Montgomery T-tube for Management of Tracheal Stenosis: A Retrospective Analysis in a Government Hospital of South India

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ABSTRACT
This study investigated the outcome of patients who developed tracheal stenosis after tracheostomy or intubation using Montgomery T-tube. We reviewed 21 patients who had experienced tracheal stenosis at a single institution, over 7 years from January 2008 to January 2015. Majority were in the age group of 20 to 30 years and a male preponderance was noted. The duration between extubation and appearance of respiratory symptoms ranged from 32 to 96 days. Location of stenosis was more common in subglottic region (61.9%), followed by tracheal (33.33%) and laryngotracheal stenosis (4.7%). At the end of 6 months, 18 of 21 patients were decannulated successfully and 3 were decannulated at the end of 9 months. Our study showed that use of Montgomery T-tube for laryngotracheal stenosis gave complete improvement in all the patients. Tracheal resection and anastomosis is the definitive surgical treatment of choice in tracheal stenosis but when surgical management is not feasible T-tube is a good alternative and T-tube as front line of choice in tracheal stenosis but when surgical management is not feasible T-tube is a good alternative and T-tube as front line of management has produced complete improvement in airway patency and restoration of voice in our study.

Keywords: Endotracheal intubation, Laryngotracheal stenosis, Montgomery T-tube, Tracheostomy.

How to cite this article: Babu MM, Kumar RA, Thirugnanamani R. Montgomery T-tube for Management of Tracheal Stenosis: A Retrospective Analysis in a Government Hospital of South India. Int J Phonosurg Laryngol 2016;6(2):73-77.

Source of support: Nil
Conflict of interest: None

INTRODUCTION
Laryngotracheal stenosis has shown a rise in recent years probably because of increased incidence of prolonged intubations, and tracheostomy was done for extensive and complex neurological conditions, cardiovascular, head and neck surgeries, and increased incidence of recovery of patients out of the intensive and critical care units secondary to the recent technological advances. Tracheal stenosis can occur following endotracheal intubation or tracheostomy with inappropriate cuff pressure.

Endotracheal tubes cause pressure necrosis of mucosa causing fibrosis to the subglottis that can result in severe commissural scarring which is difficult to treat. Tracheostomy tubes can cause severe stomal stenosis in the trachea or infraglottic region. Airway intubation resulting in pressure necrosis because of the tube cuff is a preventable problem. Pressure can result from the tube of inappropriate tube size (large tube/undersized tube secondary to more inflation in order to establish adequate seal), friction of tip of tube against tracheal wall, traction of the ventilator tubing against the tube in patients on ventilator for prolonged duration.

In recent times, despite the advent of low-pressure high-volume cuffs, in adults, prolonged intubation is mostly due to the uncertainty about final prognosis of the patients following accidents or coma due to any cause. Secondary to this uncertainty, tracheostomy is postponed causing more damage to the trachea predisposing it for stenosis. Most common site of postintubation stricture is at the site of the endotracheal tube cuff. Cuff strictures can occur as early as 36 hours of intubation and is thought to be due to ineffective deflation of the cuff and usually become symptomatic with an average of 5 weeks after extubation.

Multiple treatment options are available for tracheal stenosis. These include tracheal dilation, excision of stricture, and end-to-end anastomosis or staged reconstruction with musculocutaneous flap. Restenosis may sometimes occur, particularly when the stenosis is >2 cm in length because of the presence of excessive tension at the line of anastomosis. In addition, delayed surgical correction may increase the severity by repeated and reciprocal irritation.

Choice of procedure depends on age of patient, site of stenosis, nature of stenosis, etiology, and general condition of patient. More conservative procedure with less tissue damage should be considered in the surgical reconstruction of laryngotracheal stenosis in order to preserve...
physiological function. In our experience, laryngotracheal reconstruction followed by Montgomery T-tube stenting was effective and simpler and had less morbidity and higher success rate of decannulation.

We report 21 cases of laryngotracheal stenosis, who underwent laryngotracheal reconstruction with T-tube stenting over 7 years from Jan 2008 to Jan 2015 in Sri Venkateswara ENT Institute, Bangalore Medical College and Research Institute.

MATERIALS AND METHODS

Retrospective analysis of 21 patients was done with laryngotracheal stenosis who underwent laryngotracheal reconstruction with T-tube stenting over a period of 7 years.

