



Evaluation of Percutaneous and Surgical Tracheostomy Results in Neurocritical Care Unit

Nöroyoğun Bakımda Perkütan ve Cerrahi Trakeostomi Sonuçlarının Değerlendirilmesi

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Abstract

Objective: The aim of the study is to evaluate the advantages and disadvantages, complication and mortality rates of percutaneous and surgical tracheostomy procedures performed in patients in neuro-intensive care unit (neuro-ICU).

Materials and Methods: The study was carried out retrospectively in neuro-ICU. Patients' demographic characteristics, comorbidities, reasons for hospitalization, ICU scores at admission [Acute Physiology and Chronic Health Evaluation 2 (APACHE 2) score and Sequential Organ Failure Assessment (SOFA) score], intubation period (days), length of stay in ICU, procedural complications, mortality rates, modified Rankin scale (mRS) scores at discharge and 3rd month were evaluated. Surgical and percutaneous tracheostomy results were compared. Laryngeal mask airway (LMA), bronchoscopy, and tube withdrawal procedures used in percutaneous tracheostomy were compared as well.

Results: Fifty five patients were included in the study. Of the patients, 60.0% were male. Mean age was 71.4±11.8 years. The APACHE 2 score was 25.4±4.8 and SOFA score was 8.1±2.7 at admission to ICU. Mean number of intubation days of the patients was 20.7±11.8, and mean length of stay in ICU was 33.1±13.0 days. Tracheostomy procedure was successful in 53 (96.4%) patients, complications were encountered in 5 (9.1%) patients among all (successful and unsuccessful) intervention groups. Mortality was seen in 23 (41.8%) patients. Three-month mRS was 5 in 32 (%58.2) patients. Duration of stay in ICU, intubation period (days), and time between intensive care hospitalization and tracheostomy (days) in surgery group were significantly longer compared to percutaneous tracheostomy group. No statistically significant difference was observed in comparison of different groups such as LMA, tube withdrawal, bronchoscopy in patients undergoing percutaneous tracheostomy.

Conclusion: In the study in which we compared the surgical and percutaneous tracheostomy results, no statistically significant difference was found in the complication rates and mRS score at discharge of the two groups. In-hospital mortality rate, which was defined as mRS 6, was observed to be higher in patients who underwent surgical tracheostomy. Because of the rapid application of the procedure at the bedside in patients for whom percutaneous tracheostomy was preferred, it was observed that the length of stay in the neuro-ICU and the number of days followed up with intubation were reduced.

Keywords: Neurological intensive care unit, percutaneous tracheostomy, surgical tracheostomy

Öz

Amaç: Çalışmanın amacı, nöroloji yoğun bakım ünitesi (YBÜ) hastalarında uygulanan perkütan ve cerrahi trakeostomi işlemlerinin avantaj ve dezavantajları, komplikasyon ve ölüm oranlarını değerlendirmektir.

Gereç ve Yöntem: Çalışma 3. basamak nöroloji YBÜ'de retrospektif olarak gerçekleştirildi. Hastaların demografik özellikleri, komorbiditeleri, yatış nedenleri, YBÜ'ye giriş skorları [Akut Fizyoloji ve Kronik Sağlık Değerlendirmesi 2 skoru (APACHE 2) ve Ardışık Organ Yetmezliği Değerlendirme skoru (SOFA)], entübasyon süreleri (gün), yoğun bakımda kalış süresi, işlem komplikasyonu ve mortalite oranları, taburculuk durumu ve 3. ay modifiye Rankin skalası (mRS) skorları değerlendirildi. Cerrahi ve perkütan trakeostomi sonuçları karşılaştırıldı. Aynı zamanda perkütan trakeostomide kullanılan laringeal maske (LMA), bronkoskopi ve tüpü geri çekme yöntemleri karşılaştırıldı.

