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Clinical Study

Endoport-assisted surgery for the management of spontaneous intracerebral hemorrhage

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ABSTRACT

The aim of this retrospective study is to report our initial experience with endoport-assisted microsurgical evacuation (EAME) of intracerebral hemorrhages (ICH). Neurosurgical intervention has not been shown to significantly improve patient outcomes after spontaneous ICH. Minimally invasive technologies, such as endoport systems, may offer a better risk to benefit profile for ICH evacuation than conventional approaches. We performed a retrospective review of all patients who underwent EAME of ICH from January 2013 to February 2015 using the BrainPath endoport system (NICO, Indianapolis, IN, USA). The baseline and follow-up patient and ICH characteristics were analyzed. Of the 11 patients included for analysis, seven were women (64%), and the median age was 65 years (range: 23–84). The ICH was supratentorial in nine patients (82%), and the median ICH score was 2 (range: 1–4). The median preoperative and postoperative ICH volumes were 51 cm^3 (range: 8–168) and 10 cm^3 (range: 0.4–59), respectively, with a median reduction in ICH volume of 87% (range: 38–99). The median preoperative and postoperative amounts of midline shift were 6.7 mm (range: 4.9–14.3) and 3.7 mm (range: 2.2–8.9), respectively, with a median reduction in midline shift of 38% (range: 18–61). At the 90 day follow-up, four patients (36%) were functionally independent (modified Rankin Scale 0–2). Four patients had ICH-related mortalities (36%). EAME appears to be a safe and effective treatment option for ICH. Further studies are necessary to assess the comparative effectiveness of EAME in relation to medical therapy or other interventional techniques, for the management of ICH patients.

1. Introduction

Spontaneous intracerebral hemorrhage (ICH) is the etiology of 10–20% of all strokes and remains a significant cause of neurologic morbidity [1,2]. Unfortunately, interventional therapy has not been shown to significantly improve ICH patient outcomes compared to medical management [3–12]. Minimally invasive surgery (MIS) may offer a neurosurgical treatment option with a more favorable safety profile than conventional approaches, without compromising efficacy. The endoport is a recent development for the treatment of deep seated intracranial lesions [13,14]. This device allows for smaller skin incisions, craniotomies, and dural openings, and causes less violation of the cortex and disturbance of the subcortical white matter fiber tracts compared to traditional transcortical approaches for ICH surgery [15,16]. The aim of this retrospective cohort study is to describe the surgical technique and postoperative outcomes for endoport-assisted microsurgical evacuation (EAME) of ICH.

2. Methods

2.1. Patient selection and outcome measures

We retrospectively reviewed the medical records of all patients who underwent EAME of ICH from January 2013, when we first began using endoport technology, to February 2015. For each patient, ICH was diagnosed at the time of presentation with a non-contrast brain CT scan. Dedicated neurovascular imaging (CT angiography and/or digital subtraction catheter angiography) was used to rule out an underlying vascular lesion for all ICH patients. All neuroimaging was independently reviewed by a neurosurgeon and neuroradiologist. The ICH volume was calculated by multiplying the axial, transverse and craniocaudal dimensions of the ICH, and dividing the product by 2. The ICH depth was measured as the distance from the surgical entry point of the endoport, at the

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cortical surface, to the nearest border of the ICH. The ICH scores were calculated according to the classification established by Hemphill et al. [11] All surviving patients were clinically assessed at a 90 day follow-up, following discharge from the hospital. The clinical outcomes were graded according to the modified Rankin scale (mRS).

2.2. Operative technique

The patients were induced under general endotracheal anesthesia and placed into a three point cranial fixation with the Mayfield skull clamp system (Integra NeuroCare, San Diego, CA, USA). The StealthStation frameless stereotactic neuronavigation system (Medtronic Sofamor Danek, Memphis, TN, USA) was used to generate an accurate 3D model for trajectory planning. The operative plan was designed to allow endoport cannulation along the long axis of the hematoma. A small circular craniotomy bone flap (approximately 3 cm in diameter) was made over the planned entry point to allow adequate room for the endoport device. The dura was opened in a cruciate fashion to create an opening just large enough to accommodate the endoport. The cerebrospinal fluid loss was minimized prior to endoport deployment in order to use the patient's elevated intracranial pressure (ICP) to promote hematoma delivery through the endoport. A transsulcal entry point was used when allowed by the local anatomy.

The BrainPath endoport system (NICO, Indianapolis, IN, USA) was utilized for all patients. This endoport device consists of an outer sheath and an inner obturator. The outer sheath is 13.5 mm in diameter, with variable lengths of 50, 60 or 75 mm, which were selected based on the depth of the hematoma beneath the cortical surface. The inner obturator has a blunt, tapered tip which is 15 mm longer than the outer sheath to allow for gradual, minimally traumatic brain cannulation with the endoport system. For cannulation of shallow lesions, a shorter inner obturator with an 8 mm tip is available, but only for use with the 50 mm outer sheath.

