Use of temporary arterial occlusion during anterior cerebral artery aneurysm repair: evaluation of prospective factors

Uso de oclusão arterial temporária durante clipagem de aneurismas de comunicante anterior: avaliação de fatores preexistentes

Antônio Santos de Araújo Júnior1
Paulo Henrique Pires de Aguiar2,4
Mirella Martins Fazzito1
Renata Simm1
Apio Claudio Martins Antunes1,2,3
Carlos Alexandre Zicarelli1
Marco Stefani1,2

RESUMO

Introdução: Este estudo visa determinar os fatores prognósticos para sequelas e complicações perioperatórias nas cirurgias de aneurismas da artéria comunicante anterior (ACoA), secundários ou relacionados à clipagem temporária.

Pacientes e Métodos: Num universo de 92 pacientes operados de aneurisma da ACoA entre 2000 e 2013, 32 foram operados nos últimos sete anos. Destes, 21 foram submetidos à clipagem temporal durante a cirurgia para reparo do aneurisma, e tiveram seus dados analisados retrospectivamente.

Resultados: Aneurismas maiores que 7 mm tiveram uma tempo estatisticamente maior de clipagem temporária que aqueles menores (22±5.7 vs 11.3±4.1, Teste-t, p < 0.0001). Não se evidenciou correlação estatística entre o tempo de oclusão e o prognóstico (r=0.92, Pearson, p>0.08). Idade, Escala de Coma de Glasgow (ECG) da primeira avaliação, e Escala de Fisher da Tomografia de Crânio da entrada foram fatores de pior prognóstico (Glasgow Outcome Scale GOS ≤ 3) (regressão-cox, p<0.001). Idade maior que 50 anos, ECG menor que 13, e Fisher III ou IV resultaram em pior prognóstico. Por sua vez gênero, tabagismo, alcoolismo, obesidade, hipertensão arterial sistêmica, dislipidemia, localização da oclusão temporária, rotura trans-operatória do aneurisma e tamanho do aneurisma não foram identificados como fatores independentes de prognóstico.

Durante seguimento pós-operatório, dois terços dos pacientes tiveram um prognóstico favorável (GOS≥ 4), retomando suas atividades de vida diária sem maiores dificuldades. Cinquenta e dois por cento dos pacientes evoluíram com hidrocefalia, a despeito da fenestração rotineira da lâmina terminalis, realizada em 71,4% dos procedimentos. A maioria dos pacientes desenvolveu vasoespasmo (66%), sendo 19% vasoespasmo severo. Sequela neurológica por isquemia tardia foi observada em 28,5% dos pacientes, secundária ao vasoespasmo grave, sem correlação estatística com o tempo de oclusão ou com ruptura aneurismática intraoperatoria.

Conclusão: A clipagem temporária durante as cirurgias dos aneurismas da ACoA não parece adicionar mais morbidade ao procedimento, e não é um fator independente de prognóstico. No entanto idade, ECG e escala de Fisher são fatores independentes de mau prognóstico.

Palavras Chave: aneurisma da artéria comunicante anterior, aneurisma cerebral, neurocirurgia vascular.

ABSTRACT

Introduction: This study was undertaken to determine variables that could predict, in the perioperative period of anterior communicating artery (ACoA) aneurysms surgeries, the likelihood of postoperative sequelae and complications, after temporary arterial occlusion.

Patients and Methods: In a universe of 92 patients submitted to ACoA aneurysm clipping between 2000 and 2013, 32 were operated in the last seven years. Among these patients, 21 needed temporary arterial occlusion during surgical aneurysm repair, and had their data examined retrospectively.

Results: Aneurysms larger than 7 mm were more likely to be treated with longer temporary clipping time than small aneurysms, <7 mm (22±5.7 vs 11.3±4.1, t-Test, p < 0.0001). There was no statistical correlation between time of occlusion and outcome (r=0.92, Pearson, p>0.08). Age, Glasgow Coma Scale (GCS) at initial evaluation, and Fisher scale at 1st CT scanning were independent factors of unfavorable outcome (Glasgow Outcome Scale ≤ 3) (cox-regression, p<0.001). Among variable factors, patients older than 50 years, an initial GCS under 13, and a Fisher grade III or IV resulted in worse outcome. Meanwhile gender, tobacco or alcohol addiction, obesity, arterial hypertension, dyslipidemia, location of temporary occlusion (A1 or A2), intraoperative rupture and the aneurysm size were not identified as independent prognostic factors.

