

Combined suture and clipping for the reconstruction of a ruptured blister-like aneurysm

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Abstract Blister-like aneurysms of the internal carotid artery (ICA) present a severe therapeutical challenge. While several reconstructive techniques are in use in case of acute rupture sacrifice of the parent vessel may be required. We present a combined technique of micro-sutures and clip application to repair the parent vessel in an intraoperatively ruptured blister-like aneurysm. Following temporary trapping of an intraoperatively ruptured 7-mm blister-like aneurysm four 8-0 nylon sutures were applied to adapt the vessel walls and support the branches of subsequently applied mini-clips. The combination of micro-sutures and mini-clips might be a valuable alternative to direct clipping or suturing in some cases with intraoperative rupture of blister-like aneurysms.

Keywords Blister-like aneurysms · Rupture · Surgery · SAH · Clipping · Micro-suture

Introduction

Blister-like aneurysms are a rare but potentially dangerous entity, representing 1% of all intracranial aneurysms [17, 18]. Generally arising from non-branching segments of the internal carotid artery (ICA) and the common first presentation is major subarachnoid haemorrhage (SAH) [6, 14]. Some

authors consider blister-like aneurysms a different entity from saccular aneurysms and a tear of the vessel wall [6, 16]. Others argue that blister-like aneurysms might be a stage during the development of conventional saccular aneurysms [3].

A number of different techniques have been successfully applied for the treatment of blister-like aneurysms. These include direct clipping [1, 6, 11], direct micro-suture [16], wrapping (the most common technique, a combination of a [Goretex-]patch secured by a clip) [2, 8, 16], application of encircling clips [4, 20], endovascular or surgical trapping (with or without bypass) [5, 7, 12, 13, 21], coiling [10, 11], stenting [21] and stenting with covered or flow diverting stents [6, 13] or even multiple overlapping stents [19]. A recent meta-analysis by Peschillo et al. [15] reported an average of 67.4% and 78.9% favourable results in surgical endovascular procedures respectively. While this study shows a trend towards better outcome following endovascular treatment, it documents that despite all available treatment options for blister-like aneurysms still present a severe therapeutic challenge and no obvious general recommendations can be given at this time [3, 6, 15–17]. Intraprocedural or intraoperative major rupture, especially, can be difficult to control and may require sacrifice of the aneurysm-bearing vessel.

We here propose a combined suture and clipping technique for rapid and efficient repair of intraoperatively ruptured blister-like aneurysms.

Materials and methods

Aneurysm repair was achieved using 8-0 nylon sutures and temporary and permanent titanium Aesculap (mini) clips (Aesculap/Braun, Tuttlingen, Germany) Intraoperative ICG angiography (Pentero, Zeiss, Oberkochen, Germany).

