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Clinical Study

Stereotactic catheter placement for Ommaya reservoirs

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ABSTRACT

Ommaya reservoirs are an important surgical therapy for the chronic intrathecal administration of chemotherapy for patients with leptomeningeal carcinomatosis. Surgical accuracy is paramount in these patients with typically normal sized ventricles, and may be improved with stereotactic guidance. This paper aimed to review a large series of stereotactic Ommaya catheter placements, examining accuracy and complications. We conducted a retrospective review of 109 consecutive adult patients who underwent stereotactic Ommaya catheter placement for leptomeningeal carcinomatosis or central nervous system lymphoma at Columbia University Medical Center, USA, from 1998–2013. The rate of accurate placement in the ventricular system was 99%, with the only poor catheter position due to post-placement migration. The rate of peri-operative complications was 6.4%. Hemorrhagic complications occurred in patients with thrombocytopenia or therapeutic anti-coagulation pre-operatively or during the post-operative period. Use of stereotaxy for catheter placement of Ommaya reservoirs is safe and effective, and should be considered when placing a catheter into non-hydrocephalic ventricles.

1. Introduction

The use of Ommaya reservoirs is a common method of intrathecal anti-neoplastic medication delivery for patients with malignancies with diffuse leptomeningeal involvement. Ventricular catheters are often placed in patients with ventriculomegaly, while most patients with leptomeningeal metastasis or central nervous system lymphoma requiring Ommaya placement are not hydrocephalic, and their normal or small ventricular size demands a more spatially accurate catheter placement. For this patient population with diminished ventricular volume, use of stereotaxy for placement of these devices may improve accuracy and safety [1,2].

Improved accuracy may also reduce the number of catheter passes necessary to achieve proper placement. Fewer passes reduces disruption of parenchyma, and in this population with frequent bone marrow dysfunction and thrombocytopenia, may decrease hemorrhagic complications. Series of non-stereotactically guided Ommaya reservoir placement have reported complication rates of 7–10% [3–5]. Complications include malposition of the catheter, hemorrhage, neurologic deficit, and bacterial meningitis and catheter infection.

Small series of experience with stereotaxy for placement of Ommaya reservoirs have reported complication rates of 0–16% [6–11]. In the present study, which represents one of the largest single center series of stereotactic Ommaya catheter placement, we demonstrate that stereotactic Ommaya placement is extremely accurate and associated with a low complication rate.

2. Methods

After Institutional Review Board approval, all patients undergoing frame-based and frameless image-guided stereotactic Ommaya reservoir placement procedures at Columbia University Medical Center, USA, between 1998 and 2013 were identified. Patient demographics, diagnoses, clinical presentations, radiological studies, laboratory values, and clinical outcomes were reviewed. End points reviewed included rate of successful placement, revision, removal, procedure-related neurological morbidity, infection, intracranial hemorrhage, conversion to ventriculoperitoneal shunt (VPS), direct parenchymal toxicity, and 30 day in-hospital mortality.

Generally, all patients had a pre-operative volumetric MRI or CT scan of the head performed within 36 hours of the procedure. For frameless stereotactic procedures, general anesthesia or intravenous sedation was induced, depending on surgeon and patient preference. The patient's head was subsequently fixed in a three-point Mayfield clamp secured to the operating table. Pre-operative images were transferred to the operating room workstation, and intra-operative image guidance was performed using a wand-based navigation system. The scalp anatomy was

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co-registered to the volumetric imaging study using either surface registration with BrainLAB Z-touch software (BrainLAB AG, Munich, Germany) or fiducial registration with the Stealth system (Medtronic Sofamor Danek, Memphis, TN, USA). A linear incision was outlined in the right frontal area centered over the middle frontal gyrus and trajectory planning carried out down to the lateral ventricle. Specifically, the trajectory was planned to have all distal catheter holes within the ventricular system, minimizing the possibility of the more superficial holes ending in the periventricular white matter. To do this, the burr hole was usually lateral to Kocher's point to allow the ventricular entry point to be the anterolateral corner of the frontal horn of the lateral ventricle, with a maximized intraventricular catheter course toward the foramen of Monro.

Intra-operatively, the Ommaya catheter was advanced the stereotactically predetermined length into the frontal horn of the lateral ventricle, and cerebrospinal fluid (CSF) flow was confirmed. The catheter was then soft passed without the stylet to its final premeasured length to place the perforations within the ventricular system. When technically available, a registered stereotactic stylet provided real-time visual feedback during the catheter pass. The Ommaya reservoir was then placed medial or posterior to the incision in the subgaleal space. The ventricular catheter was then secured to the reservoir and anchored to the pericranium. The first dose of intrathecal chemotherapy was often administered if desired by the treating oncologist. Patients were closed in routine fashion, and patency of the apparatus was again confirmed by pumping the reservoir.

