, are less likely to improve with rTPA alone and a proper endovascular procedure could be planned early.

At the same time, ultrasounds could be useful to identify early recanalization not associated to a neurological improvement and not suitable for more invasive treatments

Moreover, the evaluation of the collateral pathways as well as the demonstration of cerebral steal phenomenon with persisting arterial stenosis or occlusions could provide key information for a rapid selection of patients at risk who might benefit from interventional treatment in the appropriate therapeutic window.

There is growing evidence of multimodal imaging (mMRI and mCT) feasibility and utility in selecting patients for endovascular recanalization approaches. A non invasive, repeatable at bedside, ultrasound evaluation could play a substantial role particularly in centres with limited availability to mMRI or mCT in an emergency setting or in patients with contraindications to these imaging modalities.

L19**Update on new studies in interventional neuroradiology***D. Ozretic*

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One of the major limitations of intravenous thrombolytic treatment of acute stroke is low recanalization rate for proximal arterial occlusions (ICA, MCA, BA). Despite theoretical advantage (smaller dose needed to achieve higher local concentration) intraarterial thrombolysis did not prove to be a better and safer alternative for those patients, but remains as an option in selected cases. Since both modalities of thrombolytic treatment are constrained by the same contraindications, mechanical approach consisting of thrombectomy and thromboaspiration was introduced. Much higher recanalization rates were quickly reported, but randomized trials published until last year did not demonstrate correspondingly better patient outcomes. As this findings were in opposition to general experience of neurointerventionalist community, they caused much debate, with bad trial design (inadequate patient selection, significant delay between symptom onset and treatment, and the use of older generation of retrieval devices) blamed for unexpected results. But endovascular stroke therapy gained new momentum with publishing of MR CLEAN trial results at the end of 2014, followed by three additional positive trials at the beginning of 2015, showing the benefit of new generation devices (stentrievers) for proximal occlusions in anterior circulation stroke in addition to standard intravenous thrombolytic treatment. Definitive impact of these trials on stroke treatment in general is still hard to grasp, since many important issues concerning patient selection remain unresolved, such as infarct core and penumbra imaging and assessment of collaterals.

Session VII: Free communications

L20**Associations between cerebral and systemic endothelial function in migraine patients: A post-hoc study***D. Perko, J. Pretnar Oblak, M. Šabovič, M. Zaletel*

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Recently, our group showed differences in endothelial function between the anterior and posterior cerebral circulation in healthy subjects, reduced vasodilatory capacity of the posterior

cerebral circulation and unimpaired systemic endothelial function in migraine patients without comorbidities. However, the relationship between cerebral and systemic endothelial function and the anterior and posterior cerebral endothelial function in migraine patients is still not clear. Our study suggests that the endothelial function in the cerebral and systemic circulation might be different in migraine patients without comorbidities, while that of the anterior and posterior cerebral circulation might be coupled. These results could improve understanding of endothelial function in migraine patients without comorbidities.

L21**Atherosclerosis in young people***G. Baltgaile*

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The cross-sectional survey of cardiovascular risk factors in Latvian population had shown very high prevalence of increased dyslipidemia in young adults. Our previous screening of cerebrovascular diseases among the population proved the existence of early signs of atherosclerosis at young age although the influence of risk factors on early changes of arterial wall has not been studied.

The aim of study was to examine the carotid IMT and the early formation of atherosclerotic plaque in relationship to the dyslipidemia and arterial hypertension in young adults. 95 women and 46 men aged 18-35 years underwent Doppler-Colour Duplex sonography due to the presence of cardiovascular risk factors or due to disorders not associated with them. Carotid intima-media thickness (IMT), brachial blood pressure, data of total cholesterol (TC), low-density lipoprotein cholesterol (LDL) and triglycerides (TG) were evaluated.

The thickening of intima media was found in 2,1% men and 1,4% of women at age 18-24 years; in 14% of men and 6,5% of women aged 25-35 years. Focal initial atheroma and fibroatheroma were found in 3,2% of men and 2% of women at age 25-35 years.

Male sex, age, blood pressure were positively associated with an increase in IMT in both age groups, while levels of TC, LDL cholesterol, and TG were positively associated only with the significant increase in IMT and initial focal plaque in adults 25-35 years.

These findings might reflect the adaptive response of carotid IMT to changes of blood pressure at young age, while dyslipidemia was strongly associated with the initial atherosclerotic changes in arterial wall.

L22

Over 10 years of sonothrombolysis

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In order to save threatened cerebral ischemic tissues therapeutic strategies aiming to increase the rate and speed of arterial recanalization, without increasing the risk of hemorrhagic complications are needed.

Although the underlying mechanisms are still not fully understood, ultrasound energy has demonstrated its ability to enhance the effect of fibrinolytic agents and thus to contribute to arterial recanalization, a process called ultrasound-enhanced thrombolysis or sonothrombolysis. Several studies have shown that it is a safe procedure and results in an increased rate of recanalization in the setting of acute ischemic stroke when wave frequencies and energy intensities of diagnostic ultrasound systems are used. More recently, the use of microbubble sonothrombolysis – even without r-tPA – has been shown to be also effective.

However, regarding the potentiation effect of sonothrombolysis with microspheres and its role in improving recanalization rates and clinical outcome of patients with acute proximal intracranial arterial occlusions, more evidence is still required. To give a definite proof of this treatment, future large sample-size double-blind randomized control studies will be needed.

The objective of this presentation is to review clinical studies regarding ultrasound-enhanced thrombolysis in acute ischemic stroke patients.

L23

Cerebral autoregulation in stroke

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Background: Cerebral autoregulation (CA) is regarded as the capability of the cerebral blood vessels to maintain constant cerebral blood flow (CBF) despite the changes in arterial blood pressure (ABP). In most instances we will use Transcranial Doppler (TCD) to record continuously CBF velocity (CBFV), as a surrogate of CBF, and peripheral ABP pressure. Insight into CA levels could help in management of several cerebrovascular conditions.

Methods: Review findings of the literature of all studies regarding CA evaluation in stroke

Results: In acute ischemic stroke, CA maintenance helps CBF to perfuse the ischaemic penumbra area. It is interesting to notice that in acute stroke baseline ABP levels follow similar U or J-shape relationship with prognosis. Correct identification of patients with impaired or adapted CA could lead to the establishment of impor-

tant subgroups that would really benefit from those therapies. In severe occlusive carotid artery disease it has been demonstrated that CA can be highly impaired. This could be an important risk factor for future stroke. Few studies were devoted to haemorrhagic stroke. CA seems to be impaired in subarachnoid haemorrhage, preceding vasospasm and ongoing vasoconstriction worsens CA. This is related to clinical outcome. In intracerebral haemorrhage CA was worse in the early days of the event, suggesting that dynamic CA was less effective. Finally, interesting findings seem to show that cerebral blood flow regulation may reflect the neurological dysfunction caused by cerebral microvascular disease, namely associated with slow gait speed and risk of falls.

Conclusions: Monitoring cerebral autoregulation can be used in a variety of clinical scenarios and may be helpful in delineating optimal therapeutic strategies. Nevertheless, before a large-scale application of CA to the clinical management, there is a huge need of larger studies. Finally, future studies should spend effort in standardizing the methodologies.

Session VIII: Updated protocols in neurosonology

L24

TCCS (Transcranial Color-Coded duplex Sonography) examination protocol and documentation

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An intracranial examination without information about extracranial findings is of limited value. A focused extracranial color-coded duplex examination is therefore mandatory for correct interpretation of intracranial findings. Also, a conventional TCD overview examination should precede the TCCS. For better orientation an identification of the different examining planes, the examination should start with the B-mode image. In the next step, the individual intracranial arteries can be identified by color coding of the blood flow velocity information.

The following Table gives an overview about the different TCCS insonation approaches. We distinguish between a basic examination which should be possible in each instance and an advanced examination which refers to more challenging accessible intracranial vessels.

Report: The report should include a clear patient identification, the examination date, the working hypothesis (e.g. assumed MCA territory ischemia), a summary of patient's vascular risk factors and the signature of the sonographer. The first part of the report is a description of the findings which are orientated to the assumptions done before. In case of stenosis the blood flow velocities are given with the depth of insonation (e.g. 58 mm). Indirect

information (normal up- and downstream flow signals or pre- and poststenotic flow pattern) has to be described in each case of a stenosis. The report finishes with a short conclusion which summarizes the major findings and refers to the questions raised before.

Documentation with Doppler spectrum (paper or electronic) with measurement of maximum systolic, and enddiastolic blood flow velocities after angle correction (if appropriate) should include in each case at least the BASIC vessels (see Table). Depending on the hypothesis and findings during the examination other vessel segments have to be documented.

L25

Updated protocols in neurosonology: Ultrasound of posterior circulation

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Due to the different nature, prognosis and treatment of posterior circulation occlusive disease, the following arterial segments should be investigated separately as follows: (1) the intraforaminal segment (V2) of the vertebral artery extending through the bony canal of the transverse processes C2 to C6; (2) the extraforaminal segment (V1) extending from its entrance into the foramen transversarium of C6 (in 90% of cases) to its origin; (3) the origin (V0) normally arising from the subclavian artery; (4) the proximal and distal subclavian artery (SA) segments, which by means of a steal mechanism might determine alterations in cerebral hemodynamics; (5) the tortuous segment (V3) extending from C2 to the foramen magnum; (6) the intracranial segment (V4) extending from the dura to its confluence with the contralateral V4 segment to form the basilar artery (BA); (7) proximal and (8) distal parts of the BA should be considered separately, just like (9) the P1 and (10) the P2 segments of the posterior cerebral artery. There are three golden rules for ultrasound examination of the posterior circulation: 1. investigate all segments methodically; 2. check for waveform changes; 3. check for waveform differences between right and left vertebral arteries. This will disclose flow abnormalities (direct signs, indirect signs) and clarify selection of subsequent imaging modalities. Ultrasound is a sensitive indicator of disease in SA and V0 (mainly atherosclerotic, but also arteritic), in V1 (mainly dissection), distal V4 and proximal BA (mainly atherosclerotic). It is less sensitive and more operator dependent in the evaluation of V3 (mainly dissection) and distal BA (mainly embolic) although indirect signs indicative of stenosis are often present and easily detectable. The following issues will also be discussed: 1. Criteria for V0 stenosis; 2. Diagnosis and role of VA hypoplasia; 3. Hemodynamic assessment during head turning: methods and indications.

Session IX: New technologies and applications in neurosonology

L26

Ultrasound in neurorehabilitation

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Most of the stroke patients or victims of other neurological diseases remained disabled and need specific rehabilitation. Nearly all patients are affected in a complex manner: motoric dysfunctions, restriction of upper extremity functionality, broad ranges of neuropsychological deficits, communication and swallowing problems, mood disorders etc. Each deficit has their own temporal development for regeneration or even degeneration during the rehabilitation process (e.g. degeneration of the pyramidal tract, recovery of muscle forces, neuroendocrinological adaption). Thus, it is not simple to focus therapeutic management only on one aspect of the dysfunction. At least, the risk for complications such as aspiration, cardiovascular problems, diabetic control, fall with fractures, frozen shoulder and others are very high.

Ultrasound (US) application in rehabilitation is not only limited to be informed about the vessel status and cerebral hemodynamics in stroke patients. US technologies may help us to improve therapeutic management during rehabilitation. The diagnostic tools allow to measure muscle atrophy and involvement of nerve inflammation in critical illness myopathy, to analyze dyskinetic contractions of muscles in spastic and dystonic movement disorders and to support the therapeutic approach when Botulinum Toxin injection in muscles and glands is necessary. Myosonology may also support the decision for selection of the adequate orthosis.

Ultrasound methods should be part during the neurorehabilitation process to optimize our therapeutic strategies and to improve our understanding of the regeneration and degeneration mechanism in neurological diseases.

L27

L28

L29

Application of ultrasound in NICU

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Ultrasound (US) assisted procedures are an integral part of patient management in many intensive care units. Critical care ultrasound in experienced hands is a useful bedside non-invasive tool for assessment of haemodynamics as well as a tool for punctions of vessels and organs enhancing the effectiveness and safety. Furthermore, there is evidence, that the use of point-of-care ultrasonography is associated with a significant reduction in the number of imaging studies performed by the radiology and cardiology services.

The most common applications of US on ICU are: guidance for vascular access (central venous catheters, arteries), monitoring of residual urine and puncture of urine bladder, pleural- and ascites puncture, lumbar puncture by adipose patients, assessment of pneumothorax and basic critical care echocardiography.

An overview of US assisted procedures and an update on current guidelines regarding the use of US on ICU will be presented.

Description of selected procedures with definition of sonographic landmarks, inclusive practical hints will be demonstrated.

Oral Presentations

Session I: Comprehensive assessment of atherosclerosis by ultrasound

O1

Ultrasound detected atherosclerotic load in carotid arteries and stroke

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Background: Previous studies demonstrated that carotid atherosclerotic ultrasound findings are associated with stroke. The aim of this study was to determine the association of carotid ultrasound findings with stroke, taking into account both plaque stenosis and thickness of vessel wall in the common carotid.

Methods: Analysis involved imaging by duplex of carotid arteries of 2,350 patients (1,282 males, 1,068 females, mean age: 66.03 years), to detect the presence of plaque and to assess the intima-media thickness (IMT). Cerebrovascular accident (CVA, n=498) was one of the reasons for referral to laboratory, as diagnosed on clinical

and brain CT grounds. Each vessel was assigned a score (presence of plaque with 1-49% stenosis=1, presence of plaque with equal or more than 50% stenosis=2, absence of plaque=0, IMT \geq 0.8 mm=1, IMT<0.8 mm=0) and the total score of the two carotid arteries was calculated per patient (atherosclerotic ultrasonic score-ATHUS).

Results: The prevalence of CVA in atherosclerotic group A (ATHUS=0 -n=1048) was 17.4% (182/1048). The corresponding values for atherosclerotic groups B (ATHUS=1, n=525), C (ATHUS=2, n=292), D(ATHUS=3, n=302), E(ATHUS=4, n=119), F(ATHUS=5, n=64) were: 19.4%(102/525), 20.5%(60/292), 27.8%(84/302), 35.3%(42/119), 43.8%(28/64) respectively (p<0.05).

Conclusions: Our results demonstrated that the degree of atherosclerosis predicted cerebrovascular accident, taking into account both carotid stenosis and IMT.

O2

Carotid arterial hemodynamic and stiffness parameters in patients with ischemic leukoaraiosis

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Background: Leukoaraiosis (ILA) is believed to be ischaemic in origin due to its similar location to lacunar infarctions and its association with cerebrovascular risk factors. However, its pathophysiology is not well understood. Aging and vascular risk factors contribute to the stiffening of the large elastic arteries. The ischaemic injuries may be a result of exposure of the small vessels to the abnormal flow pulsations or cerebral hypo-perfusion. Carotid duplex ultrasound was used to determine the cerebral blood flow and carotid stiffness in ILA patients and a risk factor matched control group. We tried to prove that carotid ultrasound could be used as a non-invasive diagnostic tool for ILA.

Methods: We compared 59 ILA patients to 45 risk factor matched controls with normal magnetic resonance imaging (MRI) of the head. ILA diagnosis was based on MRI and was further categorised according to the Fazekas scale. Carotid artery blood flow velocity, blood flow and resistance indexes were determined. In addition we determined pulse wave velocity b (PWVb, m/s), pressure-strain elasticity modulus (Ep, kPa), b index and augmentation index (Aix,%) and arterial compliance (AC, mm2/kPa).

Results: Blood flow velocities and blood flows were significantly lower in the ILA group, including diastolic, systolic and mean pressures (p \leq 0.05). All the velocities and blood flows showed a decreasing trend with higher Fazekas score, whereas resistance indexes showed an increasing trend. PWVb, Ep, b index and Aix values were higher and AC values were lower in the ILA group; however, only Ep and PWVb reached statistical significance (p \leq 0.05).

Conclusions: Lower blood flow and higher resistance of carotid arteries as well as increased carotid stiffness were found in ILA patients compared to risk factor-matched controls. Carotid blood flow parameters, Ep and local PWVb could have a diagnostic role in ILA patients.

O3

Quantification of internal carotid artery stenosis – comparison of 3D-ultrasound angiography (B-mode and power mode) with 2D colour-coded duplex sonography

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Background: Up to 20% of ischaemic strokes are caused by large-artery atherosclerosis, id est a significant stenosis of mainly the internal carotid artery (ICAS). In Germany, 2D colour-coded duplex sonography (2D-CDS) is considered as clinical gold standard for detection and quantification of ICAS with a good sensitivity and specificity. Here, we compare 3D-ultrasound angiography with conventional 2D-CDS for grading ICAS. **Methods:** Forty-three ICAS of 37 patients were examined by 2D-CDS and by 3D-ultrasound angiography (B-mode and power mode) using a Toshiba Aplio 500 (Toshiba Medical Systems GmbH, Neuss, Germany) equipped with a linear transducer (PLT-1204BT) set at 13 MHz and the Curefab CS (Curefab Technologies GmbH, Munich, Germany). Stenotic value of ICAS was assessed by applying the multi-parametric German “DEGUM ultrasound criteria” (2D-CDS) respectively – after manual 3D-reconstruction of ICAS – by calculating the distal diameter reduction percentage according to North American Symptomatic Carotid Endarterectomy Trial criteria. **Results:** There was no significant difference in successful 3D-reconstruction of ICAS between B-mode (35/43) and power mode (40/43), chi-square test $p=0.11$. A good intermethod agreement was found between 2D-CDS and 3D-ultrasound angiography (power mode) both in the Bland and Altman analysis and by intraclass correlation (ICC; 0.85, $p<0.001$). However, intermethod agreement between 2D-CDS and 3D-ultrasound angiography was poor (ICC 0.40, $p<0.001$) when using B-mode as basis for 3D-ultrasound. **Conclusions:** Showing a good intermethod agreement for quantification of ICAS in comparison to 2D-CDS, 3D-ultrasound angiography (power mode) is a promising complementary imaging method to the well-established flow-based classification. Therefore, invasive and potentially harmful imaging modalities like contrast-enhanced computed tomography or magnetic resonance angiography might be restricted to those cases of ICAS where a clear discrepancy for stenotic value is found between 2D-CDS and 3D-ultrasound angiography.

Oral Presentations

Session II: Heart and brain

O4

A natural history of young patients with cryptogenic stroke and PFO

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Background: The pathogenetic role of Patent Foramen Ovale (PFO) in patients with cryptogenic stroke (CS), in particular in the recently proposed subset of ESUS (embolic stroke of undetermined source), is still uncertain. Aim of our study was to define the natural history of patients with CS and PFO, with and without an embolic pattern of cerebral ischemic lesions.

Methods: Among all first-ever stroke patients (18 males, mean age 38.4 years, range 18-55), admitted to our Stroke Unit in 2012, 33 were classified cryptogenic with a PFO after a thorough diagnostic work-up including brain magnetic resonance imaging (MRI); cervical and transcranial ultrasound; Bubble test; transthoracic and transesophageal ecocardiography; lower limbs venous ultrasonography; pelvic venous magnetic resonance angiography; ≥ 24 h continuous EKG monitoring. We subdivided this cohort of study patients into two groups according brain MRI findings: ESUS and non-ESUS.

Every patient was placed on secondary prevention therapy (ASA 100mg OD) and underwent regular follow up visits.