The endoport system is advanced under continuous neuronavigation-based guidance along the planned trajectory until the target is reached, which is typically a point two thirds along the length of the hematoma's long axis. The endoport is then advanced an additional 15 mm to account for the length of the obturator tip, and the obturator is removed (Fig. 1A). The arm of the outer sheath is connected to a Greenberg retractor and fixed in position. The hematoma is then evacuated using the operating microscope, with standard bimanual microsurgical technique (Fig. 1B). The endoport is slowly backed out of the brain to allow the more superficial portions of the hematoma to come into view. The peripheral portions of the hematoma, aided by the elevated ICP, collapse inward after central debulking, thereby, falling into the surgical field and allowing for additional evacuation. The surgical cavity is then irrigated and hemostasis is achieved with standard techniques. Due to the immediate decompression from the high volume ICH evacuation, the pulsatility of the exposed cortex is often noted to increase significantly after endoport removal. Additionally, the immediate brain relaxation allows the craniotomy bone flap to be affixed back to the skull with a titanium plating system, and standard layered closure is performed.

3. Results

3.1. Patient and ICH characteristics

A total of 11 patients comprised the cohort for this study. The baseline patient and ICH characteristics, and radiographic and clinical outcomes are summarized in Table 1. There were seven women (64%) and four men (36%), with a median age of 65 years (range: 23–84). Six patients (55%) had a history of hypertension, and one patient (9%) had a history of atrial fibrillation. Three patients were taking warfarin (27%) and six patients were taking aspirin (55%), two of whom were taking both medications (18%). The median ICH volume was 51 cm^3 (range: 8–168) and the ICH depth ranged from 0–2.5 cm. The median degree of midline shift was 6.7 mm (range: 4.9–14.3). The ICH were supratentorial in nine patients (82%) and infratentorial in two (18%). The median ICH score was 2 (range: 1–4).

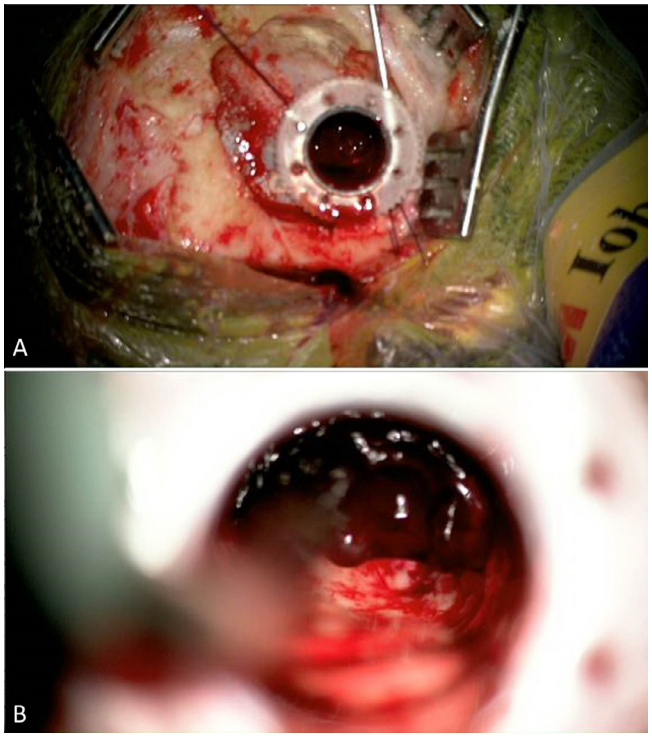

Fig. 1. (A) Intraoperative photograph showing placement of the endoport into a hematoma. (B) Intraoperative photograph showing hematoma evacuation through the endoport. This figure is available in colour at www.sciencedirect.com.

3.2. Radiographic and clinical outcomes

The median time from ICH *ictus* to surgery was 22 hours (range: 8–96). The median postoperative ICH volume was 10 cm^3 (range: 0.4–59), with a median reduction in ICH volume of 87% (range: 38–99). The median degree of postoperative midline shift was 3.7 mm (range: 2.2–8.9), with a median reduction in midline shift of 38% (range: 18–61). Three patients (27%) suffered a postoperative complication, including one patient (9%), with chronic coagulopathy secondary to severe alcoholic cirrhosis, who had a fatal rehemorrhage on postoperative day two. Of the seven patients who survived until discharge, the median number of postoperative days in the intensive care unit (ICU) and hospital were 2 (range: 1–49) and 7 (range 2–49), respectively. At the 90 day follow-up, four patients (36%) were functionally independent (mRS 0–2), two were mildly functionally dependent (mRS 3), and five were deceased (45%). Four of the mortalities (36%) were related to the ICH, despite successful surgical evacuation, while one mortality was unrelated to the ICH. Of the four patients with ICH-related mortality, three had an ICH score of 3, which is associated with an estimated 30 day mortality risk of 72%.[11] The fourth patient had an ICH score of 2, associated with an estimated 30 day mortality risk of 26%.