Management of life-threatening tracheal emergencies

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OBJECTIVE: *Tracheal pathologies are life-threatening in all age groups and may result in death if urgent action isn't taken. The aim of this study was to present cases of rare and life-threatening tracheal pathologies and discuss the management of these in the light of literature.*
METHODS: *A retrospective analysis was made of 8 patients who underwent surgery for emergency tracheal pathologies in our clinics between 2013 and November 2018. The patients were evaluated in terms of age, gender, etiology, symptoms, location of pathology, surgical approach, treatment technique, and length of hospital stay.*
RESULTS: *Of the 8 cases with tracheal pathology, 4(50%) had tracheal rupture, 3(37.5%) had tracheal stenosis due to prolonged post-intubation, and one (12.5%) had a tracheal tumor. The cases with tracheal rupture comprised 2 females and 2 males with a mean age of 28.5 years (range, 16-48 years). The cases with tracheal stenosis were 2 females and 1 male with a mean age of 29.3 years (range, 25-36 years). The patient with a tracheal tumor was 34 years old and had been diagnosed late. Preoperative mortality as a result of hypoxia was seen in one case with carina rupture. No postoperative morbidity or mortality were observed in all 7(87.5%) cases who underwent surgery.*
CONCLUSION*: Early diagnosis, treatment, determination of the location and form of the pathology is very important in tracheal pathologies. In surgical treatment, wide resection should be avoided as much as possible, and the surgical approach should be determined according to the shape of the pathology, wiht end-to-end anastomosis and/or primary repair applied when possible.*

KEY WORDS: Surgery, Tacheal tumor, Tracheal stenosis, Tracheal rupture

Introduction

Post-intubation tracheal stenosis, tracheal ruptures, and tracheal tumors, which constitute an important part of tracheal emergencies, cause respiratory distress by narrowing and disrupting the integrity of the tracheal lumen.
Narrowing of the tracheal lumen by more than 50% is considered tracheal stenosis.

The most common causes of tracheal stenosis include tracheostomy, prolonged endotracheal intubation, blunt or penetrating trauma, benign and malignant neoplasms, some chronic inflammatory diseases and collagen vascular diseases [1]. Although the most common symptom in tracheal pathologies is respiratory distress, cough and hemoptysis can also be seen [2].
Post-intubation tracheal stenosis (PETS) develops as a result of damage caused by the high pressure endotracheal intubation tube cuff and prolonged intubation. Prolonged intubation disrupts the submucosal blood flow of the compressed part of the trachea. Consequently, necrosis, fibrosis and stenosis develop in the lumen endothelium of the trachea [3].
Malignant or benign tracheal tumors can cause respiratory distress by narrowing the lumen. Tracheal tumors constitute 0.2% of upper respiratory tract tumors. Squamous cell carcinoma are the most common malig-

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nant epithelial tumors and squamous papilloma are the most common benign epithelial tumors [4]. Squamous cell carcinoma constitute 50% and adenoid cystic carcinoma, 35%, of all primary malignant tracheal tumours [5]. Tracheal rupture may occur due to blunt penetrating trauma. Although it is less common in blunt trauma, the mortality rate has been reported as 30% and 50% of these cases are seen in the first hour. It has been stated that 80% of tracheobronchial ruptures due to blunt trauma occur around the carina at a distance of 2.5 cm from the carina, 15% in the trachea, and 5% in the distal airways [6]. Penetrating trauma-related ruptures are more common in the cervical region and constitute 8% of tracheobronchial ruptures [7].

