Endovascular suction and decompression of large and giant internal carotid artery aneurysms during surgical clipping. Technical Note

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Introduction

Treatment of large and giant internal carotid artery (ICA) aneurysms is still challenging. Treatment modalities include direct clipping, trapping with or without bypass, and endovascular embolization. Even with development of endovascular techniques, direct clipping, if possible, is thought the best treatment because it is most radical and the ICA is preserved. Clipping techniques include usually tandem application of ring clips along the ICA. These lesions, however, have wide necks which involve the ICA, and angioplastic arrangement of the clips is required to make the ICA with enough patency. The aneurysms appear just like large tensive mass lesions, and they are still tensive even under trapping because collateral arterial blood supply remains from the ophthalmic artery and the cavernous branches. Against this matter, suction decompression has been applied to decompress the aneurysms.

Previously, direct needle puncture for continuous evacuation of the blood inside the aneurysm was performed4), and later "retrograde" suction decompression by evacuation of the blood from the proximal ICA was introduced by Batjer and Samson in 19902). Recently, thanks to development of endovascular equipments, retrograde suction decompression can be performed by using double-lumen balloon catheters being sent up to the cervical ICA through the transfemoral route1)5)6)9). This article reports the procedures of clipping surgery including retrograde suction decompression using balloon catheters, with reference to advantages of suction decompression.

Preoperative evaluation

The head MRI/MRA and 3-dimensional computed tomography angiography (3-D CTA) provide enough information of cerebral aneurysms for surgical planning, and basic treatment modality should be selected based on these findings. If the clipping is thought possible, surgical strategy should be considered including suction decompression. For large and giant aneurysms, diagnostic angiography (DSA) together with balloon test occlusion (BTO) is strongly recommended to check the collateral blood flow through the anterior communicating artery and the posterior communicating artery, and to check tolerance to occlusion of ICA3). These information is usefull to estimate intraoperative occlusion time and surgical strategical plan. Furthermore, permanent trapping may be considered if clipping is impossible, and tolerance to occlusion is an important information.
The distance from the aneurysm to the anterior clinoid process and the ophthalmic artery can be calculated on the preoperative 3-D CTA. Clinoidectomy and distal dural ring opening, are indispensable procedures for proximal flow

control in large and giant ICA aneurysms. However, flow control is secured by balloon catheters if suction decompression is planned, so these procedures can be skipped if the aneurysm is distant enough to the skull base (if the most proximal clip will be located near the distal dural ring, these procedures are needed).

Suction decompression

Procedures for suction decompression require endovascular skill. After induction of general anesthesia, prior to craniotomy, a 5 to 7 French double-lumen balloon catheter is sent up to the cervical ICA through the transfemoral route.

A control digital subtraction angiography (DSA) is taken to find the best working angle to check the neck remnant and completeness of occlusion of the aneurysm after clipping.

After microsurgical exposure of the aneurysm, suction decompression will be started. The balloon is inflated for proximal occlusion, and then a temporary clip is placed on the ICA distal to the aneurysm as trapping. At this time, the dome of the aneurysm is still tensive because collateral arterial supply remains from the ophthalmic artery and the cavernous branches. Suction of the blood inside the trapped ICA and the aneurysm through the distal end of the catheter is started, and then the aneurysm is deflated and shrunk (Video 1). Continuous or repeated suction is needed because collateral blood supply will not stop. However the degree of shrinkage depends on the thickness of the wall of the aneurysm, so volume of suction should be adjusted based on the reaction7). Excessive evacuation of the blood makes the ICA collapse, which may disturb clipping.
The balloon can be used as simple proximal occlusion other than suction decompression8).

Dissection and clipping

Large and giant aneurysms appear as great tensive mass lesions during surgery. Important surrounding structures such as the optic nerve, the oculomotor nerve, the anterior choroidal artery, and the small branches from the posterior communicating artery, are usually shifted and hidden. Once the dome is shrunk and softened by suction decompression, however, these structures can be found with less risk of injury, and can be dissected safely (Video 1), in similar way of internal decompression in tumor surgeries. If the dome is hard and thick, it will not be deflated. However the dome must become soft enough to be retracted much more easy and the dissection of nerves and small vessels is possible (Video 2).

In almost cases, tandem arrangement of the ring clips is the best way to occlude the aneurysm and to reconstruct the ICA (Video 3). Ideal placement of the clips is possible because the tension of the aneurysm, that causes slippage of the clips, is no longer present. After shrinkage of the dome, wide space is usually provided that had been occupied by the dome. The original course of the ICA will be restored when the dome shrinks, because the pathological rotation of the ICA disappears and the normal wall of the ICA keeps its original figure.

Once the ideal course and size of the ICA can be recognized, it is helpful for angioplastic clipping. Intraoperative angiography just after clipping can be performed with the same setting. The DSA is most sensitive among flow detecting modalities, and it can show where the neck remnant and leaking into the dome is (Video 4). Repositioning or additional placement of a clip can be performed, and complete occlusion can be achieved. The patency of the ICA and related arteries is also evaluated on the DSA. If stenosis is detected, replacement of the clips should be done.

Risks and complications

Possible thromboembolic complications may be explained due repeated ICA occlusions by a balloon catheter. Stagnation of blood inside the aneurysm is another possible cause other than the trapped ICA.

Use of heparin (3,000 units just before suction decompression) is mandatory. Fragments of the thrombus, located originally inside the aneurysms can migrate into distal branches in partially thrombosed aneurysms approached by this way.
Prolonged occlusion should be avoided. The limit of occlusion time can be estimated based on the results of preoperative BTO. The occlusion should be limited within 10 minutes at a time, and can be repeated after enough intervals. Aggressive evacuation of the blood should be refrained to avoid excessive collapse of the ICA and, especially, related small vessels. Strong vacuum pressure may cause damage on small vessel such as the anterior choroidal artery, and vasospasm or intravascular coagulation can be induced.

If the dome or neck lacerates during dissection or clipping, suction may aspirate the air inside the ICA, resulting in air embolism.

Conclusions

We describe surgical approach techniques of large and giant ICA aneurysms combined with decompression by suction through balloon endovascular approach. Because every treatments proposed for these lesions are challenging, selection of treatment modalities should be considered carefully. Once surgical clipping is indicated, suction decompression, performed by skilled endovascular surgeons, may be a very helpful aid.

Videos

Video 1

Video_1.wmv

Video 2

Video_2.wmv

Video 3

Video_3.wmv

Video 4

Video_4.wmv

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