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Three cases of AVM at eloquent areas finally treated with conventional microsurgical method

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Summary

Three special cases of AVM finally treated with conventional microsurgical method are presented. Two cases of medium sized AVMs were located at the central region, one of them was primarily treated with Gamma-knife followed by endovascular embolization having been complicated with growing cyst formation followed ultimately by microsurgical removal. The AVM of another case was embolized three times, followed by removal of the residual nidus under awake surgery. The third AVM located at the hypothalamus in the vicinity of the optic nerve was considered unsuitable for embolization and Gamma-knife therapy, and therefore removed by microsurgery using special approaches after a trial of embolization.

In terms of microsurgical removal, preoperative embolization, embolization material, awake surgery and selection of special approaches are discussed.

Keywords: Arteriovenous malformation; gamma-knife; cyst formation; eloquent area; embolization; awake surgery; approach.

Introduction

The introduction and use of additional modalities other than the classical microsurgical removal in the treatment of arterio-venous malformations AVMs such as embolization and stereotactic radiosurgery have changed the overall management of AVMs especially in terms of the currently practised indications, timing and combination treatment of these malformations. Three cases of AVMs located at eloquent areas and/or at functionally important structures finally treated with microsurgical removal are presented with special discussion on cyst formation after Gamma-knife therapy and several technical points inherent to surgical removal of AVMs. The significance of presurgical embolization, awake surgery and selection of special surgical approach is emphasized.

Case reports

Case 1 RT (Fig. 1). This 28 years old male had an intracerebral hematoma at the age of four in 1984 due to an AVM and underwent surgical evacuation of the hematoma. The medium size (6 cm) AVM was mainly located at the postcentral gyrus with a main feeder of the Rolandic artery and with drainers of the vein of Rolando and the vein of Labbé. He was primarily treated with Gamma-knife twice in 1987 and 1990 resulting in partial occlusion. The AVM presented with partial and generalized epileptic seizures which had recently become resistant to medication. Follow-up MRI in 2001 displayed increase in the size of AVM surrounded by two cysts. A cyst formation was noticed anterior to the nidus already at the time of check-up a year earlier. Another cyst of 3 cm in size was newly detected postero-supero-medial to the nidus without any neurological deterioration. The patient was hospitalized in 2002 due to neurological deterioration with increased spastic hemiparesis on the left side along with some sensory disturbance as a consequence of growth of the cyst with space occupying effect. The AVM was partially embolized followed by microsurgical removal of the AVM along with extirpation of both cysts in March 2003. Postoperative course was uneventful. Pathology of the cyst revealed to be gliosis containing a lot of calcification and some hyalinization. At the time of postoperative following up on 16. April 2004, the patient was doing well with slight hemiparesis but without any focal epileptic seizure under antiepileptic medication. Neuroimagings of MRI and MRA displayed complete removal of AVM nidus and cysts without any midline shifts.

Case 2 MC (Fig. 2). This 35 year old female suffered from slight weakness of the right extremity associated with dizziness, tinnitus and right sided ptosis three years ago (1999). AVM of 3×4 cm was found located at the postcentral gyrus and the inferior parietal lobule with main feeder of the Rolandic artery and with drainers of veins of Rolando. The first embolization procedure in 1999 at another institution resulted in partial embolization and was complicated with a right sided hemiparesis, which recovered almost completely within three months. The patient decided to have the AVM removed surgically due to the constant psychological stress. After an additional two staged embolization in our institution resulting in 80–90% occlusion of the nidus in 2003, microsurgical removal of the residual nidus was performed under awake surgery on 17. July 2003. The surgery was complicated with hemiparesis on the right side appearing 48 hours after surgery. Follow-up CT scan showed a small intracerebral hemorrhage probably of congested venous origin, which was not

