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Does duration of mechanical ventilation affect the resection length in benign tracheal stenosis?

Benign trakeal darlıkta mekanik ventilasyon süresi rezeksiyon uzunluğunu etkiler mi?

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ABSTRACT

Background: This study aims to investigate the relationship between duration of mechanical ventilation and length of resected segment in tracheal stenosis.

Methods: We retrospectively evaluated hospital records of 17 patients (14 males, 3 females; mean age 37.8 years; range 11 to 69 years) with tracheal stenosis who were performed surgical treatment in our clinic. We analyzed the patients according to age, gender, symptoms, treatment method, localization of stenosis, length of resected segment, duration of mechanical ventilation, time interval after extubation or decanulation, underlying disease, and complications of surgery. Patients were divided into two groups. Patients in group 1 (n=10) had intubation durations of less than 10 days and patients in group 2 (n=7) had intubation durations of more than 10 days. We investigated the relationship between duration of mechanical ventilation and length of resected tracheal segment statistically.

Results: Main symptom was severe dyspnea (n=17). We performed resection of stenotic tracheal segment and end-to-end anastomosis in all patients. Localizations of stenoses were regions of tube or cannula cuffs in all patients. The mean length of resection material in group 1 was 2.2 cm (range 1.4 to 3.1 cm) (n=10). This length was mean 3.5 cm (range 2.3 to 4.7 cm) in group 2 (n=7). The difference between groups 1 and 2 was statistically significant ($p<0.05$). Most frequent causes of mechanical ventilation were coronary artery disease (n=5) and trauma (n=5). We observed wound infection in two patients.

Conclusion: Early weaning from mechanical ventilation is the basic principal in reducing tracheal stenosis incidence and stenotic segment length.

Keywords: Endotracheal intubation; mechanical ventilation; tracheal stenosis; tracheotomy.

ÖZ

Amaç: Bu çalışmada, trakeal darlıkta mekanik ventilasyon süresi ve rezeke edilen segment uzunluğu arasındaki ilişki araştırıldı.

Çalışma planı: Kliniğimizde cerrahi tedavi uygulanan trakeal darlıklı 17 hastanın (14 erkek, 3 kadın; ort. yaş 37.8 yıl; dağılım 11-69 yıl) hastane kayıtları retrospektif olarak değerlendirildi. Hastalar yaş, cinsiyet, semptomlar, tedavi yöntemi, darlığın yeri, rezeke edilen segment uzunluğu, mekanik ventilasyon süresi, ekstübasyon veya dekanülasyondan sonraki zaman aralığı, altta yatan hastalık ve cerrahinin komplikasyonlarına göre incelendi. Hastalar iki gruba ayrıldı. Grup 1'deki hastaların (n=10) entübasyon süresi 10 günden daha az, grup 2'deki hastaların (n=7) entübasyon süresi 10 günden daha çok idi. Mekanik ventilasyon süresi ve rezeke edilen trakeal segment uzunluğu arasındaki ilişki istatistiksel olarak araştırıldı.

Bulgular: Ana semptom şiddetli dispne idi (n=17). Tüm hastalara daralmış trakea segmentinin rezeksiyonu ve uç-uca anastomoz uygulandı. Hastaların hepsinde darlıkların yerleşim yerleri tüp veya kanül kaf bölgeleri idi. Grup 1'de rezeksiyon materyalinin ortalama uzunluğu 2.2 cm idi (dağılım 1.43-3.1 cm) (n=10). Grup 2'de bu uzunluk ortalama 3.5 cm idi (dağılım 2.3-4.7 cm) (n=7). Grup 1 ve 2 arasındaki farklılık istatistiksel olarak anlamlı idi ($p<0.05$). En sık mekanik ventilasyon nedenleri koroner arter hastalığı (n=5) ve travma idi (n=5). İki hastada yara yeri enfeksiyonu görüldü.

Sonuç: Trakeal darlık insidansını ve daralmış segment uzunluğunu azaltmada mekanik ventilasyondan erken ayırma temel prensiptir.