Materia and Methods

A retrospective analysis was made of 8 patients who underwent surgery for emergency tracheal pathologies in the Training and Research Hospitals of Afyon Health Sciences University and Süleyman Demirel University between 2013 and November 2018. Aproval for the study was granted by the Local Ethics Committee (code: 2011-KAEK-2, date and number:2020/514).
Four patients had tracheal rupture, three had PETS, and one had tracheal tumor. The cases with tracheal rupture comprised 2 females and 2 males with a mean age of 28.5 years (range, 16-48 years). The etiologies were in-vehicle traffic accident in 2 cases, one patient had stab injury in, and a history of difficult intubation in the intensive care unit in 1. Both of the ruptures due to traffic accidents were full thickness tracheal ruptures. The 3 PETS cases were 2 females and 1 male with a mean age of 29.3 years (range, 25-36 years). The etiology was a history of prolonged postoperative intubation of 14, 17 and 20 days (mean: 17 days), respectively.
The case with a tracheal tumor was a 34-year-old male patient. Tracheal tumor was not considered in the early period and despite complaints of shortness of breath and stridor for 2 years, the patient was followed up in an external center with a diagnosis of anxiety.
The most common symptom in all eight patients was dyspnea. Other accompanying symptoms were stridor, cough and hemoptysis, respectively. On physical examination, subcutaneous emphysema and ecchymosis localized in the neck region were observed in all the cases with tracheal rupture.
Radiological examination of all the cases was preoperative computed tomography of the thorax. In appropriate cases, intraoperative FOB was performed for localization of the pathology. One case with carina rupture died due to hypoxia in the early period. No postoperative morbidity or mortality was observed in all 7 (87.5%) cases who underwent surgery.
The patients were discharged postoperatively at an average of 9 days (range, 3-14 days).

Results

Tracheal rupture was present in 4 cases. One of these cases had cervical full-thickness rupture, one had a carinal full-thickness rupture. Both of these had occurred in a traffic accident, one as a result of blunt trauma on the steering wheel (Figs. 1A, 1B, 1C).
In the third case, the rupture was due to intubation and the injury site started 1.5 cm above the carina and extended from the posterior membranous surface to the cervical region. The fourth case of rupture was due to stab injuries, and the rupture was 3 cm distal of the vocal cords, 1 cm in size and on the lateral surface. A collar incision was applied to the 2 cervical tracheal ruptures. End-to-end tracheal anastomosis was applied to the tracheal full-thickness rupture (Figs. 2, 3A, 3B), and primary repair was performed for the partial rupture. Primary repair was performed with a right thoracotomy in the case with rupture due to intubation.
Early preoperative mortality occurred due to hypoxia in the patient with full-thickness rupture at the carinal level (Fig. 4). There were no postoperative complications in the other 3 rupture cases, and all were discharged with recovery at 7-14 days postoperatively.
In the case where tracheal tumor was detected, there was

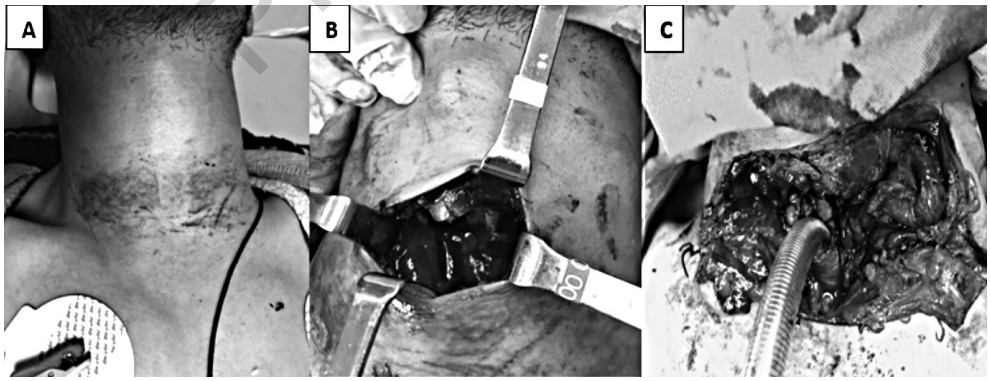

Fig. 1: A) Image of the patient who developed full thickness tracheal rupture after blunt trauma on the car steering wheel; B-C) Intraoperative view of full-thickness tracheal rupture.

Fig. 2: Computed tomography image of the patient with full-thickness tracheal rupture under the vocal cords.

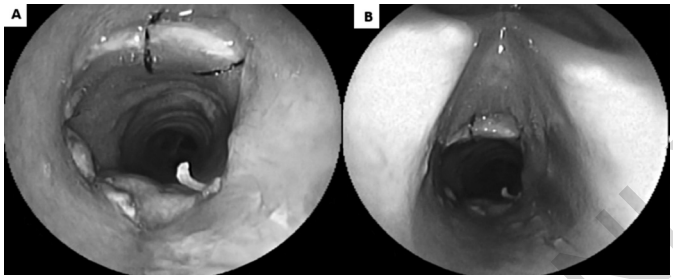

Fig. 3: A-B) Fiberoptic bronchoscopy image in the postoperative (28th day) follow-up of the end-to-end anastomosis of the trachea.

a mass proximal to the trachea, narrowing the air passage from the right lateral, with lobulated contours of 33x26x37 mm, which was observed along the segment of approximately 3 cm, with a heterogeneous appearance, 1 cm below the cricoid cartilage (Figs. 5A, 5B, 6A, 6B). The mass was totally removed with three cartilage rings. End-to-end anastomosis was then applied to the trachea (Figs. 7A, 7B).

