Management of multiple aneurysms. Experience in a Hospital of Specialties

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Abstract

Objective: To establish the frequency and results in patients carriers with multiple aneurysms (MA) treated by microsurgery and/or neurological endovascular therapy (NET) in the Hospital of Specialties on The National Medical Center La Raza.

Methods: It is an ambispective, descriptive and longitudinal study that includes patients carriers of MA treated in the National Medical Center La Raza from March the 1st of 2009 to April the 30th of 2014. **Results:** 62 patients carriers of 151 aneurysms were treated. According to the type of treatment, 30 patients (49%) were included in the surgical group (GQ), 25 (40%) in the endovascular group (GE) and 7 (11%) in the combined group (GC). The number of aneurysms was distributed this way: 69 (46%) in the GQ, 61 (40%) in the GE and 21 (14%) in the GC. At GQ, it was not possible to exclude all their aneurysms on 21% of the patients, while it was feasible in only 27%. In all GE patients (40%) the exclusion of all aneurysms was achieved. The GC, meaning surgical cases that were not completed by NET, formed 11% of the cases. At GQ there was a rate of 6% of complications, meanwhile at GE it was 0.5%.

KEY WORDS: Multiple brain aneurysms. Neurological Endovascular Therapy. Microsurgery.

Introduction

Between 1 and 5% of the world population may experience an intracranial aneurysm^{1,2}, the rupture incidence of which is around 10 per 100,000 population^{3,4}. The annual incidence of rupture in patients with already known aneurysms ranges from 1.4 to 2.3%⁵. Of total diagnosed cases, 25 to 30% can experience multiple aneurysmal brain disease.

The treatment of multiple intracranial aneurysms has been one of the big challenges for neurosurgery in the present century, and it has always been linked

to the development of technology, both for diagnosis and management.

The treatment of intracranial aneurysms can be determined from an endovascular or surgical perspective, or both. Surgery reached its peak evolution with the introduction of microsurgical techniques and turned into "real art" and a sort of new discipline in the management of vascular pathology. Interventional neuroradiology has shown a marked development over the past few decades, evolving from a minimally invasive alternative to craniotomy and clipping, reserved for poor evolution and prognosis cases, turning into a first-choice procedure in many cases and

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Figure 1. A: aneurysms of left internal carotid artery clinoid segment, pericallosal artery and middle cerebral artery (arrows), which underwent embolization with coils in a single procedure. B: digital subtraction angiography where absence of aneurysms can be appreciated. C: coil mesh (arrows).

many specialized centers of the world, owing to its good results and low morbidity and mortality⁶⁻⁹. In spite of all advances, the management of multiple aneurysms continues to present certain complexity, which implies an increase in morbidity and mortality and elevated cost.

The purpose of this work was, by means of statistical evaluation, to establish the effects of the endovascular technique, the degree of occlusion and its short-term outcome, in addition to complications, with the purpose to provide information and stimulate a critical analysis of current practice in the treatment of multiple aneurysms in our hospital, using the surgical or endovascular route, or both.

Method

This was an ambispective study that included patients with multiple aneurysms treated in the neurosurgery department of the Specialty Hospital of La Raza National Medical Center. Patient medical and imaging records were reviewed between March 2009 and April 2012 for the retrospective part, and from May 2012 to April 2014 for the prospective part.

Patient (age, gender), aneurysm (number, localization, rupture or not) and treatment (number of treated aneurysms and type of procedure) variables were recorded. For the assessment of the latter variables, patients were divided according to their management and, hence, three groups were defined (Figs. 1 to 6): patients treated with microsurgery (SG), patients treated with neuroendovascular therapy (NET) (EG) (Figs. 1 to 3 and 5), and patients with combined treatment, i.e., treated with both techniques (CG) (Figs. 4 and 6). Surgical management comprised craniotomy and microsurgery for: a) clipping, b) lining or c) trapping. Endovascular techniques^{10,11} comprised: a) simple embolization with coils (Figs. 1 and 2), stent-assisted

embolization with coils (Fig. 3), c) balloon-assisted embolization with coils, or d) use of flow diverter (Fig. 5). Treatment variables were: aneurysm occlusion, number of aneurysms treated per procedure, complications and procedure-inherent mortality.

