Cukurova Medical Journal
ÇUKUROVA ÜNİVERSİTESİ TIP FAKÜLTESİ

Cukurova Med J 2022;47(2):614-621
DOI: 10.17826/cumj.1049742

ARAŞTIRMA / RESEARCH

Effects of different endotracheal tube cuff pressures on dysphagia after anterior cervical spine surgery

Anterior servikal omurga cerrahisi sonrası farklı endotrakeal tüp kaf basınçlarının disfajı üzerine etkileri

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Cukurova Medical Journal 2022;47(2):614-621

Abstract

Purpose: The present study aimed to compare the effects of two different endotracheal cuff pressures on postoperative dysphagia, sore throat, dysphonia, and hospital stay in anterior cervical spine surgery.

Materials and Methods: Seventy patients scheduled for surgery were randomly divided into two groups. After intubation, the endotracheal cuff pressure was inflated to 20 cmH2O and 25 cmH2O in Group I (n=35) and Group II (n=35), respectively. The degree of dysphagia was assessed with the Bazaz dysphagia score. The sore throat was evaluated via Visual Analog Scale. Total pain score regarding the operation site was evaluated using VAS. Hoarseness was evaluated based on the presence of any changes to the voice asharsh or strained. Dysphagia, dysphonia, and sore throat were assessed on the post-surgical 1st and 24th hours.

Results: No differences in demographic data were present between the groups. Dysphagia and sore throat at the post-surgical 1st and 24th hours were significantly lesser in Group I than in Group II. The frequency of dysphonia was significantly less in Group I than compared to Group II only at the post-surgical 1st hour. No differences in VAS scores at the post-surgical 1st and 24th hours were present between the groups.

Conclusion: In this study, it was shown that the risk of developing dysphagia after surgery was significantly reduced with 20 cmH2O endotracheal cuff pressure compared to 25 cmH2O. Also, lower cuff pressure was associated with a milder sore throat, less hoarseness at 1 hour postoperatively, and a shorter hospital stay.

Keywords:. Dysphagia, cuff pressures, cervical spine surgery, dysphonia, sore throat.

Öz

Amaç: Bu çalışmada, anterior servikal omurga cerrahisinde iki farklı endotrakeal kaf basıncının postoperatif disfaji, boğaz ağrısı, disfoni ve hastanede kalış üzerindeki etkilerinin karşılaştırılması amaçlanmıştır.

Gereç ve Yöntem: Cerrahi planlanan 70 hasta rastgele iki gruba ayrıldı. Entübasyondan sonra endotrakeal kaf basıncı Grup I'de (n=35) ve Grup II'de (n=35) sırasıyla 20 cmH2O ve 25 cmH2O'ya şişirildi. Disfajinin derecesi Bazaz disfaji skoru ile değerlendirildi. Boğaz ağrısı Görsel Analog Skala ile değerlendirildi. Operasyon bölgesine ilişkin toplam ağrı skoru VAS kullanılarak değerlendirildi (. Ses kısıklığı, seste herhangi bir değişiklik olup olmamasına göre sert veya gergin olarak değerlendirildi. Disfaji, disfoni ve boğaz ağrısı ameliyat sonrası 1. ve 24. saatlerde değerlendirildi.

Bulgular: Gruplar arasında demografik verilerde farklılık yoktu. Ameliyat sonrası 1. ve 24. saatlerde yutma güçlüğü ve boğaz ağrısı Grup I'de Grup II'ye göre anlamlı olarak daha azdı. Disfoni sıklığı Grup I'de Grup II'ye kıyasla sadece cerrahi sonrası 1. saatte anlamlı olarak daha azdı. Gruplar arasında ameliyat sonrası 1. ve 24. saatlerde VAS skorlarında fark yoktu.

Sonuç: Bu çalışmada, 25 cmH2O'ya kıyasla endotrakeal kaf basıncı 20 cmH2O ile cerrahi sonrası disfaji gelişme riskinin önemli ölçüde azalttığı gösterilmiştir. Ayrıca, daha düşük kaf basıncı, daha hafif bir boğaz ağrısı, ameliyat sonrası 1. saatte daha az ses kısıklığı ve daha kısa hastanede kalış süresi ile ilişkilendirildi.

