Microsurgical clipping of the anterior circulation aneurysms: study of a personal series and a critical literature review.

Clipagem microcirúrgica de aneurismas cerebrais de circulação anterior: estudo de uma série pessoal e revisão crítica da literatura.

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ABSTRACT

Introduction: The authors present the analysis of the microsurgical clipping of 100 cerebral aneurysms of the anterior circulation and compare the series data with the literature. Methods: Eighty-eight patients presenting with 100 anterior circulation aneurysms operated on microsurgical techniques between 2002 and 2008 by the first author (CES) were retrospectively reviewed. Results: A total of 88 patients with 100 aneurysms of the anterior circulation were treated in a six years period. Fifty eight female (66%) and thirty male (34%) with nine patients (10.2%) presenting with multiple aneurysms. The mean age was 52 years (range from 26 to 76 years). Eighty five percent of the cases were ruptured aneurysms. The mean follow-up was 52.4 months (range from 5 to 76 months). The topography of the aneurysms was distributed as it follows: Anterior communicating artery (ACoA) 25%; posterior communicating artery (p-comm) 29%; middle cerebral artery (MCA) 27%; paracrilhoidian aneurysms 8%; pericallosal artery 6% and internal carotid artery (ICA) tip 5%. The mortality was 7.9%, and such cases presenting with Hunt Hess graduation 3 and 4. The permanent morbidity was 4.5%, cases with Hunt Hess graduation 3 and 4. The permanent morbidity was 4.5%, cases with Hunt Hess graduation 3 and 4. Perioperative rupture occurred in 17% of the cases, only in previous ruptured aneurysms. There was no clinical evidence of rebleeding during the follow up period of the series. Conclusions: The microsurgical clipping of cerebral aneurysms of the anterior circulation is a safe and curative treatment for most of such lesions. At present, studies suggest evidences of superior results of surgery compared to the endovascular techniques in the rates of total occlusion of the aneurysms, lesser rates of rebleeding of the treated cases. The results of the present series are similar to the rates of the most relevant literature.

Key-Words: Cerebral aneurysms, microsurgery, aneurysms clipping.

SUMÁRIO

Introdução: Os autores apresentam a análise da clampagem microcirúrgica de 100 aneurismas cerebrais da circulação anterior e comparam os dados da casuística com os da literatura. Métodos: Oitenta e oito pacientes com 100 aneurismas da circulação anterior operados por técnicas microcirúrgicas entre 2002 e 2008 pelo primeiro autor (CES) foram retrospectivamente revisados. Resultados: Um total de 88 pacientes com 100 aneurismas da circulação anterior foram tratados em um período de seis anos. Cinquenta e oito do sexo feminino (66%) e 30 masculinos (34%) com 9 pacientes (10,2%) apresentando aneurismas múltiplos. A idade média foi de 52 anos (variação de 26 a 76 anos). Oitenta e cinco por cento dos casos foram aneurismas rotos. O tempo médio de seguimento foi de 52,4 meses (variação de 5 a 76 meses). A topografia dos aneurismas foi a seguinte: Artéria comunicante anterior 25%; artéria comunicante posterior 29%; artéria cerebral média 27%; paracrilhoidian aneurysms 8%; pericallosal artery 6% e artéria carótida interna 5%. A mortalidade global foi de 7,9% e todos os pacientes com graduação de Hunt Hess 3 e 4. A morbidade de definitiva foi de 4,5% e todos os casos com graduação de Hunt Hess 3 e 4. A ruptura transoperatória ocorreu em 17% dos casos, somente em aneurismas rotos. Não houve evidência clínica de ressangramento durante o período de seguimento do caso. Conclusões: A clipagem microcirúrgica dos aneurismas cerebrais da circulação anterior é um tratamento seguro e definitivo para a maioria destas lesões. Os estudos atuais apresentam evidências de resultados superiores da cirurgia comparados aos das técnicas endovasculares nos percentuais de oclusão total dos aneurismas e menores índices de ressangramentos dos casos tratados. Os resultados da presente casuística são semelhantes aos encontrados na literatura.

