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HOW I DO IT - VASCULAR NEUROSURGERY - OTHER

Minimally invasive image-guided endoscopic evacuation of intracerebral haemorrhage: How I Do it

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Abstract

Background Minimally invasive endoscopic hematoma evacuation (MEHE) is an emerging surgical technique for treating spontaneous supratentorial intracerebral haemorrhage (SSICH). Multiple studies, analysing whether the outcome after such a procedure is improved, are still ongoing.

Method We herein present the indications, advantages, and perioperative considerations for the surgical technique of MEHE applied at our institution.

Conclusion MEHE with a view through a transparent brain access device is a valid and safe approach for the surgical evacuation of SSICH.

Keywords Neurosurgery · Endoscopic surgery · Intracerebral haemorrhage · Minimally invasive surgery · Haemorrhagic stroke

Introduction

Spontaneous supratentorial intracerebral haemorrhage (SSICH), with an incidence of 24.6 per 100,000 person-years, leads to devastating mortality and morbidity rates [8]. SSICH is most commonly caused by hypertension or amyloid angiopathy [9]. Responsible for the brain injury are the primary damage caused by the bleeding itself, the perifocal oedema, the toxic breakdown products of haemoglobin, and the concomitant inflammation, resulting in poor outcome for 61–88% of the patients [8, 9]. Since the STICH trials failed to show an advantage of surgical evacuation by craniotomy (CC), surgical treatment remains controversial, while best medical treatment (BMT) remains the current gold standard [2, 4, 5].

Minimally invasive surgery however appears promising, especially minimally invasive endoscopic hematoma evacuation (MEHE) seems to ameliorate functional outcome and survival rates among patients with SSICH [7].

We herein describe our neuroendoscopic image-guided approach with the ViewSite® brain access device (VSBAD, *Vycor Medical™, Boca Raton, USA*) enabling full visualisation of the surrounding hematoma and brain tissue, leading to improved rates of hematoma evacuation while protecting intact brain tissue even in deep-seated hematomas.

Relevant surgical anatomy

SSICH occur in the basal ganglia or in the superficial lobar parenchyma [9]. Depending on the location, sparing relevant structures as the primary motor and sensory cortex, Meyer's loop, language IFOF, and the perisylvian cortex in the left hemisphere becomes essential.

Description of the technique

Surgery is done under general anaesthesia and a single shot cefuroxime is given 30 min before skin incision. The head is fixed in a skull clamp (*DORO®, Black Forest Medical Group, Freiburg, Germany*) and neuronavigation (*BrainLab®, Munich, Germany*) is installed. Positioning and access site are dependent on the hematoma localisation,

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while the planned trajectory is confirmed by neuronavigation (Fig. 1). In general, the trajectory is based on two factors:

1. Shortest way to the hematoma cavity
2. Avoiding eloquent brain areas

In lobar hematomas, the shortest trajectory across the parenchyma is chosen; in deep-seated hematomas, a frontal or temporal approach is used.

After shaving and draping, a 3–4 cm straight incision is made (Fig. 2a), and two consecutive 14 mm burr holes are drilled (Fig. 2c and Fig. 3a). The burr holes are enlarged using a KERRISON® punch (*B. Braun, Tuttlingen, Germany*) to accommodate the ovaloid shape of the VSBAD (Fig. 3b). The dura is coagulated and opened in a cruciate fashion. Under neuronavigation guidance, the VSBAD (*TC120807*) is introduced into the hematoma cavity (Fig. 4) and fixed using a LEYLA® retractor (*B. Braun, Tuttlingen, Germany*). The VSBAD should ideally be placed in the centre and at 2/3 depth of the hematoma.

After introducing the 0°-freehand LOTTA® endoscope (*Karl-Storz, Tuttlingen, Germany*, Fig. 3c) through the VSBAD, the hematoma cavity is irrigated, while the hematoma is gently removed under endoscopic visual inspection using a standard suction cannula (Fig. 2d). When the deep hematoma cavity is cleared and only brain tissue is visible but residual hematoma can be seen through the transparent wall of the VSBAD under endoscopic view, the VSBAD is adjusted superficially until more hematoma is accessible and the evacuation is continued. If active bleeding is encountered, coagulation with the endoscopic bipolar is performed under endoscopic view. If no clear bleeding source is found, Floseal® (*Baxter, Illinois, USA*) can be applied into the hematoma cavity. Once only brain tissue is visible around the VSBAD, the hematoma evacuation is complete. After extensive irrigation and meticulous haemostasis, final inspection of the cavity through the VSBAD is undertaken, reassuring complete hematoma removal.

