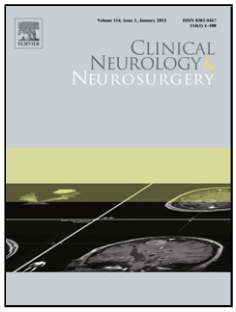

Association between intracranial aneurysm and Meningiomas: an integrative Survival analysis with identification of prognostic factors

Matheus Rodrigues de Souza, Caroline Ferreira Fagundes, Nicollas Nunes Rabelo, Manoel Jacobsen Teixeira, Eberval Gadelha Figueiredo

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Association between intracranial aneurysm and Meningiomas: an integrative Survival analysis with identification of prognostic factors

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Highlights:

- Association between Meningioma and intracranial aneurysms (IA) is uncommon 0.7%–7,7%;
- We sought the literature in order to study prognostic factors associated with this occurrence;
- 77.9% of Aneurysms were ipsilateral of the tumor; 25.97% exclusively (SAH)
- Aneurysm rupture was associated with a worse patient prognosis;
- Unruptured aneurysms and treatment were protective independent factors for OS.

ABSTRACT

OBJECTIVE: To analyze prognostic factors in clinical association between intracranial aneurysm (IA) and meningioma. Prognostic factors on overall survival (OS) were evaluated.

METHODS: We selected articles, published from January 1944 to December 2018 on the Medical databases (*Web of Sciences*, *Medline* and *EMBASE*) and included case series and reports. Clinical information was obtained and variables associated with the primary outcome of 27-mo survival were identified through Cox regression models.

RESULTS: The study evaluated 77 patients. Female represented 76.6% (n=59), a ratio of 3.27 female: 1 male. The age range was 7 to 84 years old, with an average of 54.74 (SD: 14.30). Age and sex were not significant statistically different between the two groups for overall survival (OS) (log-rank P=0.806), (log-rank P=0.983) respectively. 77.9% (n=60) were ipsilateral, the same side was 4 times more common in univariate analysis (P=0.052; 95% CI, 0.924-17.319). Most aneurysms were detected in the internal carotid artery, 29.87%. In Clinical data, 62.33% (n = 48) had exclusive tumor symptoms, while 25.97% (n=20) presented exclusively subarachnoid hemorrhage (SAH). In multivariate analysis, although there is an independent protective factor for those who did not have SAH (HR; 0.099; CI; 0.010-0.986; P=0.049) and the treatment is an independent predictor for OS (HR, 42.096; CI, 4.270-415.056; P=0.01).

CONCLUSION: This is the first study to approach this association. This is not just an occasional finding, but it seems to have a shared pathophysiology. Unruptured aneurysms and treatment modality were protective independent factors for OS. Prospective studies are warranted to provide definitive answers.

KEY-WORDS: Brain tumor; Intracranial aneurysm; Meningioma; Prognostic factor; Survival analysis

Introduction

Coexistence of primary intracranial tumor (IT) associated with intracranial aneurysms (IA) is a relatively common phenomenon.[14,29] Previous studies have shown that the incidence of this association is estimated to be 0.7%–7,7%.[8,11,14,18,26,28,29] IA is associated with several types of ITs. Meningioma is the most common tumor associated

with IAs [8,14,29], following by pituitary adenoma[28], glioma, vestibular schwannoma, lipoma, metastatic tumor, arachnoid cyst, Rathke's cleft cyst, craniopharyngioma, lymphoma, dermoid cyst and epidermoid cyst. [11,14,18,26] With advancements in diagnostic technologies, both ITs and unruptured IAs have been identified more often. Therefore, the reported incidences of both are higher in the recent literature. [28,34,37]

However, how this association may impact on the final outcome remains unclear. [18,24,29,37] In the current literature only one study have evaluated survival and risk factors in gliomas.[24] There are no studies in the literature that systematically reviewed and analyzed the impact of this association on the final clinical outcome. Therefore, in this paper we sought to perform a systematic review and a survival analysis in order to assess the influence of prognostic factors on overall survival (OS) of patients harboring IAs associated with intracranial meningiomas.