Palavras-chave: Aneurismas cerebrais, microcirurgia, clipagem aneurismas.
**INTRODUCTION**

Microsurgical clipping of the cerebral aneurysms have been compared with the coiling endovascular procedures in order to define which one is the most effective option for the treatment of such lesions. After the publication of the International Subarachnoid Aneurysm Trial (ISAT), there is a progressive tendency to offer the endovascular procedures as the first choice to manage the ruptured aneurysms in many centers around the world. The first author’s experience (CES) in 100 consecutive cases of cerebral aneurysms of the anterior circulation treated by microsurgical techniques is presented and the authors discuss the data proposing a critical evaluation compared to the literature. (23,24)

**METHODS**

A retrospective analysis of 100 consecutive cases of ruptured and unruptured cerebral aneurysms of the anterior circulation treated by microsurgical clipping in 88 patients during the period between October 2002 and October 2008 was done. The patients were graduated in their neurological status using the Hunt-Hess (HH) scale. (13) The amount of blood seen in computed tomography (CT) was evaluated by the Fisher grading. (11) Patients with Hunt Hess grades 1, 2 and 3 at the admission were treated as soon as possible. Patients with HH 4 and 5 were operated on if there were life threatening associated hematomas. Aneurysms of the anterior circulation were treated by microsurgical clipping as the first choice except the complete intracavernous lesions which were treated by endovascular techniques or patients in very poor neurological conditions whom were treated by endovascular methods or observed.

All patients were interviewed at least one time after surgery to be included in the follow up group.

**RESULTS**

Eighty-eight patients with 100 aneurysms of the anterior circulation were treated in a period of six years: 58 female / 30 male, with nine patients (10,2%) presenting with multiple aneurysms. Three patients presented three aneurysms and six presented two aneurysms. The mean follow up was 52.4 months (range from 5 to 76 months). The aneurysms were distributed according to their locations in: anterior communicating artery (ACoA) 25%; posterior communicating artery (p-comm) 29%; middle cerebral artery (MCA) 27%; paraclinoidal aneurysms 8%; pericallosal artery 6% and internal carotid artery (ICA) tip 5%. (Table 1) Paraclinoidal aneurysms were classified according to Sekhar et al. (28).

<table>
<thead>
<tr>
<th>TABLE 1 - 100 anterior circulation aneurysms</th>
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<tbody>
<tr>
<td>Topography</td>
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<tr>
<td>p-comm</td>
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<tr>
<td>MCA</td>
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<tr>
<td>AcoA</td>
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<tr>
<td>paraclinoidal</td>
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<td>pericallosal</td>
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<td>ICA tip</td>
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Legends: AcoA - anterior communicant artery; p-comm - posterior communicating artery; MCA - middle cerebral artery; ICA - internal carotid artery

There were 5% of giant aneurysms (diameter > 2.5 cm) : 2 cases of p-comm aneurysms, 2 cases of paraclinoidal aneurysms and 1 case of ICA tip.

Ruptured aneurysms comprised of 85% of the series.

The distribution of the patients according with their Hunt Hess modified classification at the time of surgery was: HH 0: 10%; HH 1: 28%; HH 2: 18%; HH 3: 35%; HH 4: 9%; HH 5: 0%. (14) (Table 2) It is important to observe that patients presenting with multiple aneurysms were operated on for both ruptured and unruptured lesions at the same procedure. Such aspect explains the difference between the percentages of HH grade 0 and unruptured clipped aneurysms.

<table>
<thead>
<tr>
<th>TABLE 2 - 88 patients with 100 anterior circulation aneurysms</th>
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<tbody>
<tr>
<td>HH</td>
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<td>5</td>
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<tr>
<td>TOTAL</td>
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Legends: HH - Hunt Hess graduation of the patients at the time of the surgery
The CT Fisher grade distribution was: F 1: 14.8%; F 2: 1.2%; F 3: 53%; F 4: 31%.

The transoperative rupture rate was 17%. There rate of transoperative rupture in each aneurysm topography were: 6 cases in ACoA (24%), 5 cases in p-comm (17%), MCA 4 cases (14%), paraclinoidal aneurysm 1 case (12.5%) and pericallosal artery 1 case (20%). All the transoperative bleeding occurred in previous ruptured aneurysms. The global risk of transoperative bleeding for the ruptured aneurysms was 20%.

Global mortality was 7.9%, all cases with Hunt Hess grade 3 and 4 distributed as follows: two cases of ACoA aneurysms, 1 patient with HH 4 and 1 patient with HH graduation 3. There were 3 cases of p-comm aneurysms, all patients with HH graduation 3. One case of pericallosal aneurysm and 1 patient presented with MCA aneurysm, both with HH grade 3.

