

# Radiofrequency Surgery and Balloon Dilation for Chronic Stenosis of the Larynx and Trachea in Children

R. U. Djuraev, H. E. Karabaev, F. B. Nurmukhamedova, Z. D. Egamberdieva

Tashkent Pediatric Medical Institute, Tashkent, Uzbekistan

**Abstract Background:** Laryngeal and tracheal stenosis pose complex challenges in pediatric otolaryngology, often necessitating surgical intervention. The choice of treatment approach is critical, as it directly impacts patient recovery and the duration of treatment. Scar-related stenosis in the larynx and trachea, often resulting from factors like prolonged intubation or surgical procedures, is a prevalent concern in pediatric patients. This study explores the efficacy of minimally invasive treatment options, such as endoscopic, microsurgical scar tissue incision, and balloon dilation, for these patients. **Methods:** A total of 34 pediatric patients with chronic non-neoplastic laryngeal and tracheal stenosis were treated using radiofrequency surgery or balloon dilation. Patient assessment included endoscopic examinations, radiographic tomography, evaluation of respiratory function, and imaging studies. Patients were divided into two groups based on the duration of intubation, mechanical ventilation, or tracheotomy. Surgical interventions were performed under general anesthesia, and postoperative monitoring occurred for 7-14 days. **Results:** The primary group, treated with radiofrequency surgery, achieved a success rate of 94.5%, with no recurrent granulation growth. In contrast, the second group, treated with balloon dilation, exhibited a success rate of 65%. Recurrence occurred in 60% of the first group. Notably, patients in the second group experienced no complications, except for one patient, likely due to the large balloon diameter in proportion to the small laryngeal size. **Conclusion:** Isolated, limited scar stenosis of the larynx and trachea, up to 1 cm long, with preserved cartilaginous structures, can be effectively managed using minimally invasive techniques. Combining these methods streamlines surgical treatment stages, facilitating patient rehabilitation in a single reconstructive therapy phase. These methods offer a shorter hospital stay, prevent tracheostomy in systemically compromised patients, and significantly improve treatment outcomes for this patient category. Minimally invasive techniques are valuable for managing pediatric laryngeal and tracheal stenosis.

**Keywords** Radiofrequency surgery, Balloon dilation, Tracheal stenosis, Laryngeal stenosis

## 1. Introduction

Laryngeal and tracheal stenosis continues to be a relevant issue in otolaryngology. The choice of surgical approach is complex and critical, as the patient's recovery and the duration of treatment depend on the decision. The primary goal of treatment is to restore the function of the hollow structures of the neck, with extubation of the patient being the ultimate stage. Stenosis of the trachea and larynx is a leading cause of airway obstruction in pediatric patients. Correcting such anomalies remains challenging due to anatomical peculiarities in the pediatric population. Various surgical options are proposed for treatment, ranging from invasive surgery to open procedures such as laryngeal reconstruction and cricotracheotomy [1] [2] [3]. With advances in pediatric intensive care and neonatology, the number of children with scar-related laryngeal stenosis has increased [4] [5].

For a long time, open laryngotracheal plastic surgery was

the primary treatment approach for scar-related laryngeal stenosis. Balloon dilation has been introduced to treat immature and mild post-intubation airway stenosis [5]. Among all cases of laryngeal and tracheal stenosis, the proportion of post-resuscitation stenosis, according to various authors, ranges from 50 to 90% [6].

The treatment of non-neoplastic laryngeal and tracheal stenosis is a challenging task due to the nuances of surgical technique and access, the complexity and risks of anesthesia support, and the tendency of the disease to recur despite its "benign" nature. In the vast majority of cases, these stenoses are scar-related and result from some form of injury to the larynx and trachea, including iatrogenic causes (prolonged intubation, surgical interventions on the larynx and trachea) [7] [8].

Children with airway stenosis have represented a significant clinical challenge throughout the history of otolaryngology and head and neck surgery. In recent decades, due to advances in neonatology and cardiac surgery, the number of surviving children with congenital developmental anomalies who have undergone significant surgical treatment and prolonged ventilatory support has increased, leading to the

development of upper airway stenosis [10]. Consequently, the number of children needing to restore the patency of their natural airways has significantly increased [8].

**Objective of the Study:** To evaluate the results of endoscopic surgical interventions using radiofrequency and balloon dilation in non-neoplastic laryngeal and tracheal stenosis in children.