Results: Regarding distribution of ischemic lesions at MRI, 60% (20/33) of patients was classified as ESUS. During the follow up period (mean 26.2 \pm 6.5 months), no cerebral ischemic events were recorded in either group. In six patients (18.8%) we were able to identify a cause of stroke alternative to PFO: in the ESUS group we detected cancer-related thrombosis in one patient, atrial fibrillation in two patients; consequently secondary prevention treatment was shifted to anticoagulation. In the non-ESUS group we disclosed episodic drug abuse (cocaine, amphetamines) in three patients.

Conclusions: In CS patients with PFO a rigorous follow-up is pivotal identifying the cause of stroke, thus avoiding unnecessary and potentially harmful PFO closures. Moreover, given the study limits, the detection of embolic sources only in the ESUS group seems to indicate anticoagulation as an appropriate treatment for these patients.

O5

Right-to-left shunt detection sensitivity with transcranial doppler and saline or succinyl-gelatin air mixture

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Background: TCD with air-saline contrast agent is nowadays the first choice examination to identify RLS. To increase visual RLS detection during echocardiography, cardiologists also use air-gelatin mixtures, which are however stopped by the pulmonary filter, but more stable and easier to be prepared. We assessed sensitivity of air-gelatin in respect to air-saline mixture for RLS detection with TCD.

Methods: patients referred for RLS detection with TCD to our neurosonology laboratory were investigated. Standard air-saline injection during TCD unilateral middle cerebral artery monitoring, both in basal and after Valsalva maneuver, was performed. The same protocol was repeated immediately thereafter, with air-gelatin mixture. To consider the TCD positive for cardiac RLS, time window for embolic detection was fixed within 40" from contrast injection. Later signals were interpreted of pulmonary origin and confirmed with trans-thoracic echocardiography. RLS was graded as follows: a) 0; b) 1-10; c) > 10, countable with shower effect; d) curtain effect with too numerous signals for a single identification.

Results: 53 patients were enrolled. 23 had negative TCD with air-saline and were also negative after air-gelatin mixture; in 5 of these 23, late (>40"), isolated microemboli, slightly more numerous with the air-gelatin mixture, were detected and interpreted as pulmonary shunts. In 18 patients in whom TCD with air-saline was positive for cardiac shunt only after the Valsalva maneuver, air-gelatin proved to reveal RLS also during basal condition. In 12 patients with early positive TCD with air-saline even during basal condition, air-gelatin mixture made RLS more evident.

Conclusions: air-gelatin mixture is safe to be used in contrast TCD for RLS detection. Air-gelatin increases RLS detection sensitivity with TCD also in basal conditions, even in patients in whom air-saline mixture gives negative basal results. The choice of the air-gelatin mixture should therefore be considered for clinical routine and research studies.

O6

Transcranial doppler evaluation of the cerebral circulation in patients with coronary disease and valvular heart disease

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Background: There are just a few data regarding the prevalence of intracranial artery disease (ICAD) in patients with coronary heart disease and valvular heart disease. The purpose of this study was to identify the burden of intracranial atherosclerotic disease evaluated by Transcranial Doppler (TCD) in patients appointed to coronary bypass or cardiac valve surgery.

Methods: Cross-sectional study of patients consecutively evaluated at our laboratory from January 2013 to December 2014, by TCD, pre-operatively to coronary bypass and to valvular heart surgery. TCD criteria for stenosis were according to the SONIA Trial. Statistical analysis was performed using SPSS 22. The presence of intracerebral artery stenosis was investigated in the three groups of patients and the OR for intracerebral artery stenosis obtained.

Results: 414 patients were studied: 198 (47.83%) with coronary artery disease (mean age: 67y; SD=11.96) and 164 (39.61%) with coronary disease (mean age: 72y; SD=12.89) and 52 (12.56%) with both (mean age: 72; SD=6.25). In 97 patients (23.54%) an intracranial stenosis was identified: 54.64% at the group with coronary heart disease; 26.8% at the group of valvular disease and 18.56% at the group with the combined diseases.

Conclusions: There was a significant association (<0.05) in all groups, being stronger in the group of intracranial stenosis and coronary disease, and weaker in the group of intracranial stenosis with valvular heart disease (OR=2.16). Our results suggest the interest in evaluating arterial cerebral circulation by TCD in order to identify stenotic disease in patients with severe coronary disease and also in patients with severe valvular heart disease.

Oral Presentations

Session III: Treatment decisions guided by ultrasound

07

Intimal lesions after carotid endarterectomy

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Background: Carotid endarterectomy is a standard therapy for symptomatic high-degree internal carotid artery stenosis. The aim of this article is to present possible intimal lesions after carotid endarterectomy. These lesions could be manifested as intimal flaps, intimal steps or dissections with or without occlusion or stenosis of the artery. **Methods:** Evaluation of the frequency and characteristics of the asymptomatic dissecting intimal lesions of the common carotid arteries was performed in a sample of 100 patients who underwent endarterectomy due to symptomatic high grade stenosis of the internal carotid artery. **Results:** We found five patients with asymptomatic dissecting intimal lesions of common carotid arteries. **Conclusion:** The most common causes of these intimal lesions are shunting and prolongation of the clamping time. Routine carotid ultrasound follow-up exams are often necessary because of a potential change of the antithrombotic therapy or due to a need to perform an endovascular treatment.

08

Management of complicated cervical artery dissection guided by ultrasound – a diagnostic and therapeutic challenge

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Background: Although spontaneous cervical artery dissection (sCAD) is a leading cause of non-atherosclerotic stroke in young adults, there are no clear indications to endovascular treatment. We report our single-center experience with an ultrasound-based protocol for complicated sCAD management.

Methods: We evaluated all consecutive patients with an ultrasound-diagnosed and MRI-proven sCAD, admitted to our Stroke

Unit in a three-year period. Endovascular treatment (stent placement or embolization) was offered to every patient with 1) severe stenosis and unstable cerebral hemodynamics; and/or 2) enlarging, symptomatic pseudoaneurysm. During follow-up, we assessed treatment safety and durability, as well as sCAD and symptoms recurrence.

Results: Among 38 patients with sCAD (males 60%; mean age 48±11 years), the majority presented with both stroke/TIA (82%) and local symptoms (63%). A complete neurovascular ultrasound assessment showed hemodynamic (95%) and/or morphological (61%) signs of dissection, 57% involving the internal carotid arteries (ICA) and 43% the vertebral arteries (VA); multiple CADs were found in 45%. Endovascular treatment of sCAD was performed in 14 patients (11 ICA, 2 VA, 1 both), using hemodynamic (64%) and/or morphologic (43%) criteria for eligibility; one patient with sICAD suffered a peri-procedural stroke; there were no sCAD recurrences. Among medically-treated patients (24; antiplatelet agents 62%, anticoagulants 38%), there were 3 early (<1 week) symptomatic sCAD recurrences (1 ICA, 1 VA, 1 both); neurosonographic monitoring showed complete and hemodynamically significant recanalization rates of 25% and 33% in the first month, rising to 43% and 52% at six months respectively.

Conclusion: Ultrasound-guided endovascular treatment in selected patients with sCAD appears to be safe and effective with low peri-procedural complication rate. Nevertheless, more data from broader studies are

Oral Presentations

Session IV: Neurosonology of cognitive impairment

09

Extracranial and transcranial color duplex sonography in vascular dementia in relation to risk factors

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Background: Extracranial and transcranial color duplex sonography are useful tools in assessment of haemodynamic changes in patients with vascular dementia.

Aim: To analyze haemodynamic changes in patients with vascular dementia and correlate them with associated vascular risk factors.

Material and methods: 45 patients with vascular dementia were studied and compared with 30 age matched controls. Extracranial color duplex sonography was used to assess intima-media thickness (IMT) of the carotid arteries. Transcranial color duplex sonography was performed to assess blood flow velocity

(V(mean)) and pulsatility indices (PI) of the middle cerebral artery (MCA). The presence of hypertension, hyperlipidemia, diabetes mellitus and other traditional risk factors was evaluated.

Results: IMT was significantly increased in patients with vascular dementia compared to the control group ($p < 0,05$). MCA V(mean) and PI values were significantly lower than in controls ($p < 0,05$). Patients with vascular dementia had higher prevalence of hypertension ($p < 0,05$) compared to the control group. No significant differences were noticed in the total cholesterol, high-density lipoprotein cholesterol and triglycerides plasma concentrations as well as glycemia level between the two groups ($p > 0,05$).

Conclusion: Patients with vascular dementia need careful management of vascular risk factors, especially hypertension and regular follow-up of vascular morphologic and haemodynamic changes.

O10

Blood flow velocity changes in anterior cerebral arteries during cognitive tasks performance in left-handed subjects

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Objective: Transcranial Doppler sonography (TCD) monitoring of blood flow velocities (BFVs) in anterior cerebral arteries (ACAs) during different cognitive tasks performance are rare (Boban M, Crnac P, Junaković A, Garami Z, Malojčić B. Blood flow velocity changes in anterior cerebral arteries during cognitive tasks performance. *Brain Cogn* 2013;84:26-33.), with no study performed in left-handed subjects, so far.

Aim: To obtain temporal pattern and hemispheric dominance of BFV changes in ACAs in left-handed subjects during different cognitive tasks performance and to assess potential of different cognitive tasks for monitoring of BFV changes in ACAs.

Methods: Fourteen left-handed, healthy subjects aged 20 to 25 were included in the study. BFVs were recorded simultaneously in ACAs during performance of cognitive tasks designed to activate frontal lobes: phonemic Verbal Fluency test (pVFT), Stroop tests and Trail Making tests (TMTs).

Results: A statistically significant BFV increase was recorded in both ACAs during performance of pVFT, TMTs and Stroop test with incongruent stimulus. Statistically significant laterality was found during performance of VFT (right dominance) and TMTA (left dominance). The most significant BFV increase was found during performance of TMTA.

Conclusion: Our results specify TMTA as a cognitive test with great activation potential for monitoring of BFVs in ACA in left-handed subjects.

O11

Identification the dominant hemisphere with the use of functional transracial doppler

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Background: In modern conceptions of functional asymmetry and interhemispheric interaction each hemisphere is considering as a dominant for certain functions. The left hemisphere is dominant for verbal functions and right hemisphere is dominant for perceptual functions in the most part of population. In the neurological and neurosurgical practices the clear criteria of identifying the dominant hemisphere is required. Last time the method of functional transcranial Doppler (fTCD) has been involved as an alternative way for traditionally used invasive methods (ex., WADA-test).

Methods: The study involved 50 volunteers (35 women) aged from 18 to 58 years old. The subjects were presented twelve types of verbal (six) and perceptual (six) cognitive tasks in the auditory and visual modalities. The results of the research were compared with the velocity of blood flow at rest.

Results: The results showed that the performing of verbal cognitive tasks accompanied by more increased blood flow velocity in left hemisphere. There is no the same tendency of increased blood flow velocity while performing the perceptual cognitive tasks.

Conclusions: To identify the dominant hemisphere for speech functions there were selected those types of cognitive tasks only, which showed statistically significant changes in blood flow velocity during their performance and takes the maximum increased blood flow velocity compared at rest.

Oral Presentations

Session V: Acute stroke and endovascular procedures

O12

Cerebral aneurysm growth and risk of rupture?

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Background: Natural history of small-unruptured incidentally discovered intracranial aneurysms (SUIA) remains unpredictable and if asymptomatic, the strategy is not consensual. The aim of this study was to clarify the risk of rupture or morphological changes of SUIA according to their location and identify risk factors associated with growth and rupture.

Methods: We studied a prospective cohort of 292 patients (mean age, 55.1 years; 77.1% women) and 368 SUIA (anterior circulation aneurysms <7mm and posterior circulation aneurysms <4mm, without previous subarachnoid haemorrhage). Baseline epidemiological data, clinical presentation, risk factors and aneurysm characteristics were collected. Outcome was reported as aneurysm's shape and size stability versus change or rupture at 6 months, 1, 2 and 5 years after the diagnosis (mean follow-up of 3.2 years and 1177.6 aneurysm years).

Results: Aneurysm location was most frequently the ophthalmic segment (n=84, 22.8%), followed by the Sylvian bifurcation (n=82, 22.2%); AcoA (n=54, 14.7%) and the M1 segment of the MCA (M1MCA) (n=41, 11.2%). Mean aneurysm size was 3.6±1.9 mm, with a majority (n=230, 62.5%) of less than 4 mm. Two unexpected ruptures were observed (M1 and AcoA). Aneurysm growth rate was 2.1% per year. The growth risk odds distribution per location was similar to the rupture risk distribution per location. M1MCA aneurysms showed the biggest risk of growth (n=10; 27%; p=0.004), as well as lesions measuring between 4-6.9 mm (OR=3.5, 95%CI 1.6-7.5, p<0.001). Together AcoA and posterior circulation aneurysms (including PcoA) showed a trend to growth.

Conclusions: It is mandatory to closely monitor small aneurysms of the M1MCA and to treat them as soon as a morphological change occurs. However, aneurysms of more than 4mm should also be screened more regularly. When classifying aneurysms by their location, there's a trend showing that growing is a normal step before rupture.

O13

Uselessness of extracranial cervical vessels sacrifice with endovascular coils positioning in 2 cases with internal carotid and vertebral artery progressive dissections

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Background: vessels permanent occlusion with endovascular coils or other materials in cases of untreatable aneurysms, pseudoaneurysms, carotid body tumors and carotid blowouts is considered an emergency procedure. We present two cases with internal carotid and vertebral arteries dissections that showed progressive symptoms and worsening of both intramural hematoma and hemodynamic parameters that were submitted to endovascular occlusion to stabilize and reduce the embolic risk.

Cases report 1: male, 52 yrs, admitted for left Bernard-Horner Syndrome with left ICA dissection and a preocclusive stenosis, with hypoechoic floating material in the carotid lumen at ultrasound. Treated with anticoagulants, his clinical neurological conditions worsened with intermittent hemiparesis. Cerebral MRI showed the developing of multiple ischemic lesions and a large hypoperfusion in the left hemisphere. Considering that the ipsilateral syphon and MCA were patent, supplied via the ophthalmic and anterior communicating arteries, it was decided to sacrifice the internal carotid artery with endovascular coils positioning. His clinical conditions were stabilized, but in the follow-up the formerly occluded internal carotid artery showed recanalization with flow restoration through the coils.

Cases report 2: female, 32 yrs, admitted for cervical pain and visual loss, cerebral MRI showed a large area of hypoperfusion in the posterior circulation. Ultrasound showed bilateral cervical vertebral artery dissections with multifocal stenosis, aneurysms and presence of irregular intramural hematoma extended from origin to the entire V2 segment. Treated with anticoagulants, she continued having cervical pain and intermittent visual deficits. Ultrasound showed increased volume of the intramural hematoma with further dilation of the V1 caliber. Occlusion of the right vertebral artery origin with coils positioning in distal V1 and V0 tracts was then performed. Clinically she improved, but at the ultrasound follow-up she showed recanalization of the right occluded segment. Interestingly, the contralateral affected side showed spontaneous recanalization with reduction of the intramural hematoma extension.

Conclusions: in our cases, we considered vessels sacrifice as an emergency option to reduce embolic risk in cervical arteries dissections with symptoms worsening and evidences of progressive hemodynamic changes. Notwithstanding the coils positioning, the vessels showed, however, recanalization. More experiences are needed before considering this approach as an effective option in such cases.

O14

Possible benefit of „bridging“ therapy in acute basilar occlusion

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Basilar artery occlusion (BAO) accounts for about 6-10% of all large vessel occlusion strokes. Natural course of stroke in this location varies depending on different but often unpredictable factors. However, according to most authors, the outcome is in 50-95% poor or fatal. Furthermore, symptoms are also not often typical and may vary from very mild but progressive neurological deficit, to acute onset of life threatening clinical picture including severe consciousness disturbance as well as respiratory or cardiac arrest. On the other hand, these differences in clinical picture do not predict final outcome.

Modern revascularisation techniques enable recanalization of basilar artery (BA) in high percentage. Still, recanalization cannot assure good clinical outcome as well. Remaining question nowadays is whether initial therapy with intravenous thrombolysis (alone or serving as „bridging“ therapy) may improve outcome in patients with basilar artery occlusion, or a direct intra-arterial access (intra-arterial thrombolysis or thrombectomy) has to be the first choice treatment. Prospective, randomized trials comparing this two approaches are still lacking in this group of patient.

We present group of patients with basilar artery occlusion (20 patients) who were treated in last 2 years in University Hospital Zagreb, according to our protocol which includes „bridging“ therapy concept, followed by endovascular recanalization methods, if necessary. Although small in number, we reached a percentage of 69% of patients with favourable outcome (mRS 0-2), and 21% of our patients died. According to our experience, „bridging“ therapy encounters for favourable outcome of patients with BAO especially in acute setting without a possibility of immediate endovascular approach.

Oral Presentations

Session VI: Pitfalls and interactive case reports

O15

O16

When symptoms are transient and the patient is young – a most difficult case

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Introduction: Up to 10% of ischemic strokes occur in individuals under 45 years of age. The etiologies of these ischemic events are different compared to those observed in the elderly and can represent a challenge for the physician in terms of diagnosis and treatment.

Case report: a 17-year-old Caucasian girl came to our attention because of a sudden and transient (2 hour) weakness in her right upper limb. Physical examination showed a slight pronation of her right hand, a systolic heart murmur and a convergent strabismus without diplopia. Cerebral CT scan was negative for acute events, while a CTA showed a severe left carotid siphon stenosis. The patient's clinical history was remarkably rich: at the age of one month, multiple large hemangiomas were detected on the parotid glands, epiglottis, lips, left eyelid, upper back and left optic tract. At the age of 16, the patient had undergone replacement surgery due to a 6 cm aneurysm in the descending aorta. She also had a coloboma of her left optic nerve. A Color-coded Doppler sonography of cervical and intracranial arteries documented a significant stenosis in the left ICA with signs of a dissection and a stenosis in the M1 segment of the MCA, which were confirmed by CTA and DSA. The past medical history of the patient and these current findings allowed us to make the diagnosis of PHACE, which is an acronym coined to describe a neurocutaneous syndrome encompassing posterior fossa brain malformations, large facial hemangiomas, arterial anomalies, cardiac anomalies, aortic coarctation, and eye abnormalities. The patient underwent left carotid artery angioplasty and stenting and has been asymptomatic ever since.

Conclusion: PHACE syndrome should be considered as a differential diagnosis for ischemic events in young patients with previous history of segmental facial hemangiomas.

Oral Presentations

Session IX: New technologies and applications in neurosonology

O17

LUPUS – lumbar puncture with ultrasound study

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Practical experience shows, that lumbar punctures are more challenging in the obese population. Not only obesity is responsible for a difficult lumbar puncture. Other factors contributing to a difficult LP approach are: fibrous tissue formation due to repeated LPs, spinal abnormalities and non-cooperating subjects. The palpation is widely used to identify the puncture site, but it is usually difficult to accurately locate the puncture site in obese patients.

Ultrasound can be used to identify the landmarks in the lumbar region, the appropriate puncture point can be determined.

We hypothesize that ultrasound assisted determination of the puncture point in obese patients decreases the incidence of multiple punctures and re-directions and enhances the safety.