The pathology result of the removed mass was compatible with adenoid cystic carcinoma. There were no postoperative complications in the patient and he was discharged on the 11th postoperative day. Absorbable

Fig. 4: Appearance of full-thickness tracheal rupture at carina level in fiberobtic bronchoscopy

(polyglactin) and / or non-absorbable 3/0 polypropylene sutures were used as the suture material in all operated cases and the trachea was primarily repaired.

In one patient with tracheal stenosis, the stenosis was approximately 3 cm distal from the vocal cords, and the tracheal lumen was reduced to a diameter of 0.4 cm. The patient also had prolonged intubation followed by tracheostomy, and after 4 months of intensive care follow-up, tracheal stenosis developed. Tracheal resection with a collar incision and then end-to-end trachea anastomosis was performed in the stenotic area of approximately 3 cm. One week postoperatively, the chin was sutured to the chest area. No complications developed, and the patient was discharged after 9 days (Figs. 8A, 8B, 8C, 8D).

In the second case with tracheal stenosis, the stenosis was 0.5 cm long, 2 cm distal to the vocal cords, the tracheal lumen was narrowed to 0.5 cm, and there was granulation tissue surrounding the trachea. Tracheal resection was performed with a collar incision. Re-stenosis developed in the postoperative 3rd month, so bronchoscopic dilatation and tracheal stenting was performed (Figs. 9A, 9B, 9C, 9D).

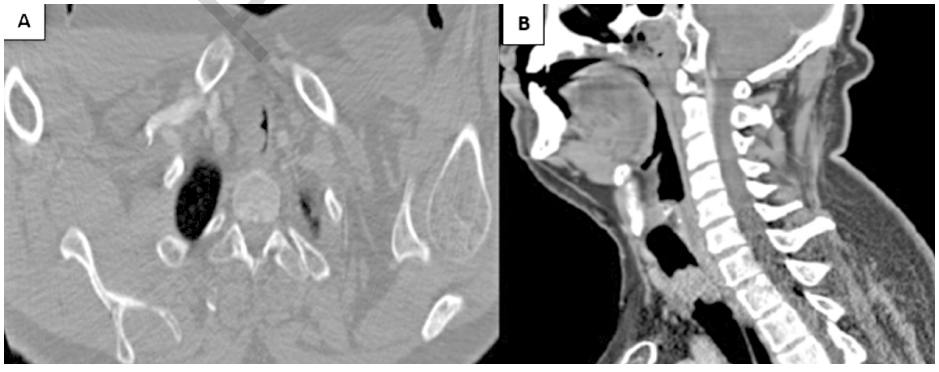

Fig. 5: A-B) Computed tomography image of the mass narrowing the lumen of the trachea.

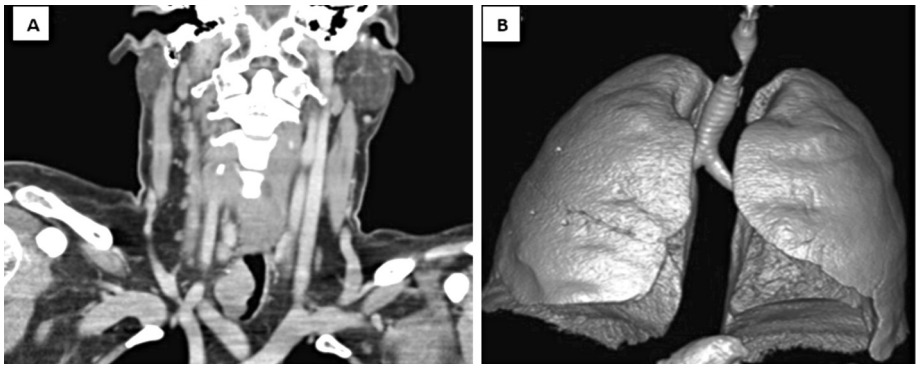

Fig. 6: A) Computed tomography of the mass narrowing the lumen of the trachea; B) Virtual bronchoscopy image of the mass narrowing the lumen of the trachea.