The VSBAD is removed, the burr holes covered with gel foam (Spongostan), and the skin closed with subcutaneous sutures and staples.

Indications

Since Grade I evidence for MEHE is lacking, the indication should only be made within the scope of studies despite systematic reviews suggesting a benefit of MEHE [7, 10]. We indicate MEHE for patients with superficial or deep-seated SSICH, a hematoma volume of 20–100 mL, and a GCS of 5–15 exhibiting focal neurological deficits (at

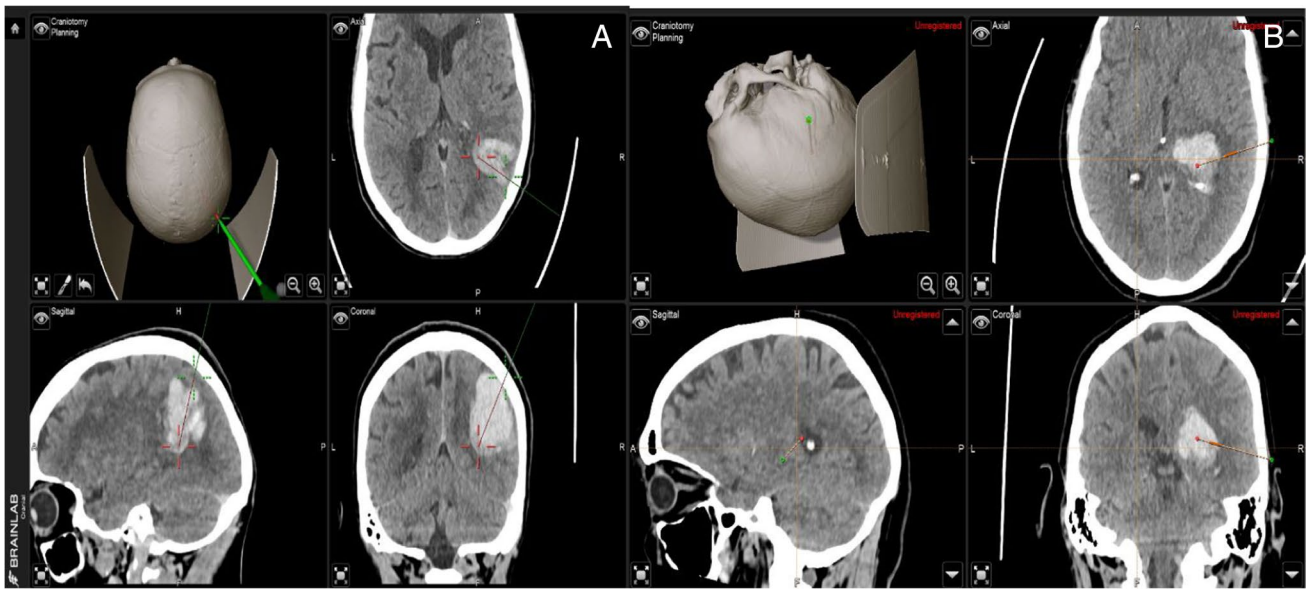

Fig. 1 Demonstration of the pre-planned trajectory **a** A superficial lobar hematoma in a 67-year-old female admitted with a hypertensive crisis, left-sided hemiparesis, and left-sided neglect. After consulting the patient's relatives, the decision for surgery was made due to the young age of the patient and the prospect of good outcome. The patient had an uncomplicated postoperative course and presented at 6-month follow-up with a complete remission of symptoms. **b** A deep-seated hematoma in a 70-year-old male admitted with a left-sided hemiparesis, a left-sided sensory and visual neglect and decreasing alertness. After consulting the patient's relatives, the indication for surgery was made due to the prospect of good outcome and the will of the patient. The patient had an uncomplicated postoperative course, and at 1-month follow-up presented with a minimal residual left-sided visual neglect and complete remission of the hemiparesis

