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The Clinical Outcomes of Ultrasonography Usage in Percutaneous Dilatational Tracheostomy in the Intensive Care Unit: A Retrospective Trial

Yoğun Bakım Ünitesinde Perkütan Dilatasyonel Trakeostomide Ultrasonografi Kullanımının Klinik Sonuçları: Retrospektif Bir Çalışma

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ABSTRACT

Aim: Preprocedural ultrasonographic examination of the upper airway anatomy is an effective method for deciding on a tracheostomy procedure, such as percutaneous or surgical tracheostomy. We aimed to compare the effects of superficial cervical plexus block (CPB) with translaryngeal block with those of local anesthesia infiltration to the incision site for percutaneous tracheostomy in terms of hemodynamic parameters, gag reflex, and anesthetic requirement. In addition, we evaluated the effect of preprocedural ultrasonography assessment compared with that of anatomical landmark examination in terms of reducing the risk of procedure-related complications.

Materials and Methods: A total of 148 patients aged at the range of 18-99 years, who were indicated for percutaneous tracheostomy in the intensive care unit, were enrolled in the study. The data intended for this study were obtained from the hospital's electronic patient database through retrospective scanning between 2018 and 2022. Patients who underwent ultrasonography for the evaluation of the related anatomical structures and superficial CPB with a translaryngeal block were assigned to the ultrasonography group (n=74), whereas those who underwent an anatomical landmark technique and local anesthetic infiltration to the procedure site were assigned to the traditional group (n=74).

Results: The patients' age and sex distributions did not differ significantly between the traditional and ultrasonography groups ($p>0.05$). In the ultrasonography group, the preprocedural, midprocedural, and postprocedural heart rates were significantly higher than in the traditional group ($p<0.05$). In the ultrasonography group, the mean preprocedural arterial pressure decreased significantly during and after the procedure ($p<0.05$). The mean arterial pressure decreased during the procedure and the postprocedural arterial pressure was significantly higher ($p<0.05$) in the ultrasonography group than in the traditional group.

Conclusion: Although ultrasonography-guided percutaneous tracheostomy takes more time to perform than traditional anatomical landmark percutaneous tracheostomy, we claim that the procedure is much safer and provides better clinical outcomes.

Keywords: Percutaneous dilatational tracheostomy, intensive care unit, superficial cervical plexus block, translaryngeal block

ÖZ

Amaç: Üst hava yolu anatomisinin işlem öncesi ultrasonografik muayenesi, perkütan veya cerrahi trakeostomi gibi bir trakeostomi prosedürüne karar vermede etkili bir yöntemdir. Perkütan trakeostomi için yüzeyel servikal pleksus bloğu (SPB) ile translaringeal bloğun; insizyon bölgesine lokal anestezi infiltrasyonu ile hemodinamik parametreler, öğürme refleksi ve anestezik gereksinimi açısından etkilerini karşılaştırmayı amaçladık. Ek olarak, işlemle ilgili komplikasyon riskini azaltma açısından işlem öncesi ultrasonografi değerlendirmesinin etkisini anatomik işaret noktası yöntemi incelemesiyle karşılaştırdık.

Gereç ve Yöntem: Yoğun bakım ünitesinde perkütan trakeostomi endikasyonu olan 18-99 yaş aralığındaki 148 hasta çalışmaya alındı. Bu çalışmaya yönelik veriler, hastanenin elektronik hasta veri tabanından 2018-2022 yılları arasında retrospektif tarama yoluyla elde edildi. İlgili anatomik

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yapıların değerlendirilmesi için, ultrasonografi ve translaringeal blok ile yüzeyel SPB yapılan hastalar ultrasonografi grubuna (n=74), anatomik işaret noktası yöntemi ve prosedür bölgesine lokal anestezik infiltrasyonu uygulananlar geleneksel gruba (n=74) dahil edildi.

Bulgular: Hastaların yaş ve cinsiyet dağılımları, geleneksel ve ultrasonografi grupları arasında anlamlı farklılık göstermedi (p>0,05). Ultrasonografi grubunda, işlem öncesi, işlem ortası ve işlem sonrası kalp hızları, geleneksel gruptakinden anlamlı olarak daha yüksekti (p<0,05). Ultrasonografi grubunda işlem öncesi ortalama arter basıncı işlem sırasında ve sonrasında anlamlı olarak azaldı (p<0,05). Ortalama arter basıncı işlem sırasında azaldı ve işlem sonrası arter basıncı ultrasonografi grubunda geleneksel gruba göre anlamlı derecede yüksekti (p<0,05).

