Research Article

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Surgical Clipping vs Endovascular Coiling for Newly Diagnosed and Recurrent Cerebral Aneurysms: an Update on the Current Literature. Single-Center Case Series

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Abstract: The ideal treatment for intracranial aneurysms has been highly controversial in the last few decades. It is particularly difficult to decide between clipping vs. coiling when it comes to an aneurysm that has already been treated. The authors performed a review of the literature published in the last ten years amongst the main neurosurgical publications and make recommendations based on this evidence and the surgical experience of the eldest author of this paper (ES). A series of cases of recurrent, incompletely coiled aneurysms treated with surgery is presented. Conclusions: aneurysms with a convenient configuration and location for either clipping or coiling might be better managed by surgical clipping in young patients considering that this treatment achieves higher rates of occlusion with a lower incidence of rebleeding. In elderly patients, each case must be discussed.

Keywords: recurrent aneurysms, surgical clipping, subarachnoid hemorrhage

1 Introduction

In the past, surgical clip ligation of intracranial aneurysms was the only available treatment for patients with subarachnoid aneurysmal hemorrhage. However, endovascular treatment has increasingly been used since the introduction of Guglielmi detachable coils in 1990. The results of the International Subarachnoid Aneurysm Trial (ISAT), the largest randomized controlled trials comparing both treatments, have determined that even more and more patients are currently being offered endovascular therapy (EVT) as the first choice.

In fact, EVT has proven to be a safe and efficient method with better clinical outcomes in selected patients. Nevertheless, it encompasses a higher risk of recanalization and rebleeding in the long term. As a result of this, a growing number of patients with incompletely treated intracranial aneurysms are presenting for further surgical management. The purpose of this paper is to gather recent evidence that may help selecting the best treatment for a patient with a newly diagnosed aneurysm or with a recurrent lesion. In the last two years, one of the authors (ES) has operated 88 aneurysms, out of which 16 were recanalized lesions. We make recommendations based on the bibliography and on his experience.

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2 Methods

We conducted a comprehensive review of the literature published in the last 10 years addressing the subject of treatment modality selection for ruptured intracranial aneurysms. Another research was performed in order to analyze recommendations for the treatment of incompletely occluded aneurysms.

The senior author of this paper operated in the last two years sixteen patient with recurrent, previously coiled, aneurysms. We analize their surgical management and outcome.

3 Results and discussion

Exclusion of the aneurysm from the general circulation aims at preventing rebleeding and its devastating consequences. The best treatment should at the same time reduce the number of poor outcomes (death or dependency). We therefore assess efficacy of treatment taking into account the number of poor outcomes, mortality and rebleeding rates. Angiographic results are related to the risk of rebleeding so they are also discussed here.

4 Clinical outcomes

Several studies have addressed the issue of poor outcome rates when it comes to compare EVT and surgical clipping for ruptured aneurysms. The ISAT study showed that 30.6% of patients treated with open surgery had a poor outcome at 1 year follow-up, whereas only 23.7% of patients allocated endovascular therapy were death or dependent at that time [1,2].

However, ISAT has been criticized for its selection bias. Recruitment rate was very low with more than 80% of screened patients being excluded from the study. Moreover, almost 90% of patients included had a favorable grade (WFNS class I or II) and the great majority of aneurysms were small (less than 10mm diameter) [3]. So, can we generalize these results? The truth is that coiling is being offered to patients who were not suitable for inclusion in ISAT. A recently published metaanalysis by Hui Li et al. [3] included studies between 1999 and 2012 with 11568 participants. There were 4 randomized controlled trials (RCT) and 23 observational studies that met the inclusion criteria. 13 studies assessed poor outcome rate (death or dependency) at 1 year. RCTs yielded the following results: 31.1% poor outcome average rate for surgical treatment and 23,4% for coiling. This corresponds with the Cochrane review. Observational studies however, showed an average of 30% poor outcome for clipping and 29,8% for coiling at 1 year. 5 studies that included 2862 patients, stratified outcome by preoperative grade. There was no difference between both treatments for patients with poor preoperative grade [3]. Coiling yielded better outcomes in the good preoperative grade group. Mortality at 1 year showed no statistical significant difference [3]. However, most studies provide 1 year all-cause-mortality and fail to provide case fatality reducing reliability. 3 trials with long term follow up (26,7 months to 5 years) assessed mortality and coiling was still associated with better outcome; 10.7% mortality vs 13,2% for clipping. The ISAT long-term follow up also showed a lower mortality rate at 5 years for the coiled group, but the number of independent patients at this time was no longer significantly different [4, 5].

The Barrow ruptured aneurysms trial (BRAT) showed a 10.5% difference favoring coiling for better outcomes at 1 year follow-up [6]. This difference remained significant for older patients (age 50 or more) and poor grade hemorrhages (Hunt & Hess greater than 2). In this group, clipping was 72% more likely to have a poor outcome. Mitchell et al. (2008) [7] analyzes age-specific outcomes for clip ligation and coil embolization of ruptured aneurysms in the ISAT.

