

Overview of Early Complications in Decompressive Craniectomy

Dekompresif Kraniektomide Erken Komplikasyonlara Genel Bakış

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ABSTRACT

Aim: The aim of this study was to investigate the prevalence and time of occurrence of complications in patients with seamless duraplasty after reverse question mark incision, and the morbidity and mortality rates after surgery.

Material and Methods: Twenty-four patients admitted with different supratentorial indications and underwent decompressive craniectomy and seamless duraplasty between 2019 and 2023, were retrospectively included in this study. The patient's age, gender, etiological reason at admission, and Glasgow coma score before surgery were recorded. The types of complications, their time of occurrence, their relationships with each other, and the procedures performed were recorded.

Results: The median time for complications during one-month follow-up was 7 (range, 1-28) days. A total of 18 complications were observed in 15 (62.5%) patients. While 7 (46.7%) of 15 patients with complications died within one month of follow-up, 7 (77.8%) of 9 patients without complications died. Although the mortality rate was higher in patients without complications, there was no statistically significant difference between patients with and without complications ($p=0.210$). The survival rate in the first month was 53.3% in patients with complications and 22.2% in patients without, and the median survival time was 5 days in patients with complications and 8 days in patients without complications ($p=0.214$).

Conclusion: The onset time and management of the complications is crucial during the first month after decompressive craniectomy which has high mortality and morbidity rates, since the complications can lead to each other, and also these complications can cause serious economic and labor loss.

Keywords: Decompressive craniectomy; complication; early period.

ÖZ

Amaç: Bu çalışmanın amacı dikişsiz duraplasti hastalarında ters soru işareti kesisi sonrası komplikasyon görülme sıklığı ve ortaya çıkma zamanı ile ameliyat sonrası morbidite ve mortalite oranlarının araştırılmasıdır.

Gereç ve Yöntemler: 2019 ve 2023 yılları arasında farklı supratentoryal endikasyonlarla başvuran ve dekompresif kraniyektomi ve dikişsiz duraplasti uygulanan 24 hasta geriye dönük olarak bu çalışmaya dahil edildi. Hastaların yaşı, cinsiyeti, başvuru sırasındaki etiyolojik nedeni ve ameliyat öncesi Glasgow koma skoru kaydedildi. Komplikasyonların türleri, oluşma zamanları, birbirleriyle ilişkileri ve yapılan işlemler kaydedildi.

Bulgular: Bir aylık takipte komplikasyona kadar geçen medyan süre 7 (aralık, 1-28) gündü. Hastaların 15'inde (%62,5) toplam 18 komplikasyon görüldü. Komplikasyon gelişen 15 hastanın 7'si (%46,7) bir aylık takip süresi içinde hayatını kaybederken, komplikasyon gelişmeyen 9 hastanın 7'si (%77,8) hayatını kaybetti. Komplikasyon gelişmeyen hastalarda mortalite oranı daha yüksek olmasına rağmen komplikasyon gelişen ve gelişmeyen hastalar arasında istatistiksel olarak anlamlı fark yoktu ($p=0,210$). İlk ay sağkalım oranı, komplikasyon gelişen hastalarda %53,3 ve gelişmeyen hastalarda %22,2, ortalama sağkalım süresi komplikasyon gelişen hastalarda 5 gün, komplikasyon gelişmeyen hastalarda ise 8 gün idi ($p=0,214$).

Sonuç: Mortalite ve morbidite oranları yüksek olan dekompresif kraniyektomi sonrası ilk bir ay içerisinde komplikasyonların birbirine neden olabilmesi ve aynı zamanda ciddi ekonomik ve iş gücü kaybına yol açması nedeniyle komplikasyonların başlangıç zamanı ve yönetimi oldukça önemlidir.

Anahtar kelimeler: Dekompresif kraniyektomi; komplikasyon; erken dönem.