During follow-up period, two thirds of the patients had a favorable outcome (GOS ≥ 4), accomplishing normal daily life activities without major complications. Fifty-two percent of patients evolved with hydrocephalus, despite of routine fenestration of the lamina terminalis, performed in 71.4% of procedures. Most patients also developed clinical vasospasm (66.6%), with 19% of the patients presenting with a severe disease. Delayed ischemic neurological deficit was observed in 28.5%, secondary to severe vasospasm, and without any statistical correlation to time of temporary occlusion or intraoperative aneurysm rupture.

Conclusion: Temporary clipping during ACoA aneurysm repair does not seem to add more morbidities to the procedure, and is not an independent prognostic factor. However, age, initial GCS and Fisher grade are associated to unfavorable outcome.

Keywords: anterior communicating artery aneurysm, brain aneurysm, vascular neurosurgery.
Anterior communicating artery (AComm) aneurysms are the most common intracranial aneurysms, accounting for approximately 30-37% of intracranial aneurysms. AComm aneurysms are also the most complex aneurysms of the anterior circulation due to the angioarchitecture and flow dynamics of the AComm region, frequent anatomical variations, deep interhemispheric location, and danger of severing the perforators with ensuing neurologic deficits.

AComm aneurysms are most commonly found at the A1-A2 junction on the dominant side. The angle of the arteries at the bifurcation and the direction of blood flow are factors of hemodynamic stress in the apical region where these aneurysms often develop. They exist at the bifurcation of dominant A1, A2 and AComm and usually point in the direction away from the dominant A1.

Worldwide, endovascular therapy is gaining an increasing role in the treatment of AComm aneurysms, but has not yet overwhelmed the microneurosurgical management, and seems to accomplish the same outcome in a long-term follow-up of ruptured cases. In everyday clinical practice and decision making, coiling and clipping are to be considered equivalent in the long term, but treatment options should be tailored case-to-case.

A variety of operative approaches to the anterior communicating complex for intracranial aneurysms have been described, but the most commonly used is the pterional approach best described by Yasargil.

The advantages of the pterional approach are as followed: neurosurgeons are familiar and comfortable with it; it provides a rapid access to the basal cisterns; it allows exposure to the proximal A1 segment to proximal control, and other common aneurysm locations when multiple ipsilateral aneurysms are present; it provides an anterolateral trajectory to the AComm region that allows for easier visualization of perforating vessels supplying the septal region and chiasm.

However, the pterional approach may present some disadvantages. This is a unilateral approach to a midline structure. Sometimes retraction of the frontal lobe cannot be achieved adequately without widely opening the sylvian fissure, increasing the risk of temporal lobe, insula, draining veins and middle cerebral artery dissection trauma. Bone removal is required to minimize brain retraction and can be cosmetically disfiguring because temporalis muscle atrophy and risk of damage to the frontal branch of the facial nerve.

To prevent some of these previous disadvantages, the anterior subfrontal and the lateral supraorbital approaches for AComm aneurysm clipping were proposed. Up to now there is no unique approach for AComm aneurysms clipping, and all seem to be feasible, being the choice of the approach an option of the surgeon. Despite the technical nuances, timing of treatment is still a controversial matter.

The ideal timing of clipping after aneurysmal subarachnoid hemorrhage (SAH) was uncertain up to the International Subarachnoid Aneurysm Trial, which assessed differences in incidence of delayed cerebral ischemia and clinical outcome between different timings of treatment. The risk for poor outcome was highest when treatment was performed after day 10; postponing treatment in patients who were eligible for treatment between days 5 to 10 after SAH was not recommended.

AComm aneurysms present frequently with small sized SAH. Furthermore, unruptured AComm aneurysm may have increased risk of rupture regardless of size, also as an associated aneurysm, and require treatment. They demonstrate the highest incidence of postoperative morbidity among anterior circulation aneurysms.

The aim in microneurosurgical management of an AComm aneurysm is total occlusion of the aneurysm sac with preservation of flow in all branching and perforating arteries. Precise dissection in the anatomy of the AComm complex and perforators requires not only experience and skill but patience to work the dome and base under repeated protection of temporary clipping.

Elective use of temporary clips (ETC) prevents intraoperative anterior circulation aneurysmal rupture (IAR). Dhandapani et al. have found a 4.5% of IAR in patients who had ETC vs 55.3% of IAR without ETC (p<0.001). They have also demonstrated that IAR had significant association with unfavorable outcome (38% vs. 24%) (p = 0.02). In addition, the use of ETC (p = 0.027) and total temporary clipping less than 20 min (p = 0.049) were noted to result in significantly...
beter outcome, independent of other factors. In Leipzig et al. study, posteroinferior cerebellar artery and anterior and posterior communicating artery aneurysms were more liable to rupture intraoperatively. The IAR rate was greater in ruptured than unruptured aneurysms (10.7 versus 1.2%, P < 0.0001). There was a lower rate of IAR in operations using temporary arterial occlusion (3.1 versus 8.6%, P < 0.0001).