Anahtar kelimeler: Disfaji, kaf basıncı, servikal omurga cerrahisi, disfoni, boğaz ağrısı

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Geliş tarihi/Received: 28.12.2021 Kabul tarihi/Accepted: 31.03.2022

INTRODUCTION

Dysphagia is a symptom caused by changes in neural or morphological structures with functions of swallowing[1]. Post-surgical dysphagia is a common complication, especially in surgeries of the neck region[1,2]. Monitoring the endotracheal tube cuff pressure is recommended as a prevention strategy for post-surgical dysphagia, sore throat and dysphonia[3]. The maintenance of the endotracheal cuff pressure between 15 and 25 cmH_2O is vital for preventing the development of post-surgical dysphagia[4-6]. Cuff pressures below 15 cmH_2O may cause gas leakage and increased aspiration risk, while pressures above 25-30 cmH_2O may lead to mucosal ischemia, tracheomalacia, tracheal stenosis, tracheal rupture, and tracheoesophageal fistula due to a decrease in tracheal wall capillary blood flow[1,2,6].

Post-surgical dysphagia is particularly common after surgeries of the anterior cervical spine[1,2]. The use of a retractor, which is placed laterally among the carotid sheath, trachea, and esophagus, to proceed towards the spine is mandatory in anterior cervical spine surgery. A significant increase in the endotracheal tube cuff pressure, which was observed after the insertion of the retractor, might result in post-surgical dysphagia, dysphonia, and/or sore throat[7].

Poor monitoring of tracheal tube cuff pressure may result in patient complications. The objective method of using a manometer is recommended to keep safe cuff pressure values (20-30 cmH_2O)[5]. Cuff pressures below 20 cmH_2O may result in the risk of aspiration of gastric and oropharyngeal secretions[8]. Cuff pressures above 30 cmH_2O may cause decreased mucosal blood flow in the anterolateral portion of the trachea[9]. Pressures above 50 cmH_2O can lead to destructive consequences, up to complete vascular obstruction and ischemia of the trachea[9]. Therefore, endotracheal cuff pressure should be kept high enough to prevent aspiration and low enough to provide adequate mucosal blood flow.

In this study we aimed to evaluate the effects of two distinct endotracheal cuff pressures on early post-surgical dysphagia in patient undergoing anterior cervical spine surgery. Today, given the fact that many clinicians adjust the endotracheal tube cuff pressure by hand feel, this study is unique in that it considers the results that can occur even at two different pressure values that can be considered as normal range.

MATERIALS AND METHODS

The approval of the study was obtained from the Clinical Research Ethics Committee at the Health Sciences University Erzurum Regional Training and Research Hospital (18.11.2019-2019 / 14-134). Written consent was obtained from all patients who participated in the study. This study was carried out in Health Sciences University Erzurum Regional Training and Research Hospital, Department of Anesthesiology and Reanimation. Our hospital is a tertiary education and research hospital, and approximately thirty-five thousand cases are performed annually.

Sample

Neurosurgery operations are performed on an average of 950 of them. Patients followed by two anesthesiologists (SGU, İHT) were included in this study. The study consisted of ASA I or II patients scheduled for one- or two-level anterior cervical spine surgery and intubated at the first attempt in less than 30 seconds. Two anesthesiologists with a similar level of expertise (SGU, İHT) intubated the patients. The exclusion criteria were patients younger than 18 and older than 65 years, a body mass index over 30 kg/m^2, presence of pre-surgical dysphagia, sore throat, hoarseness, recurrent laryngeal nerve damage, a history of previous anterior cervical spine surgery, or any other surgery in the neck region, patients assigned for fiberoptic or rapid series intubation, orotracheal intubation lasted longer than 30 seconds, development of intubation related complications, communication difficulties, and refusal of participation.

In this study, 81 patients were evaluated, and 11 patients were excluded for various reasons. In the study, which included 70 patients in total, each group consisted of 35 patients. The flow diagram according to CONSORT guidelines is provided as Figure 1[10].