Sonuç: Perkütan trakeostominin ultrasonografi rehberliğinde uygulanması, geleneksel anatomik işaret yöntemi ile uygulanmasına göre daha uzun sürse de işlemin çok daha güvenli olduğu ve daha iyi klinik sonuçlar sağladığını düşünüyoruz.

Anahtar Kelimeler: Perkütan dilatasyonel trakeostomi, yoğun bakım ünitesi, yüzeyel servikal pleksus bloğu, translaringeal blok

INTRODUCTION

Since its invention by Ciaglia et al.[3] in 1985, percutaneous dilatation tracheostomy (PDT) has been commonly performed by intensivists in intensive care units[1,2]. Even if surgical tracheostomy is still performed for up to 50% of critically ill patients, PDT techniques are increasingly used owing to their easy application and shorter procedure times[4]. Among these techniques, multiple dilator tracheostomy, guide wire dilating forceps tracheostomy, translaryngeal tracheostomy, and newer techniques such as single-step dilation tracheostomy, rotational dilation tracheostomy, and balloon dilation tracheostomy are preferred in clinical practice[4].

A superficial cervical plexus block (CPB) is easy and efficient to apply and provides satisfying anesthesia and analgesia to the head and neck region[5,6]. As the role of ultrasonography in regional anesthesia has expanded, CPBs can now be performed more safely and accurately under ultrasonographic guidance, which facilitates the identification of various important landmarks such as muscles, the cervical vertebrae, the large vessels, nerves, and the cervical fascia[5]. Superficial CPB is performed solely or in combination with various brachial plexus blocks for carotid endarterectomies[7], humerus and clavicula fracture surgeries[8,9], orthognathic surgery[10], and ear surgeries[11].

A translaryngeal block, which aims to block the branches of the recurrent laryngeal nerve in the cricothyroid region, is useful for providing topical anesthesia to the distal airway mucosa[12]. Ultrasonographic guidance or anatomical landmarks are preferred for identifying the cricothyroid membrane[13]. A translaryngeal block is known to be useful for awake fiberoptic intubation, but it was also shown to facilitate awake tracheostomy procedures[12]. A 22- or 20-gauge needle is used to deliver the local anesthetic by inserting it perpendicular to the skin of the patient lying supine, with continuous aspiration administered simultaneously to penetrate the cricothyroid membrane. To anesthetize the distal airway mucosa, the local anesthetic is injected when air bubbles start to appear in the syringe, and the needle is immediately withdrawn[13].

Preprocedural ultrasonographic examination of the upper airway anatomy is an effective method for deciding on a tracheostomy procedure such as percutaneous or surgical tracheostomy[14]. Previous studies have demonstrated the importance of ultrasonographic examination in identifying the related major and vulnerable anatomical and vascular structures to reduce complication rates[14]. Ultrasonography-guided superficial cervical plexus with translaryngeal block for percutaneous tracheostomy has been routinely performed in our clinic for almost 2 years. Prior to the introduction of this technique to our clinic, we performed all percutaneous tracheostomy procedures using anatomical landmark techniques, with analgesia induced with infiltration anesthesia to the incision site and deep sedation to almost general anesthesia. We aimed to compare the effects of superficial CPB with translaryngeal block with those of local anesthesia infiltration to the incision site for percutaneous tracheostomy in terms of hemodynamic parameters, gag reflex, and anesthetic requirement. In addition, we evaluated the effect of preprocedural ultrasonography assessment compared with that of anatomical landmark examination in terms of reducing the risk of procedure-related complications.

MATERIALS AND METHODS

This retrospective study was conducted according to the ethical principles outlined in the Helsinki Declaration and the guidelines of good clinical practice and ethical approval was obtained from Tekirdağ Namık Kemal University Non-Interventional Research Ethics Committee (protocol no: 2022.223.12.01, date: 27.12.2022).