We present the protocol of a prospective randomized multi-centre study to evaluate the impact of ultrasound imaging on the success rate of lumbar puncture in obese patients (Body mass index >25). All patients indicated for LP and a BMI >25 will be randomized into two equal-sized groups for location of the puncture site. The success rate, the number of puncture attempts, the re-directions of the needle, the complication rate (e.g. postpunctional headache, heamoragically liqour etc.) will be compared between the two groups and analysed.

O18

TCD in autonomic function testing

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Background: Transient loss of consciousness (TLOC) is an important symptom with a broad differential diagnosis. After excluding cardiac rhythm disorders and epilepsy, autonomic function testing may demonstrate disorders in blood pressure regulation as a possible cause of TLOC. It may reveal orthostatic hypotension (OH), vaso-vagal collapse (VVC) or postural orthostatic tachycardia syndrome (POTS). In order to detect these syndromes, autonomic function testing should at least include a continuous recording of heart rate and arterial blood pressure. Is there added value of a continuous recording of intracranial flow velocities by means of TCD?

Methods: The contribution of TCD to autonomic function testing was examined retrospectively, with special focus on findings during the tilt table test.

Results: Over the years 2013 and 2014 we performed 51 autonomic function tests (26 male and 25 female ageing from 13 to 87 with a mean of 55.7 yrs.). A continuous recording of at least one middle cerebral artery was obtained in 45 cases (88%). In 5 cases (10%) TCD demonstrated typical TCD changes preceding VVC. In 8 cases (16%) changes in TCD demonstrated how inflating antishocktrousers improved cerebral hemodynamics during tilt table testing in patients with OH or POTS. In 1 case with unilateral carotid artery occlusion we demonstrated an exhausted cerebral autoregulation explaining focal neurological deficit during OH.

Conclusions: At our department, the inclusion of TCD in autonomic function testing proved worthwhile in approximately 1 out of 4 cases. The benefit of incorporating TCD was: (1) to detect typical TCD changes preceding VVC that allow examiners to bring back the patient in horizontal position prior to actual LOC, (2) to demonstrate the contribution of venous pooling in patients with OH and POTS and (3) to detect an occasional patient with exhausted cerebral autoregulation.

O19

A proposed TCCS-based grading system for intracranial collaterals in cases of symptomatic ICA occlusion

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Objectives: to establish a novel TCCD-based grading system for collateral circulation in cases of symptomatic chronic total carotid occlusion (TCO). Also to correlate this new grading system with cerebrovascular reserve capacity measured by SPECT.

Methods: 34 patients with symptomatic chronic TCO diagnosed by color-coded duplex were subjected to: clinical assessment, grading of cerebral collaterals using a new TCCD criteria (table 1), Brain SPECT studies at rest and with dipyridamole stress.

Results: the new grading system for cerebral collateral circulation showed a significant positive correlation with CVR (P value < 0.001 & Spearman correlation coefficient 0.686) (figure 1).

Conclusion: the current study showed that this new TCCD grading system for cerebral collaterals is a good index for cerebral perfusion and reserve capacity in cases of chronic symptomatic TCO.

O20

Utility of ultrasonography in the diagnosis of pseudotumor cerebri syndrome

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Background: Transorbital ultrasound (TOS) has been proven to be feasible and reliable to non-invasively detect elevated intracranial pressure. In these patients TOS shows an increase in optic nerve sheath diameter (ONSD). It has been suggested that an increased internal jugular valve insufficiency (IJVVI) may represent a factor contributing to the pathogenesis of Pseudotumor cerebri Syndrome (PTCS).

The aim of this study was to investigate whether patients with PTCS have higher ONSD values and higher frequency of IJVVI compared to healthy controls.

Patients and Methods: A case-control study was performed in 4 centers. 20 consecutive patients with newly diagnosed PTCS were compared with 19 healthy controls, matched for sex, BMI and age (± 5 years). Experienced vascular sonographers used B-mode TOS to evaluate ONSD, optic nerve diameter (OND) and IJVVI. Opening pressure values were also measured.

Results: ONSD values were significantly higher in patients (6.50 ± 0.63) than controls (5.81 ± 0.64 ; $p=0.002$). No differences were found in OND values between patients (3.0 ± 0.32) and controls (3.0 ± 0.35 ; $p=1$). No correlation was found between ONSD and opening pressure values ($r=0.0058$; $p=0.8$). No difference in frequency of IJVVI between patients (5/20, 25%) and controls (3/19, 16%) was observed ($p=0.76$).

Conclusions: Increased values of ONSD detected by TOS support the diagnosis of PTCS. A causative role of IJVVI for the pathogenesis of PTCS seems unlikely.

Poster Session I – 1. Atherosclerotic plaque

P1

Plasma levels of interleukin 23 are increased in patients with symptomatic carotid stenosis and are associated with adverse events

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Background: Interleukin (IL)-23 is a cytokine mainly produced by antigen presenting cells with a central role in many inflammatory diseases. We hypothesize that IL-23 have an important role in atherosclerosis, and investigate this in a population with carotid artery atherosclerosis.

Methods: Plasma levels of IL-23 were measured in patients with carotid artery stenosis, and in healthy controls. The mRNA levels of IL-23 and its receptor, IL-23R, were measured in atherosclerotic plaques, non-atherosclerotic vessels, peripheral blood mononuclear cells (PBMCs) and plasmacytoid dendritic cells (pDCs).

Results: Our findings were: (i) Patients with carotid atherosclerosis ($n=177$) had significantly higher plasma levels of IL-23 when compared with healthy controls ($n=24$) with particularly high levels in patients with the most recent symptoms. (ii) mRNA levels of IL-23 and IL-23R were markedly increased in carotid plaques ($n=68$) when compared with non-atherosclerotic vessels ($n=8-10$). Immunostaining showed co-localization of IL-23 to plaque macrophages. (iii) Patients with carotid atherosclerosis had increased mRNA levels of both IL-23 and IL-23R in pDCs, but not in PBMCs. (iv) IL-23 increased IL-17 release in monocytes and particularly in PBMCs from patients with carotid atherosclerosis, but not in cells from healthy controls. (v) High plasma levels of IL-23 were associated with increased mortality during follow-up period.

Conclusion: Our study demonstrates an association between IL-23 and disease progression in patients with carotid atherosclerosis, potentially involving IL-17-related mechanisms. Our finding suggests that IL-23 might be a mediator for carotid artery plaque destabilization.

P2

The changes of the size of carotid arterial plaque during 10 years in acute stroke patients

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Background: Carotid arterial stenosis becomes more common and important risk factor for stroke patients in Asian area. We reviewed stroke database to investigate the changes of carotid arterial stenosis and peripheral arterial disease which reflects advanced atherosclerosis during approximately 10 years.

Methods: Acute stroke patients at the National Health Insurance Corporation Ilsan Hospital at 2005-2006 year and 2014 year with available carotid ultrasound, transcranial Doppler (TCD) examination and ankle-brachial indexes (ABI) formed the analysis cohorts. Retrospective review was performed.

Results: During 2005-2006 year, total of 304 patients were included and during 2014 year, total of 192 patients were included. By duplex ultrasound, common, internal carotid arteries are examined and the biggest diameters of plaques are recorded. 3 groups of carotid arterial plaques are defined: less than 2mm, 2-4mm and greater than 4mm. During 2005-2006 year, the prevalence of less than 2mm is 37%(112 patients), 2-4mm is 57%(174 patients) and greater than 4mm is 6%(18 patients) During 2014 year, less than 2mm is 31.7%(61 patients), 2-4mm is 57.3%(110 patients) and greater than 4mm is 11%(21 patients). As the size of carotid arterial plaques increased, ABI is decreased: the mean ABI of less than 2mm group is 1.09, the mean ABI of 2-4mm group is 1.01 and the mean ABI of greater than 4mm group is 0.95.

Conclusions: Among the acute stroke patients, the prevalence of carotid arterial stenosis tend to be increased during 10 years and more than a half of them have carotid arterial stenosis above moderate degree, and these patients tend to have higher burden of advanced atherosclerosis as evidenced by a higher prevalence of peripheral arterial occlusive disease.

P3

Intracranial stenosis characteristics in a group of patients

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Background: The risk for stroke in asymptomatic patients with intracranial stenosis (IS) is 6% / year, but it rises up to 20% in patients with previous stroke or female gender.

Methods: We present a group of 121 patients admitted in our Neurology Department from 2011 to 2013, mainly with acute stroke (91%).

Results: 74 patients (61%) were men. Age distribution: 28 (23%) under 60 yo, 74 patients (61%) between 60-80 yo, 19 patients (16%) over 80 yo.

Single or multiple vascular risk factors were present in 97% of patients:

- Hypertension: 100 patients, 59 (49%) treated,
- Diabetes Mellitus type 2: 55 patients, 45 (37.5%) treated.
- Dyslipidemia: 78 patients, 30(25%) treated
- Smoking: 51(42%) patients

Association with previous ischemic stroke was detected in 38 patients (31%), and ischemic heart disease in 42 patients (35%)

IS had the following distribution:

- anterior: 106 patients; ICA – 55 (45%) and MCA – 51 (42%)
- posterior: 31 patients; vertebral artery – 12 patients (10%) and basilar artery 19 patients (16%)
- multiple IS was detected in 16 patients (13%).

31 patients (26%) had association between intra and extracranial stenosis.

Clinical impact:

- 70 patients (58%) were symptomatic
- 16 patients (13%) were asymptomatic.
- 41 patients (34%) had symptoms in another territory
- 84 patients (69%) had small vessel disease.

Treatment for secondary prevention was personalized:

- Ac. acetylsalicylic: 38(31,5%) patients
- Clopidogrel: 22(18%) patients
- Double antiplatelet therapy (ac. acetylsalicylic + clopidogrel): 49(40,5%) patients
- Warfarin: 12(10%) patients
- Statins were recommended to 119(98,5%) patients

Conclusions: Most of our patients with IS were males with age between 60-80 yo, with one or more vascular risk factors, admitted for an acute event. The major prevalence of IS was in the carotidian territory. More of the patients received double antiplatelet therapy and statins.

P4

Relationship between carotid plaque thickness and bone mineral density

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Background: Atherosclerosis and osteoporosis are two major public health problems. Though many studies have suggested associations between bone mineral density (BMD) and atherosclerosis, these studies have emphasized coronary artery disease and calcified atherosclerosis. It is still uncertain whether an abnormal carotid ultrasonography, either increased intimal-medial thickness (IMT) or plaque thickness, is associated with osteoporosis in acute ischemic stroke patients. To investigate the possible relationships between osteoporosis and carotid atherosclerosis, we evaluated the correlation between carotid IMT/plaque thickness and BMD in acute ischemic stroke patients.

Methods: Patients having their first ischemic stroke within 7 days were screened for the study enrollment. Patients over 18 years old were eligible for the study if they did not have 1) transient ischemic attack or potential cardiac sources of embolism, 2) hormone replacement therapy or medication affecting bone metabolism, or 3) any condition that might interfere with bone metabolism.

Results: During the study period, 155 patients were enrolled in the study and the mean age was 68.3±10.34 years. Carotid IMT/plaque thickness was significantly related to age ($r=0.370$, $p<0.001$) and osteoporosis ($r=0.293$, $p<0.001$). An analysis of covariance (ANCOVA) for IMT/plaque thickness, with age, gender, and body mass index (BMI) used as covariates indicated that the osteoporosis group had significantly increased IMT/plaque thickness.

Conclusions: This study showed that increased carotid IMT/plaque thickness was significantly associated with decreased BMD after controlling for the effects of age, gender, and BMI in acute ischemic stroke patients.

Poster Session I – 2.

Ultrasound in ICU and stroke units

P5

Early evaluation of critic patients possibly evolving to brain death by transcranial doppler: The role of neurosonological education and training

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Background: Transcranial Doppler (TCD) allows to detect diagnostic patterns of Cerebral Circulatory Arrest (CCA). Since 2003 TCD has been included by Italian guidelines of the National Transplantation Council among the techniques accepted and recommended to assess CCA in specific clinical conditions. (i.e: EEG has not a diagnostic value or cannot be performed). TCD is a time saving confirming test of BD and plays a crucial role in avoiding useless artificial life support and facilitating the organ and tissue donation procedure. TCD should be the first choice confirming test of CCA.

Methods: We report the experience of the Neurosonology Laboratory of Florence in the use of TCD in routine clinical practice for the early evaluation of critical patients in Intensive Care Units (ICUs). All the Neurologists and the Technicians involved in this activity got the Italian and/or the International certification in Neurosonology. All patients were daily evaluated by TCD examination since their admission in the ICUs and TCD were repeated in case of sudden changes of clinical conditions.

Results: Out of 3067 TCD were performed in 1152 patients admitted in ICUs from 2004 to 2014, TCD patterns of CCA were detected in 97 patients. In 51 patients, TCD was employed as a confirmatory test for BD diagnosis with forensic medical value, according to the Italian legal standards. Thirty of them became organ/tissue donors.

Conclusions: Our daily activity in ICUs supported by continuous training and updating led to a relevant increasing of the quality level and the amount of TCD examinations. Sensibility and specificity values in our series are in line with those published by the AAN guidelines, ranging from 91-100% and 97-100%, respectively. Up to now the lack of skilled Neurosonologists is the main cause for the limited use of TCD in BD confirming in most countries.

P6

Transcranial doppler microembolic signals detection in patients treated with veno-venous extracorporeal membrane oxygenation

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Background: Veno – Venous (VV) Extracorporeal Membrane Oxygenation (ECMO) is a temporary respiratory support for patients with acute lung failure. **The aim of the study** is to detect the possible presence of Microembolic Signals (MES) in patients treated with VV ECMO by Transcranial Doppler (TCD).

Methods: A 60 minutes bilateral and continuous TCD monitoring of Middle Cerebral Arteries was performed in patients with VV ECMO treatment during hospitalization in our Intensive Care Units (ICUs). The monitoring was performed at the start of ECMO treatment and every 48 hours or every 24 hours in case of MES recording. We enrolled patients consecutively admitted in our ICUs from December 2013 to February 2015. We excluded patients with possible source of microembolism (cardiac right-to-left shunt or internal carotid stenosis $\geq 70\%$) and/or bilateral inadequate acoustic windows (IAW).

Results: Out of 46 patients admitted to our Regional ECMO Referral Centre 2 dropped out because of bilateral IAW and 1 because of the presence of cardiac right-to-left shunt.

The remaining 43 were evaluated by TCD monitoring during VV ECMO treatment.

In 8 patients MES were detected by TCD. Out of them, in at least one TCD monitoring 5 showed less than 10 MES and 3 more than 10 MES. No massive (curtain effect) embolism was detected.

Conclusions: No data are published on emboli detection in patients treated with VV ECMO. Our data suggest that VV ECMO is a relatively safe procedure concerning the embolic risk, because of the low incidence of embolism

P7

Transcranial doppler microembolic signals detection in patients treated with veno-arterial extracorporeal membrane oxygenation

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Background: Veno– Arterial (VA) Extracorporeal Membrane Oxygenation (ECMO) is a mechanical circulatory support for patients with potentially reversible heart injury. Possible complications of VA ECMO treatment can be ischaemic stroke and brain hemor-

rhage. Only 1 paper was published on this topic referred the presence of Microembolic Signals (MES) in VA ECMO patients. **The aim of the study** is to confirm the possible presence of MES in patients treated with VA ECMO by Transcranial Doppler (TCD).

Methods: During VA ECMO treatment, a 60 minutes multi-gate continuous TCD monitoring on both Middle Cerebral Arteries was performed in day 1 and repeated every 48 hours or every 24 hours in case of positive findings of MES. We enrolled patients admitted to our Intensive Care Units (ICUs) and treated with VA ECMO from December 2013 to February 2015. Exclusion criteria were presence of cardiac right-to-left shunt, presence of haemodynamic internal carotid stenosis and bilateral inadequate acoustic windows (IAW).

Results: Out of 7 patients admitted to our ICUs and treated with VA ECMO, 1 dropped out because of bilateral IAW. The remaining 6 were evaluated by TCD monitoring during VA ECMO treatment. All patients survived. Out of the evaluated patients, 5 showed TCD MES pattern: in 3 patients a curtain effect was recorded and in 2 patients ≤ 100 MES were detected. In 1 patient no MES were detected.

Conclusions: Our data show that patients treated with VA ECMO seem to have a high risk of embolism. In order to confirm these data the number of evaluated patients will be increased and a clinical and instrumental (e.g. brain CT or MRI) follow-up should be performed.

P8

Coregistration of transcranial doppler-sonography and EEG in the diagnostic procedures of detection of brain death

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Background: The guidelines for the determination of cerebral circulatory arrest (brain death) include clinical criteria and, depending on countries, some confirmatory testing like TCD, EEG, Evoked potential, CT angiography, brain scintigraphy. Brain death is the process and its confirmation must be done with responsibility and proven reliability, particularly in the situations of planned organ transplantation. In donor management protocol in our practice, after brain stem death determined by clinical examination, we perform EEG and TCD monitoring followed by brain scintigraphy and in exceptional conditions, cerebral angiography as additional diagnostic test for brain death confirmation.

Methods: We present a case of patient which fulfilled clinical criteria of brain death due to a massive intracerebral hemorrhage (coma, absence of brainstem reflexes, apnea) in whom we monitored EEG and TCD. Initially, on the first day of clinical proven brain death, brain scintigraphy detected only minimal signs of cerebral flow in sagittal venous sinus and cerebral angiography showed minimum sustained flow in the M2 segment of the right MCA.

Results: During the nine days of monitoring, persisting EEG activity was obtained on right temporoparietal regions and TCD

showed blood flow in right MCA on insomnation thought temporal bone window. On the tenth day TCD shows a "pattern of cerebral circulatory arrest" with absence of previously demonstrated flow with short enduring systolic spikes (125ms) with low systolic velocity (35cm/sec). 16 channels EEG, recorded according to the protocol for brain death did not show any electroencephalographic activity. We confirmed brain death by all criteria and the patient entered heartbeating brain death donor program.

Conclusion: Coregistration of transcranial Doppler-sonography and EEG is reliable diagnostic approach and criteria for detection of cerebral death.

P9

Optic nerve sheath diameter ultrasound evaluation in intensive care units for brain death diagnosis

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Background: several studies have correlated the increase of the Optic Nerve Sheath Diameter (OSND), evaluated with ultrasound, as a reliable non-invasive marker of intracranial hypertension in neurosurgery and Intensive Care Units. Aim of the study was to demonstrate the efficacy and simplicity of OSND ultrasound evaluation, when monitoring neurocritical patients, in order to early identify raised intracranial pressure and Brain Death (BD).

Methods: Data from ultrasound OSND evaluation has been retrospectively analyzed in 21 patients affected by neurological diseases that, during their clinical course, developed BD and compared with 32 non-neurological controls. Two out of the 21 patients that developed BD were submitted to decompressive craniectomy.

Results: patients with neurological diseases, before BD, showed higher OSND values than the control group (CTRL: RT 0,45±0,03 cm; LT 0,45±0,02 cm. Pre-BD: RT 0,54±0,02 cm; LT 0,55±0,02 cm. $p < .000$) even without intracranial hypertension, evaluated with invasive monitoring. OSND was further significantly markedly increased in respect to the basal evaluation in neurocritical patients at the time of BD occurrence, with mean values above 0,7 cm (RT 0,7±0,02 cm; LT 0,71±0,02 cm. $p < .000$) and correlated with a raise in intracerebral pressure higher than the mean arterial blood pressure. Conversely, in the two patients who underwent decompressive craniectomy, no significant OSND further increase was observed even after BD.