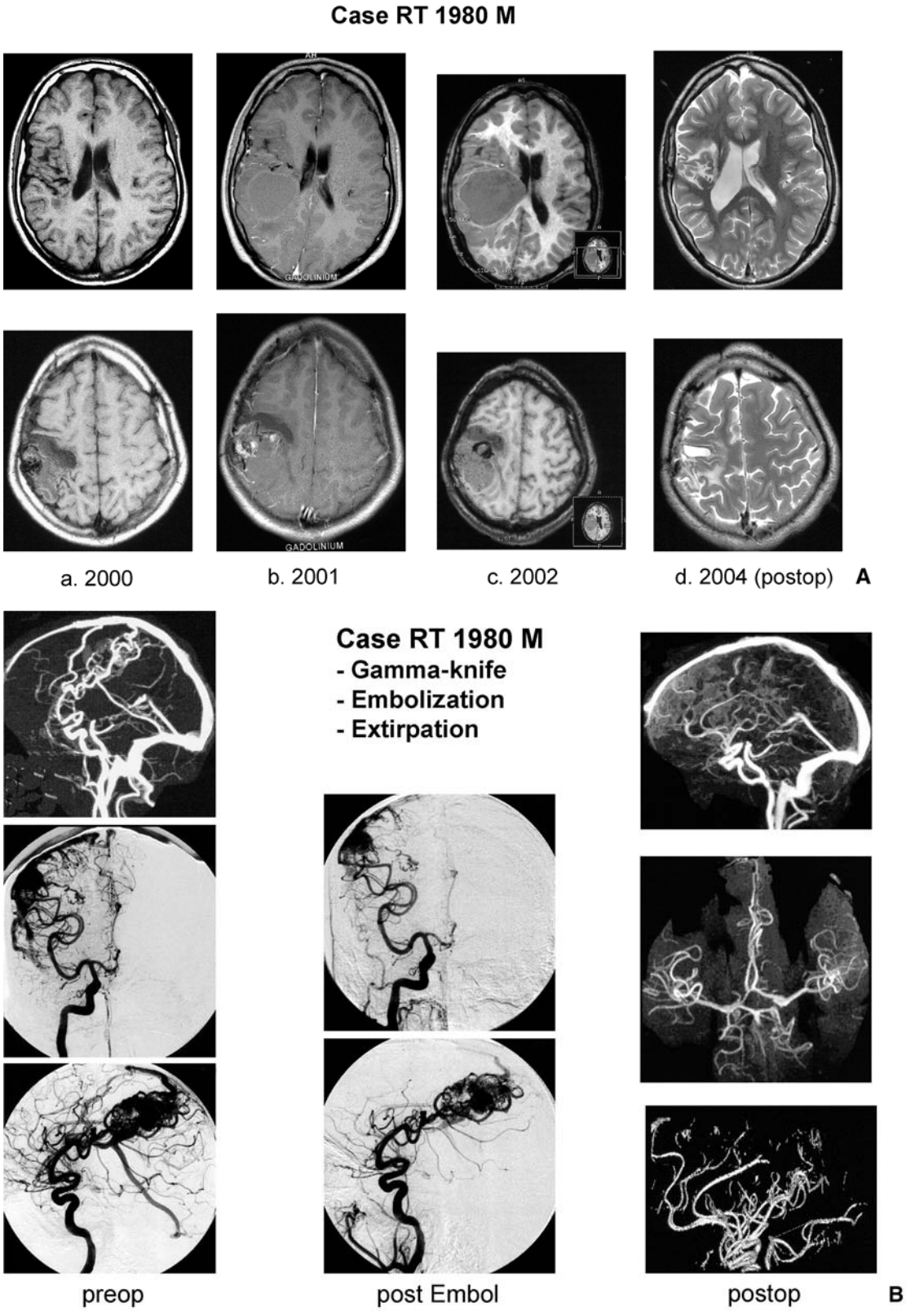
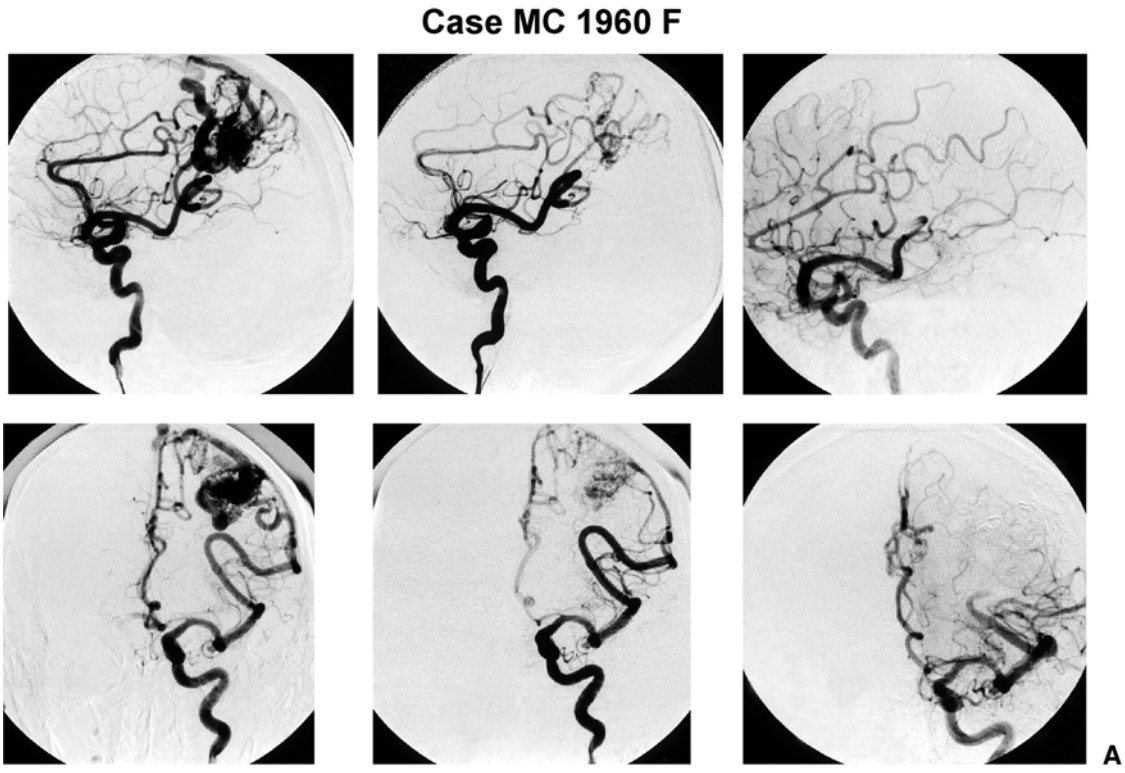


