Assessment of Cerebral Blood Flow Velocities in Pre and Post Angiographic States with Transcranial Doppler

A. Arslantas, D. Gucuyener,* N. Uzuner,* E. Cosan, R. Durmaz, M.A. Atasoy, G. Ozdemir,* E. Tel

Department of Neurosurgery and Neurology*
Osmangazi University, Faculty of Medicine,
Eskisehir, Turkey.

Summary

The frequency of complications resulting from angiograms reported in the literature vary between 0.2-5 percent. This study was planned to determine the changes in cerebral blood flow velocity before and after angiography, using transcranial doppler in patients of subarachnoid hemorrhage (SAH) undergoing angiographies. Thirty patients with subarachnoid hemorrhage underwent transcranial doppler ultrasonography immediately before and after angiography. Nonionic water-soluble agents were used during the angiograms. The mean flow velocity (MFV) and pulsatility index (PI) at the M1 segment of both middle cerebral arteries was simultaneously measured. When the patients (11 male, 19 female, mean age±SD: 52.45±12.06) were compared according to changes in MFV and PI, pre and post-angiography, there was no statistical difference in MFV (p=0.51 and p=0.99, left and right side respectively), and in PI (p=0.48 and p=0.66) pre and post angiography. Although angiogram can be used to detect vasospasm in SAH, it can also be cause of vasospasm, partially due to the effect of the contrast agent on the cerebral arteries. This study proposes that the angiographic method is still safe and TCD can be used to follow up any possible changes in diameter of cerebral arteries before and after angiography.

Key words : Angiography, Transcranial doppler, Blood flow velocity, Intracranial hemorrhage.

Introduction

Cerebral vasospasm is the term commonly used to refer to both the clinical status of delayed onset of ischemic neurological deficits associated with subarachnoid hemorrhage (SAH) and the narrowing of cerebral vessels documented on angiography.1,2 Until recent years, the only way to establish the course of vasospasm was by angiography. The development of transcranial doppler ultrasound (TCD) monitoring has made it possible to diagnose intracranial arterial spasm non-invasively.3,4 Performing angiograms on patients with vasospasm can lead to an increase in the...
risk of neurological deficits during and after the procedure, although it is uncertain whether such events should be attributed solely to angiographic procedure. The aim of our study was to show whether the angiography results is increase of vasospasm in patients with subarachnoid hemorrhage, by studying pre and post angiographic cerebral blood flow velocity using transcranial doppler.

Material and Methods

30 patients admitted to the departments of neurosurgery or neurology at University of Osmangazi after cranial tomography (CT) at the referring hospital confirmed them as having suffered spontaneous SAH were included in the study. The selection criteria of the subjects included: i) no intraparenchymal hematoma demonstrated on CT scan, ii) TCD feasible at both temporal bones, iii) angiographic proof of aneurysm, iv) technically suitable cut-film cerebral angiograms.

Neurological Assessment: Change in neurological status was determined in all patients by monitoring glasgow coma scale (GCS). The severity of SAH, was graded using Hunt and Hess classification. The patients with good results were selected in order to determine more effectively the effect of angiography on the cerebral blood flow velocity.

Transcranial Doppler Measurements: TCD (Multidop X4, DWL software) examination was performed using 2-MHz pulsed doppler probe via the trans-temporal approach. Long-term monitoring was performed while the patients were at rest in the supine position. The first parts of both MCAs were insonated simultaneously at a depth of 50-60 mm. Intergate distance was set at 5 mm. After stabilizing the doppler signals, probes were secured with an elastic headband. Initial TCD studies were performed within 24 hours of admission. The TCD measurement obtained before the actual angiogram was recorded and compared with the TCD measurements taken on the first and third day after angiography. The mean blood flow velocity (mBFV) and pulsatility indexes (PI) of the both MCA were recorded. Thus, allowing for an estimation of the change in arterial diameters over the course of angiographies. This allowed us to observe immediately the effects of angiography on vasospasm. A significant decrease was noted as evidence of arterial dilation, and an increase of MCA flow velocity was regarded as evidence for narrowing of the vessel diameter, indicating vasospasm.

Angiographies Timing: The four-vessel intra-arterial digital subtraction angiographies were performed during the five days after hospitalization. It was interpreted by a neuroradiologist, blinded to the patients’ clinical condition and to the results of TCD examinations. In each patient, these diagnostic angiograms served as a reference for assessment of the vascular narrowing at the time of clinical vasospasm in addition to delineating the aneurysms. Nonionic water-soluble agent -iohexol (Omnipaque; 40 mg/ml) was used in this procedure.

