Surgical management of intracranial aneurysms in the "coiling age"

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ABSTRACT

Background: *Intracranial aneurysm rupture is associated with substantial rates of morbidity and mortality. The classic neurosurgical treatment for such lesions is the craniotomy for clipping. However, over the last 10 years, surgery has been increasingly replaced by the endovascular technique.* ***Objective:*** *Analyze the results of surgery technique in a Public Health Hospital in the "coiling age".* ***Method:*** *We reviewed a series of 149 patients treated for 191 aneurysms by the traditional craniotomy and clipping technique.* ***Results:*** *We observed an overall mortality of 12.1%, poor outcome of 8% and good outcome of 79.8%. Hunt Hess scores ≥ 3 in the pre-surgical evaluation were associated to a higher length of hospital stay (p = 0.047). Better outcome was observed in patients with Hunt Hess score < 3 comparing with patients with Hunt Hess score ≥ 3 before surgery (p < 0.000). Patients who presented with Fisher Scale grade 4 presented a poor prognosis when compared to the other groups (p = 0.016).* ***Conclusion:*** *Excellent results may be achieved by craniotomy to treat aneurysms, which still represents a useful technique for lesions that can not be safely treated by endovascular techniques nowadays.*

KEY WORDS

Cerebral aneurysm, surgical treatment.

RESUMO

Tratamento cirúrgico de aneurismas intracranianos na "era endovascular"

Contexto: *Aneurismas intracranianos estão relacionados à grande taxa de morbidade e mortalidade. O tratamento neurocirúrgico tradicional dessas lesões é a craniotomia para clipagem da lesão, entretanto nos últimos dez anos a cirurgia vem sendo substituída, cada vez mais, pela técnica endovascular.* ***Objetivo:*** *Avaliar os resultados da técnica cirúrgica em hospital público na "era endovascular".* ***Método:*** *Analisou-se uma série de 149 pacientes tratados de 191 aneurismas por craniotomia e clipagem.* ***Resultados:*** *Obteve-se mortalidade de 12,1%, evolução ruim em 8% e boa evolução em 79,8% dos casos. O escore na escala de Hunt Hess ≥ 3 na avaliação pré-operatória foi associado com maior tempo de internação hospitalar (p = 0,047). Melhor evolução foi constatada em pacientes com escore Hunt Hess < 3 comparados a pacientes com Hunt Hess ≥ 3 antes da cirurgia (p < 0,000). Pacientes que apresentaram grau 4 na escala de Fisher apresentaram prognóstico pior em relação aos outros grupos (p = 0,016).* ***Conclusão:*** *Excelentes resultados podem ser alcançados com a abordagem cirúrgica e, portanto, atualmente esta é de grande valia para lesões que não podem ser tratadas pela técnica endovascular.*

PALAVRAS-CHAVE

Aneurisma cerebral, tratamento cirúrgico.

Introduction

Intracranial aneurysms cause substantial rates of morbidity and mortality. The main clinical manifestation of this entity is the nontraumatic subarachnoid hemorrhage (NSAH), a neurological emergency. Ruptured intracranial aneurysm accounts for about 80% of cases of NSAH and has a high rate of death and complications.[1,15]

The average case fatality rate for subarachnoid hemorrhage (SAH) is 51% percent, most deaths occurring within two weeks after the ictus. As many as 46% of

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survivors may have long-term cognitive impairment, with an effect on functional status and quality of life, requiring lifelong care.[4,12] The disorder is also associated with a substantial burden on health care resources, most of which are related to hospitalization.[14]

The risk of rupture depends on the size and location of the aneurysm. Aneurysms located in the internal carotid artery, anterior communicating artery, anterior cerebral artery and middle cerebral artery have a lower tendency to rupture than aneurysms in the posterior circulation and posterior communicating artery.[16,17]

The traditional neurosurgical treatment of intracranial aneurysms is the craniotomy for clip ligation ("clipping"). However, over the last 10 years, surgery has been increasingly replaced by endovascular methods of obliteration of the aneurysm sac.[1]

The aim of this study is to present a series of 149 patients treated for 191 aneurysms by the traditional craniotomy and clipping technique, by the same neurosurgeon team, during the period of the "endovascular treatment era".

Methods

Study design

This retrospective study comprised the evaluation of all patients who underwent surgical treatment of cerebral aneurysms at Hospital Geral de Fortaleza and Hospital Batista Memorial, Brazil, from December 2002 to December 2006. The authors reviewed the files in order to collect clinical and surgical data namely description of procedures and outcomes.

