

Management of Long Multisegmental Tracheal Stenosis by Combined Endoscopic and Surgical Technique

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Abstract

The present Paper is dedicated to the Topic of complicated, multisegmental, long tracheal stenosis where the simple resection or stenting by any kind of "conventional" endoprosthesis is not performable, or feasible. Our recommended (and in the Article introduced) solution is the combination of reconstructive surgery with a stenting by a Montgomery T-tube. This demanding procedure is illustrated by a case report with an overview of international literature and our experience in this Article.

Keywords: Long multisegmental tracheal stenosis; Combination of endoscopic and surgical technique

Abbreviations: PostTS: Posttracheostomy Tracheal Stenosis; PostINT: Postintubation Tracheal Stenosis; T-Efist: Tracheo-Esophageal Fistula; PTCA: Percutaneous Transluminal Coronary Angioplasty; RIVA: Ramus Interventricularis Anterior

Introduction

Nowadays, the topic of tracheal stenting is becoming more and more topical, mainly due to the growing problems with acquired postintubation and/or posttracheostomy stenoses [1-3].

The management of an obstructive tracheal lesion, which develops as a result of long-term intubation, is a complex issue that requires an individual approach. A fully developed stenotic lesion with a high degree of obstruction, which is manifested a certain time later after extubation, requires radical surgical resection. As is known, this solution is not always feasible [4,5]. The number of complicated tracheal lesions, where its resection and anastomosis are not successful or not applicable, increases and the situation requires a solution by an endoprosthesis [5-7]. The condition of long, multisegmental tracheal stenosis where the primary reconstructive surgery cannot be performed and the stenting by any kind of endoprosthesis does not present the definitive solution can be very challenging even for an experienced tracheal surgeon or interventional bronchologist. The present paper is dedicated to this topic; the management of complicated long tracheal stenosis by the combination of stenting and surgical techniques.

Management of Multisegmental Long Tracheal Stenosis—Case Report

The technique of endotracheal stenting together with surgical management is introduced within the following case report.

A 75-year old female patient with a history of an acute myocardial infarction managed by PTCA and stenting of RIVA, due to acute fibrillations and fluttering, postinterventionally reanimated (cardioversed), was also managed by a percutaneous, dilatation-tracheotomy in the ICU. After a period of 2 months, in an emergency situation of an acute inspiratory (and expiratory) stridor the ensuring of airways was performed. The reopening of the previous dilatation tracheotomy with intubation by a child tracheotomy-tube No. 4 was immediately completed by emergency personnel. After immediate readmission to our hospital, the posttracheostomy (postintubation) long multisegmental tracheal stenosis was diagnosed in this case (Figure 1).

For the stabilization of the tracheal wall and for ensuring the airways in this multimorbid patient the permanent surgical tracheotomy

(tracheofissure) with mucocutaneous anastomosis together with the application of the Montgomery T-tube were performed (Figure 2).

After the significant clinical stabilization of the patient, the trachea was reconstructed by a segmental resection with end-to-end anastomosis. A segment of 8 cm of the trachea was resected. The further postoperative course was uneventful and the patient was discharged 2 weeks after the procedure. The tracheobronchoscopy showed a nicely healed anastomosis (Figure 3). The patient has completely recovered, with a stable respiratory system performing her cardiac rehabilitation.

From all of the above mentioned, it is clear that in the management of long multisegmental tracheal stenosis the surgical reconstruction



Figure 1: Multisegmental long tracheal stenosis (Scheme).

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Figure 2: Permanent tracheotomy–tracheofissure: the T-tube is in situ inserted to the tracheal stenosis.

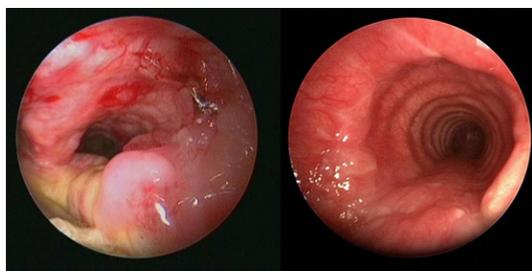


Figure 3: LEFT: The endoscopic view of the long multisegmental tracheal stenosis: the stenotic area with granulation tissue on the level of tracheostomy can be easily recognized
RIGHT: Endoscopic view of the tracheal anastomosis 2 weeks after the successful procedure

together with temporary stenting by Montgomery T-tube play a significant role.