INTRODUCTION

Decompressive craniectomy (DC) is a surgical method that aims to reduce morbidity and mortality rates in cases with high intracranial pressure that do not respond to medical treatment (1-3). DC was first described by Kocher (4) and Cushing (5,6) and is used in different intracerebral pathologies, especially; it is also used as a last remedy in cases such as traumatic brain injury (TBI), middle cerebral artery (MCA) infarction, acute subdural hematoma (ASDH), acute encephalitis, cerebral toxoplasmosis, subdural empyema and subarachnoid hemorrhage (7-14).

There is no consensus on the application of this surgical method, which is used as a last remedy to control intracranial high pressure in neurosurgery practice. Although different incision types have been described to ensure a large frontotemporoparietal DC (at least 12x15x15 cm) and avoid incision complications, the standard large frontotemporoparietal reverse question mark (RQM) incision continues to be the most used method today (15).

Again, to prevent complications, different procedures are applied, such as sealing the dura in a watertight manner or laying it on the area without performing duraplasty. Watertight closure of the dura has been found in many studies to show no significant difference in preventing cerebrospinal fluid (CSF) leakage and infection compared to rapid closure decompressive craniectomy without duraplasty (16). On the contrary, many studies have reported that watertight duraplasty should not be used in DC because non-watertight duraplasty may shorten the operation time while the possibility of complications remains the same (2,16,17).

Regardless of which method is applied, it is clear that they do not have a significant advantage over each other in terms of complications that may occur. DC is still a rescue surgery with serious and frequent complications. Understanding the type and burden of potential complications, the timeline and the reasons for their occurrence will be key to designing high-quality randomized controlled trials in the future. The aim of this study was to investigate the prevalence and time of occurrence of complications in patients with seamless duraplasty after RQM incision and to examine the possible morbidity and mortality after surgery.

MATERIAL AND METHODS

Twenty-four patients aged 18 and over, who applied to our clinic with different supratentorial indications and underwent DC and seamless duraplasty between 2019 and 2023, were retrospectively included in this study. The patient's age, gender, etiological reason at admission, and Glasgow coma score (GCS) before the surgery were recorded. Ethical approval for the study was obtained from the Non-interventional Health Research Ethics Committee of Düzce University (01.04.2024, 2024/076). All surgical procedures were performed under general anesthesia and within the first 24 hours. All patients underwent imaging with computed tomography (CT) before and after the operation, neurological and physical examinations of the patients were evaluated during daily visits, and cranial CT and magnetic resonance imaging (MRI) were performed when necessary. The types of complications, their time of

occurrence, their relationships with each other, and the procedures performed were recorded. DC was performed as described by Gudeman et al (18). In this procedure, after a skin incision starting from the zygoma, approximately 1 cm in front of the tragus, passing approximately 5 cm behind the auricle and extending to the hairline on the same side, the temporalis muscle was rolled antero-inferiorly and a craniectomy extending up to 12 cm in diameter was performed. The craniectomy was extended below the temporal bone and the dura was opened in a curvilinear manner. After the main procedure for the primary cause (such as intracerebral hematoma, empyema, subdural hematoma evacuation), if any, the dura was laid on the area and a drain was placed in the epidural area. The bone flap was placed in the abdomen. The drains used were removed after 3 days.

Statistical Analysis

Statistical analyses were performed with IBM SPSS v.22. The distribution of numerical data was examined with the Shapiro-Wilk test and the homogeneity of variance with the Levene test. One-way analysis of variance or the Kruskal-Wallis test was used for group comparisons, depending on the distribution of the data. Categorical data were analyzed by Pearson chi-square, Fisher's exact, or Fisher-Freeman-Halton test. Kaplan-Meier curves were compared with the log-rank test. Descriptive statistics for numerical variables were reported as mean and standard deviation or median, interquartile range, minimum, and maximum values, depending on the distribution of the data. Categorical data were reported as frequency and percentage. The statistical significance level was considered as 0.05.

RESULTS

The mean age of the patients included in the study was 62.4±20.9 (range, 19-90) years, and 13 (54.2%) of the patients were male and 11 (45.8%) were female. Surgical indications were acute ischemic stroke (AIS) in 8 (33.3%) patients, intracerebral hemorrhage (ICH) in 7 (29.2%) patients, ASDH in 5 (20.8%) patients, and acute epidural hematoma (AEDH) in 4 (16.7%) patients. The median GCS of the patients before the surgery was 6 and ranged from 4 to 12.