According to Salary et al, outcome after aneurysmal SAH is related to the following triad of well-established clinical factors: Hunt and Hess grade, age, and clinical vasospasm. Despite intraoperative aneurysmal rupture been recognized a factor of unfavorable outcome according to Dhandapani et al., up to now there are no multivariate study to validate the use of temporary clipping or other epidemiological data as a independent factor of outcome.

Anesthetic considerations

It is highly advisable the best anesthesiology practicing in neurosurgical treatment of intracranial aneurysms. Standard American Society of Anesthesiologists monitoring and invasive arterial monitoring is necessary during surgery. Whether central venous pressure or pulmonary artery pressure should be monitored depends on several factors including patient medical history, size and location of the intracranial aneurysms, use of inotropic agents, and the anesthesiologist’s discretion.

Induction of general anesthesia and intubation should be accomplished in a smooth and controlled manner. Small doses of sedation like midazolam can help to decrease patient anxiety preoperatively, although one should be aware that this can disturb neurological evaluation, with postoperative mental status deterioration, especially in elderly patients.

Pinning the head in a Mayfield surgical frame is associated with a high sympathetic discharge, systemic hypertension, and potential aneurysm rupture. A bolus of opioids, such as sufentanil, or fentanyl, and scalp infiltration with a local anesthetic attenuates the hemodynamic changes during head pinning.

The surgical decision to use temporary clipping should prompt the anesthesia team to consider measures for brain protection, because temporary clipping can cause a period of reversible focal cerebral ischemia.

Communication between the surgeon and anesthesiologist about timing of application and release of the temporary clip is one of the most important factors in achieving optimal oxygenation and perfusion of the brain during this critical period.

If temporary clips are used before placement of the permanent aneurysm clip, the anesthesiologist can decrease the CMRO2 (cerebral metabolic rate for oxygen) by giving a bolus of intravenous anesthetic while blood pressure is maintained. A moderate decrease in blood pressure can help the surgeon manipulate the artery for placement of the temporary clip. After temporary clip placement, however, a higher blood pressure is needed to promote collateral perfusion to the ischemic area.

The Intraoperative Hypothermia For Aneurysm Surgery Trial showed that short-duration intraoperative hypothermia did not improve 3-month neurologic outcome after craniotomy for good-grade patients with aneurysmal subarachnoid hemorrhage. Hypothermia is also associated with arrhythmias and cardiac ischemia, decreased platelet activity, prolonged coagulation, and increased infection rate.

Hyperglycemia also has a deleterious effect on recovery from ischemic brain injury. The prophylactic use of calcium antagonists like nimodipine in patients with SAH reduces the risk of brain damage. The efficacy of magnesium in preventing delayed ischemic neurologic deficits in patients with SAH seems to be comparable with nimodipine.

Methods

In a universe of 92 patients submitted to ACm aneurysm clipping between 2000 and 2013 by the senior author, 32 were operated in the last seven years. Among these patients, 21 needed temporary arterial occlusion during surgical aneurysm repair, and had their data examined retrospectively.

The admission characteristics of the patients are summarized in Table I. All patients underwent diagnostic cerebral angiography, and had their data regarding the aneurysm morphology summarized in Table II.

The surgical case characteristics and details regarding postoperative course were reviewed and are summarized in Table III. The clinical outcome of the patients was assessed.
at 1-year follow-up by “Glasgow Outcome Scale - GOS”, as defined: GOS 5 - good recovery (resumption of normal life despite deficits); GOS 4 - moderate disability (disabled but independent); GOS 3 - severe disability (conscious but disabled); GOS 2 - persistent vegetative state; and GOS 1 - death.

Table I: Clinical characteristics of patients with AComm aneurysms

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>6 (29)</td>
</tr>
<tr>
<td>Female</td>
<td>15 (71)</td>
</tr>
<tr>
<td>Male/Female rate</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Mean Age (years)</strong></td>
<td>52.8 ± 16.5</td>
</tr>
<tr>
<td><strong>Range (years)</strong></td>
<td>19-78</td>
</tr>
<tr>
<td><strong>Presentation</strong></td>
<td></td>
</tr>
<tr>
<td>Unruptured</td>
<td>9 (43)</td>
</tr>
<tr>
<td>Ruptured</td>
<td>12 (57)</td>
</tr>
<tr>
<td>Fisher Grade</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6 (50)</td>
</tr>
<tr>
<td>2</td>
<td>5 (42)</td>
</tr>
<tr>
<td>3</td>
<td>1 (8)</td>
</tr>
<tr>
<td><strong>Glasgow Coma Scale</strong></td>
<td></td>
</tr>
<tr>
<td>13-15</td>
<td>20 (95)</td>
</tr>
<tr>
<td>8-12</td>
<td>1 (5)</td>
</tr>
<tr>
<td>&lt;8</td>
<td>0 (0)</td>
</tr>
<tr>
<td><strong>Comorbidities</strong></td>
<td></td>
</tr>
<tr>
<td>Arterial hypertension</td>
<td>16 (76)</td>
</tr>
<tr>
<td>Smoking</td>
<td>14 (66)</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td>7 (33)</td>
</tr>
<tr>
<td>Obesity</td>
<td>8 (38)</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>8 (38)</td>
</tr>
</tbody>
</table>