Fig. 1. (A) (a) 2000: 13 years after the first Gamma-knife therapy and 10 years after the second Gamma-knife therapy. Cyst formation at the post central gyrus and presumably beginning of another cyst fromation at the inferior parietal lobule at the very vicinity of the residual AVM nidus. (b) 2001: enlargement of the nidus and the cyst. (c) 2002: remarkable growth of the cyst with space occupying effect. (d) 2004: status after the removal of the cyst and the residual AVM. (B) Left column: MR angiogram and the conventional digital angiogram DSA displays the residual AVM after twice a Gamma-knife therapy. Middle column: DSA shows preoperative embolization of ca. 50% of the nidus. Right column: Postoperative follow-up MRA displays complete resection of the AVM corresponding with MRI picture of d.2004



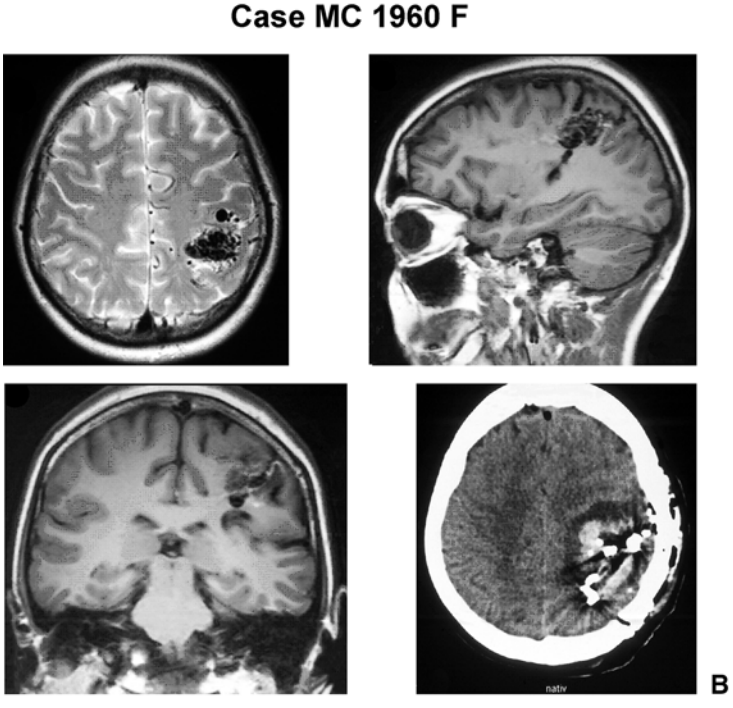


Fig. 2. (A) Left column: DSA 3 years after a partial embolization of the AVM. Middle column: after 3rd embolization resulted in ca. 80–90% occlusion of the AVM. Right column: State of complete removal of the nidus after awake surgery. (B) MRI before surgical removal of the partially embolized AVM. CT scan shows venous hemorrahge occurring 2 days after surgery

