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Case study

First-line management of chronic subdural hematoma with the subdural evacuating port system: Institutional experience and predictors of outcomes

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ABSTRACT

Chronic subdural hematoma (cSDH) is a common condition that disproportionately affects older patients. Given the greater risks of general anesthesia in this population, interest has turned towards less invasive surgical approaches such as the subdural evacuating port system (SEPS; Medtronic, Inc., Minneapolis, MN). There is a relative dearth of information about the outcomes following this procedure. Here, we present our institution's experience with SEPS and analyze factors associated with the outcomes. Using a prospectively maintained institutional database, we retrospectively identified all patients who presented with cSDH and received first line therapy with SEPS. Pre- and post-operative clinical and radiographic data was obtained from the electronic health record. Outcomes included success or failure, Modified Rankin Scale (mRS) at discharge, length of stay (LOS), and discharge disposition. A total of 126 patients met the inclusion criteria (36 females and 90 males; mean age of 71.6 years). None of the pre-procedural clinical or radiographic variables were associated with the likelihood of a successful outcome. Increasing age was associated with non-routine hospital discharge ($p = 0.003$), and lower presenting GCS was associated with longer hospital stay ($p = 0.005$). Greater thickness of the cSDH was associated with a lower likelihood of having a favorable outcome ($mRS \geq 3$; $p = 0.003$). SEPS is an effective first-line therapy for cSDH. Variables previously reported to limit the effectiveness of the technique (presence of septations, mixed density collections) were not associated with treatment failure.

1. Introduction

Chronic subdural hematoma (cSDH) is a common condition that affects 20 per 100,000 people annually in the United States [1]. There are several surgical treatment options for cSDH including craniotomy, burr hole craniotomy (BHC), and bedside twist drill craniostomy (TDC). Craniotomy has historically been the gold standard, but recent interest has shifted to more minimally invasive approaches. One of these is the subdural evacuating port system (SEPS; Medtronic, Inc., Minneapolis, MN), which can be performed at the bedside under moderate sedation. This is important because cSDH more frequently afflicts the elderly population, which is at higher risk of perioperative complications. The morbidity and mortality rates associated with craniotomy for cSDH have been reported to be as high as 25% and 11%, respectively [2]. Alternatively, TDC at bedside is associated with morbidity and mortality rates of 3% [3].

The published outcomes following SEPS placement are favorable, with high rates of radiographic and clinical improvement as well as low rates of adverse effects [4]. When compared to craniotomy or BHC for drainage of cSDH, outcomes do not differ [5–7]. However, when SEPS is unsuccessful at improving patients' symptoms, craniotomy is usually pursued. Only a few studies have identified pre-procedural risk factors for inadequate drainage and most are limited by small sample sizes.

In this study, we analyzed our institution's experience with the SEPS technique in order to further delineate risk factors for unsatisfactory outcomes, greater length of stay (LOS) and non-routine hospital discharge.

2. Methods

After obtaining institutional review board approval, we retrospectively reviewed a prospectively maintained institutional database to identify all interventions using the SEPS device as a

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first-line treatment for cSDH between 2010 and 2017. Patients were included whether or not they had mixed acute or subacute components to their subdural hematoma, or if there were septations present within the hematoma. Exclusion criteria included prior drainage using the SEPS technique. The decision to perform bedside SEPS drainage was based on physician's preference, but in general it was the first line treatment for all patients with subdural hematomas that were predominantly isodense or hypodense. Electronic health records were reviewed to determine age, sex, Glasgow coma scale (GCS), use of anticoagulant or antiplatelet medication, and symptoms at presentation. Computed tomography (CT) scans were reviewed to determine hematoma thickness and midline shift (MLS) before and after bedside drainage. The post-procedural radiographic parameters were recorded from the first CT scan obtained after removal of the SEPS device. These were typically performed the next morning. Thickness was recorded perpendicular from the inner table of the skull to the medial aspect of the subdural hematoma at the area of maximum diameter. MLS was measured by placing a reference line down the expected midline at the level of the Foramen of Monroe and measuring perpendicular to this. Before the procedure, the density of the most hyperdense component of the subdural hematoma was measured in Hounsfield units.

All procedures were performed at bedside in a neurosciences intensive care unit or step-down unit under moderate sedation with midazolam and fentanyl. Viewing the pre-procedure coronal, sagittal, and axial images, the thickest area of the hematoma was measured from the external auditory canal, and this was where the device was inserted. For patients who presented on an antiplatelet medication, 0.3 mcg/kg of desmopressin and a platelet transfusion were administered before the procedure. For patients who presented on anticoagulation, reversal was administered with confirmation of the appropriate coagulation assay when appropriate. The device was removed after output declined to less than 30 ml per 8 h.