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Results

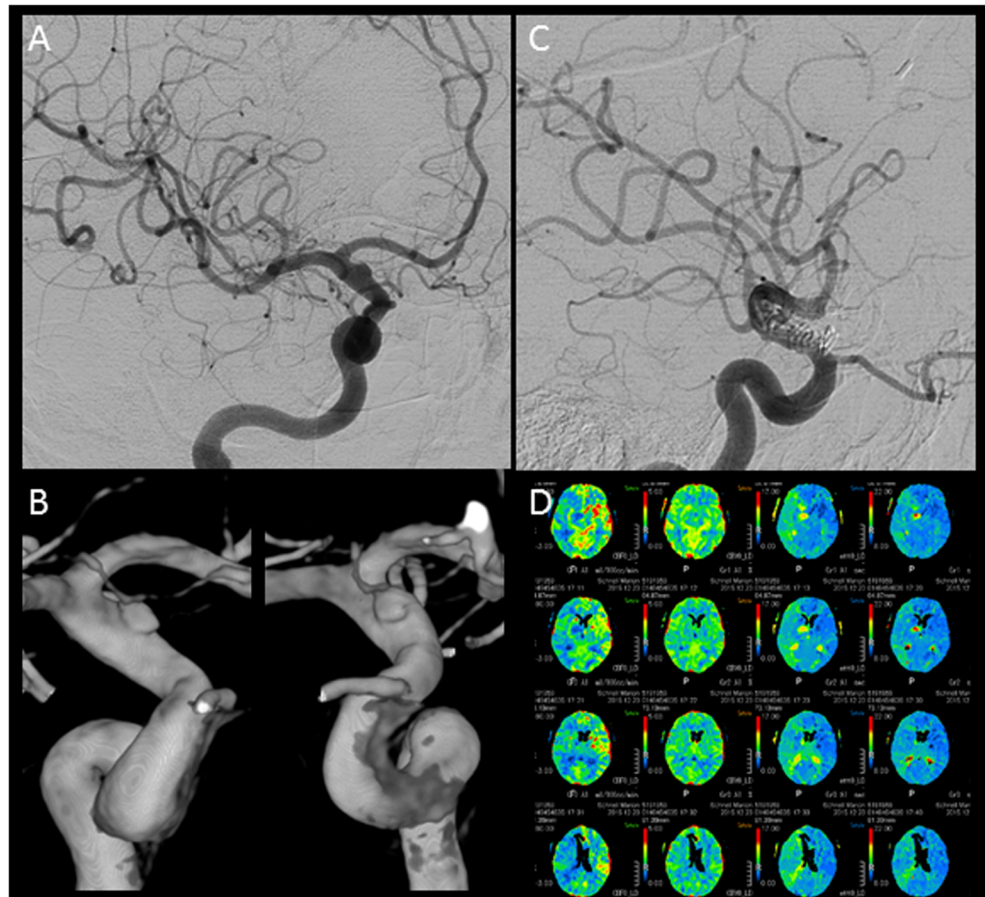
Case presentation and surgical technique

A 51-year-old woman was admitted with SAH, H&H grade 2, Fisher grade 3. Initial computed tomography (CT) and CT angiography showed the SAH but no source of bleeding. The patient underwent digital subtraction angiography (DSA) the following morning, which revealed a 7-mm blister-like aneurysm of the anterior aspect right ICA, 5 mm proximal of its branching into the middle cerebral artery (MCA) and anterior cerebral artery (ACA) (Fig. 1). In an interdisciplinary conference with neurosurgeons and neuroradiologists, immediate surgery for wrapping of the aneurysm (Goretex patch secured by a clip) was decided. We chose a conventional pterional approach, opening of the Sylvian fissure and preparation of the ICA proximal and distal to the suspected aneurysm. The blister-like nature of the aneurysm was confirmed—a tear of 7 mm length in the ICA was only covered by clotted blood and a layer of arachnoid membrane (Figs. 2a, b and 3a). Before wrapping could be attempted the aneurysm ruptured and had to be trapped by placement of

temporary clips (Figs. 2a, b and 3b). The ruptured and dislocated vessel walls were then adapted by four sutures (8-0 nylon sutures, Figs. 2c and 3c, d). To minimise temporary parent vessel occlusion, no watertight micro-suture was attempted, but two curved mini clips were placed over the four individual single-button sutures (Figs. 2d, and 3e). Thus, the single button sutures supported the clips and prevented clip dislocation. Finally, the distance between the tips of the two curved clips was closed by placement of two more straight mini-clips (Fig. 2e and 3f). After removal of the temporary clips an indocyanine green (ICG) angiography was performed to document perfusion of the parent vessels distal to the repaired segment (Fig. 2f). Postoperatively, results were re-evaluated by CT angiography, perfusion CT and digital subtraction angiography (DSA) (Fig. 1b–d).

