



# Laryngotracheal stenosis and airway surgery – An outcomes based approach<sup>☆</sup>



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## ABSTRACT

**Objectives:** To review the outcomes of endoscopic, open or a combination of both surgical modalities for laryngotracheal stenosis and establish which factors influence results.

**Methods:** Records of all children undergoing laryngotracheal procedures (excluding laryngomalacia and aspirated foreign bodies) by the Department of Otolaryngology at The Children's Hospital at Westmead between January 2003 and November 2011 were reviewed. Specific data on population, intervention, covariates and outcomes were recorded and analysed.

**Results:** A total of 104 patients undergoing 277 procedures were included. 211 (76%) of the procedures were endoscopic, remaining 66 (24%) open. Patients undergoing open surgery were more likely to have significant co-morbidity, prior intubation, require ICU admission or tracheostomy and have a longer hospital stay. 57 (54.8%) patients were successfully treated with a single procedure (48 endoscopic and 9 open). Of the endoscopic patients requiring further surgery, 16 were managed with multiple endoscopic procedures, whilst 12 underwent subsequent open procedures. Open surgery was performed on 66 patients, 63.6% (42/66) of all open procedures required further endoscopic intervention and 45.2% (19/42) of these avoided further open surgery.

**Conclusions:** Both open and endoscopic surgery have a role in laryngotracheal stenosis, and many patients benefit from a combination of both. Ultimately the decision depends on experience of the treating team, social considerations, and institutional capabilities. A multi-centre prospective data collection would be a useful tool to further investigate optimal management approach.

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## 1. Introduction

Paediatric airway surgery continues to be a challenging field for the otolaryngologist, and analysis of treatment outcomes is complicated by the relative rarity of these cases and heterogeneous nature of the patients, their underlying pathologies and the varied

treatment options available. With such a variety of treatment choices, the ultimate modality chosen to treat specific airway pathologies often largely comes down to the treating team's experience rather than evidence based decisions [1].

This review examines the outcomes of different treatment modalities for laryngotracheal stenosis in a large paediatric tertiary referral hospital in Sydney, Australia in order to establish which factors influenced surgical results [2,3]. There will always be patient, surgeon and resource factors that influence the choice of surgery, with endoscopic, open or combined approaches all being potential options. Endoscopic airway procedures have recently gained increasing popularity due to advancing technology and experience, allowing new techniques to develop. However open airway surgery often remains the only option for many children. This paper hopes to shed some light onto a method of study that examines the subject of laryngotracheal stenosis.

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## 2. Method

### 2.1. Population

All children undergoing operative airway intervention at The Children's Hospital at Westmead, Sydney Australia, from January 2003 to November 2011. Laryngomalacia and airway foreign bodies were excluded.

### 2.2. Intervention

Endoscopic, open or combined airway surgery for laryngotracheal stenosis.

### 2.3. Covariates

Sex, age at procedure, presence of multiple airway pathology, presence of co-morbidities, prior intubation and laryngotracheal pathology. These factors were a priori deemed to have a possible effect on treatment outcome, and their influence was specifically sought.

### 2.4. Outcomes

Requirement for further surgical treatment, number of procedures, complications, mortality, requirement for tracheostomy, duration of hospital stay, duration of Intensive Care unit (ICU) admission and decannulations.

With institutional research ethics board approval, International Statistical Classification of Diseases (ICD) and Related Health Problems procedure codes were used to identify and review the medical records of the children. Patients who did not have any operative intervention were excluded. Statistical analysis was performed using SPSS 19.0.

## 3. Results

A total of 1048 children underwent operative airway assessments under anaesthesia, of which 242 required subsequent surgical interventions. After excluding laryngomalacia and airway foreign bodies, 104 patients with either acute or chronic laryngotracheal stenosis were eligible for inclusion into the database.