After obtaining the approval from the ethics committee, among 3.656 patients, 148 patients aged 18-99 years, who were indicated for percutaneous tracheostomy in the intensive care unit, were enrolled in the study. The data intended for this study were obtained from the hospital's electronic patient database through retrospective scanning between 2018 and 2022. Patients who underwent ultrasonography for the evaluation of the related anatomical structures and superficial CPB with a translaryngeal block before the percutaneous tracheostomy procedure were assigned to the ultrasonography

group (n=74), whereas those who underwent an anatomical landmark technique and local anesthetic infiltration to the procedure site before the percutaneous tracheostomy procedure were assigned to the traditional group (n=74).

In our 11-bed mixed tertiary intensive care unit, ultrasonography has been widely used for interventional procedures and patient follow-up. We have been using ultrasonography in our intensive care unit for more than 2 years. Before percutaneous tracheostomy procedures, we routinely assess the upper airway anatomy and the cartilages of the larynx and upper trachea, and perform bilateral superficial CPB with translaryngeal block to reduce the need for anesthetic drugs and to provide hemodynamic stability. In the past, our intensive care unit was not equipped with an ultrasonography device, so local anesthesia infiltration with deep sedation and general anesthesia in some cases had to be administered.

The Esaote MyLab Six (Genoa, Italy) ultrasonography device with a high-frequency linear probe was used in a midline longitudinal approach to identify the upper airway anatomical structures such as the thyroid and cricoid cartilages, cricothyroid membrane, tracheal rings, and the space between the tracheal rings for the insertion of the tracheostomy cannula. After this, the probe was oriented in a transverse position to ensure the location of the isthmus of the thyroid tissue and vascular structures at the intervention site. The probe was then reoriented in a midline longitudinal position to determine the exact point for the puncture and tracheostomy incision. The exact point was drawn with a marker pen.

A 14-G intravenous cannula with a plastic cover and the needle of a 5-mL syringe filled with serum physiologic solution was inserted in the tracheal lumen, between the first and second tracheal rings, with continuous aspiration after a 2- to 3-cm transverse incision. To prevent the puncture of the endotracheal tube cuff or tube itself, the needle was stopped immediately when the air in the syringe had aspirated. Leaving the plastic cannula in place, the needle was withdrawn, and the guide wire was inserted through the plastic cannula. After the plastic cannula was removed through the guide wire, a dilatator was used to expand the puncture point. A Griggs forceps was inserted through the guide wire after the removal of the dilator. The subcutaneous tissue and tracheostomy cannula insertion point were dilated with the Griggs forceps. The tracheostomy cannula was inserted through the orifice, and the guide wire and endotracheal tube were removed. The cuff of the tracheostomy cannula was inflated, and the location of the cannula was confirmed by auscultation. All PDT procedures were performed using a percutaneous tracheostomy kit (Portex, Hythe, Kent, England), and all tracheostomies were performed in elective conditions by experienced clinicians.

The primary outcome of this study was the evaluation of the anesthetic drug usage throughout the procedure and the hemodynamic response stability. Heart rate and arterial blood pressure were recorded from the medical records of the intensive care unit patients. The secondary outcomes were the incidence rates of major and minor complications and gag reflex. The patients' records were scanned for the following complications: minor and major hemorrhage during and after the procedure, subcutaneous emphysema, misplacement of the tracheostomy cannula, and conversion to surgical tracheostomy.

Statistical Analysis

Mean, standard deviation, median lowest, highest, 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 Mann-Whitney U test was used in the analysis of quantitative independent data. The chi-square test was used in the analysis of qualitative independent data, and the Fisher test was employed when the chi-square test conditions were not met. Statistical Package for the Social Sciences 28.0 program was used in the analysis.

RESULTS

The mean age of the patients (n=148) was 56.6±20.3 years. Precise height and weight measurements of all patients were not evaluated because they could not be obtained from patient files. Of the patients, 38.5% were male, and 61.5% were female (Table 1). The complication rates were as follows, regardless of the technique used to perform the tracheostomy procedures: the presence of gag reflex (n=45; 30.4%), minor bleeding (n=30; 20.3%), major bleeding (n=12; 20.3%), cannula misplacement (n=9; 6.1%), and subcutaneous emphysema (n=9; 2%). Of the patients, 11 (7.4%) were converted to surgical tracheostomy after undergoing percutaneous tracheostomy (Table 1).