Procedure

The size of the endotracheal tube was determined considering the gender and weight of the patientsand patients were intubated with a Machintosh laryngoscope. After intubation, cuff pressures were adjusted to 20 cmH_2O in Group I (n = 35) and 25 cmH_2O in Group II (n = 35) by a manometer (Rusch®, Kernen, Germany).

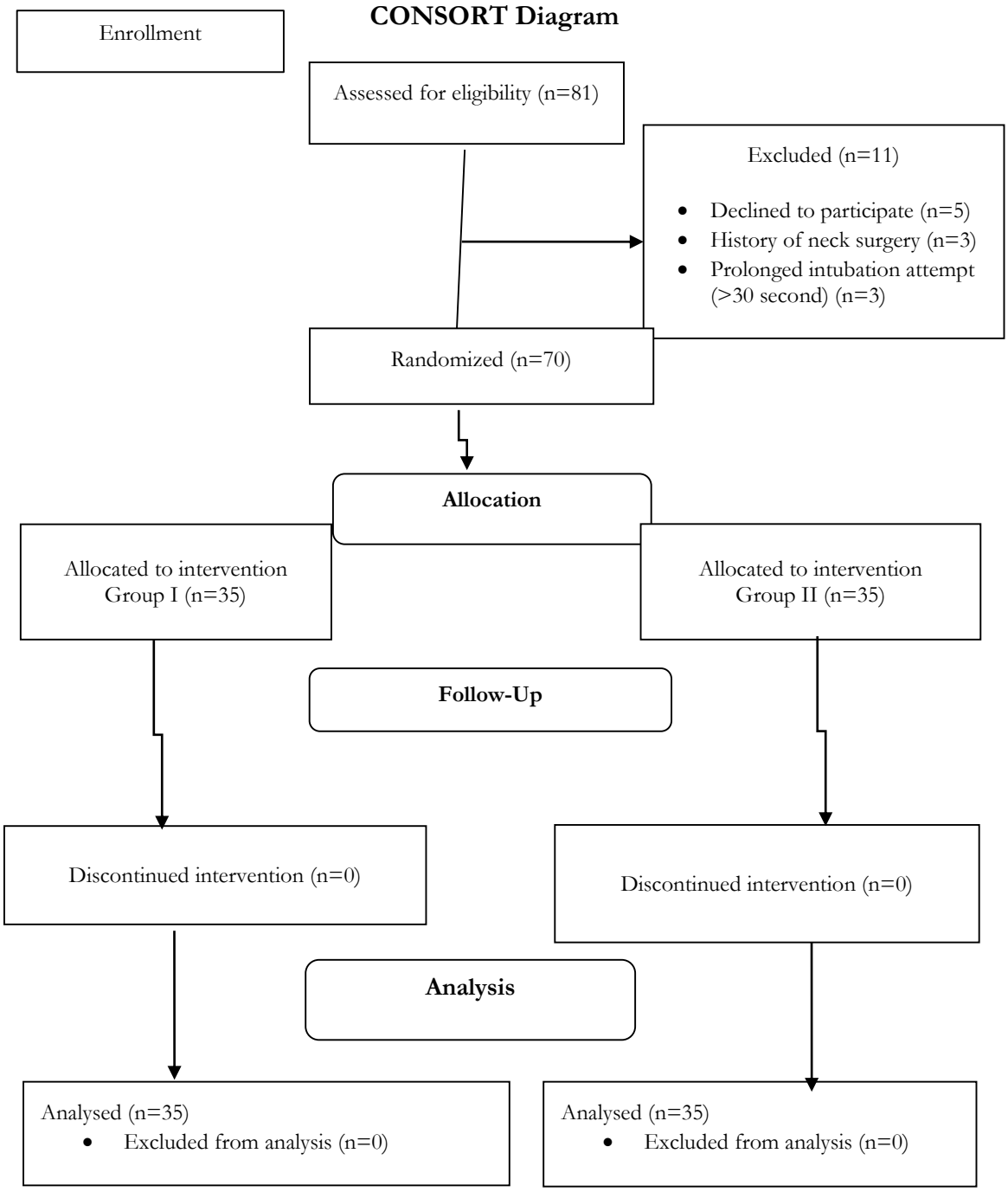

Figure 1. Consort diagram.

