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Are shunt series and shunt patency studies useful in patients with shunted idiopathic intracranial hypertension in the emergency department?

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ABSTRACT

Objectives: Shunt series and shunt patency studies can be performed in the emergency department (ED) to evaluate for shunt malfunction in patients with idiopathic intracranial hypertension (IIH). Here, we examine the utility of these studies in this specific patient population.
Methods: We retrospectively reviewed the ED visits of all shunted patients diagnosed with IIH from 2003 to 2014. ED visits for symptoms not related to the patient's IIH were excluded from the study. Collected variables included demographics, symptoms, IIH diagnosis and treatment history, imaging findings, and management changes.
Results: Twenty-five (81%) patients had a total of 105 visits involving a shunt series, with four (3.9%) showing problems with the catheter. The majority of shunt series ($n = 101$, 96%) showed no catheter pathology. Based on results of the shunt series alone, in 3 instances, management changes in the form of shunt revision or shunt reprogramming occurred. Of the 105 visits with a shunt series, 17 (16%) resulted in a change in management as compared to 12 out of 66 (18%) visits without a shunt series ($p = 0.83$). Nine patients had a total of 10 visits involving a shunt patency study: five were normal, four were abnormal, and one was inconclusive. Based on findings on the shunt patency study alone, changes in management leading to shunt adjustment or revision occurred in 4 instances. Of the 10 visits with shunt patency studies, 5 resulted in a change in management as compared to 24 out of 161 visits without a shunt patency study ($p = 0.014$).
Conclusions: Shunt series detected catheter pathology only 3.9% of the time, and there was no difference in the rate of management changes between those patients who underwent a shunt series and those who did not. There was a significant difference in the rate of management changes in patients who received shunt patency studies as compared to those who did not. Shunt series may not be a useful screening tool to be used universally to diagnose shunt malfunction in IIH patients in the ED, and should be utilized when there is concern for impending visual loss. Shunt patency studies should be reserved for patients with inconclusive diagnostic imaging and clinical findings to decide whether to proceed to surgical exploration and revision.

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1. Introduction

Idiopathic intracranial hypertension (IIH), also known as pseudotumor cerebri, is a disorder of unknown etiology, commonly affecting obese women. As defined by Friedman et al. IIH is a condition with elevated intracranial pressure (>25 cm H_2O on lumbar puncture in lateral decubitus position in adults) with a normal cerebrospinal fluid profile [6]. Common symptoms and signs include headaches, visual loss, and papilledema. In shunted patients, shunt studies are often used when evaluating for malfunction.

Emergency department (ED) evaluation of a shunted patient with IIH often includes a radiographic shunt series (SS) to evaluate for malpositioning, discontinuity, or kinking of the shunt catheter [11]. The SS typically consists of a set of AP and lateral X-rays of the skull, chest, and abdomen to examine the entire length of the catheter.

A shunt patency study, or a radiographic shuntogram, may also be used to demonstrate shunt function and cerebrospinal fluid (CSF) flow through the shunt system. It involves the injection of a small quantity of contrast material or radiotracer into

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the shunt reservoir to measure temporal CSF flow characteristics [2,9].

Although SS and shunt patency studies are commonly used in the ED, their utility for shunted patients with IIH is unclear. The objective of our study was to evaluate the relative utility of SS and shunt patency studies in evaluating this specific patient population.

2. Materials and methods

2.1. Patient selection

Approval of this study was provided from the Institutional Review Board (NA_00044584). The ED visits of all shunted patients with a diagnosis of IIH from 2003 to 2015 were retrospectively reviewed. Patient demographics, symptoms, IIH history, SS and shunt patency imaging findings, and information regarding changes in management were collected. ED visits not related to IIH were excluded from the study.

Demographic information included age, race, comorbidities, and smoking history. Variables related to shunt history included date of initial shunt placement, type and location of shunt (i.e. ventriculoperitoneal, lumboperitoneal, etc.), number of prior shunt operations, and the presence of a programmable valve (various different manufacturers), anti-siphon device (ASD) (from various manufacturers), and/or horizontal–vertical (H–V) lumbar valve system (Integra, Plainsboro, New Jersey). With regards to the patients' ED visits, collected variables included clinical presentation, ophthalmology exam findings, and the presence of papilledema. Imaging information included type of study and the presence of new pathologies or shunt malfunction seen on imaging. Catheter pathology included catheter fractures, separation, and kinking, or the presence of the proximal or distal catheter in the wrong location. Management changes included therapeutic CSF drainage via lumbar puncture (LP), medication change, shunt reprogramming, and shunt revision.