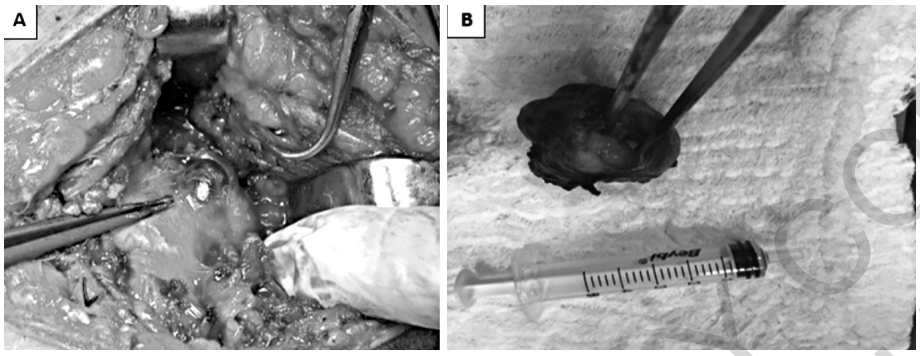

Fig. 7: A) Intraoperative tracheal mass; B) Image of the mass removed.

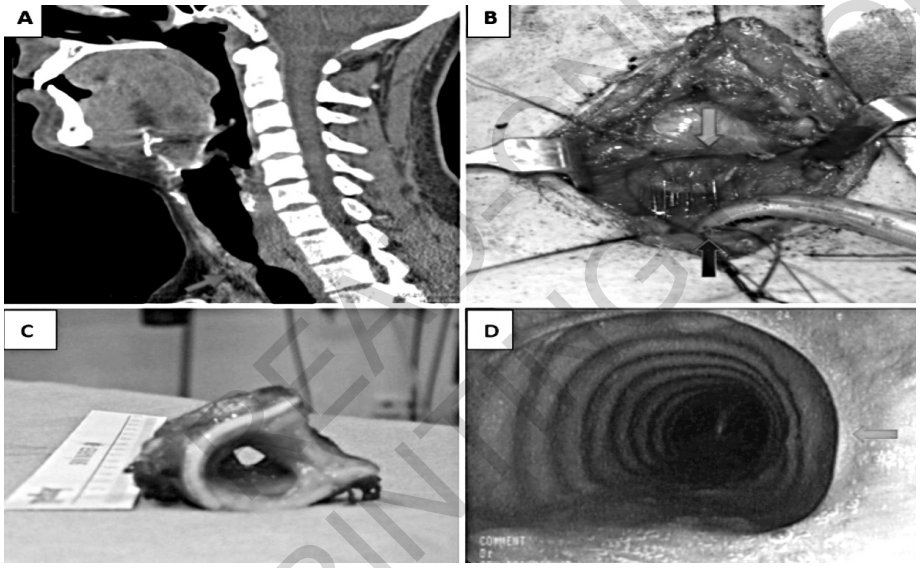

Fig. 8: A) Image of the stenotic area on computed tomography; B) Intraoperative view of the end-to-end anastomosis of the trachea after removal of the stenotic area; C) Stenotic fragment removed from the trachea; D) FOB image of the surgical area 1 month postoperatively.

In the third case with tracheal stenosis, the tracheal lumen narrowed down to 0.6 cm at a distance of 2 cm from the vocal cords, there was granulation tissue. As the patient did not accept surgical treatment, bronchoscopic dilatation and stenting were performed on this patient (Figs. 10A, 10B).

Fiberoptic bronchoscopy was performed to see the granulation tissue on the suture line and to clean the secretions in patients where there was difficulty in removing secretions in the early period. Control fiberoptic bronchoscopy was performed at the end of the postoperative 1st month. The characteristics of the cases are shown in Table I.

Discussion

Tracheal bronchial injuries are observed in 1-4% of thoracic traumas. Penetrating tracheal injuries are frequently seen in the cervical region, while blunt injuries are more common in the distal trachea and main bronchi.[7] Flynn et al. found tracheobronchial injury in 1-2% of penetrating thoracic injuries, and tracheal injury in 3-6% of penetrating cervical injuries [8].

When the literature is examined, tracheobronchial injury due to blunt and penetrating trauma has been reported to be between 0.5-2%. Although the rates seem to be the same, there is a significant difference. The difference

Fig. 9: A-B) Computed tomography image of tracheal stenosis; C-D) Computed tomography image after tracheal stent application.