The patients' age and sex distributions did not differ significantly between the traditional and ultrasonography groups ($p>0.05$). In the ultrasonography group, the preprocedural, midprocedural, and postprocedural heart rates were significantly higher than those in the traditional group ($p<0.05$). In the traditional group, no significant differences ($p>0.05$) were observed in the midprocedural and postprocedural heart rates compared with the preprocedural heart rate. In the ultrasonography group, the midprocedural heart rate showed no significant difference ($p>0.05$) when compared with the preprocedural heart rate. In the ultrasonography group, the preprocedural heart rate decreased significantly ($p<0.05$) after the procedure. No significant differences ($p>0.05$) in the midprocedural and postprocedural heart rate changes were found between the traditional and ultrasonography groups (Table 2).

Table 1. Demographic, hemodynamic and procedure-specific parameters and complication rates

		Minimum	Maximum	Median	Mean±SD / n (%)
Age		18.0	90.0	61.0	56.6±20.3
Sex	Male				57 (38.5)
	Female				91 (61.5)
Traditional group					74 (50.0)
Ultrasound group					74 (50.0)
Heart rate (beats per minute)					
Pre-procedure		50.0	169.0	95.5	101.1±32.2
Mid-procedure		43.4	170.2	97.0	100.7±33.3
Post-procedure		42.7	172.9	94.2	99.1±32.1
Mean arterial pressure (mmHg)					
Pre-procedure		50.0	100.0	72.5	74.4±14.0
Mid-procedure		47.5	108.6	73.6	72.9±14.3
Post-procedure		41.7	115.0	72.0	72.8±15.1
Propofol consumption		0.0	250.0	80.0	98.2±71.2
Opioid consumption		25.0	150.0	75.0	77.5±38.7
Total procedure time (minute)		15.0	90.0	42.0	45.1±21.4
Neuromuscular blocking agents use	(-)				116 (78.4)
	(+)				32 (21.6)
Major bleeding	(-)				136 (91.9)
	(+)				12 (8.1)
Minor bleeding	(-)				118 (79.7)
	(+)				30 (20.3)
GAG reflex presence	(-)				103 (69.6)
	(+)				45 (30.4)
Subcutaneous emphysema presence	(-)				145 (98.0)
	(+)				3 (2.0)
Cannula misplacement	(-)				139 (93.9)
	(+)				9 (6.1)
Conversion to surgical tracheostomy	(-)				137 (92.6)
					11 (7.4)

SD: Standard deviation

In terms of preprocedural, midprocedural, and postprocedural mean arterial pressures, no significant differences ($p>0.05$) were revealed between the traditional and ultrasonography groups. In the traditional group, the changes in the mean preprocedural arterial pressures during and after the procedure were not significant ($p>0.05$). In the ultrasonography group, the mean preprocedural arterial pressure decreased significantly during and after the procedure ($p<0.05$). The mean arterial pressure decreased during the procedure and the postprocedural arterial pressure was significantly higher ($p<0.05$) in the ultrasonography group than in the traditional group (Table 2).

The propofol and opioid doses used were significantly lower ($p<0.05$) in the ultrasonography group than in the traditional group (Figure 1). The use rate of neuromuscular blocking agents was significantly lower ($p<0.05$) in the ultrasonography group than in the traditional group (Table 2, Figure 2).

The incidence rates of major bleeding and complications, including subcutaneous emphysema, cannula misplacement, and conversion to surgical tracheostomy, did not differ significantly between the traditional and ultrasonography groups ($p>0.05$ for all; Figure 3). The incidence rates of minor bleeding and gag reflex were significantly lower ($p<0.05$ for both) in the ultrasonography group than in the traditional group (Figure 4). However, the procedure time was significantly longer ($p<0.05$) in the ultrasonography group than in the traditional group (Table 2).

Table 2. Comparison of demographic, hemodynamic and procedure-specific parameters and complication rates between groups

