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Basilar bifurcation aneurysms. Lessons learnt from 40 consecutive cases

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Summary

Basilar bifurcation aneurysms are lately treated frequently with endovascular technique. Microsurgical clipping occlusion technique has, however, still its solid position because of its completeness. This standard technique is required often due to unfeasibility and/or incompleteness at the time of application of the endovascular technique for aneurysms of this location. The authors suggest following strategies and tactics for safe and secure occlusion of aneurysms of this location: pterional approach, selective extradural anterior clinoidectomy SEAC, no transection of the posterior communicating artery, isolation of perforating arteries at the time of neck clipping with oxycellulose and combination of the use of fenestrated clip and conventional clip (especially for aneurysms projected posteriorly), controlled hypotension (systolic pressure of around 100 mmHg), temporary clipping (trapping) procedures of usually less than 15 min.

All these are aimed for prevention of intraoperative premature rupture, and of injury of perforating arteries and for complete occlusion of aneurysms in the narrow depth of the operative field.

Keywords: Basilar bifurcation aneurysm; selective extradural anterior clinoidectomy SEAC; perforating artery injury; microsurgical neck clipping; endovascular coiling.

Introduction

Treatment of basilar bifucation aneurysms has always been a challenging topic even since the introduction of microsurgery. In patients with relatively good risk, mortality of less than 10% (ranged 2–8%) and good outcome between 70–80% have been reported by neurosurgeons of extreme expertise [3, 9, 10, 12, 13, 16]. Perforating artery injuries rendering unfavourable results have been reported between 7–10% [3, 9, 12]. Introduction of the endovascular coiling method and its application to basilar bifurcation aneurysms has become another modality of treatment [6, 13, 15]. The immediate results have been reported as good or even better as compared to direct clipping methods. Incomplete occlusion of more than 10%, coil compaction of around 25% and impossible to perform coiling procedures of around 5% [13, 15] have been often enumerated to be the common drawbacks of coiling procedures. So the microsurgical treatment is still considered to be the standard method also superior to the endovascular treatment as a result of its completeness.

The purpose of this communication is to describe our recent strategies and tactics at the time of the microsurgical management learnt from our experience of more than 40 consecutive cases of aneurysms of this location.

Patients and results

From 1993 through October 2003, 42 cases (female 31 vs male 11) of basilar bifurcation aneurysm were surgically treated in our department. The age ranged from 28 to 81 years old with median of 50.2 years old. Ruptured aneurysms amounted to 31 cases (74%), unruptured 2 cases (5%), incidental 7 (17%) and symptomatic 1 (2%). Postoperative outcome at 3 months were as follows (Fig. 1): Good recovery GR 29 (69%), Moderately disabled MD 6 (14%), Severely disabled SD 1 (2%), Vegetative state VS 4 (10%), Dead 2 (5%). Complete neck clipping was possible in 88% of cases. The observed surgical complications were: perforator injuries 4 (9.5%), residual neck 2 (4%) and rupture 1 (2%) which took place four months later at the site where a complete neck clipping could be initially performed.

Discussion

Preoperative evaluation of angiography

Beside size, form, neck width, direction of aneurysms and their geographical relation to both P1 origins, height of aneurysm neck has been considered to be of cardinal importance to evaluate technical difficulties beforehand and to select the suitable approaches [19].

Height of aneurysm neck on angiography (lateral view) in most of the cases was within the range of 1.5 cm above the posterior clinoid process PCP. In five

