Editorial on a paper entitled “Combined suture and clipping for the reconstruction of a ruptured blister-like aneurysm”

P. Vajkoczy¹

Received: 26 July 2016 / Accepted: 1 August 2016 / Published online: 12 August 2016
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Editorial

Blister-like aneurysms are small, extremely fragile aneurysms at non-branching sites of cerebral blood vessels. The prevalence among all aneurysms is around 0.5% and the prevalence among ruptured aneurysms is 1.2%. In contrast to saccular aneurysms, they consist of only a thin layer of adventitia covered by a platelet plug, which covers a defect in the intima and media of the vessel wall. The underlying pathogenesis has been discussed to be atherosclerosis, hemodynamic stress, or dissection. Often, the vessel wall of the presumably intact blood vessel around the blister-like aneurysm is also affected and fragile. Thus, (re-) rupture of a blister-like aneurysm, both during microsurgical or endovascular treatment, may leave a large defect behind or may even destroy large parts of the circumference of the vessel wall.

The most prominent site for blister-like aneurysms is the supraclinoid internal carotid artery, where blister-like aneurysms were first described by Sundt and Murphey [6] and later by Nakagawa et al. [3]. Since then, blister-like aneurysms have been described throughout the cerebral vasculature. Often, their treatment is complicated by the proximity of perforating branches, most importantly the anterior choroidal artery in the case of blister-like aneurysms along the internal carotid artery.

Often, treatment is complicated by the fact that the proper diagnosis of a blister-like aneurysm and pre-therapeutic assessment of the extent of the arterial wall involvement may

be impossible by conventional imaging modalities. Due to the small size of the blister-like aneurysms, diagnostic angiography still carries the highest diagnostic reliability. However, it only reveals the aneurysm lumen and not the aneurysmal wall, leaving the correct pre-hoc diagnosis to the experience and level of suspicion (‘gut feeling’) of the treating neurovascular team. Even in the most experienced neurosurgical hands is the rate of failed preoperative diagnosis considerably high [4].

The fragility of these lesions and their broad neck make them extremely difficult to treat, both through microsurgical and endovascular techniques. A direct conventional attack of these lesions either from the extravascular side by clipping or from the endovascular side by coiling has been associated with a high risk of intraoperative rupture, resulting in large defects in the vessel wall. These large defects often force the surgeon to sacrifice the affected vessel segment. Treatment becomes most risky if blister-like aneurysms are not diagnosed beforehand and the surgeon—who may assume a straightforward clipping case—unexpectedly faces these malignant lesions without being properly prepared. A recent report from the UCSF group impressively confirmed the difficulty in treating these patients surgically: The intraoperative rupture rate was sixfold higher than that of a saccular aneurysm and intraoperative aneurysm rupture doubled the risk of poor outcome [4].

This is the reason why endovascular techniques seem to be very attractive, especially for blister-like aneurysms. However, the techniques are still evolving, and conventional approaches such as coiling, stent-assisted coiling, balloon-assisted embolization, as well as the use of multiple conventional stents have so far been characterized by unsatisfactory results. The most promising contemporary endovascular approach to blister-like aneurysms is the use of flow diverters. Flow diverters hold the potential to progressively occlude the aneurysm and to remodel the aneurysm lumen with minimal

✉ P. Vajkoczy
peter.vajkoczy@charite.de

¹ Department of Neurosurgery, Charité Universitätsmedizin Berlin, Augustenburger Platz 1, 13353 Berlin, Germany

to no manipulation of the aneurysmal sac via disruption of intra-aneurysmal pulsatile flow. However, one concern that has been repeatedly raised by the neurosurgical community is the need for dual antiplatelet therapy in the light of acute subarachnoid hemorrhage. In contrast, a recent case series of ten patients from two prominent endovascular centers suggests that flow diverters can be placed relatively safely for ruptured blister-like aneurysms and that 9/10 aneurysms are immediately occluded with only one flow diverter device [2]. Remarkably, dual administration of aspirin and clopidogrel did not result in relevant bleeding complications during the subacute follow-up phase after subarachnoid hemorrhage. However, these experiences are still anecdotal and need to be confirmed. On the other hand, given the above-mentioned extraordinary risks when treating these lesions microsurgically, flow diverters already today appear to be most attractive for ruptured blister-like aneurysms.

In this issue of *Acta Neurochirurgica*, Kantelhardt et al. illustrate a case where they successfully treated a ruptured blister-like aneurysm of the internal carotid artery by microsurgical means. The patient presented with an SAH H&H grade 2. Based on the conventional diagnostic angiogram, the diagnosis of a blister-like aneurysm was already made before surgery and the neurovascular team agreed on microsurgical treatment of the aneurysm. A pterional craniotomy was performed following diagnosis and when opening the basal cisterns and preparing the aneurysm for wrapping, the aneurysm ruptured, leaving a defined hole in the anterior wall of the internal carotid artery. The authors applied a suture-clipping technique to reconstruct the internal carotid artery, where sutures adapted the vessel wall and tandem clipping reinforced the suture line.