The median time for complications during a one-month follow-up was 7 (range, 1-28) days. Complications were observed in 15 (62.5%) of the 24 patients who underwent DC. A total of 18 complications were observed since there were two different complications in one patient and three different complications in another. The two different complications seen in the same patient were hydrocephalus and meningitis, respectively, while the patient who suffered three different complications had external cerebral herniation, wound infection, and hydrocephalus. The frequency of complications and their onset times were shown in Table 1.

During the first month, 14 (58.3%) patients died. GCS was 8 or lower in all patients who died. When examined in terms of GCS, 14 of 18 patients (77.8%) with GCS scores of 8 or lower died, while all 6 patients with GCS scores above 8 were still alive one month later. The mortality rate was statistically significantly higher in those with a GCS of 8 or lower (p=0.002).

While all patients presenting with AIS had a GCS of 8 or less, 4 (80%) patients with ASDH, 5 (71.4%) patients with ICH, and 1 (25%) patient with AEDH had a GCS of 8 or less. The highest rate of patients with a GCS of 8 or less was seen in patients with AIS, and this rate did not differ statistically significantly in ASDH and ICH, while it was significantly lower in the patients with AEDH compared to all other etiologies ($p=0.035$). No significant difference was detected in terms of age, gender, complications, and one-month mortality rates according to the etiology of the patients (Table 2).

The survival rate in the first month was 12.5% in patients with AIS, 42.9% in ICH, 60% in ASDH, and 75% in acute epidural hematoma ($p=0.030$, Figure 1).

While 7 (46.7%) of 15 patients with complications died within a one-month follow-up period, 7 (77.8%) of 9 patients without complications died within a month. Although the mortality rate was higher in the patients without complications, there was no statistically significant difference between patients with and without complications ($p=0.210$).

The survival rate in the first month was 53.3% in patients with complications and 22.2% in patients without complications, and the median survival time was 5 days in patients with complications and 8 days in patients without complications ($p=0.214$, Figure 2).

DISCUSSION

DC is a surgical method used as a last remedy in cases where medical treatment of high intracranial pressure is inadequate due to different etiological reasons. Although it is claimed that this procedure reduces mortality, it is an indisputable fact that patients face the risk of many different complications after the operation, which will negatively affect their quality of life. Being able to predict the timing of these complications that occur after surgery will provide a significant advantage in managing the process correctly. Complications are divided into two groups, early and late, according to the time of occurrence. Complications seen within one month are classified as early complications and are generally seen during hospitalization (19).

It has been reported in the literature that the general complication rate after DC surgery is around 53.9% (20), and in the present study, complications were observed in 15 (62.5%) of the patients who underwent DC.

The overall prevalence of DC-related CSF leak/fistulas has been shown to be up to 6.3% (21). In our study, the CSF

Table 1. The frequency and onset time of complications

Complication Type (n=18)	n (%)	Time (day)
Cerebrospinal fluid leakage	5 (27,8)	1, 1, 4, 14, 25
Contralateral intracranial hematoma	1 (5,6)	3
Hydrocephalus	2 (11,1)	5, 25
External Cerebral Herniation	2 (11,1)	7, 7
Subdural Hygroma	1 (5,6)	10
Incision Site Infection	2 (11,1)	10, 10
Incision Site Ulseration	3 (16,7)	4, 15, 15
Sinking Skin Flap Syndrome	1 (5,6)	28
Meningitis	1 (5,6)	30
Total	18	

