CLINICAL STUDY

The benefit of a temporary vessel occlusion in aneurysm surgery

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Abstract

Objective: **Temporary clipping in aneurysm surgery has been used more frequently in last years to increase the efficacy and safety of the neck dissection and obliteration. Experimental studies have shown that neuroprotection using hypertension and mannitol administration diminishes the risk of ischemia during this procedure. However, recent studies show that this method has to be used with caution.**
Methods: **In 85 aneurysms we used temporary vessel occlusion with neuroprotection described above in 17 patients (20 %), ranging from 2 to 35 minutes (mean 9 minutes). The indication was peroperative rupture (3 cases), difficult neck dissection (13 cases) and a giant aneurysm (1 case).**
Results: **Forteen of these patients had a good result, one was severely disabled, the other 2 died. One of them had a large temporal hematoma and was HH=V before the operation, the other one had a premature peroperative aneurysm rupture. Shorter occlusion times were used in patients with a good outcome, in patients with elective use of the clip and in patients with no new ischemia on the postoperative CT scan (t-test, $p<0.05$). The postoperative infarction rate was similar in the group of patients with (17 %) and without temporary clipping (15 %).**
Conclusion: **We conclude that temporary clipping in aneurysm surgery is a relatively safe procedure which facilitates the aneurysm neck dissection and enables neck obliteration in difficult cases. Better results are achieved with short duration of occlusion.** ***(Fig. 4, Ref. 13.)***
Key words: aneurysm, brain ischemia, temporary clip.

Elective temporary clipping (TC) of a parent artery has been widely used in aneurysm surgery in the last decade. Its main advantage is the decrease of blood flow inside the aneurysm which enables faster and more precise dissection of the aneurysm neck and sac. Particularly in acute surgery the anatomical situation around the aneurysm maybe difficult to understand due to bleeding and adhesions within the cisterns (1). TC can diminish the risk of bleeding during the dissection in such situations. The clipping itself is safer as well, especially in proximally located aneurysm (carotid artery) and large aneurysms, which are under high pressure. The management of giant aneurysms is sometimes impossible without the use of TC. According to some authors the use of TC on the parent artery lowers the risk of perioperative complications (aneurysm rupture, iatrogenous ischemia due to inappropriate clip position) almost three times (2).

Of course, the main risk of this maneuvre is that the focal ischemia will become irreversible. Therefore those authors who use TC routinely emphasize the need to use it for the shortest possible times or to use intermittent occlusion (3, 4). New methods of a perioperative monitoring have disclosed a relatively high vulnerability of the brain tissue. Microdialysis and tissue oximetry have shown that a significant dicrease of $PtiO_2$ and pH, and an increase of pCO_2 and the lactate/pyruvate ratio occurs with occlusions lasting more than 3 minutes (5, 6). Occlusions lasting more than 20 minutes may lead to postischemic hyperperfusion, edema and infarction (7, 8). The safe occlusion interval for the middle cerebral artery (MCA) is said to be 10 minutes (9). Various neuroprotective methods are used to increase the time of a safe TC use. Their effectiveness was proved both ex-

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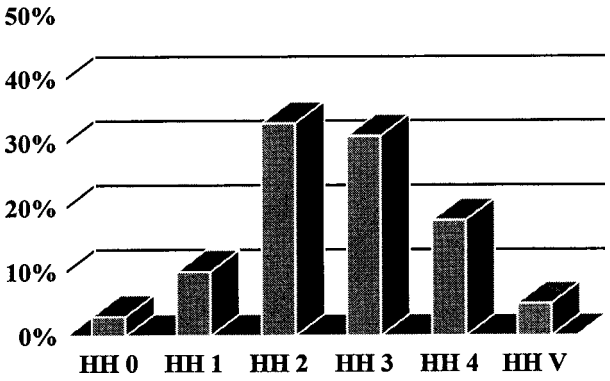

Fig. 1. Distribution of patients after SAH according to their preoperative HH scale score.