The authors have to be applauded for managing this difficult situation so well and for achieving a good result for their patient. The result of this case is also remarkable in a way that suturing of the vessel wall following rupture of a blister-like aneurysm is in most cases hardly possible, and any attempt to place sutures may result in further damage to the wall of the internal carotid artery with growth of the circumferential hole. Critically speaking, the authors were lucky that they got away with this technique. Specifically, the authors were lucky for multiple reasons: [1] the aneurysm was located on the anterior wall, which made it easily amenable to placing the sutures without the need for manipulation of the parent artery. A location at the posterior wall would have made this technique almost impossible; [2] the blister-like aneurysm was a type 2 (berry-like) aneurysm, according to the classification of Bojanowski et al. [1]. As a consequence, the defect was limited and well defined, and the remaining vessel wall was healthy and strong enough to hold the sutures; [3] finally, the lumen of the parent artery was large enough to tolerate adaptation of the vessel wall with sutures and clips without inducing hemodynamically relevant stenosis. Based on this

evaluation, I am quite reluctant to recommend the present technique as a reliable contingency plan for ruptured blister-like aneurysms.

Clearly, when treating blister-like aneurysms by microsurgery, the surgical team should have all options available. In our practice, direct clipping remains the first choice for treatment. However, even in experienced hands, clipping can be only successfully accomplished in two-thirds of blister-like aneurysms [2]. Before attempting to clip the aneurysm, the lesion should be carefully inspected whether it is suited for direct clip reconstruction. This is the case for aneurysms with well-defined necks and with enough tissue in the wall of the aneurysm to support the clip. If, however, the location is unfavorable (e.g., posterior wall), the neck is ill-defined, the aneurysm wall appears friable, or the aneurysm is a type 3 or type 4 aneurysm (longitudinal or circumferential morphology), the surgeon should be very cautious to even begin dissection and preparation of the aneurysm for clip reconstruction. For these cases, the surgeon needs to have contingency plans. Our second choice for treatment of these cases is the clip-enforced wrapping technique [5]. Here, a synthetic material is tailored to the individual anatomy of the internal carotid artery, eventually leaving space for perforating arteries, such as the anterior choroidal artery, and wrapped around the parent artery and the blister-like aneurysm. Ideally, the aneurysm sac is not manipulated or touched during this maneuver. Then, a clip is placed over the wrapping material so that the clip blades support the wall of the parent artery and obliterate the aneurysm at the same time. However, this technique often fails to be a non-touch technique and, thus, does not come without a relevant intraoperative rupture risk. If this happens, the parent artery needs to be trapped and a high-flow bypass with either a radial artery graft or saphenous vein to the M2 segment has to be created. The problem with this in real life is that [1] if the internal carotid artery needs to be trapped most surgeons have no idea about the collateralization pattern and respective ischemic tolerance and [2] harvesting the bypass graft at the very moment following aneurysm rupture and establishing two anastomoses takes a considerable amount of time and may result in MCA/ICA strokes. As a consequence, our threshold for a prophylactic bypass preparation is very low and we attempt to have an idea about the ACOM/PCOM crossflows before starting surgery.

In our institution, the following measures have become routine in the preparation for microsurgical treatment of blister-like aneurysms of the internal carotid artery: (1) assess the extent of collateralization of the parent artery through a balloon-occlusion test; (2) decide beforehand on the basis of the assessment of collateralization whether the patient would need a superficial temporal artery (STA), a radial artery (RAG), or a saphenous vein (SVG) graft, in case the parent artery needs to be trapped; (3) harvest and prepare the potential bypass graft prior to the craniotomy, in case a bypass needs

to be performed on an emergency basis; (4) drape the neck or even expose the external carotid artery at the beginning of the procedure if collateralization is poor and a high-flow bypass would be indicated; (5) open the Sylvian fissure widely and identify a suitable recipient M2 branch before addressing the aneurysm; (6) establish a prophylactic bypass before targeting the aneurysm if the surgeon suspects a high rupture risk with direct treatment strategies. This strategy may seem to pose a significant extra effort and increase of the case complexity. However, we feel that this extra effort is justified in light of the dangers of intraoperative rupture.

Despite our own preferences (and strong bias towards bypass surgery), the authors again have to be commended for introducing an alternative contingency technique to the microsurgical armamentarium that can be applied to the treatment of blister-like aneurysms. Regardless of the technique used to treat these difficult lesions, the surgical risks remain high and surgeons should be aware of all the available treatment options, both microsurgical and endovascular.

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