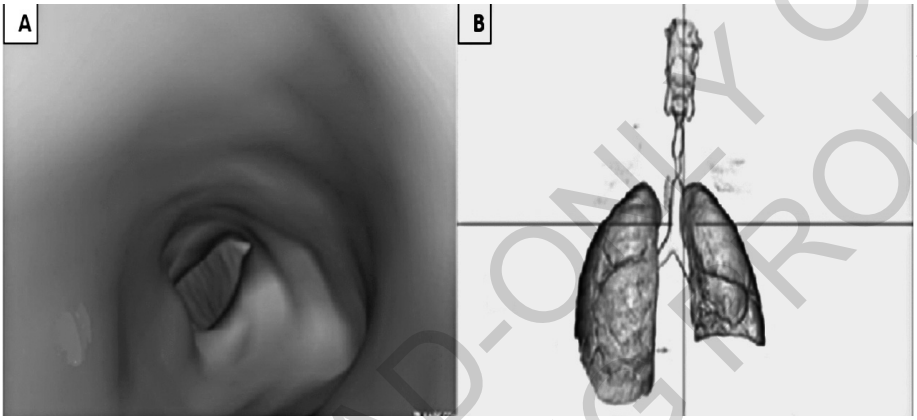

Fig. 10: A-B) Virtual bronchoscopy view of tracheal stenosis.

is that 4% of all blunt traumas cause cervical trachea injury, and 8% of all penetrating traumas cause cervical trachea injury [6].

Four of the current cases had tracheal rupture. Full thickness tracheal rupture due to blunt trauma was detected in two cases. Tracheal rupture was detected due to difficult intubation in one case and stab injury in one case. In one of the two full-thickness tracheal ruptures due to blunt trauma, the rupture site was in the carina region in accordance with the literature. The other, less common, was in the cervical region.

In the case where the rupture of the trachea developed as a result of stab injury, it was localized in the left anterolateral of the trachea under the vocal cords.

Most iatrogenic tracheal ruptures occur during endotracheal intubation tube insertion. Rates varying between 0.05% and 0.37% have been reported in the literature. In the etiology, the reasons include lack of experience, recurrent intubations, and excessive inflation of the balloon. The rate of rupture is higher in females of short stature. The rupture is usually in the membranous part and in a linear shape. Mediastinal and subcutaneous emphysema, and pneumothorax are the most frequent findings. Lesions are mostly in the distal trachea and main bronchi. Such injuries are not common in the cervical region [9].

In a study of 182 cases, Eduardo Minambres et al.[10] reported that 82.6% of the cases with tracheal rupture were female, and the mortality rate was higher than for males. It was also reported that the mortality rate in cases requiring emergency intubation was three times higher than in those with elective intubation, and that ruptures due to forced intubation were longitudinal on the membranous surface and cartilage facial border [11].

Due to the current use of double lumen endotracheal tubes, the rate of rupture has increased due to the increased frequency of tracheal entry as the tube cannot be placed in intubation. Therefore, it can be considered that intubation with the help of anesthesia experience and thin FOB will decrease the complication rates.

When subcutaneous emphysema, pneumothorax or mediastinal emphysema is observed in patients who have undergone intubation under general anesthesia, tracheal stenosis should be kept in mind first if there are com-

Table I - *Characteristics of the cases*

	Age	Gender	Pathology	Etiology	Localization	Operation	Postoperative complication	Time to discharge
Case I	32	Male	Tracheal rupture (total)	Blunt trauma	Cervical area (1 cm distal to vocal cords)	Collar incision + end-to-end tracheal anastomosis	No	14 days
Case II	48	Female	Tracheal rupture	Intubation	A 5-6 cm rupture starting from the membranous surface 1.5 cm above the carina and extending to the cervical region	Right thoracotomy + Primary repair	No	7 days
Case III	18	Male	Tracheal rupture (total)	Blunt trauma	Carina	No	Exitus	Exitus
Case IV	16	Female	Tracheal rupture	Injury with sharp objects	3 cm distal to the vocal cords	Collar incision + primary repair	No	10 days
Case V	25	Female	Postintubation stenosis	Postoperative prolonged intubation	2 cm distal to the vocal cords	Collar incision + tracheal segment resection + end-to-end anastomosis	Recurrent tracheal stenosis (after 1.5 months)	12 days
Case VI	27	Male	Postintubation stenosis	Postoperative prolonged intubation	4 cm distal to the vocal cords	Collar incision + tracheal segment resection + end-to-end anastomosis	No	10 days
Case VII	36	Female	Postintubation stenosis	Postoperative prolonged intubation	2 cm distal to the vocal cords	Bronchoscopic dilatation	No	3 days
Case VIII	34	Male	Adenoid cystic carcinoma	Tracheal tumor	2 cm distal to the vocal cords	Collar incision + tracheal segment resection + end-to-end anastomosis	No	10 days

