■ CLINICAL INVESTIGATION

Resection With End-to-End Anastomosis for Post-Intubation Tracheal Stenosis

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Objective: To study results of resection and end-to-end anastomosis in tracheal stenosis (TS).
Patients and method: Retrospective review of 14 patients with previous long-term intubation and residual tracheal stenosis, all operated on with resection and end-to-end anastomosis. We studied the percentage of surgical success, decannulation index, use of Montgomery T tube, and complications.
Results: We performed a total of 42 interventions (mean, 2.93) and 19 T-Montgomery tubes were used. We achieved surgical success in 85.12 % of patients, with a decannulation index of 71.42 %. Two patients developed granulomas in the suture field that required treatment with endoscopic laser and cryotherapy. One patient died intraoperatively.
Conclusions: Surgical resection with end-to-end anastomosis and insertion of a T-Montgomery tube is a useful technique in post-intubation tracheal stenosis despite involving multiple interventions in a large percentage of patients.

Key words: Tracheal stenosis. End-to-end anastomosis. T-Montgomery tube.

Resección con anastomosis término-terminal en la estenosis traqueal tras intubación
Objetivo: Evaluar los resultados de la cirugía de resección con anastomosis término-terminal en la estenosis traqueal (ET).
Pacientes y método: Estudio retrospectivo de 14 pacientes con antecedentes de intubación prolongada y ET, operados mediante resección y anastomosis término-terminal. Se estudia los porcentajes de resolución de la estenosis, decanulación, utilización del tubo en T de Montgomery y complicaciones.
Resultados: Se realizó un total de 42 (media, 2,93) intervenciones y se colocaron 19 tubos en T de Montgomery. En el 85,12 % de los pacientes se resolvió la estenosis, con decanulación en el 71,42 %. Dos pacientes desarrollaron granulomas en la zona de sutura, que requirieron exéresis mediante broncoláser y crioterapia. Una paciente falleció durante la operación.
Conclusiones: La cirugía resectiva con anastomosis término-terminal y colocación de tubo en T de Montgomery es una técnica útil para la resolución de la ET tras intubación, aunque en un alto porcentaje de pacientes requiera múltiples intervenciones.

Palabras clave: Estenosis traqueal. Anastomosis término-terminal. Tubo en T de Montgomery.

INTRODUCTION

The treatment of tracheal stenoses (TS) poses a challenge to otorhinolaryngologists due to the risks to life implied by an obstruction of the airway. The complexity of the surgery involved, the high rate of revisions needed and the possibility of a permanent residual tracheotomy may negatively impact patients' quality of life.

The main cause of TS is prolonged intubation. Due to the growth in intensive care units in the last few years, and with this the number of intubations left inplace for a long time, the incidence of this condition is increasing[1,2].

Treatment depends on several factors, some imposed by the patient such as age, clinical condition, the state of their lungs, physical demands or concomitant illnesses, and others associated with the stenosis itself, such as its length, location or the residual lumen diameter[3,4]. Surgical options are divided into endoscopic techniques (including the use of laser, dilation and stent placement) and open surgery. As otorhinolaryngologists do not have access to some of these techniques, it is important to adopt a multidisciplinary approach to obtain the maximum results from each one.

At our hospital, some of these stenoses are treated endoscopically at the bronchoscopy department and they only refer to the otorhinolaryngologist those cases where the initial treatment has failed or where the length of the

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stenosis and loss of cartilage support recommend open surgery with exeresis and end-to-end anastomosis.

It is frequently found during surgery that the segment of trachea compromised is larger than was initially foreseen. This is due to the fact that the computerized tomography (CT) image, of fundamental importance to determine the location and length of the stenosis, is not sensitive to most of the minor alterations in the mucosa, thus potentially leading to an image that underestimates the damage to the trachea. The need to apply a suture in an area of altered mucosa warrants the use of support systems fostering re-epithelialization of the area. At our department, the support system used is Montgomery's T tube.

We have conducted a retrospective study of our experience in the treatment of TS. We analyzed the relationships between various general factors and the onset of stenosis, the results of resection with end-to-end anastomosis, the usefulness of Montgomery's T tube and complications.

PATIENTS AND METHOD

Patients

During the period between May 1993 and April 2005, surgery was performed on 32 patients with laringotraqueal stenosis in the Otorhinolaryngology Department of the "Juan Canalejo" University Hospital in Corunna. We selected 14 patients out of the total, corresponding to those with stenoses exclusively in the tracheal segment and originating in prolonged intubation, all of whom were subjected to exeresis and end-to-end anastomosis. We only included patients with tracheal stenosis without sub-glottal involvement. Thus, none of them required cricoid recalibration manoeuvres.

In the same way, stenoses of tumoral origin (n=3), immune-related (n=2), idiopathic stenoses (n=2) and/or those with laryngeal involvement (n=11) were excluded.

All of the patients presented a fixed obstruction of the respiratory function. None reported alterations in swallowing. One of them had previously been operated on for a tracheo-oesophagic fistula caused by the prolonged intubation.