Conclusions: OSND is a reliable marker of intracranial hypertension, easy to be performed, with a minimal training, even by non-neurosonologists. Routine OSND daily monitoring could be of help in Intensive Care Units or when invasive intracerebral pressure monitoring is not available, to early recognize intracranial hypertension and to suspect BD – when OSND is rapidly increased over 0,7 cm – in neurocritical patients who develop signs of cerebral deterioration.

P10

The relevance of daily transcranial doppler monitoring in clinical management of patients with subarachnoid hemorrhage

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Background: The utility of Transcranial Doppler (TCD) in patient with Subarachnoid Hemorrhage (SAH) is still debated. The aim of our study is to evaluate the clinical relevance of daily TCD monitoring in patients with SAH.

Methods: We enrolled consecutive patients admitted to the Intensive Care Units (ICUs) of our hospital because of SAH during a 12 months period. All the evaluated patients showed a brain TC scan positive for SAH at the admission in ICU. The presence of the hemorrhagic aneurysm was confirmed by cerebral angiography. Patients with bilateral inadequate acoustic windows were excluded. Diagnosis and grading of vasospasm were assessed according to Aaslid criteria. All patients were daily followed up by TCD since their admission in ICU until the 15th day or until vasospasm resolution in case of persisting hemodynamic pattern of vasospasm. At admission Hunt & Hess (H&H) and Fisher scale were collected. Glasgow Coma Scale (GCS), pharmacological and neurosurgical treatments and clinical data were daily collected for each patient. Clinical follow-up was performed by means of the Glasgow Outcome Scale (GOS) at 6 months.

Results: We evaluated 36 patients (mean age 54±18 yo, 75% female). Twenty-five (69,4%) patients showed TCD hemodynamic signs of vasospasm. Mean time of vasospasm onset was 7.12±4.6 days. Treatment strategy was modified according to TCD pattern in 27.7% of patients. TCD and Fisher scale did not show a positive predictive value of clinical outcome. GCS and H&H showed a significant positive correlation to clinical outcome ($P=0.001$ and $P=0.028$ respectively).

Conclusions: Daily TCD monitoring allows to detect real time hemodynamic changes before the appearance of clinical signs related to vasospasm. A correlation between clinical scales and clinical outcome was found. The original datum of this study is the utility of TCD daily monitoring in modifying treatment strategy of SAH patients aimed at preventing SAH complications.

P11

Micro embolic signals (MES) detection in acute stroke by transcranial doppler (TCD)

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Background: Micro emboli signal detection is one of the main applications of Transcranial Doppler (TCD) in stroke. MES are reported to be an independent risk factor for stroke. MES also helps in identifying the underlying pathophysiology of stroke. MES also helps in assessing the response to treatment.

Aim of study: To evaluate the yield of TCD in detecting MES, predictors for positive MES & recurrence of stroke.

Method: 260 patients with stroke were evaluated with TCD over a period of 3 years from January 2012 to January 2015. TCD monitoring of MCA, ACA & PCA were done bilaterally for one hour. Positive MES TCD monitoring was defined by the presence of more than or equal to 1 MES on either hemisphere.

Results: Mean age of the patients was 58. 72% were males & 28% were females. Median duration of the monitoring was one hour. The risk of MES positive was calculated with multiple logistic regression analysis. 52 patients out of 260 were MES positive. The presence of valvular heart disease (Odds ratio 5.8) & The number of infarcts (Odds ratio 2.4) increased the odds of having positive MES. Patients with positive MES on TCD monitoring are twice at risk of stroke recurrence than patients with negative MES.

Conclusion: Our study showed that the presence of valvular heart disease and presence of multiple infarcts on neuro imaging are associated with positive MES on TCD emboli monitoring.

P12

The role of transcranial Doppler ultrasonography in posterior reversible encephalopathy syndrome

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Introduction: Posterior reversible encephalopathy syndrome (PRES) is an infrequent, usually benign clinic-radiological syndrome, although may be complicated by cerebral ischaemia or haemorrhage. Our aim was to evaluate the role of early TCCS in predicting these complications.

Methods: We performed a retrospective analysis of patients' charts with the diagnosis of PRES that had a TCCS evaluation early after the beginning of symptoms. All evaluations were performed by two experienced technicians. We evaluated arterial blood pressure (BP), mean cerebral blood flow (MFV) and the presence of criteria for vasospasm. Cerebral ischaemia (CI) and intracranial haemorrhage (ICH) was evaluated with MRI.

Results: We included eleven patients, 8 female, with a median age of 35 years (range: 11-74). TCCS was performed in median 2 days after symptom onset (range: 1-10). Vasospasm criteria were present in 7 patients (ACA=3, PCA=5 and VA=4). ICH was detected in 4 patients and CI in 5. BP was similar among patients with and without CI ($p=0.648$) but significantly higher in ICH (103 ± 17 vs 84 ± 9 mmHg, $p=0.040$). MFV tended to be higher in CI patients but significantly lower in ICH (MCA, 54 ± 10 vs 89 ± 24 , $p=0.014$; ACA, 46 ± 2 vs 66 ± 15 , $p=0.011$; PCA, 32 ± 21 vs 51 ± 18 , $p=0.146$; VA, 33 ± 4 vs 48 ± 12 , $p=0.017$). Vasospasm was associated with CI detection (62.5% vs 0%, $p=0.182$).

Conclusions: In PRES patients, detection of vasospasm by TCCS was associated with an increased risk of cerebral ischaemia.

On the other hand, lower MFV values and higher BP pressures associated with intracranial haemorrhage. This small series demonstrates the important role of TCCS in PRES patients, particularly in predicting brain ischaemia that may warrant more aggressive treatment.

P13

Hemodynamic impact of carotid siphon wall calcification in intravenous thrombolysis

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Background: Arterial wall calcifications are recognized as an indirect imaging evidence of chronic atherosclerosis. Moreover, they have been recently reported as an important pathobiological process impairing vascular hemodynamics and leading to worst outcomes after acute myocardial infarct. However, the potential impact of intracranial arterial wall calcifications in patients undergoing intravenous thrombolysis for acute ischemic stroke has not yet been assessed.

Methods: We included consecutive ischemic stroke patients submitted to intravenous thrombolysis in a tertiary stroke center between January 2011 and September 2014. Patients submitted to acute intra-arterial therapies were excluded. Baseline CT-scan was used to calculate the total carotid siphon calcium score (TCSC) by two blinded neuroradiologists. Recanalization was defined as Thrombolysis in Brain Ischemia score of 4 or 5 by transcranial color coded Doppler and/or CT-angiogram performed within 6 hours after symptoms onset. Hemorrhagic transformation was graded according to ECASS criteria in the 24 hours control CT scan, both parenchymal hemorrhage grades 1 and 2 were considered. Variables with statistically significant univariate association with TCSC were inserted in multivariate logistic regression models to identify independent predictors of recanalization and hemorrhagic transformation. Statistical significance was set for $p<0.05$.

Results: We analyzed 433 patients, mean age 74.61 ± 11.15 years, 226 (52.2%) male. Median TCSC was 5.0 (interquartile range: 3.0). In univariate analysis TCSC was associated with older age, diabetes mellitus, high blood pressure and cardiac insufficiency. In multivariate analysis TCSC was not an independent predictor of recanalization (OR: 0.951, 95%CI: 0.863-1.048, $p=0.311$) nor hemorrhagic transformation (OR: 1.010, 95%CI: 0.843-1.210, $p=0.914$).

Conclusion: In the setting of acute ischemic stroke, the presence of intramural calcifications in the carotid siphon is not a predictor of hemodynamic outcomes after intravenous thrombolysis.

P14

The intracranial arterial stenosis and extracranial internal carotid arterial stenosis in acute stroke patients

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Background: Intracranial arterial stenosis are relatively common findings of stroke patients in Asia area. We reviewed stroke database to investigate clinical risk factors related to intracranial arterial stenosis, including carotid disease, and peripheral arterial disease which reflects advanced atherosclerosis.

Methods: Acute stroke patients at the National Health Insurance Corporation Ilsan Hospital from January 2014 to December 2014 with available transcranial Doppler(TCD) examination, carotid ultrasound and ankle-brachial indexes(ABI) formed the analysis cohorts. Retrospective review was performed.

Results: 24.5 % of the patients with incomplete TCD study due to poor insonation windows were excluded, a total of 304 patients were included during that period, According to TCD criteria, 3 groups of intracranial arterial stenosis are defined: 0 vessel stenosis is in 40% of the patients, 1-2 vessels in 34.5%, more than 3 vessels in 25.5%. By duplex ultrasound, common, internal carotid arteries are examined and the biggest diameter of plaques are recorded. 3 groups of carotid arterial plaques are defined: less than 2mm is 31.7% of the patients, 2-4mm is 57.3% and greater than 4mm is 11%. As the arterial number of intracranial stenosis increased, the prevalence of carotid artery plaque above moderate degree is increased.

Conclusions: Among the acute stroke patients, about a half of them have intracranial arterial stenosis and these patients tend to have higher burden of advanced atherosclerosis as evidenced by a higher prevalence of moderate to large sized plaques of carotid artery.

Poster Session I – 3. Neuroparenchymal sonography

P15

Diagnostic accuracy of transcranial sonography and DaTSCAN in early stages of Parkinson's disease

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Background: The diagnosis of Parkinson's disease (PD) is a challenge in the early stages of the disease. Currently, both transcranial sonography (TCS) and DaTSCAN are recommended as auxiliary exams for the diagnosis of PD. However these exams imply different costs and biological risks. Our goal is to evaluate the diagnostic accuracy of the TCS and DaTSCAN (123I-Ioflupane) in the diagnosis of PD in early stages.

Methods: We consecutively evaluated patients followed in movement disorders consultation with the clinical diagnosis of PD in early stages (Hoehn & Yahr ≤ 2) and Essential Tremor (ET). All patients underwent DaTSCAN and TCS with a maximum interval of six months. The Investigators were blinded to the clinical diagnosis and DaTSCAN results. The area of hyperechogenicity in the substantia nigra (SN) was measured bilaterally in the axial plane, using an area ≥ 0.24 cm² in either side as cut-off for abnormal study, according to internationally accepted criteria for the ultrasound system used.

Results: 58 patients were analysed, 3 (5.2%) were excluded due to poor temporal acoustic bone window. From a total of 55, the clinical diagnosis was ET in 24 (43.64%) and PD in 31 (56.36%), mean age 59.44 ± 10.98 years and 33 (60.0%) were male. Mean disease duration of PD was 1.82 ± 0.86 years. Compared to clinical diagnosis of PD, TCS had a sensitivity of 90.3% and specificity of 88.9%; DaTSCAN had a sensitivity of 81.5% and specificity of 83.9%. Diagnostic tests demonstrated a substantial level of agreement between them (kappa coefficient of agreement: 0.709, $p < 0.001$).

Conclusion: TCS and DaTSCAN have similar diagnostic accuracy for the clinical diagnosis of early stage PD. Considering the advantages of TCS regarding safety and expenses it appears to have a more favourable profile for clinical use in this stage.

P16**Midbrain area measurement by transcranial sonography for discrimination Parkinson disease from progressive supranuclear palsy (PSP)**

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Background: Parkinson disease (PD) is the most common cause of parkinsonism syndrome. In many cases especially in early stage of the disease, differentiating PD from other parkinsonism syndromes (atypical parkinsonisms) solely by clinical findings is very difficult if not impossible. So dependable imaging finding for discrimination these diseases. Transcranial sonography (TCS) is a noninvasive imaging technique that has sparked an increasing amount of interest in the past decade.

Methods: We studied 18 patients with PD and 17 patients with progressive supranuclear palsy (PSP). TCS was performed by an expert neurosonologist who was blind to the patient's diagnosis. Midbrain area, third ventricle diameter and substantia nigra (SN) echogenicity was determined.

Results: TCS was performed in 35 patients (17 PSP, 18 PD). Patients with PSP obviously had smaller midbrain area (3.616 cm² vs 4.86 cm², $P < 0.001$). With a cut point of 4.22 cm² one can differentiate PD from PSP with a positive predictive value 75% (Sensitivity = 83%, Specificity = 75%). As expected, patients with PSP had a smaller area of hyperechogenicity in SN (0.25 cm² vs 0.384 cm², $P < 0.05$). Patients with PSP also had a higher third ventricle diameter (0.818 cm vs 0.435 cm, $P < 0.001$). No relationship between these findings and age or duration of disease was found.

Conclusion: Using TCS for measurement of midbrain area, third ventricle and SN echogenicity can be a great help to differentiating PD from PSP.

P17**Transcranial sonography in differential diagnosis of Wilson disease and early-onset Parkinson disease**D. Školoudík^{1,2}, J. Mašková¹, P. Dušek¹¹ Department of Neurology, Charles University in Prague, 1st Faculty of Medicine and General University Hospital Prague, Prague, Czech Republic² Department of Nursing, Faculty of Health Science, Palacký University Olomouc, Olomouc, Czech Republic

Background: Wilson's disease (WD) is an autosomal recessive disease caused by *ATP7B* mutation resulting in copper accumulation in liver and brain. Early-onset Parkinson's disease is a neurodegenerative movement disorder with age of onset less than 40 years. WD may manifest as adolescence or early-adulthood onset parkinsonism and may be difficult to distinguish from EO-PD. The aim of our study was to find out whether transcranial sonog-

raphy (TCS) could be used as a reliable tool in the differential diagnosis of these disorders.

Methods: We examined 14 neurological WD patients, 15 EO-PD patients and 24 age-matched healthy control subjects. Echogenicity of substantia nigra (SN) and nucleus lentiformis (NL) were measured using TCS with the capability of brain magnetic resonance fusion imaging using Virtual Navigator. The echogenicity indices of SN and NL were processed using digital image analysis to exclude subjective evaluation errors.

Results: Mean SN echogenicity index in EO-PD (39.9±6.0) was higher compared to WD (27.8±5.4, $p < 0.0001$) and control subjects (28.8±4.9, $p < 0.0001$). Mean NL echogenicity index was higher in WD (118.7±41.0) compared to EO-PD (61.5±5.5, $p < 0.0001$) and control subjects (54.9±11.2, $p < 0.0001$). The SN hyperechogenicity had sensitivity 93.3%, and specificity 85.7%, while the NL hyperechogenicity had sensitivity 100% and specificity 93.3% for differential diagnosis of WD and EO-PD.

Conclusions: Transcranial sonography can be used as highly sensitive and specific tool for differential diagnosis of WD and EO-PD.

P18**Transcranial sonography in differing Parkinson's disease from essential tremor**I. Štenc Bradvica, S. Soldo-Butković, D. Jančuljak, M. Bradvica¹, I. Mihaljević²

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We wanted to determine the specificity and sensitivity of transcranial sonography (TCS) in differing Parkinson's disease (PD) from essential tremor (ET) and to compare the results with the specificity and sensitivity of DaTSCAN which was taken as a gold standard.

In this study we included 110 patients with the symptomatology of parkinsonism lasting 6 to 12 months. The computed brain tomography in all patients was normal. According to the DaTSCAN results, patients were divided into two groups. Using TCS the substantia nigra hyperechogenicity was encircled and measured. The sensitivity and specificity of TCS was calculated. From 110 patients, 51 (46.4%) patient had ET and 59 (53.6%) patient suffered from idiopathic PD. The specificity of TCS was 88.2%, and the sensitivity 94.9% in confirming Parkinson's disease.

Transcranial sonography highly correlates due to its specificity and sensitivity with DaTSCAN,

so the results suggest performing it before or even instead of DaTSCAN.

P19

The results of transcranial sonography in the group of Polish patients with parkinson disease: Case – control study

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Background: Substantia nigra (SN) hyperechogenicity assessed by transcranial sonography (TCS) is a well-recognized phenomenon detected in patients with Parkinson's disease (PD). Guidelines emphasize the need to define the standard reference values of SN echogenic sizes for an every ultrasound system.

The main **aim of the study** was to investigate the association between PD in Polish patients and SN hyperechogenicity measured by Aloka Prosound 7 device, which has not been done so far.

Methods: In this study SN hyperechogenicity was evaluated in 102 PD patients consecutively admitted to the hospital. The control group included 95 subjects without central nervous system disease. We performed SN area measurement with the relation to the clinical features of PD. Inter- and intra-observer reliability were also calculated.

Results: The mean area of SN hyperechogenicity was significantly greater in the PD patients than in the controls $0.23 \pm 0.04 \text{ cm}^2$ and $0.12 \pm 0.06 \text{ cm}^2$, respectively ($P < 0.001$). Analysis of receiver operating characteristic indicated a cut-off value for SN echogenicity at 0.19 cm^2 (accuracy equal to 90%, specificity – 86% and sensitivity – 93.7%). The relation between SN hyperechogenicity and clinical status has not been found. Reliability was good if an experienced sonographer had performed the SN measurements.

Conclusions: The study with application of the new ultrasound device confirmed the previous results: SN hyperechogenicity visualized by TCS can be helpful in the process of PD diagnosing.

P20

Ultrasound-MR-fusion imaging – new insights for transforaminal B-mode insonation

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Background: Transcranial B-mode ultrasound has become an established tool for non-invasive bedside analysis of brain parenchymal structures. So far, measurements of ventricle width, midline shift or alterations of basal ganglia echogenicity are common clinical questions to the technique using the transtemporal bone window. The transforaminal window seems to lack relevant B-mode information is mainly be used for assessment of vascular structures like vertebral and basilar artery and their branches. Improved B-mode imaging of modern ultrasound systems, however,

increases the diagnostic yield, allowing transforaminal medulla oblongata visualization. In this study we report transforaminal measures of the medulla oblongata in comparison with MRI using US-MRI-fusion imaging (UFI) in a group of patients with normal transforaminal MR imaging.

Methods: Patients were recruited from our hospital if routine cMR-imaging (T2-sequence) was available and showed normal medulla oblongata anatomy at the foramen magnum level. The applied US-MRI-fusion imaging (UFI) is a new bedside technique permitting a combination of live ultrasound with simultaneous visualisation of exactly matched MR images, derived from pre-registered datasets. UFI was performed as an additional image sequence during routine transcranial vascular ultrasound using an Esaote Mylab Twice system (Italy, Padua) equipped with the “Virtual Navigator” software.

Results: UFI was performed in 10 patients with good matching results between live ultrasound and MR images. US-derived transverse and longitudinal foramen ovale diameter was $4,4 \pm 1,6$ and $4,0 \pm 1,2$ cm, MR-derived measures were $3,6 \pm 0,3$ and $3,7 \pm 0,6$ cm, respectively. US-derived transverse and longitudinal medulla oblongata diameter was $1,5 \pm 0,2$ and $1,5 \pm 0,2$ cm, MR-derived measures were $1,5 \pm 0,2$ and $1,6 \pm 0,2$ cm, respectively.

Conclusions: Transforaminal B-mode imaging permits medulla oblongata assessment in excellent agreement with MR-derived measures. Comparison using ultrasound-MR-fusion imaging shows better correspondence of medulla oblongata measures than measures of the foramen magnum.

