Volume 12, Issue 3, Page 93-98, 2023 https://doi.org/10.46810/tdfd.1341318 Research Article

BİNGÖL ÜNİVERSİTESİ

Türk Doğa ve Fen Dergisi
Turkish Journal of Nature and Science

The Effect of Subcutaneous Tunneling on External Lumbar Drainage Complications

Ece UYSAL[1*]

[1] Health Sciences University, Prof. Dr. Cemil Tascioglu City Hospital, Neurosurgery Department, Istanbul, Türkiye
Ece UYSAL ORCID No: 0000-0002-2355-8395

**Corresponding author: dr.eceuysal.nrs@gmail.com*

(Received: 11.08.2023, Accepted: 04.09.2023, Online Publication: 27.09.2023)

Keywords
Lumbar drainage, Lumbar puncture, Cerebrospinal Fluid Leak, Meningitis

Abstract:
Patients with a lumbar catheter become prone to infection due to the outflow of CSF. This research aimed to investigate how tunneled lumbar drainage affected infection in patients undergoing lumbar drainage.This study was conducted on patients with lumbar drainage who were hospitalized for various clinical reasons. Subcutaneous drain length was measured by post-procedural lumbar tomography. The length of the lumbar drainage catheter, the duration of lumbar drainage, fever monitoring, CSF leaking, and biochemical blood tests, the length of hospitalization, infection were recorded.This study comprised a total of 93 cases with external lumbar drainage. 51 (54.8%) of the 93 cases were inserted using the classic technique, 42 (45.2%) were inserted using the tunneled technique. The rate of CSF leakage was decreased using the tunneling approach (p = 0.003). A significant correlation was established between CSF leakage around the drain and subcutaneous drain length. CSF culture was negative in 78.8% of patients with subcutaneous drain lengths between 0 cm and 3 cm, and 100% of patients with subcutaneous drain lengths of 5 cm or more. Seven days or less was the cutoff value for negative CSF culture.External lumbar draining can lead to issues such as infection and CSF leakage. The tunneling procedure is straightforward, affordable, and successfully prevents these complications.

Subkutan Tünellemenin Eksternal Lomber Drenaj Komplikasyonlarına Etkisi

Anahtar Kelimeler
Lomber drenaj, Lomber ponksiyon, Beyin omurilik sıvısı, Menenjit

Bel bölgesinde uzun süre kateter bulunan hastalar, BOS sıvısının dış ortama çıkışı nedeniyle enfeksiyona yatkın hale gelebilir. Bu araştırma, tünelli lomber drenajın lomber drenaj uygulanan hastalarda enfeksiyonu nasıl etkilediğini araştırmayı amaçladı. Bu çalışma, çeşitli klinik nedenlerle hastaneye yatırılan lomber drenajlı hastalar üzerinde yapılmıştır. Subkutan dren uzunluğu işlem sonrası lomber tomografi ile ölçüldü. Lomber drenaj kateterinin uzunluğu, lomber drenaj süresi, ardından ateş izlemi, lomber drenaj çevresinden BOS sızıntısı ve günlük biyokimyasal kan testleri, hastanede kalış süresi, enfeksiyon ve antibiyotik ihtiyacı kaydedildi. Bu çalışma eksternal lomber drenajı olan toplam 93 olguyu içermektedir. Doksan üç olgunun 51'i (%54.8) klasik teknikle, 42'si (%45.2) ise tünelli teknikle yerleştirildi. BOS kaçağı oranı, tünelleme yaklaşımı kullanılarak azaltıldı (p = 0.003). Hastanede kalış süresi açısından iki işlem arasında fark yoktu. Dren etrafındaki BOS sızıntısı ile subkutan dren uzunluğu arasında istatistiksel olarak anlamlı bir ilişki saptandı. Subkutan dren uzunluğu 0-3 cm arasında olan hastaların %78.8'inde, 5 cm ve üzeri dren uzunluğu olan hastaların ise %100'ünde BOS kültürü negatifti. Negatif BOS kültürü için cut-0ff değeri yedi gün olarak belirlendi. Dış lomber drenaj, enfeksiyon ve BOS sızıntısı gibi sorunlara yol açabilir. Tünel açma prosedürü basittir, ekonomiktir ve bu komplikasyonları başarılı bir şekilde önler.