Morbidity rate at the discharge was 12.5%. However, during the follow-up period, most patients recovered their normal functions. The final morbidity was 4.5%, and these patients were operated on Hunt-Hess grade 3 and 4. There were 3 patients with transient hemiparesis and one with aphasia. Two transient hemiparesis were observed in patients with unruptured aneurysms. Such cases presented cardiac and pulmonary complications and prolonged ICU period. (Table 3) The global morbidity and mortality rate was 11.5%.

<table>
<thead>
<tr>
<th>TABLE 3 - 88 patients with 100 anterior circulation aneurysms</th>
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<tr>
<td>Data</td>
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<tr>
<td>Ruptured aneurysms</td>
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<tr>
<td>Transoperative rupture</td>
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<td>Unruptured aneurysms</td>
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<tr>
<td>Mortality</td>
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<td>Definite morbidity</td>
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</table>

* All patients with Hunt Hess graduation 3 and 4.

There was no clinical evidence of rebleeding during the follow-up period. There were three patients who needed CSF shunts for hydrocephalus. (3.4%)

**LEARNING CURVE ANALYSIS**

The analysis of the learning curve was done dividing the series in two halves, with 50 aneurysms in each one. The learning curve evidences the progressive improvement of the results of the microsurgical clipping in the series. The first 50 aneurysms were treated in 40 patients and they cursed with 13 transoperative ruptures (26%). The last 50 lesions were operated on 48 patients with 4 ruptures during the operation (8%). Mortality rate was 6 cases in the first 40 patients (15%) and 1 case in the last 48 (2%). Even when the HH graduation was considered in the analysis, the improvement of the results are evident (Table 4).

<table>
<thead>
<tr>
<th>TABLE 4 - 88 patients with 100 anterior circulation aneurysms</th>
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<tr>
<td>First half (50 aneurysms / 40 patients)</td>
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| Transoperative rupture                                       | 26%
| Mortality                                                    | 15%
| HH3                                                          | 38%
| HH4                                                          | 14%
| Second half (50 aneurysms / 48 patients)                     |
| Transoperative rupture                                       | 8%
| Mortality                                                    | 2%
| HH3                                                          | 28%
| HH4                                                          | 4%

**Legends:** HH - Hunt Hess graduation of the patients at the time of the surgery

**DISCUSSION**

The International Subarachnoid Aneurysm Trial (ISAT) presents the endovascular procedure as an alternative with better immediate outcomes and at 1 year after procedure concerning to the relative risk of death and dependency. However, several methodological aspects of such study have been criticized in the last analysis. Most centers included in the ISAT were located in Europe, Australia and Canada. The U.S., Central and South America centers present different characteristics that could modify the final results of the study. The most relevant critic is that only 20% of the 9559 cases included in the ISAT were randomized. The selection of the majority of cases for one treatment could create some introducing bias. (23,24)

The present series has a mortality of 7.9%, all patients with HH 3 and 4. The inclusion of such patients increases the surgical mortality but the goal was to reduce the final mortality avoiding the natural selection performed by the conservative approach waiting for the patient’s improvement. There was no definite morbidity or mortality in the patients with Hunt Hess graduation 1 and 2.

All the aneurysms included in the present series were clipped during the first surgical procedure. There was no case of failed approach.
The patients followed in the present series have no clinical evidence of rebleeding after microsurgical clipping. All patients had at least one post-operative interview to be included in the follow up group. Only 12 patients (13.6%) were submitted to postoperative angiography in the series, with total occlusion of the aneurysms in all of them. Nevertheless, even in the ISAT study, angiography was performed in only 47% of patients treated by microsurgical clipping because it is not a standard clinical practice in all centers. Rebleeding is the most serious risk for the patients that undergone endovascular procedures compared with microsurgical clipping. The ISAT data are: rebleeding in 28 patients of 1073 cases after endovascular treatment up to 1 year and rebleeding in 10 patients of 1070 cases with microsurgical clipping in the same period. After the first year an additional group of 7 patients have bled their aneurysms in the endovascular group and 2 patients in the microsurgical group. A recent study suggests that the initial benefit of the endovascular procedure evidenced by the ISAT cannot be assumed for patients younger than 40 years-old because of the better long-term results of the microsurgical clipping for such patients. In fact, the ISAT’s technical outcome evidenced 92.5% of complete occlusion of the aneurysms in the endovascular group and 96.4% of total occlusion in the microsurgical group during the first treatment. Nevertheless, in the first angiography after treatment the total occlusion rate of the target aneurysm was 66% for endovascular and 82% for microsurgical clipping. Is it advantageous to offer a procedure with higher risk of incomplete occlusion for younger patients? (21,23,24)