		Traditional group		Ultrasound group			
		Mean±SD / n (%)	Median	Mean±SD / n (%)	Median	p	
Age		53.6±21.2	54.0	59.6±19.1	62.5	0.091	m
Sex	Male	23 (31.0)		34 (45.9)		0.063	X^2
	Female	51 (69.0)		40 (54.1)			
Heart rate (beats per minute)							
Pre-procedure		94.2±30.0	90.5	108.1±33.2	101.5	**0.011**	m
Mid-procedure		93.5±32.0	85.6	107.9±33.1	100.8	**0.008**	m
Post-procedure		93.4±31.1	92.2	104.8±32.2	98.5	**0.033**	m
Change according to pre-procedure							
Mid-procedure		-0.68±8.98	-1.50	-0.14±3.27	0.00	0.268	m
Intra-group change p		0.296[w]		0.821[w]			
Post-procedure		-0.86±8.93	-2.00	-3.28±1.05	-3.00	0.154	m
Intra-group change p		0.347[w]		**0.000[w]**			
Mean arterial pressure (mmHg)							
Pre-procedure		74.0±14.0	72.0	74.8±14.0	74.0	0.721	m
Mid-procedure		74.7±15.1	74.8	71.1±13.3	70.3	0.195	m
Post-procedure		75.0±16.2	75.2	70.7±13.7	69.8	0.116	m
Change according to pre-procedure							
Mid-procedure		-0.68±8.98	-1.50	-0.14±3.27	0.00	**0.000**	m
Intra-group change p		0.279[w]		**0.000[w]**			
Post-procedure		-0.86±8.93	-2.00	-3.28±1.05	-3.00	**0.000**	m
Intra-group change p		0.594[w]		**0.000[w]**			
Propofol consumption		151.2±60.4	150.0	45.3±29.4	50.0	**0.000**	m
Opioid consumption		106.1±30.9	100.0	49.0±20.0	50.0	**0.000**	m
Neuromuscular blocking agents use	(-)	49 (66.2)		67 (90.5)		**0.000**	X^2
	(+)	25 (33.8)		7 (9.5)			
Major bleeding	(-)	66 (89.2)		70 (94.6)		0.228	X^2
	(+)	8 (10.8)		4 (5.4)			
Minor bleeding	(-)	54 (73.0)		64 (86.5)		**0.041**	X^2
	(+)	20 (27.0)		10 (13.5)			
GAG reflex presence	(-)	35 (47.3)		68 (91.9)		**0.000**	X^2
	(+)	39 (52.7)		6 (8.1)			
Subcutaneous emphysema presence	(-)	72 (97.3)		73 (98.6)		1.000	X^2
	(+)	2 (2.7)		1 (1.4)			
Cannula misplacement	(-)	69 (9.2)		70 (94.6)		0.731	X^2
	(+)	5 (6.8)		4 (5.4)			
Conversion to surgical tracheostomy	(-)	66 (89.2)		71 (95.9)		0.117	X^2
		8 (10.8)		3 (4.1)			
Total procedure time (min.)		30.6±9.4	30.0	59.7±20.1	63.0	**0.000**	m

[m]Mann-Whitney U test, [X²]Chi-square test (Fisher test).