After sequring the airway, the cuff was inflated so that a minimum air leakage could beallowed, and cuff pressure was maintained at 20-30 cmH_2O. The level of cuff pressure was measured during the operation intermittently. When the cuff pressure exceeded the specified limits, it was reduced to the predetermined value using the manometer. Manual ventilation was used to monitor and adjust for leakage, followed by a transition to mechanical ventilation. During the operation, the recurrent laryngeal nerve was preserved and retracted. Endotracheal cuff pressure control was performed at different time points; after intubation, before the placement of the retractor, five minutes after the placement of the retractor, after the removal of the retractor, and before extubation.

Measures

The degree of dysphagia was evaluated with the Bazaz dysphagia score (no/mild /moderate /severe)[11]. Dysphagia, dysphonia, and sore throat were assessed on the post-surgical 1st and 24th hours. A visual analog scale (VAS) was used for assessing the severity of sore throat (0 = none, 1-3=mild, 4-6=moderate, 7-10 =severe) and pain on the operation site (0 = none, 10 = most severe).

Any changes in the voice, like becoming harsh or strained, were considered as dysphonia. Post-surgical dysphonia and length of hospital stay were secondary objectives of the study. Besides demographic data, Mallampati score, cuff volume leak percentage, retraction time, operation time, number of operating levels, and operation levels were recorded.

Statistical analysis

As the primary aim of the study was to investigate the effect of different cuff pressures on postoperative dysphagia, a preliminary study was performed on ten patients from each group with two different cuff pressures in our clinic. The mean ± standard deviation at 5th min. cuff pressure was 35.07±3.87 in group I and 39.01±5.72 in group IIafter retractor placement. The sample size calculated at a power of 90% and a significance level of 5% by using G*Power software (version 3.1.9.4, Kiel University, Kiel, Germany) was approximately 35 patients per group with an effect size of0.80 for statistical significance.

IBM SPSS v22.0 software package (SPSS Inc., Chicago, Illinois, USA) was used for statistical analyses. Kolmogorov-Smirnov and histogram tests were used for evaluating the normal distribution of variables. The Chi-square test was used for analyzing categorical variables in the evaluation of demographic data and the presence of side effects. The student's t-test was used for continuous variables with a normal distribution. Mean ± standard deviation (SD) and numbers was used for expressing descriptive data. A p-value below 0.05 was considered statistically significant.

RESULTS

No significant differences between groups were found for demographics ($p>0.05$) (Table 1). The mean duration of the hospital staysof Group I was significantly shorter than that of Group II ($p<0.05$) (Table 2). Cuff pressure and leakage percentage were compared between Group I and Group II. The endotracheal cuff pressures before the retractor insertion, five minutes after the retractor removal, and before the extubation was significantly lower in Group I compared to those in Group II, while there was significantly less amount of leakage after the retractor removal in Group I compared to Group II ($p<0.05$) (Table 3).

Table 1. Demographic data between Group I and Group II.

	Group I (n=35)	Group II (n=35)	p
Age (years)	39.83 ± 8.98	40.37 ± 7.24	0.782[a]
BMI	29.06 ± 2.52	28.99 ± 4.14	0.931[a]
Gender (M/F)	18/17	20/15	0.631[b]
ASA Score(I/II)	32/3	25/10	0.062[b]
Mallampati Score (I/II)	18/17	21/14	0.470[b]
Smoking (Yes/No)	26/9	29/6	0.382[b]
Additional disease (No/DM/HT)	31/2/2	25/6/4	0.191[b]

Values are expressed mean ± Standard deviation or number, kg; kilogram, M; male, F; Female, ASA; American Society of Anesthesiologist, BMI; Body Mass Index, DM/HT; Diabetes Mellitus/ Hypertension
[a]Student's t- Test, [b]Chi-square test

Table 2. Duration of operation, smoking and length of hospital stay between Group I and Group II.