Anahtar sözcükler: Endotrakeal entübasyon; mekanik ventilasyon; trakeal darlık; trakeotomi.

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Benign tracheal stenosis usually occurs as a complication of endotracheal intubation and tracheotomy.[1,2] Although this is a benign condition, clinical picture related to airway stenosis may be frightening. The location and length of stenosis show differences among cases, but symptoms and findings are similar in nearly all patients. The management of benign tracheal stenosis include invasive and non-invasive methods. Nevertheless, standard treatment regime is resection of stenotic area in fit patients.[3] Although the relationship between the incidence of tracheal stenosis and prolonged intubation is well-known, to our knowledge, the linkage between the length of stenotic segment and intubation duration has not been reported yet. In this study, we aimed to investigate the relationship between duration of mechanical ventilation and length of resected segment in tracheal stenosis.

PATIENTS AND METHODS

We retrospectively evaluated the hospital records of 17 patients (14 males, 3 females; mean age 37.8 years; range 11 to 69 years) who underwent surgery because of tracheal stenosis due to endotracheal intubation or tracheotomy at Medical Faculty of Atatürk University between January 2000 and March 2015. We analyzed records of these patients according to age, gender, symptoms, therapeutic option, localization of stenosis, length of resected segment, duration of mechanical ventilation, time interval after extubation or decanulation, underlying disease, and complications of surgery. Before resection, rigid bronchoscopy and dilatation were performed at least once in all patients (mean 2.02 times, range 1 to 7 times) (Figure 1). Resection of stenotic tracheal segment and end-to-end anastomosis were performed in all patients. After cutting of the distal portion of stenotic segment, anesthesiologists withdrew the intubation tube and we inserted a sterile intubation tube into distal trachea (Figure 2). Then, we cut the upper border of stenotic area. When we reached the stenosis, we cut the trachea again until we accessed the non-stenotic segment (Figure 3, 4). After completion of tracheal resection, we continuously sutured the membranous part of trachea with 3/0 or 4/0 absorbable polydioxanone suture material and in cartilaginous part, we performed interrupted suturing with the same suture material (Figure 5, 6). The patients were divided into two groups according to duration of mechanical ventilation. Patients in group 1 (n=10) had intubation durations of less than 10 days and patients in group 2 (n=7) had intubation durations of more than 10 days. Then, we investigated the relationship between duration of mechanical ventilation and length of resected tracheal segment statistically. The study protocol was approved by the Medical Faculty of Atatürk University Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical analysis

Statistical analysis was performed using IBM, SPSS software package version 20.0 (IBM Corporation, Armonk, NY, USA). Student's t-test was used as the hypothesis test and p values less than 0.05 were considered statistically significant.

RESULTS

Main symptom was severe dyspnea (n=17, 100%). Other symptoms were wheezing (n=7, 41.4%) and

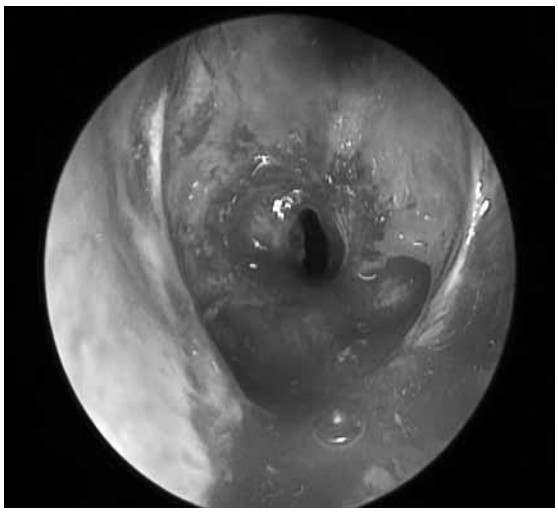

Figure 1. Bronchoscopic imaging of tracheal stenosis.

