Balloon-assisted coil embolization of intracranial aneurysms: incidence, complications, and angiography results

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Object. The aim of this study was to assess the incidence, indications, complications, and angiography results associated with balloon-assisted coil embolization (BACE) of intracranial aneurysms and to compare these factors with those for conventional coil embolization (CE).

Methods. Between 1995 and 2005, 827 intracranial aneurysms in 757 consecutive patients were packed with coils. Balloon-assisted coil embolization was used in 8.6% (71 of 827) of the coil insertion procedures and was more frequently used in large aneurysms, unruptured lesions, and those located on the vertebrobasilar system and carotid artery. Procedure-related complications leading to death or dependency were significantly higher in BACEs (14.1%) compared with those in CEs (3%). Packing densities and the results of 6-month follow-up angiography studies did not differ significantly between the two types of treatments. There was a strong trend for a higher retreatment rate in the aneurysms treated with BACE.

Conclusions. Balloon-assisted coil embolization of intracranial aneurysms is associated with a high complication rate and should only be used if conventional CE of these lesions is impossible or has failed and if anticipated surgical risks are too high. The BACE procedure does not improve the occlusion rates of the aneurysms on follow-up evaluation.

KEY WORDS • intracranial aneurysm • coil embolization • complication • balloon-assisted coil embolization

The BACE, or reconstruction or remodeling technique, in the treatment of wide-necked intracranial aneurysms was introduced by Moret and colleagues in 1997. Since then, several authors have reported on the safety and efficacy of BACE. Procedural complications were reportedly low, and angiography results were good and stable. Note, however, that this information was gleaned from studies in which either there were a small number of patients or the researchers did not compare the results of BACE and conventional CE. In the present study, we evaluated the indications, complications, packing density, angiography results, and retreatment rates associated with 71 intracranial aneurysms treated using BACE and compared these factors with those associated with 756 aneurysms treated using CE.

Clinical Material and Methods

Between January 1995 and January 2005, 827 intracranial aneurysms in 757 consecutive patients were embolized at our institution. For the purposes of this study, indications for treatment, procedural complications, and angiography results were assessed for every aneurysm rather than for every patient.
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Packing system (Solstice; Medtronic MIS, Sunnyvale, CA), and a 15-mm balloon (Sentry; Boston Scientific). These balloons were used in wide-necked aneurysms only. In approximately one half of the cases, BACE was performed after conventional CE had failed; in the other half, as the primary method because of anticipated difficulties.

Comparison of Indications and Procedural Complications

The following indications and lesion characteristics in the 71 intracranial aneurysms treated with BACE and 756 aneurysms treated with CE were compared: previous subarachnoid hemorrhage, aneurysm location (categorized as anterior cerebral artery, carotid artery, vertebralbasilar artery, and middle cerebral artery), and aneurysm size.

Procedural complications leading to dependency or death in the 71 cases treated using BACE were compared with those in the 756 cases treated using CE.

Packing Density, Follow-Up Angiography Studies, and Additional Treatments

Packing density could be calculated in 49 of the 71 aneurysms treated with BACE and in 493 of 756 aneurysms treated with CE by using methods previously described. Results of the 6-month follow-up angiography study, dichotomized into (near-) complete (90–100%) and incomplete occlusion (< 90%) groups, were compared for both treatments, as were the results of additional coil placement procedures and/or surgeries. Extended angiography follow-up data and the final result in the 71 aneurysms treated with BACE were assessed.

Statistical Analysis

Using commercially available software, statistical analysis was performed: the chi-square test for a comparison of the proportions and the t-test for a comparison of the means (MedCalc, Mariakerke, Belgium). Probability values less than 0.05 were considered statistically significant.

Results

The BACE procedure was used in 71 (8.6%) of 827 aneurysms. It was more frequently used in large aneurysms, unruptured lesions, and those located in the vertebralbasilar system and on the carotid artery (Table 1). Among the 71 cases treated with BACE there were 10 procedural complications (14.1%) leading to death (six incidences) or dependency (four incidences; Table 2). These complications included thromboembolism in seven instances (9.8%) and rupture in three (4%). Among the 756 CEs, 23 procedural complications (3%) occurred, leading to death in 13 cases (1.7%) and dependency in 10 (1.3%). These complications consisted of thromboembolism in 17 cases (2.2%) and rupture in six (0.8%). Procedure-related complications leading to death or dependency were significantly higher in patients who underwent BACE compared with those who underwent CE (p < 0.0001).

The mean packing density was 22.7% (median 21.7%, range 10.7–37.8%) in aneurysms treated with BACE and 24.1% (median 23.1%, range 7.6–64.3%) in those treated with CE. This packing difference was not statistically significant (p = 0.21).