Bulgular: Çalışmaya 55 hasta dahil edildi. Hastaların 33'ü (%60,0) erkekti. Yaş ortalaması 71,4±11,8 yıldır. Komorbidite olarak hipertansiyon 35 (%63,6) hastada, diabetes mellitus 19 (%34,5) hastada ve inme 10 (%18,2) hastada mevcuttu. Yatış tanıları olarak; iskemik inme 37 (%67,3) hastada, hemorajik inme 7 (%12,7) hastada, amiyotrofik lateral skleroz 5 (%9,1) hastada, koronavirüs hastalığı (COVID-19 pnömonisi) 2 (%3,6) hastada, miyastenia gravis 1 (%1,8) hastada,

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miyopati 1 (%1,8) hastada ve Guillain-Barré sendromu 1 (%1,8) hastada mevcuttu. Yoğun bakıma giriş skorlarından APACHE 2 skoru ortalaması $25,4 \pm 4,8$ iken, SOFA skoru ortalaması $8,1 \pm 2,7$ idi. Hastaların entübe kaldığı gün sayısı ortalama $20,7 \pm 11,8$, yoğun bakımda ortalama kalış süresi ise $33,1 \pm 13,0$ gün olarak saptandı. Başarılı trakeostomi 53 (%96,4) hastada sağlandı. Başarılı ve başarısız işlemlerde toplam 5 (%9,1) hastada komplikasyon izlendi. Mortalite 23 (%41,8) hastada görüldü. Otuz iki (%58,2) hastada taburculuk mRS skoru 5 olarak saptandı. Cerrahi ve perkütan trakeostomi işlemlerinin sonuçları karşılaştırıldı. Cerrahi grubunda yoğun bakımda kalış süresi, entübe gün sayısı ve YBÜ yatışı ile trakeostomi arasında geçen süre (gün) perkütan trakeostomi grubundan anlamlı olarak uzundu ($p < 0,05$). Perkütan trakeostomi uygulanan hastalarda LMA, tüp geri çekme ve bronkoskopi gibi farklı yöntemlerin karşılaştırılmasında istatistiksel olarak anlamlı farklılık izlenmedi.

Sonuç: Cerrahi ve perkütan trakeostomi sonuçlarını karşılaştırdığımız çalışmada, iki grubun komplikasyon oranları ve taburculuk mRS skorları arasında istatistiksel olarak anlamlı farklılık görülmedi. Cerrahi trakeostomi uygulanan hastalarda mRS skoru 6 olarak belirtilen hastane içi ölüm oranı daha yüksek izlendi. Perkütan trakeostomi tercih edilen hastalarda işlemin yatak başı hızlı uygulanması sonucu, nöroyoğun bakımda yatış süresi ve entübe takip edilen gün sayısının azaldığı görüldü.

Anahtar Kelimeler: Nöroloji yoğun bakım, perkütan trakeostomi, cerrahi trakeostomi

Introduction

Patients with stroke constitute the majority of patients in neurology intensive care units (ICU). Herniation may develop due to extensive cerebral damage and respiratory and cardiac functions may be adversely affected due to brain stem compression. These patients are intubated and followed up with a ventilator, and extubation attempts may fail during intensive care follow-up. Tracheostomy is recommended in neurointensive care patients whose intubated follow-up days are prolonged up to 2-3 weeks and extubation attempts are unsuccessful. Early tracheostomy placement reduces the need for prolonged mechanical ventilation and the length of stay in the ICU. It also reduces the rate of pneumonia and the need for analgesic and sedative drugs. It facilitates oropharyngeal hygiene, swallowing evaluation, aspiration and nursing care procedures, and increases patient comfort (1,2,3,4).

Tracheostomy can be performed in two ways as surgical and percutaneous (3). Percutaneous tracheostomy may be preferred as an alternative to surgical tracheostomy, especially for patients in the ICU (5). In our study, we aimed to evaluate the advantages/disadvantages, complication rates, modified Rankin scale (mRS) scores at discharge and 3rd month of percutaneous and surgical tracheostomy procedures in patients treated and followed up in a tertiary neurology ICU.