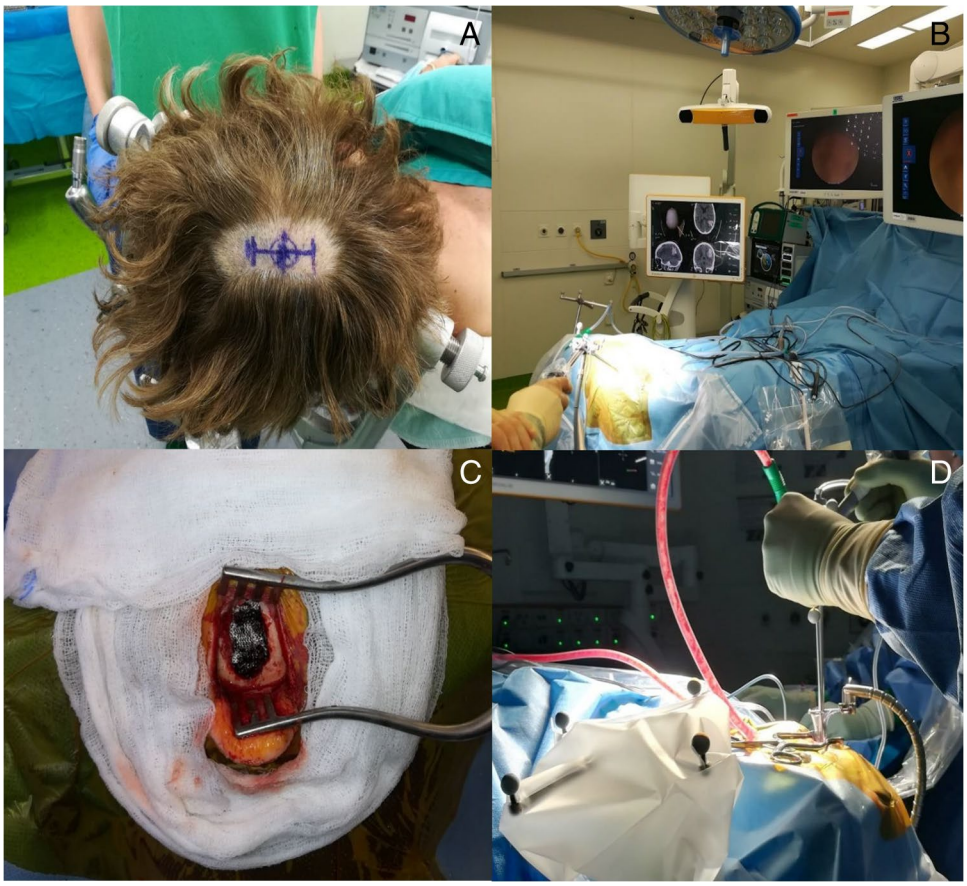

Fig. 2 **a** Markings of the skin incision. **b** Surgeons view on the navigation and endoscopic set-up. **c** The view on the enlarged burr holes for the VSBAD. **d** Use of the endoscope and the suction device in the ViewSite® brain access device

least NIHSS > 8 points or severe hemiparesis; motor or sensory aphasia; profound hemi-inattention; decreasing consciousness). Contraindications in our practice are age > 85, hematoma volume > 100 mL, active spot sign, midbrain involvement, the need for emergent decompression, or an underlying structural cause of the hematoma (vascular/oncological).

Limitations

Evacuation might be limited by the location of the hematoma (e.g. areas of high eloquence). The technique requires handling and experience of endoscopic assisted surgery; however, a steep learning curve can be observed. The mobility of the VSBAD within the burr holes might be limited, leading to restraint access in large hematomas, requiring enlargement of the burr holes. The technique described requires neuronavigation, neuroendoscope, and a VSBAD which might not be readily available at every centre. MEHE is not an established treatment for SSICH, and results from ongoing trials are awaited. Therefore, no recommendations on preference over BMT can be made; usage of this technique should ideally occur within the scope of prospective trials.

How to avoid complications

Careful preoperative planning based on neuronavigation using recent CT scans to determine the location and expansion of the hematoma and the surgical access site is needed. Intraoperative neuronavigation helps orientating within the hematoma cavity and prevents unnecessary tissue damage; however, as in all cases with neuronavigation, shift of structures has to be considered, requiring expert knowledge in interpretation of the intraoperative situation. A transparent VSBAD provides an excellent 360° view of the surrounding and superficial regions informing about residual hematoma or intact brain parenchyma, aiding to achieve a more complete hematoma evacuation and less tissue destruction. Strict blood pressure control according to the current guidelines to prevent re-bleeding [2] and strict patient selection are essential in avoiding complications.