1. INTRODUCTION

CSF (Cerebrospinal Fluid) diversion methods are commonly used in neurosurgery. External lumbar drainage was first introduced in 1963 as a technique to alleviate cerebral tension during surgical procedures and it has been widely adopted as a method of cerebrospinal fluid (CSF) diversion in various clinical contexts [1]. These include the management of post-traumatic CSF leaks, evaluation of normal pressure hydrocephalus, and skull base surgery. It can be utilized to treat CSF fistulas as well as traumatic or non-traumatic cases of high intracranial pressure [2,3]. It allows for the evacuation of cerebrospinal fluid from the lumbar area to the external environment, relieving intracranial pressure and CSF pressure. Because of the length of the treatment procedure, it may be necessary to remain attached to the patient for a longer amount of time. Although external lumbar drainage is an easy method, it has complications such as infection or CSF leakage due to contact with the external environment [4]. Patients with a catheter in the lumbar area for an extended period may become prone to infection due to the outflow of CSF fluid to the external environment. Because of retrograde infection, lumbar drains may result in the colonization of bacteria [5]. This research aimed to investigate how tunneled lumbar drainage, a previously suggested method, affected infection in patients undergoing lumbar drainage [6].

2. MATERIAL AND METHOD

2.1. Study Design

Our study adheres to the ethical principles outlined in the Helsinki Declaration of the World Medical Association and is approved by the Clinical Research Ethics Committee decision for Clinical Research at Istanbul Prof. Dr. Cemil Tascioglu City Hospital dated 06.03.2022 and numbered 38. This study was conducted on patients with lumbar drainage who were hospitalized at the neurosurgery clinic for various clinical reasons between 2019 and 2022. Only patients with lumbar drainage were included in our study. Patients with ventricular drainage, those with previous infection, those under antibiotics, those under immunosuppressants, and those with a known cancer history were excluded from our study. In 2021, due to a policy shift, the tunneled lumbar drainage method began to replace the traditional method, which had been in use since 2019. The acquired data for the study were retrospectively assessed. Sociodemographic information and causes of lumbar drainage in patients were recorded. Patients having infection prior to insertion of lumbar drainage, using immunosuppressants or antibiotics, and infection from another region following lumbar drainage were excluded from our study. The length of the lumbar drainage catheter was measured using post-procedure lumbar tomography and lumbar radiography. 0 cm indicates classic technique. The duration of lumbar drainage, subsequent fever monitoring, CSF leaking surrounding the lumbar drain, and daily biochemical blood tests were recorded. Meanwhile, CSF samples collected from the lumbar drainage catheter every two days as part of a standard drainage process were analyzed and documented. In the case of elevated infection parameters in CSF samples, lumbar drainage catheter CSF culture samples were also received. The length of hospitalization related to lumbar drainage and infection and the requirement for antibiotics were also evaluated. The patient's diagnosis determined the duration of lumbar drainage, and lumbar drainage was ended after the patient's therapy concluded.

2.2. CSF infection Criteria

A positive CSF culture, a CSF/blood glucose ratio of less than 0.5, a neutrophilic CSF pleocytosis (> 5 cells/L), and fever (body temperature of greater than 38°C) [3].

2.3. External Lumbar Drainage Placement Procedure

Before performing the surgery on any patient, informed consent was obtained. The procedure was conducted in an operating room by a neurosurgeon or a neurosurgical assistant with considerable experience. Before the procedure, patients received intravenous cefazolin as a prophylactic (vancomycin if allergic to penicillin). Patients were placed in the lateral decubitus or sitting position to measure distance. After the appropriate sterilizing, lidocaine was administered as a local anesthetic. Between L3 and L4, the subarachnoid region was reached with a spinal needle (Tuohy needle). A 10 to 15-cm catheter was inserted into the subarachnoid area when CSF was observed. After removing the drainage catheter from the area of the skin where the needle was directly implanted, fixation sutures were used to secure it to the skin. In patients who underwent tunneling, the drain was removed after it had been advanced laterally in the subcutaneous tissue for a while [6].