Methods

Literature Search

We performed Sistematic Review, performing PRISMA protocol. Was peformed search on the *Web of Sciences*, *Medline*, and *EMBASE* databases for case series, case reports, randomized studies, systematic reviews on the topic that presented reports of this association between IAs and meningiomas published in English, Portuguese and Spanish between January 1944 December 2018. The following key words were used: "aneurysm", "associated", "coexisting", "meningioma" with different forms of spelling (e.g. tumor and tumour, coexisting and co-existing, coexistence and co-existence). The keywords were searched in "all fields" modality. Studies were independently evaluated for inclusion criteria by 2 authors. In cases of disagreement, a third and fourth author made the final decision.

Study Selection

Clinical cases, case series, randomized studies or systematic reviews with histologically-proven benign meningioma cases associated with IAs with image proof were included in our review. Individuals of any age were included. Studies without individual patient-level data were excluded. Papers were carefully scanned for

duplications. If duplications occurred, the most recent description was selected. To identify other relevant studies, we scanned reference lists from identified studies and reviewed articles. Authors would be contacted if any further information was needed.

Data Abstraction

Information such as gender and age, location of the aneurysm, tumor, clinical picture, relative laterality of the tumor and the aneurysm, proposed treatment of both, outcome and the follow-up time. The mean follow-up was 27 months and was used as an endpoint for OS.

Statistical Analysis

For descriptive purposes, categorical variables were presented through relative and absolute frequencies. Normally distributed continuous data were presented as mean and standard deviations and, otherwise, by median and quartiles.

Potential predictors of survival were identified through the Kaplan-Meier method, using the Log-rank (Mantel-Cox) test to compare the survival functions, when it was statistically significant, it was also performed the Breslow and Tarone-Ware test. Continuous variables were analyzed through a univariate Cox regression. The variables considered for inclusion on the multivariable Cox regression model were age, gender, relative laterality, presence of subarachnoid hemorrhage, treatment of tumor and treatment of aneurysm.

Results were presented through hazard ratios (HR) and 95% confidence intervals (CI). All tests were 2-sided and final *P* values under .05 were considered to be statistically significant. All analyses were conducted with the Statistical Package for Social Sciences (*IBM SPSS Statistics for Windows, version 20.0.; IBM, Armonk, New York*) software.

Results

The research flowchart and literature screening is presented in Figure 1**.** Seventy-seven cases were retrieved from 24 articles.[2,4,20–22,25,27,30–34,5,35,36,38,41,8,9,13–17]

Patients characteristics

76.6% (n=59) of the patients were female and 23.4% male (n=18), representing a ratio of 3.27: 1 from women to men, with statistically significant difference (p <0.05 CI:

1.67 - 1.86). The age was between 7 and 84 years old, with an average of 54.74 (SD: 14.30). There is a peak incidence between 50-55 years old, with patients in this age range representing 17.9% of the sample. In addition, the incidence between different age groups follows a normal distribution, as shown in Figure 2. Univariate analysis showed that age was not significant statistically for OS (log-rank P=0.806) and gender had no statistical significance for OS (log-rank P=0.983).

Tumor and aneurysm localization

Regarding the laterality between the location of tumor and aneurysm, 77.9% (n=60) of both lesions occurred at the same side. A significant difference between the ipsi and contralateral groups was demonstrated by the Test t (p=0.00 CI: 1.126-1.315). Univariate analysis showed that this relationship has no statistical significance for OS (log-rank P=0.300), and the Odds Ratio for side showed that it is 4 times more common to the aneurysm occur at the same side of meningioma, although no statistics statistically significant (P=0.052; 95% CI, 0.924-17.319).

Most aneurysms were detected in the internal carotid artery (ICA), 29.87% (n=23), the anterior communicating artery (ACoA) 22.07% (n=17) and the posterior communicating artery (PCoA), 16.88% (n=13). Multiple aneurysms were also found, 14.28% (n=11). The detailed description of the individual location of each case is described in Table 1**.**

Regarding the location of the tumor, meningiomas of the frontal region were the most frequent, present in 15.47% (n=13), which included frontal parasagital, fronto-basal, fronto-polar and fronto-temporal. Olfactory groove meningiomas represented 14.28% (n=11) of the sample, followed by sphenoid wing 10.38% (n=8). Multiple and tentorial meningiomas were present in 6.49% (n=5) each.

