Cerebrospinal fluid shunt complication

- Risk Factors, Indications, and Effectiveness of Cerebrospinal Fluid Diversion in Patients With High-Grade Glioma-Associated Hydrocephalus: A Systematic Review and Meta-Analysis
- Fluid dynamics model of the cerebral ventricular system
- Active Cerebrospinal Fluid Exchange vs External Ventricular Drainage in the Neurocritical Care Unit: An International, Retrospective Cohort Study
- Post-traumatic hydrocephalus after decompressive craniectomy: a multidimensional analysis of clinical, radiological, and surgical risk factors
- Endoscopic assessment of ventricular anomalies diagnosed by MRI in hydrocephalus associated with myelomeningocele
- Surgical Nuances in Ultrasound-Guided Percutaneous Distal Catheter Placement in Pediatric Ventriculoatrial Shunts
- Integration of continuous lumbar drainage and third-generation EGFR-TKI in managing leptomeningeal metastasis-induced life-threatening intracranial hypertension: a case report
- Rehabilitation in a child with Chiari II malformation, lumbosacral meningomyelocele, achondroplasia and impaired respiratory regulation - a case report and literature review

Ventriculostomy is a common neurosurgical technique and accurate placement of the ventricular catheter is one of the most important variables in the longevity of shunt survival [1) 2)].

Shunt surgery consumes a large amount of pediatric neurosurgical Healthcare resources. Although many studies have sought to identify risk factors for shunt failure, there is no consensus within the literature on variables that are predictive or protective.

In this era of “quality outcome measures,” some authors have proposed various metrics to assess quality outcomes for shunt surgery.

see Preventable Shunt Revision Rate

Ventricular shunts for pediatric hydrocephalus continue to be plagued with high failure rates. Reported risk factors for shunt failure are inconsistent and controversial. The raw or global shunt revision rate has been the foundation of several proposed quality metrics.

The most common problems related to cerebrospinal fluid shunt are shunt obstruction, shunt infection and shunt overdrainage. The incidence of shunt complications is higher when less time has elapsed since the previous shunt surgery. Nearly all shunt patients end up with one or multiple reoperations. Thorough history, head scan (ultrasound, CT or MRI) and plain x-ray (shunt series) are the corner stones when reviewing shunt problems.

Wong et al. performed a PubMed search using search terms “cerebral shunt,” “cerebrospinal fluid shunt,” “CSF shunt,” “ventriculoperitoneal shunt,” “cerebral shunt AND complications,” “cerebrospinal fluid shunt AND complications,” “CSF shunt AND complications,” and “ventriculoperitoneal shunt AND complications.” Only papers that specifically discussed the relevant complication rates were included. Papers were chosen to be included to maximize the range of rates of occurrence for the adverse events reported. RESULTS: In this review of the neurosurgery literature, the reported rate of mechanical malfunction ranged from 8% to 64%. The use of programmable valves has increased but remains of unproven benefit even in randomized trials. Infection was the second most common complication, with the rate ranging from 3% to 12% of shunt operations. A meta-analysis that included 17 randomized controlled trials of perioperative antibiotic prophylaxis

demonstrated a decrease in shunt infection by half (OR 0.51, 95% CI 0.36-0.73). Similarly, use of detailed protocols including perioperative antibiotics, skin preparation, and limitation of OR personnel and operative time, among other steps, were shown in uncontrolled studies to decrease shunt infection by more than half. Other adverse events included intraabdominal complications, with a reported incidence of 1% to 24%, intracerebral hemorrhage, reported to occur in 4% of cases, and perioperative epilepsy, with a reported association with shunt procedures ranging from 20% to 32%. Potential management strategies are reported but are largely without formal evaluation.

Surgery for CSF shunt placement or revision is associated with a high complication risk due primarily to mechanical issues and infection. Concerted efforts aimed at large-scale monitoring of neurosurgical complications and consistent quality improvement within these highlighted realms may significantly improve patient outcomes [3)].

Infection

see Cerebrospinal fluid infection

see Shunt infection

Lumboperitoneal shunt complication

see Lumboperitoneal shunt complication.

Cerebrospinal fluid shunting and hearing loss

Cerebrospinal fluid shunting and hearing loss

Ventriculoperitoneal shunt complications

see Ventriculoperitoneal shunt complications.