Clinical status of the patients was graded by the physicians using the Hunt-Hess (HH) Scale score: patients with HH < 3 were considered as presenting a good clinical condition and patients with HH ≥ 3, as a poor condition.[6] The extent of SAH verified by computed tomography (CT) was classified by the Fisher Scale (FS).[3] Digital subtraction angiographies were performed with the aim of studying cerebral circulation previous to treatment.

The techniques of aneurysm management and operative surgery were well established and were not undergoing any significant change during the period of this study.

After surgery, the patients were submitted to control angiography in cases judged necessary for confirm the complete isolation of the aneurysm from the circulation. Control CT was performed according to the clinical evaluation.

The Glasgow Outcome Scale (GOS) was used to evaluate the outcome of the patients at the discharge and six months after treatment.[8] Patient's follow-up varied between six months to five years.

Patient selection

Although ruptured aneurysm comprises the majority of the cases, we also included in this series unruptured aneurysms that manifested with symptoms of mass effect. All patients were treated by the same medical team, using identical procedures.

Data analysis

The outcome classification was analyzed as: good outcomes, defined as functionally independent or mild to moderate disability (GOS 4 and 5); poor outcomes, defined as severe disability (GOS 2 and 3); and death (GOS 1).

Statistical analysis

All data are expressed as mean ± standard deviation (SD). Statistical software, SPSS 16.0 (SPSS Inc., Chicago, IL) was used for statistical analysis, with $P < 0.05$ considered statistical significant.

Results

A total of 149 patients were submitted to surgical treatment of 191 intracranial aneurysms during the period analyzed by the study. Eighty patients were from Hospital Geral de Fortaleza and 69 patients from Hospital Batista Memorial. The female group represented most of the patients treated, 108 patients (72.5%). The mean age was 48.1 ± 11.6 years (ranging from 21 to 73).

The anatomical site of the intracerebral aneurysm is specified in table 1. Multiple aneurysms were present in 33 patients (22.1%). The aneurysms sizes were: ≤ 10 mm in 144 aneurysms (75.4%); 11 mm to 25 mm in 31 (16.2%) and > 25 mm (giant) in 16 (8.4%). There was no statistically significant correlation between aneurysm site and outcome, neither between aneurysm size and outcome ($p > 0.05$).

The clinical presentation was spontaneous SAH in 133 patients (89.3%) and development of signs and symptoms of secondary to mass effect (HH score = 0), such as cranial nerve palsy observed in 16 patients

Table 1
Site of aneurysm

Site of aneurysm	n	%
Internal carotid artery	59	30.9
Posterior communicating artery	37	19.4
Middle cerebral artery	37	19.4
Anterior communicating artery	34	17.8
Pericallosal artery	11	5.7
Anterior cerebral artery	4	2.1
Oftalmic artery	4	2.1
Anterior choroidal artery	2	1
Basilar artery	1	0.5
Superior cerebelar artery	1	0.5
Posterior inferior cerebelar artery	1	0.5
Total	191	99.9

(10.7%). The HH scores at admission of the patients in our service were: HH = 0 in 16 (10.7%); HH1 in 68 (45.6%); HH2 in 33 (22.1%); HH3 in 26 (17.4%); HH4 in 6 (4%). The Fisher Scale grades (FS) at admission were: FS1 in 31 (20.8%), FS2 in 37 (24.8%), FS3 in 65 (43.6%), FS4 in 16 (10.7%). Correlation between HH and FS is presented in table 2.

Table 2
Hunt-Hess score versus Fisher grade

–	Fisher 1 n (%)	Fisher 2 n (%)	Fisher 3 n (%)	Fisher 4 n (%)	Total HH n (%)
HH0	16 (100)	0 (0)	0 (0)	0 (0)	16 (10.7)
HH1	9 (13.2)	22 (32.3)	35 (51.5)	2 (2.9)	68 (45.6)
HH2	6 (18.2)	10 (30.3)	10 (30.3)	7 (21.2)	33 (22.1)
HH3	0 (0)	3 (11.5)	17 (65.4)	6 (23)	26 (17.4)
HH4	0 (0)	2 (33.3)	3 (50)	1 (16.7)	6 (4)
HH5	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total Fisher	31 (20.8)	37 (24.8)	65 (43.6)	16 (10.7)	149 (100)

HH: Hunt-Hess Scale.

