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Editorial

Stroke is the second most common cause of death in Croatia, and it is predicted to become the most common cause of death worldwide by 2020. Therefore, prompt recognition of stroke victims should be assessed and treated. Risk factors for stroke should be recognized in asymptomatic patients. From early findings of Satomoura and Kaneko in 1960, of noninvasive carotid hemodynamics detection by applying Doppler principles, the development of ultrasonographic techniques has enabled by far more extended applications than the initial carotid imaging or indirect signs of carotid hemodynamics[1]. In 2007, we will celebrate the 33rd anniversary of our Doppler laboratory, because the first zero-crossing detector was applied at the University Department of Neurology, Sestre milosrdnice University Hospital in 1974. Since then, from the initial recording of carotid Doppler curves, the development of ultrasonography has enabled a broad spectrum of applications presented in this issue.

On the basis of carotid and vertebral artery color Doppler imaging, information on the vessel wall morphology and hemodynamics can be obtained. Besides normal findings and different degrees of variation, especially in vertebral arteries, the carotid intima-media thickness measurements, plaque location and characterization on gray scale imaging, flow disturbance and areas of stenosis are obtained on color Doppler sonography, and flow velocities on spectral Doppler sonography. The degree of the internal carotid artery stenosis diameter is the main parameter used for therapeutic approaches. The ultrasonographic characteristics of plaques speak about the plaque stability. Besides atherosclerotic disease, other rare causes of stroke can be recognized, such as vasculopathy or dissections. Therefore, neurosonologic investigation has become a standard diagnostic tool in stroke assessment. Such imaging provides morphological and functional information on the stroke mechanisms as well as on the risk of stroke recurrence and the possibilities of secondary stroke prevention. It is increasingly becoming the first and often the sole imaging study before endarterectomy, whereas costly and invasive procedures are reserved for special cases. In preventive trials, the carotid intima-media thickness has proved to be a surrogate marker of atherosclerosis and useful in the evaluation of further therapeutic interventions in atherosclerotic disease. Also, new methods like E-tracking, assessment of beta stiffness, and measurement of endothelial dysfunction are now in use, and some have just been tested in trials.

Transcranial Doppler (TCD) is a noninvasive ultrasonic technique that measures local blood flow velocity in the proximal portion of large intracranial arteries. The interpretation is based on the depth of insonation, flow direction, velocimetry and analysis of hemodynamic spectra. It is a "blind" method, depending on the operator's skill, mental image of the insonated vessels, and interpretation of findings depending on the knowledge and experience of the operator. The first application was for evaluation of intracranial hemodynamics in subarachnoid hemorrhage[2]. Nowadays, evaluation of intracranial hemodynamics is possible in stroke patients for localization of intracranial artery stenosis or occlusion, embolus detection, assessment of collateral flow in extracranial or intracranial arterial stenosis or occlusion, monitoring of recanalization and enhancement of rt-TPA induced recanalization, assessment of vasospasm in hemorrhagic stroke and trauma, and screening for vascular malformations. It is used in stroke prevention in hematologic diseases such as sickle-cell anemia. In intensive care units, evaluation of intracranial pressure can be monitored as well as the development of cerebral circulatory arrest, defining the exact time of brain death. Monitoring of the cerebral circulation is possible during surgery. Recent TCD modalities enable detection of cerebral microemboli from cardiac source, aortic arch or large cerebral arteries, estimation of cerebral vasoreactivity, and cerebral autoregulation by analyzing cerebral microcirculatory responses after different stimulation tests. The application of contrast agents can provide useful information in the right-to-left cardiac or extracardiac shunts, since the results are comparable with contrast transesophageal echography (TEE). TEE provides

direct anatomic information regarding the site and nature of the right-to-left shunts due to patent foramen ovale (PFO) or presence of an atrial septal aneurysm, while TCD can assess the extent of the communication and can be useful in the control of PFO closure.

Transcranial color coded sonography (TCCS) adds two-dimensional gray-scale real-time and color Doppler imaging to conventional TCD. Evaluation of intracranial brain parenchyma and hemodynamics enables differentiation between ischemic and hemorrhagic stroke, assessment of the localization of arterial occlusion, monitoring of cerebral thrombolysis, monitoring of midline shift in space-occupying lesions, and assessment of collateral flow in extra- or intracranial arterial stenosis or occlusion. In hemorrhagic stroke, visualization of large cerebral aneurysms or large or medium sized arteriovenous malformations is possible as well as the assessment of their feeding vessels. It is possible to assess and monitor cerebral vasospasm in brain hemorrhage. The use of sonographic contrast agents can increase the number of conclusive TCCS studies in patients with insufficient acoustic windows. TCCS has been used as an excellent screening method in neurodegenerative disorders, especially in patients with Parkinson's disease, and can also provide information on other intracranial pathomorphology.

The neurosonological methods are extremely operator-dependent and require training and experience to perform and interpret results. They are performed by technologists, sonographers and physicians, and are interpreted by neurologists and other specialists. The quality of the data obtained highly depends on the trained personnel, so that each laboratory should set its own criteria based on the data obtained in correlation with other techniques, to achieve high sensitivity and specificity of each method. Since a diversity of sensitivity and specificity of a particular method has been reported, the Subcommittee of the American Academy of Neurology has published a report[3] of the therapeutics and technology assessment for use in TCD ultrasonography and TCCS, proving the utility of these techniques.

In this issue, we present recommendations for the use of neurosonology in stroke, and consensus for the use of TCD as a confirmatory test in brain death, both in accordance with international guidelines.

In order to enable neurosonological methods to be accessible in daily routine at every center in Croatia, numerous training sessions and courses were organized at University Department of Neurology, Sestre milosrdnice University Hospital. The implementation of neurosonology has also been achieved through international courses entitled Summer Stroke School, held every year since 1990 at the Inter-University Center in Dubrovnik. Neurosonologists are members of the Croatian Society for Ultrasound in Medicine and Biology as well as of numerous international ultrasound societies such as European Federation for Ultrasound in Medicine and Biology; European Society for Neurosonology and Cerebral Hemodynamics; and Neurosonology Research Group of the World Federation of Neurology.

Neurosonologic investigations are nowadays sensitive methods for evaluation and monitoring of cerebral hemodynamics, and are also used for evaluation of cerebral functions. Bedside evaluation enables implementation of these methods for routine use even in unstable patients. Accessibility enables implementation of these techniques in evaluation of individuals at risk as a surrogate marker of atherosclerosis and for further therapeutic interventions.

Vida Demarin

References

1. HODEK-DEMARIN V, MÜLLER HR. Reversed ophthalmic artery flow in internal carotid artery occlusion. An appraisal based on ultrasound in Doppler investigations. Stroke 1987; 4:461-3.
2. AASLID R, MARKWALDER TM, NORNES H. Noninvasive transcranial Doppler ultrasound recording of flow velocity in basal cerebral arteries. J Neurosurg 1982;57:769-74.
3. SLOAN MA, ALEXANDROV AV, TEGELER CH, SPENCER MP *et al*. Assessment: transcranial Doppler ultrasonography. Report of the Therapeutics and Technology Assessment Sub committee of the American Academy of Neurology. Neurology 2004;62:1468-81.