Ventriculoatrial Shunts in Adults, Incidence of Infection, and Significant Risk Factors: A Single-Center Experience

Abdul Rahman Al-Schameri[1], Jasmina Hamed[2], Gerasimos Baltsavias[3], Peter Winkler[1], Lukas Machegger[1], Bernd Richling[4], Stephan Emich[1]

BACKGROUND: **In recent years, the number of ventriculoatrial (VA) shunt insertions has decreased worldwide, the major cause being the risk of shunt infection. VA shunts remain as an alternative option to ventriculoperitoneal shunts. We describe our 10-year experience with VA shunts by analyzing the incidence of shunt infections and predisposing cofactors.**

METHODS: **During a median follow-up of 15.3 months, 259 shunt insertions, performed on 255 patients, were analyzed. The infection rate was calculated and the predisposing cofactors age, gender, cause of the hydrocephalus, previous external ventricle drainage, antibiotic-impregnated catheters, the number of revisions, the educational level of the surgeons, and the duration of the operations were analyzed. Two observation times were stratified.**

RESULTS: **We found overall infections in 18 patients (7.1%), 16 deep infections (6.3%) including 1 shunt nephritis (0.4%) and 2 superficial infections (0.8%). Wound dehiscence occurred in 17 patients (6. 6%). Analyzing follow-up time, the infection rate was 3.65% (95% confidence interval, 0.9%—5.9%) at survival time 1, 3.38% (95% confidence interval, 1.1%—6.2%) at survival time 2. In the first 6 months, 95% of patients were free of infection. Only the number of revision procedures was associated with the number of infections (*P* value < 0.0005).**

CONCLUSIONS: **In our patient cohort, the infection rate related to VA shunt insertion is low; the only statistically significant risk factor was the number of revisions. If the VA shunt is applied following a standardized protocol, the infection risk does not represent an argument for reluctance towards the VA draining concept.**

INTRODUCTION

In the absence of evidence-based guidelines, the modality chosen for permanent cerebrospinal fluid (CSF) shunting in adults depends mostly on the personal preference and experience of the surgeon. Reported data suggesting or justifying a recommendation for one of the different methods are missing, and in the pediatric population, the superiority of ventriculoperitoneal (VP) shunting is unquestionable.[1-4] CSF shunt infection is one of the most serious complications after shunt insertion. We present a single-center study with a homogeneous adult population analyzing shunt-related infections and their eventual predisposing cofactors after ventriculoatrial (VA) shunt insertion.

PATIENTS AND METHODS

Patients

From 2003 to 2012, 255 patients (145 women [57%] and 110 men [43%]) underwent 259 VA shunt operations for the first time. The minimum age was 19 years, the maximum age was 84 years, and the mean age was 59.1 years (standard deviation, 14.2 years.). The shunt surgery was performed 65 times (25.1%) by residents, 112 times (43.2%) by specialists, and 82 times (31.7%) by consultants.

Key words
- Adults
- Complication
- Hydrocephalus
- Infection
- Ventriculoatrial shunt

Abbreviations and Acronyms
CI: Confidence interval
CSF: Cerebrospinal fluid
EVD: External ventricle drainage
VA: Ventriculoatrial
VP: Ventriculoperitoneal

From the [1]Neurosurgical Department, Paracelsus Medical University, Salzburg, Austria; [2]Neurological Department, Medical University of Vienna, Vienna, Austria; [3]University Hospital, Neuroradiology Department, Zurich, Switzerland; and [4]Paracelsus Medical University, Salzburg, Austria

To whom correspondence should be addressed: Abdul Rahman Al-Schameri, M.D. [E-mail: a.al-schameri@salk.at]

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During the same period, 82 VP shunts were implanted. The causes of the hydrocephalus were posthemorrhagic hydrocephalus (82/32.2%), idiopathic and secondary normal pressure hydrocephalus (67/26.3%), tumors (37/14.5%) and posttraumatic hydrocephalus (36/14.1%; Table 1). After approval by the ethics committee (415-E/1655/3-2013), all respective charts were reviewed retrospectively.

