A new expandable cannula system for endoscopic evacuation of intraparenchymal hemorrhages

Technical note

VICKNES WARAN, F.R.C.S.,1 NARAYANAN VAIRAVAN, M.S.,1 SHEAU FUNG SIA, M.S.,1 AND BASRI ABDULLAH, F.R.C.R.2

Departments of 1Neurosurgery and 2Radiology, University of Malaya Medical Centre, Kuala Lumpur, Malaysia

The authors describe a newly developed expandable cannula to enable a more efficient use of an endoscope in removing intraparenchymal spontaneous hypertensive intracerebral hematomas. The cannula is introduced like a conventional brain cannula, using neuronavigation techniques to reach the targeted hematoma accurately, and, once deployed, conventional microsurgical techniques are used under direct endoscopic visualization.

This method was used in 6 patients, and, based on the results of intraoperative intracranial pressure monitoring and postoperative CT scanning, the authors were able to achieve good hematoma removal. They found that by using the expandable cannula, efficient endoscopic surgery in the brain parenchyma was possible.

KEY WORDS • expandable cannula • endoscope • intraparenchymal hemorrhage

Abbreviations used in this paper: ICH = intracerebral hematoma; ICP = intracranial pressure.
camera and also a system to anchor the cannula once in position so that it does not move unintentionally and possibly damage the brain parenchyma (Video 1).

**Video 1.** The cannula in position with navigation array and self-retaining retractor holding it in place. Click here to view with Windows Media Player.

The hematomas were approached by making a mini-craniotomy measuring ~ 3 cm across, and localization was based on the navigation system–planned trajectory with the aim of accessing the hematoma along its long axis while avoiding critical structures.

When introduced in the closed position, the blades have a 2 × 5–mm leading end. Once the cannula was in position, it was opened to yield an aperture measuring 16 × 5 mm (the maximum width can be varied depending on the procedure being undertaken). Either a 2- or 4-mm endoscope without a sheath was then introduced through the tunnel, and the hematoma was removed using conventional metal sucker tubes and other microsurgical instruments (Fig. 2). Hemostasis when necessary was performed using conventional slim bipolar forceps and Surgicel (Johnson & Johnson).

**Clinical Evaluation**

A total of 6 consecutive patients with large hypertensive thalamic and basal ganglia ICHs were selected after being informed that the value of removing these hematomas remains controversial. All patients had a Glasgow Coma Scale score < 13; in all cases we believed that the mass effect was the reason for the poor Glasgow Coma Scale score. A plain CT scan was obtained using the necessary navigation protocol, and the patient data were registered in our Radionics neuronavigation system. The trajectory was plotted whenever possible with the aim of accessing the hematoma along its long axis to enable maximal clot evacuation and also avoid eloquent cortex.

Intraoperative ICP monitoring was used. We performed repeat CT scanning within 48 hours of surgery to ensure the success of hematoma removal and to assess for any damage along the track of the cannula.

**Results**

Intraoperative ICP recordings were made at 6 important phases of the procedure, as illustrated in Table 1. In most of the patients there was a transient minimal rise in the pressure when introducing the cannula into the brain compared with the ICP just prior to opening the dura mater. This increase lasted < 20 seconds, which was the time taken to introduce the cannula. It was not possible to take an accurate reading when the cannula was actually opened in position because, in all patients, the hematoma ejected itself through the cannula and caused a rapid drop in the ICP even before we introduced a suction tube.

**TABLE 1: Summary of trends in ICPs during evacuation of intraparenchymal hemorrhages**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Initial</th>
<th>Before Opening Dura</th>
<th>Cannula Introduction</th>
<th>Immediately After Initial ICH Removal</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>10</td>
<td>11</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>13</td>
<td>14</td>
<td>5</td>
<td>−2</td>
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<td>31</td>
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<td>16</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>55</td>
<td>60</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>19</td>
<td>19</td>
<td>22</td>
<td>0</td>
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<td>45</td>
<td>50</td>
<td>0</td>
<td>5</td>
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</table>
The ICP remained low in all 6 patients throughout the ICP monitoring period, usually up to 5 days. All patients underwent CT scanning within 48 hours of surgery, and scans were compared with those acquired for navigation. In all patients there was a reduction of the size of hematoma when measured at its widest area. In all cases there were also other features of a reduction in ICP such as a reduction in the midline shift and the reduction of the effacement of the gyri and the basal cisterns (Fig. 3). None of the patients exhibited any visible signs of trauma along the track taken by the cannula. There were no deaths related to this technique.