2.4. Statistical Examination

The statistical analysis was conducted with SPSS 15.0 for Windows. Descriptive statistics; number and percentage for categorical variables, and mean, standard deviation, median, minimum, and maximum for numerical variables. The Chi-Square Test was used to compare the group rates. The Mann-Whitney U test was used to compare numerical data between two independent groups since the assumption of a normal distribution was met. Since the parametric test condition was unsatisfied, the relationships between numerical variables were investigated using Spearman correlation. Cut-off value analysis was evaluated via ROC Curve Analysis. The significance level regarding statistical alpha was accepted as $p<0.05$.

3. RESULTS

This study comprised a total of 93 cases with external lumbar drainage. There were 32 (34.4%) females and 61 (65.6%) males, averaging 53,214.3. (20-87). 51 (54.8%) of the 93 cases were inserted using the classic technique, whereas 42 (45.2%) were inserted using the tunneled technique. The duration of the drainage varied from 5 to 8 days, with an average of 6.33 days. In 10 (10,8) cases, CSF was detected leaking around the drain. In 16 (17.2%) cases, infection was observed correlated with fever, CSF culture, CSF/blood glucose, and elevated CSF neutrophils. All infected patients required antibiotics (17.2%). Hospital stays ranged from 7 to 23, with a mean of 9,65 days. The length of the subcutaneous drain ranged from 0 to 8 (Table 1).

Table 1. A breakdown of the demographics of the 93 patients

Age Mean ±SD (Min-Max)		53.2±14.3 (20-87)
Gender n (%)	**F**	32 (34.4)
	M	61 (65.6)
Duration of drain Mean± SD (Min-Max)		6.33±1.15 (5-8)
Technque n (%)	**Classic**	51 (54.8)
	Tunneled	42 (45.2)
Fever n (%)	**No**	77 (82.8)
	Yes	16 (17.2)
CSF leakage around drain n (%)	**No**	83 (89.2)
	Yes	10 (10.8)
CSF culture n (%)	**Negative**	77 (82.8)
	Positive	16 (17.2)
CSF/Blood Glucose Mean± SD (Min-Max)		0.61±0.17 (0.2-0.8)
CSF Neutrophil >5 n (%)	**No**	77 (82.8)
	Yes	16 (17.2)
Hospital Stay Mean ±SD (Min-Max)		9.65±4.17 (7-23)
Plus antibiotic need n (%)	**No**	77 (82.8)
	Yes	16 (17.2)
Subcutaneous drain length Mean± SD (Min-Max)		2.74±3.27 (0-8)

When comparing the classical and tunnel lumbar drainage techniques, it was found that the classical approach resulted in CSF leakage in 10 cases (19.6%) (Table 2). No CSF leakage was reported among individuals who utilized the tunnel approach. The rate of CSF leakage was statistically significantly decreased using the tunneling approach (p = 0.003). Regarding fever, CSF culture, CSF/blood glucose, and CSF neutrophil > 5, no statistically significant differences were detected between the approaches. There was no difference between the two procedures in terms of hospital stay.

Table 2. Comparison of classic and tunneled external lumbar drainage technique

	Technique		
	Classic	Tunneled	p
Fever n (%)	11 (21.6)	5 (11.9)	0.219
CSF leakage around drain n (%)	10 (19.6)	0 (0.0)	0.002
CSF culture n (%)	11 (21.6)	5 (11.9)	0.219
CSF/Blood Glucose*	0.59±0.19 0.6 (0.2-0.8)	0.63±0.15 0.7 (0.2-0.8)	0.359
CSF Neutrophil >5 n (%)	11 (21.6)	5 (11.9)	0.219
Plus antibiotic need n (%)	11 (21.6)	5 (11.9)	0.219
Hospital Stay*	10.3±4.9 8 (7-23)	8.8±2.9 8 (7-20)	0.334

* Mean.±SD (Median) Min-Max

Comparing the duration of the subcutaneous drain with infection parameters such as fever, CSF culture, and CSF neutrophil count >5 (p=0.037) showed significant differences (p=0.05) (Table 3). It was also discovered that decreasing the length of the subcutaneous drain increased the likelihood of cerebrospinal fluid (CSF) leakage from the edge of the drain (p=0.005). There was no statistically significant association between CSF/blood glucose levels and drain duration (p=0.329).