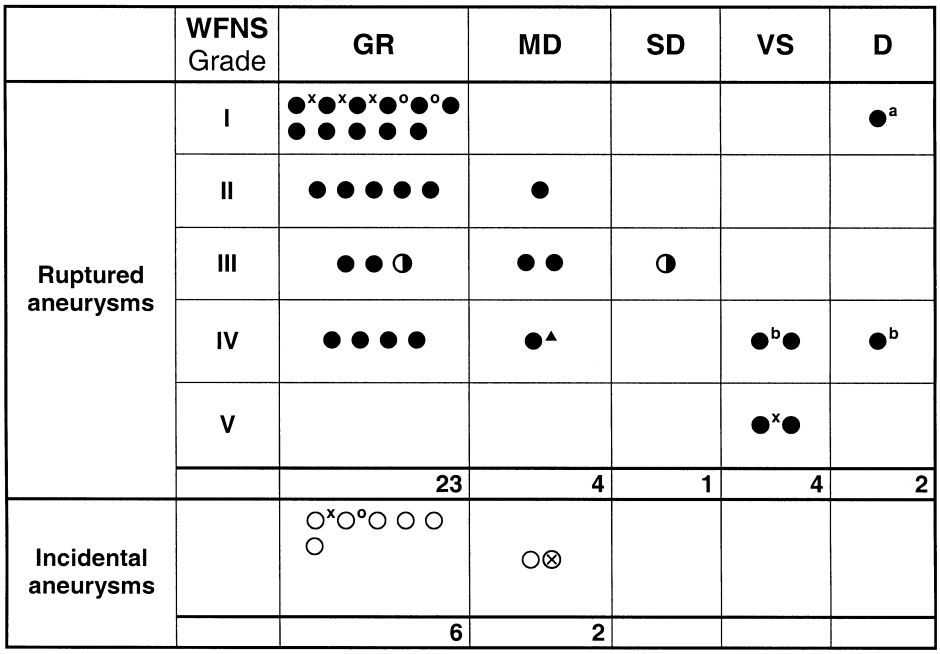

Fig. 1. Outcome of microsurgical treatment of basilar bifurcation aneurysms. Outcome at three months: *GR* good recovery, *MD* moderately disabled, *SD* severely disabled, *VS* vegetative state, *D* death. ×: coiled after failed clipping procedure, ○: clipped after failed coiling procedure, ▲: coating, (*a*): giant aneurysm, (*b*): severe vasospasm, ⊗: symptomatic aneurysm, ◑: unruptured aneurysm

cases of this series (10%), necks were positioned lower than the level of the PCP: two of them (7 mm and 10 mm) were managed with subtemporal approach and the rest could be managed with pterional approach combined with selective extradural anterior clinoidectomy SEAC [20]. Need of further combination of posterior clinoidectomy depended on the distance between the PCP and the basilar artery trunk. The smaller this distance is, the more difficult is the placement of a permanent clip to the aneurysm neck or of a temporary clip to the basilar artery without additional use of posterior clinoidectomy. So the distance of more than 5 mm between the PCP and the basilar artery signifies some technical ease of this procedure also in cases with low positioned aneurysms.

Craniotomy with SEAC

There is no doubt that the subtemporal approach pioneered by Drake *et al.* is one of the standards approach for the basilar bifurcation aneurysm [2, 3]. Especially this has been reported to be effective in preservation of the perforating arteries running at the posterior surface of the aneurysm of this location even of those aneurysms that are posteriorly projected. One of the main drawbacks of this approach lies in the use of it in aneurysm cases where there is accompanying brain swelling at the acute stage of bleeding. We applied subtemporal approach only in three cases with low positioned aneurysms. In one of these cases presenting at the subacute stage of bleeding and with the height of the aneurysm neck 3 mm below the PCP, surgery through this approach was interrupted because of swollen brain and therefore the patient was operated upon later with the classical pterional approach with additional SEAC.

Pterional approach developed by Yasargil *et al.* [17] was applied for all cases except for cases mentioned above and SEAC was combined (except for four cases in the early series) in 90% of cases. One of the great advantages of pterional approach is considered to be applicability also for surgery in the acute stage, especially in combination with SEAC and with opening of the lamina terminalis for cerebrospinal fluid CSF drainage [19]. The SEAC procedure adds several advantages to surgery: a wider working space hence also better illumination and better mobility of the internal carotid artery and the optic nerve, this being of cardinal importance [20]. Posterior clinoidectomy [16] and/or transcavernous approach [4] to the aneurysm can be performed with more ease (Fig. 2). SEAC procedure has been reported to enlarge the carotid-oculomotor space and the opticocarotid triangle OCT to more than double [5, 22] so that the space gained can be