**Poster Session I – 4.
Case reports and pitfalls**

P21

Outpatient cardiac arrest (CA) with prolonged cardiopulmonary resuscitation (CPR), more than 30 minutes

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Young patient 28 years, no personal history, who was treated on public road by loss of consciousness, cardiac arrest, initially detected ventricular fibrillation (VF), requiring several cardioversions, pulseless heart rate recobres and finally sinus rhythm with pulse, after more than 30 min of CPR. In the emergency department of our hospital, has a GCS of 3 points, with some facial myoclonic movement. Nonreactive medium pupils. Endotracheal intubation, mechanical ventilation, SpO₂ 100%. The CT scan shows no abnormalities. On admisión to the ICU: TA 90/55 mm Hg; FC 90/

min; SpO₂ 98%. Without sedation GCS 6-7 (O1V1M4-5). Connected to CMV. Jugular engorgement. Rest exploration anodyne. Additional tests: Thorax Rx, no alterations, ECG, Sinus rhythm 90/min. Analysis: hyperglycemia; pH 7.17 PaCO₂ 42 CO₃H 14; lactate 96 mg%; elevated enzymes. Test negative psychotropic drugs in urine.

Evolution: favorable, 9 days of stay in ICU. Echocardiography shows severe ventricular dysfunction (LVEF 12%), with severe global hypokinesia and apical akinesia. Urgent catheterization showed healthy coronary arteries and severe ventricular dysfunction. Hemodynamics of the right cavities with S. Ganz, confirms situation cardiogenic shock, guiding us in therapy with vasoactive, norepinephrine and dobutamine. On the 3rd day of ICU stay, a new ecocardiography was still showing LVEF 29%. EEG shows generalizad moderate to severe cortical affectation, and normal SSEP (somatosensory evoked potentials). The 6th day, sedation withdrawal, progressively gets an adequate level of consciousness allowing removal of the mechanical ventilation and extubation. So it gradually withdrawing vasoactive is achieved, norepinephrine the 7th day and dobutamine the 9th day, can move to the floor of Cardiology to continue studies. Three studies of Transcranial Doppler Ultrasonography were performed during his stay, the day of admission in ICU, and every three days.

P22

Ischemic stroke and brachiocephalic artery thrombosis: Do we know the acute management?

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Introduction: The occlusion of the brachiocephalic artery (BCA) may compromise the blood supply of the right upper limb (UL) and the brain. The diagnosing tools and management of this condition is not well known. We report two cases of thrombosis of the BCA with different clinical features and management.

Patient/Methods/Results:

Case 1: 51-year-old male, hypertensive and smoker who presents with abrupt left hemiparesis, hemisensitive extinction and hemianopsia. Computerized tomography (CT) shows hypodensity of the territory of the right middle cerebral artery (MCA) with spontaneous hyperdensity in M1. The transcranial duplex sonography (TDS) shows a TIBI 2 grade at right MCA. Subsequently the patient starts feeling pain in the right UL and developing paresis, paleness, coldness and absence of distal pulse. CT angiography shows an intraluminal thrombus at the ostium of the BCA. Interventional management is implemented due to the ischemia of the right UL followed by anticoagulation. The mRS is 0 when the patient is discharged.

Case 2: 59-year-old woman, hypertensive, obese. Complaining of dizziness. At the physical exploration right hemianopsia, he-

misensitive extinction and left Horner syndrome. Normal CT. CT angiography: BCA thrombus. Supra-aortic trunks duplex: Presence of a mobile, isoechogenic image at the distal section of BCA consistent with thrombus. TDS: TIBI 3 grade at right MCA. No signs of ischemia in the right UL. Intravenous anticoagulation is started with subsequent oral anticoagulation. The mRS is 1 when discharged.

Conclusions: BCA thrombosis may appear only as cerebral ischemia. The Supra-aortic trunks duplex could be a useful tool to diagnose these cases, as we show in the second case. There is no data currently available suggesting a specific treatment for patients with BCA thrombosis and ischemic brain injury.

P23

Oscillating thromboemboli as markers of acute carotid occlusion

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Clinical manifestations of carotid occlusion are highly variable from ocular TIA to devastating stroke. However, it is not easy to differentiate acute from chronic occlusion with MRA or CTA. We report three patients of minor stroke with acute carotid occlusion, who showed characteristic ultrasonographic findings in the symptomatic ICA. Mobile oscillating thromboemboli or spontaneous echo contrast were observed. Complete recanalization was documented by follow-up MRA and carotid ultrasonography, and oscillating thromboemboli also disappeared in one patient. Other two patients showed persistent occlusion, however, oscillating thromboemboli disappeared. Ultrasonography is useful to differentiate acute versus chronic occlusion in case of carotid occlusion with minor stroke or TIA. Oscillating thromboembolic and subsequent recanalization indicate acute embolic rather than chronic thrombotic occlusion. These findings may be critical for the diagnosis and proper management of the patients.

P24

Usefulness of vasomotor reactivity measurement for predicting stroke risk in patients with MCA stenosis

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Background: Despite medical therapy, the risk of stroke in patients with Intracranial atherosclerotic stenosis (ICAS) remains high according to stenosis degree. We report a patient with bilateral MCA stenosis who developed stroke in less stenotic MCA territory with impaired vasomotor reactivity (VMR).

Case presentation: A 72-year-old male visited neurology clinic due to memory impairment. On imaging and neuropsychological study, he was diagnosed as mild degenerative dementia. Incidentally, bilateral MCA stenosis was detected on MRA, which was more severe on right side (right side, severe vs. left side, mild). Mean flow velocity (MFV) of MCA was 80 and 30 cm/sec in right and left side respectively. Aspirin and statin were prescribed for stroke prevention. One month later, suddenly he felt right side weakness with slurred speech. DWI revealed acute infarction in left parietal cortex. The VMR was measured as percent increase of MFV in the MCA after intravenous injection of acetazolamide up to 1g according to body weight. VMR was lower in left MCA than right one (right 40.5% vs. left 9.7%). Dual antiplatelets and high intensity statin were prescribed for secondary prevention.

Conclusions: VMR evaluated by acetazolamide TCD may provide additional information to assess the future stroke risk in patients with MCA stenosis over stenosis degree.

P25

Internal carotid artery dysgenesis and altered vasomotor reactivity as a potential trigger of epileptic seizure: functional TCD and EEG coregistration

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Background: several metabolic disorders, such as hypo/hyperglycemia and electrolytes alterations, may be implicated in seizure arousal. We present a case of a patient admitted to our emergency department for the sudden onset of epileptic seizures and in whom internal carotid dysgenesis with altered hemodynamics were detected.

Case description: BF, female, 20 yrs old was admitted for five consecutive episodes of tonic-clonic seizures, starting with right head deviation. Upon admission, she was neurologically asymptomatic, with EEG showing asymmetry of alpha activity in posterior regions, increased in the right side. Cerebral MRI was normal and MR Angiography showed right internal carotid artery hypoplasia. Carotid Duplex showed the agenesis of the right common carotid artery with a hypoplastic internal carotid artery (mean diameter 1.7 mm) originating directly from the anonymous artery. TCD showed minimal asymmetry of MCAs blood flow velocities (r-MFV 51 cm/sec, l-MFV 60 cm/sec), with asymmetry of resistance indices, lower in the right side (r-MCA: RI 0.46 – PI 0.62; l-MCA: RI 0.63 – PI 1.02) and intracranial compensation to the right hemisphere via anterior and right posterior communicating arteries. Functional TCD (f-TCD) Cerebral CO₂ reactivity, performed with a 5% CO₂ mixture inhalation and hyperventilation (Et CO₂ < 24 mmHg) showed VMR asymmetry (65.4% right – 76.9% left) with reduction of the vasodilation capacity on the right side. Quantitative EEG co-registration during f-TCD showed an asymmetric response: during CO₂ inhalation the alpha peak activity observed in basal condition in the right posterior areas disappeared; during hyperventilation, theta and del-

ta amplitudes were symmetrically increased in the temporo-parietal regions while alpha activity returned to basal conditions.

Conclusion: in our patient, intracranial hemodynamic changes to compensate the carotid vessel malformation could be involved in the epileptic susceptibility. f-TCD seems to be an interesting method to non-invasively assess seizure pathogenesis when hemodynamic alterations are identified.

P26

Bilateral extra-adrenal paraganglioma coexisting with coronary artery disease and transient ischemic attacks

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Background: Carotid paragangliomas belongs to group of rare neuroendocrine tumors of head and neck. We present a very rare case history of patient with coronary artery disease (CAD) and transient ischemic attacks (TIA), whom a large carotid paraganglioma initial detected by color-coded sonography (ECCS).

Case presentation: 53 years old woman was examined neurologically due to repeated TIA with short lasting weakness of the left leg, associated with elevated blood pressure. On neurological examination, the tongue deviation to the left side with left sided hemiatrophy and fibrillations was observed, indicating impairment of the left XIIIn. The patient told that ten years ago she began to feel dyspnea, generalized weakness, palpitations, intermittent chest pain. An acute myocardial infarction (MI) occurred at 45yrs. Cardiac catheterization identified critical RIA stenosis, managed by PTCA and stenting. ECCS showed mild atherosclerotic changes, and a carotid paraganglioma with prominent vascularization in the left carotid bifurcation was found. MRI confirmed ultrasound findings: a carotid paraganglioma in the left up to 5cm, involving XIIIn, CCA bifurcation, and ICA and additionally the smaller carotid paraganglioma in the right. After partial resection of the left carotid paraganglioma, the pathologic diagnosis of extra-adrenal paraganglioma was made. Immunohistochemical staining shows strong positivity for synaptophysin, and chromogranin A. Repeated MRI showed no progression of the tumors. Due to cardiac pain, repeated catheterization identified RIA in-stent restenosis, managed by PTCA or stenting again. The patient is followed by cardiologist, neurologist, repeated ECCS and MRI. It remains unclear if the coexisting the paragangliomas and CAD in presented case is accidental or not. **Conclusions:** ECCS is a noninvasive, inexpensive diagnostic tool for initial diagnosis of the carotid paraganglioma. In the presence of tumor in the submandibular area, ECCS is recommended to exclude the carotid paraganglioma. The delay of the diagnosis may cause nerves and vessels involvement.

P27

Ultrasonographic findings of arteria lusoria

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Background: Changes of waveform and flow direction in the vertebral artery indicate subclavian steal phenomenon mostly suggesting the steno-occlusive lesion of the subclavian or brachiocephalic artery. However, arteria lusoria could affect hemodynamic status of the right vertebral artery due to a long, tortuous retroesophageal course of the right subclavian artery.

Methods: We reviewed ultrasonographic findings of three ischemic stroke patients with arteria lusoria confirmed by MR angiography.

Results: Three patients had hypertension and dyslipidemia and underwent carotid ultrasound and transcranial Doppler for evaluation of intracranial and extracranial arteries. All had no clinical symptoms associated with arteria lusoria. MR angiography showed no steno-occlusion of the right common carotid artery or vertebral artery. Ultrasonography in the right vertebral artery showed systolic notch in one patient and normal waveform in the others. Hyperemia test demonstrated antegrade flow but reduction of systolic flow velocity in the right vertebral artery of all patients.

Conclusions: Arteria lusoria may be considered as a cause of early subclavian steal phenomenon in the right vertebral artery.

P28

The incidence of atherosclerotic complications in patients with diabetes mellitus

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Background: Diabetes mellitus (DM) has high prevalence and ascending trend in the number of patients, especially in younger patients. The prevalence of atherosclerotic complications in diabetic patients increases with duration of the illness. Patients with DM have an elevated risk of cardiovascular morbidity compared to the general population, as a result of increased prevalence of traditional and other specific risk factors. The aim of this study was to characterize factors associated with the risk for atherosclerotic complications in Croatian diabetic patients.

Methods: A cohort of 160 diabetic patients in Clinical Hospital Merkur University Clinic Vuk Vrhovac, Zagreb were included in this study, from May to October 2012: 77 women/ 83 men, mean age 62.3 years with body mass index (BMI) 29,0. There were 87, 5 % type -2 diabetic patients with average duration of the illness 17, 5 years. 72,5 % diabetic patients used insulin therapy, 89,37 % antihypertensives and statins. Patients underwent detailed medical history, laboratory, somatic and neurological status, color- doppler flow imaging (CDFI) of carotid artery and leg arteries, cardiological examination with ECG and heart ultrasound.

Results: Mean HbA1c was 7,2%, cholesterol- 4,85 mmol/L, HDL- 1,4 mmol/L, LDL- 2,65 mmol/L triglycerides-1,8 mmol/L. Coronary artery disease (CAD) was detected in 41,25% diabetic patients, cerebrovascular disease in 31,25 % diabetic patients. Among patients with cerebrovascular disease, 8,125% had stroke and 23,12 % had significant stenosis or endarterectomy of carotid artery. 24,37 % patients had diabetic nephropathy and 15, 62% patients had peripheral artery disease (PAD).

Conclusions: Atherosclerotic complications in diabetic patients are largely undetected and not treated adequately; they are frequently associated with other risk factors and asymptomatic organ damage. Appropriate treatment of DM and atherosclerotic complications for this high-risk patients are practical patients management.

P29

A double anatomic variation of intracranial circulation: Neurosonological diagnosis and stroke risk

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To describe a case with the suspicion of an acute ischemic stroke in whom a double anatomic variation in the cerebral circulation was detected.

We bring the case of a young patient admitted into our Neurology Department suspecting an acute ischemic stroke likely related to carotid dissection. An Angio-TC (CTA) showed a probable vertebralbasilar hypoplasia and a fetal variant of the Circle of Willis. Our Laboratory of Neurosonology carried out a complete ultrasonographic study 24 hours after admission, detecting hypoplasia of vertebral arteries (VAs), a blind-ended right V4 artery and a fetal origin of both posterior cerebral arteries (PCAs), as well as the related hemodynamic changes in the intracranial circulation.

We do believe that a reliable diagnosis of the anatomic variations of supra-aortic arteries and the Circle of Willis could be achieved with an ultrasonographic test carried out by experts. Secondly, we contemplate the possibility, as it has already been de-

scribed in scientific literature, that the association of vertebrobasilar hypoplasia and a fetal variant of the Circle of Willis might be related to an increased risk of vertebrobasilar ischemia.

The association of vertebrobasilar hypoplasia and a fetal variant of the Circle of Willis might increase the risk of cerebral ischemia, being its diagnosis feasible by an ultrasonographic study carried out by experts.

P30

Non-pulsatile cerebral perfusion in a patient with partial recanalization of middle cerebral artery occlusion after thrombolysis

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Background: Low pulsatile or non-pulsatile cerebral perfusion was noted in patients with aortic arch dissection, acute proximal internal carotid or common carotid artery occlusion and means impending large cerebral infarction. A 45-year-old man had a sudden aphasia and left hemispheric symptoms with NIHSS of 16 on arrival. Complete occlusion of left middle artery with leptomeningeal collateral circulation from left anterior and posterior cerebral artery was observed on TFCA. After chemical and mechanical thrombolysis, occlusion of left MCA was partially recanalized. TCD showed a non-pulsatile waveform in left middle cerebral artery. In this case, non-pulsatile cerebral perfusion results from MCA lesion, which is more distal rather than proximal occlusion of carotid artery.

Conclusion: This report noticed that non-pulsatile cerebral perfusion does not always point proximal source of arterial flow obstruction.

P31

Cardiovascular risk in patients with systemic lupus erythematosus

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Background: Cardiovascular diseases (CVD) are the leading cause of death in all countries worldwide. The role of traditional risk factors in the development of CVD has been well studied. Pa-

tients with autoimmune diseases such as systemic lupus erythematosus (SLE) have an elevated risk of cardiovascular morbidity compared to the general population. This risk is result of an increased prevalence of traditional risk factors for CVD and other specific factors, like chronic inflammation, immune activation and contributing role of therapy. Contributing presence of inflammation atherosclerosis suggests that systemic inflammation independently contributes to the elevated risk for CVD. In order to better elucidate risk factors for CVD in SLE patients, we investigated the incidence of finding of atherosclerotic plaque of carotid artery, assessed via ultrasound, and incidence of unrecognized chronic kidney disease (CKD) in patients with SLE.

Methods: In this study, we included outpatients with SLE: 89 women/ 16 men, mean age 54.8±15.4 years. From January 2012 to September 2014, 105 patients with SLE underwent consecutively carotid ultrasound examination. A clinical and routine laboratory evaluation (glucose, hemoglobin and creatinine concentration) was performed. Kidney function was estimated by the calculation of glomerular filtration rate (eGFR) by MDRD formula.

Results: In 36 from 105 (30%) patients with SLE we detected incidental nonsignificant atherosclerotic plaque on ultrasound of carotid artery. Average cholesterol value was 5,63±1,91 mmol/L; LDL 3,42±2,52 mmol/L. The prevalence of de novo CKD in all 105 patients was 35 % based on eGFR-MDRD (<60 ml/min/1.73m²). 61% of patients (22 from 36) with nonsignificant atherosclerotic plaques on ultrasound of carotid artery have unrecognized CKD.

Conclusions: Patients with SLE have very often an unrecognized CKD and asymptomatic atherosclerotic plaque in carotid artery. We need programs for early detection of CVD in these patients are required to reduce the complications and economic burden.

Poster Session II – 1. Atherosclerotic plaque II

P32

Study of carotid intima-media thickness in Indian coronary and stroke patients: Early pointer to atherosclerosis

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Background: In rural India, stroke and coronary artery disease (CAD) is the most common cause of morbidity and mortality. Several studies show that carotid intima-media thickness (CIMT) is strongly associated with cardiovascular risk factors. It possibly reflects cumulative burden of atherosclerosis of major vessels regardless of underlying risk factors like hypertension and diabetes.

Acceptability of Doppler as non-invasive tool for measuring intima by Indian population made it valuable tool.

Methods: Case-control cross-sectional study that explored the use of CIMT as a marker for atherosclerosis. 150 individuals coming from the rural population were enrolled into three equal groups for the purpose of CIMT assessment. Group 1 (controls) - individuals with no symptoms of stroke or CAD, Group 2 - patients with established stroke and in Group 3 - patients of CAD. In the current study, the baseline characteristics of the study groups are same including age groups, male/female ratio; to avoid confounding. Multivariate logistic regression analysis was performed with use of version 16-SPSS software.

Results: Average CIMT in Controls was -1.0 mm, stroke group - 1.3 mm and CAD group -1.3 mm. CIMT is marker of atherosclerosis as its value is raised in stroke and CAD groups compared to age and gender matched controls. And raised values of CIMT are statistically associated with Stroke and CAD. Most important determinants for CIMT in our study are age, hypertension, DM, dyslipidemia, smoking and, family history.

Conclusion: CIMT is simple monitoring tool for progression and regression of the atherosclerosis process burden. Large-scale studies with randomization are required to establish cut-off value, above which primary prevention of atherosclerosis can be started.

P33

Common carotid artery stiffness and intima-media thickness in acute ischemic stroke patients

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The aim of the study is to find the correlation between the atherosclerosis risk factors, functional status of the patients and the carotid artery stiffness / intima-media thickness in the group of the acute ischemic stroke patients.

Methods: Eighty and one patients were examined: 71 with acute ischemic hemispheric stroke and 10 matching on age without such a diagnosis. Carotid artery ultrasound procedure was done using MYLAB 70 platform. The common carotid artery stiffness was assessed using Automatic Quality Arterial Stiffness (QAS) calculation. The α and β stiffness, pulse wave velocity (PWV) and intima-media thickness (QIMT) were calculated. The functional status of the patients was assessed using the SSU on the day of admission, on the day 7th and on the last day of the hospitalization. The biochemical atherosclerosis risk factors included blood level of the cholesterol and its lipoprotein fractions, C-reactive protein, homocysteine and pentosidine were examined. Statistical analysis was conducted using the Kendall tau-b and t-Student tests.