Variables Studied

General information was collected on gender, age, reason for intubation, degree of stenosis (using the Myer-Cotton classification), the number of rings resected, intubation time and concomitant illnesses, and the existence of correlations between these and the onset of stenosis was studied.

With respect to surgery, the use of Montgomery's T tube, the time it was in place, complications and surgical outcome were all analyzed.

Statistics

The data collected were tabled in an Excel worksheet (Microsoft) for statistical analysis using the EPI Info 6.0® programme. Significance was examined using the Kruskal-Wallis test and the χ^2 test while the correlation between factors was analyzed using Spearman's rho correlation. The threshold accepted for statistical significance was $p < 0.05$.

RESULTS

We studied a total of 14 patients, of whom 28.57% (4/14) were women and 71.42% (10/14) were males. The mean age was 45.35 years (range 14-74). The reasons they required prolonged endotracheal intubation were: traffic accidents (64.28%; 9/14); surgery (21.42%; 3/14); respiratory insufficiency due to pneumonia (7.14%; 1/14); and caustic substances (7.14%; 1/14). As for their concomitant illnesses, there were 3 cases of IDDM (21.42%); 2 with COPD (14.28%); and 1 with a history of IVDU and seropositive for HBV and HCV (7.14%). The mean endotracheal intubation time was 17.64 days (446).

The Myer-Cotton classification divides our patients into 14.28% (2/14) with grade II, 64.28% (9/14) with grade III and 21.42% (3/14) with grade IV.

With respect to the number of rings resected, the mean was 3.28 rings (2-5).

The only statistically significant relationship among the factors analyzed was between age and the degree of stenosis ($p=0.04$). The study did not show any significant relationships among the others.

The patients were subjected to a total of 42 operations (1-5) with a mean of 2.93 per patient (Table 1). Of this total, 16 corresponded to resection and end-to-end anastomosis, i.e. surgery was repeated in 2 patients (14.28%) due to re-stenosis. The rest of the operations corresponded to the removal or replacement of the T tube, opening of tracheotomies and treatment of granulomas in the suture area. In all cases, a simple suture line was applied with Vycril 3-0 reabsorbable material.

In total, 19 Montgomery's T tubes were inserted (Table 1), with a mean duration of 10.88 months (1-36). Of these, 9 (64.28%) were placed after the initial surgery and the rest were tube replacements or insertion secondary to tracheotomy. Thus, 5 patients (35%) left the operating theatre after decannulation, but 3 (60%) subsequently required tracheotomy for insertion of a T tube.

Out of the total of tubes placed, 2 (10.52%) were removed due to an incorrect position after 1 month, and one of the patients was decannulated at that point. Another 4 tubes (21.05%) were later changed due to obstruction by mucus, granulations or fungal colonization. All of the tubes were finally removed, except for 1 (5.26%) in a patient with residual stenosis without the option of further surgery.

Two patients developed tracheal granulomas in the suture area that were treated with a flexible bronchoscope. These interventions were performed without general anaesthesia and in collaboration with the bronchoscopy department using Nd:YAG laser and cryotherapy. In one patient, it was necessary to repeat the process.

With respect to the final outcome, the stenoses were resolved in 85.71% of the patients (12/14). In other words, 71.42% (10/14) of the total were decannulated and 14.28% (2/14) remained with a fenestrated cannula without clinical or radiological stenosis, but rejecting final decannulation. One patient kept the T tube permanently due to stenosis. One female patient died while a tracheotomy was being performed, due to rupture of the innominate artery. The

Table 1. Operations Performed on Each Patient

Case	*1st Qx*	*2nd Qx*	*3rd Qx*	*4th Qx*	*5th Qx*
1	Ra + Decannul.	Trach. (deceased)			
2	RA+ TT (1)	Decannul.			
3	RA+ TT (11)	Decannul.	RA+ TT (1)	Change of TT (3)	Fen. Cannula
4	RA+ TT (13)	Fen. Cannula			
5	RA+ TT (8)	Change of TT (12)	Decannul.	Trach. + TT	
6	RA+ TT (14)	Change of TT (36)	Decannul.		
7	Ra + Decannul.				
8	RA+ TT (7) Decannul.				
9	RA+ TT (11)	Decannul. Trach. + TT (24)	Change of TT (10)	Decannul.	
10	Ra + Decannul.	Trach. + TT (3)	Decannul.		
11	RA+ TT (11)	Decannul.	Bronch.	Ra + Decannul.	
12	Ra + Decannul.	Bronch.	Bronch.		
13	Ra + Decannul.	Trach. + TT (14)	Decannul.		
14	RA+ TT (12)	Change of TT (5)	Decannul.		

Bronch. indicates bronchoscopy and exeresis of the tracheal granuloma; Fen. Cannula, fenestrated cannula; Decannul., decannulation; RA, resection and end-to-end anastomosis; Trach., tracheotomy; TT, Montgomery's T tube (duration in months); Qx, surgery ordered.

minor complications observed included 2 cases of mild subcutaneous emphysemas. No recurrent paralysis was detected.