Table 3. The comparison of subcutaneous drain length on other parameters

		Subcutaneous drain length		
		Mean ±SD	Median (Min-Max)	p
Fever n (%)	No	3.14±3.42	0 (0-8)	**0.037**
	Yes	0.81±1.28	0 (0-3)	
CSF leakage around drain n (%)	No	3.07±3.31	0 (0-8)	**0.005**
	Yes	0.00±0.00	0 (0-0)	
CSF culture n (%)	Negative	3.14±3.42	0 (0-8)	**0.037**
	Positive	0.81±1.28	0 (0-3)	
CSF Neutrofil >5 n (%)	No	3.14±3.42	0 (0-8)	**0.037**
	Yes	0.81±1.28	0 (0-3)	
CSF/Blood Glucose		r:0.102 p=0.329		

There was a statistically significant difference between the subcutaneous drain length levels and CSF culture rates (p<0.001) (Table 4). The length of subcutaneous drains for classical procedures was assumed to be 0 cm. CSF culture was negative in 78.8% of patients with subcutaneous drain lengths between 0 and 3 cm, and 100% of patients with subcutaneous drain lengths of >5 cm.

Table 4. The comparison of subcutaneous drain lengths with CSF

		CSF culture				
		Negative		Positive		
		n	%	n	%	p
Subcutaneous drain length (cm)	0	41	78.8	11	21.2	**<0.001**
	2	0	0	2	100	
	3	0	0	3	100	
	5	2	100	0	0	
	6	11	100	0	0	
	7	18	100	0	0	
	8	5	100	0	0	

As the duration of the drainage increases, there is a statistically significant increase in the likelihood of experiencing fever (p=0.001), CSF leaking around the drain (p=0.002), CSF culture (p=0.001), and CSF neutrophil >5 (p=0.001). There was a statistically significant inverse connection (p=0.001) between the duration of draining and the CSF/blood glucose level (Table 5).

Table 5. Comparison of the duration of external lumbar drainage and its effect on other parameters

		Duration of drainage		
		Mean ±SD	Median (Min-Max)	p
Fever n (%)	No	6.14±1.09	(6) 5-8	**0.001**
	Yes	7.25±1.00	(8) 5-8	
CSF leakage around drain n (%)	No	6.20±1.10	(6) 5-8	**0.002**
	Yes	7.40±0.97	(8) 5-8	
CSF culture n (%)	Negative	6.14±1.09	(6) 5-8	**0.001**
	Positive	7.25±1.00	(8) 5-8	
CSF Neutrofil >5 n (%)	No	6.14±1.09	(6) 5-8	**0.001**
	Yes	7.25±1.00	(8) 5-8	
CSF/Blood Glucose		r:-0.341 **p=0.001**		

There is a statistically significant association between the duration of drainage and the positive CSF culture (p=0.001). While the CSF culture negatives rate is high in patients with a length of 5 days (96.7%), it is low in patients with a duration of 8 days (55%) (Table 6).

Table 6. The assessment of CSF culture positive based on the duration of external lumbar draining.

	CSF culture					
	Days	Negative		Positive		
		n	%	n	%	p
Drainage duration (day)	5	29	96.7	1	3.3	**0.002**
	6	19	86.4	3	13.6	
	7	18	85.7	3	14.3	
	8	11	55.0	9	45.0	

With 85.7% sensitivity and 56.7% specificity, seven days or less was established to be the cut-off value for negative CSF culture. Positive predictive value (PPV) was 90.4%, whilst negative predictive value (NPV) was 45% (Figure 1) (Table 7).