SD: Standard deviation

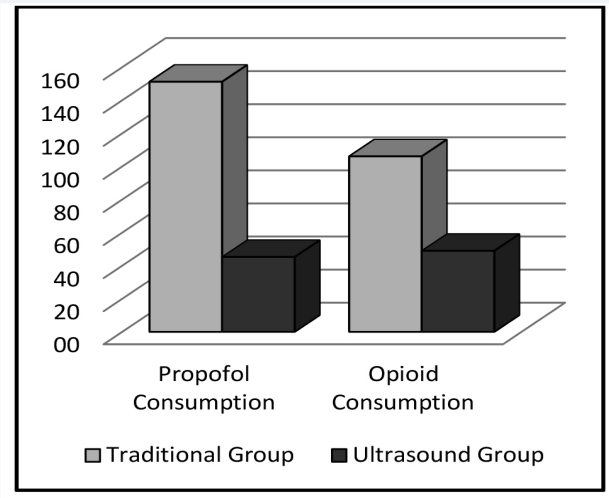

Figure 1. Propofol and opioid consumption of the patients

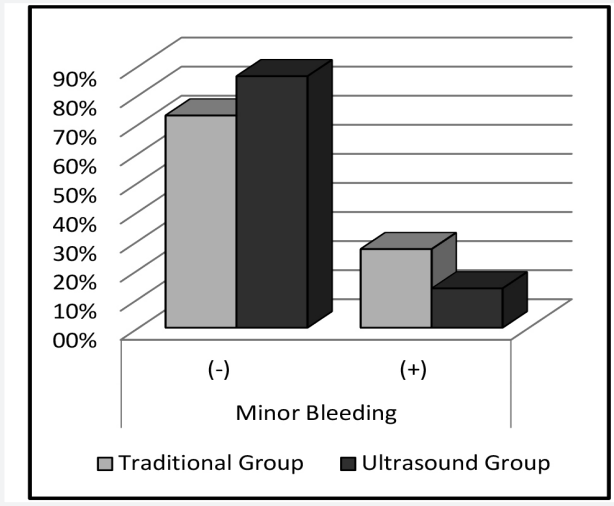

Figure 2. Neuromuscular blocking agent use of the patients

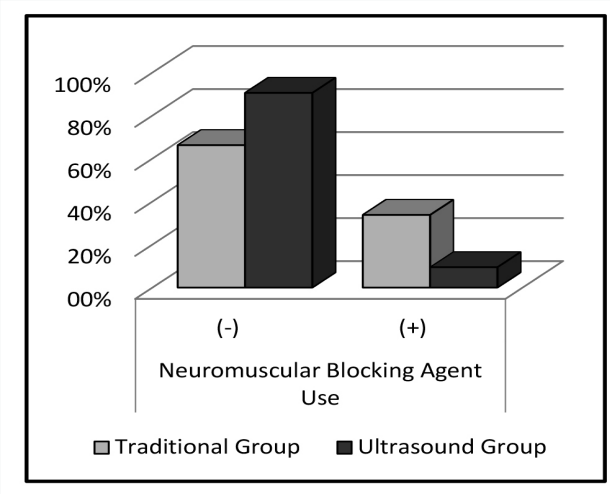

Figure 3. Minor bleeding seen between the groups

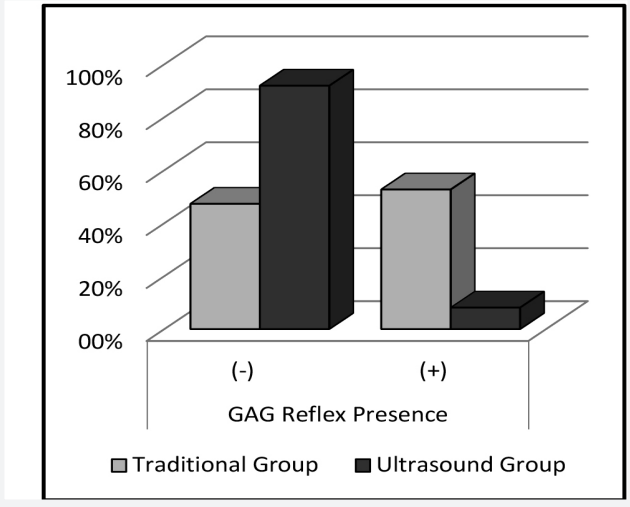

Figure 4. Presence of GAG reflex in the patients

DISCUSSION

The purpose of this study was to demonstrate that ultrasonography was an essential assessment device in percutaneous tracheostomy to facilitate the procedure and maintain effective analgesia using ultrasonography-guided regional anesthesia techniques and hemodynamic stability during the procedure. Ultrasonographic examination of the neck and puncture site in percutaneous tracheostomy is useful to avoid complications such as hemorrhages caused by puncturing the vascular structures and thyroid gland and to master the exact puncture point level to avoid damage to the cartulary structures[14-17].

As several studies have confirmed that preprocedural ultrasonographic examination of the anterior region of the neck minimizes the occurrence of complications related to percutaneous tracheostomy[17-20], we aimed to retrospectively scan for the characteristics of patients who had undergone elective tracheostomy to document the effect of ultrasonography usage in our clinic.

The traditional anatomical landmark technique for percutaneous tracheostomy consists of palpation of the underlying structures such as the cricothyroid membrane, cricoid cartilage, and tracheal rings[2,21]. Blind detection of the anatomical structures in the laryngeal region might be challenging and can have negative consequences. Placement of the tracheal tube above

the first tracheal ring may increase the risk of late subglottic stenosis. Sustić et al.[22] reported that when the tracheal tube was placed blindly, it could be mispositioned above the first tracheal ring, unlike with ultrasonography guidance.