Materials and Methods

The study was carried out in Eskisehir Osmangazi University Faculty of Medicine, Neurology ICU. After the study was approved by the Eskisehir Osmangazi University Faculty of Medicine Ethics Committee (decision number: E-25403353-050.99-183151), the data of all patients who were hospitalized in the tertiary neuro-ICU and underwent tracheostomy between 01.01.2020 and 31.06.2021 were retrospectively analyzed. Demographic characteristics of patients, comorbidities, reasons for hospitalization [such as ischemic stroke, hemorrhagic stroke, amyotrophic lateral sclerosis, myasthenia gravis, myopathy, Guillain-Barré syndrome (GBS)], Acute Physiology and Chronic Health Evaluation 2 (APACHE 2) score, Sequential Organ Failure Assessment (SOFA) score, Charlson comorbidity index, number of days intubated, length of stay in the tertiary ICU, mRS scores at discharge and 3rd month were evaluated. Surgical tracheostomy and bedside percutaneous tracheostomy results were compared in terms of mortality, complication rates, and length of stay in the ICU. At the same time, the results of technical methods such as the use of laryngeal mask airway (LMA),

tube withdrawal and bronchoscopy in patients who underwent percutaneous tracheostomy were compared, and the differences in procedural success rates, complication rates, and length of stay in the ICU were evaluated.

Tracheostomy Technique

Surgical tracheostomy was performed under general anesthesia in operating room conditions by otolaryngologists in some of the patients who underwent tracheostomy. Anatomical characteristics of the patients (short neck, scoliosis), obesity, and thyroiditis were taken into account for surgical tracheostomy indication.

In most of the patients, bedside percutaneous tracheostomy was performed in the ICU. Three different techniques were used in percutaneous tracheostomy procedures: Bronchoscopy, LMA and endotracheal tube withdrawal. In this group, appropriate doses of intravenous anesthetics (midazolam, propofol, fentanyl) and muscle relaxants (esmeron) were used for sedation purposes. After the neck area of the patients who underwent percutaneous tracheostomy was wiped with antiseptic solution and covered with a sterile drape, subcutaneous local anesthetic agent was applied. Then, the balloon of the endotracheal tube was deflated and withdrawn so that its distal end was just below the vocal cords. In patients in whom LMA was used, the tube was withdrawn with aspiration and replaced with LMA. After palpating the second and third intervals of the tracheal cartilage, the 14G needle was advanced vertically into the tracheal lumen. Then, after the guide wire was placed in the tracheal lumen, the needle was withdrawn and the incision area was widened with a dilator. The skin, subcutaneous tissue and trachea were expanded with forceps. The appropriate size tracheostomy tube was placed in the trachea. The endotracheal tube/LMA was removed after the balloon of the tracheostomy cannula was inflated and the location of the cannula was confirmed by listening for respiratory sounds.

Statistical Analysis

Mean, standard deviation, median (minimum-maximum), frequency and ratio values were used in the descriptive statistics of the data. The distribution of variables was measured with the Kolmogorov-Smirnov test. The Kruskal-Wallis and Mann-Whitney U tests were used in the analysis of quantitative independent data. Chi-square test was used in the analysis of qualitative independent data, and the Fischer Exact test was used when the chi-square test conditions were not met. Analyses were performed with the SPSS 27.0 program.