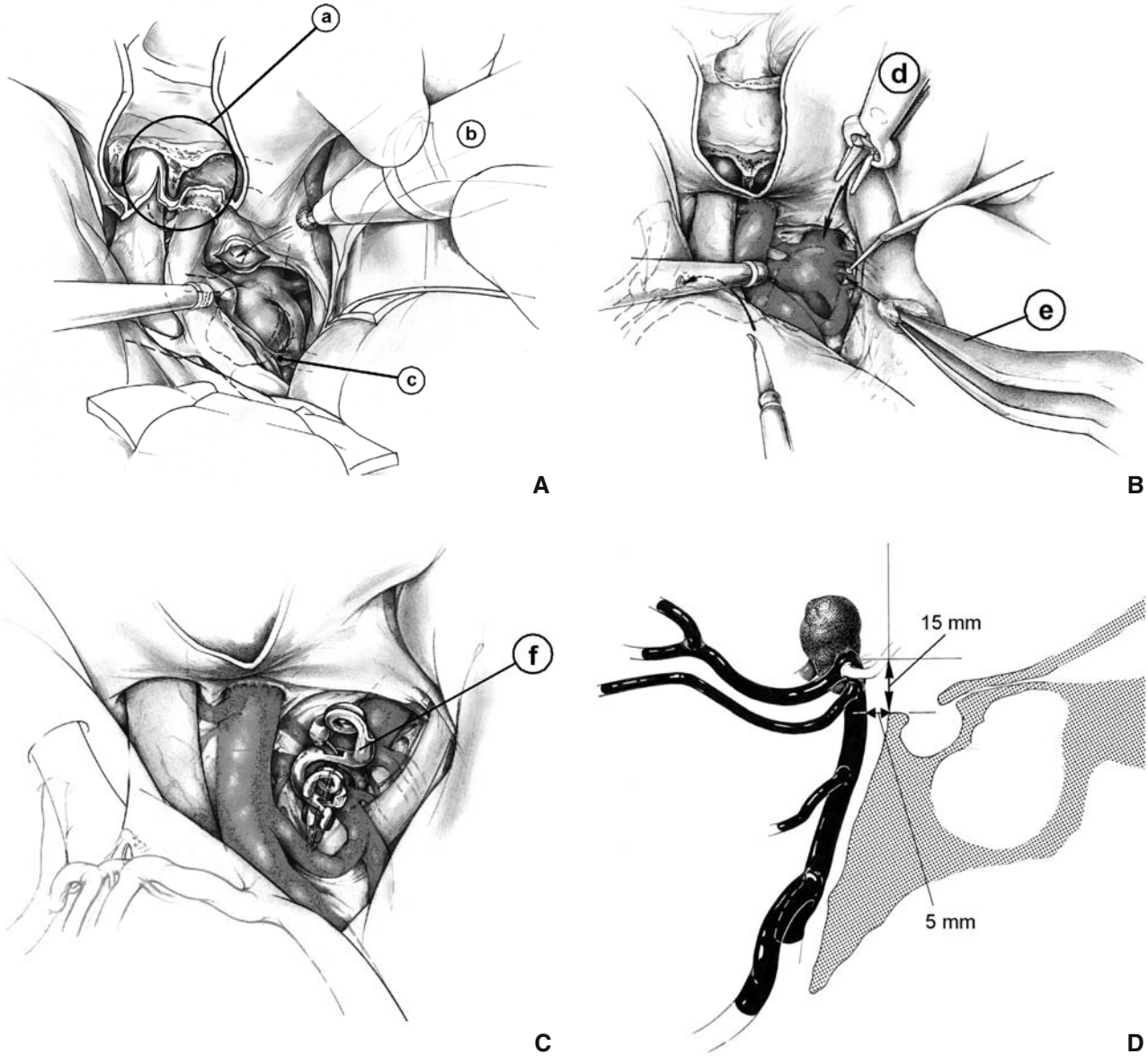

Fig. 2. Artists drawing of our procedure in the microsurgical treatment of basilar bifurcation aneurysms by pterional approach. (A) *a* SEAC, *b* Posterior clinoidectomy, *c* O – no transection of the Pcom A. (B) *d* Temporary clipping. *e* Oxycellulose insertion. (C) *f* Combined clipping procedure with the use of a fenestrated clip and a straight clip in which P1 and a part of the aneurysm neck incorporated to the P1 is preserved at the fenestration of the former clip. The distal part of the incompletely occluded aneurysm is closed with a straight clip. (D) PCP-basilar artery distance: if the distance is more than 5 mm, clipping procedures can be performed with more ease even if the aneurysm necks are 3 mm below the level of PCP

used more effectively for placement of a temporary clip even to the opposite P1 and for placement of a permanent clip to aneurysms of relatively high position.

Transection of the posterior communicating artery

This technique has been recommended to be a helpful and harmless procedure for the access to aneurysms of special location [17]. However, the occurrence of tuberothalamic infarction due to ischemia of the anterior thalamoperforating arteries territorial supply especially after transection of the posterior communicating artery PcomA [1, 11] is becoming increasingly evident. This transection was performed in 15 of cases of our early series: 11 cases were without any neurological and neuroradiological sequellae, 3 cases presented with initial slight hemiparesis followed by complete recovery as a consequence of tuberothalamic infarction

on CT scan, and 1 case presented with persistent hemiparesis along with the infarction extending to the posterior limb of the internal capsule. The complication of persistent hemiparesis was considered to be due to an individual variation of the perfusion territory pattern of the sacrificed anterior thalamoperforating arteries arising from the PcomA. After this complication of persistent hemiparesis, our strategy of the use of PcomA transection as a routine procedure has been abandoned. Additionally the introduction of SEAC has also made this procedure unnecessary. However also to mention is that this type of infarction was also observed in a further two cases of this series with subarachnoid hemorrhage SAH without a PcomA transection.

Temporary clipping and trapping

Temporary clipping method (including temporary trapping method in about half of the cases) to obtain secure aneurysm dissection and appropriate placement of permanent clip was used in all but one case. In 75% of the cases the duration was of less than 15 min. The rest ranged between 15 min and 30 min. The longest duration was 40 min. During the aneurysm dissection the blood pressure was controlled and maintained at 100 mmHg of systolic pressure, under which local cortical bood flow lCBF measured with thermal clearlance probe did nit change from the orginal lCBF values. As additional neuroprotective measures Mannitol, barbiturate and heparine were used in accordance to our protocol prior to and during the temporary clipping procedure [18]. Damaging sequellae due to temporary clipping procedure could not be detected in our series except for in one case presenting with bilateral thalamic infarction presumably due to timing of surgery being carried out at the very stage of vasospasm.