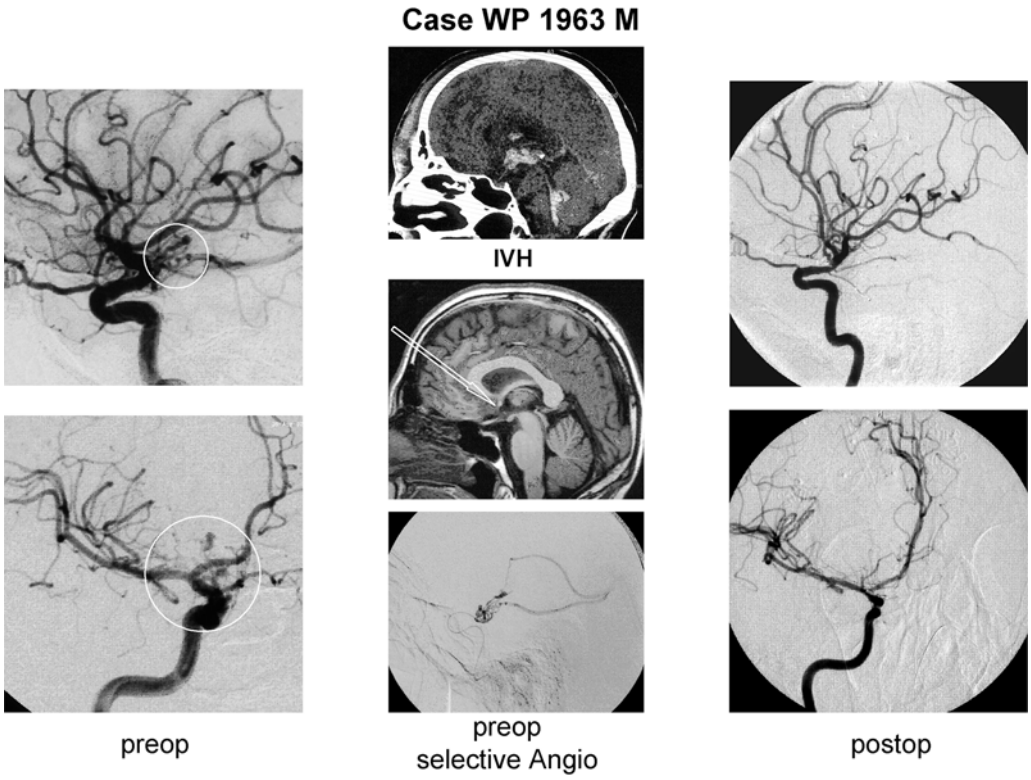


Fig. 3. Left column: Circles indicate the AVM nidus containing aneurysmatic components. Middle column: the sagittal CT view shows hematocephalus in which the third ventricle and the fourth ventricle are full of hematoma due to rupture of the AVM. Arrow indicates the access to the nidus via the RCCLTA. Bottom images indicates a super-selective angiography with the nidus at the hypothalamus and draining veins of the internal cerebral vein and the vein of Rosenthal. Right column: Follow-up DSA shows complete removal of the AVM

seen on CT scan taken the next day after surgery. Follow-up angiography displayed complete removal of the AVM. The hemiparesis subsided almost completely at the time of follow-up three months later and the patient returned to previous work.