Statistical Analysis: Statistical analysis was performed using a commercially available SPSS software package. Changes in TCD velocities and in mGCS score between pre and post procedure were tested using the paired t-test.

Results

Twenty patients (11 males and 19 females, mean age ± SD, 52.45±12.06) with SAH were included in this study. Initially, all the cases were in Hunt and Hess grades I/II. The GCS was between 14-15 in 24 patients and 12-13 in 6 patients. There was no change in the clinical picture of the patients nor in the values of the GCS and Hunt-Hess grading after angiographies. Neurologically, no significantly different clinical course could be identified pre and post angio as seen by changes in GCS. Symptomatic vasospasm occurred in only one patient, who developed symptoms (focal motor and change in sensorium) on the 3rd day, after a probable recent bleeding.

TCD findings: There was no significant difference between left and right mBFV and PI in before and after angiography. The mean values of TCD monitoring are shown in Table I. A 25% decrease in vessel diameter was defined as mild vasospasm, 50% narrowing as moderate vasospasm and 75% as severe vasospasm. In this population angiographically determined vasospasm was found to be less than mild in all patients (5-8% in 4 patients, 8-10% in 10 patients, and 10-12% in 16 patients).

Discussion

Cerebral vasospasm is a major cause of delayed severe morbidity and death. It may begin on the third day and extend beyond three weeks. Cerebral angiography remains the gold standard for diagnosis of the intracerebral cause of SAH and for following the course of vasospasm. On the other hand, angiography is not altogether without risk. There is a small but significant risk of major stroke or death during or soon after angiography.
after cerebral angiography. In most instances, events occurring during or within 24 hours of angiograms have been considered a direct complication of angiographies. High concentrations of the injected medium may induce vascular spasm and occlusion. Overall morbidity from the procedure is about 3 percent.10 In the past, the most common causes of brain damage had been the use of toxic contrast agents and the local damage to the carotid or vertebral arteries.11 Nowadays, after digital subtraction angiography, brain damage attributable to the contrast medium is zero and local trauma is also relatively infrequent. However, despite a few reports demonstrating their safety, we still cannot be sure whether angiography itself leads to vasospasm or not. Until the advent of transcranial doppler, angiography was the only method to diagnose vasospasm. In recent years, many studies have been performed showing the importance of TCD in SAH.12,13

Our aim was to determine the comparison of the TCD and angiograms from a different approach. We sought to find out whether the angiography by itself affects cerebral blood flow velocity and pulsatility indexes. Our results show that the angiographic technique did not have any additionally adverse effect on the cerebral arteries. No significant change in either blood flow velocities or pulsatility indexes in the TCD examinations was observed. This was not an unexpected result. Transcranial doppler is a relatively recent advancement in imaging that enables measurement of blood flow velocity in large intracranial arteries though temporal, occipital and orbital portions of the skull. It is now an established method for diagnosing hemodynamically significant vasospasm in major intracranial arteries. It is safe, inexpensive and readily available. The angiography which can visualize intracranial vascular lesions with relatively small amounts of dye, does not lead to an increase in vasospasm in SAH and that these results can be shown by TCD. Finally, TCD results show, once more that the new contrast agents can continue to be used safely and with efficacy.

### Table I

<table>
<thead>
<tr>
<th></th>
<th>Pre angiography Mean ± SD</th>
<th>Post angiography (1 st day) Mean ± SD</th>
<th>Post angiography (3 rd day) Mean ± SD</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left mBFV</td>
<td>65.56 ± 25.62</td>
<td>69.61 ± 35.68</td>
<td>68.45 ± 32.12</td>
<td>0.51</td>
</tr>
<tr>
<td>Right mBFV</td>
<td>65.30 ± 23.62</td>
<td>65.36 ± 24.2</td>
<td>65.34 ± 23.90</td>
<td>0.99</td>
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<tr>
<td>Left PI</td>
<td>1.04 ± 0.35</td>
<td>0.99 ± 0.20</td>
<td>1.03 ± 0.32</td>
<td>0.48</td>
</tr>
<tr>
<td>Right PI</td>
<td>0.98 ± 0.36</td>
<td>1.01 ± 0.20</td>
<td>0.99 ± 0.28</td>
<td>0.66</td>
</tr>
</tbody>
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References