Clinical data

Forty-eight patients (62.33%) presented only symptoms related to the tumor, while 25.97% (n=20) had exclusively SAH. In two cases, the symptoms were associated. Univariate analysis showed a statistically significant difference in OS in patients with SAH, who had an average survival of 28.89 months, while those who did not present SAH had survival of 179.37 months (log rank P=0.017, Breslow P=0.008, Tarone-Ware P=0.010). However, in multivariate analysis, there is an independent protective factor for

those who did not have SAH, as described at Table 2 (HR; 0.099; CI; 0.010-0.986; P=0.049). A survival function comparing the two groups is presented in Figure 3.

Treatment

Complete or partial removal was performed in 64 of 77 patients. In 7 cases, no treatment was performed and in 6 cases the treatment has not been described. The univariate analysis showed that surgery for the tumor is statistically significant for OS (log-rank P=0.00; Breslow P=0,000; Tarone-Ware P=0.000). The estimated survival time for treated patients was 167.85 months (CI, 135.9-188.0) and for the untreated was 15.06 (CI, 0.053-30.067). Multivariate analysis showed that treatment is an independent predictor for OS (HR, 42.096; CI, 4.270-415.056; P=0.01) (Table 2). The survival function comparing the two groups is presented in Figure 4.

Regarding the aneurysm, in 31.16% (n=24) no treatment was carried out. 41.6% (n=32) were clipped, 14.3% (n=11) of the patients received endovascular treatment, 9.1% (n=7) received other types of treatment such as balloon occlusion, coating and carotid ligature.

Univariate analysis showed no statistically significant difference between treatment types (log-rank P=0.877) for OS. When considering whether or not treatment was performed, univariate analysis showed that it is statistically significant for OS (log-rank P=0.029, Breslow P=0.025; Tarone-Ware P=0.027). Cox regression analysis revealed that it was not an independent prognostic factor for OS, as described at Table 2. (HR, 7.881; CI, 0.876-70.880; P=0.065)

Discussion

The association between meningioma and aneurysms is a rare event and usually with incidentally diagnosed.[24,30,41] It is estimated that there are several underdiagnosed cases, considering that in practice it is not the rule to request angiographic imaging exams in patients with diagnosis of brain tumors. [35]

This study corroborates this fact by presenting that in most cases the symptomatology is caused by the tumor and not by the aneurysm. There are no consensus or studies demonstrating a clear and definitive association between brain tumors and aneurysm development, although this study showed a statistically significant difference

in the presence of ipsilateral aneurysm. The study by Niu et al.[24] that described prognostic factors in the association between gliomas and aneurysms also describes that most of these (80.3%) were ipsilateral to the tumor. Similarly, Fisher et al.[11] showed a pronounced proximity of the aneurysm location in the feeding arteries and or adjacent to the tumor capsule. The local relationship of aneurysms associated with meningiomas, especially when the aneurysm is situated on a tumor feeding artery adherent to or within the tumor required a discussion about hemodynamic factors.[29] Tachikawa et al. reported a case in which an aneurysm, located on a tumor feeding artery disappeared after tumor resection. They hypothesized that, due to the tumor removal, feeding vessel hemodynamics changed and the aneurysm obliterated spontaneously.[34]

These findings corroborate the non-occasional occurrence of this event and a possible relationship between them. Andrews at al. suggest that in malignant tumors there may be an invasion of tumor cells into the vessel wall, which may explain the possible instability of the wall and the consequent development of the aneurysm. [3]

Nevertheless, better understanding over the hemodynamic factors involved in this association is still needed.[29] Regarding gender, there was a significant predominance for females in both meningiomas and IAs, which may corroborate the hypothesis of a possible hormone-mediated development in both pathologies, given the reports of the influence of estrogen on these conditions. Interaction with progesterone may be modulated via alteration in the ratio of PR-A to PR-B expression, and higher PR-A expression may result in reduced progestin responsiveness.[12] The PRA isoform has been shown to diminish the response of ERs to their ligands.[1,12,28,30] In addition, genetic studies also support the hypothesis that this association is not occasional. Some mutations or loss of gene expression for both pathologies were found at the same loci, for example 1p36.2-p34, 11q13 and 17p13.1.[6,39,40]