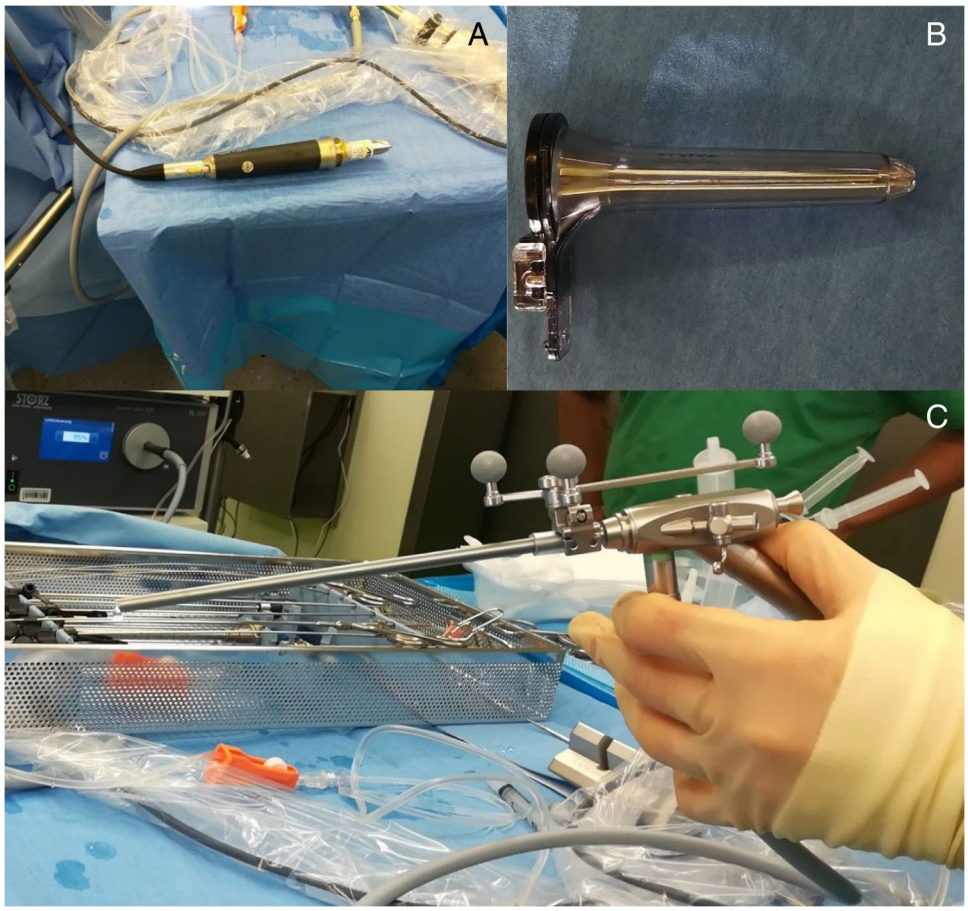

Fig. 3 **a** A 14-mm ELAN® drill. **b** The ViewSite® brain access device. **c** The endoscope together with the BrainLab® neuronavigation star

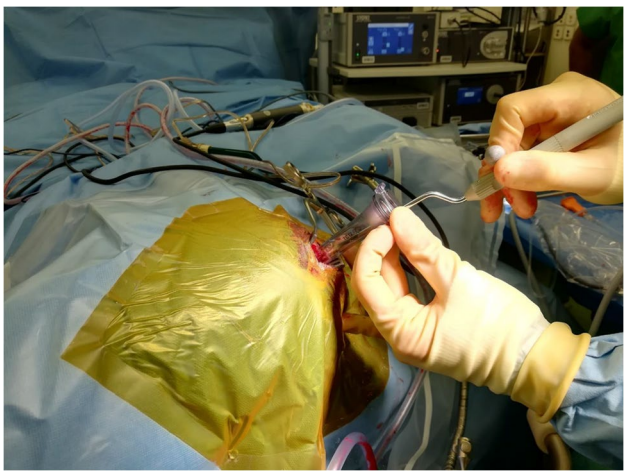

Fig. 4 Navigation of the ViewSite® brain access device to the hematoma cavity with the neuronavigation stylet

Specific perioperative considerations

In our institute, we promote hematoma removal within 6–24 h, since studies suggest early evacuation to improve outcome, yet we refrain from ultra-early evacuation [1, 6]. Anticoagulation should be reverted whenever possible. Optimal preoperative access planning to the hematoma cavity on a neuronavigation console is essential in optimising surgical access and sparing eloquent structures. We strongly promote the use of perioperative imaging, ideally intraoperative if available (CT/US), to confirm adequate hematoma evacuation (Fig. 5c and d), to detect and treat hematoma remnants, and to ensure no acute rebleeding has occurred. Postoperatively, patients should be admitted to an ICU and treated according to the current guidelines for ICH [2].