plaints of shortness of breath and stridor in the follow-up of patients with a history of tracheal rupture, prolonged intubation and intensive care follow-up.

The current case of tracheal rupture due to intubation was a female patient. The rupture started just above the carina and extended from the posterior membranous surface and the cartilage to the cervical region. This case was compatible with the literature in terms of gender and location of rupture.

In penetrating cervical tracheal injuries, carotid artery and vein, esophagus, jugular vein, larynx, recurrent nerve, and spinal cord injuries can also be seen. Blunt cervical tracheal injuries may accompany head trauma, abdominal and orthopedic traumas [12]. One of the current patients with tracheal rupture had bilateral recurrent nerve injury and pelvic injury together with total cervical rupture.

Of tracheobronchial injuries that occur after blunt traumas, 80% occur at a distance of 2.5 cm to the main carina [13]. In one of the current series of patients with full-thickness tracheal rupture due to blunt trauma, the rupture site was just below the cricoid cartilage and the others were at the carina level. Primary malignant tumors of the trachea constitute 1-2% of respiratory system tumors [14]. Weber and Grillo reported that this rate is 75 times less than laryngeal cancers and 180 times less than bronchial cancers [15].

Of all primary tumors of the trachea, 50% are epidermoid carcinoma, and 35% are adenoid cystic carcinoma [5].

The pathology result of the patient who was operated on for tracheal tumor in our clinic was compatible with the second most common adenoid cystic carcinoma according to the literature.

Post-intubation tracheal stenosis is a condition that often occurs due to prolonged intubation or tracheostomy. Tracheal stenosis due to prolonged intubation is seen at the rate of 0.6%-21%. Stenosis is often seen in the tracheal body and subglottic region [16]. Subglottic stenosis occurs due to over-inflation of the endotracheal balloon within the cricoid cartilage or tracheal rings. The blood circulation and nutrition of the affected mucosa are impaired due to compression, and necrosis develops, which then causes the development of stenosis [17]. There was an intubation period of 14, 17, and 20 days postoperatively in the three patients with tracheal stenosis. The localisation of stenosis was in the upper third of the trachea in all three cases, and this location was consistent with the literature.

In conclusion, in tracheal pathologies, emergency intervention and / or the urgent transfer of the patient to a well-equipped center is vital, depending on the experience and available facilities. Therefore, early diagnosis, treatment, determination of the location and form of the pathology should be applied without any loss of time, extensive resection should be avoided as much as possible in surgical treatment, the surgical approach should be determined according to the shape of the pathology, and end-to-end anastomosis and / or primary repair should be preferred.

Riassunto

OBIETTIVO: Le patologie tracheali sono pericolose per tutte le età e possono portare alla morte se non trattate urgentemente. La nostra indagine ha come obiettivo quello di mostrare le patologie tracheali rare pericolose con la letteratura e i casi.
MATERIALE E METODO: Sono stati esaminati retroattivamente otto (8) casi che si sono sottoposti a un intervento chirurgico a causa delle loro patologie tracheali urgenti nella nostra clinica tra il 2013 e Novembre 2018. I pazienti sono stati esaminati in termini di età, genere, eziologia, sintomi, localizzazione della patologia, approccio chirurgico, tipo di cura e durata dell'ospedalizzazione.
RISULTATI: Il 4 (50%) dei casi con patologie tracheali ha avuto una frattura tracheale, 3 (37.5%) ha avuto una stenosi tracheale avendo una intubazione prolungata e un (12.5%) ha avuto un tumore tracheale. Due dei casi con frattura tracheale erano donne, due di loro erano uomini e l'età media era di 28.5 anni (16-48). Due dei casi con stenosi tracheale erano donne, uno di loro era uomo e l'età media era 29.3 anni (25-36). Il caso con tumore tracheale aveva 34 anni, non è stato possibile diagnosticarlo prima ed è stato diagnosticato in ritardo. Un caso con frattura carinale è morto a causa di una anticipata ipossia, morbilità e mortalità postoperatorie non sono state osservate in nessuno dei 7 (87.5%) casi che hanno subito una operazione chirurgica.
CONCLUSIONE: La risposta all'emergenza e la gestione del paziente sono di vitale importanza nelle patologie tracheali. Inoltre, la diagnosi precoce, la cura, la localizzazione e la determinazione della forma della patologia deve essere effettuata senza perdere tempo. La resezione ampia nel trattamento chirurgico deve essere evitato per quanto possibile e l'approccio chirurgico deve essere determinato sulla base della forma della patologia, anastomosi e/o chiusura primaria deve essere preferita se possibile.