The present study describes the impact of aneurysm rupture on overall survival. This occurrence was an obvious independent predictor for survival. This fact should draw attention to the urgency of the proper management of these patients, who in themselves already have factors that may contribute to increased intracranial pressure due to the presence of the tumor.[7,10,19] Regarding treatment, most patients had tumor-related symptoms and surgical treatment subsequent to diagnosis showed an impact on overall survival, however, one should take into account the patient's previous conditions, surgical indications, and prognostic factors.[6,23]

Neurosurgical treatment for meningiomas resulted in a significant impact on overall survival. However, we emphasize that data such as the size of the aneurysm, its rupture or not and the presence of clinical comorbidities must be taken into account in the decision making process.

In one third of the sample, the diagnosed aneurysms were not treated. In cases in which conservative treatment is chosen, we recommend the follow-up of these patients with imaging studies to evaluate the evolution of the aneurysm, as well as future indications of surgery.

A frequent question that follows the diagnosis of an aneurysm associated with tumor is when to treat the asymptomatic aneurysm. A trend towards conservative treatment was observed when small aneurysms contralateral to the tumor or those ipsilateral, also of reduced size, that did not interfere with tumor resection, were found. When ipsilateral and symptomatic or large aneurysms are found, there is a preference for the initial treatment of the aneurysm, either surgically or endovascularly. The endovascular approach is an interesting alternative for aneurysms located close to the tumor. Unfortunately, only the minority of authors describes the sequence of treatment for each of the lesions.

Given that in the last 6 decades there has been an evolution in endovascular techniques as well as the development and microsurgical refinements, the present study does not intend to make inferences about the best therapeutic choice for aneurysm treatment. Moreover, this is still a controversial topic in the literature, which needs further studies regarding isolated aneurysms as well as associated with intracranial tumors.

Finally, we believe that it is not yet possible to recommend, based on the literature evidence, a vascular study before the treatment for all patients with meningiomas. The literature describes an incidence of this association that varies between 0.7% to 7.7%. However, the actual incidence may be even higher, due to the lack of pre-operative vascular studies in most cases.

Prospective cohort studies are necessary to provide better data and propose management protocols for diagnosis of both lesions. One important aspect is to identify subgroup of patients with meningeomas that might benefit from vascular image study.

Study Limitations

This study performed an integrated survival analysis in patients who had aneurysms associated with meningiomas. However, the study has some limitations. First, all articles were series or case reports and all limitations regarding retrospective study may be applied. In addition, several studies incompletely described patients' follow-up and some outcome data were missing. These cases were used in the study only to describe epidemiological factors and those that completely presented follow-up time and outcome data were used to perform survival analysis. In addition, over the years there has been the development and improvement of endovascular techniques, as well as microsurgery, which directly impacts the prognosis of patients. Thus, the present study may contribute to the future, in association with subsequent report of additional cases, to propose an algorithm for the best management strategy for patients with this association.

Conclusion

The present study shows that intrinsic and extrinsic clinical factors influence as prognostic factors for OS on association between meningioma patients and intracranial aneurysm. Their predominance occurrence it is proximal and ipsilateral aneurysm to the tumor. SAH and tumor surgical resection were independent prognostic factors for OS.

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Conflict of Interest: All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Ethical approval: For this type of study formal consent is not required

Informed consent: This article does not contain any studies with human participants performed by any of the authors.

Disclosure

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

I, Prof. Dr. Eberval G. Figueiredo, certify that this manuscript is a unique submission and is not being considered for publication, with any other source in any medium.

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Originality

I, Prof. Dr. Eberval G. Figueiredo, certify that this manuscript is a unique submission and is not being considered for publication, with any other source in any medium.

