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ENDOVASCULAR TREATMENT OF CEREBRAL ANEURYSMS

A retrospective study of 163 embolized aneurysms

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ABSTRACT - *Objective:* To present the results of cerebral aneurysms treated by endovascular technique. *Method:* Retrospective analysis of patient files of Hospital Geral de Fortaleza, Brazil. *Results:* We report the results of 163 cerebral aneurysms treated by endovascular techniques from January 2002 to October 2005. Patients with ruptured aneurysms (87.2%), according to Hunt-Hess scale were: 33.7% HH I, 28.4% HH II, 24.1% HH III, 13.8% HH IV. The Fisher scale grade IV was the most common (39.7%). Remodeling, coil embolization, arterial occlusion and histoacryl embolization were the techniques employed. Effective occlusion was achieved in 87.7%, partial occlusion in 5.3% and non-effective occlusion in 7.0% of the patients. Glasgow outcome scale results were: 76.3% GOS 5, 5.0% GOS 4, 5.8% GOS 3, 1.4% GOS 2 and 11.5% GOS 1. *Conclusion:* Endovascular treatment seems to be feasible within Brazilian public health system, with results as good as those obtained in larger international centers.

KEY WORDS: intracranial aneurysm, endovascular treatment, coils.

Tratamento endovascular de aneurismas cerebrais: estudo de 163 aneurismas embolizados

RESUMO - *Objetivo:* Apresentar os resultados de aneurismas tratados pela técnica endovascular. *Método:* Análise retrospectiva de prontuários do Hospital Geral de Fortaleza, Brasil. *Resultados:* Apresentamos os resultados de 163 aneurismas cerebrais tratados por técnicas endovasculares de Janeiro de 2002 a Outubro de 2005. Os pacientes com aneurismas rotos (87,2%) eram, segundo a escala de Hunt-Hess: 33,7% HH1; 28.4% HH II, 24.1% HH III, 13.8% HH IV. O Grau IV da escala de Fisher foi o mais comum (39,7%). Empregaram-se as técnicas de *remodeling,* espiras metálicas, oclusão arterial e embolização com *histoacryl.* Foi obtida oclusão efetiva em 87,7%, oclusão parcial em 5,3% e oclusão não-efetiva em 7,0% dos casos. De acordo com a Glasgow outcome scale, os resultados foram: 76,3% GOS 5, 5,0% GOS 4, 5,8% GOS 3, 1,4% GOS 2 e 11,5% GOS 1. *Conclusão:* A aplicação de técnica endovasculares mostra-se viável na rede pública brasileira, com resultados comparáveis aos de grandes centros mundiais.

PALAVRAS-CHAVE: aneurisma intracraniano, tratamento endovascular, *coil.*

The advances of the endovascular techniques observed in the past two decades has made this surgical alternative, previously recommended only for aneurysms with no indication to be treated by conventional surgical technique (clipping), into a first choice approach for a large number of cerebral aneurysms in some services[1-3]. One of the main advances in these techniques was the advent of detachable platinum coils termed Guglielmi detachable coils (GDC). The development of coils with a better capacity to conform to aneurysms, quicker and safer detachable mechanisms and the use of bioactive materials in addition to coils are responsible for the higher rate currently obtained in aneurysm occlusion[4]. The development of the remodeling techniques, the use of intracranial stents and of liquid embolic ma-

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terial such as N-butyl-methacrylate and ethylene vinyl alcohol (EVOH) are other important factors for the improvement of clinical results of the endovascular approach[5].

The results of the International Subarachnoid Aneurysm Trial (ISAT)[6] demonstrate the great potential of the endovascular technique in important aspects such as: small rate of complications, reduced number of deaths and patients with mild to moderate sequelae one year after the procedure.

The current retrospective study aims at presenting the results of 163 cerebral aneurysms treated by the endovascular technique at the Endovascular Neurosurgery Department of the Hospital Geral de Fortaleza, Brazil.