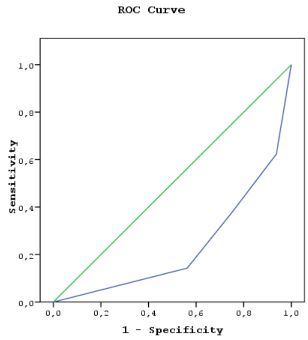

Figure 1. The ROC analyses for CSF culture negativity of <7 days of duration of the drainage

Table 7. Test Result Variable(s): Drainage duration

Area Under the Curve	SE	p	95% Confidence Interval	
0.233	0.064	0.001	0.108	0.359

CSF culture Positive rate was 19.2 times greater among patients with CSF leakage around the drain (p<0.001 OR:19.2 95% CI 4.2-87.7) (Table 8).

Table 8. Comparison of CSF cultures according to the CSF leakage around the drain

		CSF leakage around drain				
		No		Yes		
		n	%	n	%	p
CSF culture	**Negative**	74	89.2	3	30.0	**<0.001**
	Positive	9	10.8	7	70.0	

4. DISCUSSION AND CONCLUSION

Continuous lumbar drainage systems are employed in the treatment of cerebrospinal fluid leaks [7]. These techniques also diagnose patients with hydrocephalus at standard pressure and benign intracranial hypertension [8, 9]. After inserting a needle into the lumbar area, typically at the L3-4 or L4-5 level, a catheter is advanced into the subarachnoid space. This catheter transports CSF to the external environment, and its pressure decreases [10]. Local infections, nerve root irritations, headaches, meningitis, retained catheter, symptomatic intracranial subdural collections, and symptomatic intracranial traumatic pattern subarachnoid hemorrhage may develop regardless of the straightforwardness of the procedure [11]. Meningitis, an infection of the central nervous system, is a severe problem requiring treatment. Our investigation determined that the infection detection rate among patients who were followed up with external lumbar drainage was 17.2%. These patients all needed further antibiotics. The observed infection rate was more significant than that reported in the literature. The high infection rate is associated with the sociodemographic composition and personal cleanliness.

Moreover, the drain can produce a permanent CSF fistula at the exact location of its implantation. Mainly, it is vital to take precautions against infection, such as prophylactic antibiotic use [12], revision of lumbar drainage at 5-day intervals [13], tunneled catheters [10], and antibiotic-impregnated lumbar catheters [14].

The long-tunneled approach was initially applied to the external ventricular catheter, another catheter constantly in contact with CSF. Khanna et al. were the initial group to describe this technique by extending the standard 5 cm subcutaneous tunnel [15]. While some research indicated that extended tunneling in EVD lowered the risk of infection [16], other studies did not detect a significant difference in infection risk [17, 18].

After that, its technical application in external lumbar drainage systems in contact with another CSF is described [6]. They reported that the eventual effectiveness of this tunneling approach in reducing infectious problems is debatable. However, it decreases CSF leakage at the exit site and raises the patient's tolerance for the indwelling catheter. In our series, we examined the infection rates of the classical and tunneling procedures. In this study, it was observed that the infection rate resulting from external lumbar drainage decreased from 21.6% to 11.6% through the implementation of the tunnelling technique. This result is also important in light of the literature's disagreements. Further and exhaustive research is required.

The tunneling procedure considerably impacts minimizing CSF leakage around the drain. There was no CSF leakage around the drain in catheters implanted using the tunneling technique. CSF leaks around the catheter considerably increased the risk of infection. In our study, the tunneling method avoids CSF leaks, hence minimizing infection rates. Comparing the lengths of subcutaneous drains revealed a substantial difference in infection formation and CSF leakage prevention surrounding the drain. There was no infection in those with at least 5 cm of tunneling. This threshold value demonstrates that 3 cm tunneling is equal to the conventional method and is insufficient to prevent infection. At least 5 cm of tunneling should reduce the incidence of infection.

Examining the effects of catheter duration on infection rates and CSF leakage around the catheter reveals that this period is statistically significant. The greater the danger of infection increases, the longer a catheter is left in place. Moreover, presumably due to epithelialization, CSF circumvents the catheter and causes leakage. Negative rates were increased in those with less than seven days of CSF culture. This indicates that catheterization for no more than seven days can lower the risk of infection. The infection rate increases dramatically when catheters are retained for longer than seven days.

External lumbar draining can lead to issues such as infection and CSF leakage. The tunneling procedure is straightforward, affordable, and successfully prevents these complications.

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