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Navigated peel-away sheath assisted placement of fully pre-assembled Ommaya reservoir systems: Technical note

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1. Introduction

Intraventricular Ommaya reservoir placement has been a routinely performed neurosurgical procedure since the 1960's.[1] Given its utility as a long term access point for administration of intrathecal drugs and cerebrospinal fluid (CSF) sampling, accurate placement is critical to ensure reliable device function. While the use of electromagnetic (EM) based intraoperative navigation increases the accuracy and safety of ventricular catheter placement, its use in the placement of Ommaya reservoirs is complicated by the need to attach and secure the reservoir to the ventricular catheter after removal of the navigated stylet.[3,4] During this process the catheter may inadvertently become malpositioned as securing the reservoir to the catheter requires at least partial withdrawal of the ventricular catheter. Additionally, the often small sized ventricular caliber of patients who require Ommaya placement further complicates accurate Ommaya catheter placement.[2] Here we present a simple yet effective technique to enable more efficient and safer placement of Ommaya reservoirs with the aid of intraoperative navigation and a peel-away sheath.

2. Methods

Prior to bringing the patient to the operating room, a preoperative stereotactic computed tomography (CT) scan of the head is obtained and loaded into the Stealth Surgical Navigation system (Medtronic Inc, Minneapolis, MN). A pre-operative trajectory is planned with the target placed just above the ipsilateral foramen of Monroe. Following the induction of general anesthesia, the patient is placed supine in the standard fashion with the head resting in a horseshoe head holder. After patient registration, the predetermined entry point is marked on the patients scalp and a semicircular incision is planned. After standard sterile prep and drape the entry point is again verified using the EM stylet. Prior to incision, the ventricular catheter is trimmed to the appropriate length as determined by the pre-planned trajectory, and the Ommaya reservoir (CSF Ventricular Reservoir, 2.1 mm outer diameter, Medtronic Inc, Minneapolis, MN) is then connected to the catheter and secured with a 3-0 silk tie.

After the planned incision is made, burr hole location is confirmed and placed. The dura is opened sharply, and bipolar cautery is used on the pial surface of the planned entry point. Next, the navigated stylet is placed within the inner cannula of the peel-away sheath and retracted until the tip of the stylet aligns with the tip of the sheath (10F, 15 cm length, PTFE Peel-Apart Percutaneous Introducer, Bard, New Providence, NJ) (Fig. 1, Panel A). Care is taken not to inadvertently retract or advance the stylet relative to the sheath as this may result in malpositioning. Using the guidance view the navigated sheath is then passed into the ventricle until the foramen of Monroe is reached. The stylet and inner cannula are removed, leaving the peel away sheath in place (Fig. 1, Panel B). Appropriate positioning is confirmed with CSF egress while minimizing the volume of CSF drained. While an assistant stabilizes the

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position of the sheath at the outer table of the skill, the primary surgeon begins to peel away the sheath until just above the assistant's fingertips (Fig. 1, Panel C). The assistant then places the pre-assembled Ommaya reservoir through the peel-away sheath while the surgeon continues to peel away the sheath until it has been removed in its entirety (Fig. 1, Panel D). At this point the Ommaya should be resting in its final position. Appropriate catheter positioning is confirmed by accessing the reservoir and observing appropriate CSF flow. The incision is then closed in standard fashion and a head CT is obtained prior to transfer out of the post anesthesia recovery unit to confirm position of the catheter.

3. Results

In our practice we have found that this technique facilitates efficient and safe placement of Ommaya reservoirs using readily available supplies. In the first three patients in whom this technique was utilized, we achieved 100% first-pass placement, even in patients with small caliber ventricles. Immediate post-operative CT revealed appropriate placement of the catheter tip adjacent to the foramen of Monroe in all patients. We have found that this also decreases the length of the procedure as the assistant can assemble the system during the initial exposure so it is ready to insert as soon as ventricular access is obtained. While the assembly of the system is straightforward, this task is made substantially easier and safer by pre-assembling the entire system on the back table prior to surgical insertion. This approach negates the risk of catheter explant from the ventricle during assembly which is currently a limitation of traditional navigated ventriculostomy techniques.

4. Discussion

Given the need for long-term, reliable intrathecal access and the elective nature of the procedure, significant efforts have been made to improve the accuracy and safety of Ommaya reservoir placement.[5–8] Unfortunately, the design of these devices necessitates significant manipulation of the ventricular catheter after placement into the ventricle, regardless of the use of neuronavigation. This manipulation to secure the reservoir to the catheter requires partial removal of the catheter and subsequent blind replacement which can result in possible malpositioning of the catheter or intracranial hemorrhage. Further, the lack of ventriculomegaly in many patients requiring Ommaya reservoir placement can make this procedure a challenge.

