Surgical Management of Ruptured Posterior Circulation Aneurysms – A Single Center Experience

Tratamento cirúrgico dos aneurismas rotos da circulação posterior no Centro Hospitalar do Porto

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Abstract

Objective The treatment of ruptured aneurysms of the posterior circulation is a controversy in neurosurgery. The aim of this work is to describe the experience and results of the early surgical treatment of this pathology at Centro Hospitalar do Porto.

Method We retrospectively analyzed the medical records of all patients aged over 18 who, in the period between 1999–2013, were admitted to our center with the diagnosis of ruptured saccular posterior circulation aneurysm. The patients were clinically staged at admission using the Hunt & Hess (H&H) scale. The modified Glasgow Outcome Scale (mGOS) was used to assess the outcome at discharge and after 6 months.

Results Between 1999–2013, 59 patients underwent surgery for ruptured posterior circulation aneurysms. Eighty percent of the patients were female, and their average age was 58.7 years. Posterior-inferior cerebellar artery aneurysms accounted for 49.2% of surgeries, while basilar aneurysms accounted for 28.8%. Upon admission, 86.4% of patients were classified as H&H1–3, and 13.6% as H&H4–5. The outcomes at discharge and at 6 months were as follows: at discharge, mGOS1 in 5.1%, mGOS2–3 in 18.6%, and mGOS4–5 in 76.3%; at 6 months, mGOS1 in 10.2%, mGOS2–3 in 10.2%, and mGOS4–5 in 79.6%. There was a statistically significant correlation between basilar aneurysms and worse outcomes ($p = 0.011$). No correlation was found between the values of the H&H scale upon admission and outcome.

Conclusions The functional outcome of our group of patients is mainly in line with what is described in other series from the literature. However, there is a trend toward lower mortality but higher morbidity rates.

Keywords
- subarachnoid hemorrhage
- brain aneurysms
- posterior circulation aneurysms
- surgical treatment

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Resumo

Objetivo O tratamento dos aneurismas rotos da circulação posterior é uma controvérsia neurocirúrgica. Pretende-se com este trabalho relatar a experiência e os resultados do tratamento cirúrgico precoce desta patologia no Centro Hospitalar do Porto.

Métodos Foram analisados retrospectivamente os processos clínicos dos pacientes com idade $>$ 18 anos que, no período entre 1999–2013, foram admitidos no nosso centro com o diagnóstico de aneurisma sacular roto da circulação posterior. Utilizou-se a escala de Hunt & Hess (H&H) para aferir a gravidade clínica dos pacientes, e a Escala de Outcome de Glagow modificada (mGOS) para aferir o *outcome* dos pacientes à data da alta e aos 6 meses.

Resultados Entre 1999–2013, foram operados 59 pacientes com aneurismas rotos da circulação posterior. Oitenta por centro dos pacientes eram do sexo feminino, com uma média de idade média de 58.7 anos. Aneurismas da artéria cerebelosa posteroinferior foram responsáveis por 49,2% das cirurgias, ao passo que os da artéria basilar, por 28,8%. À admissão, 86,4% dos pacientes eram H&H1–3, e 13,6%, H&H4–5. O *outcome* à data da alta e aos 6 meses foi o seguinte: à data de alta, mGOS1 em 5,1%, mGOS2–3 em 18,6%, e mGOS4–5 em 76,3%; aos 6 meses, mGOS1 em 10,2%, mGOS2–3 em 10,2%, e mGOS4–5 em 79,6%. Verificou-se uma correlação estatisticamente significativa entre aneurismas da basilar e um pior *outcome* ($p = 0{,}011$). Não se verificou qualquer correlação entre os valores da escala de H&H à admissão e o *outcome*.

Conclusões O *outcome* funcional do nosso grupo de pacientes está em linha com o descrito noutras séries da literatura. Contudo, destaca-se uma tendência para uma mortalidade mais baixa, mas uma morbilidade mais alta no nosso grupo de pacientes.