Procedures

Surgical technique

The surgical technique for segmental tracheal resection with end-to-end anastomosis is well-known and was already described and introduced elsewhere [8,9].

Here, only a brief description of its most important steps is given:

- Surgical approach should provide the best exposure of the trachea and its chosen type depends on the level of the stenotic lesion; for the proximal lesion the cervical incision is preferred, for the middle and the distal part of trachea, the median sternotomy and the posterolateral thoracotomy are recommended approaches.
- Sufficient preparation and mobilization of the whole trachea is mandatory to achieve a tension-free anastomosis after the resection of the stenotic segment.
- The dissection of the trachea has to be done close to the trachea to avoid damage to the recurrent nerve, especially near the cricoid.
- The stenotic segment of the trachea should be completely removed; the future anastomosis should be constructed in healthy, vital tissue without granulations or scars.
- The recommended technique of tracheal anastomosis is an interrupted single-layer suture by monofilament, absorbable material of 3-0 or 4-0 being tied out.
- The tracheal anastomosis can be covered (wrapped) by some

autologous pedicled flap e.g. intercostal muscle flap, pedicled pericardial flap, etc.

- Early extubation of the patient with spontaneous breathing and coughing activities postoperatively are also important.
- Stenting can be added to procedure in case of problematic anastomosis in complex tracheal injuries in order to ensure the reconstruction [10,11].

In our case, the temporary stenting by a Montgomery T-tube before the surgery was performed. This was necessary to achieve a stable (not collapsed) tracheal wall in its initially long, multisegmental stenotic stage. The relatively long T-tube stent with its horizontal branch offers a unique service—it can serve as a temporary tracheostomic tube with stenting the airway also above the tracheostomy. From all of the above mentioned, it is clear that a significant role in the management of long multisegmental tracheal stenosis belongs to Montgomery T-tube (Figure 4). Therefore, the next section will briefly introduce this endoprosthesis.

Stenting by T-tube

In 1964, Dr. William W. Montgomery used for the first time a two piece rigid acrylic stent during a reconstruction surgery of the cervical trachea to prevent postoperative tracheal stenosis [12]. This stent was designed as a combination tracheal stent and tracheostomy tube, but it proved to be too rigid, with significant complexity in manufacturing and insertion. Nonetheless, it served as a prototype for the Montgomery T-tube tracheal stent introduced by Montgomery in 1965 [13]. The improved version was a one-piece flexible silicone stent that possessed greater flexibility and caused minimal tissue reaction [14]. Its greatest advantage is that this T-tube serves as an internal stent as well as a tracheostomic tube. Its smooth and non-adhesive surface restricts the mucous sputum adherence and incrustation creation.

It has to be said that the silicone gum material is so far the best material for temporary tracheal stenting. It is rigid enough to restrict the narrowing of tracheal lumen during the granulation tissue maturation and, on the other hand, it is fine (smooth) enough to allow the tracheal epithelium growth through granulations [11,15]. The therapy of stenting is time-consuming. The period of time necessary for trachea wall stabilization and trachea mucosa healing individually differs, which is why the patients retained the T-tubes for different time periods. They are well tolerated by patients and, compared to conventional tracheostomy tubes, they have several advantages. They preserve normal respiration and phonation, minimal cough and tissue reaction due to the (already mentioned) silicone material.

Indications for T-tube applications

In general, the T-tube can be applied in all cases of tracheal stenosis,



Figure 4: The Montgomery T-tube and some of its modifications.

where its radical segmental resection is not feasible or performable. These are the three situations wherein the T-tube can be inserted, as:

- a) a temporary stent before segmental resection
- b) a temporary stent after segmental resection
- c) a single intervention—generally in all patients with long and multi-segment stenoses, and also in those with severe comorbidity, where the radical segmental resection is not feasible. Standard indication criteria is shown in Table 1.

To complete this section, it has to be mentioned that, in general, tracheal stenosis can be managed in three different ways, incl. segmental tracheal resection, endoscopic stenting, recanalization via direct techniques (stenotic segment dilatation with discision/excision of stenotic granulated tissue surgically, or by laser evaporation).

As was already stated in the Introduction, the management of tracheal stenotic lesion always requires an individual approach considering not only the local (tracheal wall) but also the general-condition of the suffering individual.