Discussion

The use of endoscopy in the brain is presently restricted to surgery within the ventricular system, with the exception of a few instances, because the brain lacks natural cavities. Additionally the working channels do not allow any instrument of significant size to be used and, because they are arranged in a parallel fashion, if two instruments were introduced simultaneously, they would be unable to interact with each other at the working end of the endoscope. Furthermore, because the instruments would always have to move in tandem with the camera as they all pass through the same sheath separated by channels, this could result in damage to the proximal brain parenchyma. The system that we have developed has overcome the aforementioned problems and at the same time, with the use of navigation techniques, has ensured accurate deployment of the cannula. The idea to create a tunnel within which to operate using an endoscope has been discussed previously. In 2004 Bakshi described the creation of a tunnel using a bipolar and suction technique to reach a hematoma before a 3-channel endoscope removed the ICH. Nishihara and coworkers first described the use of a transparent tube as a sheath and an endoscope passed within it to remove ICH. Later Chen and associates used a stainless-steel tube as a sheath to successfully remove a putaminal ICH in 6 patients. In both of these descriptions the tube sheath was introduced in its full diameter. More recently Ogura et al. described a microsurgical technique in which a rolled-up 0.1-mm polystyrene film was used to find a way into a hematoma, and once in place, it was dilated to create a cylinder that was 2 cm in diameter. The film was introduced using navigation techniques, but the hematoma itself was removed using microsurgical techniques. Our concept is similar to that of Ogura except that our cannula can not only be accurately guided to its position, but it can also have its working channel size adjusted as necessary. In addition it can be reduced in size before it is withdrawn. The other advantage is that the smaller introduction profile reduces damage to brain parenchyma common in earlier methods. In all 6 of our patients, the cannula did not appear to have caused any significant damage.

In a second report Nishihara and colleagues advocated the use of an open transparent plastic tube that, in addition to allowing the visualization of the entire working area, permitted the use of basic microsurgical instruments together with an endoscope. We reached the same conclusion: The tunnel protects the brain parenchyma from accidental injuries caused by conventional microsurgical instruments being passed in and out, and at the same time these instruments make endoscopic surgery more effective. The cannula is also held in position using a conventional neurological self-retractor system. The wider diameter of the tunnel allows the instruments and the camera to function independently of each other. Instruments, such as microdissectors, standard steel suction tubes, and conventional slim bipolar forceps, that cannot be otherwise used with conventional neurological endoscopy can also be used with our technique. The cannula itself does not move from side to side because it is fixed in position, thereby protecting the brain parenchyma and, at the same time, allowing the camera and the instruments to move with a degree of freedom not possible in previous endoscopic techniques.

In 2006 Hayashi and colleagues reported their experience in treating 22 patients in whom an endoscope with an attached suction tube was used to remove ICHs. In 3 of these patients postoperative imaging demonstrated an increased hematoma and in 2 patients the authors observed uncontrolled arterial hemorrhage that required conversion to an open standard craniotomy. With our cannula system we were able to use bipolar coagulation to manage arteri bleeding under direct endoscopic vision; when encountering smaller hemorrhages, we were able to use Surgicel as well as standard microsurgical patties delivered using microcup biopsy forceps. In all patients we were able to reduce the size of hematoma in a single procedure; this was proven both clinically with ICP monitoring and radiologically with postoperative CT scanning.

The ability to combine navigation techniques also proved invaluable as we could plan the trajectory both to avoid important structures and access the hematoma along its long axis. We were able to avoid the sylvian fissure territory when removing the deep intracerebral hemorrhages as in many of the patients the cannula was introduced via a frontal minicraniotomy in the forehead region, thereby accessing the hematoma along its anteromedial aspect (Figs. 1 and 2). This was especially impor-
tant when we were performing surgery in patients with a left dominant hemisphere.

While this study was undertaken to show that the aforementioned technique is suitable for evacuation of ICHs, we are confident that we will be able to use this method for treating other intracranial pathological entities.

Disclosure

A patent for the expandable cannula system is pending. The patent holder will be the University of Malaya. Dr. Waran is the inventor of the cannula and, as an employee of the University of Malaya, stands to receive royalties if the device is developed for commercial use.

Acknowledgment

The authors would like to thank Professor Martin Wastie for his contribution in editing this paper.

References


Accepted April 2, 2009.
Please include this information when citing this paper: published online May 1, 2009; DOI: 10.3171/2009.4.JNS081506.

Supplemental online information:

Address correspondence to: Vicknes Waran, F.R.C.S., Division of Neurosurgery, Department of Surgery, Faculty of Medicine, University of Malaya, Lembah Pantai, 50603, Kuala Lumpur, Malaysia. email: cmvwaran@gmail.com.