	Group I (n=35)	Group II (n=35)	p
Duration of operation (min.)	68.43±16.70	67.00±15.34	0.711
Retractor time (min.)	23.57±4.78	22.71±4.75	0.455
Length of Hospital Stay (day)	2.26±0.50	2.57±0.65	**0.028***

Values are expressed mean ± Standard deviation or number, kg; kilogram, M; Male, F; Female, min; minutes
*Student's T-test

Table 3. The comparison of cuff pressure and percentage of leak values between Group I and Group II.

	Group I(n=35)	GroupII(n=35)	p
Cuff pressure before retractor	26.03±2.45	30.14±3.20	**0.000***
Cuff pressure 5 minutes after retractor insertion	36.11±4.96	40.06±6.16	**0.004***
Cuff pressure after retractor removal	23.40±4.83	24.40±4.12	0.355
Cuff pressure before extubation	22.37±3.10	25.69±1.38	**0.000***
Percentage of leak after intubation	8.49±13.58	4.63±8.52	0.159
Percentage of leak before retractor	0.60±2.54	0.00±0.00	0.172
Percentage of leakage 5 minutes after retractor insertion	0.00±0.00	0.00±0.00	N/A
Percentage of leak after retractor removal	5.46±10.13	12.86±16.31	**0.026***
Percentage of leak before extubation	0.86±2.26	1.71±3.82	0.259

Values are expressed mean ± Standard deviation or number, N/A: not applicaple
*Student's T-test

Table 4. The comparison of incidence of side effects between Group I and Group II.

	Group I (n=35)	Group II (n=35)	p
	no/mild/moderate/severe	no/mild/moderate/severe	
Dysphagia postoperative 1^{st}_{h}	17/16/2/0	1/16/17/1	**0.000***
Dysphagia postoperative 24^{th}_{h}	33/1/1/0	8/26/1/0	**0.000***
Dysphonia postoperative 1^{st}_{h}	33/2/0/0	16/19/0/0	**0.000***
Dysphonia postoperative 24^{th}_{h}	34/1/0/0	33/2/0/0	0.555
Sore throat postoperative 1^{st}_{h}	3/30/2/0	2/3/17/13	**0.000***
Sore throat postoperative 24^{th}_{h}	30/5/0/0	4/25/6/0	**0.000***

Values are expressed number. h; hour, *Chi-square test

Table 5. The comparison of VAS values between Group I and Group II.

VAS	Group I (n=35)	Group II (n=35)	p
Postoperative1^{st}_{h}	6.20±0.58	6.31±0.58	0.415*
Postoperative24^{th}_{h}	3.57±0.50	3.66±0.80	0.594*

Values are expressed mean ± Standard deviation or number, VAS: Visual analog pain scale, h; hour, *Student's T-test

Dysphagia and sore throat at the 1st and 24th hours in Group I were significantly lesser than in Group II. Dysphonia at the 1st hour was significantly lesser in Group I ($p<0.05$); however, no such difference was found between the two groups at the 24th hour ($p>0.05$) (Table 4). No differences in VAS for operation site at the post-surgical 1stand 24th hours were recorded between the groups ($p>0.05$) (Table 5).

DISCUSSION

In the current study, we found that the risk of developing post-surgical dysphagia significantly decreased with an endotracheal cuff pressure of 20 cmH_2O compared to 25 cmH_2O. Moreover, lower cuff pressure was associated with a milder sore-throat, lesser hoarseness at the 1st post-surgical hour, and a shorter duration of hospital stay. However, no effect of endotracheal cuff pressure was found on pain scores on the operation side.

Dysphagia after anterior cervical spine surgery is a common finding in the early post-surgical term[12-14]. Injuryto the recurrent laryngeal nerve (RLN) branches due to the retractors used in anterior cervical spine surgery has an essential role in the development of post-surgical dysphagia. The anterior cervical spine is accessed by sliding the retractor

through the neighboring structures, i.e., sternohyoid muscle, esophagus, trachea, RLN, and thyroid gland on the contralateral side. The retractor should attentively be positioned, especially considering the RLN on the anterior of the esophagus. Otherwise, any disturbances to the RLN and esophageal branches could directly lead to dysphagia[14].