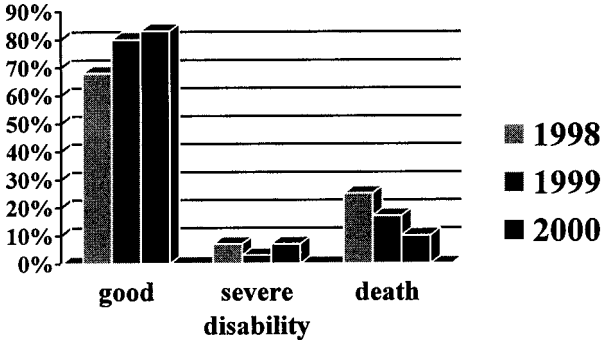

Fig. 2. The results of treatment of the ruptured aneurysms are slightly improved with the establishment of a new vascular team 3 years ago (mean follow up 24 months).

perimentally (10) and clinically. Commonly used pharmacological neuroprotection includes mannitol, barbiturates, phenytoin, tocopherol (9, 11, 12), systemic hypertension, and hypothermia (10).

Methods

During the years 1998–2000 we cared for 91 patients after subarachnoid hemorrhage (SAH) with total of 98 aneurysms. Their distribution according to the Hunt and Hess scale (HH) is shown in Figure 1. The majority of them were HH 2 and 3. Seventy-four patients (81 %) were operated within 4 days after the bleeding, 17 patients (19 %) had a delayed surgery. Out of the total of 98 aneurysms 38 % were located on the MCA, 31 % on the anterior communicating artery (ACoA), 25 % on the internal carotid artery (ICA) and 6 % in the posterior circulation. The aneurysm was clipped in 82 % of patients; wrapping of the aneurysmal sac was used in 12 %; and coiling was used in 6 % of patients.

Within the group of 85 patients who were operated microsurgically, TC was used in 17 of them (20 %). TC was used either electively (difficult neck dissection, giant aneurysm) or in cases of perioperative rupture. For TC we use Yasargil temporary clips. Before the application of TC the patient receives 100 g of mannitol and during the ischemic period the systolic blood pressure is elevated to approximately 180 mmHg. We retrospectively evaluated the treatment results of a whole group of patients according to the Glasgow Outcome Scale (GOS) and compared them to the group of those with the use of TC. We also evaluated the influence of the length of temporary ischemia on the treatment results and we compared new postoperative ischemic changes on CT in patients with and without TC.

Results

The results for the whole group of 91 patients treated for aneurysmal SAH are as follows (mean follow up 24 month): 77 % had good results, 6 % were severely disabled; and 17 % died. We found a significant difference in the preoperative HH score in patients with a good result (HH = 2.4) compared to those who died (HH = 3.2) (t-test, $p<0.05$). We noted a trend of improved results after the establishment of a new neurovascular team three years ago (Fig. 2).

TC has been used in 17 out of 85 patients treated surgically (20 %). In 11 (66 %) of the patients TC was used on the middle cerebral artery (MCA), in 3 (17 %) cases on the internal carotid artery (ICA) and in 3 (17 %) cases on the anterior cerebral artery (ACA). The length of the temporary ischemia varied from 2 to 35 minutes (mean 9 minutes). In 14 (82 %) patients TC was used electively with mean time of temporary ischemia of 8 minutes. If we do not include a patient with a giant aneurysm on the MCA (35 minutes of ischemia)in this group, in the other 13 patients the mean time of ischemia was only 6 minutes. In 3 patients the use of TC was forced by a perioperative rupture of the aneurysm. In these patients the temporary ischemia lasted 20, 22 and 5.5 minutes with the mean of 16 minutes, which is significantly longer compared to the elective group (t-test, $p<0.05$).