Palavras-chave

- hemorragia subaracnoideia
- aneurismas cerebrais
- aneurismas da circulação posterior
- tratamento cirúrgico

Introduction

Cerebral aneurysms are responsible for $\sim$ 85% of the cases of spontaneous subarachnoid hemorrhage (SAH).[1] Posterior circulation aneurysms account for 10–15% of all ruptured aneurysms, and their most common location is the tip of the basilar artery (BA), followed by the origin of the anterior superior cerebellar artery (ASCA) and the posterior-inferior cerebellar artery (PICA).[2]

The global incidence of spontaneous SAH ranges from 2–23 cases per 100,000 inhabitants/year. In the Portuguese population, the incidence of spontaneous SAH is $\sim$ 9 cases per 100,000 inhabitants.[3] However, this incidence may be slightly higher, since it is estimated that 10–15% of SAHs are fatal *ad initium* and, therefore, those patients do not even reach the healthcare services.

The three most studied risk factors for this entity are: hypertension, smoking and genetic factors.[4]

In developed countries, there has been a progressive decline in the mortality rates of spontaneous SAH: it was $\sim$ 57% in the 1970s, and nowadays it ranges from 26 to 36%. However, morbidity is still significant, and some degree of functional dependence may affect about one-half of the patients who survive.[5]

Several studies show a particular propensity of posterior circulation aneurysms to rupture.[6] Additionally, they also have a worse prognosis and pose increased difficulties and requirements in the surgical technique. Concerning the mortality of this entity, it declined progressively over the last decades, remaining around 5% in the 2000–2010s. Morbidity also declined, and is now around 10%.[7] Until the end of 1980s, all of these patients underwent surgery as the treatment of choice for the aneurysm. This "way of treating" suffered a big paradigm shift with the publication of two seminal papers by Guido Guglielmi in 1990[8,9] showing the possibility and efficacy of the endovascular treatment of intracranial aneurysms. Since then, endovascular therapies have acquired an increasingly important role in the management of these patients.

The two biggest trials designed to compare the efficacy of surgery versus endovascular surgery (the International Subarachnoid Aneurysm Trial [ISAT] and the Barrow Ruptured Aneurysm Trial [BRAT] – although ISAT encompasses essentially anterior circulation aneurysms) stated the superiority of the endovascular surgery in the treatment of this condition. However, the crossover rate with endovascular treatments was significant (in the BRAT, the crossover rate for posterior circulation aneurysms was of 11.6%), showing that surgical treatment is still useful and necessary for some patients.[10,11]

Surgery remains a good treatment option, particularly in young patients ($<$ 50 years), those with aneurysms in the distal anterior inferior cerebellar artery (AICA), PICA, superior cerebellar artery, posterior cerebellar artery (PCA1), and

those unsuitable for endovascular therapy.[12] Endovascular surgery should be the primary option for those aneurysms of the posterior cerebral artery (PCA2), basilar trunk and tip of the basilar, proximal AICA, and even the vertebral or vertebrobasilar junction. Different surgical approaches are defined by the location and characteristics of the aneurysm, so the surgical team should be familiar with all approaches to tailor the best possible technique to the specific pathology.[2]

Therefore, the purpose of this publication is to report the experience of our center in the surgical treatment of ruptured saccular posterior circulation aneurysms since the beginning of the program of early treatment of cerebral aneurysms, which began in our institution in 1999.

Methods/Materials

We analyzed all patients aged over 18 years in the period between 1999 and 2013 who were admitted to Centro Hospitalar do Porto (CHP) with the diagnosis of ruptured posterior circulation aneurysm and underwent surgery. Only the patients with saccular aneurysms underwent surgery; the patients with fusiform or blister-like aneurysms were excluded. No mycotic posterior circulation aneurysms were treated throughout that period of time.

The data collection was done retrospectively by consulting the clinical process of each patient. Information was collected on the following variables: name; gender; age; location of the aneurysm; time between the clinical *ictus* and the arrival at the medical facility; time between diagnosis and surgical treatment; Glasgow coma score (GCS); and Hunt & Hess (H&H) and Fisher scales at admission. As a standardized outcome measure, we utilized the modified Glasgow Outcome Scale (mGOS) at discharge, 3 and 6 months.[13] We also collected data on the surgical approach, as well as the surgical technique used to exclude the aneurysm.

We proceeded to the descriptive analysis of the patients' characteristics. To study the possible associations between the clinical characteristics at admission and the different outcomes, we used the chi-square or Fisher's exact tests. A p value < 0.05 for Type Error limit I was adopted. The statistical treatment of the data was done using the SPSS® version 21.0 software (IBM, Armonk, New York, US).

Results

Between 1999 and 2013, 59 patients with ruptured posterior circulation aneurysms underwent surgery at CHP (a total of 62 aneurysms), accounting for 5.8% of the aneurysms that were surgically treated during this period in our center (1,021).