METHOD

This retrospective study comprised the evaluation of all patients who underwent endovascular techniques for the treatment of cerebral aneurysms from January 2002 to October 2005 at the Endovascular Neurosurgery Department of Hospital Geral de Fortaleza, Brazil. The authors reviewed the files in order to collect clinical and surgical data namely description of procedures and outcomes. This study was approved by the Ethics Committee of the Hospital.

Sacular, mycotic, traumatic and fusiform, ruptured and unruptured aneurysms were included. All patients were treated by a medical team using identical procedures.

Clinical status of the patients was graded by the physicians using the Hunt-Hess (HH) scale[7] whereas computed tomographic exams were classified by the Fisher scale[8]. Digital subtraction angiographies were performed with the aim of studying cerebral circulation previous to treatment. After embolization, the patients were submitted to control angiography to determine the results of the procedure. The Glasgow outcome scale[9] was used to evaluate the recovery of the patients 3 months after treatment. Patients' follow-up varied between 3 months and 4 years.

The result of the endovascular surgery was estimated by post-embolization angiography and classified as effective occlusion (≥95%), partial occlusion (≥90 and <95%) or non-effective occlusion (<90%).

Descriptive statistics were used for the analysis of the collected data. Sample size calculation was not performed since this was a descriptive study in which were included all the patients defined by the above criteria.

RESULTS

A hundred and fifty two patients were submitted to 171 endovascular procedures for the treatment of 163 aneurysms during the studied 4 year period at Hospital Geral de Fortaleza. About 80% of the treated patients were female with a mean age of 53.3 years, ranging from 9 to 90 years. Of these patients, 37 (24.3%) had multiple aneurysms (not all of them were treated at our service), 10 (6.6%) had more than one embolized aneurysm and 9 (5.9%) were submitted to more than one procedure.

Table. Origin of aneurysms.

	No. of aneurysms	%
Anterior communicating artery	33	20.2%
Ophthalmic artery	33	20.2%
Posterior communicating artery	32	19.6%
Internal carotid artery	15	9.2%
Middle cerebral artery	13	8.0%
Top of basilar artery	7	4.3%
Pericallosal artery	6	3.7%
Hypophysial artery	5	3.1%
Posterior inferior cerebellar artery	3	1.8%
Carotid artery bifurcation	2	1.2%
Anterior choroidal artery	2	1.2%
Vertebral artery	2	1.2%
Superior cerebellar artery	2	1.2%
Anterior cerebral artery	2	1.2%
Basilar artery	2	1.2%
Posterior cerebral artery	1	0.6%
Anterior inferior cerebellar artery	1	0.6%
Primitive trigeminal artery	1	0.6%
Angular artery	1	0.6%
Total	163	100.0%

Out of the total of patients, 12.8% had had no hemorrhage, corresponding to incidental aneurysms or to those with compressive symptoms. From those who bleeded, 33.7% had Hunt-Hess grade I, 28.4% had grade II, 24.1% had grade III and 13.8% had grade IV. Regarding Fisher scale 16.4% were classified as grade I, 14.2% as grade II, 29.7% as grade III and 39.7% as grade IV.

Anterior and posterior circulation aneurysms corresponded to 89.0% and 11.0% of the cases, respectively. The most prevalent aneurysms were those arising from the anterior communicating and the ophthalmic arteries (20.2% each) (Table). Aneurysms size varied from 1 to 30 mm. In general, 47.8% measured between 0-7 mm, 47.2% between 8-25 mm and 5.0% were giant (larger than 25 mm).

GDC embolization was the most frequently used endovascular treatment (69.0%), where Matrix® coils were used in 70.0% of the cases. The remodeling technique was the second most frequent (17.0%). The average number of coils used was of 5, ranging from 1 to 12.