DISCUSSION

Resection with end-to-end anastomosis is a technique offering good results in the treatment of TS. In this study, 85.71% of the cases studied were resolved, with decannulation in 71.42% of the total. For this reason, this technique has been put forward as the technique of choice for the treatment of stenoses measuring more than 1 cm in length with complete loss of tracheal lumen, or where it cannot be definitively resolved using endoscopic techniques[5-7].

Not all stenoses are candidates for open surgery as the first choice. We must not forget that some of them may be resolved by means of endoscopic treatment with minimal morbidity for patients. In this way, we must understand open treatment as one more step towards the resolution of tracheal stenoses. Endoscopic techniques have been classified into those with exeresis of the stenosis, basically using Nd:YAG[8,9] or CO_2 lasers, for which good results have been reported in selected cases, and other techniques such as dilation[10] or endoluminal stents[11] with results that are difficult to confirm in the long term. Endoscopic treatment with laser has been widely verified and offers good outcomes in the treatment of membranous stenoses or those less than 1 cm long, with residual lumen and providing there is a stable framework of cartilage[12,13]. In our hospital, the treatment protocol for stenoses located in the tracheal segment begins with endoscopic surgery using Nd:YAG laser in collaboration with the bronchoscopy department. In some of the cases reported in this article, this treatment had previously been attempted, as it does not in any case hinder subsequent open treatment. With respect to dilations and stents, the results described are not very homogeneous, revision surgery has been required and there have been problems with migration[10,14], so they are only used for palliative purposes in our department.

Recalling the factors studied that might influence the onset of stenoses, we only found a significant relationship between the degree of stenosis and age. This has already been reported and indicates the need to avoid prolonged intubation in elderly patients[15].

The use of T tubes to favour epithelialization is a controversial topic. Although some authors use them in all tracheal resections[15], we only do so in those cases where the suture is performed in an area with mucosa in poor condition, with the impossibility of resecting additional tracheal rings. Despite this, as has been noted in our results, some of the patients who were not given these tubes after primary surgery required them later. The use of the T tube is not free from complications and, although it fosters epithelialization in the suture area, it may give rise to the early formation of granulomas, especially in the upper area in contact with the laryngeal structure, forcing it to be replaced by another of different length. Other complications that may arise later on are obstruction of the tube by accumulation of mucus or colonization by *Candida*. These problems occur repeatedly in the literature revised, so the duration of the tube is highly variable, although there is general agreement not to remove it, if possible, during the first 5 months[16,17]. In our study, we only removed 2 tubes within 1 month after surgery due to poor positioning, in that they caused problems when swallowing. Another 4 tubes were

replaced late on due to subsequent obstruction by granulomas, mucus or colonization by *Candida*. With regard to the incorrect position of the tube, this could in part be prevented by verifying the placement with a fibroscope then flexing and extending the patient's head. In those cases where the tube is going to be close to the vocal cords, we prefer to place it above these, creating a bevel for the settlement of the supraglottis during swallowing, as the possibility of the onset of granulomas is much higher when the upper branch is at the level of the vocal cords than if the tube is completely above them. Pressure granulomas appearing in the laryngeal region must be resected with CO_2 laser accompanied by the removal or re-placement of the T tube.

Some authors[5,7] have defended the possibility of leaving the endotracheal ventilation tube in place for hours or days after surgery. In our experience, this is not useful. It is preferable for the patient to leave the operating room breathing spontaneously, and if we consider the possibility of an acute re-stenosis, it is preferable to place a T tube. All of the patients included in this study had their tubes removed in the operating room following the surgery and those with a T tube were aroused from anaesthesia with the horizontal branch occluded.

The intra-operative and peri-operative mortality rate is not high in the literature reviewed[6,18,19]. In our case, one patient died following re-stenosis while an emergency tracheotomy was being performed, in the course of which the innominate artery was injured. In this respect, scarring after multiple operations and, in particular, infection at the site of a prior tracheotomy imply an increase in morbi-mortality[2,18,20]. For this reason, it is necessary to find the optimal moment for surgery and to ensure correct cleaning and treatment of prior tracheotomies.

Complications such as subcutaneous emphysema, infection, dehiscence of the suture, haemorrhaging or tracheo-oesophagic fistulae, albeit described in papers from other authors[5,20,21], are infrequent in our series. The only noteworthy finding was 2 cases of granulations that apepared in the suture area, obstructing airflow and requiring the collaboration of the bronchoscopy department for treatment by means of Nd:YAG laser and cryotherapy. The 2 cases of subcutaneous emphysema were resolved spontaneously with compression measures.

Finally, we feel it is important to recall the need to ensure close follow-up during the first months following surgery, as many of the obstructive complications start in the form of granulomas or polyps that can be treated endoscopically. If left alone, these formations may end up as stable scarring leading to re-stenosis, thus foring further open surgery or the placement of a permanent T tube[2,18]. The possibility of success is greater if the stenosis is fuly resolved after the first surgery. Subsequent operations increase the scarring processes in the suture area, with the consequential rise in the rate of failures.

CONCLUSIONS

Tracheal stenoses require a multi-disciplinary approach. Resection and end-to-end anastomosis offer good results in stenosis following intubation. The prolonged use of Montgomery's T tubes is fundamental in selected cases. Complications must be diagnosed early in order to prevent re-stenosis.

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