Patients were evaluated according to their age, gender, etiology, duration of intubation/tracheostomy, location, and size of the stenotic segment on computed tomography (CT), follow-up time with T-tube, the complications that occurred after T-tube removal, and additional tracheal surgeries done if required.

The selection criteria for T-tube insertion in patients were:

- Subglottic, tracheal, mixed type of stenosis
- Good laryngeal function and normal vocal cord mobility
- Adequate pulmonary reserve
- Medically fit for general anesthesia.

Operative Technique

All patients were given general anesthesia through tracheostomy tube. Diagnostic laryngoscopy and rigid bronchoscopy was performed to confirm the level of stenosis.

Midline vertical incision was taken extending from superior border of stoma to lower border of thyroid cartilage. Subcutaneous tissue and strap muscles were separated. Thyroid isthmus separated from trachea was clamped, cut, and ligated. Anterior wall of trachea was exposed and incision was taken from upper border of tracheal stoma to cricoid cartilage. In case of subglottic stenosis, cricoid cartilage was divided. Stenotic segment was exposed and measured. Fibrous tissue in tracheal lumen was released and lateralized with 3-0 Vicryl. Tracheal trough was created by taking tagging sutures from tracheal wall to subcutaneous tissue. Injection Mitomycin C was prepared by diluting 2 mg in 1 mL of normal saline. Cotton patties soaked in Mitomycin C were applied to the stenotic segment for 5 minutes. The T-tube was cut to exact length; sharp edges of tip, thus created, were rounded with file. Tracheostomy tube was removed. Silastic tube was inserted in stenotic segment with distal limb at least 1 cm above the carina and proximal limb just below the glottis. Anesthesia was continued through the T-tube. Skin separated from subcutaneous tissue and sutured over the T-tube with 4-0 Ethilon. Horizontal extraluminal portion of the T-tube was capped as soon as transglottic air flow was tolerated so that patient breathed through nose on operation table.

Postoperative management included prophylactic antibiotics for 1 week, steam 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 had recovered from ventilation anesthesia to maintain humidification and phonation.

Fiberoptic bronchoscopy was performed under local anesthesia every month to check the T-tube condition. Patients were followed up every month and by the end of 6 months CT was done without the T-tube. Only in cases where stenosis still persisted T-tube was reinserted, otherwise T-tube was removed. Patients were followed up every 10 days in cases where tube was removed for next 2 months and thereafter monthly. In only one patient the tube was removed in 4th month in order to remove the granulation tissue near the tube end and reinserted after removal. All patients regained voice after decannulation but the assessment of quality of the voice was not done.

RESULTS

Age and sex distribution among the subjects studied is shown in Graph 1. Majority were in the age group 20 to 30 years and a male preponderance was noted.
Initial diagnosis for which the patients were intubated or tracheostomized was organophosphorous compound poisoning 52.38%, road traffic accident 28.57%, and suicidal cut throat injury 19%. Fourteen out of 21 patients were intubated, only 4 underwent tracheostomy and 3 were intubated initially and later tracheostomized, as depicted in Table 1.

The duration between extubation and appearance of respiratory symptoms ranged from 32 to 96 days. Location of stenosis was more common in subglottic region (61.9%), followed by tracheal (33.33%) and laryngotracheal stenosis (4.7%), which is depicted in Graph 2.

Fourteen out of 21 patients had stenotic segment length between 2 and 4 cm, which is represented in Graph 3. Figures 1 and 2 show the intraoperative picture. Figure 3 is a picture of the Montgomery T-tube before insertion. Figure 4 depicts the patient with T-tube in situ and Figure 5 depicts the postoperative picture.

At the end of 6 months, 18 of 21 patients were decannulated successfully and 3 patients were decannulated at the end of 9 months. Four patients developed granulation tissue formation around the stoma which was managed with copper sulfate. Our study showed that the use of Montgomery T-tube for laryngotracheal stenosis gave complete improvement in all the patients in terms of decannulation.