Six-month follow-up angiography studies of 608 aneurysms were obtained. There was no difference in the occlusion rates between the two types of treatments.

Of the 71 aneurysms treated with BACE, 12 (16.9%) were subjected to additional treatment: coil insertion in 10 and surgery in two. Of the 756 lesions treated with CE, 68 (9%) were subjected to additional treatment: coil insertion in 55 cases and surgery in 13. This difference was not statistically significant (p = 0.052).

Extended Angiography Follow-Up and Final Results in Aneurysms Treated With BACE

Among the 71 cases treated with BACE, 19 lesions in 19 patients did not have 6-month angiography follow-up data for the following reasons: refusal (seven patients), procedure-related death (five patients), death caused by sequelae of subarachnoid hemorrhage (four patients), additional therapy (clip application) before the angiography session (two patients), and unrelated death (one patient). At the 6-month follow up, angiography results in the remaining 52 cases were as follows: (near-) complete occlusion in 37 (71%) and incomplete occlusion in 15 (29%). Of the 37 aneurysms with (near-) complete occlusion, extended angiography follow-up data were available for 18, and all 18 lesions remained stable. Among the 15 aneurysms with incomplete occlusion, additional coils were placed in 10 (one additional coil session in eight lesions, two additional sessions in one aneurysm, four additional sessions in one aneurysm), clips were applied to two, and three aneurysms were left untreated. Final angiography results in the 10 patients with 10 aneurysms that had been packed with additional coils demonstrated (near-) complete occlusion. The median angiography follow up in the 52 patients treated with BACE was 18 months (mean 22.3 months, range 3–71 months).

The 15 patients with incomplete aneurysm occlusion at the 6-month angiography follow-up evaluation were clinically monitored for a median of 28 months (mean 41.7 months, range 6–102 months). One patient died of progressive brainstem compression of a basilar tip aneurysm that had been packed with coils twice, 40 months after the initial coil insertion. There were no rebleedings in this group.

Discussion

We found that BACE has a procedural complication rate
leading to death or dependency of 14%. Complications occurred significantly more often with this procedure than with conventional CE. The fact that aneurysms treated with BACE were larger, more often located on the carotid artery and in the vertebralbasilar system, and more often unruptured does not explain this higher complication rate, because it has been shown that these factors hardly influence complication rates. 

It is plausible that both the higher incidence of procedure-related embolic complications and ruptures can be largely attributed to the use of the temporary supporting balloon. In contrast to CE, the BACE technique requires the introduction of an additional microcatheter with its inherent higher risk of thromboembolic events as shown by Soeda and colleagues in their study involving diffusion-weighted magnetic resonance imaging after BACE. This finding was not confirmed in a similar study by Albayram and associates, although more thromboembolic events were reported with increased microcatheter and coil manipulations and a larger aneurysm neck. Furthermore, the tendency for procedural rupture to occur when the microcatheter is fixed by the balloon has been described.

Complication rates of BACE in previous studies have varied between 0 and 5.3%. Although a direct comparison may not be valid because of possible differences in patient and aneurysm selection, we cannot explain the large discrepancies in the complication rates reported in previous studies and those in the present study. Moreover, we could not confirm the excellent angiography follow-up data reported by the authors of those studies. On the contrary, we found a trend for worse angiography results as well as a higher retreatment rate in the aneurysms treated with BACE. This result is not surprising because the median size of the aneurysms treated with BACE was larger, and size is the most important risk factor for reopening over time. Packing densities obtained in aneurysms treated with BACE were slightly lower than those for aneurysms treated with CE. Thus, the general opinion that BACE in itself increases packing density is not valid. At best, one can postulate that BACE relatively increases packing in these large and wide-necked aneurysms.

Given that the complication rate associated with BACE is high and that the angiography results are poor, surgical clip application should be considered as a first treatment option in large and wide-necked aneurysms. However, the surgical complication rate is higher in these aneurysms, especially when the lesions are located in the posterior circulation. In contrast, although angiography results of coil insertion in very large and giant aneurysms are poor and additional therapy is frequently needed, the clinical outcome in patients is good.

Our results do not imply that we should refrain from using BACE; some aneurysms would be untreatable, both endovascularly and surgically, without the use of a supporting balloon. Nonetheless, we believe that BACE should be restricted to aneurysms in which conventional CE is obviously impossible or has failed and anticipated surgical risks are too high. Perhaps the use of endovascular stents as supporting devices will become an alternative to BACE, but complication rates with these devices are also substantial and the required use of rigorous antiplatelet medication remains a major drawback.

Conclusions

In summary, BACE treatment of intracranial aneurysms is associated with a high complication rate and should only be used if conventional CE is impossible or has failed and if anticipated surgical risks are too high. The BACE procedure does not improve occlusion rates of aneurysms on follow-up.

References


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