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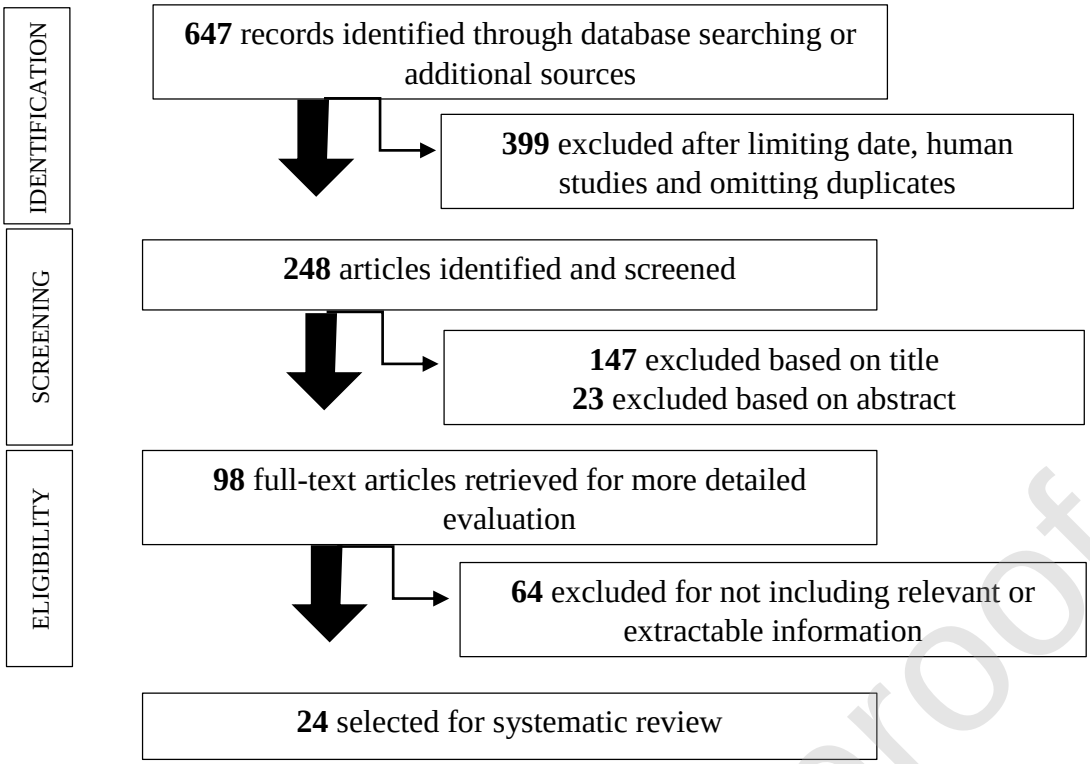

Figure 1. The flow diagram of literature search and screening.

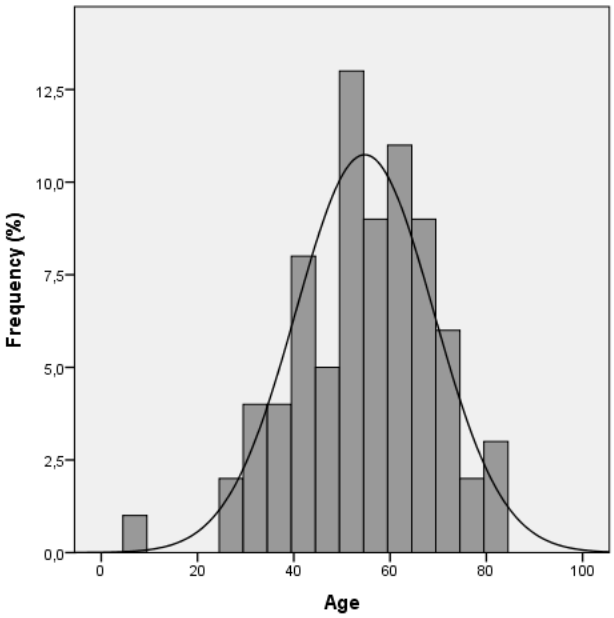

Figure 2. Histogram of age distribution of patients with aneurysm-associated meningiomas, presenting a normal distribution