Results

Tracheostomy was performed in 55 (28.64%) of 192 patients hospitalized in the neurology ICU during the study period. Of the patients, 33 (60.0%) were male and 22 (40.0%) were female. The mean age was 71.4 ± 11.8 years. Hypertension was present in 35 (63.6%), diabetes mellitus in 19 (34.5%) and previous stroke in 10 (18.2%) patients. In patients who underwent tracheostomy, the reason for hospitalization were ischemic stroke in 37 (67.3%) patients, hemorrhagic stroke in 7 (12.7%) patients, amyotrophic lateral sclerosis in 5 (9.1%) patients, coronavirus disease (COVID-19) pneumonia in 2 (3.6%) patients, myasthenia gravis in 1 (1.8%) patient, myopathy in 1 (1.8%) patient, and GBS in 1 (1.8%) patient. While the APACHE 2 mean at admission to the ICU was 25.4 ± 4.8 , the mean SOFA score was 8.1 ± 2.7 . Charlson comorbidity index was 7.2 ± 2.4 . The mean number of days the patients were intubated was 20.7 ± 11.8 days, and the mean length of stay in the ICU was 33.1 ± 13.0 days. Tracheostomy was performed on an average of 24.8 ± 13.2 days of ICU hospitalization. Tracheostomy was successfully performed in 53 (96.4%) patients. In 3 patients who had a successful procedure, bleeding in the form of leakage around the tracheostomy was observed in the post-procedure period. The reason for this was that tracheostomy procedure was performed in patients with newly inserted stent without discontinuing antiaggregant treatment. One of these patients underwent surgical procedure, and the other two patients underwent percutaneous tracheostomy. Complications were encountered in a total of 5 (9.1%) patients, including 3 patients who continued to bleed in the form of leakage for a few days despite the successful procedure and spontaneously recovered, and 2 patients who had an unsuccessful procedure as a result of incorrect passage and died within 24 hours. Apart from this, no death was observed as a result of the tracheostomy procedure. No complications related to the anesthetic agents used were observed. The number of patients with mRS 6 at discharge was 23 (41.8%). The major causes of mortality in these patients were sepsis and multiple organ failure. The number of patients with a discharge mRS of 5 was 32 (58.2%). When the 3rd month mRS of these patients was examined, it was seen that 12 of 32 patients resulted in death within 3 months. The mRS score of 17 (30.9%) patients was 5, 2 (3.6%) patients had an mRS score of 4, and 1 (1.8%) patient who was admitted to the neuro-ICU with the diagnosis of COVID-19 pneumonia and had no cerebrovascular disease had an mRS score of 1 (Table 1). Surgery was performed in 15 (27.3%) patients, and percutaneous tracheostomy was performed in 40 (72.7%) patients. Comparison results of surgical and percutaneous tracheostomy procedures are given in Table 2. The length of stay in the ICU was significantly longer in patients who underwent surgery than in patients who underwent percutaneous tracheostomy ($p=0.035$), and the number of days intubated was longer in patients who underwent surgery than in patients who underwent percutaneous tracheostomy ($p=0.004$). Tracheostomy time in the ICU was longer in the surgical procedure group than in the percutaneous tracheostomy group ($p=0.032$). There was no significant difference between the procedural success, complication rates, discharge and 3rd month mRS score of the two groups. While no procedure failure was observed in the surgical procedure group, it was seen in 2 (5.0%) patients in the percutaneous tracheostomy group. There was no statistically significant difference between

