Transcranial Doppler Use in Early Detection and Evaluation of the Acute Ischaemic Stroke

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SUMMARY
Applying Transcranial Doppler (TCD) we have measured the mean blood flow velocities in the arteries of the circle of Willis, and during the 2nd measurement, the results were a decreased velocity in the right MCA (Middle Cerebral Artery) in 46.7% of the patients. During the 1st measurement we registered a decreased blood flow velocity in the left MCA in 56.7% of the patients. During the 2nd measurement, a decreased blood flow velocity was noticed in the right MCA in 48.3% of the patients, and in the left MCA among 55% of patients. These values confirm that the cases of severe stenotic changes in extra-cranial blood vessel, or an increased circulation resistance due to the generalized atherosclerosis in the cases of synergic impact on multiple pathological changes in the brain blood vessels. Barkat and colleagues, among numerous other authors, showed by TCD that atherosclerotic changes of extra-cranial part of ICA (Internal Carotid Artery) (occlusion or stenosis greater than 70%) leads to reduction of mean blood flow velocities in the same side of MCA that was registered in our study as well. Increased velocities in the right MCA during the 1st measurement was noted among 15% of patients, while, during the 2nd test, a reduction was noted in the right MCA in 11% of the cases. Normal values in the right MCA during the 1st measurement were registered in 38.3% of the patients, while during the 2nd measurement it was normal in 40% of the cases.

Key words: stroke, diagnosis, transcranial Doppler

1. INTRODUCTION
Acute stroke (AS) is defined as a focal or global disorder in brain function, with sudden onset, last longer than 60 minutes, and it is a consequence of disorder in brain blood flow or states in which the blood flow is insufficient to satisfy metabolic oxygen and glucose needs of the neurons, which cause the morphological damage to the nervous elements (1,2,3,4,5,6). About 85% of strokes are ischemic type, and the rest 15% is caused by hemorrhage. Even with the best possible care, stroke cause death of almost one thirds of patients; one third remain dependent on others care, and only one third recovers. Stroke is one of the first three causes of death in the World, primary cause of disability and significant cause of dementia and depression. Age analysis show that the number of deaths and age specific mortality rate due to cerebrovascular disease increases with age, and significant increase occurs after 50 years. Because of that stroke is a major problem among elderly. In diagnosing the pathology of the brain blood circulation, Doppler sonograph diagnostic become inevitable method. Especially practical is the application of transcranial Doppler (TCD) in evaluation of brain hemodynamic and monitoring of the blood flow velocities trough the intracranial blood vessels which are hidden to other tests methods.

2. AIM
The aim of this paper is early detection and evaluation of the acute cerebral stroke by following the mean values of blood flow velocities (MBFV) trough intracranial blood vessels and comparative analysis of the hemodynamic of left and right hemisphere.

3. METHOD AND PATIENTS
This research included 60 patients in the time period from December 31st 2004 until January 31st 2005 with the diagnosed acute ischemic stroke which was treated at the Neurology Clinic of the Clinical Center of Sarajevo University as indicated by neurologist. Each patient underwent head CT to determine ischemic stroke, also performed is severity of neurology deficit by use of NIHSS scale, and applied TCD to evaluate intracranial blood circulation.

Testing is done twice for each patient, first 3-7 days after the insult, and second 3-4 weeks after the insult (first and second measurement). Clinical features are expressed in quantitative manner by use of numeric scale (NIHSS) for evaluation of stroke severity. With the use of 2MHz probe of the ultrasonic TCD device placed at the temporal bone window, we measured blood flow velocities (BFV) trough the median brain artery. Measured parameters applied to the mean blood flow velocity with the assumption that the other hemodynamic parameters such as arterial blood pressure were constant. Normal limits for the mean blood flow velocity trough the MCA are determined in range 50-74 cm/s). Lowered mean values in MCA were noted only if the velocity was less than 50 cm/s, while the increased were noted when the velocity was over 74 cm/s. Occurrence of lowered or increased BFV are considered pathological according to the referent values.

The findings are compared as within groups over the period of time, as between the groups, and in the baseline.

