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Technical note

A minimally invasive anterior skull base approach for evacuation of a basal ganglia hemorrhage

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ABSTRACT

We describe the technical nuances of a minimally invasive anterior skull base approach for microsurgical evacuation of a large basal ganglia hematoma through an endoport. Patients who suffer from large spontaneous intracerebral hemorrhages (ICH) of the basal ganglia have a very poor prognosis. However, the benefit of surgery for the management of ICH is controversial. The development of endoport technology has allowed for minimally invasive access to subcortical lesions, and may offer unique advantages over conventional surgical techniques due to less disruption of the overlying cortex and white matter fiber tracts. A 77-year-old man presented with a hypertensive ICH of the right putamen, measuring 9 cm in maximal diameter and 168 cm^3 in volume. We planned an endoport trajectory through the long axis of the hematoma using frameless stereotactic neuronavigation. In order to access the optimal cortical entry point at the lateral aspect of the basal frontal lobe, a miniature modified orbitozygomatic skull base craniotomy was performed through an incision along the superior border of the right eyebrow. Using the BrainPath endoport system (NICO, Indianapolis, IN, USA), the putaminal hematoma was successfully evacuated, resulting in an 87% postoperative reduction in ICH volume. Thus, we show that, in appropriately selected cases, endoport-assisted microsurgery is safe and effective for the evacuation of large ICH. Furthermore, minimally invasive anterior skull base approaches can be employed to expand the therapeutic potential of endoport-assisted approaches to include subcortical lesions, such as hematomas of the basal ganglia.

1. Introduction

Intracerebral hemorrhage (ICH) accounts for 10–20% of strokes, and is associated with a dismal prognosis [1,2]. The most common etiology of spontaneous ICH is hypertension, and the most frequently affected location is the basal ganglia [3]. The role of surgical intervention in the management of ICH patients is controversial, and surgical evacuation of supratentorial ICH has not been shown to afford a significant clinical benefit [4–6]. However, large basal ganglia ICH can cause significant local and global mass effect, leading to rapid deterioration and death, despite maximal medical therapy.

Conventional surgical approaches for these subcortical lesions necessitate dissection through white matter fiber tracts and may result in prolonged periods of brain retraction, both of which lead to an increased vulnerability to postoperative venous infarction, cerebral edema and seizures. In an attempt to avert these postoperative complications, minimally invasive techniques for surgical ICH evacuation have been employed with varying degrees of success [7,8]. The endoport is an emerging technology which can provide access to subcortical lesions with minimal disruption of normal structures. However, the literature for its use in ICH patients is quite limited [9]. In this case report, we describe the technical aspects of utilizing an endoport system in conjunction with a minimally invasive anterior skull base approach for microsurgical evacuation of a large putaminal ICH.

2. Technical note

A 77-year-old man with a history of hypertension presented with an acute onset of left hemiplegia. His systolic blood pressure was 200 mmHg upon arrival to an outside hospital, with an initial modified Rankin scale of 5 and Glasgow coma scale of 11. A brain

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CT scan showed a large $9.0 \times 5.5 \times 6.8$ cm ICH of the right putamen (volume 168.3 cm^3) with intraventricular extension (ICH score of 3; Fig. 1A) [10]. The man was subsequently intubated when his level of consciousness declined, and he was transferred to our institution for further evaluation. Due to the significant local and global mass effect caused by the ICH, and the rapid course of neurological deterioration, we elected to proceed with endoport-assisted surgical evacuation. Surgical intervention was undertaken in this patient within 24 hours of ICH onset.

A thin slice brain CT scan was obtained (slice thickness less than 1 mm) so that a frameless stereotactic neuronavigation system (StealthStation; Medtronic Sofamor Danek, Inc., Memphis, TN, USA) could be used for preoperative planning and intraoperative guidance. A trajectory through the long axis of the hematoma was planned. We decided that a lateral subfrontal cortical entry point would provide the optimal surgical corridor to achieve the target trajectory. The hematoma was 2.5 cm below the cortical surface at the site of entry. The surgical plan involved a minimally invasive anterior skull base approach through a right-sided eyebrow incision and miniature modified orbitozygomatic (mini-mOZ) skull base craniotomy, which would allow for placement of the endoport at the desired cortical location in the specified trajectory.

After induction of general anesthesia, the patient was placed into a three point cranial fixation with a Mayfield skull clamp system (Integra NeuroCare, San Diego, CA, USA) and secured in capital and cervical extension with rotation towards the left. An incision was made along the superior border of the right eyebrow, extending from the supraorbital notch medially to the frontozygomatic suture laterally. Monopolar electrocautery was used to dissect through the frontalis muscle and galea so that a pericranial graft could be harvested. The temporalis muscle was dissected off of the keyhole, and the orbital rim was exposed from the supraorbital notch to the frontozygomatic suture. A mini-mOZ craniotomy was performed with bony cuts lateral to the supraorbital notch and at the frontozygomatic suture. An osteotome was used to fracture the orbital roof in order to release the bone flap (Fig. 1B).