Table 1. Characteristics of the patients

	Minimum-maximum	Median	Mean \pm SD/n (%)
Age	48-93.0	73,0	71.4 \pm 11.8
Gender			
Female	-	-	22 (40.0%)
Male	-	-	33 (60.0%)
Comorbidity			
Hypertension	-	-	35 (63.6%)
Diabetes mellitus	-	-	19 (34.5%)
Ischemic stroke	-	-	10 (18.2%)
Diagnosis			
Ischemic stroke	-	-	37 (67.3%)
Hemorrhagic stroke	-	-	7 (12.7%)
Amyotrophic lateral sclerosis	-	-	5 (9.1%)
Myasthenia gravis	-	-	1 (1.8%)
Myopathy	-	-	1 (1.8%)
Guillain-Barré syndrome	-	-	1 (1.8%)
Hydrocephalus + status epilepticus	-	-	1 (1.8%)
COVID-19 pneumonia	-	-	2 (3.6%)
APACHE 2 score	15.0-35.0	25.0	25.4 \pm 4.8
SOFA score	3.0-17.0	8.0	8.1 \pm 2.7
Charlson comorbidity index	3.0-13.0	7.0	7.2 \pm 2.4
Length of stay in intensive care unit (days)	4.0-60.0	35.0	33.1 \pm 13.0
Intubation (days)	2.0-41.0	22.0	20.7 \pm 11.8
Time between intensive care admission and tracheostomy (days)	2.0-49.0	26.0	24.8 \pm 13.2
Anesthesia during the procedure			
General anesthesia	-	-	15 (27.3%)
Neurosedation	-	-	40 (72.7%)
Neurosedative agents			
Midazolam	-	-	37 (67.3%)
Propofol	-	-	5 (9.1%)
Fentanyl	-	-	36 (65.5%)
Esmeron	-	-	38 (69.1%)
Successful procedure			
Yes	-	-	53 (96.4%)
No	-	-	2 (3.6%)
Use of laryngeal mask	-	-	17 (42.5%)
Tube withdrawal	-	-	12 (30.0%)
Use of bronchoscopy	-	-	11 (27.5%)
Complication			
(-)	-	-	50 (90.9%)
(+)	-	-	5 (9.1%)
mRS at discharge			
- mRS 5	-	-	32 (58.2%)
- mRS 6	-	-	23 (41.8%)
mRS at 3 months			
- mRS 3	-	-	1 (1.8%)
- mRS 4	-	-	2 (3.6%)
- mRS 5	-	-	17 (30.9%)
- mRS 6	-	-	35 (63.6%)

SD: Standard deviation, COVID-19: Coronavirus disease-2019, APACHE 2: Acute Physiology and Chronic Health Evaluation 2 score, Sequential Organ Failure Assessment score, mRS: Modified Rankin scale

Table 2. Evaluation of surgical and percutaneous tracheostomy results

		Surgical tracheostomy		Percutaneous tracheostomy		
		Mean ± SD/n (%)	Median	Mean ± SD/n (%)	Median	p
Age		72.0±9.9	72.0	71.2±12.6	73.0	0.820 ^m
Gender	Female	6 (40.0%)	-	16 (40.0%)	-	1.000 ^{X²}
	Male	9 (60%)	-	24 (60%)	-	
Comorbidity						
Hypertension		9 (60%)	-	26 (65.0%)	-	0.731 ^{X²}
Diabetes mellitus		7 (46.7%)	-	12 (30.0%)	-	0.247 ^{X²}
Ischemic stroke		3 (20.0%)	-	7 (17.5%)	-	0.830 ^{X²}
APACHE 2 score		24.9±4.1	25.0	25.6±5.1	25.0	0.653 ^m
SOFA score		8.1±2.2	8.0	8.1±2.9	8.0	0.944 ^m
Charlson comorbidity index		7.7±3.2	8.0	7.1±2.0	7.0	0.593 ^m
Length of stay in intensive care unit (days)		39.1± 10.4	37.0	30.8±13.2	31.0	0.035 ^m
Intubation (days)		28.1±11.4	30.0	18.0±10.8	16.5	0.004 ^m
Time between intensive care admission and tracheostomy (days)		31.0±11.7	33.0	22.5±13.1	22.0	0.032 ^m
Successful procedure	Yes	15 (100.0%)	-	38 (95.0%)	-	1.000 ^{X²}
	No	0 (0.0%)	-	2 (5.0%)	-	
Complication	(-)	14 (93.3%)	-	36 (90.0%)	-	1.000 ^{X²}
	(+)	1 (6.7%)	-	4 (10.0%)	-	
Mortality	(-)	8 (53.3%)	-	23 (57.5%)	-	0.781 ^{X²}
	(+)	7 (46.7%)	-	17 (42.5%)	-	
mRS at discharge		5.5±0.5	5.0	5.4±0.5	5.0	0.658 ^m
mRS at 3 months		5.5±0.8	6.0	5.6±0.6	6.0	0.704 ^m

^m: Mann-Whitney U test, X²: Chi-square test (Fischer test), SD: Standard deviation, APACHE 2: Acute Physiology and Chronic Health Evaluation 2 score, SOFA: Sequential Organ Failure Assessment score, mRS: Modified Rankin scale

the complication rates of the two groups. There were 8 (53.3%) patients with a discharge mRS score of 5 in the surgical group, and 24 (60.0%) in the percutaneous tracheostomy group. While there were 7 (46.7%) patients with an mRS score of 6 discharging from the ICU in the surgical group, there were 16 (40.0%) patients in the percutaneous tracheostomy group. There was no statistically significant difference ($p=0.658$).