Specific information for the patient about surgery and potential risks

Patients and their relatives must be informed about the circumstances, the possible complications, and potential benefits of surgery keeping expectations realistic and transparent. Patients should be advised that studies suggest that MEHE improves the chance of achieving functional independence as compared to BMT and CC [7]. Mortality rates 6 months after MEHE range around 16%, while the risk of recurrent ICH is 1–5%

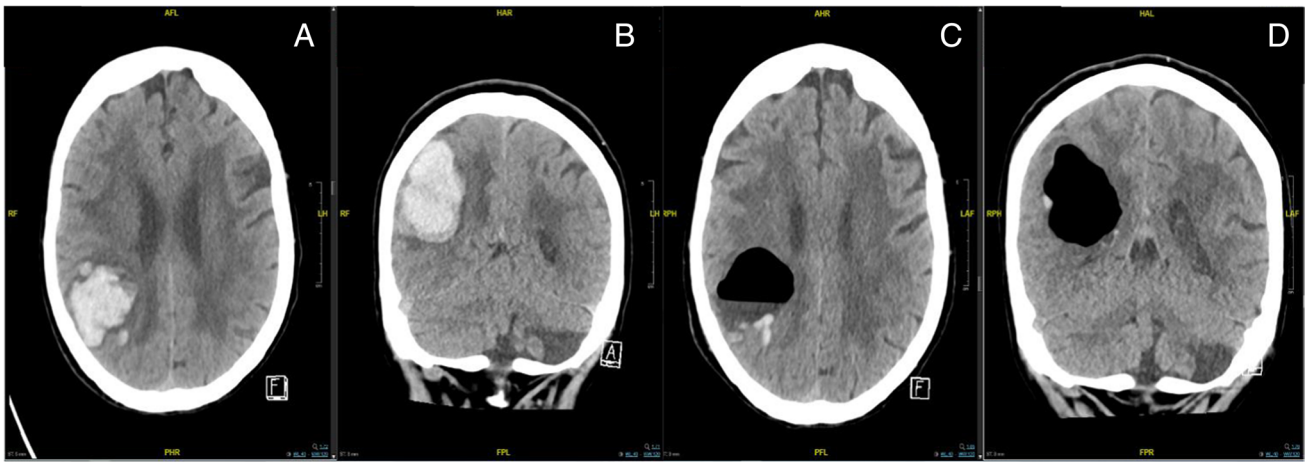

Fig. 5 Preoperative CT scan of a lobar SSICH in **a** axial and **b** coronar axis. Postoperative CT scan of the same hematoma with minimal residual hematoma in **c** axial and **d** coronar axis

per year after surgery [2, 3]. Further, functional outcome and mortality depend on the location of the hematoma, current anticoagulant therapy, ongoing bleeding, and the timely hematoma evacuation after SSICH onset.

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Declarations

Ethics approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the local ethics committee (Ethikkommission Nordwestschweiz) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The pilot trial, in which this technique was used, was approved by the local ethics committee (EKNZ-2021–00161).

Consent to participate Informed consent was obtained from all patients or their relatives/legal guardians included in the pilot trial.

Conflict of interest The authors declare no competing interests.

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10 key point summary

• MEHE shows promising results, while the indication remains relative, it can be recommended within study protocols for patients with a hematoma volume > 20 mL exhibiting focal neurological deficits.
• It seems that early (within 6–24 h from ictus) MEHE helps improve mortality and morbidity rates.
• A transparent trocar enables 360° view of the surrounding brain parenchyma and hematoma cavity reducing the risk for postoperative residual hematoma and brain tissue damage.
• The shortest path to the hematoma cavity across the parenchyma using neuronavigation should be chosen.
• The transparent VSBAD should be inserted at 2/3 depth of the hematoma cavity where the evacuation is started and thereafter continued proximally.
• Through endoscopic view, the hematoma can be removed safely in a minimal invasive fashion.
• Active bleeding sites are coagulated with the endoscopic bipolar, and, if needed, Floseal® can be applied.
• Immediate perioperative imaging is advised to confirm satisfactory hematoma evacuation and rule out acute rebleeding.
• Rigorous blood pressure regimes should be implemented to avoid hematoma recurrence.
• Experience in endoscopic assisted surgery is required; however, the learning curve is steep.