Eighty percent ($n = 47$) of the patients were female. The mean age of the patients was 58.7 $\pm$ 13.9 years, with women being older than men (61.6 $\pm$ 13.3 versus 48.3 $\pm$ 10.6; $p = 0.003$). Concerning the location of the aneurysms, their distribution was as follows: vertebral artery (VA) in 2 patients (3,.%); PICA in 29 patients (49.2%); AICA in 4 patients (6.8%); ASCA in 2 patients (3.4%); BA in 17 patients (28.8%); PCA (sum of PCA1 and PCA2) in four patients (6.8%); and unknown in 1 patient (1.7%) (►**Table 1**). Three patients had multiple aneurysms (PICA aneurysm – 4th and 5th segments), and 2 patients had aneurysms secondary to the posterior fossa arteriovenous malformation (pfAVM) (1 patient had 2 PICA aneurysms). In our series, 90.3% (56) of the aneurysms were treated using clipping as the sole technique. Three aneurysms (two of the apex of the BA and one in the 4th segment of the ASCA) were wrapped, and two of them were endovascularly treated in a second approach. Two aneurysms (one of the apex of the BA and another of the 4th segment of the AICA) were clipped and wrapped in the same procedure. Another aneurysm (of the 5th segment of the PICA associated with a pfAVM) was trapped. Only one out of our patients had a giant aneurysm (of the 4th segment of the PICA).

Our standardized surgical approach to posterior circulation aneurysms is the following:

I. PCA2–subtemporal approach;
II. PCA1, apex of BA, BA (superior third) and 1st segment of the ASCA – pterional approach;
III. BA (inferior third), 4th segment of the AICA, and (4) 1st, 2nd, and 3rd segments of the PICA in four patients – retrosigmoid approach; and
IV. PICA (all segments) – suboccipital approach (plus C1 posterior arch removal in six patients with PICA 4th and 5th segments aneurysms.

NOTE: one additional ASCA 4th segment aneurysm underwent surgery using a supracerebelar-infratentorial approach; we have no record of the approach used to treat the aneurysm for one patient.

We also highlight that 79.7% of patients arrive at the medical facility in the first 48 hours after the first symptom, and 62.7% were treated within the first 48 hours after diagnosis (of those, 47.5% were treated within the first 24 hours).

Regarding the clinical severity of the patients, 10.2% presented with a GCS < 8; 16.9% with a GCS 9–13; and 72.9% with a GCS 14–15. Concerning the H&H scale, 86.4% presented with a H&H1–3, whereas 13.6% presented with a H&H4–5. Regarding the Fisher scale, 5.1% presented with a Fisher 1; 15,3% with a Fisher 2; 33,9% with a Fisher 3; and 45.8% with a Fisher 4.

Grouping the range of H&H into 2 groups (H&H1–3 versus H&H4–5), we found that 78.4% of H&H1–3 patients had a mGOS4–5 at discharge, while only 62.5% of H&H4–5 patients had the same mGOS. At 3 and 6 months, these ratios increase, respectively, to 80.4% in the H&H1–3 group, and to 75% in the H&H4–5 group, with a mGOS4–5 (►**Table 2**).

Regarding gender associations, we found no correlation between gender and the GCS ($p = 0.15$), H&H ($p = 0.484$), Fisher ($p = 0.959$), location of the aneurysm ($p = 0.382$), and time between the diagnosis and surgery ($p = 0.582$). Analyzing the outcome according to gender, we see that there was no statistical significant correlation between the gender and the outcome (mGOS) at discharge ($p = 0.602$), at 3 months ($p = 0.857$), and at 6 months ($p = 0.334$) (►**Table 3**).