A cruciate dural opening was made, just large enough to accommodate the endoport, but as small as possible in order to curtail the loss of cerebrospinal fluid before endoport placement. We used the BrainPath endoport system (NICO, Indianapolis, IN, USA), which is comprised of an outer sheath and an inner obturator. The arm of the outer sheath attaches to a Greenberg retractor, allowing the outer sheath to maintain access to the hematoma in a fixed position after endoport deployment. The outer sheath is available in varying lengths of 50, 60 and 75 mm, with a consistent diameter of 13.5 mm for all lengths. The tip of the inner obturator extends 15 mm beyond the outer sheath and is tapered and blunt, which allows gradual, atraumatic introduction of the endoport system. Cannulation of shallow lesions can be performed with an 8 mm obturator tip, although this can only be used with the 50 mm outer sheath.

Using continuous StealthStation neuronavigation, the BrainPath endoport system with a 75 mm outer sheath was advanced through the frontal cortex and into the hematoma, targeting a point two thirds along its long axis. After removing the inner obturator, the operating microscope was brought in to perform the hematoma evacuation with a standard bimanual microsurgical technique. A large quantity of the central hematoma was readily evacuated, resulting in portions of the peripheral hematoma collapsing inward into the potential space of the surgical cavity. After circumferential inspection of the cavity and attainment of hemostasis, the outer sheath was gradually withdrawn, during which the additional hematoma was revealed and removed. The wound closure was performed in a standard layered fashion, including titanium plating of the craniotomy bone flap back to the skull. The postoperative brain CT scan showed significant volume reduction of the ICH (87% decrease), as well as marked abrogation of the local mass effect and midline shift (Fig. 1C).

3. Discussion

The benefit of surgical intervention for spontaneous supratentorial ICH was challenged by the surgical trial in intracerebral hemorrhage [4]. However, despite advances in neurocritical care, patients with large ICH, especially those of the deep nuclei, have high rates of mortality and functional dependence. Broderick et al. found that patients with an ICH volume of greater than 30 cm^3 had only a 1.4% rate of functional independence, and those with an ICH volume of greater than 60 cm^3 had a mortality risk of greater than 80% at 30 days [11]. Based on an ICH classification system developed by Hemphill et al., our patient who presented with an ICH score of 3 had a 30 day predicted mortality of 72% [10].

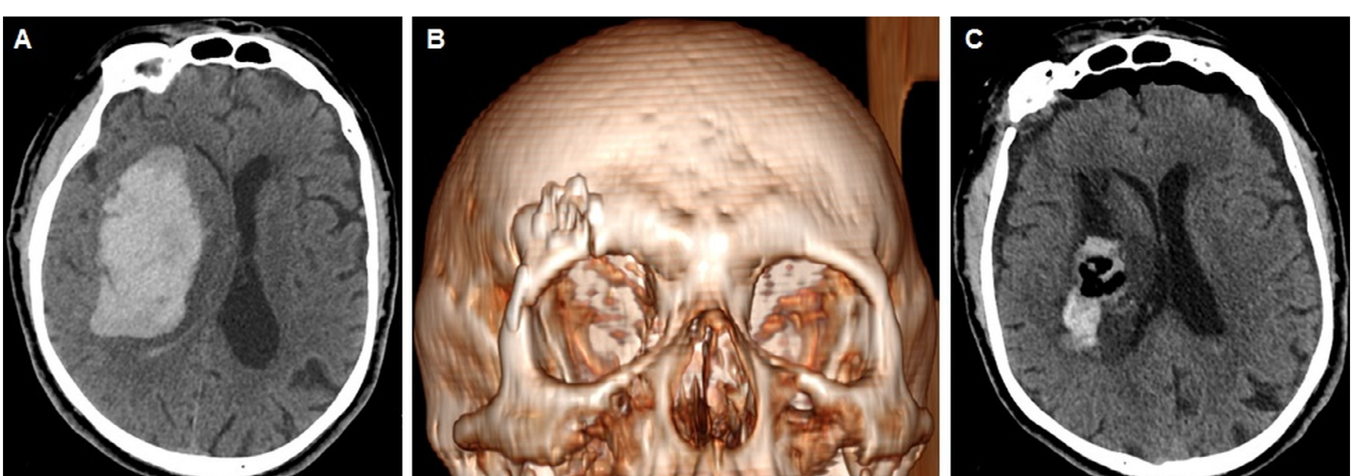

Fig. 1. (A) Preoperative axial brain CT scan showing a very large, right putaminal intracerebral hemorrhage (ICH) measuring $9.0 \times 5.5 \times 6.8$ cm (volume 168.3 cm^3), with an associated intraventricular hemorrhage and resulting in 6.5 mm of midline shift. The ICH was evacuated through a right-sided miniature modified orbitozygomatic (mini-mOZ) craniotomy with the BrainPath endoport system (NICO, Indianapolis, IN, USA). Postoperative brain CT scans, (B) 3D reconstruction, shows the mini-mOZ craniotomy and, (C) axial view, shows significant reduction of the local mass effect and the degree of the midline shift, with the residual ICH measuring $5.4 \times 2.3 \times 3.4$ cm (volume 21.1 cm^3; 87% reduction). This figure is available in colour at www.sciencedirect.com.