In the ISAT, the experience of the surgeons and the endovascular interventionists were not clearly reported and could not be comparable. Different centers present microsurgeons and interventionists with different skills according to the characteristics of the departments and their routines. Interventionists were allowed to work in the study after having performed at least 30 endovascular procedures. The questions are: Is this number sufficient to allow a safe learning curve for all professionals? Can the final results be achieved if the endovascular procedures are performed by interventionists with less experience? Can the rates of total occlusion be higher in most experienced endovascular surgeons? (23,24,25)

Another interesting question is: Which are the morbidity and mortality rates for the patients who bled their aneurysms during the endovascular procedures compared with the cases when the aneurysms ruptured during the microsurgery?

When both procedures are presented to the patients as alternatives for the treatment, all these statistical data should be presented. The risk of not to be cured by the endovascular procedure is higher. There is a general risk of 33% of fail in exclusion of the aneurysm of the circulation in such method compared with 18% in the microsurgery, using the same ISAT study as a reference. There is an additional risk of periodical angiography that should be done to check the risk of aneurysm refilling in patients treated by endovascular techniques. Angiography after the microsurgical clipping usually is the final procedure if the aneurysm was excluded.

There were 15 unruptured aneurysms operated on in the present series, with no mortality. In this group, there was no transoperative rupture even in the first 50 aneurysms, and no definite morbidity. There were 2 transient hemiparesis (13.3%). In the International Study of Unruptured Intracranial Aneurysms (ISUIA) the overall rate of surgery-related morbidity and mortality was 17.5% at 30 days and 15.7% at 1 year for patients with unruptured aneurysms without history of subarachnoid hemorrhage from a different aneurysm. (4,15,22,26)

In the last decade the number of endovascular interventionists is growing up, and there is a general tendency to indicate the method as the minimally invasive solution for all cases of ruptured aneurysms. The technical advances of such procedures are improving the results and it is superior to the microsurgical clipping in selected cases, especially in the posterior circulation and intracavernous aneurysms. (1,2,9,10,16,18,19,29,32) Older patients, the patients with poor neurological conditions at the initial hospital management are treated with lesser risks by endovascular coiling. The complexity of the microsurgical training to prepare a neurosurgeon to deal with aneurysms of the brain circulation is higher than to the endovascular procedures and it can be an attractive situation for choosing the second alternative to the youngest surgeons. (3,5,6,7,30,31) On the other hand, if the microsurgical skills are not encouraged, a considerable number of patients will be treated by endovascular procedures with a doubtful indication in the future. (8,27)

There is a special group of patients with ruptured aneurysms which needs microsurgery in almost all circumstances: patients with intracranial hematoma with mass effect needing evacuation surgery and direct control of the aneurysms. Such cases need a skilled microsurgeon to treat the intracranial hypertension and the rupture of the aneurysms during the surgical procedures should be controlled. It is another goal during the education of the neurosurgeons in order to avoid the dangerous situation of not being prepared to treat such emergency cases.

The costs of the methods of treatment of cerebral aneurysms are clearly favorable to the microsurgery. The coils and other technologies should improve their costs to be competitive with the clips and it is another important element to consider. (12,17,20)

The individual learning curve is a subjective data which modify the results in all medical procedures. In the present series, the second group of 50 patients presented better results in all the evaluated aspects.
CONCLUSIONS

The microsurgical clipping of cerebral aneurysms of the anterior circulation is a safe and curative treatment for most of such lesions. Exceptions are the complete intracavernous aneurysms of the ICA which are better managed by endovascular techniques. At present, studies suggest evidences of superior results compared to the endovascular techniques in the rates of total occlusion of the aneurysms and lesser rates of rebleeding of the treated cases. The surgical repair of such lesions should be considered especially for the younger patients (age < 40). The results of the present series are similar to the rates of the most relevant literature.

REFERENCES


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