Table 1 Distribution of the different characteristics of patients with ruptured PCAs according to gender

	Women ($n = 46$)		Men ($n = 13$)		Global ($n = 59$)		
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	***p***
Mean age (SD)	61.6	(13.3)	48.3	(10.6)	58.7	(13.9)	0.003
Time between clinical ictus and first physician call for help							0.781
≤48	37	80.4	10	76.9	47	79.7	
> 48	9	19.6	3	23.1	12	20.3	
Glasgow Coma Score							0.150
0–8	5	10.9	1	7.7	6	10.2	
9–13	10	21.7	–	–	10	16.9	
14–15	31	67.4	12	92.3	43	72.9	
Hunt & Hess							0.484
1–3	39	84.8	12	92.3	51	86.4	
4–5	7	15.2	1	7.7	8	13.6	
Fisher							0.959*
1	2	4.3	1	7.7	3	5.1	
2	7	15.2	2	15.4	9	15.3	
3	16	34.8	4	30.8	20	33.9	
4	21	45.7	6	46.2	27	45.7	
Location							0.382
PICA	24	52.2	5	38.5	29	49.2	
BA	12	26.1	6	46.2	18	30.5	
Others	10	21.7	2	15.4	12	20.3	
Time between diagnosis and surgery							0.582
≤48	28	60.9	9	69.2	37	62.7	
> 48	18	39.1	4	30.8	22	37.3	

Abbreviations: BA, basilar artery; PICA, posterior-inferior cerebellar artery, PCA, posterior cerebellar artery; SD, standard deviation.
Note: *Fisher's exact test

Table 2 Characterization of the outcome according to the Hunt & Hess scale at admission

	Hunt & Hess scale						
	1–3		4–5		Global		
	n	%	n	%	N	%	*p*
mGOS							
At discharge							0.354*
1	3	5.9	–	–	3	5.1	
2–3	8	15.7	3	37.5	11	18.6	
4–5	40	78.4	5	62.5	45	76.3	
At 3 months							0.476*
1	4	7.8	–	–	4	6.8	
2–3	6	11.8	2	25.0	8	13.6	
4–5	41	80.4	6	75.0	47	79.6	
At 6 months							0.344*
1	6	11.8	–	–	6	10.2	
2–3	4	7.8	2	25.0	6	10.2	
4–5	41	80.4	6	75.0	47	79.6	

Abbreviation: mGOS, modified Glasgow Outcome Scale.
Note: *Fisher's exact test

Table 3 Distribution of the outcome according to gender

	Gender						
	Female		Male		Global		
	n	%	n	%	n	%	*p*
mGOS							
At discharge							0.602*
1	2	4.3	1	7.7	3	5.1	
2–3	8	17.4	3	23.1	11	18.6	
4–5	36	78.3	9	69.2	45	76.3	
3 months							0.857*
1	3	6.5	1	7.7	4	6.8	
2–3	7	15.2	1	7.7	8	13.6	
4–5	36	78.3	11	84.6	47	79.6	
6 months							0.334
1	4	8.7	2	15.4	6	10.2	
2–3	6	13.0	–	–	6	10.2	
4–5	36	78.3	11	84.6	47	79.6	

Abbreviation: mGOS, modified Glasgow Outcome Scale.
Note: *Fisher's exact test

Table 4 Characterization of the outcome according to age

	Age						
	≤64		≥65		Global		
	n	%	n	%	n	%	*p*
mGOS							
At discharge							0.423
1	1	2.7	2	9.1	3	5.1	
2–3	6	16.2	5	22.7	11	18.6	
4–5	30	81.1	15	68.2	45	76.3	
At 3 months							0.594
1	2	5.4	2	9.1	4	6.8	
2–3	4	10.8	4	18.2	8	13.6	
4–5	31	83.8	16	72.7	47	79.6	
At 6 months							0.291
1	4	10.8	2	9.1	6	10.2	
2–3	2	5.4	4	18.2	6	10.2	
4–5	31	83.8	16	72.7	47	79.6	

Abbreviation: mGOS, modified Glasgow Outcome Scale.

Regarding the age, and dividing the patients between those younger than 65 years and those older, there was no statistical significant correlation between the age and the outcome at discharge ($p = 0.423$), at 3 months ($p = 0.594$), and at 6 months ($p = 0.291$) (►**Table 4**).

Table 5 Characterization of the outcome according to the time between diagnosis and surgery

	Interval between diagnosis and surgery						
	≤48		> 48		Global		
	n	%	n	%	n	%	*p*
mGOS							
At discharge							0.198
1	3	8.1	–	–	3	5.1	
2–3	5	13.5	6	27.3	11	18.6	
4–5	29	78.4	16	72.7	45	76.3	
At 3 months							0.658
1	3	8.1	1	4.5	4	6.8	
2–3	4	10.8	4	18.2	8	13.6	
4–5	30	81.1	17	77.3	47	79.6	
At 6 months							0.189
1	5	13.5	1	4.5	6	10.2	
2–3	2	5.4	4	18.2	6	10.2	
4–5	30	81.1	17	77.3	47	79.6	

Abbreviation: mGOS, modified Glasgow Outcome Scale.