Case WP (Fig. 3). 37 year old male suffered from SAH for the first time in 2001. The patient underwent partial embolization for the small AVM detected in the right hypothalamus at that time. The AVM bled again in April 2004 into the third and the fourth ventricle. The patient presented with generalized seizure associated with loss of consciousness. On angiography a small nidus of 1 cm with some aneurysmatic components was found in the right hypothalamus and in the very vicinity of the right optic nerve and the chiasm. The nidus was fed by direct branches of the right internal carotid artery and drained into the vein of Rosenthal and into the internal cerebral vein. After another trial of embolization, which was abandoned for fear of the risk of visual disturbances and hypothalamic dysfunction, direct microsurgical removal was performed in April 2004 with the right pterional approach plus selective extradural anterior clinoidectomy SEAC in combination with a transrostrum corporis callosi–lamina terminalis approach TRCLTA. Part of the nidus located at the lateral eminence under the right optic tract could be removed by the former approach and the remaining nidus with extension into the right hypothalamus with aneurysmatic component was removed by the latter TRCLTA after an additional right sided frontal craniotomy. Careful treatment in the intensive care unit was necessary for a couple of weeks: long lasting disturbance in consciousness, diabetes insipidus associated with electrolyte disturbances due to hematocephalus and hypothalamic syndrome. It took several months for the patient to recover (outcome of moderate disability) with some recent memory disturbances but with neither visual disturbance nor hemiparesis.

Discussion

Three cases of AVMs finally treated with microsurgical removal are presented. These are specific examples in which other treatment modalities were primarily applied for years because of the AVM location in eloquent cortical and subcortical sites and of their difficult surgical accessibility. Discussion will be focussed on the following topics.

Cyst formation after Gamma-knife therapy of AVMs

Among complications of Gamma-knife therapy, cyst formation due to gliosis and spongy degeneration of the brain tissue has been reported to be rather infrequent and to be benign, so that need of surgical treatment seems to be exceptional [4, 6–8, 10]. Our case with medium sized AVM submitted to Gamma-

knife therapy twice resulted in partial obliteration of the nidus and in cyst formation after 10 years showing that a careful follow-up is mandatory and for a long time duration. Once this complication is found out especially in the presence of residual nidus, opimal timing of removal of the residual AVM and the cyst should not be overlooked.

Preoperative embolization and embolization material

It is now evident that endovascular embolization alone itself can complete AVM treatment in considerable cases [10]. On the other hand, there is so far to date no publication known to prove systematically the benefit of presurgical partial embolization in a large series of AVM patients. We support, however, the view that preoperative embolization makes microsurgical removal easier: less intraoperative bleeding due to partial embolization, decreased numbers of feeding arteries from the depth. For this purpose, merits of embolization with liquid material such as EVAL was reported [4], but embolization with bucrylate turned out to have several advantages, although a rigid or solid mass of embolized AVM interferes in its preparation in the depth. Piece by piece removal of embolized AVM is possible and some demarcation layer between partially embolized AVMs and their surrounding tissue due to ischemia and/or heating effect at the time of polymerization makes nidus preparation easier [2].

Awake surgery

Awake surgery is common for the microsurgical removal of gliomas in eloquent areas, this has been developed especially for epilepsy surgery [3, 6]. Awake surgery for the AVM of our case 2 revealed to be effective, although the case was complicated with small bleeding. This may be due to venous congestion [1]. One could check motor and sensory functions at the time of temporary occlusion of some perinidal feeding branches of the Rolandic artery and at the time of stimulation of the cortex around the AVM nidus. Case No 1 would have been treated with success with the same method namely preoperative embolization and awake surgery without any use of Gamma-knife therapy. Awake surgery for small and medium sized AVMs in an eloquent area should be seriously taken into consideration as treatment option with or without presurgical embolization.

Selection of approaches

The case No 3 of rather small hypothalamic AVM with repeated intraventricular bleeding is considered to be inappropriate for endovascular embolization or Gamma-knife therapy because the feeding arteries also supply important structures and also the close proximity of the optic nerve to the hypothalamus. For the safe surgical removal some special approaches were necessary. Use of the additional SEAC procedure [11] to the pterional approach enabled to have access to the nidus of AVM at the eminentia lateralis by increased mobilization of the optic nerve and of the internal carotid artery (hence enlarging the optico-carotid triangle) determining feeding arteries and non feeding arteries originating directly from the ICA. Transrostrum corporis callosi–lamina terminalis approach TRCLA [9] enabled us to have access to the nidus with aneurysmatic component in the right hypothalamus. This is a specific case example in which selection of the appropriate surgical approach for safe removal of an AVM was crucial.

Conclusion

Three cases of microsurgical removal of AVMs at eloquent areas and/or functionally important structures are presented. Strategical consideration on the use of preoperative embolization, awake surgery and selection of approaches are discussed along with special mention of cyst formation as a complication of Gamma-knife therapy which required surgical removal.

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