Aneurysm clipping

Latest PubMed Aneurysm clipping-related articles

- A Case of a Non-giant Intracranial Aneurysm with Spontaneous Occlusion Directly Observed during Clipping Surgery
- Management and outcomes for thoracic anterior spinal artery aneurysms: illustrative case
- Statin versus no statin after treatment with pipeline embolization device for intracranial aneurysms: a meta-analysis
- Reshaping neurosurgical training: a novel simulation-based concept for structured skill acquisition and curriculum integration
- Analysis of short-term efficacy and rebleeding risk in aneurysmal subarachnoid hemorrhage patients undergoing vascular intervention
- Revisiting sylvian fissure dissection - A preliminary investigation into surgical process modelling for evaluating surgical proficiency
- Remote cerebral vasospasm following elective clipping of middle cerebral artery bifurcation-A1 aneurysms: A correspondence and review of putative pathophysiological mechanisms
- Bedside Sonographic Ventricular Monitoring Through a Sonolucent Cranial Implant for Weaning of External Ventricular Drain After Aneurysmal Subarachnoid Hemorrhage

---

Aneurysm clipping is a neurosurgical procedure performed to treat cerebral or intracranial aneurysms.

The purpose of intracranial aneurysm clipping is to prevent the aneurysm from rupturing by sealing it off from normal blood circulation. Here is an overview of the procedure:

Preoperative Evaluation: Before the surgery, a patient's medical history and imaging studies, such as CT scans, MRI scans, or angiography, are thoroughly reviewed to determine the size, location, and characteristics of the aneurysm.

Anesthesia: The patient is placed under general anesthesia, rendering them unconscious and pain-free throughout the procedure.

Access to the Aneurysm: A neurosurgeon typically performs the surgery. They make an incision in the scalp to create a small opening in the skull, called a craniotomy, to access the brain and the aneurysm.

Clipping the Aneurysm: Once access is achieved, the surgeon carefully locates the aneurysm. A tiny metal clip is placed across the base of the aneurysm, effectively sealing it off from the surrounding blood vessels. This prevents blood from flowing into the aneurysm, reducing the risk of rupture.

Closure: After successfully clipping the aneurysm, the surgeon closes the incision in the scalp and may use surgical materials such as sutures, screws, or plates to secure the bone flap in place. The wound is then closed with stitches or staples.

Recovery: The patient is closely monitored in the intensive care unit (ICU) for a period to ensure stable vital signs and neurological function. Recovery times vary but can be several days to weeks depending on the complexity of the surgery and the patient's overall health.

Intracranial aneurysm clipping is a highly effective treatment for preventing aneurysm rupture. However, it is a complex procedure with potential risks, including infection, bleeding, and damage to nearby structures in the brain. The choice of treatment, whether clipping or endovascular coiling (a less invasive procedure), depends on the specific characteristics of the aneurysm and the patient's overall health.

Evolution in the surgical treatment of intracranial aneurysms is driven by the need to refine and innovate. From an early application of the Hunterian carotid ligation to modern-day sophisticated aneurysm clip designs, progress was made through dedication and technical maturation of the cerebrovascular neurosurgeons to overcome challenges in their practices. The global expansion of endovascular services has challenged the existence of aneurysm surgery, changing the complexity of aneurysm case mix and volume that are presently referred for surgical repair. Concepts of how to best treat intracranial aneurysms have evolved over generations, and will continue to do so with further technological innovations. As with the evolution of any type of surgery, innovations frequently arise from the criticism of currently available techniques [1)].

Intracranial aneurysm surgery by clipping requires meticulous technique and is usually performed through open approaches. Endoscopic endonasal clipping of intracranial aneurysms may use the same techniques through an alternative corridor.