A new ischemia on the postoperative CT scan (performed usuallly 24–48 hours after the operation) occured in 10 (15 %) out of 68 surgically treated patients without the use of TC. Five (50 %) of these patients have finally died. A new postoperative ischemia also occured in 3 (17 %) out of 17 patients operated with the use of TC. In two of these patients, the use of TC was forced by a perioperative rupture and the third patient with postoperative ischemia was the patient with a large temporal hematoma from a giant MCA aneurysm (Fig. 3). The mean time of occlusion in these patients was 20 minutes and two (66 %) of them have finally died. We have found, however, no statistical difference in the incidence of a new postoperative ischemia in patients with and without TC.

The results in the group of patients with the use of TC are as follows (mean follow up 24 months): 14 (82 %) of them had a good result, 1 (6 %) was severely disabled and 2 (12 %) patients died. The mean length of temporary ischemia in patients with a good result was 7 minutes compared to 27.5 minutes in the patients who died ($p<0.05$).

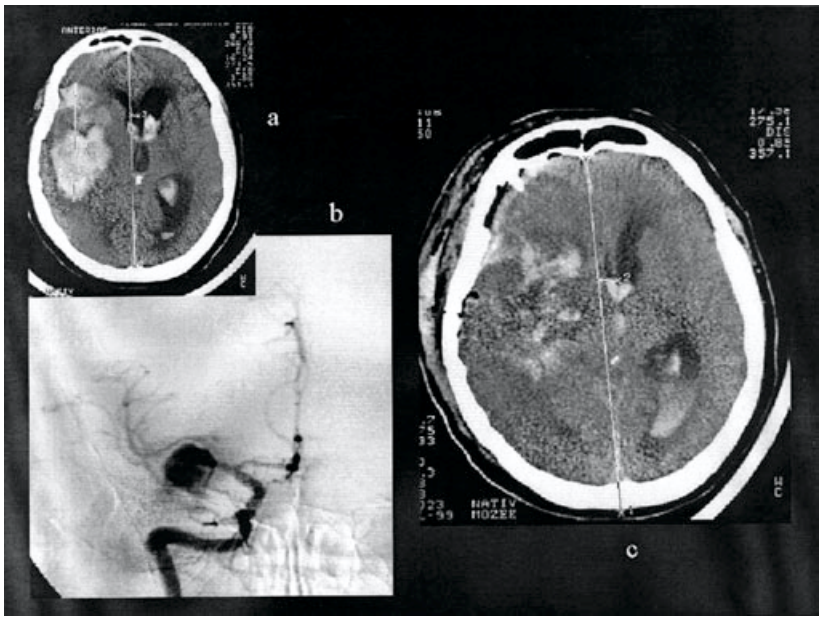

Fig. 3. A large temporal hematoma on the right side in a 62-year old male patient (a). The source was a giant MCA aneurysm (b). The hematoma was urgently evacuated and the aneurysm clipped with the use of TC for 35 minutes. The follow up CT scan 48 hours after the operation shows new ischemia in the right MCA territory (c). The development of this ischemia was probably influenced by the long occlusion time as well as by the hematoma itself with herniation symptoms.

Discussion

In the beginning of 90‘s, when the technique of temporary clipping of the parent artery became widely used, there was a tendency to underestimate the possible ischemic complications of this procedure. There were frequent statement from neurosurgeons supporting longlasting occlusions (20 minutes or more) (13). Various neuroprotective methods, of course, were applied at the same time. Their effectivness was proved and their use undoubtedly increased the safe time of temporary occlusion. Even 40 minutes ischemia in some of these cases therefore did not cause infarction. Also one of our patients with a good treatment result had TC on both A1 segments for 22 minutes without any ischemic sequelae (Fig. 4).

After this period of initial enthusiasm, it was found that the effectivness of the neuroprotective methods is very individual and that the same type and length of the vessel occlusion with the use of the same neuroprotection might not be tolerated the same way by all patients. The anatomical variability and reactivity of the circulation is likely to play a role in this respect. Also pathological pre-conditions, such as atherosclerosis, play a role as well. At present there is unfortunately no method which would be certain to predict the impact of a vessel occlusion in a specific individual.