Results

During the study period, 750 patients with intracranial aneurysms were admitted to our department, out of which 700 were intervened with the surgical or endovascular approach, or with both. From all of them, we included in our study 62 (9%) carriers of 151 aneurysms. Patient mean age was 57 years, with a range of 16 to 85 years. The female gender was predominant, with 52 cases (84%), whereas males were 10 (16%).

As previously mentioned, there was a total of 151 recorded aneurysms, which were distributed as follows: 42 patients (68%) were carriers of 2 aneurysms, 15 patients (24%) had 3 aneurysms, 3 patients (3%) had 4 aneurysms and 2 patients (3%) had 5 aneurysms each.

As for aneurysms' localization, internal carotid artery was widely predominant, with 85 aneurysms (56%), followed by the cerebral middle artery with 32 (21%). The distribution by localization is shown in table 1.

The first clinical presentation was with subarachnoid hemorrhage (SAH) in 44 cases (71%), whereas in 18 patients (29%) the discovery was incidental. In those patients with ruptured aneurysm, the Hunt & Kosnik scale was used for clinical assessment,¹² as well as the Fisher scale for CT imaging evaluation¹³. According to the Hunt & Kosnik scale, most patients presented with grade 3 and 1, with 16 (36%) and 14 (32%) cases, respectively, while at grades 2 and 1a there were 8 (18%) and 6 (14%) cases, respectively.

Figure 2. A: female patient carrier of 4 aneurysms at the right cerebral middle artery and anterior communicating artery bifurcation (arrows). B: aneurysms at the left internal carotid artery clinoid and communicating segments (arrows). C: embolization with coils in two times, first the right ones (arrows). D: left internal carotid artery embolized aneurysms are observed, as well as those at the right cerebral middle artery and anterior communicating artery (arrows).

Figure 3. Two right internal carotid artery paraclinoid aneurysms (arrows). Simple coil embolization was attempted, but the aneurysm neck prevented keeping them within the aneurysmal sac, and a stent was therefore placed (discontinuous arrows in A and B). The aneurysms were immediately embolized in a single procedure, first the one at the pituitary (arrow in B) and then the ophthalmic one (arrows in C and D).

According to Fisher's scale, the vast majority was at grades 3 and 4, with 16 (36%) and 27 (61%) patients, respectively.

Overall, there were 22 patients who only underwent one surgical event by means of clipping, other 7 underwent two surgeries, 22 underwent a single embolization event, 3 underwent a total of two embolizations, 5 underwent one surgical and one endovascular therapy event, one patient underwent one surgery by clipping and in two, ENT was practiced.

According to the type of treatment, of total patients, we assigned 30 (49%) to the SG, 25 (40%) to the EG, and 7 (11%), to the CG. The number of aneurysm was distributed as follows: 69 (46%) in the SG, 61 (40%) in the EG and 21 (14%) in the CG (Table 2).

Total segregation from circulation was achieved in 138 aneurysms (91%). We observed that, only in the SG, 13 aneurysms (18%) could not be segregated in 13 patients after their first surgical event, owing to patient clinical deterioration or mortality due to any complication, inherent or not to the procedure, or for not attending for the performance of a new procedure (Table 2). Thus, in the EG and CG, all aneurysms could be treated.

The number of procedures needed for the segregation of all aneurysms at each group was recorded; therefore, all 13 patients with incomplete management

were not included in this account. We found that, for the SG, one surgical time was required in 10 patients (16%), and two times in 7 patients (11%). In the EG,

Figure 4. Patient with Fisher's scale grade IV subarachnoid hemorrhage (plain tomography in **A**). Angiography with digital subtraction demonstrated two aneurysms, a large ruptured one at the left internal carotid ophthalmic segment (arrow in **B**), which was clipped (image of two clips indicated by two discontinuous arrows in **C**), and another at the basilar artery apex (arrow in **C**). The latter was embolized with stent-assisted coils (arrow in **D**).

only one time was required in most cases, with 35% (22 cases), whereas in 3 patients, two times were required. In the CG, one surgical time and one endovascular time was required in 5 cases (8%), two surgical times and one endovascular time in one patient (2%), and one surgical time and two endovascular times in one case (2%) (Table 3).

Including only patients without SAH, mean hospital length of stay for the SG was 4 postoperative days, whereas for the EG it was 24 hours.

The distribution of complications inherent to the procedures showed that in the SG there were 6 cases (4%) and in the EG there was one case (0.5%), while in the CG, no complications occurred. The type of complications is shown in table 4.