Inclusion criteria was the patients of both genders, age from 45 to 78 years, with confirmed diagnosis of ischemic supratentorial stroke and with mixed type of brain stroke (according to ethiopathogenesis). Exclusion criteria were the pa-
Patients with confirmed diagnosis of infratentorial stroke and with hemorrhagic stroke (intracerebral hematoma).

4. RESULTS

Most often subtype in our sample is thrombosis with 61.7%, after which follows embolism 33.3%, and mixed subtypes with only 5% within baseline.

In the group with thrombosis more dominant are males with 83.8% while in the group with mixed type more present are women with 66.7%.

Average patient age in our sample is 67.41 years, which means that the most frequent age group was over 70 years with 41.7%, after which follows age group 60-69 years with 31.7%. According to the results of chi-square analysis there is no statistically significant difference in frequencies of individual age groups according to subtypes.

Among 46.7% of patients we noticed decreased MBFV in the right MCA; in 15% we noticed increased values of MBFV, and the normal values in 38.3% of patients.

In case of 34 (56.7%) patients there was a decreased value of MBFV in the left MCA, in 22 (36.7%) normal values of MBFV, and in 4 cases (6.7%) there was increased values.

Table 1.

<table>
<thead>
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<th>Age review</th>
<th>sub type:</th>
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<tr>
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<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
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<td>37</td>
</tr>
</tbody>
</table>

Figure 1. Subtypes of ischaemic stroke

Figure 2. Average by sex

Figure 3. The first measurement on the left side in the MCA

Figure 4. The first measurement on the right side in the MCA

Figure 5. The second measurement on the left side in the MCA
During the second measurement on the right side in the MCA there was decreased MBFV values among 29 (48.3%) patients, increased among 7 (11%), normal values in case of 24 (40%) patients. On the left side among 33 (55%) patients we noticed decreased MBFV, increased among 5 (8.3%), and normal in case of 22 (36.7%) patients.

Asymmetry of blood flow was equally present in all three subtypes so there are no statistically significant differences.

During the second measurement there was a statistically significant increase of asymmetry in blood flow velocities (compared to the first measurement) in form of normalizing the velocities, or increase of flow which indicated normalizing of the circulation (rechanneling) or reperfusion.

Analysis of stenosis during the first and second evaluation showed that as in case of asymmetry there are no statistically significant differences between subtypes, but that there is a statistically significant decrease in number of stenoses during the second evaluation.

Based on this chart we can conclude that we found stenoses during the first evaluation in 61.7% of patients and during second one in 51.7% patients.

5. DISCUSSION

Age is the strongest risk factor for the cerebral infarction. Our results showed that the average age in our sample is 67.41 years, and the most frequent age group was between 60-69 years with 31.7%. Mean age of 67.41 years with standard deviation is relatively young, but we have to mention that the inclusion criteria were survival with the recovery. Because of that from the study we excluded all the patients which life was endangered due to some severe somatic illness such as cardiac decompensation, high fever, and symptoms of the acute brain syndrome.

In the study by Bilic et al from the Clinical hospital in Split they tested the stroke during 2005: average age for the ischemic stroke reported was 72.5±10.4 years with male to females ration of 51.1%:48.9%. Our sample is little bit older with the remark that the study from Split gathered all the patients with stroke during 2005, as well as all etiology and outcomes (5,6).

Risk for stroke among people at age from 75 to 84 years is about 25 times higher compared to the age group 45-54. In our sample there were 5% of patients younger than 40 and 5.4% patients under 50 years (4) Data from the Clinical hospital Sestre Milosrdnice, Dezmalj et al reported 3.4% patients with the ischemic stroke younger than 45 years in a baseline sample of 1153 patients with stroke which is comparable to our results (7,8,9,10).

Regarding gender distribution in relation to the subtype, in the group with thrombosis more dominant are males with 83.8% which agrees with the data by the Brown et al 1996. In the group of mixed more present are women with 66.7%. Male gender is a risk factor for stroke, but more women will have a stroke during lifetime (5,6).

American Heart Association, (Stroke Statistics, 2006 Update) reported that the female gender have the same stroke rate, but not only that women lives longer but also have the higher survival rate after the stroke. Most often subtype in our sample was thrombosis with 61.7%, followed by embolism with 33.3%, and mixed subtypes with only 5% within baseline (12,13).