The basics of the frame-based procedure were similar, with the following differences. The Cosman–Roberts–Wells (CRW) head frame was affixed to the skull under local or general anesthesia, depending on surgeon and patient preference, and a volumetric head CT scan was obtained. This was used to plan a trajectory for catheter insertion at the BrainLAB workstation. The trajectory specifics were similar to those described above for the frameless procedures. Coordinates for the target trajectory as well as ring and arc parameters for trajectory were obtained, and the placement of the catheter was performed using the head frame rather than the frameless system. A long ventricular stylet was required to place the Ommaya catheter using the CRW frame in order to accommodate the target length of the CRW system of 175 mm, including block and collar.

3. Results

3.1. Demographics

One hundred nine stereotactic Ommaya reservoir placement procedures were performed at Columbia University Medical Center between 1998 and 2013 for central nervous system involvement of various malignancies. The mean patient age was 51 years. The study cohort consisted of 47 male patients (43%).

3.2. Accuracy

Thirty-five of 109 (32%) patients had mild ventricular dilation, and the other 74 patients (68%) had normal or small ventricles. Two (1.8%) patients required two passes of the catheter to confirm CSF flow. Ninety-three (85%) patients had post-operative axial imaging.

The initial scan showed good placement in 92/93 (99%) scans. The one initial scan showing suboptimal placement showed the catheter too deep with a kink in the catheter in the frontal white matter and the reservoir just outside the burr hole, suggesting post-placement migration prior to the CT scan. All other 92 catheters were judged by the attending neurosurgeon to be in good position with all the catheter holes within the ventricular system, without need to be replaced, pulled back, or advanced (Table 1). As a result, no patient demonstrated evidence of toxicity due to direct delivery of chemotherapy into brain parenchyma.

3.3. Revisions

Eight (7.3%) patients required further surgery due to Ommaya malfunction, infection, or poor placement; four catheters required removal for infection and four were revised. The infections were diagnosed on post-operative day (POD) 5, 30, 31, and 44, respectively, followed by immediate removal of the entire system without replacement. One of the four revisions was the aforementioned immediate post-operative catheter migration, and the other three all demonstrated good position on post-operative CT scan, and malfunctioned for different reasons. One worked well for over a month but was noted on POD 40 to be malfunctioning, at which point a CT scan showed migration into the thalamus, and the catheter was revised on POD 41. One malfunctioned on POD 12, and CT scan at that time showed stable position but a small amount of pericatheter hemorrhage, and was found to be clotted at revision. This patient's platelet level had fallen to 2 on POD 3. The fourth revised catheter malfunctioned on POD 4 with no change on CT scan, and was revised. In addition to these eight patients, four patients developed symptomatic hydrocephalus and their catheters were revised to VPS (Table 1).

3.4. Hemorrhagic complications

Seven (6.4%) patients experienced hemorrhages, four (3.7%) symptomatic and three (2.8%) asymptomatic. One patient was the aforementioned small pericatheter hemorrhage resulting in clotting and malfunctioning of the catheter. One patient had platelet level of 3 on the morning of surgery and had previously responded to platelet transfusions with an appropriate increase. However, despite intra-operative transfusion of 12 units of platelets, the patient experienced intra-operative bleeding after an initially clear CSF pass. Severe thrombocytopenia remained refractory to transfusions, and the surgery was aborted without leaving any implant. The hemorrhage grew slowly over the next several days with the platelet level remaining refractory to transfusions. The patient was eventually listed as do not resuscitate and died. One patient had a post-operative CT scan without acute blood, started therapeutic enoxaparin, and developed altered mental status on POD 3 with tract hemorrhage and intraventricular

Table 1
Accuracy and complications in stereotactic catheter placement for Ommaya reservoirs

	Number of patients (%)
Total patients	109 (100)
Accuracy	
Normal sized ventricles	74/109 (68)
Only one catheter pass	107/109 (98)
Had post-operative scan	93/109 (85)
Good radiographic placement	92/93 (99)
Complications	
Total peri-operative complications	7/109 (6.4)
Hemorrhagic complications	7/109 (6.4)
Symptomatic hemorrhage	4/109 (3.7)
Peri-operative malfunctions	3/109 (2.8)
Delayed malfunctions	1/109 (0.9)
Peri-operative infections	1/109 (0.9)
Delayed infections	3/109 (2.8)
Conversion to VPS	4/109 (3.7)

VPS = ventriculoperitoneal shunt.