Discussion

The frequency of multiple aneurysms in our hospital was 9%, which is lower than that described in other authors' case series, which ranges from 15 to 31%¹⁴. As in other series, the female gender is broadly predominant.

Aneurysmal sacs' localization is variable. They use to be located in the carotid artery at its supraclinoid portion and branches, with one case associated with the basilar artery occurring in this series, which makes

Figure 5. Patient with subarachnoid hemorrhage due to the rupture of a large aneurysm of the right internal carotid ophthalmic segment (arrow in **A**), who also had another aneurysm at the left internal carotid clinoid segment (arrow in **B**). The ruptured aneurysm was initially treated with stent-assisted coil embolization (arrow in **C**). The left side aneurysm was treated by placing a flow-diverter stent (arrow in **D**). Left carotid axis control at 3 months shows the absence of aneurysm.

Figure 6. Patient with two aneurysms, one at the left middle cerebral artery bifurcation (arrow in **A**) and another in a fenestration of the basilar artery proximal third (arrow in **B**). The middle cerebral artery aneurysm was clipped (arrow in **C**), and the basilar aneurysm was embolized with coils (arrow in **D**).

it different from other works, where this location was not described. Forty percent of aneurysms usually occur in a bilateral, symmetric form.

Most patients admitted to our department do it with SAH, which is no different in multiple aneurysm cases, with 71% of cases herein reported.

Our tendency, as described in the literature, is to treat all aneurysms, especially in patients who manifest them with SAH, since this condition increases the risk of incidental aneurysm rupture and, in addition, each hemorrhage increases the risk of poor evolution¹⁵.

The treatment decision goes in favor of patient clinical grade at admission; those at Hunt and Kosnik scale grade 4 are excluded from management. As previously described, first intervening aneurysms showing clinical and imaging data suggestive of rupture is decided, but this can slightly vary in surgical cases where there are two or more aneurysms at the same carotid axis, in this case deciding to first clip the most distal aneurysm with the purpose to prevent surgical field limitations by possible clips placed at more proximal segments. In the cases without rupture, the decision about the order of treatment is given by aneurysm size, localization and morphology. For example, large, irregular or multilobulated aneurysms have priority, as well as those of the posterior circulation¹⁶.

In our hospital, the trend between surgery or NET is currently 50%, approximately. Undoubtedly,

posterior circulation and large/giant aneurysms, as well as those with broad neck, have endovascular priority. In some occasions, the decision on the type of management depends on operating and endovascular rooms' ready availability.

In this study, the 50% trend was observed to persist in patients who were carriers of multiple aneurysms; however, the result shows that this tendency should be modified, as we'll see later. In the SG, only in 16% of patients could all aneurysms be treated with a single procedure, while in 21%, treatment was incomplete. In the EG, all patients were fully treated, and among them, barely 5% required two therapeutic events. In addition, it should be noted that the CG, which were 12% of the cases, was actually comprised by patients who were initially treated with microsurgery. Therefore, if patients who were discharged without all their aneurysms being fully treated and the CG are added, we find that there are 33% of cases where complete treatment could not be accomplished with microsurgery.

As regards complications inherent to the procedure, the SG had 4% thereof, resulting in 1% of mortality, whereas in the EG there was 0.5% of morbidity, with no mortality being recorded. Evidently, our SG had higher morbidity and mortality than our EG, since there was a total of 45 surgical events. For Yasargil¹⁷, postsurgical results were the same if the patient had one or more aneurysms. However, this author's figures depended on SAH status, patient selection for surgery and surgical skills¹⁷. In addition, we should consider that in patients with SAH who are at Hunt and Hess 2 and 3 grades, the cerebral arteries are highly sensitive to manipulation¹⁸. Failure to clip all aneurysms in a single surgical intervention is multifactorial, and the surgeon's experience is beyond any doubt relevant, although temporary clipping is also an important factor, which is usually safe under stable surgical conditions, but in the context of aneurysm intraoperative rupture, the risk of poor evolution is significantly increased since the beginning of surgery. This confirms once more the inconvenience for surgery to be continued in conditions as adverse as the attempt to clip all aneurysms in a single operation¹⁹. Maximum exposure with judicious use of skull base techniques, early acquisition of a proximal vessel and distal control of afferent and efferent vessels are key to success.