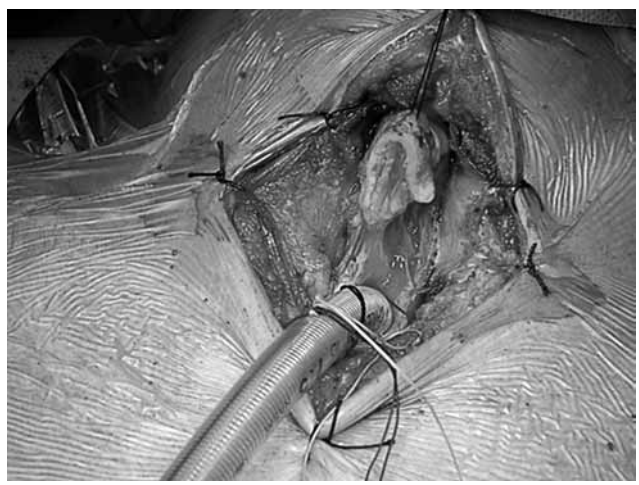

Figure 2. Cutting of distal portion of stenotic segment and insertion of intubation into distal trachea.

Figure 3. Cutting of proximal site. Double incision was performed to access non-stenotic segment.

Figure 4. Imaging of trachea after total removal of stenotic segment.

cough (n=5, 29.4%). Most prominent physical findings were stridor (n=17, 100%), intercostal retraction (n=11, 64.7%), and facial sweating (n=3, 17.6%). Localizations of stenoses were regions of tube or cannula cuffs in all patients. Chest radiographs and axial computed tomography (CT) sections were taken in all patients for evaluation of the stenotic segments and peristenotic soft tissues. Three dimensional CT (3D-CT) was not performed routinely and the lengths of stenosis were calculated by bronchoscopy before surgery. Three patients had undergone tracheotomy in group 2 and tracheotomy was performed after the 15th day of mechanical ventilation in these patients because of prolonged mechanical ventilation. Mean mechanical ventilation durations in groups 1 and 2 were 6.2 days (range 3 to 9 days) and 19.9 days (range 13 to 32 days), respectively. Mean lengths of resection material in groups 1 and 2 were 2.2 cm (range 1.4 to 3.1 cm) and 3.5 cm (range 2.3 to 4.7 cm), respectively. The difference between groups 1 and 2 was statistically significant (p=0.002). Mean time interval between extubation or decannulation and surgery was 6.1 months (range 1 to 48 months). Causes of mechanical ventilation were coronary artery disease (n=5, 29.4%), trauma (n=5, 29.4%), pneumonia (n=2, 11.8%), post-surgical respiratory failure (n=2, 11.8%), adult respiratory distress syndrome (n=1, 5.9%), drug intoxication (n=1, 5.9%), and chronic obstructive pulmonary disease (n=1, 5.9%). Two patients had wound infection and were treated with topical treatment.

Figure 5. Continuation suturing of membranous part with 3/0 polydioxanone suture.

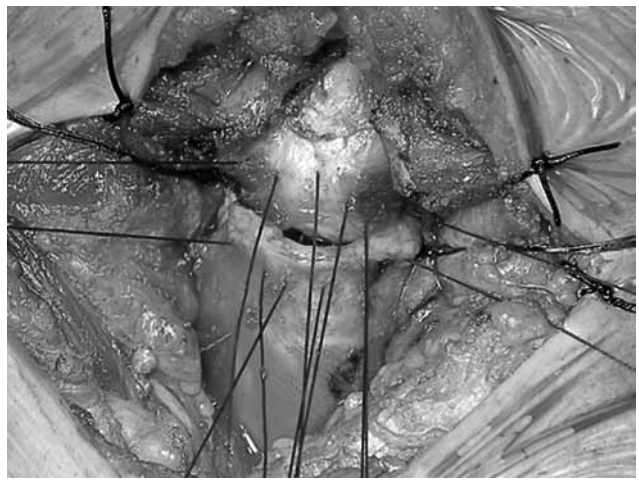

Figure 6. Interrupted suturing of cartilaginous trachea with 3/0 polydioxanone suture.