### DISCUSSION

Management of laryngotracheal stenosis is a challenging problem that requires a multidisciplinary approach from different surgical teams. The basic aim of any treatment modality adopted is airway patency, glottic competence

<table>
<thead>
<tr>
<th>Duration (days)</th>
<th>Intubated</th>
<th>Tracheostomized</th>
<th>Both</th>
</tr>
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<tbody>
<tr>
<td>&lt; 10</td>
<td>1</td>
<td>1</td>
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<tr>
<td>10–15</td>
<td>6</td>
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<td>16–20</td>
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<tr>
<td>21–30</td>
<td>–</td>
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<td>1</td>
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<tr>
<td>31–50</td>
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**Graph 2:** Depiction of association between location and percentage of occurrence of the stenotic segment

**Graph 3:** Variation in the length of the stenotic segment
for airway protection against aspiration, and acceptable
voice quality⁴,⁵ in that order of priority. Predisposing
factors for tracheal stenosis related to the endotracheal
tube include a wider tube diameter, longer intubation
time, continuous movement of the tube in the tracheal
lumen, and difficult intubation. Other etiologies include
traumatic and nonsterile aspiration, emergency cricothy-
rotomy, high-level tracheotomies, and mechanical venti-
lation.⁶ Some studies claim that tracheal damage begins
17 hours in adults and 1 week in infants following intuba-
tion.⁷ Although permanent tracheotomy is the simplest
treatment method, it has limitations, such as inability to
vocalize without occluding the stoma, inherent disfig-
urement associated with the tracheotomy tube, and the
inability to engage in certain recreational activities (e.g.,
swimming). Decannulation and closure of a preliminary
tracheotomy is thus yet another goal of modern therapy
addressing airway stenosis.⁸ The T-tube is the preferred
tracheal stent for stenosis of upper airway when surgical
reconstruction cannot be accomplished and dilatation
provides inadequate relief.⁹ Advantages of T-tube include
preservation of speech, better tolerance and maintenance
of nasal respiration, which humidifies lower airway. The
tube is socially acceptable and its daily care is easy.

The high level of tolerance and the efficacy of
silicone endoprostheses in maintenance of airway
patency have been extensively documented, but still
considerable debate is going on how long the stent
should remain installed to achieve best results. Initially,
Dumonⁱ⁰ recommended 6 to 12 months, but later he rec-
ommended use of stent for longer period as it reduces
risk of restenosis. Martinez-Ballarin et al⁰¹ reported
temporary stenting of the airway for 18 months. In this
study we have kept the tube in place for a minimum
period of 6 months, following which decannulation
was done based on the patient’s need. In 18 patients
tube was removed at the end of 6 months, and only in
3 patients tube was removed at the end of 9 months.

The tracheal T-stent initiates little or no tissue reaction
unless it touches the undersurface of the vocal cord.
This serves as both a stent and a tracheostomy tube. The
intraluminal portion is of sufficient density and thickness
to support a reconstituted stenotic larynx and trachea.
Mucus and crusts do not readily adhere to the smooth
surface of the silicone material. Most of the time, the soft
T-stent remains plugged, thus allowing respiration and
phonation while maintaining the airway.¹²

The study conducted by Huang¹³ regarding the use of
silicone T-tube to treat tracheal stenosis or tracheal injury
showed that all 11 patients who were treated with the
T-tube for tracheal stenosis benefited from the operation,
with relief of respiratory distress and voice restoration.

Dass et al¹⁴ in their retrospective analysis using tra-
cheal T-tube stent for laryngotracheal stenosis concluded
that 65 of 71 patients (91.5%) treated with Montgomery
T-tube were decannulated successfully.
Kelkar et al\textsuperscript{15} in their study of management of laryngotracheal stenosis by Shiann-Yann Lee technique using T-tube showed that 23 of 30 patients (78.6\%) had an uneventful period between the insertion and removal of T-tube without any complications.

In our study improvement in patient symptoms was complete in terms of decannulation, which correlates with the above studies.

**CONCLUSION**

Tracheal resection and anastomosis is the definitive surgical treatment of choice in tracheal stenosis. However, this surgical approach is not feasible when the glottis and subglottis are involved, or in patients with poor general condition. Hence, we used T-tube as first line of management in cases of laryngotracheal stenosis secondary to various causes in which surgical management is not feasible. We followed up our patients for an average of 6 to 9 months and made additional management options based on requirement in the follow-up session. Given the complexity of tracheal surgery, we feel that T-tube application should be initially attempted in tracheal stenosis. We propagate that this technique would be more efficient and should be considered, since it has produced complete improvement in airway patency and restoration of voice in our study.

**REFERENCES**