Results: There was a tendency for the mean values of α (7,89 vs 7,87) and β stiffness (16,01 vs 15,96), PWV (9, 57 vs 9, 55 ms⁻¹) and QIMT (808,37 vs 796,22 μ m) of the carotid artery on the side

of the ischemic stroke to be higher, but it was not statistically significant. There was a correlation between carotid artery QIMT on the side of the stroke and functional status of the patients assessed by SSU on the day of admission to the hospital ($p < 0,05$; $r = -0,202$). There was no correlation between the selected biochemical atherosclerosis risk factors and α and β stiffness, PWV, QIMT.

Conclusion: Worse functional status on the day of admission to the hospital in acute stroke patients correlates with thicker common carotid artery IM complex on the side of the brain ischemic changes.

P34

Intima-media thickness of carotid arteries significance in subclinical atherosclerosis assesment

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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 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.

P35

Arterial stiffness indices in aggressive periodontitis patients

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Background: The exposure to inflammatory periodontal disease represents a risk factor for the development of atherosclerosis. The aim of this research was to assess the relationship between carotid elastic properties and periodontal condition in patients with aggressive periodontitis.

Methods: The study was conducted on 30 subjects with untreated aggressive periodontitis (test group, 13 men and 17 women, mean age 34.7±6.3 years) and 34 periodontal healthy volunteers (control group, 15 men and 19 women, mean age 27.7±5.7 years). Periodontal parameters were assessed in terms of clinical attachment level using a periodontal probe. Arterial stiffness measurements on common carotid artery (CCA) were performed using Aloka ProSound ALPHA 10 with 13 MHz linear probe.

Results: In comparison with the control group, test group showed statistically significant difference ($p < 0.05$) in the mean beta stiffness (9.4 vs. 6.7), compliance (0.85 vs. 0.99), and pulse wave velocity (6.6 vs. 5.4) when measured on right CCA only. Test group also showed statistically significant difference ($p < 0.05$) in the mean beta stiffness (8.3 vs. 6.5), elastic modulus (98.5 vs. 83.0), compliance (0.87 vs. 0.99), and pulse wave velocity (6.2 vs. 5.4) when measurements were observed for both CCA. No statistically significant differences were found among groups regarding intima media thickness ($p > 0.05$).

Conclusion: The present results demonstrate that aggressive periodontitis may affect carotid artery hemodynamics, despite normal intima media thickness values. Assessment of atherosclerosis by arterial stiffness measurements represents a valuable diagnostic tool that might reveal a potential role of periodontitis in the earliest stages of atherosclerosis.

P36

Cerebral autoregulation and shunt flow index in the region of arteriovenous malformation

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Background: A decrease of cerebral autoregulation (CA) rate in the region of arteriovenous malformation (AVM) may be caused either by the long-term steal of brain in perinidal cerebral area or

pathologic shunting. The last may disguise the true state of CA. The influence of both factors on CA could be hardly diagnosed on preoperative stage. It has recently been established the potentiality of precerebral arteries Duplex scanning for evaluation of shunt flow index (SFI). SFI dynamics after AVM exclusion from circulation may allow to estimate the true state of CA in perinidal area.

Purpose: To assess dynamics of SFI and CA in patients with AVM in perioperative period.

Methods: 14 patients with AVM were studied before and after embolization with Hystoacryl or Onyx. According to Spetzler & Martin classification 1 case corresponded to II grade, 9 – to III and 4 – to IV. Blood flow velocity (BFV) in basal cerebral arteries was monitored with Multi Dop X (DWL, Germany), blood pressure (BP) – noninvasively with CNAP (Austria). CA was evaluated with cuff test (autoregulation index – ARI) and cross-spectral analysis of spontaneous oscillations of BP and BFV within the range of Mayer's waves (phase shift – PS). Blood flow index in precerebral arteries was defined with Vivid E (GE, USA).

Results: Preoperative values of ARI and PS on affected side in all patients were 1.0 ± 1.0 and 0.3 ± 0.1 rad, respectively, SFI – 618 ± 276 ml/min. Postoperative values of ARI and PS on affected side were 1.9 ± 2.2 and 0.5 ± 0.4 rad, respectively, SFI – 370 ± 376 ml/min. Such variation of indices was associated with their different dynamics after surgery. In 12 cases of partial embolization with no or insignificant positive dynamics of CA SFI remained unchanged or decreased by 35 – 60%. As concerns the cases of total embolization, in one patient with full postoperative CA restoration SFI was practically absent, in the second patient having insignificant postoperative CA changes SFI decreased by only 10%.

Conclusion: There was no direct relationship between the SFI and rate of CA in the region of AVM. Quantitative CA assessment in perinidal zone may be important for the management of surgical treatment of AVM and prognostication of postoperative neurologic complications.

P37

Cerebral autoregulation in operated patients with stenosis of the carotid arteries

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Background: It was shown the informative value of preoperative assessment of cerebral autoregulation (CA) to define effectiveness of surgical treatment of patients with carotid artery stenosis. But at the same time perioperative dynamics of CA is not investigated properly.

Purpose: To assess CA dynamics in patients with carotid arteries stenosis in perioperative period.

Methods: 21 patients (17 men and 4 women) with atherosclerotic stenosis lesions of carotid arteries in age from 48 to 78 years were studied. In 16 patients revealed critical stenosis, severe – in 5. Stenting of carotid arteries performed in 5 patients, carotid endarterectomy – in 16. Postoperative complications were not observed. CA was evaluated with cross-spectral analysis of spontaneous oscillations of systemic blood pressure (CNAP, Austria) and blood flow velocity in middle cerebral arteries (Multi Dop X, DWL, Germany) within the range of Mayer's waves (evaluation of phase shift – PS).

Results: CA impairment was verified in 10 patients (8 – asymptomatic, 2 – symptomatic). On the ipsilateral side PS before surgery was 0.3 ± 0.2 rad, BFV – 77 ± 20 cm/s and BP – 94 ± 16 mmHg. Carotid endarterectomy and stenting resulted in a significant improvement of CA after surgery. On the side of the pathology PS after surgery was 0.9 ± 0.6 rad ($p < 0.01$). Significant changes of the BFV and BP weren't noted. There was no CA impairment in 11 cases (6 – asymptomatic type). The mean values of PS on the ipsilateral side was 1.2 ± 0.4 rad, BFV – 58 ± 9 cm/s and BP – 96 ± 13 mmHg. Surgery (stenting or endarterectomy) in cases without preoperative CA impairment didn't led to reliable changes of PS, BFV and BP in postoperative period.

Conclusion: Thus, the absence of significant preoperative CA impairment in patients with asymptomatic carotid artery stenosis is not a contraindication for surgery. An absence of reliable dynamics of CA indices in patients with asymptomatic stenosis requires further investigation.

P38

The relationship between small vessel disease and intracranial vessel resistance

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Background: Neurological deterioration associated with the enlargement of the lesion is often seen in the small vessel disease (SVD) patients. Some risk factors have been reported to be related with the neurological deterioration or lesion enlargement, however, there is no widely-accepted factor.

Purpose: The aim of this study is to clarify the relationship between the lesion size of SVD and the factors including the transcranial Doppler.

Method: This study is retrospective study. We divided the supratentorial SVD patients into two group; large (L) group is the patients with the large lesion defined as larger lesion more than 1.5cm or 3 slices on MRI, small (S) group is the patients with smaller lesion than that and we compared the factors between two groups.

Results: Sixty-eight patients (mean age 68 years old, male 44) were included. Seventeen (25%) patients were in L group, 51 (75%) were in S group. Neurological deterioration was seen in 41% in L group and 8% in S group ($p = 0.004$). There is no difference in baseline characteristics including general atherosclerotic marker (CA-VI; 9.77 vs 9.85, $p = 0.192$, max IMT 0.91 vs 0.98, $p = 0.45$). Regarding the factors of transcranial Doppler, pulsatility index (PI) was higher in L group than that in S group (1.03 ± 0.22 vs 0.86 ± 0.18 ,

$p = 0.019$) and resistance index (RI) also tend to be higher in L group (0.62 ± 0.07 vs 0.57 ± 0.07 , $p = 0.051$).

Conclusion: Intracranial vessel resistance is high in small vessel disease patients with large lesion.

P39

Prognostic significance of monocyte chemotactic protein -1 in patients with carotid restenosis

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Background: Early screening of patients with carotid artery stenosis as well as postoperative ultrasound follow up of thromboendarterectomy (CEA) treatment is a key procedure for prevention of stroke. Our intention was to determine the prognostic value of MCP-1 in system circulation with the purpose of early screening and discovery of patients with a high risk of carotid restenosis.

Methods: We included 75 patients with carotid artery stenosis. After CEA we scheduled an ultrasonographic follow up according to a 7, 30 and 90 day after CEA algorithm. MCP-1 serum levels have been determined using ELISA method and a procedure where we implemented follow up according to a 0, 2 and 90 day after CEA algorithm.

Results: A statistically significant difference between stenosis and restenosis groups has been determined. The groups were divided into subgroups according to MCP-1 plasma levels found on day 0 (before CEA) $\chi^2 = 4.66$; $p = 0.031$ and on day 90 after CEA $\chi^2 = 4.66$; $p = 0.031$.

Conclusion: With these results we verified a key hypothesis of this study in confirming a prognostic value of determining serum MCP-1 levels combined with Doppler ultrasonographic follow up in patients prior and after CEA. Now we can recognize patients with potential for carotid restenosis and implement intensive ultrasound follow up both before and after CEA.

P40

Diagnosis of near-total internal carotid occlusion by ultrasonography

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Background: To present a series of cases in which an internal carotid occlusion was detected in the CT-Angiography (CTA) while the Duplex-ultrasonography demonstrated a near-total occlusion.

Methods: Nine cases of patients hospitalized in the Neurology Department with the suspicion of an acute ischemic stroke are depicted. At the Emergency Department a CTA was performed, describing an internal carotid occlusion. 24 hours after admission, Duplex-ultrasonography carried out by our Laboratory of Neurosonology showed findings compatible with near-total occlusion, though.

The management of near-total internal carotid occlusion is highly controversial. As a matter of fact, carotid endarterectomy or angioplasty and stenting are being performed in nowadays clinical practice when experienced professional are available.

Hence, as a consequence of the reliable ultrasonographic diagnose of a near-total carotid occlusion, these patients were indeed able to get through surgical intervention.

Results: We do believe that sufficient evidence may exist to affirm that the ultrasonographic study carried out by experts in the acute phase of an ischemic stroke might lead the CTA as the gold standard technique in the differential diagnosis among a total and a near-total internal carotid occlusion, with its consequences in the therapeutic procedure to follow.

Conclusions: The ultrasonographic study carried out by experts in the acute phase of ischemic stroke might lead the Angio-CT to diagnose pre-occlusive internal carotid stenosis.

Poster Session II – 2. Case reports and pitfalls II

P41

Reversible cerebral vasoconstriction syndrome and cerebral infarction associated with midrin in a patient with rheumatoid arthritis

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Background: Reversible cerebral vasoconstriction syndrome (RCVS) is characterized by segmental, multifocal vasoconstriction

of arteries, which produce recurrent thunderclap headache, seizure, and ischemic stroke. Isometheptene, singly or combined with other drugs, is a common headache medication available by prescription or over the counter. We report a case of RCVS and cerebral infarction associated with Midrin (combination of sometheptene mucate, dichloralphenazone and acetaminophen) in a patient with rheumatoid arthritis.

Case Report: A 33-year-old woman presented with abrupt onset of left hemiplegia. Ten days ago, she complained of a sudden-onset, severe, recurrent, throbbing headache accompanied by nausea. The headache lasted several hours without aura, photophobia or phonophobia. She took propranolol 20 mg/day and ibuprofen 400 mg/day. She took Midrin 2 capsules daily for 2 days. A day before admission, she developed sudden onset of left hemiplegia. She had past medical history of rheumatoid arthritis for 8 years, and was taking immunosuppressive agent, steroid and analgesics. Neurological examination revealed left hemiplegia. Extensive laboratory tests with ESR and *hs-CRP* were normal. Serum rheumatoid factor was 107 IU/ml (normal, <12.5 IU/ml). Brain diffusion-weighted MRI showed acute multiple infarcts involving the bilateral frontal and right basal ganglia, especially in watershed zone. A transfemoral cerebral angiography revealed diffuse multifocal segmental vasoconstriction in the intracranial vessels. She was treated with calcium channel blocker, anti-platelet agent and steroid orally. Left hemiplegia was gradually improved. Three months later, MR angiography was entirely normal.

Conclusions: We suggest that RCVS may be triggered by Midrine. As vasoactive drugs such as Midrin could trigger vasospasm in some patients, it should be used with caution. RCVS is a neurological emergency that is being diagnosed with increasing frequency and should be considered in the setting of certain medication usage.

P42

An unusual case of migraine with aura in a middle-aged woman

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A 59 year old woman with a history of migraine and visual aura since childhood presented with balance problems, transient left hemiparesis and left sided hemianopia. Her migraine attacks had changed character and were increasing the last six months and she had fluctuating visual symptoms. A head Ct scan was unremarkable, Ct-angiography showed a stenosis/constriction of the right posterior cerebral artery (PCA). In the TCCS examination a decreased peak systolic velocity (PSV) of the right PCA as isolated finding was found. A migraine attack with aura and a local vasoconstriction of the PCA was suspected. In the following days she developed hypoesthesia of her left face. A MRI brain showed infarcts in the territory of the right PCA and a watershed infarction of the left MCA and ACA, while MR-angiography confirmed the isolated constriction of the right PCA. In the following months the patient deteriorated with a picture of multiple infarcts in the bilateral MCA,

PCA, PICA, some lesions showed regression while others appeared at the same time as MR Angio displayed the isolated pathology of the right PCA and no other vascular pathology. A lumbar puncture was unremarkable. No antibodies associated with vasculitis were found. No source of embolization could be detected (findings including ultrasound of the heart were negative). Coagulation status showed no pathology. After three weeks the patient was diagnosed with disseminated ventricular cancer and an associated vasculitis was suspected. She was treated with cortisone and chemotherapy. A TCCS examination after two months was unchanged showing a decreased PSV of the right PCA and no other pathology. The patient died in the picture of a multi-infarct syndrome. An autopsy was declined by the relatives. We present this case as a pitfall because of its short history and dramatic course.

P43

Neck pain as a first sign of Takayasu's arteritis

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Background: We present a 21-year-old woman with a continuous pain in her right anterior part of the neck for the last three months. She was referred in 2009 to our Neurology Department. Four years earlier, she had her first symptoms of intermittent neck pain in the same region, followed by fatigue and weakness. At that time she had been examined by a cardiologist (TTE: mild mitral valve insufficiency) and endocrinologist (ultrasound evaluation of the thyroid gland and laboratory examinations: all normal).

Methods: Neurological examination was normal. A bruit was audible on auscultation over both carotids and a significant difference (> 15mmHg) in systolic blood pressure between arms was found. We performed a complete extracranial and intracranial ultrasound evaluation (US) followed by multislice computed tomography angiography of the cervical vessels (MSCTA), magnetic resonance angiography (MRA), digital subtraction angiography (DSA). Duplex US of the renal artery, the upper and lower extremities and laboratory evaluation.

Results: Cervical vessel ultrasound evaluation revealed a characteristic, homogeneous, midechoic, circumferential thickening of the wall of the common carotid arteries, with a significant increase of blood flow velocity values. Carotid wall dynamics was also altered as we found a "macaroni" sign. Her left vertebral artery disclosed and inverted flow, while her right vertebral artery showed a

significant and diffuse increase of flow velocity values. Transcranial ultrasound, brain MRI and MRA, ultrasound of the renal artery as well as of the upper and lower extremities showed no pathological findings. Immunological screening was normal. We started the treatment with corticosteroids. Since then, the patient had regular clinical and ultrasound evaluations and she is asymptomatic.

Conclusion: Takayasu's arteritis is an idiopathic and chronic inflammatory disease of the large arteries occurring in the young and resulting in occlusive or ectatic changes mainly in the aorta and its immediate branches. Early diagnosis allows application of therapies that may be of key importance in controlling the progression of the disease. Ultrasound has allowed in this case a complete and accurate diagnosis, has guided therapy and monitored the response to treatment.

P44

Unraveling the mystery of an atypical cerebellar hematoma

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Objective: We present a 76 year-old patient who was admitted to our emergency unit with headache and inability to walk. Fifteen days ago he had elevated temperature with nausea, vomiting and diarrhea. Gait disturbances started three days after. History revealed chronic gastric problems, operation of the right inguinal hernia. He was not taking any medical therapy.

Methods: Neurological examination showed ataxia, abasia, left-sided dysmetria, motor reflexes enhanced to the right. He was afebrile, cardio-pulmonic sufficient. We performed LAB analysis, multi-slice computed tomography (MSCT), MSCT cerebral angiography, magnetic resonance (MR) and MR angiography (MRA), digital subtraction angiography (DSA)

Results: Laboratory report slightly elevated leukocytosis, glucose and creatine kinase. Standard coagulation was normal. The first multi-slice computed tomography (MSCT) of the brain showed an atypical cerebellar hematoma of the vermis and left cerebellar hemisphere with perifocal edema and a slight dislocation of the fourth ventricle to the right. MSCT with contrast media showed engorgements of the infratentorial veins and veins of the left cerebral hemisphere and a small pathological opacification of the left transversal sinus. MRA and DSA revealed a tentorial dural arteriovenous fistula (TDAVF) Borden classification type 3.

Conclusion: Dural arteriovenous fistulas (DAVFs) are fistulas connecting the branches of dural arteries to veins or venous sinus.

The incidence is approximately 10-15% of all intracranial vascular abnormalities. TDAVFs are rare. They can cause mild neurologic symptoms or severe hemorrhage. Early diagnosis and definitive treatment of the type of TDAF is of key importance since endovascular or microsurgical treatment is the only effective long-term treatment and emergent decompression may be life-saving.

P45

Bilateral internal carotid artery occlusion – first presenting symptoms of cerebral ischemia:

Case report

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Objective: We present a 72 year-old patient who was admitted to our emergency unit. He was afebrile, somnolent with left-sided hemiplegia and respiratory insufficiency. The first suspected clinical picture was of vertebrobasilar stroke. In the morning he lost consciousness and fell on the bathroom floor. He was shaking and convulsing. During the transport to the hospital he was somnolent with look gazed to the right. History revealed hypertension and depression.

Methods: We performed LAB analysis, an complete extracranial and intracranial ultrasound evaluation, multi-slice computed tomography (MSCT), MSCT angiography of the cervical vessels and cerebral angiography

Results: Laboratory report verified leukocytosis, raised levels of: glucose, urea, creatinine, creatine kinase, C-reactive protein, fibrinogen, cholesterol, and abnormal urine report. The first multi-slice computed tomography (MSCT) of the brain showed initial ischemic lesion of the right middle cerebral artery (ACM) – section M1 and MSCT carotid angiography showed absence of contrast filling in C1 regions of both ACI. The cerebral angiography showed extremely low arterial contrast filling – showing retrograde flow. The ultrasound (US) confirmed the finding of bilateral occlusions of both ICA/C1 regions – secondary to atherosclerotic echogenic plaques. Both external ICE showed increase in flow (above 120cm/s). The transcranial doppler insonation of the cerebral circulation assessed decreased average flow in both posterior cerebral arteries (PCA) – more in the left PCA. The patient's condition rapidly deteriorated, and the lethal outcome occurred during the sixth day of hospitalization.