After the treatment, effective occlusion of the aneurysms was achieved in 87.7% of the cases, par-

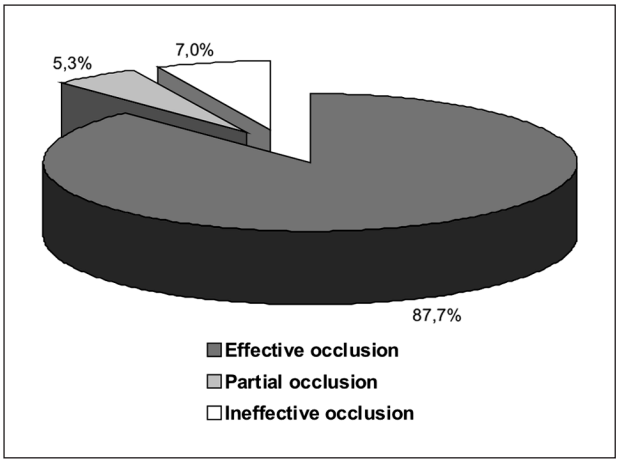

Fig 1. Treatment outcome.

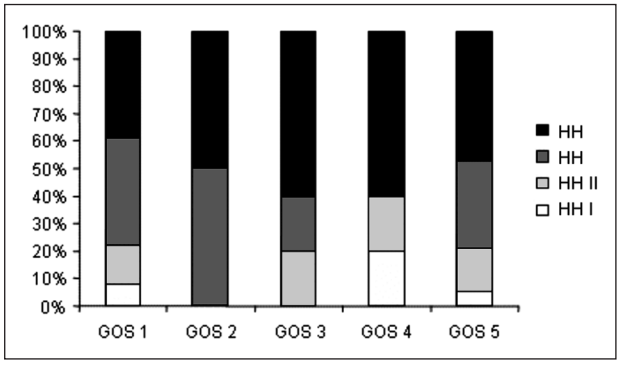

Fig 2. Association between Hunt-Hess (HH) grade and Glasgow Outcome Scale (GOS) score.

tial occlusion in 5.3% and non-effective occlusion in 7.0% (Fig 1). According to the Glasgow outcome scale, 76.3% of all the patients had a GOS score of 5, 5.0% had a GOS score of 4, 5.8% had GOS 3, 1.4% had GOS 2 and 11.5% had GOS 1.

Control angiography was possible in 76 of the 152 patients, which showed 8 cases of recanalization (10.5%), of which 4 were successfully reembolized and 4 did not need treatment. There were no reported cases of re-haemorrhage in our data.

Concerning procedure complications, the occurrence of 5 arterial occlusions and 6 hemorrhages was reported. Of the total of patients, 3 (2.0%) died due to complications associated with aneurysm perforation during treatment.

The association between the Glasgow outcome scale and the clinical status of the patients with ruptured aneurysms, evaluated by the Hunt and Hess scale, is schematically shown in Figure 2. Patients with unruptured aneurysms showed good medical outcome (GOS 4 and GOS 5) in 94.1% of the cases.

DISCUSSION

The endovascular treatment for intracranial aneurysms was first described in the early 70s by the Russian neurosurgeon Fedor Serbinenko, who used a vascular catheter with a detachable latex balloon, either by placing the balloon directly into the aneu-