Posteriorly projected aneurysms

Beside height and size of aneurysms, their projection have been considered to be one of the factors which make clipping procedures difficult especially at the time of pterional approach, as the running course of perforating arteries is behind aneurysms and therefore hidden in this projection. Subtemporal approach has been reported to be superior to the former for the management of such aneurysms at the time of dissection of perforating arteries from aneurysms and hence their preservation [3]. But even with subtemporal approach this dissection procedure in the depth is troublesome especially in the presence of swollen brain at the acute stage of SAH.

In this series five cases of which recently three were treated successfully with the method of insertion of oxycellulose between the back side of the aneurysm and perforating artery for isolation [7, 14] followed by occlusion of aneurysms by combination of a fenestrated clip and a conventional clip have been reported elsewhere [21].

Others

For extremely high positioned aneurysms, some special approaches have been reported: transorbital transzygomatic approach and transthird ventricular approach followed by subfrontal interhemispheric approach [8]. Although we did not encounter the need of these approaches in our series, as none of the aneurysms were of such extremely high position, one might take into consideration the approach of transrostrum corporis callosi-lamina terminalis. This approach has been developed for craniopharyngiomas or hypothalamic tumors extending into the third ventricle and into the intercrural and prepontine cistern [18]. This approach offers an unexpextedly wide view of the upper part of the basilar artery after opening the lamina terminalis and the floor of the third ventricle by a one sided (non dominant side) craniotomy without compromising either the olfactory nerve or the frontal sinus. Preservation of hypothalamic branches running on the lamina terminalis and the wall of the third ventricle is considered to be mandatory to prevent postoperative deterioration of cognitive function.

This series includes five cases that required an additional endovascular coiling procedure due to incompleteness or impossibility of neck clipping and four cases of neck clipping procedures; two cases of posteriorly projected aneurysms, a case of residual neck of one large aneurysm, a case of large aneurysm with calcificed neck and a case of a de novo aneurysm after neck clipping of basilar – superior cerebellar artery aneurysm 12 years ago in which neck clipping procedure was hampered by previously placed clips. This series includes, on the other hand, three cases after coiling procedures; one case of coil compaction (Fig. 3) and two cases of unfeasibility of the coiling procedure due to small size of the ruptured aneurysm and due to tortuousness of vessels.

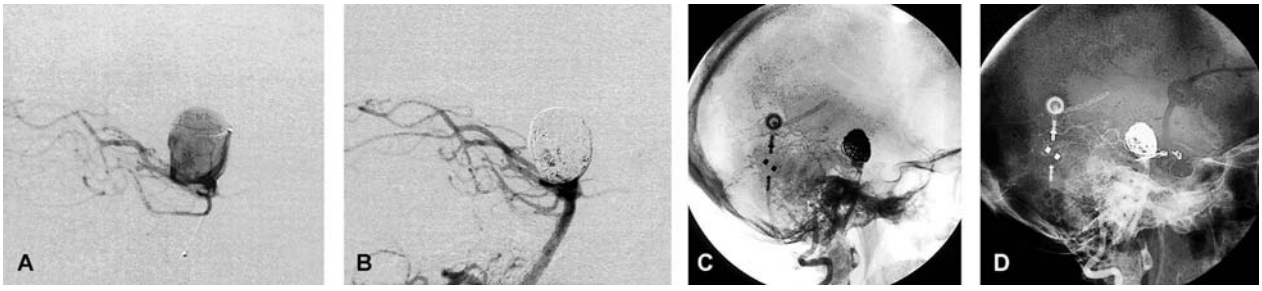

Fig. 3. A case of coil packing followed by clip occlusion. (a) Before coiling. (b) Directly after coiling. (c) 3 months later. (d) Follow-up angiography after the clipping.

Conclusion

Microsurgical occlusion of basilar bifurcation aneurysms should be the standard treatment of use in the face of the presently developing endovascular techniques due to the completeness of aneurysm occlusion acquired through this procedure. After having experienced more than 40 consecutive cases of basilar bifurcation aneurysms, the authors describe their strategies and tactics in the surgical management of basilar bifurcation aneurysms along with the surgical outcome. The safe and effective use of SEAC procedure along with pterional approach, no use of the technique of PcomA transection, clips-combination technique along with use of oxycellulose insertion for posteriorly projected aneurysms and possible application of transrostrum corporis callosi-lamina terminalis approach for extremely high positioned aneurysms have been emphasized.

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