Conclusion: The annual incidence of internal carotid artery occlusion (ICA) in the general population is 6/100,000. In a single study of 2288 patients with transient ischemic attack or stroke showed that only 0.4% had bilateral ICA occlusion. The most common symptoms which present acute bilateral occlusion ICA are: coma, tetraplegia and signs of decerebration. This life-threatening cerebrovascular syndrome could initially be misdiagnosed with brain stem stroke or metabolic encephalopathy. Therefore it is important to perform US assessment, neuroradiological and laboratory evaluation promptly.

P46

A rare consequence of whiplash injury

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Objective: We present a case report of a 44 year-old woman who was admitted to our surgical emergency unit two day after a car accident. She complained of pain in the neck, left shoulder, numbness and hypoesthesia in the left thumb and forefinger. Recent history revealed no specific disease, in childhood she had meningitis.

Methods: Neurological and somatic exam was normal. We performed LAB analysis, a complete extracranial and intracranial ultrasound evaluation, multi-slice computed tomography (MSCT), MSCT angiography of the cervical vessels and magnetic resonance of the cervical spine (MR).

Results: Laboratory report was normal. MSCT of the brain was normal. The MSCT and the following MRI of the cervical spine revealed a fracture of the left processus articularis of the 6th cervical vertebrae. Complete extracranial and intracranial ultrasound evaluation showed absent flow of the left vertebral artery. We preformed MSCT and MRI angiography of the vertebral arteries which showed absence of contrast filling from the C 2 distal – V2/V3 section of the left vertebral artery showing a thrombosis due to a posttraumatic dissection.

Conclusion: Posttraumatic vertebral arterial dissections are usually asymptomatic. In most cases with unilateral vertebral artery dissection and thrombosis recovery is complete. But trauma of the cervical spine ends can lead to lethal outcome in cases of bilateral occlusion and stroke of the brain stem. Complete extracranial and intracranial ultrasound evaluation can accurately diagnose, grade, and follow the progress of the disease.

P47

To fly or not to fly ... anymore?

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Objective: We present a case of a 28 year-old military male pilot who was admitted to our emergency unit with an increasing neck pain for the last seven days. He had nausea, the night before he vomited. He took some analgesics, but without recovery. His medical history revealed an episode of a headache three years ago. He was checked by a neurologist. All examinations were unremarkable. He was not taking any other medical therapy.

Methods: Neurological examination showed just mild neck stiffness. He was afebrile, cardio-pulmonic sufficient. We performed LAB analysis, cranial multi-slice computed tomography (MSCT), and pancerebral MSCT venography.

Results: Laboratory report at admittance showed mild elevated d – dimers. The initial cranial MSCT and the MSCT venography revealed a central filling defect and lack of flow in the right transverse and sigmoid sinus caused by venous sinus thrombosis. Search for precipitating factors disclosed: decreased results of Factor V Leiden, tests on thrombophilia showed mutation on gene for PAI (genotype 4G/G5) and mutation of gene for ACE (insertion genotype II). Patient was managed medically with anticoagulation, anti-edema, and anti-epileptics and supportive treatment. Patient was released home with anticoagulant therapy (Warfarin) and without neurological deficits.

Conclusion: Cerebral venous thrombosis (CVT) is a rare type of stroke (0.3-5%) affecting young patients. The onset of CVT shows a variety of neurological symptoms. Mortality rate is about 8% and morbidity rate about 12,6%. There are several risk factors which include female gender, oral contraceptive use, pregnancy and puerperium period, thrombophilia, infectious disease and cancer. It has been shown that male gender, later onset of CVT, deep cerebral vein thrombosis, coma, mental status disorder show worse long term outcome.

Our case report confirms the need of routine blood work tests and screening for prothrombotic conditions, especially thrombophilia.

P48

Carotid dissection and stroke-case report

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Dissections of craniocervical (carotid and vertebral) arteries are sudden lesions of the arterial wall. A rare cause of stroke in the general population (0, 4% -2, 5%), but more often in young age (5% -20%), and in women. In most cases, the cause and pathogenesis of dissection are unknown, but are generally divided into two groups: trauma (injuries after head and neck resulting in lesions of the arteries) and spontaneous. According to the localization we can divide it on: the intracranial and extracranial.

The different diseases with arterial wall affections are predisposed to dissection like fibromuscular dysplasia, cystic medial necrosis, Marfan syndrome. People with decreased level of alpha 1 antitrypsin also have tendency for dissection.

Insignificant trauma (cough, strongly vomiting, sneezing, strenuous exercise, movement of the head and neck, chiropractic procedures, inconvenient sleeping position) can result with spontaneous dissection of arteries. In up to one third of patients, dissections can be extremely multiple, At the same time more than a single blood vessels can be affected. About 20% of dissections are asymptomatic.

In our case we shall present a 63 year old male patient with hypertension and neck back pains in his history of diseases, who was admitted in our Department because of left central facioparesis and discrete paresis of left arm. We found ischaemic stroke in right frontotemporal area on MSCT of brain. After that on CDFI of carotid arteries we couldn't find (show) the right carotid artery, so we needed to make other diagnostic procedures like MSCT

angiography, DSA and MR angiography of carotid arteries and we found dissection of right carotid artery.

After that we started to give oral anticoagulant to the patients and consulted vascular surgeon.

Together we start to monitor our patient and made few control MSCT angiographies till the result of complete recanalisation.

P49

Dissection of ascending aorta: A case report

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Dissection of aorta is layering of aortic wall that can happen in any part of aorta – root, ascending aorta, arc, thoracic and abdominal part of aorta. In that case, the false lumen is appeared between intima and media and it can spread proximal and distal and suppress the real lumen.

After that, the symptoms of loss circulation are appeared in any segment of blood supply. Also it is possible to rupture and it is fatal.

We classify aortic dissection in few ways: according Stanford: type A (ascending aorta) and type B (descending aorta) ; according De Bakey: type I (ascending and descending aorta), II (ascending aorta) and III (descending aorta).

Also we can differentiate acute and chronic aortic dissection. Acute aortic dissection appears in 15 days after the initial event and requires urgently surgical treatment because of threatening rupture.

Chronic aortic dissection lasts longer than 15 days after initial event with pain in chest, back, abdomen and requires monitoring of patient. Symptoms of aortic dissection are: intensive chest pain between scapulas, pain in abdomen, weakness, nausea, excessive sweating, difficulties with swallowing and breathing. Also, disturbance of consciousness and other neurological symptoms can appear.

In physical status, loss of pulse on peripheral arteries and distinction of blood pressure more than 20 mm Hg on extremities and sometimes, precordial murmur are dominated.

Diagnostic procedures are CT angiography (for definitive confirmation), chest X-ray (wide shadow of mediastinum), ECG, TTE and TEE.

In type A of dissection the best way of treatment is surgical treatment and implantation of tubus graft with or without replacement of aortic valvula.

In type B of dissection we use medical drugs as beta blockers and vasodilators to secure regulation of blood pressure. Despite all medical measures the mortality in type A dissection is 30%, in type B 10 % and in ruptured aorta is 80%.

In our case we shall present a 30- years old female patient who had dissection of ascending aorta and died at the end in ICU of our hospital. We'll present her symptoms and diagnostic procedures and treatment.

P50

Difficult differential diagnosis of intracranial occlusive disease: Clinical case

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We present a clinical case of young women with TCD/TCCS findings of intracranial high-velocity flow signals compatible with intracranial severe stenotic disease. She presented on 2011 with sudden left hemiparesis and hemihypoesthesia, intention tremor and ataxia of left extremities which resolved spontaneously. Multiple TIA-like episodes of stereotypic neurological deficit recurred several times a day, with duration up to 1 hour, during the first week. TCD findings included high velocities and marked turbulence in right MCA, compatible with severe M1 stenosis, as well as microembolic signals 1-2 per minute. Cranial MRI showed acute cortical ischemic abnormalities in right F-P region. 4 years of follow up showed gradual progression of high-graded MCA M1 stenosis to complete occlusion. Patient did not have vascular risk factors, and only few transient episodes of left arm numbness recurred in 2012. Major efforts have been made to determine the etiopathogenesis of intracranial occlusive disease, including repeated TCD with HITS monitoring (no more HITS were detected in 2012-2014), TCCS, CTA, DSA, MRI, cardiac echo, blood tests for hypercoagulation conditions. Differential diagnosis included fibromuscular dysplasia, intracranial vasculitis, dissection, moyamoya syndrome.

P51

Change of pulsatility indices of a superficial temporal artery after treatment of temporal arteritis

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A 85-year-old man who was considered as temporal arteritis. Before starting medical treatment (systemic steroid administration) biopsy of the superficial temporal artery (STA) was requested from the department of internal medicine to the department of neurosurgery. The bilateral STA were swollen. The patient complained bilateral temporal pain and compressive pain of the STA was also observed. Ultrasound examination of the STA was performed. The halo sign was observed. The peak systolic velocity (PSV) was 56.9cm/sec, the endodiastolic velocity (EDV) was 19.1cm/sec, pulsatility index (PI) was 1.15. Since pain was slightly strong at the left side, biopsy was performed at the left side. Ultrasound examination was performed at the right side after biopsy. Under local anesthesia the left temporal skin was incised and the main trunk, frontal branch and parietal branch of the left STA was exenterated. The left STA was swollen macroscopically. Histological findings were as

follows: markedly-thickened intima and destroyed internal elastic lamina, infiltration of histiocyte including giant cell to the media. The diagnosis was made as temporal arteritis. The subjective symptoms and inflammation findings of blood sampling were improved one month after steroid administration. The halo sign was disappeared. The PSV increased to 97cm/sec, EDV declined to 12.1 and PI increased to 2.24. This results of ultrasound examination was discussed as follows. The vascular structure of the STA was partially broken from inflammation. This phenomenon led to decrease of vascular resistance, and it was observed as decrease of the value of PI. Since inflammation was improved after medical treatment, repair mechanism of the vascular structure occurred. Then vascular resistance (i.e. the value of PI) returned to the normal level. **Conclusions:** Change of pulsatility indices of a superficial temporal artery after treatment of temporal arteritis was thought as a reflection of repair mechanism of the vascular structure.

Poster Session II – 3.

Vasomotor reactivity and functional TCD

P52

Is vasomotor reactivity impaired in idiopathic Parkinson's disease?

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Background: The diameter of a cerebral blood vessel is regulated by a combination of myogenic, metabolic and neurogenic influences. The ability of a blood vessel to change diameter in response to a change in $[CO_2]$ is often referred to as vasomotor reactivity (VMR).

The autonomic neurogenic influences originate from both noradrenergic neurons and dopaminergic neurons. In addition to its local effects, a change in $[CO_2]$ affects activation of the autonomic nervous system.

Idiopathic Parkinson's disease (IPD) is a neurodegenerative disease affecting noradrenergic, serotonergic and dopaminergic neurons. The current study investigates whether VMR is impaired in patients with IPD in comparison to healthy controls (HC).

Methods: Transcranial Doppler was used to measure cerebral blood flow velocity (CBFV) in the middle cerebral artery in forty patients with IPD and fifty HC. End-tidal CO_2 ; heart rate and arterial blood pressure were continuously monitored. Subjects breathed room air for 60 seconds, hyperventilated for 90 seconds and returned to breathing room air for a further 120 seconds. VMR ($\Delta CBFV/\Delta ET CO_2$) was calculated under normocapnic and

hypocapnic conditions. The effects of dopaminergic medication were also assessed.

Results: Baseline CBFV in patients with IPD did not differ to HC either ON (45.4 (10.1) cm/s vs. 49.8 (12.7) cm/s, $p = 0.200$) or OFF (48.8 (12.3) cm/s vs. 49.8 (12.7) cm/s, $p = 0.702$) medication. Dopaminergic status did not affect baseline CBFV (45.4 (10.1) cm/s vs. 48.8 (12.3) cm/s, $p = 0.391$). VMR in patients with IPD did not significantly differ to HC either ON (1.17 (1.11) cm/mmHg.s vs. 1.50 (0.78) cm/mmHg.s, $p = 0.12$) or OFF (1.35 (1.21) cm/mmHg.s vs. 1.50 (0.78) cm/mmHg.s, $p = 0.52$) medication. Again dopaminergic status was not found to have a significant effect on VMR (1.17 (1.11) vs. 1.35 (1.21), $p = 0.48$).

Conclusions: Neither baseline CBFV or VMR was found to significantly differ in patients with IPD in comparison to HC. Dopaminergic status did not affect either measure.

P53

Cigarette smoking, and cerebral microangiopathy in type 1 diabetes

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Introduction: Cigarette smoking may increase risk for the development of microvascular complications of type 1 diabetes (DM1). Cerebral microangiopathy in DM1 is reflected by decrease of vasomotor reactivity reserve (VMRr) or increase of pulsatility index (PI). However, cigarette smokers are routinely excluded from studies on VMRr or PI in DM1. Therefore, we aimed to assess the impact of cigarette smoking on VMRr and PI in these patients.

Methods: VMRr and PI of the middle cerebral artery were measured with transcranial Doppler in 79 patients with DM1 (median age 33.0 years, range 20–51, 44% males). The relationships between the presence of cigarette smoking ($n=20$, mean pack-years 9.4 ± 6.1) and VMRr, PI, concomitant risk factors, medications and the presence of systemic microvascular complications were analysed.

Results: Smokers and non-smokers did not differ in terms of their clinical characteristics, with the exception of higher circadian insulin demand in smokers (60 ± 12.9 vs. 49.2 ± 14.2 units; $p=0.004$). A correlation between pack-years and PI ($r=0.6$, $p=0.004$), but not VMRr, was found in smokers. However, no significant differences between smokers and non-smokers were found regarding either VMRr (mean $85.9 \pm 20\%$ vs. $84.1 \pm 20.1\%$; $p=0.74$) or PI (median 0.85, range 0.61–1.09 vs. 0.88, range 0.48–1.52; $p=0.2$).

Conclusions: The association between pack-years and PI may indicate the negative impact of intensive cigarette smoking on the cerebral microvasculature in DM1. However, we did not prove a significant impact of smoking on VMRr in DM1 patients.

P54

Association between carotid stenosis and cerebral vasomotor reactivity measured by breath holding index

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Background/aims: Many extrinsic and intrinsic factors influence cerebral vasomotor reactivity (VMR), which is a reliable marker of cerebral small vessels functional status, including morphological and functional parameters of large and small brain blood vessels.

The aim of our study was to investigate correlation between VMR, and morphological and hemodynamic parameters of carotid arteries.

Methods: In retrospective cross sectional study we included 285 patients. Cerebral VMR was evaluated measuring breath holding test (BHI), while morphological and hemodynamic parameters of carotid arteries were measured using ultrasonic methods (intima-media thickness-IMK, peak systolic velocity-PSV, end diastolic velocity-EDV). We also noted middle cerebral artery (MCA) hemodynamic parameters: mean flow velocity (MFV) and pulsatility index (PI). From medical records we collected information about age, gender, and vascular risk factors: hypertension, diabetes mellitus, atrial fibrillation, cardiomyopathy, dyslipidemia and smoking.

Results: Patients mean age was 54,62 (125 males, 160 females). We found correlation between BHI and some vascular risk factors: 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, and BHI and IMK ($r=-0,203$, $p<0,01$). Positive correlation between BHI left ACM and EDV left ACI ($r=0,121$, $p<0,05$) was registered. We also found negative correlation between BHI and PI ACM on both sides ($r=-0,268$, $p<0,01$).

Conclusions: Our investigation shows correlation between cerebral VMR, and morphological as well as hemodynamic parameters in carotid arteries. Our results also show higher influence of morphological then hemodynamic parameters on VMR.

Poster Session II – 4. New technologies and applications

P55

Ultrasound fusion imaging and monitoring of intracranial lesions

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Background: The fusion of different imaging modalities can be used to better understand relations between static and dynamic compartments or to improve visualization of otherwise obscured structures. Virtual Navigator (VN) by Esaote is one of the fusion imaging systems that provides real time fusion of transcranial color coded sonography (TCCS) and MRI or CT images within the ultrasound system. Other authors already presented the benefits of VN in the assessment of brain parenchyma of the patients with degenerative diseases, edema and intracerebral hemorrhage and in the analysis of cerebral arteries and veins.

Patients and Methods: We present here how VN system might be used in brain tumors and intracranial aneurysms. In the first fusion we wanted to analyze the blood flow within a giant aneurysm of the right MCA and how this aneurysm influences the flow distally from its neck. In the second fusion we assumed that the astrocytoma of the right temporal lobe will be visible by transcranial B mode ultrasound and that the estimate of its size by MRI will match the one of transcranial ultrasound.

Results: Fusion imaging of the giant aneurysm revealed that the whole lumen of the aneurysm is patent and that the aneurysm does not influence the distal blood flow. In the second fusion the circumference of the brain tumor and surrounding edema in T2 MRI images matched the one measured by transcranial B mode ultrasound (4,2 cm).

Conclusion: Fusion imaging, if confirmed in larger number of patients, might have its role in planning of endovascular procedures and follow up of patients with brain tumors and aneurysms.

P56

Diagnostic power of a novel probe attached to the cervix for the detection of right-to-left shunt

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Background: We developed the novel probe (paste-able soft ultrasound probe; PSUP) attached to the cervix for the detection of RLS, because insufficient temporal bone window interrupts the precise examination for detecting right-to-left shunt (RLS). Pur-

pose of this study is to compare diagnostic accuracy of RLS by PSUP with those of transesophageal echocardiography (TEE) as a gold standard and transcranial color flow imaging (TC-CFI).

Methods: Subjects were patients with ischemic stroke and transient ischemic attack who underwent TEE and TC-CFI. PSUP was a 2.0-MHz center frequency and had an equal property with TCD transducer. The shape was thin, soft, and square modified for adequate attachment to the neck. At first, we performed TEE and TC-CFI by standard protocol for detecting RLS. We monitored unilateral middle cerebral artery and/or intracranial vertebral artery by TC-CFI. The procedure was performed with and without Valsalva maneuver. Then, monitoring using PSUP was performed at unilateral common carotid artery (CCA) using similar preparation and procedure to TEE and TC-CFI. RLS by PSUP was diagnosed as having 1 and more MES in CCA. After compared RLS detectable rate among TEE, TC-CFI and PSUP, accuracy parameters for RLS detection of PSUP and TC-CFI against TEE were calculated.

Results: Forty-five patients were included in this study. RLS was 19 (42%) on TEE (large PFO; 6, small PFO; 11), and 12 (27%) on PSUP, 18 (40%) on TC-CFI, respectively. As a reference of TEE findings, diagnostic power of PSUP was 58% of sensitivity, 96% of specificity, and 80% of accuracy. Those of TC-CFI were 58% of sensitivity, 73% of specificity, and 67% of accuracy.

Conclusion: Although detectable rate of RLS by PSUP was a little lower than TEE, PSUP may be useful for patients with insufficient temporal bone window.

P57

Treatment decision of unruptured intracranial aneurysms: Can it be based on phases score?