The mean time between clinical presentations and surgery was 23 ± 17.4 days (ranging from 0 to 127days). Length of stay in the hospital after surgery was 20.4 ± 15.8 days (ranging from 3 to 80 days). Occurrence of poor grade (HH ≥ 3) in the pre-surgical evaluation was associated to a higher length of hospital stay (25.37 ± 17.93 *versus* 19.11 ± 14.99, p = 0.047). The mean stay in intensive unity care unit was 2.2 ± 3.5 days (range from 1 to 33 days).

We have not found in this series a cut point age to predict poor prognosis. Although when the cut point was 40 year-old, we observed a trend toward poor prognosis to the older group (p = 0.072 when equal variances assumed and p = 0.041 when equal variances not assumed).

The Glasgow Outcome Scale scores at hospital discharge were: GOS1 (death) 18 (12%); GOS2, 3 (2%); GO3, 9 (6%); GOS4, 19 (12.7%); GOS5, 100 (67.1%). Good outcome was achieved in 119 patients (79.8%). Correlation between HH and GOS as well as FS and GOS are demonstrated in tables 3 and 4, respectively. The comparison between the outcome of patients with good (HH < 3) and poor clinical presentation (HH ≥ 3) before surgery, demonstrate that the first group is associated with a better prognosis after surgery (GOS 4.54 ± 1.05 versus GOS 2.96 ± 1.65, p < 0.000). Patients who presented with Fisher Scale grade 4 in the CT evaluation presented a poor prognosis when compared to the other groups (GOS 4.3 ± 1.32 versus GOS 3.43 ± 1.5, p = 0.016).

Table 3
Hunt-Hess score versus Outcome

Clinical presentation	Death GOS 1 n (%)	Bad Outcome GOS 2-3 n (%)	Good Outcome GOS 4-5 n (%)	Total HH n (%)
HH 0	0 (0)	1 (6.2)	15 (93.8)	16 (10.7)
HH 1	4 (5,9)	2 (3)	62 (91.1)	68 (45.6)
HH 2	3 (9.1)	3 (9.1)	27 (81.8)	33 (22.1)
HH 3	7 (26.9)	4 (15.4)	15 (57.7)	26 (17.4)
HH 4	4 (66.6)	2 (33.3)	0 (0)	6 (4)
HH 5	0 (0)	0 (0)	0 (0)	0 (0)
Total Outcome	18 (12.1)	12 (8)	119 (79.8)	149 (100)

HH: Hunt-Hess Scale score; GOS: Glasgow Outcome Scale.

Table 4
Fisher grade versus Outcome

CT presentation	Death GOS 1 n (%)	Bad Outcome GOS 2-3 n (%)	Good Outcome GOS 4-5 n (%)	Total Fisher n (%)
Fisher 1	2 (6.4)	3 (9.7)	26 (83.9)	31 (20.8)
Fisher 2	3 (8.1)	2 (5.4)	32 (86.5)	37 (24.8)
Fisher 3	10 (15.4)	3 (4.6)	52 (80)	65 (43.6)
Fisher 4	3 (18.8)	4 (25)	9 (56.2)	16 (10.7)
Total Outcome	18 (12.1)	12 (8)	119 (79.8)	149 (100)

GOS: Glasgow Outcome Scale.

Discussion

Since the second half of the 1990s, the endovascular treatment of intracranial aneurysm has been increasing.[9] The International Subarachnoid Aneurysm Trial (ISAT) transformed the history of vascular neurosurgery, comparing the results of clipping versus coiling

for the treatment of ruptured intracranial aneurysm.[7] ISAT analyzed a total of 2143 patients with ruptured intracranial aneurysms which were randomly assigned to clipping (n = 1070) or coiling (n = 1073). At one year, the outcome was assessed by a modified Rankin score. A significant difference was found between the groups and the trial was abandoned: 22.7% of coiled patients were dependent or dead compared with 30.6% of those subjected to surgery. The risk of re-bleeding observed after coiling was 0.16% (2 cases per 1276 patient years) and zero for clipping.[7]

More advantages have been associated with coiling, such as shorter hospital stay, avoidance of open surgical manipulation of the brain, and reduction of the incidence of postoperative seizures.[7,9]