Clipping is an important technique for intracranial aneurysm surgery. Although clip mechanisms and features have been refined, little attention has been paid to clip appliers. Clip closure is traditionally achieved by opening the grip of the clip applier. Sato et al.. reconsidered this motion and identified an important drawback, namely that the standard applier holding power decreased at the moment of clip release, which could lead to unstable clip application develop a forceps to address this clip applier design flaw.The new clip applier has a non–cross-type fulcrum that is closed at the time of clip release, with an action similar to that of a bipolar forceps or scissors. Thus, a surgeon can steadily apply the clip from various angles. They successfully used the clip applier to treat 103 aneurysms. Although training was required to ensure smooth applier use, no difficulties associated with applier use were noted. This clip applier can improve clipping surgery safety because it offers additional stability during clip release. [2)].

Indications

see Surgical clipping versus endovascular coiling for intracranial aneurysm.

Intracranial Aneurysm treatment with surgery remains the recommended form of treatment in high-grade SAH patients with intracerebral space occupying hematomas, where the surgical decompression of the mass effect may be warranted, and along with it the clipping of the bleeding aneurysm.

In the US, a number of training programs include endovascular exposure to residents during their training, assuming the endovascular suite as a regular OR room.

The training of surgeons in both techniques seems promising and the right way to go, regardless of whether a dually trained neurosurgeon will end up opting for the use of one technique over the other. The important is that we guarantee the ability to deliver our patients the best possible care by providing them with a choice that is not born out of a turf war but based on evidence both on a general, but similarly important, local one [3].

Preoperative planning

Three-dimensional printing in vascular neurosurgery

Three-dimensional printing in vascular neurosurgery is trending and is useful for the visualization of intracranial aneurysms for both neurosurgeons and trainees. The 3D models gives the surgeon time to practice beforehand and plan the surgery accordingly. The aim of the study of Ozgıray et al. was to examine the effect of preoperative planning with 3D printing models of aneurysms in terms of surgical time and patient outcomes.

Forty patients were prospectively enrolled in this study and divided into two groups: Groups I and II. In group I, only the angiograms were studied before surgery. Solid 3D modeling was performed only for group II before the operation and was studied accordingly. All surgeries were performed by the same senior vascular neurosurgeon. Demographic data, surgical data, both preoperative and postoperative modified Rankin Scale scores (mRS), and Glasgow Outcome Scores (GOS) were evaluated.

The average time of surgery was shorter in Group II, and the difference was statistically significant between the two groups ($p < 0.001$). However, no major differences were found for the GOS, hospitalization time, or mRS.

This study is the first prospective study of the utility of 3D aneurysm models. They show that 3D models are useful in surgery preparation. In the near future, these models will be used widely to educate trainees and pre-plan surgical options for senior surgeons [4].

Anesthesia

The guidelines relevant to the anesthesiologists in the day-to-day perioperative management of patients with ruptured intracranial aneurysm given by various societies are:

Diringer MN, Bleck TP, Claude Hemphill J, 3rd, Menon D, Shutter L, Vespa P, et al. Critical care management of patients following aneurysmal subarachnoid hemorrhage: Recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference. Neurocrit Care. 2011;15:211–40.

Bederson JB, Connolly ES, Jr, Batjer HH, Dacey RG, Dion JE, Diringer MN, et al. Guidelines for the management of aneurysmal subarachnoid hemorrhage: A statement for healthcare professionals from a special writing group of the Stroke Council, American Heart Association. Stroke. 2009;40:994–1025.

Steiner T, Juvela S, Unterberg A, Jung C, Forsting M, Rinkel G, et al. European Stroke Organization guidelines for the management of intracranial aneurysms and subarachnoid haemorrhage.

Cerebrovasc Dis. 2013;35:93–112.

Both intravenous and inhalational anesthetic technique may be used for maintenance keeping in mind the objectives of stable intraoperative hemodynamics, early smooth recovery and effect on special monitoring techniques. Cerebral perfusion increases with isoflurane when compared with propofol without increase in ICP in aSAH.

Hypocapnia is not essential in good grade patients as it can reduce ICP and increase transmural pressure within aneurysmal sac predisposing it to rupture. In poor grade patients, hyperventilation however is beneficial to reduce ICP and provide lax brain.