It concludes that advantage of coil embolization over clip ligation cannot be assumed for patients 40 years old or younger. The difference in the safety of the two procedures is small and the better long-term protection from bleeding afforded by clip placement may give this treatment an advantage in life expectancy for young patients [7].

5 Re-canalization and rebleeding. Need for re-treatment

Regarding re-bleeding we must say that this is a relatively rare complication for treated aneurysms with total or near-total obliteration. The Cerebral Aneurysm Rerupture After Treatment (CARAT) study evaluated the risk of rebleeding in 1001 patients along a 4-year period follow-up [8]. There were 19 reruptures at 3 days median time and 58% of these patients died. The risk of rerupture is 1,1% with complete occlusion, 2,9% with near-total occlusion (91-99% of the volume of the aneurysm), 5,9% for partially occluded aneurysms (70-90%) and 17,6% for aneurysms with less than 70% of their volume occluded.

Tamatani et al. [8] demonstrated a strong correlation between stability of aneurysms and their embolized volume. Partially occluded aneurysms tend to be unstable lesions. It is agreed that approximately one third of coiled aneurysms will become recanalized, particulary under high shear stress and high flow velocity conditions. Persistent aneurysm filling after coil embolization has been reported in 31% (Raftopoulos) to 60% of cases (Kuether). Murayama et al. published one of the articles with the longest follow-up time, 11 years. They found that 45% of aneurysms had persistent filling at first angiographic control post-embolization and 21% had recanalized during this observation period [9]. Most endovascular series report 60-90% total or near-total occlusion rates at first treatment. However, these rates drop to 10-20% less at the time of follow-up examinations. Thus, there is a large group of patients harboring potentially dangerous recurrent or residual lesions after coiling [9].

The ISAT revealed that rebleeding rates are 0,3% per year greater with coil embolization. Early rebleeding (during the first 30 days after treatment) was the most frequent: 1,9% for coiling vs 0,7% for clipping. Lanzino et al. mention that rebleeding rate in the first month after coil embolization might reach 2,7% 10.

A follow up study of the patients treated in the ISAT was performed to compare the frequency and consequences of aneurysm recurrence. Retreatment was performed in 17.4% of patients after primary endovascular coiling and in 3.8% of patients after neurosurgical clipping [2,4,5]. Late retreatment was 6.9 times more likely after coiling. Younger age, larger lumen, size, and incomplete occlusion were factors for late retreatment after coiling.

Byrne, Molyneux et al. followed 317 coiled patients for 5 years. They found a 15% recurrence rate with an annual rebleeding rate of 1-2% in general. 8% of recurrent aneurysms rebleed [11]. Van der Schaaf et al. performed a metaanalysis that rendered fewer poor outcomes with coil embolization but a higher rate of rebleeding and incomplete angiographic occlusion [9].

An update of BRAT including 6 year-results demonstrated that clipping is better than coiling for aneurysms of the anterior circulation. Only 48% of the aneurysms who were coiled remained completely occluded at 6 years follow up. Clipping provided a 96% rate of complete obliteration. 13% of the coiled aneurysms needed retreatment, whereas only 4% of the clipped ones did. Rebleeding rate was 2.5 to 6 times higher for coiling. Last, only 64% of the patients could be treated with coiling while clipping proved to be suitable for more than 99% of them [7,8,9,12].

Finally, both BRAT studies stated that the clip group had a higher degree of aneurysm obliteration and a lower rate of recurrence and retreatment.

At the moment, there is no evidence showing that coiling is superior to clipping in the long term, except for posterior circulation aneurysms. On the other hand for anterior circulation the BRAT showed a great difference between coiling and clipping, with better results for clipping [12,13]. Recently, Robert Spetzler showed the finally BRAT conclusions of ten years. This is not yet published. Spetzler showed it in the Neurosurgical World Congress in Istambul (August 2017). The final conclusion affirm even more that the open surgery it is better than the coiling. Just the 24% of the coiling aneurysms continue occluded after ten years of following.

All in all, we can say that the decision of wether to clip or to coil an aneurysm should be taken by a neurovascular team and it depends on the expertise of neurosurgeons and endovascular therapists. The aforementioned information as well as aneurysm location, neck width, size and shape must be considered along with the patient's medical and neurological status in order to choose the best treatment. As a rough guidance, we can say that factors in favor of clipping are: younger age, presence of space occupying

intracranial hematoma, and aneurysmspecific factors such as: location (anterior circulation aneurysms), wide aneurysm neck, or arterial branches exiting directly out of the aneurysmal sac [14].