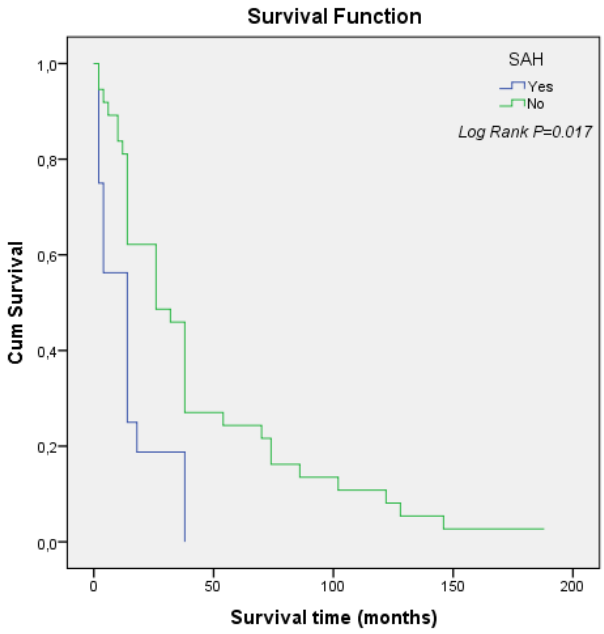

Figure 3. Relationship between presence or absence of SAH and survival outcome in case of meningiomas

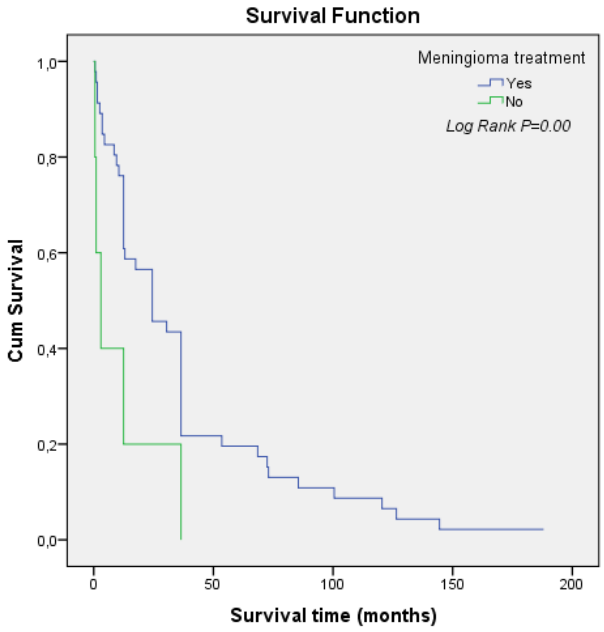

Figure 4. Relationship between tumor treatment and survival outcome in case of meningiomas.

Table 1. Details of the Included 77 Patients of Meningioma Coexisting with Intracranial Aneurysms