Mean BFV in MCA on the side with occlusion is...
on average of 20 cm/sec lower in comparison to the side without occlusion, which indirectly indicates that despite of quality of collateral circulation, side with disease suffers in hemodynamic sense. In the studies by Barkatov et al, Silvestrini et al and many other authors, TCD evaluation showed that atherosclerotic changes at the extra cranial part of ICA (occlusion or stenosis is over 70%) lead to reduction of MBFV in the MCA of the same side.

In this research we found correlation between decrease of the MBFV with the patient’s age, which can be considered as the normal effect of the “blood-system” aging because with aging is too demanding and actually impossible to exclude all the factors with influence of “blood vessels aging” such as hypertension, border or increased blood sugar and fat levels, alcohol use or smoking during lifetime which leaves trace on a blood vessels, regardless of fact that patient had abstinence for a longer time period, until the moment when we evaluate him, because the patient usually neglect existence of such data in personal history (14,15).

Our results showed during the first measurement decreased MBFV in the right MCA for 46.7% patients, for the 15% of patients we noticed increased MBFV, and the normal values in 38.3%. In the left MCA in case of 34 (56.7%) patients there was decreased MBFV, in 4 (6.7%) cases there was increased values of MBFV, and in 22 (36.7%) patients the values was in normal limits. TCD studies also showed that the occlusion in more than three MCA branches are combined with the flow velocity decrease in M1 segment of the MCA in the majority of cases according to the results of Zanetti et al 1995, which is in accordance with our results. Andrew in year 2000 followed 190 patients with the occlusion in ICA, and TCD in 67% of cases showed abnormal waves in MCA due to stenotic changes on ICA, and most frequent was abnormally low values less than 20 cm/s, such low flow values we find in case of cardiac patients (congestive cardiac illness, myocardial infarction).

Second measurement show permanently abnormal TCD findings for the 36 patients, and in 22 cases normal blood flow velocities.

Side to side differences in velocity are also useful in making diagnosis. Asymmetry indicates the side of the lesion and also evaluation of the collateral blood flow in case of patient with the ICA occlusion. That is why TCD plays an important role in early prognosis of stroke in frontal circulation. Kaps et al in 1992 point out on the sample of 81 patients initial reduction of flow in MCA on the side with ischemia.

Asymmetry was equally present in all three sub types, so there are no statistically significant differences (10,11,13). During the second measurement there was a statistically significant increase in asymmetry (compared to the first one) which indicates that the Willis field is one dynamic area with the permanent blood redistribution according to the brain tissue needs. In case of our patients the results indicated that major changes are happening between the first and second evaluation, so 44% of BFV in ACA on the right side was changes in comparison to the first measurement due to blood redistribution. Toni et al in 1998, Alexandrov et al in 1998, noticed that spontaneous rechanneling happens in 14 -24% of patients during the first 24 hours after stroke, and Razumovsky et al in 1999 showed that it is present in 33% of cases. We came to the conclusion that in baseline the highest percentage of collateral flow was trough the right ACA or frontal left ACA.

Our sample of 60 patients evaluated according to the inclusion criteria measured MBFV in two time periods: 1-5 days of acute phase and one month after the first evaluation. Time period of one month, as well as period of 1-5 days in the acute stroke phase were insufficient for evaluation of the collateral circulation and rechanneling after the intracranial blood vessel occlusion especially because we had two measurements without emphasis of the most frequent collateral pathway of the frontal flow or a.ofthalmika which could be the topic for some other research. By analyzing the occurrence of the decreased MBFV in case of our patients in the frontal circulation (especially MCA)and according tool the results of other authors (TCD interpretation) it is a case either of occlusion in the previously stenotic arteries r development of collaterals with the consequential flow decrease trough this artery. Hemisphere decrease in flow occurs due to infarction and as a consequence of decreased from trough certain artery (15).

6. CONCLUSION
TCD is a good indicator of asymmetry in blood flow, as well as the side of the ischemic lesion location.

We showed that TCD is simple and comfortable method for the patient which enables early detection and follow up of the clinical evolution of stroke.

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