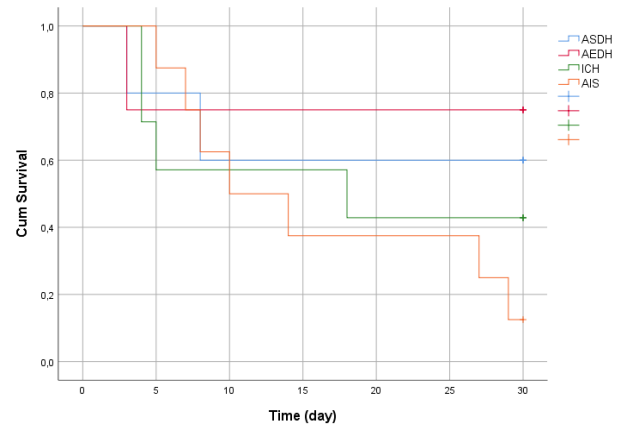


Figure 1. The survival rate in the first month according to the indications

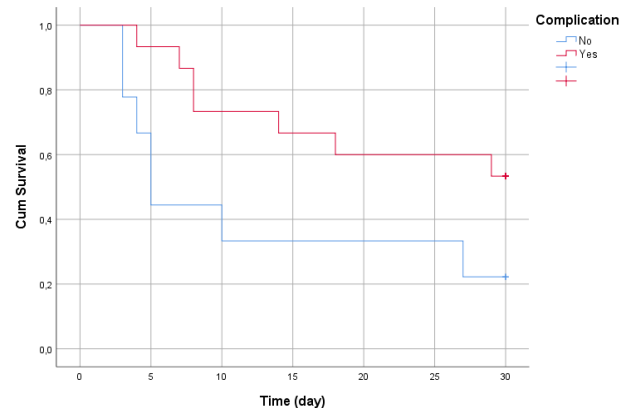


Figure 2. The survival rate in the first month in patients with and without complications

Table 2. Comparison of the demographic and clinical characteristics according to the etiology

	ASDH (n=5)	AEDH (n=4)	ICH (n=7)	AIS (n=8)	p
Age (year)	63.6±29.1	61.0±28.9	64.1±8.8	60.9±22.7	0.990
Gender , n (%)					
Male	3 (60.0)	2 (50.0)	4 (57.1)	4 (50.0)	0.981
Female	2 (40.0)	2 (50.0)	3 (42.9)	4 (50.0)	
GCS	7 (4) [5-10]	10 (5) [6-12]	5 (5) [4-10]	6 (2) [4-8]	0.089
GCS , n (%)					
≤8	4 (80.0)	1 (25.0)	5 (71.4)	8 (100)	0.035
>8	1 (20.0)	3 (75.0)	2 (28.6)	0 (0.0)	
Complication , n (%)	3 (60.0)	3 (75.0)	4 (57.1)	5 (62.5)	0.947
One-month mortality , n (%)	2 (40.0)	1 (25.0)	4 (57.1)	7 (87.5)	0.180

ASH: acute subdural hematoma, AEDH: acute epidural hematoma, ICH: intracerebral hemorrhage, AIS: acute ischemic stroke, GCS: Glasgow coma score

leak rate was 27.8%. Although Vieira et al. (2). stated that the risk of CSF leakage does not increase if the arachnoid is intact during the DC procedure, and therefore whether the dura is sutured or not does not cause a significant difference in the frequency of this complication, we think that in our study, the free laying of the dura and high intracranial pressure increased the rate of this complication.

CSF leakage, which is the most common complication we see in patients in whom we performed DC, was observed on days 1, 4, 14, and 25. Ban et al. (20) in their study including 89 patients, reported the average time for CSF leak was 7.0 ± 4.2 days. In all patients with CSF leakage, a solution was achieved with tight dressing and head elevation.

In general, the frequency of contralateral or distant hematoma following DC was found to be 8.6% (21). In this study, this rate was 5.6%. New and expanding hematomas are characteristically reported in the first few days after DC, and the disappearance of the buffering effect after falling ICP is held responsible (20,22). These bleedings may vary as contusion, epidural hematoma, subdural hematoma, and intracerebral hematoma. It has been shown that after DC, contralateral hematoma occurs on average after 2.1 days (22), and ipsilateral hematoma occurs after 1.5 days (20). In our study, in one patient who underwent DC surgery 3 days prior, a brain CT scan was performed after mental status decline. The imaging showed contralateral hematoma. It regressed spontaneously without the need for surgical intervention.