Success was defined clinically as improvement in the patient's chief presenting symptom or neurologic deficit. The outcome was considered unsuccessful if the patient did not experience any such improvement or required repeat SEPS placement, surgical intervention in the operating room, or recurrence within 30 days after discharge, defined as symptomatic and radiographic recurrence requiring reoperation [8]. Disposition was recorded as home/self care or any non-routine hospital discharge (such as a skilled nursing facility).

Binary logistic regression analyses were used to identify *peri*-procedural factors associated with success and disposition. Linear regression analyses were used to identify *peri*-procedural factors associated with LOS. The Wilcoxon Signed-Rank Test was used to compare radiographic factors before and after the procedure. All statistical analyses were performed using SPSS version 24.

3. Results

A total of 151 patients underwent SEPS drainage between 2010 and 2017, and 126 patients met the inclusion criteria. The remaining patients were excluded due to a history of prior craniotomy or TDC. Table 1 lists pertinent demographic, clinical, and pre-procedural radiographic information.

As shown in Fig. 1, the mean pre-procedural SDH diameter and MLS decreased significantly after the procedure. The median amount of drainage was 70 ml (range: 5–300 ml). 85 patients had the SEPS left in for one day, 39 for two days, and 2 for three days. 96 (76%) patients had a successful outcome, and 30 (24%) were unsuccessful. Of those with unsuccessful outcomes, 15 required additional SEPS placement, 12 did not experience improvement in their presenting symptom(s) or experienced recurrence within 30 days, and three underwent craniotomy. Nine of the 15 (60%) patients who underwent a second SEPS placement displayed improvement in their presenting symptom(s), and all three patients who underwent craniotomy experienced improvement. Of those with successful outcomes, 75 (78%) were seen in clinic an average of 2.7 months after hospital discharge. All but one had sustained symptomatic improvement at this time. 81 (64.3%) patients were discharged to home or self-care, 44 (34.9%) had a non-routine discharge, and one expired prior to discharge due to complications associated with his comorbidities. The median LOS was four days (range: 1–42). One patient developed an intraparenchymal hematoma as a result of the procedure. This was stable on a repeat CT and did not require any further intervention. There were no other complications in the cohort.

Table 1
Demographic and presenting radiographic data.

Mean age	71.6
M	90
F	36
Median GCS	14
Atrophy present	60 (48%)
No. with presenting symptoms:	
Headache	49 (39%)
Altered mentation	64 (51%)
Weakness	36 (29%)
Ataxia and gait disturbance	11 (9%)
Aphasia or dysarthria	16 (13%)
Seizure	1 (0.7%)
Incidental	1 (0.7%)
On antiplatelet medication	26 (21%)
On anticoagulation	24 (19%)
Mixed density collections	67 (53%)
Septations present	37 (29%)
Mean thickness on presentation	17.2 mm
Mean MLS on presentation	8.01 mm

A logistic regression analysis was performed to ascertain the effects of pre-procedural clinical and radiographic factors on the likelihood of success (Table 2). The logistic regression model did not reach statistical significance ($X^2 = 15.08$, $p = 0.45$). The model explained 17% (Nagelkerke R^2) of the variance in outcome and correctly classified 78% of the cases. None of the pre-procedural variables were associated with the likelihood of a successful outcome. In a separate analysis, whether or not the SEPS was left in for one or two days was not associated with success ($p = 0.49$).

Additionally, a logistic regression analysis was performed to ascertain the effects of the same pre-procedural clinical and radiographic factors on the likelihood of having a non-routine hospital discharge (Table 2). The logistic regression model met statistical significance ($X^2 = 45.6$, $p < 0.001$). The model explained 42% (Nagelkerke R^2) of the variance in outcome and correctly classified 74% of the cases. Increasing age was associated with an increasing likelihood of a non-routine hospital discharge ($p = 0.003$).

A multiple regression was run to predict LOS from the previously described pre-procedural clinical and radiographic factors. These variables did not significantly predict LOS. However, lower presenting GCS was associated with an increasing likelihood of a longer hospital stay ($p = 0.005$).

The mRS at time of discharge were distributed as follows: 0–25 (20%); 1–41 (33%); 2–22 (17%); 3–19 (15%); 4–15 (12%); 5–3 (2%); 6–1 (0.8%). Thus, 88 (70%) patients had favorable outcomes (mRS 0–2), and 38 (30%) had unfavorable outcomes (mRS 3–6). A logistic regression analysis was performed to determine the effects of pre-procedural clinical and radiographic factors on the likelihood of having a favorable outcome (Table 3). The logistic regression model met statistical significance ($X^2 = 45.6$, $p = 0.013$). The model explained 32% (Nagelkerke R^2) of the variance in outcome and cor-

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