Factors that predict clipping failure are better known because this treatment modality has been more widely used owing to its accessibility in hospital centers (it

Table 1. Aneurysm localization

No. of patients (total aneurysms): 62 (151)

	Aneurysms	Percentage		Aneurysms	Percentage*
ICA	85	56	Com. s	36	24
			R	16	11
			L	20	13
			Opht. s	22	15
			R	7	5
			L	15	10
			Chor. s	2	1
			R	0	0
			L	2	1
			Pit. s	1	0.50
			R	1	0.50
			L	0	0
			Bif.	15	10
			R	5	3
			L	10	7
			Clinoid	9	6
			R	5	3
			L	4	3
MCA	32	21	RMCA	13	9
			LMCA	19	13
ACA	11	7	A1	2	1
			pericallosal	9	6
ACOA	10	7			
Basilar	4	3	Basilar top	2	1
			Laterobasilar	1	0.50
			Fenestrated	1	0.50
Vertebrobasilar junction	2	2			
Vertebral	3	2	R	2	1.50
			L	1	0.50
PCA	3	2	R	1	0.50
			L	2	1.50
PCOA	1	0.50			

*Percentage with regard to total number of aneurysms in the series.

ACA: anterior cerebral artery; ACOA: anterior communicating artery; Bif.: bifurcation; Chor. S.: choroid segment; Com. S.: communicating segment; ICA: internal carotid artery; L: left; LMCA: left middle cerebral artery; MCA: middle cerebral artery; Opht. S.: ophthalmic segment; PCA: posterior communicating artery; PCOA: posterior communicating artery; Pit. S.: pituitary segment; R: right; RMCA, right middle cerebral artery.

Table 2. Groups and number of aneurysms

Group (no. of cases)	No. of aneurysms
SG (30)	56*
EG (25)	61
CG (7)	21
Total	138

*13 aneurysms could not be treated in the SG; therefore, a total of 138 aneurysms were treated. CG: combined management group; EG: endovascular group; SG: surgical group.

Table 3. Number of procedures per group

Procedures	Patients (%)
SG	
1 time	10 (16)
2 times	7 (11)
3 times	13 (21)
Incomplete	
EG	
1 time	22 (35)
2 times	3 (5)
3 times	
CG	
1 surgery + 1 embolization	5 (8)
2 surgeries + 1 embolization	1 (2)
1 surgery + 2 embolizations	1 (2)
Total	62 (100)

CG: combined management group; EG: endovascular group; SG: surgical group.

Table 4. Complications per group

Group	Patients	Percentage	Complication	Patients (%)
SG	6	4	Cerebral infarction	4 (3)
			Wound dehiscence	1 (0.5)
			Profuse hemorrhage	1 (0.5)
EG	1	0.50	Cerebral infarction	1 (0.5)
CG	0			0

CG: combined management group; EG: endovascular group; SG: surgical group.

remains the most important factor); however, its usefulness considerably varies according to the aneurysm location. Posterior circulation aneurysms are less sensitive than those at anterior circulation, except for basilar apex and posteroinferior cerebellar artery aneurysms; the same difficulties arise along the carotid artery from the petrous to the clinoidal segment. Aneurysms between both these extreme sites require skull base surgical approaches that are highly invasive and considerably increase morbidity, and are even little attractive to patients and to some surgeons²⁰⁻²².

Follow-up studies of NET-treated patients are necessary to document adequate segregation of the lesion from cerebral circulation. There are many factors that have to be considered when deciding to operate a patient with multiple aneurysms, including patient medical

and neurological status, aneurysm location and conformation, and the endovascular technique that is most adequate^{23,24}. The endovascular route of access is more immune to aneurysm location whims, which is why it is especially adequate for those locations where surgical access is limited^{25,26}. In our study, 76% of studied patients were treated with coils, a flow diverter was used in 17% and a stent was used as a technical aid for embolization in 7%. In our hospital, in a 5-year ambispective study, the frequency of multiple aneurysms was observed to be lower than in other series²⁷⁻³¹.

Conclusions

Primary endovascular management of patients with multiple aneurysms resulted in the resolution of all aneurysms in most patients, in addition to being efficacious in the treatment of previously operated patients with microsurgery. Morbidity and mortality was lower in the EG.

Although having a larger number of patients available would be convenient, we can determine that, at least in our institution, NET should be the first choice for the management of multiple aneurysmal disease.

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