6 Management of recurrent aneurysms

With the growing volume of aneurysms treated with endovascular methods and the unavoidable risks of incomplete coiling or recurrence, the volume of coiled aneurysms requiring surgical management is growing. The paper published by Zhang and Barrow illustrates neurosurgical management of 40 intracranial aneurysms previously treated with endovascular therapy. This is a large cases series with a 7-year period follow-up [15]. They indicate retreatment with surgery for patients whose unfavorable vascular anatomy or aneurysm configuration impede endovascular techniques. Depending on the patient medical and neurological condition, retreatment is recommended when an aneurysm is less than 90% obliterated (partial occlusion criteria) or if progressive growth of the remnant is demonstrated [16]. Retreatment choice should be individualized on the basis of the remnant's anatomy and available neurosurgical and endovascular expertise. Recurrent aneurysms can be treated with endovascular therapy using more recent adjuncts such as improved coils, stents or balloon remodeling. Ringer and Lanzino found in their prospective multicentric study of 311 patients, that pretreatment with coils had a low risk (1,28%) of death or major disability [17].

Repeated embolization, however, may complicate further treatment and may predispose patients to fatal complications. Surgery, on the other hand, is difficult and technical challenges should be anticipated. It should be reserved to lesions that are not amenable to further endovascular therapy, and specially for young patients with surgically accessible aneurysms [16,18,19]. A coiled aneurysm is no longer soft and manipulable. It tends to be rigid and coils might be encountered at the neck thus making clip placement difficult. Coil strands can be found incorporated into the parent vessel as soon as 2 weeks after treatment [6]. They might also be seen extruding into the subarachnoid space through the aneurysm's fundus in a dense scar tissue. Coils usually transform the wall of the aneurysm into a thin transparent membrane. This is the so-called "coil acid effect" by Hernesniemi [16]. Therefore, removing coils involves high risk of tearing the parent vessel or damaging the aneurysm wall during surgery. Horowitz, Solomon and Zhang suggest that coils be removed only when absolutely necessary to achieve clipping [11]. Romani and Hernesniemi have shown that coil removal is associated with an increased risk of poor surgical outcomes [16].

Dorfer and col. [20], report management of 127 patients with residual and recurrent aneurysms after coil embolization for over 18 years. 60% of them underwent re-coiling and 40% were elected for surgery. They conclude that an individualized approach resulted in complete occlusion of almost 90% of these aneurysms. Treatment morbidity was 11.9%, without significant differences between surgical (15.6%) and endovascular (9.3%) patients (P = .09). Recurrences from coil compaction were safely treated by re-embolization, whereas recurrences from aneurysmal regrowth may best be managed surgically when technically feasible [21-23].

Waldron and Lawton reported an interesting case series 24. They remark that coil extrusion occurs more often than expected and is often misdiagnosed as simply compaction. They recommend direct clipping as the preferred microsurgical treatment. "Clippability" of a coiled aneurysm could be predicted by the relationship between coil width and compaction height. If the C/H ratio is greater than 2.5, then the aneurysm will probably not be amenable to simple clipping and will require complex clipping (thrombectomy or coil extraction) or other techniques (by-pass or wrapping). Aneurysms with broad coil widths or shallow compaction heights have a wedge angle greater than 90 degrees, which prevents the clip blades from closing, forces the clip to slide down the aneurysm neck, and often occludes important branches or parent arteries.

In our series, 16 patients out of 88 operated in the last two years had recurrent aneurysms. They had all been treated by endovascular coiling three months to two years before. The diagnosis of recanalization was made a few months after endovascular treatment in all cases with the control angiography. All of them showed progressive compaction of coils in successive angiographic controls. In our experience, surgical clipping could be easily performed, even though in five of these cases we found coil strands in the neck

of the aneurysm. Only twice did we need to open the aneurysm fundus and remove coils. This maneuver allowed us to replace the clips successfully without producing any kinking of the arterial branches. These two cases corresponded to patients with big o giant aneurysms. There was no mortality or morbidity in our series. This is a small series and our results have no statistical value, they are only anecdotical but, still, important to report.

To conclude, we recommend that once coiling has failed, no further attempts to re-coil should be done. Surgery is preferable for accessible aneurysms and even some times for posterior circulation aneurysms.

7 Conclusions

The following conclusions are not guidelines but only suggestions based on our research of evidence and personal experience. For ruptured aneurysms in patients with good preoperative grade, endovascular treatment has better clinical outcomes at 1 year. This is not sustained in the long term and cannot be assumed for young patients (<40y). For aneurysms of the anterior circulation the rate of occlusion and the possibility of treatment is better with clipping that coiling.

For patients with poor preoperative grade, there is no difference between clipping or coiling. In cases where the aneurysm appears to be equally effectively treated either by coiling or clipping, we recommend clipping for young patients. The main reason is that endovascular treatment has a greater chance of incompletely occluding aneurysms, which increases the risk of recanalization and rebleeding. Aneurysms that show progressive recanalization or those that are partially occluded (<80- 90%) are at high risk for rebleeding.

For recurrent aneurysms, retreatment should be indicated in the presence of symptoms deriving from mass effect, when the occluded volume is less than 80-90%, or if persistent growth of the remnant is documented. Treatment choice depends on the vascular anatomy of the remnant, predictors of clippability and mechanism of recurrence (regrowth or coil compaction). The authors recommend surgery as a more durable treatment with low morbidity. We agree that coil removal should not be attempted unless absolutely necessary.

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