When different subgroups such as LMA, endotracheal tube withdrawal, and bronchoscopy were compared in patients undergoing percutaneous tracheostomy, no statistically significant difference was observed in mortality, discharge, 3rd month mRS score, successful procedure and/or complication rates, as well as other analyzed parameters ($p>0.05$) (Table 3). During percutaneous tracheostomy, LMA was used in 17 (42.5%) patients, endotracheal tube withdrawal was used in 12 (30.0%) patients, and bronchoscopy was used in 11 (27.5%) patients. The complication rate was 11.8% in the LMA group and 16.7% in the tube withdrawal group. No complications were observed in the bronchoscopy group. There were 2 patients in the percutaneous tracheostomy group who underwent tracheostomy with the endotracheal tube withdrawal method, which resulted in failure and death due to false passage. Esophageal rupture was observed in one of these patients, and widespread emphysema with rapid

progression in the subcutaneous tissues was observed in the other patient.

Discussion

Cerebrovascular diseases (ischemic stroke, intracranial hemorrhage and subarachnoid hemorrhage) constitute the majority of the patient population followed up in the neurological ICU. In this group of patients with extensive brain damage, mechanical ventilation may be needed from the early period of hospitalization. As the number of days intubated increases, the ventilator-associated pneumonia and in-hospital mortality rates increase, or the intensive care follow-up period is prolonged. For this reason, it is important to evaluate patients with stroke who may undergo prolonged intubation in terms of tracheostomy in the early period. Tracheostomy is also performed in diseases such as GBS, amyotrophic lateral sclerosis, myasthenia gravis and myopathy, which are rarely seen in neurological ICU. GBS, as we know, is an acute onset and rapidly progressing disease which may require intensive care follow-up with intubation as a result of affected respiratory muscles. Since the rehabilitation process of these patients continues for months, if the need for long-term mechanical ventilation continues, tracheostomy may

Table 3. Evaluation of laryngeal mask, tube withdrawal and bronchoscopy results used during percutaneous tracheostomy procedure

		Laryngeal mask Mean ± SD n (%)	Tube withdrawal Mean ± SD n (%)	Bronchoscopy Mean ± SD n (%)	P
Age	Mean ± SD	70.0±14.4	73.7±12.2	69.2±10.3	0.691 ^K
	Median	73.0	72.5	73.0	
Gender	Female n (%)	6 (35.3%)	6 (50.0%)	4 (36.4%)	0.699 ^{X²}
	Male n (%)	11 (64.7%)	6 (50.0%)	7 (63.6%)	
APACHE 2	Mean ± SD	25.7±5.9	27.1±4.8	23.8±3.7	0.317 ^K
	Median	25.0	27.0	24.0	
SOFA	Mean ± SD	8.8±3.2	9.0±2.2	5.9±2.0	0.011 ^K
	Median	9.0	9.0	5.0	
Charlson comorbidity index	Mean ± SD	7.5±2.4	6.8±1.8	6.6±1.6	0.494 ^K
	Median	7.0	7.0	6.0	
Length of stay in intensive care unit (days)	Mean ± SD	26.2±10.9	42.1±12.1	25.7±10.6	0.001 ^A
	Median	28.0	40.0	31.0	
Number of days intubated	Mean ± SD	14.5±11.1	23.8±10.1	17.0±9.1	0.062 ^K
	Median	8.0	26.5	14.0	
Successful procedure	Yes n (%)	17 (100.0%)	10 (83.3%)	11 (100.0%)	p>0.05 ^{X²}
	No n (%)	0 (0.0%)	2 (16.7%)	0 (0.0%)	
Complication	(-) n (%)	15 (88.2%)	10 (83.3%)	11 (100.0%)	p>0.05 ^{X²}
	(+) n (%)	2 (11.8%)	2 (16.7%)	0 (0.0%)	
Mortality	(-) n (%)	11 (64.7%)	5 (41.7%)	7 (63.6%)	0.414 ^{X²}
	(+) n (%)	6 (35.3%)	7 (58.3%)	4 (36.4%)	
mRS at discharge	Mean ± SD	5.4±0.5	5.6±0.5	5.3±0.5	0.284 ^K
	Median	5.0	6.0	5.0	
mRS at 3 months	Mean ± SD	5.7±0.6	5.6±0.7	5.5±0.5	0.349 ^K
	Median	6.0	6.0	5.0	

