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ORIGINAL ARTICLE

Long-tunneled versus short-tunneled external ventricular drainage: Prospective experience from a developing country

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ABSTRACT

Background: External ventricular drains (EVD) are commonly utilized for temporary diversion of cerebrospinal fluid (CSF). Many neurosurgeons prefer long-tunneled EVDs in their routine practice. However, it is still unclear whether this extended tunneling helps in reducing CSF infection. Keeping this in mind, we decided to compare infection rates in long-tunneled versus short-tunneled EVDs in the setting of a developing country.

Materials and Methods: A prospective study of 60 patients was conducted. Consenting patients who underwent short-tunneled (Group A) or long-tunneled (Group B) EVDs between January 2008 and June 2009 were followed during the course of their inpatient care. All operational protocol was standardized during the trial. Serial samples of CSF were analyzed to detect infection.

Results: Mean age of patients was 33.6 years with 32 males (53.3%). Mean duration of long-tunneled EVD was 13.4 ± 7.2 days, whereas that of short-tunneled EVD was 5.3 ± 2.7 days ($P < 0.001$). Three patients with long-tunneled EVD (10.0%), whereas one patient with short-tunneled EVD (3.3%) developed drain-related infections; however, this was non-significant ($P = 0.301$). However, patients with short-tunneled EVD got infected earlier on day 3when compared with the long-tunneled EVDs, which got infected after a mean duration of 7.3 days. The overall risk of infection for long-tunneled EVDs was 7.46 per 1,000 ventricular drainage days which was comparable to the risk of 6.33 per 1,000 ventricular drainage days seen for short-tunneled EVDs.

Conclusion: Long-tunneled EVDs appear to only delay potential infections without having any effect on the actual risk of infection. Long-tunneled EVD in a resource-limited setting is technically challenging and may not yield additional benefits to the patient. However, larger and prospective studies are needed to establish the rate of infections and other complications.

Key words: External ventricular drainage, hydrocephalus, Pakistan

Introduction

External ventricular drains (EVD) are an integral component of neurosurgical practice.[1] Commonly utilized in situations requiring temporary diversion of cerebrospinal fluid (CSF) including intra-ventricular hemorrhages, intracranial hypertension, and tumors and central nervous system infections,[2] EVDs can be subsequently removed, revised or converted to ventriculoperitoneal shunt (VP Shunt) depending upon the further need of CSF diversion.[1] As expected with all external catheters, catheter-related infection is a significant complication of EVD.[3]

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A variable rate of catheter-related CSF infections has been reported in literature, ranging between 2% and 23%.[4-8] Reports from developing countries go as high as 32.2%.[9] It is hypothesized that external colonization of the catheter is responsible for catheter-related central nervous system (CNS) infection and hence, various techniques to reduce external colonization have been suggested.

Long-tunneled EVD is one such technique, initially described by Khanna *et al*., which involves longer subcutaneous tunneling of the distal end of the catheter before it is externalized,[10] when compared with the conventional 5 cm tunneling (called short-tunneled EVD in this study).In theory, this should delay the external colonization of the catheter and hence, prolong the number of days that a catheter can remain in place before a revision due to CNS infection is required.

Undoubtedly, many neurosurgeons use this technique in their routine practices, but it has not been a focus of discussion in the literature and it is still unclear whether this extended tunneling helps in reducing CSF infection. In this study, we present a comparison in rate of infections between long-tunneled and short-tunneled EVD in a resource-limited setting of a developing country like Pakistan.

Materials and Methods

After approval by the Research and Training Monitoring Cell, College of Physicians and Surgeons, Pakistan and the in-house Ethics Review Committee of the Aga Khan University, Karachi, Pakistan patients undergoing short- and long-tunneled EVD placements at the Aga Khan University Hospital between October 2008 and July 2009 were prospectively followed. All patients regardless of age, gender, comorbid conditions, or indication for EVD were included in the study until a pre-set sample size of 60 patients (30 in each group) was reached. Patients with inadequate information to establish new-onset catheter-related infections were excluded from this study. Using this sample size and assuming the initially reported infection rate of 4% in long-tunneled EVD catheters, our study is adequately powered to detect a 9-fold higher risk of infection in short-tunneled EVD with 95% confidence and 80% power.

On the basis of tunnel length, the patients were divided into two groups (Group A and Group B). Patients in Group A underwent a short-tunneled EVD placement and patients in Group B underwent long-tunneled EVD placement. The choice of long versus short-tunneled procedure was based on the decision and practice of the attending physician and the investigators of the study did not pose any influence in this regard.