Brain laxity is crucial to obtain good surgical access to the aneurysm without causing IOAR or compromising underlying brain from excessive retractor pressure. This is important as early surgery risks a tense/full brain and dissection without adequate exposure can result in IOAR. Both 20% mannitol and 3% hypertonic saline are suitable osmotic agents for intraoperative brain relaxation in the dose of 2-4 ml/kg. Head end elevation, avoiding jugular venous compression, avoiding high concentration of inhalational agents and nitrous-oxide and mild hyperventilation are other measures to achieve a lax brain. If full brain persists, additional measures like moderate hyperventilation, switching to intravenous anesthetic maintenance and release of cerebrospinal fluid might be helpful. [5].

Approaches

Pterional approach via standard frontotemporal craniotomy and interhemispheric approach via bifrontal craniotomy is the gold standard for clipping of cerebral aneurysms in the anterior circulation. Endovascular treatment is now widely used, but subsets of aneurysms are still indicated for surgical clipping. Modern technological advances allow less invasive clipping techniques such as the keyhole approach. Mori and Watanabe discussed the surgical indications, preoperative simulation, surgical techniques, and pros and cons of keyhole (supraorbital) clipping. Selection of standard craniotomy or keyhole craniotomy should be uncontroversial, but keyhole clipping requires definite surgical indications based on the characteristics of the target aneurysm for safe clipping [6].

To enhance visual confirmation of regional anatomy, endoscopy was introduced.

see Endoscopic endonasal approach for intracranial aneurysm

Outcome

see Intracranial aneurysm clipping outcome.

Complications

see Intracranial aneurysm clipping complications.

Postclipping evaluation

A challenge is to ensure noninclusion of normal vessel/perforators within the clip and perform complete aneurysmal isolation. This is done with either intraoperative microvascular Doppler sonography (IMD) or Indocyanine green videoangiography (ICG-VA) as they are simple and safe. Anesthesiologists administer ICG and also help perform IMD. ICG-VA appropriately assessed vessel patency and aneurysm obliteration in 93.5% of 109 aneurysms clipped [7)] However, ICG can cause transient oxygen desaturation [8)]. IMD use confirms aneurysm isolation and patency of parent vessel and branching arteries. Hui et al. observed that clip repositioning was required based on IMD findings in 24% of aneurysms clipped in 91 patients and concluded that IMD could reduce the rate of residual aneurysm and unanticipated vessel stenosis [9)].

The complete clipping of a cerebral aneurysm usually warrants its sustained occlusion, while clip remnants may have far-reaching consequences. The aim of this study is to identify the risk factors for clip remnants requiring retreatment and/or exhibiting growth. METHODS All consecutive patients with primary aneurysm clipping performed at University Hospital of Essen between January 1, 2003, and December 31, 2013, were eligible for this study. Aneurysm occlusion was judged on obligatory postoperative digital subtraction angiography and the need for repeated vascular control. The identified clip remnants were correlated with various demographic and clinical characteristics of the patients, aneurysm features, and surgery-related aspects. RESULTS Of 616 primarily clipped aneurysms, postoperative angiography revealed 112 aneurysms (18%) with clip remnants requiring further control (n = 91) or direct retreatment (n = 21). Seven remnants exhibited growth during follow-up, whereas 2 cases were associated with aneurysmal bleeding. Therefore, a total of 28 aneurysms (4.5%) were retreated as clip remnants (range 1 day to 67 months after clipping). In the multivariate analysis, the need for retreatment of clip remnant was correlated with the aneurysm's initial size (> 12 mm; OR 3.22; p = 0.035) and location (anterior cerebral artery > internal carotid artery > posterior circulation > middle cerebral artery; OR 1.85; p = 0.003). Younger age with a cutoff at 45 years (OR 33.31; p = 0.004) was the only independent predictor for remnant growth. CONCLUSIONS The size and location of the aneurysm are the main risk factors for clip remnants requiring retreatment. Because of the risk for growth, younger individuals (< 45 years old) with clip remnants require a long-term (> 5 years) vascular follow-up. Clinical trial registration no: DRKS00008749 (Deutsches Register Klinischer Studien) [10)].