Performing an ultrasonography-guided superficial plexus block with a translaryngeal block is essential in maintaining analgesia for percutaneous tracheostomy[12,23]. Owing to the impacts of the advantages of ultrasonography-guided regional anesthesia techniques performed in the operation theater, these techniques have also been used for pain management in critically ill patients in intensive care units[24]. To avoid the risks related to opioid and hypnotic use, we prefer ultrasonography-guided regional anesthesia techniques in intensive care. In our study, the propofol and opioid doses needed for the tracheostomy procedure were lower in the ultrasonography group. We think that this is the advantage of the preprocedural superficial CPB with a translaryngeal block. It is also related to a low hemodynamic response to pain. As patient response to the incisions during the tracheostomy procedure is heightened, higher propofol and opioid doses are needed. When the preprocedural and postprocedural heart rates and mean arterial pressures were compared within the groups, the patients in the ultrasonography group showed only decreases compared with the traditional group. We think that this was due to the regional anesthesia techniques we performed. The hemodynamic response to the tracheostomy procedure was avoided in the ultrasonography group owing to the ultrasonography-guided blocks.

Adding a translaryngeal block is also effective in preventing gag reflex, which is an involuntary defense mechanism to protect the pharynx and throat from foreign objects[12,25]. Following the studies by Şahin et al.[12] and Koshy and Thankamony[23], we experienced the advantages of adding a translaryngeal block to the superficial CPB, and related to this fact, the patients in the ultrasonography group had a lower incidence rate of gag reflex[23].

Contrary to the study of Plata and Gaszyński[17] reporting that ultrasonography guidance shortens the procedure duration, the procedure was much longer, nearly double, in the ultrasonography group than in the traditional group in our study (p=0.000)[17]. The major cause of this result was the longer time needed for the inspection of the anterior neck region followed by ultrasonography-guided superficial CPB with translaryngeal block in the ultrasonography group.

According to the study of Topcu et al.[26], which was a retrospective cohort study with 59 patients enrolled after scanning 2852 patients who were followed up in the intensive care unit, the time needed to perform ultrasonography-guided percutaneous tracheostomy was shorter than that required for Griggs percutaneous tracheostomy. By contrast, our study only required the total time for ultrasonography-guided percutaneous tracheostomy, including the time for preprocedural assessment of the anterior neck region combined with superficial CPB and translaryngeal block. As the patients' medical records contained no information on the time for the tracheostomy procedure alone apart from the preprocedural assessment and ultrasonography-guided block of the procedure region, this was considered a limitation of our study.

Several complications such as minor and major bleeding, pneumothorax, tracheal and esophageal injuries, paratracheal placement, hemodynamic instability, desaturation, and ruptured endotracheal tube cuff have been reported as immediate and early complications in the literature[2,27,28]. Rudas et al.[27] reported that they found no statistically significant difference in the mean complication rate between the two groups in their Traditional Landmark versus Ultrasound-Guided Evaluation Trial study, where in one group, the tracheal puncture site was decided using the landmark technique, whereas in the other group, ultrasonography guidance was used. On the basis of the noted complications in the patients' medical records and hospital data system, we found that only the incidence rate of minor bleeding was significantly different between the groups. The incidence rates of major bleeding, subcutaneous emphysema, and conversion to surgical tracheostomy were not significantly different between the groups. We expected the rate of conversion to surgical tracheostomy to be significantly higher in the traditional anatomical landmark group. Prospective studies are needed to improve the outcomes in terms of reducing the risk of other complications.

Neuromuscular blocking agents are not needed for some minor surgical interventions. However, they are required in the percutaneous tracheostomy procedure if the patient shows gag reflex, which indicates a direct relationship between the presence of gag reflex and the use of neuromuscular blocking agents. The results of our study corroborate this claim.

Study Limitations

In this single-center study, our case number was low compared to similar studies in the literature. The records in the hospital information system from past to present have been one of the limiting steps of our study. Prospective randomized controlled studies are needed to provide better clinical data.

CONCLUSION

Although ultrasonography-guided percutaneous tracheostomy takes more time to perform than traditional anatomical landmark percutaneous tracheostomy, we claim that the

procedure is much safer and provides better clinical outcomes. Randomized controlled trials with larger patient populations are warranted to document outcomes more accurately.

Ethics

Ethics Committee Approval: The study was approved by the Tekirdağ Namık Kemal University of Non-Interventional Research Ethics Committee (protocol no: 2022.223.12.01, date: 27.12.2022).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: O.B., Concept: O.B., M.C.A., Design: O.B., A.Ş., M.C.A., Data Collection or Processing: O.B., Analysis or Interpretation: A.Ş., M.C.A., Literature Search: A.Ş., Writing: O.B.

Conflict of Interest: No conflict of interest was declared by the authors.

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