## 2. Materials and Methods

The research was conducted at the Department of Otolaryngology, Pediatric Otolaryngology, and Pediatric Dentistry in TashPMI Clinic from 2020 to December 2022 to investigate the potential applications of radiofrequency surgery and balloon dilation for the treatment of laryngeal and tracheal stenosis in pediatric patients. A total of 34 children diagnosed with chronic non-neoplastic laryngeal and tracheal stenosis were treated with these techniques during this period.

Patient evaluations involved a comprehensive assessment, including endoscopic examinations of the larynx and trachea, radiographic tomography, the measurement of external respiratory function parameters, and both computed tomography and magnetic resonance imaging. Patients were divided into two groups based on the time that had passed since their initial intubation, mechanical ventilation, or tracheotomy.

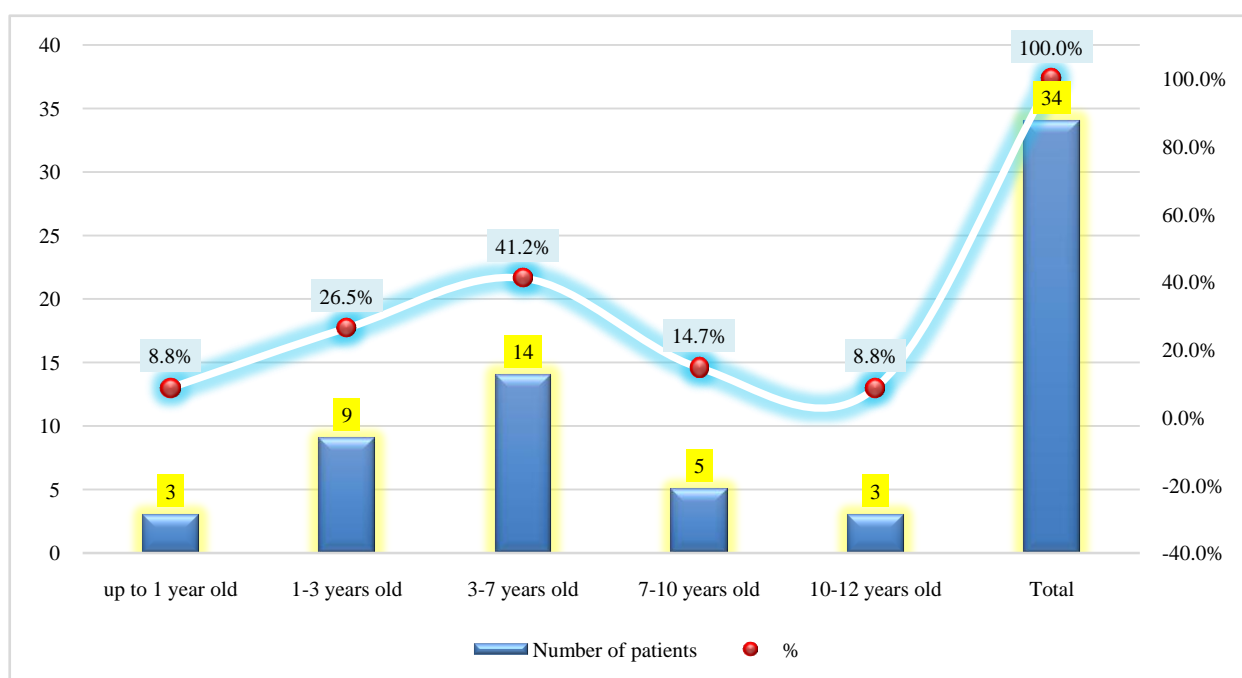
The first group consisted of 16 patients who received treatment in the intensive care units at TashPMI and underwent radiofrequency surgery. The second group included 18 patients

who had a history of intubation, mechanical ventilation, and tracheotomy for one month or longer. For this group, balloon dilation was chosen as the treatment modality.