The use of a navigated peel away sheath is advantageous as it enables the placement of a pre-assembled reservoir thus minimizing subsequent manipulation, while still enabling the use of neuronavigation for accurate placement. This may also serve to minimize the risk of surgical site infection by minimizing contact between the hardware, patient's skin and surgeon's hands. Other techniques have been described that also allow preassembly of the Ommaya reservoir. Magill et al described a technique in which a transcortical tract is created by navigating a red rubber catheter with subsequent placement of a preassembled Ommaya using a spinal needle inserted through the reservoir as a stylet.[9] In comparison to that approach, the peel-away sheath technique eliminates the need for passing a second catheter through the brain which may result in malpositioning if a new tract is inadvertently created. The use of the peel away sheath adds minimal additional cost to the procedure while potentially saving significant operative time or need for reoperation for a malpositioned Ommaya.

There are several theoretical downsides to using the peal-away catheter technique we described. Firstly, this approach requires the creation of a slightly larger pial opening. Thus careful entry point selection at the crest of a sufficiently large gyrus to accommodate this larger size without risk to vascular structures in the sulci is necessary. Secondly, the use of the peel away sheath results in a marginally larger cortical tract than the Ommaya catheter itself. This mismatch between tract and catheter size creates a theoretical risk for reflux of CSF around the outside of the catheter and subsequent pseudomeningocele formation, although this has not been encountered in our experience. Future studies are necessary to compare perioperative and long-term outcomes using this technique, including surgical time, first pass accuracy, need for reoperation for catheter malfunction or malposition, or development of surgical site infection.

CRediT authorship contribution statement

Connor A. Wathen: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Maria Punchak:** Writing – review & editing, Investigation, Conceptualization. **Peter Madsen:** Writing – review & editing, Conceptualization. **Kerry Vaughan:** Writing – review & editing, Investigation, Conceptualization. **Vivek Buch:** Writing – review & editing, Investigation, Conceptualization. **Paul J. Marcotte:** Writing – review & editing, Investigation.

Declaration of competing interest

The authors have no conflicts of interest or relevant disclosures to the content of this work.

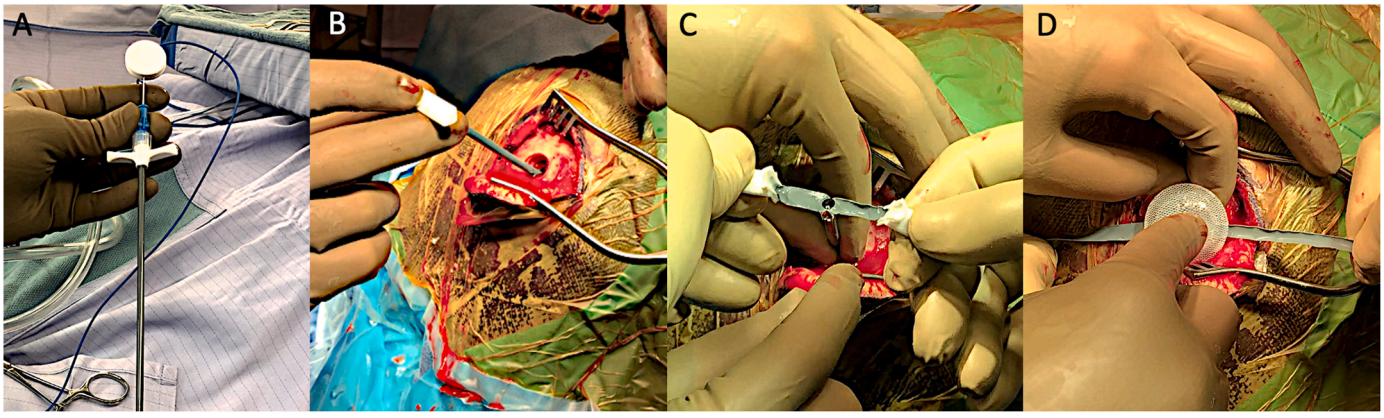

Fig. 1. Axiem Navigated, Peel-Away Sheath Assisted Ommaya Placement. EM Stylet is placed inside inner cannula of peel-away catheter and is retracted so tip is placed just within the inner cannula (Panel A). Using Stealth guidance view catheter is guided until target is reached; stylet and inner cannula are then removed and CSF flow is confirmed while ensuring minimal CSF drainage (Panel B). While securing catheter at the outer table, the catheter is peeled away down to the level of the outer table (Panel C). The peel away sheath is carefully removed while maintaining downward pressure on the Ommaya until only the Ommaya remains in its final position (Panel D).

Abbreviations

Cerebrospinal Fluid CSF
Computed Tomography CT

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