Author	Sex	Age	Symp		Location			Treatment		Outcome	Time of	
			A	T	Ipsi	Tumor	Aneurysm	Aneurysm	Tumor		Symp*	Follow-up*
Love et at, 1963	F	48	-	+	+	Sphenoid wing	Mult. ICA	Ligature	Partial Removal	Alive		
Pecker et al, 1965	F	57	-	-	+	Olfactory groove	AcoA	Clipping	Removal	Alive		3
Raskind et al, 1965	M	44	-	+	+	Fronto-polar	ACA	None	Removal	Alive	4	20
Levin et al, 1966	M	51	-	+	-	Frontal	AcoA	NA	Removal	Death	180	8
	M	67	-	+	+	Fronto-temporal	MCA	None	Removal	Alive	24	12
Jimenez et al, 1971	F	28	-	+	+	Mult	ICA	Clipping	Partial Removal	Death	24	0,1
	M	44	-	+	+	Mult	ICA	Clipping	Removal	Alive	192	12
Arseni et al, 1973	M	30	-	+	-	Sphenoid wing	BA	None	Removal	Death	36	84
	M	37	-	+	+	Olfactory groove	AcoA	None	Removal	Alive	0,8	12
Handa et al, 1976	F	39	+	+	+	Fronto-basal	Mult	None	Removal	Alive		
Probst et al, 1980	M	30	-	+	-	Tentorial	Mult	Clipping	Removal	Alive	1	3
Okamura et al, 1981	F	33	-	+	+	Falx	ICA	Coating	Partial Removal	Alive	12	12
	F	54	-	+	+	Frontal	ICA Bi	Clipping	Removal	Alive		
	F	35	-	+	+	Olfactory groove	ICA	None	Removal	Alive	8	1
	F	65	+	-	+	Sellar	PCoA	Clipping	Removal	Alive		
Punto et al, 1984	F	26	-	+	+	Mult.	NA	Wrapping	Removal	Alive		36
Licata et al, 1986	F	52	+	-	+	Posterior Fossa	AcoA	None	None	Death		0,1
	F	67	+	-	+	Frontal parasagital	AcoA Mult. AcoA, AchorA, MCA,	Clipping	Removal	Alive	5	12
	F	71	+	-	+	Frontal	ICA	None	None	Death	1	1,7
	F	62	-	+	+	Sphenoid wing	ICA	Wrapping	Removal	Alive		120
	M	68	-	+	-	Sellar	ICA	None	Partial Removal	Alive		10
	M	60	+	-	+	Posterior Fossa	AcoA	None	None	Death	0,3	0,2
Kandel et al, 1986	F	7	-	+	+	Fronto-temporal	MCA	Removal	Partial Removal	Alive	0,5	72
Bloomgarden et al, 1987	F	65	+	-	+	Cavernous sinus	ICA	None	Removal	Alive	0,5	1,5
Plangger et al, 1987	F	53	-	+	+	Olfactory groove	PericalA	Coating	Removal	NA		
Delfinei et al, 1990	F	61	-	+	-	Olfactory groove	ICA	Clipping	Removal	Alive		144
	F	53	-	+	-	Olfactory groove	ICA	Clipping	Removal	Alive		72
	F	68	-	+	+	Fronto-temporal	ICA	None	Removal	Alive		8
Simoes et al, 1991	F	56	-	+	+	Olfactory groove	AcoA	Clipping	Removal	Alive	6	6
Iwanowski et al, 1994	F	53	-	-	-	CPA	PICA	None	None	Death		
Scamoni et al, 1997	F	50	-	-	-	Petroclival	ICA	1th	2th	NA		
	F	67	-	-	-	Olfactory groove	PcoA	1th	2th	NA		
Ziyal et al, 1998	F	48	-	-	-	Mult. NA	Mult. NA	None	None	NA		