Table 6 Characterization of the outcome according to the location of the aneurysm

	Location						
	Other		Basilar		Global		
	n	%	n	%	n	%	*p*
mGOS							
At discharge							0.276*
1	1	2.4	2	11.1	3	5.1	
2–3	7	17.1	4	22.2	11	18.6	
4–5	33	80.5	12	66.7	45	76.3	
At 3 months							0.107
1	1	2.4	3	16.7	4	6.8	
2–3	5	12.2	3	16.7	8	13.6	
4–5	35	85.4	12	66.7	47	79.6	
At 6 months							0.011
1	1	2.4	5	27.8	6	10.2	
2–3	5	12.2	1	5.6	6	10.2	
4–5	35	85.4	12	66.7	47	79.6	

Abbreviation: mGOS, modified Glasgow Outcome Scale.
Note: *Fisher's exact test.

Regarding the time of surgery, comparing the patient group whose surgery was performed up to 48 hours post-SAH, and those whose surgery was performed after 48h, there was no statistical significant correlation between the time of surgery and the outcome at discharge ($p = 0.198$), at 3 months ($p = 0.658$), and at 6 months ($p = 0.189$) (►**Table 5**).

Regarding the location of the aneurysm, separating those from the BA from the others, we found that, at 6 months, there was a statistically significant correlation between the BA aneurysm and a worse prognosis ($p = 0.011$) (►**Table 6**).

As we found in the data presented before, the rate of mortality at discharge was of 5.1%, and it increased to 10.2% at 6 months. At discharge, 13.6% of the patients had a mGOS2–3, whereas 79.7% had a mGOS4–5. At 6 months, the proportion of patients with a mGOS4–5 was the same, whereas for those patients with a mGOS2–3, it decreased to 10.2%.

Grouping the outcome at discharge, and at 3 and 6 months, we found that, concerning those patients with a mGOS2–3 at discharge (11), 1 outcome was death at 6 months, 6 had a mGOS2–3, whereas 4 improved to a mGOS4–5. Regarding these patients with a mGOS4–5 at discharge, 2 outcomes were death at 6 months (one in the sequence of a cerebral abscess, and the other following a recurring hemorrhage after a BA aneurysm that was wrapped) (►**Table 7**).

Discussion

One of the first topics of discussion necessarily involves the acknowledgment that in our center not all posterior circulation aneurysms underwent surgery: this is an important bias that must be stated *ad initium*. Most of the apex of the BA and

Table 7 Evolution of the outcome

		At 3 months						At 6 months					
		1		2–3		4–5		1		2–3		4–5	
At discharge	N	n	%	n	%	n	%	n	%	n	%	n	%
2–3	11	–	–	7	63.6	4	36.4	1	9.1	6	54.5	4	36.4
4–5	45	1	2.2	1	2.2	43	95.6	2	4.4	–	–	43	95.6

other posterior circulation aneurysms are today preferably treated by an endovascular approach. However, this fact itself does not invalidate the fact that our center continues to state the importance and focus on the surgical treatment of posterior circulation aneurysms.

We found that in our center, like in other centers around the world, PICA aneurysms are the most clipped ones, a fact that is explained by its easier surgical access. Contrary to some of the published literature,[14] which states that PICA aneurysms are associated with a poor outcome regarding the close proximity to the medulla and lower cranial nerves, in our group, PICA aneurysm patients had an improved outcome when compared with other patients.

Regarding the distribution of ruptured aneurysms by gender, there was a clear predominance of female subjects (80%), with a mean age of 58.7 $\pm$ 13.3 years.

Concerning the severity of the clinical picture, there was a clear predominance of patients who presented with an H&H1–3 (86.4% of cases). It is known that the H&H scale constitutes one of the most important prognostic factors in the outcome of these patients. However, our data do not reveal a statistical significant difference between the H&H scale and the outcome. In these patients, this grading was obviously corrected to the presence/absence of hydrocephalus. There is, to our knowledge, no obvious explanation to the absence of a correlation between the H&H at admission and the outcome. This may be caused by an insufficient number of patients evaluated, since many other case series state this relationship.

Regarding age, often described as very important in the prognosis of this disease, our data do not document this relationship. Again, this could possibly be explained by the insufficient number of patients treated.