Shunt malfunction

see Shunt malfunction.

Solid noninfectious growing mass

Shunt-related craniocerebral disproportion.

Slit ventricle syndrome and secondary craniosynostosis are late-onset complications after shunt placement these 2 conditions occasionally occur together.

see Tension pneumocephalus after shunt insertion.

The results of shunt testing are helpful in many circumstances, such as the initial choice of shunt and the evaluation of the shunt when its dysfunction is suspected [4].

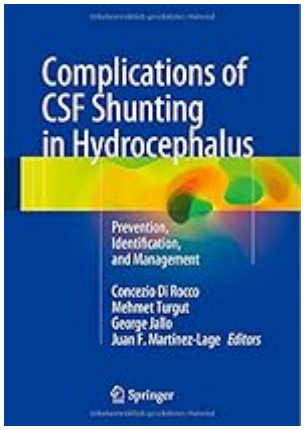
Shunting procedures for syringomyelia have been criticized due to the inconsistent long-term outcomes.

This is largely the result of small volume flow at a very low-pressure profile leading to occlusion or malfunction of the shunts.

Diagnosis

Radionuclide shuntogram is important in the evaluation of cerebrospinal fluid shunt complications such as mechanical failure, malpositioning, pseudocyst, or overdrainage. Bermo et al present a case of congenital hydrocephalus and posterior fossa cyst with multiple shunt procedures and revisions with breakage of the proximal tube of the ventriculoperitoneal shunt but preserved CSF drainage through the patent fibrous tract. Careful correlation with SPECT/CT images helped confirm the breakage and exclude Cerebrospinal fluid fistula outside of the tract, which was suspected on planar images [5].

Books



Noises

Patients have reported anecdotally on noises associated with their shunts [6].

Case series

2017

Kaestner et al. from the Department of Neurosurgery, Klinikum Kassel, Germany, identified all patients who had been treated or followed in our neurosurgical department within a 15-year period from January 2000 up to the end of 2014. After approval of the local ethics committee all patients who were cognitively intact were explored by a questionnaire and by personal interview about acoustic phenomena related to their shunts.

Three hundred forty-seven patients were eligible for the survey, and 260 patients completed the questionnaire. Twenty-nine patients (11.2%) reported on noises raised by their shunts. All of them experienced short-lasting noises while changing body posture, mainly from a horizontal to an upright position, or while reclining the head. Most of the patients reported on soft sounds, but loud and even very loud noises occurred in some patients. Seventy-six percent of the patients were not bothered by these noises as they considered it as a normal part of the therapy or as proof that the shunt device was functioning. Modern valves with gravitational units are prone to produce noises in young adults, but nearly all valve types can evoke noises.

Noises caused by a shunt do occur in a considerable number of patients with shunts. One should be aware of this phenomenon, and these patients must be taken seriously [7)].

2016

Rossi et al undertook a study to determine risk factors for shunt revision within their own patient population.

In this single-center retrospective cohort study, a database was created of all ventricular shunt operations performed at the authors' institution from January 1, 2010, through December 2013. For each index shunt surgery, demographic, clinical, and procedural variables were assembled. An “index surgery” was defined as implantation of a new shunt or the revision or augmentation of an existing shunt system. Bivariate analyses were first performed to evaluate individual effects of each independent variable on shunt failure at 90 days and at 180 days. A final multivariate model was chosen for each outcome by using a backward model selection approach.

There were 466 patients in the study accounting for 739 unique (“index”) operations, for an average of 1.59 procedures per patient. The median age for the cohort at the time of the first shunt surgery was 5 years (range 0-35.7 years), with 53.9% males. The 90- and 180-day shunt failure rates were 24.1% and 29.9%, respectively. The authors found no variable-demographic, clinical, or procedural-that predicted shunt failure within 90 or 180 days.

In this study, none of the risk factors that were examined were statistically significant in determining shunt failure within 90 or 180 days. Given the negative findings and the fact that all other risk factors for shunt failure that have been proposed in the literature thus far are beyond the control of the surgeon (i.e., nonmodifiable), the use of an institution's or individual's global shunt revision rate remains questionable and needs further evaluation before being accepted as a quality metric [8)].