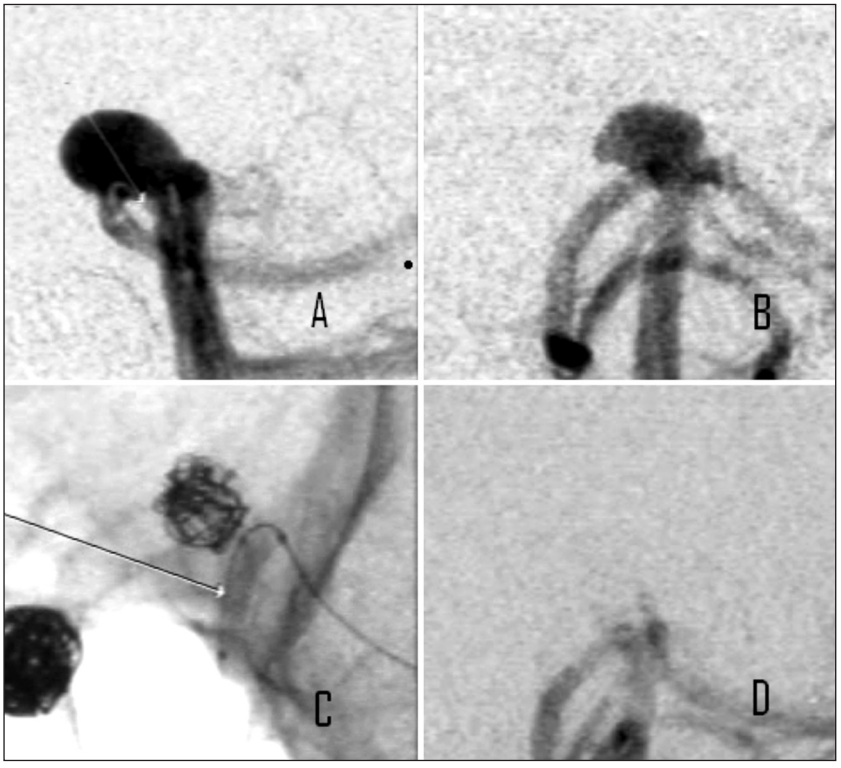

Fig 3. Aneurysm at the top of basilar artery (A) angiography view previous to embolization; (B) anterior-posterior view previous to embolization; (C) balloon-assisted coil embolization; (D) final control after embolization.

rysm lumen or by occluding the artery from which the aneurysm arose[10,11].

In 1991, Guido Guglielmi was the first to describe the aneurysm occlusion technique by endovascular approach with detachable platinum coils by electrolysis, known as Guglielmi detachable coils[12,13]. The GDCs are directly introduced in the aneurysm lumen through a microcatheter and detached from the microguidewire by electric current. Therefore, the aneurysm is filled with one or more GDCs, excluding it from circulation.

The Endovascular Neurosurgery Department from Hospital Geral de Fortaleza receives monthly over 100 patients for diagnostic study and endovascular treatment. We follow patients with cerebral aneurysms, cerebral and medullar arteriovenous malformations, dural fistulas and cranial tumors to be embolized, besides performing interventionist treatment for patients with diseases of the vertebral column.

In the present study, by observing the features of the patients and of the aneurysms, important findings should be highlighted. The mean age of the patients is 53.3 years, which corresponds to the values seen in other hospitals, that range between 40-60 years[14-16]. The majority of the patients were female (80.1%). The higher rate of cases in females found in our study is consistent with the usual feature of the sacular aneurysms, which are more usual in women, presenting a female:male ratio of 5:1 in the literature[16].

A Hunt-Hess scale grade of I to III was present in 86.2% of the patients. Satisfactory results were also observed in other studies on aneurysm endovascular treatment, where Hunt-Hess scale grade I to III occurred in about 58-80% of the cases[17].

The aneurysm size and the presence of multiple aneurysms were also similar to literature descriptions, with 24.3% of the cases having multiple aneurysms, whereas other authors describe estimates which range from 20-24%[16].

The most frequent locations of the aneurysms treated in our service were carotid- ophthalmic artery and anterior communicating artery, each representing 20.2% of the total. This number is somewhat different from results presented in other works, where median cerebral and posterior communicating artery aneurysms are the most usual[18,19]. We believe that this difference occurs due to the proximity between the two departments of the Neurosurgery Service of the Hospital Geral de Fortaleza that work with cerebral vascular pathologies - the Vascular Neurosurgery and the Endovascular Neurosurgery - since neurosurgeons refer the cases of aneurysms with a difficult surgery approach to be treated by the endovascular technique.