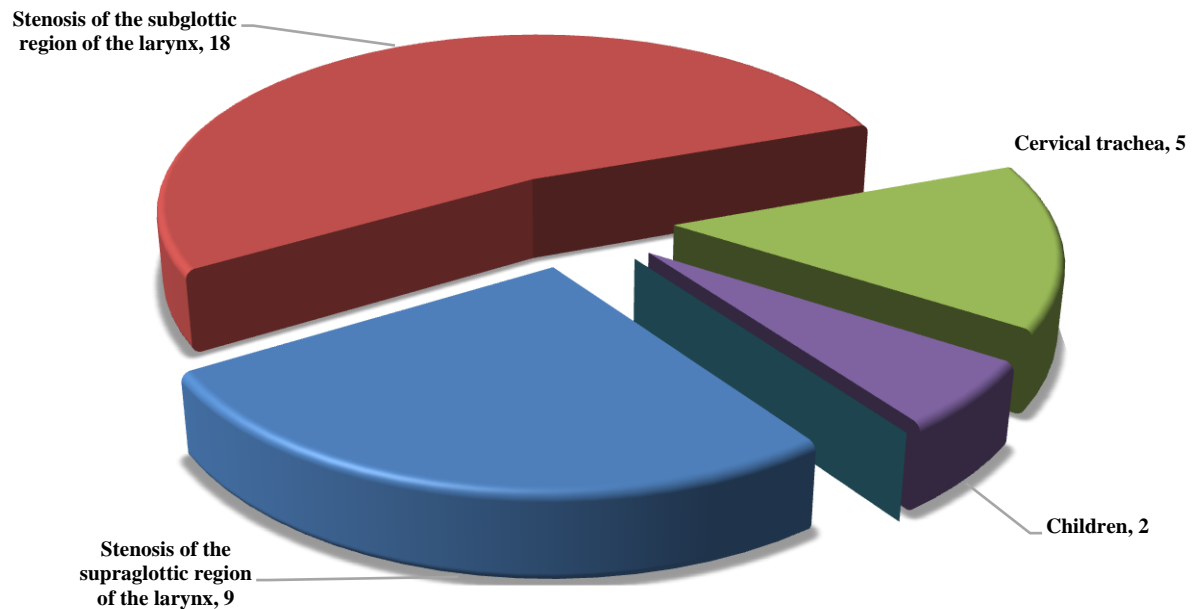
## 3. Results

The patient population was stratified by age as follows. The age distribution of the observed patients ( $n = 34$ ) included the following age groups: under one year - 3 children (8.8%), 1-3 years - 9 children (26.4%), 3-7 years - 14 children (41.1%), 7-10 years - 5 children (14.7%), and 10-14 years - 3 children (8.8%). From the presented information, it is evident that the majority of patients fell within the age range of 3-7 years (see Figure 1).

Based on the degree of stenosis, we categorized the children according to the Cotton-Myer classification. Stenosis was located in the larynx and the upper third of the trachea in 22 patients, with 2nd-degree stenosis observed in 22 cases and 3rd-degree in 12 cases. This distribution represents the 2nd and 3rd degrees, with 2nd-degree stenosis present in 64% of cases and 3rd-degree stenosis in 35%. The average age at the time of the operation was seven years and four months, with the youngest patient being eight months old and the oldest 14 years. Furthermore, patients were categorized by the location of stenosis, with nine children having supraglottic stenosis and 18 having subglottic stenosis. In the cervical section of the trachea, stenosis due to the proliferation of granulation tissue was detected in 5 children. In contrast, in the thoracic section, it was observed in 2 children (see Figure 2).



**Figure 1.** Demographic Characteristics of Patients with Laryngeal and Tracheal Stenosis



**Figure 2.** Distribution of Patients by Stenosis Location

During endoscopic examinations, pathological changes characterized by dense granulation and scar tissue were identified. The extent of stenosis was measured using rigid or flexible endoscopes, as well as data from computed tomography. Based on preoperative assessments of external respiratory function, peak expiratory flow rates ranged from 0.5 to 2.2 liters per second, with an average of  $2 \pm 1.8$  liters per second (representing  $20 \pm 18.5\%$  of expected values for gender, age, and body mass index). Nearly 3/4 of the children had previously undergone surgical treatment for laryngotracheal stenosis, with 2/3 of them having undergone multiple procedures. At the time of admission, 1/3 of the children were decannulated. All surgeries were performed under general anesthesia with muscle relaxation. Induction of lung ventilation was accomplished either through the use of a metal insufflator passed via an operative laryngoscope or through a tracheostomy (if present). Surgical treatment was conducted using a radiofrequency knife for half of the patients in the main subgroup. The surgical intervention was performed once, and patients were monitored for 7-14 days post-surgery, during which no recurrent growth of granulations and soft tissue formations was observed. All patients were gradually decannulated in the intensive care unit. In 18 (30%) patients in the main subgroup, traditional methods were utilized. For the second group, a balloon for airway dilation was introduced into the narrowing segment and filled with physiological saline to a pressure of 8-10 atmospheres. The balloon was positioned so that its center aligned precisely with the segment of maximal laryngeal or tracheal constriction, thus preventing the balloon from

slipping proximally or distally during saline inflation. Dilation of the stenotic segment was performed under apnea conditions 2-3 times for 1.0 minutes each.