2.2. Statistical analysis

Categorical variables are described by frequency (percentage) and continuous variables are presented as median (interquartile range). Continuous variables were compared using two-tailed Student's *t*-test with all computations were carried out using GraphPad Prism. Statistical significance was determined by a p-value of <0.05.

3. Results

3.1. Shunt series

Twenty-five (81%) shunted patients had a total of 108 visits involving a SS. Patient demographic information is summarized in Table 1. Median age at ED presentation was 36 (interquartile range (IQR): 18) years. The majority of the patients in the series were Caucasian ($n=16$, 64%) and female ($n=21$, 84%). Six (24%) patients had a history of smoking. Common comorbidities included migraines ($n=8$, 32%), hypertension ($n=8$, 32%), and diabetes ($n=3$, 12%). The median BMI of the patients was 36 (IQR: 12) kg/m^2.

Table 2 summarizes information regarding the patients' IIH shunt history. The median age at diagnosis was 27 (IQR: 9) years, and median age at shunt placement was 27 (IQR: 11) years. The types of shunts included ventriculoatrial ($n=10$, 40%), ventriculoperitoneal ($n=8$, 32%), lumboperitoneal ($n=5$, 20%), lumbopleural ($n=1$, 4%), and ventriculopleural ($n=1$, 4%). Sixteen (64%) patients had a programmable shunt, 10 (40%) patients had an ASD, and 2 (8%) patients had an H–V valve. At the time of the ED visit, the median number of prior shunt operations was 8 (IQR: 2).

Table 1
Patient demographics. Information is presented as median (IQR) or as *n* (%).

	Shunt series ($n=25$)	Shunt patency ($n=9$)
Age at ED visit, (*years*)	36 (18)	34 (18)
Female	21 (84%)	9 (100%)
Race		
Caucasian	16 (64%)	5 (56%)
Black	9 (36%)	4 (44%)
BMI	36 (12)	35 (14)
Comorbidities		
Smoking	6 (24%)	2 (22%)
Alcohol/drug use	0 (0%)	0 (0%)
Hypertension	8 (32%)	3 (33%)
CVD	1 (4%)	0 (0%)
Coagulopathy	1 (4%)	1 (11%)
Diabetes	3 (12%)	2 (22%)
Hyperlipidemia	2 (8%)	1 (11%)
COPD	1 (4%)	0 (0%)
Migraines	8 (32%)	3 (33%)

Abbreviations: BMI, body mass index; CVD, cardiovascular disease; COPD, chronic obstructive pulmonary disease; *n*, number; IQR, interquartile range.

Table 2
Information regarding prior shunt procedures for treatment of IIH. Information is presented as mean (SD) or as *n* (%).

	Shunt series ($n=25$)	Shunt patency ($n=9$)
Age at diagnosis (*years*)	27 (9)	28 (2)
Age at shunt placement (*years*)	27 (11)	27 (10)
Number of prior shunt operations	8 (2)	3 (3)
Type of shunt		
VP	8 (32%)	3 (33%)
VA	10 (40%)	4 (44%)
LP	5 (20%)	1 (11%)
Lpleural	1 (4%)	1 (11%)
Vpleural	1 (4%)	0 (0%)
Programmable shunt	16 (64%)	8 (89%)
ASD	10 (40%)	6 (67%)
H–V valve	2 (8%)	1 (11%)

Abbreviations: ASD, antisiphon device; H–V valve (horizontal–vertical valve); IIH, idiopathic intracranial hypertension; LP, lumboperitoneal; LPleural, lumbopleural; *n*, number; SD, standard deviation; VA, ventriculoatrial; VP, ventriculoperitoneal.

The characteristics of the patients' ED visits are presented in Table 3. Patients commonly reported headaches ($n=93$, 89%), nausea or vomiting ($n=62$, 59%), and visual acuity changes ($n=40$, 38%). Formal ophthalmologic exams were performed in 64 (61%) visits and papilledema was observed on 7 (11%) of these exams.

As presented in Table 4, most shunt series ($n=101$, 96%) showed stable findings; only 4 (3.9%) scans demonstrated new pathologies. Based on results of the shunt series alone, changes in management

Table 3
Symptoms and signs during ED visit. Data is presented as n (%).

	Shunt series ($n=105$ visits)	Shunt patency ($n=10$ visits)
Presenting symptoms		
Headache	93 (89%)	10 (100%)
Nausea/vomiting	62 (59%)	6 (60%)
Dizziness	13 (12%)	2 (20%)
Tinnitus	2 (2%)	1 (10%)
Fever/chills	8 (8%)	1 (10%)
Visual acuity change	40 (38%)	7 (70%)
Ophthalmological exam	64 (61%)	8 (80%)
Papilledema	7 (11%)	3 (38%)