The danger of irreversible ischemia using TC is described in the recent literature. Monitoring of some parameters of brain metabolism, such as tissue oxymetry or microdialysis is used in this respect. It has been shown that the pathological values of the tissue oxygen, carbon dioxide, lactate or pH, already occur after 3 minutes of focal ischemia (6). According to our experimental studies of focal ischemia in rats, apoptosis is triggered by 15 minutes ischemia or sooner (unpublished data). With respect to the fact that the irreversible damage (necrosis) evolves usually with much longer ischemia, this proof of an early insufficiency of the aerobic metabolism is somewhat surprising. This knowledge leads us to recommend against the use of longlasting parent artery occlusions. Also the results of this study favor the use of short occlusions (approximatelly untill 8 minutes), because they limit the development of irreversible ischemic complications. The patients with good results had significantly shorter times of TC than the patients with unfavorable results. Also we noticed longer times of TC in patients with premature aneurysm rupture than in patients with the elective use of TC. Premature perioperative rupture is, according to the literature, a factor negatively influencing the outcome (2).

The main aim of aneurysm microsurgery is the exclusion of the aneurysm from the circulation by clipping of its neck. TC is only an auxiliary procedure. If the dissection of the aneurysmal neck is feasible, we consider the use of TC in a common sized aneurysm unnecessary. In cases with difficult anatomical orientation after previous bleeding, where the neck cannot be dissected without an increased risk of perioperative rupture, it is probably better to use TC electively and finish the dissection under ischemic conditions. In any case, the identification and control of the parent artery remains the primary requirement before one starts dissecting the aneurysm itself.

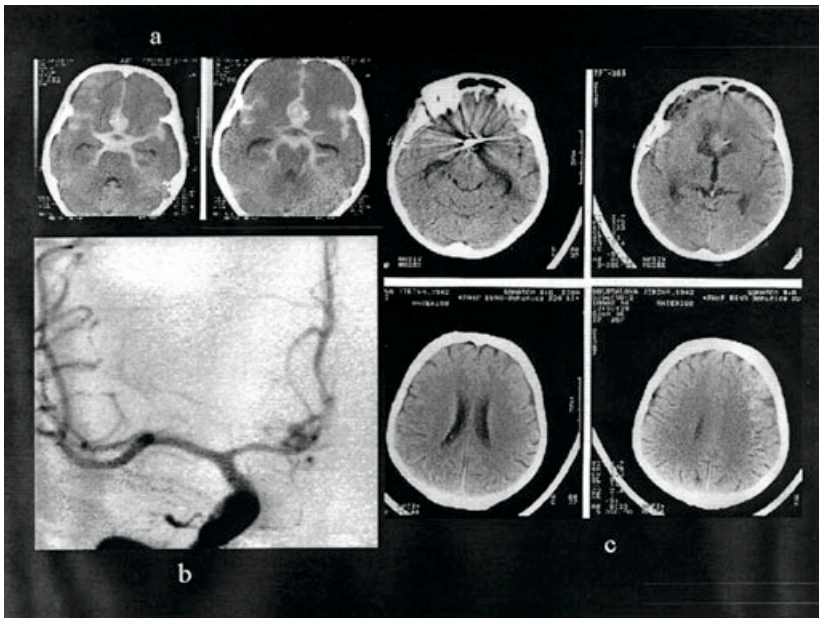

Fig. 4. A severe SAH (Fischer 3) in a 56 years old female patient (a) originated from an upward and backward pointing AcoA aneurysm (b). The aneurysm was clipped on the 3rd day after the hemorrhage with the use of TC on both A1 segments of the ACA for 22 minutes. The follow up CT scan on day 3 after the operation did not show any new ischemia and the clinical result was good (c).

In conclusion, the use of TC is an effective method enabling safer aneurysm dissection and clipping. According to our opinion, however, it should be used rather individually due to the risk of ischemic complications. Therefore only short occlusion times (8–10 minutes) with adequate neuroprotection, or intermittent occlusions should be used. In elderly, above 70 years of age, this method is not recommended at all.

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