Costs

Total index hospitalization costs for clipping are lower than for coiling. Costs of clipping and coiling are driven by different clinical variables. The cost of coils and devices is the predominant contributor to the higher total costs of coiling [11)].

Virtual reality simulator for aneurysmal clipping surgery

see Virtual reality simulator for aneurysmal clipping surgery.

[1)]

Lai LT, O'Neill AH. History, Evolution and Continuing Innovations of Intracranial Aneurysm Surgery. World Neurosurg. 2017 Feb 9. pii: S1878-8750(17)30166-3. doi: 10.1016/j.wneu.2017.02.006. [Epub ahead of print] Review. PubMed PMID: 28189863.

2)
Sato A, Koyama JI, Hanaoka Y, Hongo K. A Reverse-Action Clip Applier for Aneurysm Surgery. Neurosurgery. 2015 Mar 12. [Epub ahead of print] PubMed PMID: 25774701.
3)
Santiago BM, Cunha E Sá M. How do we maintain competence in aneurysm surgery. Acta Neurochir (Wien). 2015 Jan;157(1):9-11. doi: 10.1007/s00701-014-2265-8. Epub 2014 Nov 14. PubMed PMID: 25391972.
4)
Ozgıray E, Husemoglu B, Cınar C, Bolat E, Akınturk N, Bıceroglu H, Kızmazoglu C. The Effect of Preoperative Three Dimensional Modeling and Simulation on Outcome of Intracranial Aneursym Surgery. J Korean Neurosurg Soc. 2023 Sep 15. doi: 10.3340/jkns.2023.0035. Epub ahead of print. PMID: 37709549.
5)
Sriganesh K, Venkataramaiah S. Concerns and challenges during anesthetic management of aneurysmal subarachnoid hemorrhage. Saudi J Anaesth. 2015 Jul-Sep;9(3):306-13. doi: 10.4103/1658-354X.154733. Review. PubMed PMID: 26240552; PubMed Central PMCID: PMC4478826.
6)
Mori K, Watanabe S. Keyhole Approach in Cerebral Aneurysm Surgeries. Adv Tech Stand Neurosurg. 2022;44:265-275. doi: 10.1007/978-3-030-87649-4_15. PMID: 35107685.
7)
Özgiray E, Aktüre E, Patel N, Baggott C, Bozkurt M, Niemann D, et al. How reliable and accurate is indocyanine green video angiography in the evaluation of aneurysm obliteration? Clin Neurol Neurosurg. 2013;115:870–8.
8)
Sriganesh K, Vinay B, Bhadrinarayan V. Indocyanine green dye administration can cause oxygen desaturation. J Clin Monit Comput. 2013;27:371.
9)
Hui PJ, Yan YH, Zhang SM, Wang Z, Yu ZQ, Zhou YX, et al. Intraoperative microvascular Doppler monitoring in intracranial aneurysm surgery. Chin Med J (Engl) 2013;126:2424–9.
10)
Jabbarli R, Pierscianek D, Wrede K, Dammann P, Schlamann M, Forsting M, Müller O, Sure U. Aneurysm remnant after clipping: the risks and consequences. J Neurosurg. 2016 Feb 12:1-7. [Epub ahead of print] PubMed PMID: 26871206.
11)
Duan Y, Blackham K, Nelson J, Selman W, Bambakidis N. Analysis of short-term total hospital costs and current primary cost drivers of coiling versus clipping for unruptured intracranial aneurysms. J Neurointerv Surg. 2014 Jun 2. pii: neurintsurg-2014-011249. doi: 10.1136/neurintsurg-2014-011249. [Epub ahead of print] PubMed PMID: 24891453.