Methods

The primary end point was infection (positive CSF culture, wound infection, shunt nephritis). The secondary end point was the number of revisions. Diagnosis, former implantation of an external ventricle drainage (EVD), duration of the VA shunt operation, educational level of the surgeons (divided into juniors [residents], specialists, and seniors [consultants]), use of antibiotic-impregnated catheters (Bactiseal [Codman Neuro, Johnson & Johnson, Boston, Massachusetts, USA]) were considered as potential risk factors. According to our education system, the specialist has gone through 6 years of training, whereas consultants have been fully trained for at least 4 years. The individual follow-up period started from the initial shunt implantation and ended with the last documented patient contact. Two observation times were stratified, with different starting points: 1) the day of the last revision preceding the infection and 2) the day from the first operation to manifestation of shunt infection. Infection rate at 100 days after the last (survival time 1) and 100 days after the first (survival time 2) operation were calculated. In case of shunt removal, the observation period ended with the date of explanation. All related operations as a result of shunt insertions as well as invasive shunt testing and shunt ligation were defined as revision.

Standard of Care

The VA shunt represents the first choice of treatment. The external jugular vein or the facial vein was used for distal catheter insertion to the atrium. All patients scheduled for shunt surgery were investigated for foci of infection. Preoperatively, the laboratory parameters C-reactive protein and white blood cell count were within the normal range. If an EVD was implanted previously, 2 or more negative CSF cultures of bacterial growth were obligatory. Immediately before surgery, the hair was washed with an antiseptic shampoo (Octenisan [Schülke & Mayr, Norderstedt, Germany]). Preoperative antibiotic therapy was started with 1.5 g cefuroxime 3 times per day for 7 days; the first dose was started simultaneously with anesthesia. Before incision, the skin was prepared with antiseptic agents (Kodan Tincture Forte [Schülke & Mayr]) for 5 minutes. The attended operation area was covered with antimicrobial surgical incise drapes (3M Ioban [3M, St Paul, Minnesota, USA]). Special attention was paid to reducing the number and migration of involved staff in the operation theater during the operation. Shunt components were opened only immediately before implantation. The CSF shunt device used in all patients was the Codman Hakim Programmable valve (Johnson & Johnson).

Table 1. Causes of Hydrocephalus in 255 Patients

Cause	n	%
Subarachnoid hemorrhage	82	32.5
Normal pressure hydrocephalus	67	26.3
Tumor	37	14.5
Trauma	36	14.0
Intracerebral hematoma	17	6.7
Pseudotumor cerebri	8	3.0
Others	8	3.0
Total	255	100

DEFINITION OF INFECTION

Infection was defined according to the guidelines laid down by the Robert Koch institution[5] and subdivided into superficial (wound infection), deep (CSF infection), and shunt nephritis. Clinical signs such as body temperature higher than 38°C or intermitted fever, headache, neck rigidity, impairment of consciousness with a positive pathogen in the blood culture/CSF, and increased white blood cell count, increased protein content, or reduced glucose concentration in the CSF were considered as signs of shunt-related infection. The infection rate was calculated and the predisposing cofactors were analyzed.

Statistical Analysis

The overall infection rate was analyzed with and without taking the observation time into consideration. Without considering the observation time, the overall infection rate was calculated as the number of patients with infection divided by the number of all patients. Here, the effect of possible cofactors on the infection rate was examined using contingency tables and a χ^2 test when the number of cases was sufficient or otherwise by a Fisher exact test. We used Kaplan-Meier survival analysis to calculate the infection and revision rate in relation to the time. Cox regression was carried out for multivariate analysis of the revision rate and potential influencing factors. Statistical significance was defined as a P value < 0.05. All the statistical analysis and calculations were performed with SPSS (PASW) statistics version 18 (SPSS Inc., Chicago, Illinois, USA).

RESULTS

Primary Objective

Of the 255 patients, 18 (7.1%) had infection. Sixteen patients developed deep infections, including 1 patient with shunt nephritis, and 2 developed superficial infections. Both superficial infections occurred on the basis of wound dehiscence, which occurred in 17 patients (6.6%). In 15 cases, the shunt system was removed and an EVD inserted, whereas 3 cases were treated with systemic antibiotics only. One patient died of the consequence of shunt nephritis 5 years after implantation. Table 2 shows the microbiological findings of isolated organisms in deep and superficial infections. *Staphylococcus epidermidis* was isolated in