Female gender, advanced age, prolongedoperation time, smoking, and surgery for multiple levels have previously been identified as the risk factors for dysphonia, sore throat, and dysphagia[3,15-17]. In our study, age, BMI, gender distribution, ASA and Mallampati Scores, smoking rates, and accompanying diseases were not significantly different in both groups.

The literature about the post-surgical dysphagia rates after anterior cervical spine surgery is limited and conflicting. Gowd et al. have recently reported rates of 20.4% and 4.6% for dysphagia and voice hoarseness, respectively, in a prospective study on anterior cervical discectomy and fusion surgery. The authors also determined the endotracheal cuff pressure, the number of vertebral levels, body mass index, and intubation time as imperative variables related to postoperative symptoms[18]. Grasso et al. reported a significant reduction in the rate of early dysphagiawhen the pressure of endotracheal tube cuff was reduced, local irrigation using methylprednisolone performed, and the intra-surgery pharynx/esophagus retraction was minimized[19]. Ratnaraj et al.[3] reported that adjustment of endotracheal tube cuff pressure at 20 mmHg did not cause any significant differences in the post-surgical first-hour rates of sore throat, dysphagia, and hoarseness after anterior cervical spinesurgeries, while a significant decrease in the rates of sore throat at the post-surgical 24th hour was observed the adjusted group[3]. On the contrary, Kowalczyk et al.[20], who compared the treatment group with endotracheal tube cuff pressures sustained at 15 mmHg and the control group monitored without any manipulation, reported no significant differences between the groups regarding the Dysphagia Disability Index or Bazaz-Yoo Dysphagia Score.In contrast with our results, In't Veld et al.[21] reported that adjusting endotracheal tube cuff pressure to 20 mmHg after retractor placement did not affect the early (the first day) or late (2 months after the operation) dysphagia rates.

In our study, we monitored cuff pressure with manometric measurements during the surgery and accordingly reduced the increased pressures after retractor placement. We also continued to maintain the cuff pressures after the retractor was removed. The rates of sore throat and dysphagia at post-surgical first and 24th hours were significantly lesser in the lower cuff-pressure group. Adjusting the cuff pressure by a cuff manometer compared to the conventional palpation method was recommended to reduce the upper airway-related complications secondary to intubation[22]. Tracheal ischemia may develop if the pressure applied to the endotracheal region exceeds the capillary pressure. It has been suggested that endotracheal cuff pressure should be kept in the range of 20-22 cmH_2O to prevent tracheal ischemia[3]. Similarly, Inada et al. showed that low endotracheal cuff pressure during hypothermic cardiopulmonary bypass was associated with low rates of tracheal mucosal ischemia[23]. On the other hand, Koo et al.[24] reported that post-surgical sore throat rates were lower with lesser cuff pressures, while no such differences in the incidence of hoarseness or dysphagia were found by altering the cuff pressure during endoscopic and robotic thyroidectomy. Although no standardization of endotracheal cuff pressure measurements has been achieved yet, routine monitoring of cuff pressure is essential in preventing potential post-surgical complications[25].

In a study by Riley et al.[26], post-surgical pain was associated with a high incidence of dysphagia. For dysphagia evaluation, we assessed the pain of the patient at the surgical site using the VAS scoring system to eliminate the possible effects of post-surgical pain. No significant differences in VAS at the surgical site were present between the groups. We speculate that the lack of difference might be duetothe short surgical time and the adequatepost-surgical analgesia.

Prolonged retraction times and increased endotracheal cuff pressures have been associated with post-surgical sore throat and dysphonia in a study[27]. Nevertheless, another study reported no relationship between the retraction time and sore throat and dysphonia, and that time was associated with an increased incidence of dysphagia at 24th in patients with cuff pressures>20 cmH_2O[3]. Two levels of surgery were performed in our study. Incision length and retractor retraction were limited to 3-4 cm. Retractor usage times were similar in both groups in our study. It might be interpreted as the short

retractor usage times in both groups did not result in any different effects.