2015

A study aims to review the imaging findings of distal (thoracic and abdominal) complications related to ventriculo-peritoneal (VP), ventriculo-pleural (VPL), and ventriculo-atrial (VA) cerebrospinal fluid (CSF) shunt catheter placement. Institution review board-approved single-center study of patients

with thoracic and abdominal CSF catheter-related complications on cross-sectional imaging examinations over a 14-year period was performed. Clinical presentation, patient demographics, prior medical history, and subsequent surgical treatment were recorded. The presence or absence of CSF catheter-related infection and/or acute hydrocephalus on cross-sectional imaging was also recorded. There were 81 distal CSF catheter-related complications identified on 47 thoracic or abdominal imaging examinations in 30 patients (age 5-80 years, mean 39.3 years), most often on CT (CT = 42, MRI = 1, US = 4). Complications included 38 intraperitoneal and 11 extraperitoneal fluid collections. Extraperitoneal collections included nine abdominal wall subcutaneous (SC) pseudocysts associated with shunt migration and obesity, an intrapleural pseudocyst, and a breast pseudocyst. There were also two large VPL-related pleural effusions, a fractured catheter in the SC tissues, and a large VA shunt thrombus within the right atrium. Ten patients (33.3 %) had culture-positive infection from CSF or shunt catheter samples. Ten patients (33.3 %) had features of temporally related acute or worsening hydrocephalus on neuroimaging. In four of these patients, the detection of thoracic and abdominal complications on CT preceded and predicted the findings of acute hydrocephalus on cranial imaging. Thoracic and abdominal complications of CSF shunts, as can be identified on CT, include shunt infection and/or obstruction, may be both multiple and recurrent, and may be predictive of concurrent acute intracranial problems [9].

2011

From January 1999 to December 2006, Korinek et al., conducted a prospective surveillance program for all neurosurgical procedures including reoperations and infections. Patients undergoing CSF shunt placement were retrospectively identified among patients labeled in the database as having a shunt as a primary or secondary intervention. Revisions of shunts implanted in another hospital or before the study period were excluded, as well as lumbo- or cyst-peritoneal shunts. Shunt complications were classified as mechanical dysfunction or infection. Follow-up was at least 2 years. Potential risk factors were evaluated using log-rank tests and stepwise Cox regression models.

During the 8-year surveillance period, a total of 14 275 patients underwent neurosurgical procedures, including 839 who underwent shunt placement. One hundred nineteen patients were excluded, leaving 720 study patients. Mechanical dysfunction occurred in 124 patients (17.2%) and shunt infection in 44 patients (6.1%). These 168 patients required 375 reoperations. Risk factors for mechanical dysfunction were atrial shunt, greater number of previous external ventriculostomies, and male sex; risk factors for shunt infection were previous Cerebrospinal fluid fistula, previous revisions for dysfunction, surgical incision after 10 am, and longer operating time.

Shunt surgery still carries a high morbidity rate, with a mean of 2.2 reoperations per patient in 23.3% of patients. Our risk-factor data suggest methods for decreasing shunt-related morbidity, including peritoneal routing whenever possible and special attention to preventing Cerebrospinal fluid fistulas after craniotomy or external ventriculostomy [10].

Case reports

James et al. describe 3 children who presented with progressively enlarging skin-covered solid masses over the shunt catheter in the neck/clavicular region. The authors reviewed the clinical, laboratory, pathological, radiographic, and follow-up data for all 3 patients and reviewed the literature on the subject. The patients had no clinical evidence of an infectious process. Surgical exploration revealed that masses were surrounding and encasing the shunt tubing to which they were strongly attached. Pathological studies of the tissues demonstrated varying degrees of exuberant chronically inflamed

granulation tissues, interstitial fibrosis, and dystrophic calcification. One patient had associated thinning of the skin overlying the mass and subsequently developed ulceration. No infectious organisms were observed. The cerebrospinal fluid aspirates from the shunts did not yield any organisms. There has been no recurrence of the masses. The presence of a growing mass over the shunt tube in the neck or the chest region without clinical evidence of infection does not indicate that the mass should be treated with antibiotics and complete shunt removal. Rather, the mass can be cured by extirpation and with “bypass” new shunt tubing locally [11].

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