The endovascular techniques used were detachable coils embolization, arterial occlusion, remodeling (by using balloon and coil or stent and coil) and histoacryl application (Figure 3). Isolated GDC embolization was the most common treatment (69% of all the procedures) being used in proximal small-necked aneurysms. The remodeling technique, where an inflatable balloon or intracranial stent for coil support is used in such a way that it remains stable within the aneurysmatic bag, was used in 17.0%, mainly in cases of wide-necked aneurysms. Arterial occlusion was used in 23 procedures. The main indications were: large (>10 mm) and giant (>25 mm) aneurysms of wide neck. Histoacryl was used in one mycotic aneurysm of the angular artery.

In the literature, rates of ≥90% occlusion using the endovascular technique vary from 82.8% to 97.7%[17], while total occlusion rates (100%) may vary from 40 to 66.0%[20-22]. In our study, the rate of effective and partial occlusion (≥90%) was 93.0%, whereas total occlusion rate was about 59.8%. Another method currently in use for treatment assessment is the classification in total occlusion, persistent neck or subtotal occlusion and incomplete occlusion[23]. This assessment definition was used by the International Subarachnoid Aneurysm Trial[22], with the following results: 66.0% of complete occlusion, 26.0% of subtotal occlusion and 8.0% of incomplete occlusion.

The main complications related to the procedures are hemorrhagic lesions and ischemic complications. In literature, complication rates related to the procedure vary between 6.0% and 14.4%[24]. Our results show a complication rate of 7.3%. Three out of six hemorrhagic complications observed in our service were secondary to artery perforation. Ischemic complications related to migration of coils and to thromboembolism occurred in 5 cases (3.3%). Hemorrhagic complications are within the values described in other publications, but the ischemic complication rate seems to be below that described in other studies (6.7-13.4%)[17].

Two deaths were related to hemorrhage due to artery perforation. One patient with an aneurysm located at the middle cerebral artery died during hospitalization in Intensive Care Unit due to coil migration and hemorrhage. The other deaths reported after treatment (all in patients with ruptured aneu-

rysms) were not directly related to the procedure. In our case, mortality (8.1%; n=16) within patients with ruptured aneurysms during the studied period was inversely proportional to the grade of the Hunt-Hess scale. This mortality seems to be close to that found is some previous studies, which show values of 9.0% to 19.0%[23,24]. No deaths occurred in patients treated for unruptured aneurysms.

Medical follow-up of the treated patients showed that 81.3% had a good recovering after treatment (GOS 4 and 5). In the group of patients with hemorrhage, there was a considerable association between patient recovery and the Hunt-Hess scale grade, as shown in Figure 2. In the cases where subaracnoid hemorrhage did not occur, all patients showed a good medical outcome, with minimal disabilities after surgery.

Recanalization rates and re-bleeding are the main problems with endovascular techniques. Recanalization rate is variable in literature, ranging from 14.0% to up to 37.0% of the cases[24-26]. Recanalization is associated to some factors, namely: a) aneurysm characteristics, like size, neck and location; b) primary vessel characteristics, like size, blood flux and presence of vasospasm and c) embolization material, like density and shape[23].

It was possible to perform angiographic follow up in 76 of the 151 treated patients within six months after surgical procedure. Among these, recanalization was observed in 8 cases (10.5%), with re-embolization in 4 cases whereas the remaining did not need treatment until the last exam. The retrospective nature of this study as well as our high rate of loss to follow up may partially account for such low recanalization rate.

In conclusion, the wide variety of materials available nowadays for the treatment of cerebral aneurysms using endovascular techniques and the ongoing advances render this method increasingly safe and effective in the approach of this disease which shows high rate of morbid mortality. The development of new materials and neurosurgical techniques will surely provide even better results, mainly for those patients that seem to be unfavorable clinical cases at the initial treatment phase. With this study, we conclude that endovascular treatment of cerebral aneurysms can currently be performed in a public hospital, with acceptable results and in accordance with those from larger worldwide hospitals.

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