All efforts were made to standardize the procedure. EVD placement was performed in the operating room under standard aseptic measures with prophylactic pre-operative antibiotics in all patients. Short-tunneled EVD catheters were tunneled subcutaneously for approximately 5 cm from the ventriculostomy site before externalization. In comparison, long-tunneled EVD catheters were tunneled subcutaneously for approximately 50-60 cm using malleable shunt passers and externalized on the lower chest or upper abdomen.

Post-operatively, patients were managed within a standardized protocol and closely monitored for CSF outputs. Serial samples of CSF were sent to Aga Khan University laboratory by the primary investigator for cell count, gram staining, and culture to detect infection and intra-ventricular hemorrhage. Upon resolution of hydrocephalus and symptomatic improvement, patients were challenged by either increasing the EVD height to 25 cm of water or blocking of the catheter for 24 h. EVD was discontinued if no EVD output was produced in the former or if the patient remained asymptomatic in the latter scenarios.

Catheter-related infection was considered when any one of the following conditions was met:

- Rise in CSF leukocyte count above 10,000 cells/μl in a patient with previously normal CSF leukocyte count and at least one clinically documented fever spike with a temperature ≥38°C
- Evidence of growth of any micro-organism (not suggested to be a contaminant) on culture of CSF or the catheter tip in a patient whose initial CSF culture showed no growth
- Evidence of growth of a new micro-organism (not suggested to be a contaminant) on culture of CSF or the catheter tip in a patient with pre-existing CNS infection at the time of EVD.

Statistical Package for Social Sciences (SPSS) version 17.0 (Chicago, IL, USA) was used for data analysis. Continuous variables were found to be normally distributed using the Shapiro–Wilk test and were described using mean ± SD. Differences in continuous variables were tested using the Student's *t*-test, whereas those in categorical variables were tested using odds ratio or Chi-squared test as appropriate. $P < 0.05$ was considered significant.

Results

Of the 60 participants included in the study, 32 (53.3%) were male and 28 (46.7%) were female with an average age of 33.6 ± 24.4 years. When considering comorbidities, 15 (25.0%) were diabetic, 19 (31.7%) were hypertensive, 5 (8.3%) had a history of ischemic heart disease, and 1 (1.7%) had a history of an ischemic stroke. The two most common etiologies for hydrocephalus and hence the indications for EVD in our patients were non-pyogenic CNS infections in 24 (40.0%) and intracranial hemorrhage in 24 (40.0%). Intracranial tumor was seen in 8 (13.3%), followed by hydrocephalus post-craniotomy in 4 (6.7%) patients. No significant differences were found and both groups were statistically comparable [Table 1].

The mean hospital stay was 21.5 ± 17.8 days, whereas the mean number of days with EVD catheter in place was 9.3 ± 6.8 days. The number of days with EVD catheter in place was significantly longer in Group B (13.4 ± 7.2 days) when compared with Group A (5.3 ± 2.7 days; $P \leq 0.001$). Subsequently, a similar pattern was noted in the duration of hospital stay: 27.1 ± 20.3 days in Group B when compared with 16.7 ± 13.9 days in Group A ($P = 0.029$).

When considering the outcomes of the EVDs, 33.3% ($n = 10$) short-tunneled EVDs were converted to VP shunts, 46.7% ($n = 14$)

Table 1: Summary of the study findings

	Total population (*n*=60)	Short tunnel EVD Group A (*n*=30)	Long tunnel EVD Group B (*n*=30)	*P* value
Demographics				
Gender				
Male	32 (53.3)	15 (50.0)	17 (56.7)	0.605*
Female	28 (46.7)	15 (50.0)	13 (43.3)	
Age	33.6 (24.4)	39.3 (25.2)	27.8 (22.6)	0.068†
Hospital stay	21.5 (17.8)	16.7 (13.9)	27.1 (20.3)	0.029†
Duration of EVD placement	9.3±6.8	5.3±2.7	13.4±7.2	<0.00†
Co-Morbidities				
Diabetes	15 (25.0)	8 (26.7)	7 (23.3)	0.766*
Hypertension	19 (31.7)	12 (40.0)	7 (23.3)	0.165*
Ischemic heart disease	5 (8.3)	2 (6.7)	3 (10.0)	0.640*
Stroke	1 (1.7)	1 (3.3)	0 (0.0)	0.313*
Indications				
Non-pyogenic infection	24 (40.0)	11 (36.7)	13 (43.3)	0.881*
Hemorrhage	24 (40.0)	12 (40.0)	12 (40.0)	
Post-craniotomy	2 (6.7)	2 (6.7)	2 (6.7)	
Tumor	8 (13.3)	5 (16.7)	3 (10.0)	
Infection	4 (6.7%)	1 (3.3%)	3 (10.0%)	0.301*
Mean day of infection	6.25	3	7.3	

*Chi-squared test, †Student's *t*-test

were removed, and 20.0% ($n = 6$) patients expired with the EVD in place. In the long-tunneled group, 43.3% ($n = 13$) were converted to VP shunts, 53.3% ($n = 16$) were removed, and 3.3% ($n = 1$) patient expired with the EVD in place.