Hydrocephalus

The incidence of hydrocephalus varies between 0.7% and 86%, depending on etiological causes (23). In our study, the prevalence was observed as 11.1%. Although it is generally classified in the late-term complications group, hydrocephalus was detected in two patients on the 5th day and 25th day, respectively in our study. In the patient with hydrocephalus seen on the 25th day, external cerebral herniation and wound ulcerations were observed to have developed sequentially. In the patient who suffered hydrocephalus on the 5th day, after a series of lab tests it was concluded that meningitis had developed. CSF circulation disorders are held responsible for hydrocephalus. We performed ventriculoperitoneal shunt surgery on our patient who developed hydrocephalus on the 25th day. In the latter patient who developed meningitis after hydrocephalus, we first performed medical intervention with antibiotics, after the condition had resolved external ventricular drainage surgery was performed followed by VP shunt surgery.

External Cerebral Herniation

External cerebral herniation was defined by Yang et al. (22) as the protrusion of cerebral tissue more than 1.5 cm from the middle of the DC. Its incidence was found to be 25% in studies. In our study, it was 11.1%. Inadequate craniectomy is held responsible for its etiology. In patients with insufficient craniectomy, the condition becomes worse due to the compression of the venous structures at the bone edges after brain edema (7). While in studies external cerebral herniation was observed within the first 14 days (19), in our case it was observed on the 7th day, consistent with the literature. We determined that the external cerebral herniation in our case was due to

inadequate craniectomy, and we enlarged the craniectomy defect in one patient, and a spontaneous regression of hernia was observed one month later in the other patient.

Subdural Hygroma

The pathophysiology of subdural hygroma, the most common CSF circulation disorder, is unclear. Extra-axial collections have been reported to occur after DC in 53% of patients, even if hydrocephalus was controlled (21). In our study, the prevalence was 5.6%. Subdural hygroma was observed an average of 8 days after DC, and it was observed that it prolonged the hospital stay and caused deterioration in the neurological picture (21). In our case, it was seen after 10 days. The condition regressed with a tight dressing.

Incision Site Complications

Incision site complications include ulceration, necrosis, and insufficient wound healing. In one study, the rate was found to be 10%. In our study, wound infection was 11.1% and wound ulceration was 16.7%. The causes of these complications, apart from patient-specific factors, have been blamed on large skin flaps and damage to the temporal artery (21). We observed local wound infections on the 10th day and ulceration on the 4th and 15th days. We treated it with oral antibiotics and wound care.

Meningitis

In our study, meningitis was diagnosed in 1 (5.6%) patient on the 30th day after hydrocephalus, with CSF samples taken after on the basis of clinical observations and laboratory values. Antibiotic treatment was applied.

Sinking Skin Flap Syndrome

This complication is also called trephine syndrome (24). This condition, which includes many cognitive and emotional symptoms, was later defined as sinking skin flap syndrome to also describe focal neurological disorders. The difference between the external environment and intracerebral pressure causes the skin to collapse in the surgical area (25). Although a study has shown that it can occur at any time between 3 days and 7 years, it is stated that it is most common on the 30th day and its incidence is 10% (19). In our study, it was seen on the 28th day and its rate was 5.6%.

In our study, the most common surgical indication was AIS, and since all of them had a GCS below 8, we think that AISs cover an important area in patients who underwent DC. Although complications are seen to be higher in those with a GCS score of 8 and lower in those with a GCS score above 8, no statistically significant difference is observed, and the reason why the mortality rate is 77.8% in those without complications and 46.7% in those with complications can be explained by the shorter lifespan in those with lower GCS.

The main limitations of the study are its single-centered nature, its retrospective character, and its low number of patients, which makes statistical analysis difficult.

CONCLUSION

The fact that complications can be seen at any time from the first day to the 30th day, even after the first month after DC, has high mortality and morbidity rates, and those complications can cause each other, that it causes serious economic and labor loss, is why it is called a last resort salvage surgery and that complications. It reveals the time of emergence and the need for management.

Ethics Committee Approval: The study was approved by the Non-interventional Health Research Ethics Committee of Düzce University (01.04.2024, 76).

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