Demographics, variables and outcomes are summarised in Table 1. A total of 277 procedures were performed on these 104 patients, with a mean of 2.7 procedures per patient. 144 (51.8%) procedures required either post-operative intubation (117 cases – 42.2%) or a tracheostomy (27 cases – 9.7%). 142 procedures (51.1%) required post-operative admission to ICU. The mean length of hospital stay per procedure was 14.7 days. 142 (51.3%) of procedures required ICU admission with a mean length of ICU stay of 6.0 days (range 0–166 days). There were 7 (6.7%) deaths in the cohort although only 2 were directly related to airway surgery; one during an endoscopic procedure and the other following an open procedure.

There were 211 (76.2%) endoscopic airway interventions and 66 (23.7%) open procedures. Endoscopic procedures included the use of cold steel, diathermy, powered instrumentation (microdebrider), CO<sub>2</sub> LASER and balloon dilatation with or without topical therapy such as mitomycin C or injectable steroids. Open procedures included, but were not limited to, tracheostomy, laryngotracheal reconstruction with anterior and/or posterior cricoid graft, external epiglottopexy, slide tracheoplasty and anterior laryngofissure. Nine paediatric otolaryngologists participated in the caseload.

**Table 1**

Population demographics, co-variables and outcomes.

No. of children requiring airways intervention (excluding laryngomalacia and airway foreign bodies)	104
Male:female	56:48
Total no. of procedures	277
Co-morbidities	69 (66.3%)
Multiple airway pathology	38 (36.5%)
Prior history of intubation	62 (59.6%)
Mean age at 1st procedure	34.2 months
Range	0–174.3
Median	9.5
Mode	0 or 4
Mean no. of days admitted to hospital per patient	39.2
Range	0–269
Median	8
Mode	0
Average no. of days admitted to ICU per patient	25.6
Range	0–166
Median	10
Mode	1
No. of patients requiring tracheostomy	27
No. of patients successfully decannulated	17/27 (65.4%)
No. of patients requiring more than 1 procedure	47 (45.2%)
No. of patient with complications related to procedure	21 (20.2%)
No. of patient deaths	7 (6.7%)
No. of patient deaths related to surgery	2 (1.9%)

Within our study group, 104 cases underwent airways intervention, of which 57 (54.8%) were successfully treated with a single procedure (48 endoscopic and 9 open). 47 (45.2%) required multiple airway surgeries, of which there were 4 distinct subsets. These are: (a) endoscopic, followed by further endoscopic surgery (16 cases – 34.0%); (b) endoscopic followed by open surgery (12 cases – 25.5%); (c) open surgery, followed by further endoscopic surgery (7 cases – 14.9%); and (d) open surgery, followed by further open procedures ± endoscopic procedures (12 cases 25.5%) (Fig. 1).

A comparison of open versus endoscopic procedures (Table 2) showed several characteristics for those patients undergoing open procedures. They were more likely to have significant co-morbidity, prior intubation, require ICU admission or tracheostomy and have a longer hospital stay. There was no significant difference in the proportion of endoscopic and open procedures requiring further airway intervention (62.1% vs. 68.2% respectively).

## 4. Endoscopic surgery outcomes

211 endoscopic procedures were performed in total. Endoscopic surgery was utilised as the initial therapy in 76 procedures, with 48(63%) successfully treated with a single endoscopic procedure, 16 (21%) required multiple endoscopic procedures and 12 (16%) required a subsequent open procedure. These cases underwent a mean of 1.8 endoscopic procedures before proceeding to open surgery.

Table 3 examines the cases treated successfully with endoscopic treatment and those that subsequently required open surgery. Patients requiring subsequent open procedures were more likely to have a prior history of intubation ( $p < 0.05$ ), but otherwise showed no significant difference with respect to age, sex and co-morbidity. These patients had significantly longer hospital admissions ( $p < 0.05$ ), and their underlying diagnoses included subglottic or posterior glottic stenosis (7 patients), bilateral vocal cord palsy (2 patients), extensive head and neck lymphatic malformation (2 patients) and supraglottic stenosis (1 patient).

## 5. Open surgery outcomes

Open surgery was performed in 66 cases overall and used initially in 28 patients. 63.6% (42/66) of all open procedures

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