In the postoperative period, the first group exhibited a 60% success rate, with some cases experiencing recurrences, while all patients in the second group had uneventful recoveries except for one. We attribute this outcome to the relatively small size of the larynx, for which an 8mm diameter balloon was too large. The surgical intervention's efficacy in the main patient group was 94.5%. The proportion of decannulated patients following endoscopic treatment of laryngotracheal stenosis was 33%, whereas after balloon dilation, it was 65%.

Surgical treatment under local anesthesia using flexible endoscopic techniques is recommended for limited, uncomplicated scar stenosis of the larynx and trachea with a length of up to 5 mm (membranous stenosis) and a preserved lumen of more than 5 mm. Contact laser incision of scar tissue is a more promising method, as compared to remote destruction; it causes relatively less thermal damage to the surrounding wound tissues, leading to wound healing without significant scarring.

## 4. Conclusions

Isolated, limited scar stenosis of the larynx and trachea, with a length not exceeding 1 cm, and the preservation of cartilaginous structures, regardless of the lumen diameter, represents an indication for minimally invasive treatment methods. These methods include endoscopic, microsurgical

scar tissue incision, and balloon dilation. These techniques facilitate the rehabilitation of patients within a short duration of hospitalization, prevent the need for tracheostomy in patients with systemic pathologies, and significantly enhance the effectiveness of treatment for this patient category. The streamlining of surgical treatment stages by combining them allows for the rehabilitation of patients in a single stage of reconstructive therapy.

## REFERENCES

- [1] Kirasirova EA, Frolkina EA, Rybalchenko IE, Tyutina SI. Correction of chronic respiratory insufficiency in scar-related laryngeal and tracheal stenosis using a helium-oxygen mixture. *Vestn Otorinolaringol.* 2022; 87(4): 63-70. doi:10.17116/otorino20228704163.
- [2] Mesolella M, Di Lullo AM, Testa D, Salerno G, Salzano FA, Motta G. The CO2 laser in treating laryngeal and tracheal stenosis: Our personal experiences. *Ann Ital Chir.* 2020; 91: 239-247.
- [3] Perryman MC, Kraft SM, Kavookjian HL. Laryngotracheal reconstruction for subglottic and tracheal stenosis. *Otolaryngol Clin North Am.* 2023; 56(4): 769-778. doi:10.1016/j.otc.2023.04.018.
- [4] Zakharova ML, Pavlov PV. Endoscopic laryngotracheoplasty with balloon dilation in treating congenital and acquired chronic laryngeal stenosis in children. *Russian Otorhinolaryngology.* 2016; 82(3): 70–75.
- [5] Kornievsky LA. Characteristics of patients with perinatal scar-related laryngeal stenosis treated with balloon dilation. 2018; 1: 65–68.
- [6] Zenger VG. Prevent tracheal scar stenosis in patients undergoing prolonged artificial lung ventilation or tracheostomy. In: *Proceedings of the Russian Scientific-Practical Conference on the Prevention, Diagnosis, and Treatment of Tracheal Scar Stenosis.* Moscow, 1999. p. 20.
- [7] Nouraei S, Ma E, Patel A, Howard D, Sandhu G. Estimating the population incidence of adult post-intubation laryngotracheal stenosis. *Clinical Otolaryngology.* 2007; 32(5): 411-412. doi:10.1111/j.1749-4486.2007.01484.x.
- [8] Zakharova ML, Pavlov PV. Endoscopic laryngeal tracheoplasty with balloon dilation in managing congenital and acquired chronic laryngeal stenosis in children. doi:10.18692/1810-4800-2016-3-70-75.
- [9] Salomov KM, Amonov SE, Rasulova NA, Djabbarova DR, Adullaev HN, Nurmukhamedova FB. Laryngeal ultrasound features in dysphonia diagnosis. *Bull Env Pharmacol Life Sci.* 2023; 12(4): 105-110.
- [10] Mizuno K, Kanazawa Y, Takeuchi M, Kishimoto Y, Kawakami K, Omori K. Indications and postoperative outcomes of surgery for laryngotracheal stenosis: A descriptive study. *Auris Nasus Larynx.* 2021; 48(1): 110-115. doi:10.1016/j.anl.2020.06.011.