A total of four patients (6.7%) developed catheter-related infection in this series of patients. Three patients (10.0%) in Group B developed a catheter-related infection, whereas one patient (3.3%) in Group A developed such an infection [Table 1]. However, this difference was not statistically significant ($P = 0.301$), it is of interest to note that the short-tunneled EVD got infected earlier on day 3 when compared with the long-tunneled EVDs, which got infected after a mean duration of 7.3 days.

The cumulative duration of short-tunneled EVD placement was 158 days, whereas long-tunneled EVDs were in place for a total of 402 days. When considering risk of infection in terms of days of ventricular drainage, the risk of infection becomes 7.46 per 1,000 ventricular drainage days for long-tunneled EVDs which were comparable with the risk of 6.33 per 1,000 ventricular drainage days seen for short-tunneled EVDs.

Discussion

Shortly after the formalization of ventriculostomies, Bering in 1951 reported the first occurrence of post-procedure CSF infections.[11] Since then, neurosurgeons have adopted a vast variety of strategies to minimize E100VD-related infections. These measures include valve-regulated sump drainage,[12] the use of periprocedural and prophylactic antibiotics,[13] revision of ventriculostomies after 5 days,[14] tunneled catheters,[10] and recently antibiotic-impregnated ventricular catheters.[15] Arguably, the most successful of these measures have been the tunneled catheters when considering patient safety and cost.

The tunneling technique creates a subcutaneous tract between the burr hole and catheter exit site, working on the principle of preventing ascending infection as applied in the design of in-dwelling intravenous catheters. Initially, a 5 cm short tunneling technique was utilized, followed by introduction of long-tunneled drains with distal ends exiting from low anterior chest wall or abdomen usually between 50 and 60 cm from the proximal end.[1,10] Numerous studies have addressed the efficacy of long-tunneled catheters;[10,16-19] however, a majority of published literature is retrospective in nature and highly variable in terms of study population, definition of infection, use of antibiotics, and duration of monitoring. These differences make it difficult to arrive at conclusive infection rates.

Two centers have published major studies on the use of long tunnel EVDs. Khanna *et al*., when describing the procedure, retrospectively reported the results of long-tunneled EVDs in 100 patients, with an average duration of 18.3 days. According to their study, no infections were observed during the first 16 days and the overall incidence of infection was 4%.[10]

Leung *et al*. retrospectively reviewed 114 patients who received long-tunneled EVDs, with a mean duration of drainage of 20 days. The overall infection rate was 6.8% with a majority of infections occurring within the first 5 days of drainage. Intra-ventricular instillation of urokinase was identified as the only statistically significant risk factor.[1] The overall infection rate reported by Leung *et al*. was comparable with that of conventional short-tunneled drains.[1]

When prospectively comparing data, we found the risk of infection in short-tunneled EVD to be lower (3.3%) than long-tunneled catheters (10%). However, no statistically significant difference was found between the two types of EVDs with regard to infection in our cohort of patients, rejecting our initial hypothesis that long-tunneled EVDs would lead to a reduced risk of infection. A notable increase in the duration of placement of EVDs prior to infection was also noticed in our study. However, it did not reduce the overall probability of infection, we believe that long-tunneled EVDs only delay potential infections without having any effect on the actual risk of infection. Keeping this in mind, long-tunneled EVDs in a limited-resource setting is technically challenging and may not yield additional benefits to the patient.

Limitations

Although prospective data collection was strength of our study, it resulted in a rather unequal distribution of etiologies, with a majority of patients in Group B (43.3%) having hydrocephalus secondary to non-pyogenic infections such as tuberculosis and parasitic infestations. In Group A, only 36.7% had non-pyogenic infections. This difference was not statistically significant. Incidentally, patients in Group A also had a shorter duration of catheter placement and had shorter hospital stay than patients in Group B ($P < 0.001$ and $P < 0.029$, respectively). Both these issues may have had some confounding effects, a larger sample size with multicenter enrolment is recommended to further improve the significance of these findings.

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