The type and placement method of the retractor placed under the longus colli for pressure on the laryngeal structures are also important[28]. Pressure on the tissue from the outside impairs local blood flow. If this pressure lasts for a long time, both nerves and muscles are damaged. Ischemia as a result of retraction and reperfusion injury after surgery-related tissue edema may cause early postoperative dysphagia[7,29,30].

In this study, the duration of hospital stay was significantly shorter in the patient group with lesser endotracheal cuff pressure. The damage to the aerodigestive pathway, tissue damage with edema, posterior pharyngeal wall edema, esophageal denervation, injuries to the pharyngeal plexus or the vagus nerve, glossopharyngeal nerve or hypoglossal nerve, and prevertebral soft tissue swelling, which are among the surgical technique-related factors that causedysphagia, could be affected by endotracheal cuff pressures and might explain the reason for more extended hospital stay periods in the higher endotracheal cuff pressure group. However, data regarding the association of the length of hospital stay with the endotracheal cuff pressures are limited. Therefore, our findings are valuable and may shed light for future investigations.

The current study has some limitations that should be mentioned. The first is that the tracheal wall thickness of the patients was not detected by the ultrasonography. Since we excluded the patients with high body mass index and difficult intubation from our study, no related analysis could be performed. Our second limitation is that we did not use video laryngoscopy, which is considered the gold standard in evaluating the function of swallowing[31]. Although the objective evaluationof dysphagia provides essential information, we consider that the presence of dysphagia defined by the patient might be more clinically significant, as supported by previous publications[9,29].

In conclusion, we evaluated the development and causes of post-surgical dysphagia, sore throat, and dysphonia in patients who underwent anterior cervical surgery. The causes and pathophysiology of post-surgical dysphagia are not fully understood yet. We suggest that an endotracheal cuff pressure of 20 cmH_2O may decrease the incidence of dysphagia, as well as sore throat and dysphonia. Moreover, lesser endotracheal cuff pressure is associated with a shorter hospital stay. Further comparative studies are warranted to determine the effects of endotracheal cuff pressure on complications and outcomes after anterior cervical spine surgeries.

Yazar Katkıları: Çalışma konsepti/Tasarımı: SGU, İHT; Veri toplama: SGU, İHT; Veri analizi ve yorumlama: SGU, İHT; Yazı taslağı: SGU, İHT; İçeriğin eleştirel incelenmesi: SGU, İHT; Son onay ve sorumluluk: SGU, İHT; Teknik ve malzeme desteği: SGU, İHT; Süpervizyon: SGU, İHT; Fon sağlama (mevcut ise): yok.
Etik Onay: Bu çalışma için Sağlık Bilimleri Üniversitesi Erzurum Bölge Eğitim ve Araştırma Hastanesi Klinik Araştırmalar Etik Kurulundan 18.11.2019 tarih ve 2019/14-134 sayılı kararı ile etik onay alınmıştır.
Hakem Değerlendirmesi: Dış bağımsız.
Çıkar Çatışması: Yazarlar çıkar çatışması beyan etmemişlerdir.
Finansal Destek: Yazarlar finansal destek beyan etmemişlerdir.

Author Contributions: Concept/Design: SGU, İHT; Data acquisition: SGU, İHT; Data analysis and interpretation: SGU, İHT; Drafting manuscript: SGU, İHT; Critical revision of manuscript: SGU, İHT; Final approval and accountability: SGU, İHT; Technical or material support: SGU, İHT; Supervision: SGU, İHT; Securing funding (if available): n/a.
Ethical Approval: For this study, ethical approval was obtained from the Clinical Research Ethics Committee of the University of Health Sciences Erzurum Regional Training and Research Hospital with the decision dated 18.11.2019 and numbered 2019/14-134.
Peer-review: Externally peer-reviewed.
Conflict of Interest: Authors declared no conflict of interest.
Financial Disclosure: Authors declared no financial support

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