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Background: The natural history of unruptured incidentally discovered intracranial aneurysms (UIA) remains unpredictable. Therefore, when asymptomatic, the management remains subject of controversy. The PHASES score¹ was recently proposed for prediction of 5-year risk of rupture of UIA.

Methods: The aim of this study is to validate the PHASES score using our prospective and consecutive dataset (2006-2014). We compared scores calculated from the untreated follow-up cohort of UIA (UIAFU) between cases with stable lesions and those with aneurysm growth or rupture but also with those UIA initially treated (UIAIT). Secondly, scores calculated for UIA and patients diagnosed with Sub-Arachnoid Haemorrhage (SAH) were compared.

Results: Two hundred ninety one patients were followed up with a mean follow-up time of 3.2 years and 1177.6 aneurysm years. Twenty-nine cases were observed with growth of aneurysms and two ruptures. PHASES score of patients with observed aneurysm growth or rupture showed a trend towards higher values (mean 3,9±2,7 SD) than in patients with unruptured stable lesions (mean 3,0±2,3 SD). Comparing 269 SAH patients and 291 cases of UIAIT with the follow-up cohort (UIAFU), we observed that SAH

and UIAIT patients had significantly higher PHASES scores than UIAFU patients (SAH: mean 5,6±2,9 SD; UIAIT: mean 5,4±3,14 SD; UIAFU: mean 3,0±2,4 SD).

Conclusions: There's a clear progression of the PHASES score in our prospective cohort from UIAFU to SAH aneurysms with a treatment threshold above 3 that should be used with caution. It does not apply to patients with a familial history, polycystic kidney disease or symptomatic aneurysms and does not take smoking, among other important risk factors, into account.

P58

Non-invasive assessment of cerebral autoregulation in real-time mode

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Background: It has been already revealed the prognostic value of phase shift between blood flow velocity (BFV) in basal cerebral arteries and systemic blood pressure (BP) using an off-line transfer function analysis for the assessment of cerebral autoregulation (CA). The same role of linear estimation of stochastic relationship between BP and BFV within the range of M-waves (0.08 – 0.12 Hz) in real-time mode is not studied to the present time.

Purpose: to assess CA by spectral analysis methods using the linear estimation of stochastic relationship between BP and BFV in real-time mode.

Methods: 10 healthy volunteers (aged 23 to 30 years) were studied. BFV in middle cerebral arteries with MultiDop X DWL (Germany) and BP with CNAP (Austria) were monitored during 30 min. The examination was performed in spontaneous respiration, compulsory breathing (6 times per minute) and breath holding. Client-server software has been developed for investigation of non-stationary quasiperiodic stochastic processes within the range of M-waves in real-time mode.

Results: BFV in spontaneous respiration was 77 ± 14 cm/s on the right, 76 ± 9 cm/s on the left. BP was – 77 ± 5 mm Hg. Compulsory breathing led to significant (p<0.05) decrease of BFV (61 ± 13 cm/s on the right, 60 ± 11 cm/s on the left). During breath holding the significant (p<0.05) increase of BFV (87 ± 12 cm/s on the right, 89 ± 11 cm/s on the left) was observed. Index of linear estimation of stochastic relationship between BP and BFV within the range of M-waves in spontaneous respiration varied from 0 up to 0.8 on both sides. It reliably (p<0.05) decreased up to -0.3 – 0.2 during compulsory breathing and increased during breath holding up to 0.7 – 0.9.

Conclusion: Linear estimation of stochastic relationship between BP and BFV within the range of M-waves in real-time mode can be used for non-invasive CA assessment. The reason of great variations of index seen in spontaneous respiration may be due to non-stationary nature of studied slow processes and requires further investigation.

P59

Carotid plaque lipid content on MRI is associated with plaque instability

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Background and Aim: The composition of a carotid plaque is thought to be important for plaque vulnerability and stroke risk. The main aim of this study was to assess the level of agreement between semi-automated MRI assessments of plaque components with histological assessments of plaques removed at endarterectomy.

Methods: Thirty-four consecutive patients with ³70 % carotid stenosis scheduled for carotid endarterectomy underwent a clinical neurological examination, Colour Duplex ultrasound, 3T MRI with an 8 channel carotid coil and blood tests. All examinations were performed less than 24 hours prior to surgery and plaques were assessed histologically following endarterectomy. Plaques were defined as symptomatic when associated with ipsilateral cerebral ischemic symptoms within 30 days prior to inclusion. The level of agreement between the size of the lipid-rich necrotic core (LRNC) and calcification on MRI to the histological estimation of the same tissue components, plaque echolucency and symptoms were assessed.

Results: The size of the LRNC on MRI was significantly correlated to the percentage amount of lipid per plaque on histological assessment (p=0.010), and to echogenicity on ultrasound with echolucent plaques having larger LRNC compared to echogenic plaques (p=0.001).

Conclusion: In this study we found that the percentage LRNC per plaque on MRI was significantly correlated to the percentage LRNC per plaque on histological assessment, and to plaque echogenicity on ultrasound with echolucent plaques having larger LRNC compared to echogenic plaques.

P60**Flow velocity dependent blood viscosity of carotid arteries in patients with lacunar infarction**

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Background: Lacunar infarction can be closely related with decreased blood flow velocity and wall shear stress in the carotid arteries. Wall shear stress is the term multiplying shear rate and blood viscosity (BV), and shear rate specific BV could be used to represent the dynamic viscous nature of blood inside the artery. Until now, no previous study have examined whether the shear rate specific BV in the carotid artery could be associated with lacunar infarction.

Methods: Time-Of-Flight magnetic resonance angiography were conducted in carotid artery of 37 patients (14 controls and 11 lacunar infarction patients), and the source axial images were used to build up 3-dimensional arterial mesh. Wall shear stress was calculated with computational fluid dynamics, and BV was measured with an automated scanning capillary viscometer. Peak-systolic (PS) and end-diastolic (ED) blood flow velocities were measured in the carotid artery with duplex ultrasonographic examination and used for an inlet/outlet conditioning. Finally wall shear stress and shear rate specific BV along carotid artery were obtained as the final outcomes.

Results: PS and ED velocities were significantly lower in the patients with lacunar infarction than controls, but no significant difference was observed for the ratio of splitting conditions. PS and ED wall shear stresses in CCA were significantly lower in the patients with lacunar infarction (mean±SD, 35.5 ± 17.5 dyne/cm² for PS) than the controls (66.8 ± 43.7 dyne/cm², p=0.004). Native BV values including yield stress and the Casson constant were not significantly different between the two groups. However, shear rate specific BV values were significantly higher in the patient group (4.3±1.0 centiPoise for PS) than those controls (3.8±0.7 cP, p=0.039).

Conclusion: In addition to the significant difference of wall shear stress, shear rate specific BV values in the carotid artery were significantly higher in the patients with lacunar infarction than controls. It suggested that the risks of thrombotic evolution in carotid artery could be higher in the patients with the ischemic stroke.

P61**TCCS: high prevalence of intracranial stenosis in patients with severe coronary artery disease**

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Objectives: According the population-based Rotterdam study data, intracranial carotid artery calcification detected by computed tomography contributed to 75% of all strokes. The purpose of our prospective study was to estimate the prevalence of intracranial stenosis by non-invasive transcranial color-coded duplex sonography (TCCS) in neurologically asymptomatic patients with severe coronary artery disease (CAD).

Methods: We included prospectively 391 patients with three vessels and / or left stem CAD. All the patients were examined by extracranial color-coded duplex sonography (ECCS) and TCCS. Magnetic resonance imaging and angiography was performed for selected number of patients scheduled to CABG.

Results: From 391 pts (age 67±9, 39-88; 27% female), 237 pts (61%) were diagnosed with three vessels disease, 154 pts (39%) with left stem disease with/without three vessels damage (115 and 39). TCCS revealed at least one intracranial stenosis in 62% echo positive pts (218/352). The distribution of intracranial stenosis: 124 (59%), in three vessel CAD, 17 (52%) in left stem, and 77 (71%) in three vessel and left stem CAD pts group (p=0,04). ECCS revealed >50% ICA stenoses in 16,6% pts (65/391). In the case of significant extracranial ICA stenosis, intracranial stenoses were detected in 79 % (49/62), and in low grade extracranial ICA stenoses, intracranial stenoses were detected in 58% (169/290), p=0,002.

Conclusions: According to our data, the patients with three vessels and left stem CAD have the highest risk to have an silent intracranial stenosis. TCCS is a feasible method for evaluation of intracranial atherosclerosis in severe CAD patients to gain the useful information about cerebrovascular disease as a risk factor for stroke.

P62

Right to left shunt in cryptogenic stroke: TCD vs. TEE

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Background: Identification of Right to left shunt (RLS), especially patent foramen ovale (PFO), is essential for secondary prevention in patients with cryptogenic stroke. Transesophageal echocardiography (TEE) has been known to be the gold standard method in detecting of PFO but Transcranial Doppler (TCD) is recently spotlighted to a safe, easy to perform and non-invasive method. We tried to standardize TEE and TCD technique as a screening method for PFO and compare the results of TEE with modified Spencer TCD grading system.

Methods: 220 patients who had been hospitalized in Chonnam National University Hospital from January, 2008 to December, 2011 for ischemic stroke/TIA with undetermined etiology (UD) or a suspicion of cardiogenic etiology were enrolled. The TCD procedure followed as standardized protocol of TCD agreed on in the consensus conference on Venice. TEE procedure was similar to TCD using microbubble test during Valsalva maneuver. Comparative analysis was performed between positive result and negative result groups of TCD & TEE.

Results: The mean age was 61.3 (SD 13.1) years and 139 patients (63.2%) were males. In the group of patients with TCD and TEE, we observed that the detection of RLS was higher with TCD than with TEE (86.8 % vs. 80.9 %). TCD and TEE for diagnosis of PFO had a 16.4% and 10.9% false negative value each other. Compared with TEE, Modified Spencer RLS grade ≥ 4 on TCD can predict the presence of PFO on TEE.

Conclusion: TCD and TEE is a complementary inspection tool rather than competitive tool for diagnosis of RLS. Furthermore, if more than modified Spencer grade IV bubble is detected on TCD, intracardiac PFO was confirmed without invasive technique of TEE.

P63

Ultrasound-MRI fusion imaging in muscle disease

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Background: MRI and ultrasound are helpful tools in the diagnostic workup of muscle diseases. MRI is the best technique to identify muscle involvement patterns to find the optimal location of a muscle biopsy. However, MRI can not be taken into the operating room. US-MRI-fusion imaging (UFI) is a new bedside technique permitting a combination of live ultrasound with simul-

taneous visualisation of exactly matched MR images, derived from pre-registered datasets. We report UFI application in a series of patients with muscle diseases, scheduled for biopsy.

Methods: Patients were recruited from our hospital if routine pre-biopsy MR-imaging (spin echo T1-, T2, STIR) was available. UFI was performed as an additional image sequence during pre-biopsy ultrasound using an Esaote Mylab Twice system (Italy, Padua) equipped with the "Virtual Navigator" software.

Results: UFI was performed in 57 patients. (muscle of the: upper leg 37, lower leg 14, hip 2, upper arm 4, lower arm 1). MRI-defined muscle segments of interest could be identified in all patients with the need of minor matching corrections during the insonation process. Ultrasound-MR comparison of affected muscles were not always congruent. E.g. in regions with MR-suspected edema, US demonstrated tissue hyperechogenicity, suggestive of fibrosis.

Conclusions: UFI is a promising technique, which should be further evaluated concerning its applicability and reliability in the diagnostic of muscle diseases. Comparison of MRI and US might help to further differentiate muscle tissue alterations. However, this hypothesis has yet to be confirmed e.g. by histological evaluations.

P64

Duplex ultrasound analysis of pupils and the pupillary reflex

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Background: Analysis of pupillary diameter and pupillary reflex is a standard diagnostic procedure of every clinical neurological examination. However, its documentation is commonly performed only in a semi-quantitative way while standard assessment procedures suitable for comparative or follow-up measurements are missing. We report a simple duplex ultrasound approach for pupillary reflex assessment in a series of healthy subjects.

Methods: Subjects were recruited from patients visiting the vascular ultrasound laboratory if the neurological examination had revealed normal findings. Duplex ultrasound was performed with standard dimmed light conditions of the ultrasound lab in a supine position with the eyes closed using an Esaote Mylab 25 system equipped with a linear 11-18MHz probe, adjusted for near field eye examination. Each pupil was visualized with the probe positioned flatly on the lower eyelid utilizing the physiological Bell-phenomenon.

Results: 20 patients (10 males, 10 females) were studied with the pupillary diameter at rest and during ipsilateral torch-light stimulation. All eyes could successfully be insonated. Mean pupillary diameter at rest and under light stimulus was $4,4 \pm 0,9$ and $2,5 \pm 0,5$ mm for the right and $4,3 \pm 0,9$ and $2,5 \pm 0,6$ mm for the left eye. The time delay from stimulus to maximal constriction, assessable in 50% of patients was $1,3 \pm 0,3$ and $1,3 \pm 0,4$ seconds, respectively.

Conclusions: Duplex ultrasound is a suitable tool for objective assessment and documentation of pupillary function. Based on normal values, the method may be applied to pathological conditions of patients e.g. with pupillary function disturbances.

P65**Brain sonography features in X-linked dystonia-parkinsonism**

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Background: X-linked recessive dystonia-parkinsonism (XDP, Lubag, DYT3) is a rare movement disorder that is highly prevalent in the Philippines. XDP has been associated with different genetic mutations on the X chromosome not yet unequivocally determined¹ and with morphological and functional evidence of an involvement of the dopaminergic nigrostriatal pathway². Our purpose was to evaluate the correlation between transcranial brain sonography (TCS) findings and the genetic and clinical state in XDP patients, relatives and controls.

Methods: Filipino participants underwent TCS using a portable device (MyLab 25Gold; Esaote, Genova, Italy) with a 2.5-MHz phased-array transducer. Echogenicity of substantia nigra (SN) and lenticular nuclei (LN) was quantified post-hoc on digitized analysis of anonymized TCS images using Math-Lab based software. Participants were classified with respect to family history, mutational status, and clinical symptoms of XDP.

Results: 89 participants (36 female; mean age 45.1±12.9 years) were enrolled of whom 40 were clinically affected patients with positive genetic status, 20 clinically unaffected relatives of XDP patients (7 with positive genetic status, 7 with negative genetic status, 6 with unknown genetic status), and 29 healthy controls. Increased echogenicity of SN (sum of bilateral measures) was more frequent in subjects with mutation (78%; unaffected relatives only: 67%) than in those without mutation (34%; unaffected relatives only: 20%; chi-square test, p<0.001), Increased echogenicity of LN (sum of bilateral measures) however was related to clinical affection rather than to mutational status, found in 81% of the clinically affected patients but only 27% of clinically unaffected subjects (p<0.001).

Conclusions: SN and LN alteration are frequent sonographic features in XDP. SN alteration may be a diagnostic marker already in presymptomatic disease stages. LN is affected predominantly in the symptomatic stages. TCS expands the knowledge on the pathophysiology of XDP and may be an interesting tool for screening asymptomatic relatives of XDP patients

P66**Elevated free fatty acid is associated with ischemic stroke with atrial fibrillation**

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Background: Free fatty acid (FFA) is associated with cardiovascular diseases, insulin resistance, atherosclerosis, myocardial dysfunction and cardiac arrhythmia. Few studies related to cardioembolic stroke and serum FFA level have been reported. We investigated whether the serum FFA level can be used as a biological marker to differentiate stroke with atrial fibrillation (AF) from stroke without AF.

Methods: We retrospectively included acute ischemic stroke patients who admitted in single university hospital between March 2011 and June 2014. Total 214 consecutive patients (mean age, 66.8±12.3 years; 39.7% women) were enrolled. Patients were divided into two groups: stroke with AF and stroke without AF. Thirty five patients (16.4%) had stroke with AF.

Results: The mean serum FFA level of stroke with AF group was significantly higher (1.82-fold) than that of the stroke without AF group (1379.7±717.5 uEq/L and 757.8±520.5 uEq/L, respectively, p<0.0001). Multivariate logistic regression analysis demonstrated that age (OR, 1.062 for every 1 year; 95% CI, 1.006-1.121, p<0.05), NIHSS score at admission (OR, 1.090; 95% CI, 1.002-1.185, p<0.05), serum FFA level (OR, 1.002 for every 1.0 uEq/L; 95% CI, 1.001-1.002, p<0.001) and involvement of insular cortex (OR, 5.036; 95% CI, 1.801-14.086, p<0.005) were independently associated with stroke with AF group. The optimal cut-off value of serum FFA level for distinguish stroke with AF from stroke without AF was 881.5 uEq/L (sensitivity 0.74, specificity 0.74, AUC 0.76).

Conclusions: Our study shows that FFA level is independent predictor for AF in patients with acute ischemic stroke. FFA level may provide a biological marker to differentiate stroke with AF from stroke without AF.

Poster Session II – 5.

Monitoring & Follow up of surgical and endovascular procedures

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Cerebral microemboli during carotid artery endarterectomy and angioplasty with stenting

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Background: Cerebral microembolism is the common reason of neurological complications with carotid artery endarterectomy (CEA) and angioplasty with stenting (CAS). Intraoperative solid and gaseous microemboli are associated with post-procedural ipsilateral ischemic stroke. However the real clinical significance of microembolic signals (MES) is still controversial.

The aim of our research to correlate the frequency and type of per-procedural MES and cerebrovascular ischemic events in early postoperative period.

Methods: Fifty one patients with high grade internal carotid artery stenosis ($\geq 70\%$ by NASCET) were treated by CEA (30) and CAS (21) and monitored by transcranial bilateral Doppler during vascular surgery. Differentiation MES was performed with frequency modulation index (FMI) estimation.

Result: Both solid and gaseous emboli were detected during all surgery cases. The embolic loading to the brain was prevailed in the CAS group: >1000 MES per hour in CAS group and ≤ 50 MES in the CEA group. However post-procedural differentiation revealed the prevalence of solid MES during the open surgery: 55% and 21% of all emboli were solid during CEA and CAS respectively. Only solid emboli were independently associated with cerebrovascular complications in postoperative period ($p < 0.005$).

Conclusions: Carotid surgery is strongly associated with the high microembolic loading on the cerebral vessels and can be the reason of post-procedural vascular complications. The most harmful to the brain during CEA and CAS are solid microemboli.

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Ultrasonographic follow-up after carotid artery stenting in post-radiotherapy stenosis patients

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Background: Radiation-associated carotid stenosis is relatively common in head and neck cancer patient. Carotid artery stenting is the first choice of revascularization in these patients.

Methods: We performed six carotid stenting in four patients with radiation-associated carotid stenosis. We analyzed the brain MRI, neck MRA, digital subtraction angiography and carotid duplex ultrasonography of the patients before carotid artery stenting. And we followed up the patient with carotid ultrasonography to evaluate the status of stent and the degree of restenosis.

Results: Two arteries had stenosis in internal carotid artery stenosis and 4 cases had in common carotid artery. All of common carotid artery stenosis showed ulcerative plaque with intraluminal turbulent flow. After carotid stenting, we performed carotid duplex scanning at 0, 3, 6, 12 months, and then every year. There was no significant restenotic change during follow-up period.

Conclusions: Carotid duplex ultrasonography is feasible, useful, cost-effective follow-up imaging tool for the patient with radiation-associated carotid stenosis after carotid stenting procedure.

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