^K: Kruskal-Wallis (Mann-Whitney U test), ^{X²}: Chi-square test (Fischer test), SD: Standard deviation, APACHE 2: Acute Physiology and Chronic Health Evaluation 2 score, SOFA: Sequential Organ Failure Assessment score, mRS: Modified Rankin scale

become the only option that will ensure the discharge of patients from neurological ICU. Patients with advanced amyotrophic lateral sclerosis and myopathy, in whom respiratory muscles are insufficient to maintain respiration and upper respiratory tract patency cannot be maintained due to insufficiency of nasopharyngeal and laryngeal muscles, are also intubated in neuro-ICUs. Early tracheostomy procedures are important for these patients to be discharged from ICU to palliative care services or home (1,6,7). In our study, 80% of the patients who underwent tracheostomy had cerebrovascular diseases. The remainder had amyotrophic lateral sclerosis, myasthenia gravis, myopathy, and GBS. Two patients without a primary neurological diagnosis were hospitalized in our ICU with the diagnosis of COVID-19 during the pandemic. In our study, there were 23 (41.8%) patients whose hospital follow-up period ended in death and had an mRS score of 6 at discharge. All of these patients were patients with stroke. In the current literature, the mortality rate in the cerebrovascular diseases group has been reported to be higher compared to the other groups (8).

In the literature, there are many studies comparing surgical and percutaneous tracheostomy results (8,9,10,11,12,13). Among these studies, the retrospective study conducted by Yaka et al. (13) on patients with stroke in neuro-ICU draws attention. In this study, when bedside percutaneous tracheostomy procedures performed by neurologists were compared with surgical tracheostomy, no significant difference was found in terms of complication and death rates (13).

Today, although the application of surgical tracheostomy in intensive care patients has decreased significantly, there are still centers that apply it. In our center, surgical tracheostomy is applied to patients in whom we predict difficulties in the percutaneous tracheostomy procedure (anatomical short neck, spinal cord deformities such as scoliosis, obesity, thyroid hyperplasia, previous neck surgery). Surgical tracheostomy was performed in 27.3% of the patients included in the study. Bedside percutaneous tracheostomy was performed in 72.7% of the patients. General anesthesia was applied to all patients in the surgery group, while neurosedation was applied to the percutaneous tracheostomy

group by neurology ICU specialists. Many studies have shown that complication rates are lower in percutaneous tracheostomy compared to surgical tracheostomy (8,10,12).