DISCUSSION

The most common cause of benign tracheal stenosis is mechanical ventilation by endotracheal intubation and tracheotomy.[4] This benign condition is usually seen between the third and fourth decade of life and more commonly occurs in males.[5,6] The incidences of tracheal stenosis related to tracheotomy and endotracheal intubation are between 0.6 to 21% in the literature.[7,8] However, recently, reports showed that its incidence decreased to 6% due to improvement of mechanical ventilation equipments.[9] Nevertheless, despite all technological developments in intensive care units, tracheal stenosis related to mechanical ventilation is still on the agenda of thoracic surgeons.

Although the most common localization of stenosis related to endotracheal tubes is the cuff site, regions of stenosis related to tracheotomy may be different such as site of cannula cuff, stoma, or superior and inferior of stoma.[10] Ischemic injury due to cuff pressure is the main etiological factor in this benign condition. Stenosis might be seen after a series of consecutive processes: local infection may be superimposed on the damaged endotracheal surface and perichondritis may occur in tracheal cartilage, then fibroblastic activity accelerates in this area, and finally scar tissues and stenosis occur in traumatic area.[10] Steroids and antibiotics are helpful in reducing granulation and fibrosis.[10]

The gold standard in diagnosis of tracheal stenosis is bronchoscopy.[11,12] Fiberoptic bronchoscopy may be the first option in elective patients but rigid bronchoscopy should be preferred in cases with respiratory distress. Virtual bronchoscopy, plain radiographs, magnetic resonance imaging, conventional and 3D-CT are helpful in diagnosis. Particularly, 3D-CT can determine the length of stenotic segment in preoperative period and treatment can be planned according to the findings of this imaging. The best imaging technique in tracheal disease is CT and its sensitivity is approximately 97% in main airways pathologies.[13] Tracheal lumen smaller than 2 cm is a typical finding of stenosis in CT in adults.[13] Nevertheless, the sensitivity of virtual bronchoscopy was reported to be between 63% and 100% in the literature and superiority of this technique against bronchoscopy is its being a non-invasive method.[14] We conducted rigid bronchoscopy as the first choice in our patients since bronchoscopic dilatation was performed in all patients before surgery. Principal imaging methods in our study were plain radiographs, conventional/3D-CT, and virtual bronchoscopy.

Bronchoscopy is a therapeutic method in certain cases with mild symptoms and small stenotic segment.[3] The success rate of bronchoscopic dilatation in these patients was reported as approximately 72% in the literature.[3] Other treatment modalities are surgical resection, balloon dilatation, tracheal T-tube, various lasers, and stents.[10,15-17]

Although several techniques, such as mentioned above, have been described in the management of tracheal stenosis related to intubation, principal approach is resection of affected tracheal segment and end-to-end anastomosis. Success rate of resection was reported to be between 74% and 96% in the literature.[7,18-20] Length of stenotic segment differs in patients according to use of endotracheal tube or tracheotomy cannula. Stenosis related to intubation tube is usually greater than cannula stenosis.[21] Many studies have reported the relationship between prolonged intubation and frequency of tracheal stenosis; however, to our knowledge, no study has been conducted showing the relationship between intubation duration and stenotic segment length in the literature. According to the literature findings, the most important factor affecting resection length is the number of stenotic areas.[22] Particularly in patients with tracheotomy, stenotic areas in stoma and cuff site may be present and long segment resection may be required. In this situation, separate resection per each stenosis is recommended to avoid excessive resection.[7] Nevertheless, in our study, we found a significant relationship between intubation duration and length of resected tracheal segment and the difference between the two groups was statistically significant ($p<0.05$). We believe that the probable cause of this difference is displacement of cuff throughout prolonged mechanical ventilation leading to increase in tracheal segment length exposed to pressure.