Results

In all kinds of trachea reconstruction, a relatively good toleration of silicone material was observed. The Silicone T-tube causes minimal complications. Obstructions of the T-tube by dense sputum, which required the T-tube removal and its replacing by a double-coated tracheotomy tube, were the most common complication. The location, where most complications occurred was the upper part of the T-tube, in the place from where it was inserted to subglottic area. Here, irritations and granulations could be sporadically observed. It is really difficult to estimate the correct length of the upper end of the T-tube's vertical branch. For this reason, it was necessary to perform endoscopic checks with the adjustment of the tube's upper end (due to the close position of vocal cords, and due to a necessity of granulations' overbridging). After inserting the T-tube's upper vertical part through vocal cords and its long-term positioning in this area, no significant changes of vocal cords were observed. After the removal of the tube, the patient's voice spontaneously appeared, even though it was not always clear.

In accordance with our standard indications criteria (Table 1), the following results were recorded:

- a) In 13 patients, the T-tube was used as a bridge to definitive reconstructive surgery. As it is illustrated by our case report, these are those patients with active coexisting medical conditions or severe deconditioning following their extended ICU stay and/or in acute injured trachea by previous interventions (tracheotomy, intubation etc.). From among these cases, 5 patients had posttracheostomy stenosis, 4 patients

had combined (posttracheostomy and postintubation stenosis) and 4 patients had benign tracheo-esophageal fistulae. All of these patients already underwent successful segmental tracheal resection with end to end anastomosis and their T-tubes were definitely removed.

- b) In three cases, the stenting by T-tube was performed after the segmental resection as an adjunct to primary tracheal reconstruction. There were three young patients (2 males, 1 female) after car accidents. Their T-tubes were successfully removed after 6, 10, and 15 months, respectively.

c) In this last group of patients (n=51), the insertion of T-tube was performed as a single procedure. Generally, in all of these patients their poor general condition prohibited a surgery or their tracheal lesion was not feasible for surgical repair due to the length and multisegmental character. The results were analyzed and already presented in detail elsewhere [16] and, therefore, herein only a brief analysis of these results is presented. In 32 patients, the T-tube was inserted for benign conditions; posttracheostomy and postintubation tracheal stenosis in 29 cases, and functional stenoses in 3 cases. In the rest of the cases (n=19), the T-tube was inserted as a palliative measure in malignant tracheal stenoses. This group includes 2 patients with malignant tracheo-esophageal fistulae and 17 cases with non-resectable malignant tumors, which caused tracheal stenosis. In the vast of majority of these cases, the indication for urgent surgical intervention was primarily to ensure the patency of the upper respiratory ways, secondarily to gain histologization of tumors. All of these patients underwent tracheofissure, discision of the tracheal front wall, and the insertion of the T-tube. In all cases, it was an advanced malignant tumor where the radical surgical resection was not feasible. Some of these patients had already distant metastases (pulmonary, bone etc.) in the time of the tracheal intervention. Finally, we can only state that the results in the treatment of such patients with malignancies, where the radical surgical intervention cannot be performed, are burdened with high mortality rate. However, we believe that to ensure respiratory ways by a T-tube and thus to make patient's quality of life better is very important. We also must not forget the fact that, recently, the number of such patients has increased.

As it was emphasized in the Introduction already, tracheal stenosis is a serious disease with increasing tendency. Among this increased number of tracheal stenosis often complicated, multi-segmental, long stenoses can be found. There is also a growing number of patients with non-resectable tumors and patients after segmental tracheal resection, where anastomosis insufficiency developed. In such cases of dramatic situations, the optimal solution is to use a complex way with T-tube stenting together with surgery after the significant stabilization of the patient.

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Before segmental resection as a temporary stent	After segmental resection	As a single intervention
<ul style="list-style-type: none"> • Complicated tracheal lesion • Significant inflammatory changes on trachea • Tracheo-esophageal fistula • Non-compliant patient 	<ul style="list-style-type: none"> • Considering non-reliable suture (inflammation, tension) as a prevention of restenosis • Anastomosis insufficiency, margins' separation, restenosis • Obstructions in the area of the vocal cords 	<ul style="list-style-type: none"> • Non-resectable tumors, • Long stenotic segments (over 50%), • Multi-segmental stenoses, • Accompanying problems, which contraindicate segmental resection (fibrosis, inflammation in the surrounding area, situation after repeated interventions).

Table 1: Standard indication criteria for T-tube application.

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