References

1. Grillo HC, Donahue DM, Mathisen DJ, Wain JC, Wright CD: *Postintubation tracheal stenosis. Treatment and results*. J Thorac Cardiovasc Surg, 1995; 109:486-92.

2. Sağiroğlu G: *Analysis of 42 patients who underwent tracheal resection*. Dicle Medical Journal, 37(4), 375-81

3. Ernst A, Silvestri GA, Johnstone D: *Interventional pulmonary procedures: Guidelines from the american college of chest physicians.* Chest 2003; 123:1693-717.

4. Gaissert, HA, Grillo HC, Shadmehr MB, Wright, CD, Gokhale M, Wain JC, Mathisen DJ: *Long-term survival after resection of primary adenoid cystic and squamous cell carcinoma of the trachea and carina.* Ann Thorac Surg, 2004; 78(6), 1889-897.

5. Maziak DE, Todd TR, Keshavjee SH, Winton TL, Van Nostrand P, Pearson FG: *Adenoidcysticcarcinoma of theairway: Thirty-two-yearexperience.* J Thorac Cardiovasc Surg, 1996; 112:1522-31.

6. Grillo HC: *Tracheal and bronchial trauma.* In Grillo HC ed. *Surgery of the trachea and bronchi.* London BC Hamilton Inc, 2004: 271-90.

7. Altinok T, Can A: *Management of tracheobronchialinjuries*. Eurasian J Med, 2014; 46: 209-15.

8. Özdülger A: Trakeobronşiyal Yaralanmalar, TTD Toraks Cerrahisi Bülten, Cilt: 1 Sayi: 1 Ocak 2010.

9. Naghibi K, Hashemi SL, Sajedi P: *Anaesthetic management of tracheobronchial rupture following blunt chest trauma.* Acta Anaesthesiol Scand, 2003; 47: 901-03.

10. Hood RM: *Injury to the trachea and major bronchi.* In Hood, Boyd and Culliford eds. *Thoracic Trauma.* Philadelphia, W.B. Saunders Company; 1989: 245-66.

11. Miñambres E, Burón J, Ballesteros MA, Llorca j, Muñoz P, González-Castro A: *Tracheal rupture after endotracheal intubation: A literatüre systematic review*. Eur J Cardiothorac Surg, 2009; 35: 1056-62.

12. Ishibashi H, Ohta S, Hirose M, Akimoto T: *Blunttrachealtransectionandlongtear in posteriormembranoustrachea*. Eur J Cardiothorac Surg, 2006; 30:945-47.

13. Reece GP, Shatney CH: *Bluntinjuries of thecervicaltrachea: Review of 51 patients*. South Med J, 1988; 81:1542-48.

14. Grillo HC: *Primarytrachealtumours.* Thorax, 1993; 48:681-82.

15. Weber AL, Grillo HC: *Trachealtumors. A radiological, clinical, and pathological evaluation of 84 cases.* Radiol Clin North Am, 1978; 16:227-46.

16. Ulusan A, Sanli M, Isik F.A, Celik İ.A, Tuncozgur B, Elbeyli L: *Surgicaltreatment of postintubationtrachealstenosis: A retrospective 22-patient seriesfrom a singlecenter*. Asian Journal of Surgery, 2018; 41, 356-62 http://dx.doi.org/10.1016/j.asjsur.2017.03.001

17. Ercan S, Yüksel M: *Trakea cerrahisi.* In: Yüksel M, Kalayci G eds. Göğüs cerrahisi. İstanbul: Bilmedya Grup; 2001. s. 727-46