Dolenc et al, 1998	M	50	-	+	+	Sellar	AcoA	None	Removal	Alive	84	1
Tancioni et al, 1998	F	48	-	+	+	Fronto-temporal	MCA Bi	Clipping L None	Embolization + Removal	Alive	24	12
Ogino et al, 1999	F	70	+	-	+	Sellar	AcoA	Clipping	Removal	Alive	1	
Lama et al, 2000	F	69	-	+	+	Pterional	Mmening A	1th endovascular	2th Removal	Alive		
Tachikawa et al, 2002	M	51	-	+	+	Olfactory groove	AethmoA	None	Removal	Alive		
Javadpour et al, 2004	F	61	-	+	+	Suprasellar	AcoA	1th endovascular	2th Removal	Alive	12	18
Fischer et al, 2008	F	72	-	+	+	Olfactory groove	AcoA	None	None	Death		12
	F	83	+	-	-	Tentorial	ICA	Coiling		Alive		12
	F	55	+	-	+	Fronto-basal	AcoA	Clipping		Alive		12
	M	44	-	+	+	Sphenoid wing	ICA	Coiling + clipping	Removal	Alive		24
	F	41	-	+	+	Frontal	AcoA	Clipping	Removal	Alive		12
	F	77	-	+	+	Sphenoid wing	ICA Bi	None	Removal	Alive		12
	M	44	+	-	+	Cerebellar	ACoA	Clipping	Removal	Alive		12
	F	54	+	-	-	Tentorial	MCA	Clipping	Removal	Alive		12
	F	59	-	+	+	CPA	ICA Bi		Removal	Alive		12
	F	61	-	+	+	Olfactory groove	ACoA	Endovascular	Removal	Alive		12
	F	66	+	-	-	Mult. Frontal, Parietal	ICA	Balloon occlusion		Alive		12
Javalkar et al, 2009	F	70	-	+	+	Pterional	PCoA Bi	Clipping	Removal	Alive		0,5
	F	37			-	Petroclival	ICA	Clipping	Removal	Alive		36
	F	63	+	-	+	Planum sphenoidale	ACoA	Clipping	Removal	NA		
	F	61	+	-	+	Clinoidal	PCoA	1th Endovascular 2th Clipping	Removal	NA		
Petrecca et al, 2009	F	81	-	+	+	Sphenoid wing	ICA	Clipping	Removal 1th	Alive		0,2
Maekawa et al, 2009	F	72	-	+	+	Convexity	Mmening A	Endovascular	Embolization 2th Removal	Alive	1	
Suslu et al, 2011	F	41	-	+	-	Frontal	ICA	None	Removal	Alive		24
Alnaami et al, 2013	M	34	+	-	+	Falx	PericalA	Endovascular	Removal	Alive	1	0,1
Kanamori et al, 2013	F	64	+	+	+	Petrous	PCoA	Clipping	Removal	Alive		
Zhong et al, 2013	F	56	+	-	+	Parietal	ICA	Embolization 1th	NA	Alive		36
	F	52	-	+	+	Petroclival	PCoA	Clipping 2th	2th Removal	Alive		36
	F	41	-	+	+	Parietal	PCoA	Clipping	1th Removal	Alive		36
	F	46	+	-	+	Sphenoid wing	ICA	Embolization	None	Alive		36
	M	49	+	-	+	Falx, Planum	ACA, ACoA	Clipping 1th	Removal	Alive		36
	F	50			-	Parietal	MCA	Clipping	2th Removal	Alive		36
	M	59	-	+	+	Sphenoid wing	PCoA	Clipping	Removal	Alive		36
	F	44	-	+	+	Temporal	PCoA	Clipping	Removal	Alive		36
Waqas et al, 2015	F	60	+	-	+	Clinoidal	ICA	Clipping	Removal	Alive		3

Von Spreckelsen et al, 2016	M	57	+	+	+	Parasellar	ICA	None	Descompression	Alive	4	
Takeda et al, 2017	F	58	-	-	+	Parietal convexity	PCoA	None	Removal	Alive		68
	F	75	-	+	+	Parasellar	Pcoa	Removal	Removal	Alive		
	F	63	-	+		Parasagittal	Bi MCA	None	Removal	Alive		100
	F	58	-	+	+	Clinoidal	ICA	1th endovascular	2th Removal Partial	Alive		
	M	84	-	+	+	Parasagittal	PICA	None	Removal	Alive		53
	F	52	-	+	+	Falx	ICA-Ach	Clipping	Removal	Alive		
	F	63	-	+	+	Tentorial	ICA-PCoA	None	Removal	Alive		126
Eulate-Beramendi et al, 2017	F	71	-	+	-	Tentorial	PCoA	1th endovascular	2 th Removal	Alive		

A, Aneurysm; T, Tumor; Symp, Symptoms; Ipsi, Ipsilateral; ACA, Anterior Cerebral Artery; AcoA, Anterior Communicating Artery; AchorA, Anterior Choroidal Artery; MCA, Middle Cerebral Artery; ICA, Internal Carotid Artery; PICA, Posterior Inferior Cerebellar Artery; PcoA, Posterior Communicating Artery; BA, Basilar Artery; Ach, Choroidal Artery; PICA, Posterior Inferior Cerebellar Artery; PericalA, Pericallosal Artery; MmeningA, Middle Meningea Artery; AethmoA, Ethmoidal Artery; Mult, multiple; NA, not available; [ ], Not informed by the author; F, Female; M, Male

*, Time in months

Patient data extracted from previous reviews where the original article could not be found are referenced to the review article which was originally cited.

Table 2: The Outcome of Multivariate Analysis for Overall Survival

Covariates	P value	HR	95% CI
Rupted Aneurysms (Yes/No)	0.049	0.099	0.010 – 0.986
Tumor Treatment (Yes/No)	0.01	42.096	4.270 – 415.056
Aneurysm Treatment (Yes/No)	0.065	7.881	0.876 – 70.880

HR, hazard ratio; CI, confidence interval