At discharge, the patient had a marked paresis of the oculomotor nerve on the right side with (ptosis, severely impaired motility of the right eye bulb with double vision). At 3 months post-surgery, the patient presented with a mild hypaesthesia at the right parietal region adjacent to the surgical scar and a slight residual impairment of the right oculomotor nerve function (slight ptosis of the right eye lid and corresponding

Fig. 1 **a** Preoperative DSA of a 7-mm blister-like aneurysm on the ventromedial wall of the right internal carotid artery and **b** three-dimensional (3D) reconstruction of the aneurysm. **c** Postoperative DSA demonstrating occlusion of the blister-like aneurysm and patency of ICA with marked stenosis of the parent vessel, **d** but sufficient perfusion of the distal vessels on corresponding CT-perfusion image



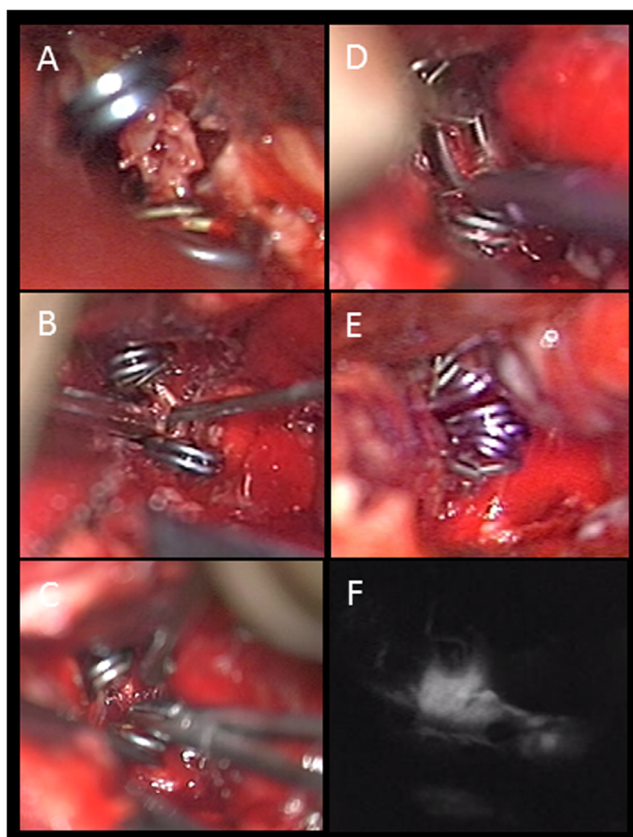


Fig. 2 Series of intraoperative images of blister-like aneurysm occlusion. **a** The ruptured aneurysm as a large tear in the carotid artery. Note the temporal clips trapping the aneurysm. **b** The tear; the tip of the micro-dissector is in the carotid artery. **c** Sutures are placed to adapt the vessel walls and subsequently avoid clip dislocation. **d** The first permanent clip is inserted. **e** All four permanent clips applied in this case in place. **f** ICG angiogram documenting perfusion of vessels distally of the clipped segment

impairment of the motility of the right eye bulb with double vision when looking to the left side). No further neurological deficit was noted.

Discussion

In the case of intraoperative rupture of blister-like aneurysms, wrapping techniques might be insufficient to control the bleeding and sacrifice of the aneurysm-bearing vessel may be the only solution [11]. Intraprocedural rupture during endovascular treatments may likewise require sacrifice of the parent vessel or rescue surgery although endovascular reconstruction of ruptured blister-like aneurysms using stent and coil have been reported [9]. Here again acute bleeding is difficult to control and patients are further loaded with antiplatelet drugs to prevent stent-thrombosis.

As the most commonly affected segment is the ICA, sacrifice of the aneurysm-bearing artery will, however, have severe neurological or even mortal consequences and, as Meling