There are many factors that affect the clinical outcome of a patient in mechanical ventilation. The most important factor in weaning from mechanical ventilation is effective treatment of underlying disease. Nevertheless, whatever the cause of artificial ventilation, careful and regular respiratory care is a sine qua non. Also, pulmonary hygiene is a basic principal for respiratory care in intensive care units. Periodical suction of secretions, postural drainage, effective antibiotherapy, sufficient hydration and mucolytics are needed for pulmonary hygiene. Furthermore, frequent check of cuff pressure, intermittent deflation of intubation tube or tracheotomy cannula cuff, stabilization and immobilization of tube or cannula in same tracheal level are other principals in respiratory

care and these precautions must be taken to reduce the incidence of tracheal stenosis. In fact, as mentioned above, the epicenters in relationship between long stenotic tracheal segment and prolonged mechanical ventilation are frequent displacement or movement of tube and cannula throughout the tracheal lumen during long ventilation period and reoccurrence of progressive process from cuff necrosis to stenosis in different tracheal segments at every turn.

Complications of tracheal resection include restenosis, aspiration pneumonia, cervicomediastinal sepsis, rupture of innominate artery, suture dehiscence, and recurrent laryngeal nerve paralysis.[1,16,23] Anastomotic dehiscence is one of the most severe complications in early period.[24] If in late period, the most alarming case is restenosis of which its incidence was reported to be between 10.5% and 14%.[1,24] Factors that increase the incidence of restenosis are stenosis in subglottic area, long stenotic segment, and anastomosis stress. Furthermore, excessive releasing of trachea and use of non-absorbable suture materials may increase the complication rate.[8,24] Additionally, inappropriate suturing technique may accelerate the granulation tissue formation after tracheal resection.[25] In our study, wound infection occurred in two patients, while restenosis or suture dehiscence did not develop. We believe that the causes for this low complication rate are use of absorbable suture materials, the suture technique we performed, and our avoidance of excessive tracheal dissection.

The limitations of this study are its retrospective design and single-centre site.

Although the incidence of tracheal stenosis related to intubation and tracheotomy decreased when compared to previous years, it seems to remain on the agenda of thoracic surgeons and anesthesiologists. Basic principles in reducing its incidence are using modern mechanical ventilation equipment and weaning from mechanical ventilation as early as possible. Simple resection of stenotic tracheal segment and end-to-end anastomosis may be performed with low complication rates in suitable patients. Nevertheless, studies with larger sample sizes are needed to shed more light on the relationship between duration of mechanical ventilation and resection length.

