In cases of tracheal stenosis, tracheal resection and anastomosis is widely accepted as the procedure of choice. It has excellent results, reported in many large series. When the subglottis is involved, surgical treatment is more difficult and complex laryngotracheal techniques are necessary.

Usually acquired subglottic stenosis is secondary to localized trauma to subglottic structures. Approximately 90% of all cases of acquired chronic subglottic stenosis in children and adults result from endotracheal intubation. The reported rate of stenosis following intubation ranges from 0.9-8.3%. Duration of intubation is the most important factor in the development of stenosis. A 7-10 day period of ICU intubation is acceptable, but the risk of laryngotracheal injury increases drastically after that. Stenosis could also be secondary to foreign body, infection, inflammation, or chemical irritation. Respiratory epithelium is susceptible to injury. Initial edema, vascular congestion, and acute inflammation can progress to ulceration and local infection with growth of granulation tissue. Finally, fibroblast proliferation, scar formation, and contracture can occur and also cause stenosis.

Subglottic stenosis is classified as follows:
- Grade 1: < 50% luminal obstruction.
- Grade 2: 50-70% luminal obstruction.
- Grade 3: 71-99% luminal obstruction.
- Grade 4: complete luminal obstruction.

Our aim was to discuss the indications for laryngotracheal surgery, provide step-by-step explanation of the technique and share our results in cases with benign tracheal stenosis.

**Material and methods**

We studied 23 patients (17 male and 6 female), with average age of 46.7 (SD±14.7, min 18, max 74), who had benign tracheal stenosis, usually after intubation or tracheotomy. 2 of them already had end to end tracheal anastomosis.

The main clinical symptoms were:
- dyspnea (n = 23, 100%);
- cough (n=19, 82.6%);
- stridor (n=14, 60.9%);
- recurrent infections - usually postobstructive and below the stenosis (n=10, 43.5%);
- comorbidity (n=16, 69.6%).

All patients had endoscopic evidence for stenosis longer than 1 cm. It was located in the upper third of the trachea and affected the subglottic space in 9 cases. In 8 cases it was in the upper tracheal third, not affecting the subglottic space, in 6 - in the middle third. All patients were with grade 2 and 3.

**Surgical technique**

The length and size of the T-tube depended on the location and diameter of the trachea. After anesthesia, a longitudinal incision was performed over the posterior midline of neck upward or downward depending on the obstructed site. After mobilizing the stenotic trachea, we made longitudinal extension of the tracheotomy from the pre-existing tracheostomy or newly created tracheal stoma to the distal part of the narrowest trachea. At the same time, the granulation tissue in the trachea was debrided and resected. We then stopped the ventilation and removed the endotracheal tube under adequate monitoring. The T-tube was inserted into the trachea and its position was checked by fibrobronchoscopy. The postoperative management included prophylactic antibiotics for one week nebulization inhalation and airway hygiene every 4 to 6 hours for 2 weeks. After discharge, the cleaning procedure with cotton tip applicators dipped in normal saline was performed 3 times a day, or more often if necessary, to dislodge tenacious mucus and crusts. In addition, the skin around the stoma was treated with antibiotic ointment at least 3 or 4 times a day.

The horizontal limbs of the T-tube were plugged, if possible, as soon as the patient has recovered from ventilation anesthesia to maintain the normal humidification and phonation. The fiberobronchoscopy was performed under local anesthesia every month to check the T-tube condition and clean the tracheal airway. The T-tube was removed after 11-18 months under local anesthesia.

**Discussion**

Endoscopic approach has decreased morbidity and shortened hospital stay. The refinements in microlaryngeal instruments, rigid telescopes, imaging, and CO2 laser mean many laryngeal lesions facilitate it. Success rate is between 40 and 70%. The most frequent cause of failure is scar formation and restenosis. For cases not suitable for endoscopic surgery Maddaus et al. described a technique of laryngotracheal reconstruction indicated for stenosis close to the vocal cords (less than 5 mm) where their function is not compromised. Once the anterior cricoid arch is removed, the thyroid cartilage must be incised vertically in the midline to protect the vocal cords. Afterward, the affected mucosa is removed by incising the upper limit of the stenosis with the scalpel. The posterior cricoid plate can be then resurfaced by a membranous flap tailored from the distal tracheal stump.

A different technique has been described by Couraud. This is generally indicated for stenosis with current involvement of the glottis and compromised vocal cord function or in case of larynx cartilages damage by previous procedures (laser, cartilageotomies, Montgomery T-tube, surgery).

In this operation after laryngofissure, the cricoid plate is incised and divided at the midline. Free cartilage or bone graft can be interposed to enlarge the larynx lumen. The use of these techniques is more frequent in the pediatric population. The Montgomery stent is soft and can be left in place for >12 months. Its main advantage is that the patient can speak. Looking at literature data, there is general conviction that good functional outcome can be obtained with bronchoscopic treatment of benign stenosis if the indication is restricted to tracheal disease excluding subglottic location. Therefore, at present these techniques are mainly employed to stabilize the stenosis before surgery or to achieve an acceptable palliation in patients who are not suitable for surgery. Temporary Montgomery T-tube and tracheostomy have been considered the only possible alternatives to surgery for a long time. However, these options have the disadvantage of potentially increasing the extent of the tracheal stricture and of favoring bacterial colonization. These two problems may be particularly detrimental for patients who are likely to be reconsidered for surgery thanks to improved general and/or local conditions.

**Conclusions**

Treatment of tracheal stenosis, especially when located in the subglottic region is a major therapeutic challenge. In experienced hands the gold standard is reconstruction with temporary laryngotracheal stent placement for prevention of airway collapse. In our study this treatment had good results in 79% of the patients.