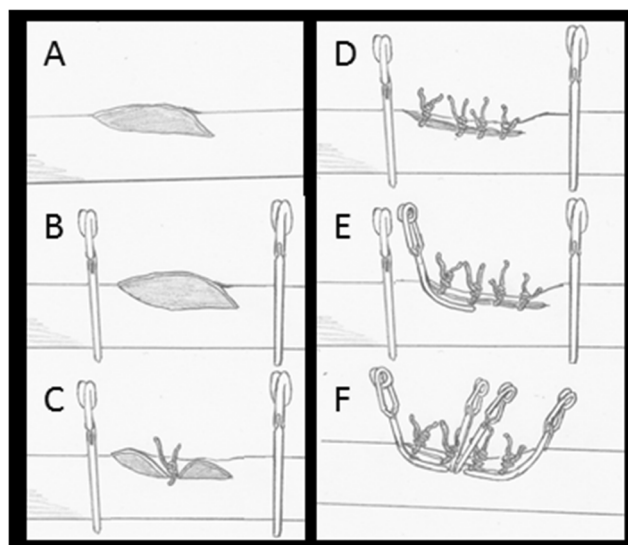


Fig. 3 Schematic representation of the applied technique. **a** The artery with the tear (ruptured blister-like aneurysm). **b** Firstly, the aneurysm/tear is trapped by placement of temporary clips. **c, d** Then the vessel wall is adapted by placement of sutures. **e** Finally, clips are placed over the sutures, sealing the tear. The sutures now serve to prevent dislocation of the clips when the temporary clips are removed and the blood flow is restored

et al. [11] observed, sacrifice of the ICA within 48 h of SAH leads to a poor outcome even if adequate collateralisation is present. In this situation, alternative vessel-sparing techniques are needed. These include direct clipping or suturing of the vascular tear or the application of encircling clips [4]. A common drawback of the first two techniques is a certain degree of stenosis of the aneurysm-bearing segment.

In the case of large tears and dislocated vessel walls, direct clipping or the placement of encircling clips can be difficult, as the vessel walls have to be carefully adapted first and buckling in of a clot and vessel wall fragments has to be avoided to prevent further stenosis [4]. Further, in direct clipping a rather large portion of the healthy wall of the parent vessel has to be gripped in the clip branches to prevent the clip from slipping, which has to resist blood pressure and does not have any support except the ruptured vessel wall itself. Direct micro-suture techniques, in contrast, are time-consuming and a direct micro-suturing of the arterial wall as standalone management could be insufficient due to the fragile walls composed of severed adventitia and fibrinous tissue. Especially for large fissures or those located near the clinoid portion of the ICA, micro-suturing can be very challenging and time-consuming and, thus, requires prolonged temporary clipping. Depending on the site (especially in cases where the temporary clips are below the posterior communicating artery, anterior choroidal artery, or small perforators arising from the ICA) a rapid surgical technique can reduce the risk of cerebral damage due to ischaemia. Encircling clips are much faster to apply than sutures [4], but they are not always available, fitting in diameter,

or their placement might be not feasible due to the complexity of the tear.

For such situations, a few micro-sutures, which consume more time than direct clipping or application of encircling clips, facilitate precise approximation of the edges of the vascular defect and allow consecutive safe clip placement and provide distal support for the clip branches. It might, thus, allow inclusion of a smaller portion of the remaining wall of the parent vessel, subsequently leading to less stenosis; while enabling the application of the (faster) clipping technique instead of the rather time-consuming placement of watertight micro-sutures.

Conclusions

The combination of micro-sutures and mini-clips for vessel wall adaptation, repair and subsequent prevention of clip dislocation of ruptured blister-like aneurysms is feasible and safe. The technique might be a valuable alternative to direct clipping or suturing in some cases with intraoperative rupture of blister-like aneurysms.

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Compliance with ethical standards

Informed consent The patient has consented to submission of this case report to the journal.

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Comments

This is nice description of an ingenious technique which could come in handy in very specific circumstances. There are caveats to this technique, specifically the difficulty and time under temporary clipping to suture the tear. The preferred and fastest method to treat these pseudo aneurysms, is to utilize an encircling clip and to ensure that flow is not compromised as a result [4]. However, the authors' methods can come in handy if the encircling clips are not available and methods to place a sling around

the vessel not practical. The authors in this report, describe a “shortcut” in which the carotid breach is approximated and not fully repaired, but instead used to facilitate the purchase of clips to fully seal the breach. This is a worthwhile paper and the technique described is a useful addition to our surgical options and can prove useful in instances where other

alternatives to repairing the tear, such as with encircling clips, are not available. The authors are to be congratulated for this original contribution.

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