Although the great importance of the ISAT, many points related to this study deserve special analysis:[9,11] first, only a minority of the patients admitted to the centers participating in the trial were eventually randomized; secondly, they state quite correctly that clipping provides a permanent cure for the overwhelming majority of treated patients, in contrast, complete occlusion by coiling is achieved in only about 70% of aneurysms and it is known that even fully coiled aneurysms may reform and bleed. Third, while a high proportion of the coiling may have been carried out by radiologists who were very experienced in this field the same may not have been true of the surgeons concerned who may have had a greater mix of ability. Heros[5] points out that even in the best hands only about 60% of aneurysms can be fully coiled at the first attempt; the proportion being somewhat greater in small aneurysms with narrow necks. Furthermore, recanalization of completely coiled aneurysms occurs in between 2% and 37% of aneurysms and the risk of this is greatest in the larger aneurysms.[5]

It is in this period of large and disseminated use of endovascular therapy that we have decided to review the results of the clipping for treatment of intracranial aneurysms in our center.

Because of Public Health System limitations, we have several obstacles concerning the endovascular treatment. Although we have a treatment protocol of: treat surgically patients with good HH grade and give preference to endovascular treatment to patients with poor grade without hematoma or hydrocephaly, it is extremely difficult to follow it in all cases.

There is great variability in the literature studies about aneurysm surgery, mainly about the clinical presentation of the patient at the time of surgery, the interval between the ictus and the operation and the criteria used to analyze signs and symptoms presented at the ictus and outcomes.[2,7,9,10,13]

We observed an overall mortality of 12.1%, poor outcome of 8% and good outcome of 79.8%. When analyzed just patients with good grade before surgery, we observed a mortality of 6%, bad outcome of 5.1% and good outcome of 88.9%. Other papers previously published in the literature, demonstrate operative mortality varying from 3% to 36%; excellent to good outcome varying from 63.6% to 94.7%; and poor outcome or death varying from 5.3% to 44.2%.[2,7,9,10,13] The low mortality and morbidity rates presented probably are, in some degree, related to the development of the endovascular treatment, once more adequate selection of patients for clipping is now feasible.

The timing of aneurysm surgery after SAH is a major neurosurgical controversy and there is still lack of evidence on the optimal timing of surgical intervention. There is a trend to proceed with definitive aneurysmal surgery as soon as logistically possible, at least in patients with good clinical presentation.[10] However, there are no definitive data to support a universal policy of either early or late surgery.[10] The majority of our patients were submitted to late surgery (mean, 23 days), mainly because of referral patterns and crowded hospital, which resulted in the fact that majority of patients were admitted to our service several days after bleeding, making surgical treatment in the acute phase an extremely hard task.

According to Maurice-Williams,[11] the technology of surgery did not have any great advance since the introduction of the operating microscope into aneurysm surgery in the late 1970s and early 1980s. On the other hand, the endovascular techniques is improving and evolving all the time, and the interventional radiologists gaining more experience. His opinion is that it is a delusion to believe that there will still be a role for vascular neurosurgeons treating aneurysms that are not amenable to endovascular treatment or where the latter has failed.

However, the development of the intra-operative monitoring techniques, the endoscopic assistance, the use of angiogram intra-operatively and the improvement of the surgical instruments used for the surgical treatment of aneurysms demonstrate, not only that the approach for the clipping of intracranial aneurysm is still improving, but that they also represent a useful, safe, reliable option for the treatment of those lesions. This technique must, therefore, not be replaced by the endovascular technique, but represent an option for the treatment of specific sizes and sites aneurysms that can not be adequately treated by the coiling.

Conclusion

Comparing to the literature data from worldwide neurosurgery centers, we present extremely satisfactory

results, in many aspects similar to well known centers of developed countries. We attribute these good results to: first, to the majority of very late surgery, when patients have already survived the acute stages of SAH and its complications such as the re-bleeding in the early period of SAH and the morbidity related to vasospasm. Also in this situation, the effects of acute hemorrhage had decreased, thus making the surgery easier to perform; second, the high prevalence of patients operated with good admission grade (HH < 3), corresponding to 78.5% of patients; third, surgeries performed by the same neurosurgical team, without the influence of the initial learning curve.

The optimal management of both ruptured and unruptured intracranial aneurysms has not been fully determined. The endovascular treatment showed great advances in the last years with some studies demonstrating the efficacy and security of this method, such as done by ISAT, revolutionized the aneurysm treatment. However, excellent results are achieved with the use of the surgical approach for those lesions and, therefore, it should be, in our opinion, the first line of treatment for anterior and middle fossa aneurysms in patients with good clinical status. The endovascular technique would, then, be used for posterior fossa aneurysms and for the treatment of patients with no clinical conditions for the surgical approach.

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