One of the topics that aroused the most interest and discussions in the neurosurgical world throughout the XX century was the question of the best timing for the treatment of ruptured aneurysms: during the acute phase or after the vasoactive period. Our center pioneered the adoption of an early treatment strategy.

When in good clinical condition, all patients underwent surgery in the first 48h; when the clinical condition was judged to be bad, the treatment was delayed for at least 14 days, or the patients were referred to endovascular therapy. This was the procedure adopted by the most experienced group of neurosurgeons (led by Dr. Charles Drake) who dealt with this problem, which is expressed in their 1994 paper: "Early surgery for vertebrobasilar aneurysms".[15]

We didn't analyze the number of patients with clinical vasospasm, nor the number of patients with acute or delayed hydrocephalus and its relationship to the degree of Fisher at admission. Instead, we found a higher proportion of patients with Fisher 4 in our group, which could explain the proximity of these hemorrhages with the 4th ventricle and the most likely possibility to rupture into this.

With our study, we can state the worst prognosis at 6 months associated with the surgical treatment of BA aneurysms ($p = 0.011$) and the fact that the women are older than men when they present with SAH due to a ruptured PCA ($p = 0.003$). Obviously, a conclusion should not be made based on our results, but there is a clear trend concerning basilar apex aneurysms: that those submitted to surgery should be the high complex ones.[16]

Finally, the mortality rate associated with the surgical treatment of this condition in our series stands at 5.1% at the time of discharge. These 5.1% correspond to 3 patients, 2 of whom died in the context of complications of SAH, and another one, who died in the context of a gastric carcinoma diagnosed at the same time. As relevant post-operative complications, we had one patient who died in the context of a post-operative cerebral abscess, and another who died in the context of a mesencephalic hemorrhage (this case corresponds to a BA aneurysm clipped and wrapped in the same procedure). One other patient died of an unknown cause. No other major complications occurred in our group of patients. Another point of interest is that our severe morbidity (mGOS2–3) was of 18.6% at the time of discharge, and of 10.2% at 6 months – clearly higher than the rates reported in the literature.

Comparing our data with those of other published series (surgical and endovascular surgery series), we see that our mortality is, actually, below most of them, even including those patients who died of causes unrelated to SAH or surgery. One of the largest series published to date concerning endovascular surgery-treated aneurysms of the posterior circulation was authored by F. Vinuela in 1997 with a reported 30-day mortality of 6.1%.[17] A more recently published series reports mortality around 5%, like that published in 2007 by Pandey et al.[18] In a chapter of a book published by Signorelli,[7] there is a compilation of some endovascular series of the past 20 years, in which the median mortality was of 9.1%, with a median morbidity of 4.4%. In the same chapter, concerning the surgical treatment mortality and morbidity of these patients in the past 40 years, the rates are, respectively, 9.1% and 10.5%.

Concerning the endovascular group of patients and comparing it with our results at the time of discharge, our

patients have half the mortality but four times more morbidity. Concerning the surgical group, our group has half the mortality but twice the morbidity.

When we compare our results with other surgical series, like the one published by Peerless et al[15], they reported a mortality of 9.7% for patients with SAH aneurysms undergoing early surgery (206 patients). Though our mortality at the time of discharge was of 5.1%, we should not forget that, at 6 months, it increased to 10.2%, which is a value closer to the mortality reported by Peerless et al.

To end the discussion, we want to note that this is obviously not a closed study. The study should have included the coiled aneurysms and compared both groups. However, to date, this data are not accessible to us, and this remains the great bias of our study.

Conclusions

Based on our experience and results, we can conclude that the surgical treatment of SAH secondary to ruptured saccular posterior circulation aneurysms remains a remarkable treatment for this group of patients, and it is obviously dependent on the existence of a group of neurosurgeons with experience in treating this condition. Of course, these facts do not invalidate the fact that this type of pathology should deserve an interdisciplinary discussion regarding the suitability of the type of treatment concerning the type of SAH and the characteristics of the aneurysm.

These results are, an encouragement for us to continue in the pathway initiated by Doctors Walter Dandy, Norman Dott, and Charles Drake,[19–21] pioneers of surgical the treatment of SAH and cerebral aneurysms. To the youngest generations of neurosurgeons, this work should be an encouragement for them to initiate the learning curve of knowledge necessary to actually treat with high proficiency their future patients.

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