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REFERENCES

1. Nakache G, Primov-Fever A, Alon EE, Wolf M. Predicting outcome in tracheal and cricotracheal segmental resection. Eur Arch Otorhinolaryngol 2015;272:1471-5.
2. Altuntas B, Subası M, Türktarhan ZP, Kaba E, Cinici O. Tracheal stenosis related to prolonged intubation. Selcuk Tıp Derg 2013;29:190-1.
3. Oh SK, Park KN, Lee SW. Long-term results of endoscopic dilatation for tracheal and subglottic stenosis. Clin Exp Otorhinolaryngol 2014;7:324-8.
4. Pookamala S, Kumar R, Thakar A, Venkata Karthikeyan C, Bhalla AS, Deka RC. Laryngotracheal stenosis: clinical profile, surgical management and outcome. Indian J Otolaryngol Head Neck Surg 2014;66:198-202.
5. Cherian TA, Rupa V, Raman R. External laryngeal trauma: analysis of thirty cases. J Laryngol Otol 1993;107:920-3.
6. Yen PT, Lee HY, Tsai MH, Chan ST, Huang TS. Clinical analysis of external laryngeal trauma. J Laryngol Otol 1994;108:221-5.
7. Sarper A, Ayten A, Eser I, Ozbudak O, Demircan A. Tracheal stenosis aftertracheostomy or intubation: review with special regard to cause and management. Tex Heart Inst J 2005;32:154-8.
8. Merati AL, Rieder AA, Patel N, Park DL, Girod D. Does successful segmental tracheal resection require releasing maneuvers? Otolaryngol Head Neck Surg 2005;133:372-6.
9. Ahn HY, Su Cho J, Kim YD, I H. Surgical outcomes of post intubational or post tracheostomy tracheal stenosis: report of 18 cases in single institution. Ann Thorac Cardiovasc Surg 2015;21:14-7.
10. Nair S, Mohan S, Mandal G, Nilakantan A. Tracheal stenosis: our experience at a tertiary care centre in India with special regard to cause and management. Indian J Otolaryngol Head Neck Surg 2014;66:51-6.
11. Türkyılmaz A, Aydın Y, Ermancık M, Erdem AF, Eroglu A. The treatment of postintubation tracheal stenosis. EAJM 2007;39:189-93.
12. Dollner R, Verch M, Schweiger P, Deluigi C, Graf B, Wallner F. Laryngotracheoscopic findings in long-term follow-up after Griggs tracheostomy. Chest 2002;122:206-12.
13. Acar T, Bayraktaroglu S, Ceylan N, Savas R. Computed tomography findings of tracheobronchial system diseases: a pictorial essay. Jpn J Radiol 2015;33:51-8.
14. Morshed K, Trojanowska A, Szymanski M, Trojanowski P, Szymanska A, Smolen A, et al. Evaluation of tracheal stenosis: comparison between computed tomography virtual tracheobronchoscopy with multiplanar reformatting, flexible tracheofiberoscopy and intra-operative findings. Eur Arch Otorhinolaryngol 2011;268:591-7.
15. Whitehead E, Salam MA. Use of the carbon dioxide laser with the Montgomery T-tube in the management of extensive subglottic stenosis. J Laryngol Otol 1992;106:829-31.
16. Brichet A, Verkindre C, Dupont J, Carlier ML, Darras J, Wurtz A, et al. Multidisciplinary approach to management of postintubation tracheal stenoses. Eur Respir J 1999;13:888-93.
17. Bolliger CT, Probst R, Tschopp K, Solèr M,

Perruchoud AP. Silicone stents in the management of inoperable tracheobronchial stenoses. Indications and limitations. Chest. 1993;104:1653-9.

18. Rubikas R, Matukaityte I, Jelisiejevas JJ, Rackauskas M. Surgical treatment of non-malignant laryngotracheal stenosis. Eur Arch Otorhinolaryngol 2014;271:2481-7.
19. Keshavjee S. 50th Anniversary Landmark Commentary on Pearson FG, Andrews MJ. Detection and management of tracheal stenosis following cuffed tube tracheostomy. Ann Thorac Surg 1971;12:359-74.
20. Grillo HC, Donahue DM, Mathisen DJ, Wain JC, Wright CD. Postintubation tracheal stenosis. Treatment and results. J Thorac Cardiovasc Surg 1995;109:486-92.
21. Zias N, Chroneou A, Tabba MK, Gonzalez AV, Gray AW, Lamb CR, et al. Post tracheostomy and post intubation tracheal stenosis: report of 31 cases and review of the literature. BMC Pulm Med 2008;8:18.
22. Couraud L, Jougon JB, Velly JF. Surgical treatment of nontumoral stenoses of the upper airway. Ann Thorac Surg 1995;60:250-9.
23. Bisson A, Bonnette P, el Kadi NB, Leroy M, Colchen A, Personne C, et al. Tracheal sleeve resection for iatrogenic stenoses (subglottic laryngeal and tracheal). J Thorac Cardiovasc Surg 1992;104:882-7.
24. Friedel G, Kyriss T, Leitenberger A, Toomes H. Long-term results after 110 tracheal resections. Ger Med Sci 2003;1:10.
25. Bagheri R, Majidi M, Khadivi E, attar AS, Tabari A. Outcome of surgical treatment for proximal long segment post intubation tracheal stenosis. J Cardiothorac Surg 2013;8:35.