*Values represent number of patients, with percentages given in parentheses

Table II: Summary of aneurysm morphological characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aneurysm Size</td>
<td></td>
</tr>
<tr>
<td>Small (&lt;10mm)</td>
<td>21 (100)</td>
</tr>
<tr>
<td>Large (10-25mm)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

*Values represent number of patients, with percentages given in parentheses

Table III: Summary of surgical case characteristics and post-operative course

<table>
<thead>
<tr>
<th>Characteristic</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraoperative aneurysm rupture</td>
<td>3 (14)</td>
</tr>
<tr>
<td>Temporary clipping performed</td>
<td>21 (100)</td>
</tr>
<tr>
<td>Average clip duration</td>
<td>13.8 ± 6.4</td>
</tr>
<tr>
<td>Lamina terminalis opening</td>
<td>15 (71)</td>
</tr>
</tbody>
</table>

Results

Aneurysms larger than 7mm were more likely to be treated with longer temporary clipping time than small aneurysms, <7mm (11.3±4.1 vs 22±5.7, t-Test, p <0.0001). There was no statistical correlation between time of occlusion and outcome (r=0.92, Pearson, p>0.08). There was also no statistical difference in outcome between patients submitted to intraoperative temporary clipping during more or less than 20 min.

Age, Glasgow Coma Scale (GCS) at initial evaluation, and Fisher scale at first CT scanning were independent factors of unfavorable outcome (Glasgow Outcome Scale ≤ 3) (cox-regression, p<0.001). Among variable factors, being older than 50 years, an initial GCS under 13, and a Fisher grade III or IV resulted in worse outcome.

Meanwhile gender, tobacco or alcohol addiction, obesity, arterial hypertension, dyslipidemia, location of temporary occlusion (A1 or A2), intraoperative rupture and the aneurysm size were not identified as independent prognostic factors.

During follow-up period, two thirds of the patients had a favorable outcome (GOS ≥ 4), accomplishing normal daily life activities without major complications. Among nine patients presenting with unruptured aneurysms 100% had a favorable outcome at 1-year follow-up (GOS ≥ 4), meanwhile only 41.6% of patients presenting with ruptured aneurysms had a favourable outcome.

Fifty-two percent of patients evolved with hydrocephalus, despite of routine fenestration of the lamina terminalis, performed in 71.4% of procedures. Most patients also presenting with severe symptoms. Delayed ischemic neurological deficit was observed in 28.5%, secondary to severe vasospasm, and without any statistical correlation to time of temporary occlusion or intraoperative aneurysm rupture.
Discussion

Despite Dhandapani et al.6 findings, we were not able to demonstrate any statistical difference in outcome of patients submitted to ETC, even with time longer than 20 min, neither among whom IAR was observed. It may be explained because we had only 4 cases of ETC longer than 20 min, and just 3 cases of IAR.

Nevertheless we have taken statistically longer time of ETC in aneurysms greater than 7 mm, probably due to more difficult dissection of the dome and base of larger aneurysms, and to locate all perforating branches before permanent closure of the aneurysm.

Our results are quite similar to those obtained by Salary et al.18, which revealed unfavorable outcome following SAH related to age older than 50 years. Other independent factors of unfavorable outcome were Fisher grade III or IV and Glasgow Coma Scale under 13 at admission.

From all epidemiological comorbidities, such as tobacco or alcohol addiction, obesity, arterial hypertension or dyslipidemia, none has revealed as independent factor of unfavorable outcome.

Despite the severity of the illness, two thirds of patients evolved with favorable outcome (GOS ≥ 4). However, in the group of patients who presented with SAH, only 41.6% patients evolved well.

Conclusion

Temporary clipping during ACom aneurysm repair does not seems to add more morbidities to the procedure, and is not an independent prognostic factor. However, age, initial GCS and Fisher grade are associated to unfavorable outcome.

References


**CORRESPONDING AUTHOR**

**Antônio Santos de Araújo Júnior**

**Work Address:** Rua Peixoto Gomide, 515, cj 96
Cerqueira César - São Paulo - Brazil
CEP 01409-001

*e-mail: dr.antonioaraujojr@gmail.com*