On the other hand, although percutaneous tracheostomy is a method that can be applied easily in a short time, it has been reported that perioperative complications and mortality rates increase, especially when performed by inexperienced practitioners (9). Complication rates of percutaneous tracheostomy have been reported in the literature between 1% and 10% (8,14). In our study, this rate was 10% in patients undergoing percutaneous tracheostomy. While reviewing the causes of complications in our study group, complications such as bleeding from the stoma after the procedure were observed in 3 patients. Surgical technique was applied in one of these patients, and percutaneous tracheostomy was performed in the other two patients. In the retrospective review, it was seen that these patients had to use antiaggregant due to aneurysm treatment/flow diverting stent or emergency stenting during mechanical thrombectomy. Two patients died as a result of incorrect passage. Percutaneous tracheostomy was performed with tube withdrawal method in these 2 patients. While the procedure failure rate was 5% in percutaneous tracheostomy, no unsuccessful procedure was found in patients who underwent surgical procedure. Tracheostomy time was longer in the surgical tracheostomy group than in the percutaneous tracheostomy group, according to the length of stay in the ICU, the number of days followed up with intubating and the day of hospitalization in the ICU. The reason for this is due to the prolongation of the preoperative evaluation process before the surgical tracheostomy procedure and delay in determining of the operation day. Prolonging the length of stay in the ICU brings with it the risk of nosocomial infection and increased in-hospital care costs.

During the percutaneous tracheostomy procedure, there are different methods applied by withdrawing the bronchoscope, LMA or intubation tube (15,16,17,18). Considering the tracheal structures in a study, it was shown that the use of LMA was advantageous over the endotracheal tube withdrawal method (15). Strametz et al. (16), on the other hand, claimed that the use of LMA did not provide safe airway patency in critically intensive care patients. In another study comparing the use of LMA and the results of tracheostomy performed by withdrawing the intubation tube, it was emphasized that there were insufficient data to make a definitive decision about efficacy or safety, that there might be late complications especially in the use of LMA, and that there was not enough research on this subject (17). In addition, there are studies in the current literature showing that the results of percutaneous tracheostomy performed with bronchoscopy are good and the complication rates are low (18,19,20,21).

In our study, while procedural failure was not observed in the patients in whom LMA and bronchoscopy were used, serious complications such as subcutaneous emphysema and esophageal rupture were observed as a result of incorrect passage in two patients who underwent tracheostomy with tube withdrawal. As a result, the patients died in the early period. A retrospective analysis of our own database showed that percutaneous tracheostomy would not be appropriate for patients with an indication for surgical tracheostomy, without assistive techniques such as bronchoscopy. In the current literature, there are also studies showing that the results of percutaneous tracheostomy performed by experienced personnel, accompanied by bronchoscopy, are successful in many

patients with surgical tracheostomy indications (short neck, obesity, thyroid hyperplasia, soft tissue infection in the neck, inability to extend the neck, presence of pulsatile veins in the procedure area, coagulation disorders, malignancy in the procedure area, history of neck surgery, history of tracheostomy) (19,22,23). There are also studies showing that the results of percutaneous tracheostomy performed with bronchoscopy by experienced personnel are successful (19,22,23).

Study Limitations

The most important limitation of the study was the small number of patients in our cohort, as well as the low number of neurological diseases other than stroke. Since it was a retrospective study, it was not possible to evaluate parameters such as the duration of the tracheostomy procedure.

Conclusion

In the study in which we compared surgical and percutaneous tracheostomy results, no significant difference was found between the complication rates of the two groups. Although the mRS score at discharge did not differ statistically significantly, the mortality rate, indicated by the mRS score of 6, was higher in the surgical group.

As a result of the rapid application of the procedure at the bedside in patients for whom percutaneous tracheostomy is preferred, the length of stay in the tertiary neurological ICU and the number of days followed up with intubation can be reduced. Therefore, the risk of in-hospital infection and the cost of intensive care can be reduced. Performing percutaneous tracheostomy with bronchoscopy reduces the possibility of complications even in the most difficult patients.

Ethics

Ethics Committee Approval: The study was approved by the Eskisehir Osmangazi University Faculty of Medicine Ethics Committee (decision number: E-25403353-050.99-183151).

Informed Consent: This study did not require informed consent.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: F.M., F.G.A., Z.M., Ö.A., M.Ö.P., M.K.G., A.Ö.Ö., Concept: A.Ö.Ö., Design: A.Ö.Ö., Data Collection or Processing: F.M., F.G.A., Z.M., Ö.A., Analysis or Interpretation: F.M., A.Ö.Ö., Ö.A., Literature Search: F.M., Writing: F.M.

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