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Transglottic corticosteroid injection for treatment of soft post-intubation subglottic stenosis: a retrospective analysis of 26 children

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Abstract

Purpose Surgical treatment is generally recommended for severe subglottic lesions following traumatic endotracheal intubation in children. An alternative approach is early transglottic corticosteroid administration to reduce scar formation and prevent the need for subsequent surgical intervention. This technique has been practiced successfully for several decades at the Children's Hospital of Cologne and the outcomes of 26 subsequent patients reviewed in this analysis.

Methods All patients who underwent transglottic corticosteroid injection for treatment of post-intubation stridor and dyspnoea between 2012 and 2018 were identified and their records and endoscopy images analysed. Severity of the endoscopic findings was assessed using the Myer–Cotton classification (MCC) and an Expected Need for Surgical Intervention (ENSI) score (1 = inevitable; 2 = very likely necessary; 3 = probably avoidable and 4 = most likely not necessary) was recorded. Treatment was considered successful if the children had a complete resolution of clinical symptoms.

Results A total of 26 patients with a median (range) age of 1.9 (0.02–7.2) years and weight of 9.8 (1.8–25) kg were identified and included into the analysis. Endoscopic images were available for 22 children. All children underwent transglottic corticosteroid injection prior to any potential surgical treatment. A total of 22 patients (85%) improved following transglottic corticosteroid injection including 4 of 5 patients with a MCC = 3 and ENSI = 1 avoiding surgical intervention. None of the patients experienced a deterioration of clinical symptoms or endoscopic findings.

Conclusion Transglottic corticosteroid injections as first-line treatment in children with severe post-endotracheal intubation trauma can successfully resolve symptoms and prevent invasive surgery.

Keywords Post-intubation stridor · Subglottic stenosis · Iatrogenic laryngeal lesion · Paediatrics

Introduction

Traumatic endotracheal intubation of children can cause long-term iatrogenic harm to the larynx and lower airway with children frequently experiencing dyspnoea and stridor. Post-intubation stridor is commonly caused by a swelling of the mucous membranes of the larynx and subglottic area which is effectively treated with the inhalation of β-adrenoreceptor agonists. In some rare cases, however, a significant airway narrowing remains resulting in respiratory failure and distress necessitating intervention. Common recommended treatment options for long-established stenosis favour significant surgical treatments [1–3], stent insertion [4] or balloon dilatation with an associated long-term morbidity and possible mortality [5, 6].

Topical corticosteroids are reported to limit the scarring process [7]; however, there is currently no published

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evidence for the treatment of severe subglottic lesions in children. We have successfully used transglottic injections of corticosteroids in children with severe post-intubation stridor for several decades but not yet analysed this patient cohort. The current manuscript describes the technique used in this institution and reviews a series of 26 consecutive cases.

Methods

An electronic patient records system that included surgical procedure codes was established in 2012. All patients that underwent injections of corticosteroids in the endoscopy department of the Cologne Children's Hospital between 2012 and 2018 were identified and their data anonymously analysed. The entire electronic record was screened for each patient including demographic information, clinical presentation and if possible, videos of the endoscopic investigation were obtained from the archiving data storage devices.

The analysis of endoscopic imaging was standardized by assessing four pictures with clearly defined views: (1) view of the entire larynx; (2) view of the complete glottis opening; (3) view of the subglottis including the cricoid ring with the tip of scope between the vocal cords; (4) view through the cricoid ring into the trachea (Fig. 1). All images were assessed by an experienced ORL surgeon using the Myer–Cotton classification (MCC): Grade 1—up to 50% stenosis, Grade 2—51–70% stenosis and Grade 3 > 71% stenosis [8]. Additionally, the severity of the finding was subjectively assessed according to the expected need for surgical intervention (ENSI): ENSI 1 = inevitable; 2 = very likely necessary; 3 = probably avoidable and 4 = most likely not necessary.

Immediate and late complications (stridor, dyspnoea, oxygen requirement, and need for further interventions) were recorded. Treatment was defined as successful if the child had no further surgical or procedural intervention and was discharged without stridor, supplemental oxygen or other respiratory impairment.

Transglottic corticosteroid injection technique

Following induction of anaesthesia and muscle relaxation all children are intubated using an uncuffed endotracheal tube. A smaller endotracheal tube size is chosen ensuring an air leak during positive pressure ventilation. The endotracheal tube size has to be individually chosen according to the severity of the obstruction. Commonly, an inner diameter of 0.5–1.0 mm smaller than usual for this age and weight is appropriate. The transglottic injection is performed by puncturing the outer edge of the middle of both vocal cords (between the vocal cord and the false vocal cord) to about 4–5 mm deep (Fig. 2) using a bayonet-needle. This can be done either under direct view or while endoscopic visualisation by a rigid scope (e.g. Hopkins straight forward telescope). Using a Luer lock 1 ml syringe, 0.2–0.4 ml of a corticosteroid (betamethasone disodium phosphate 0.4%) is injected into each side with a marked resistance while injecting. Correct needle placement of the injection into

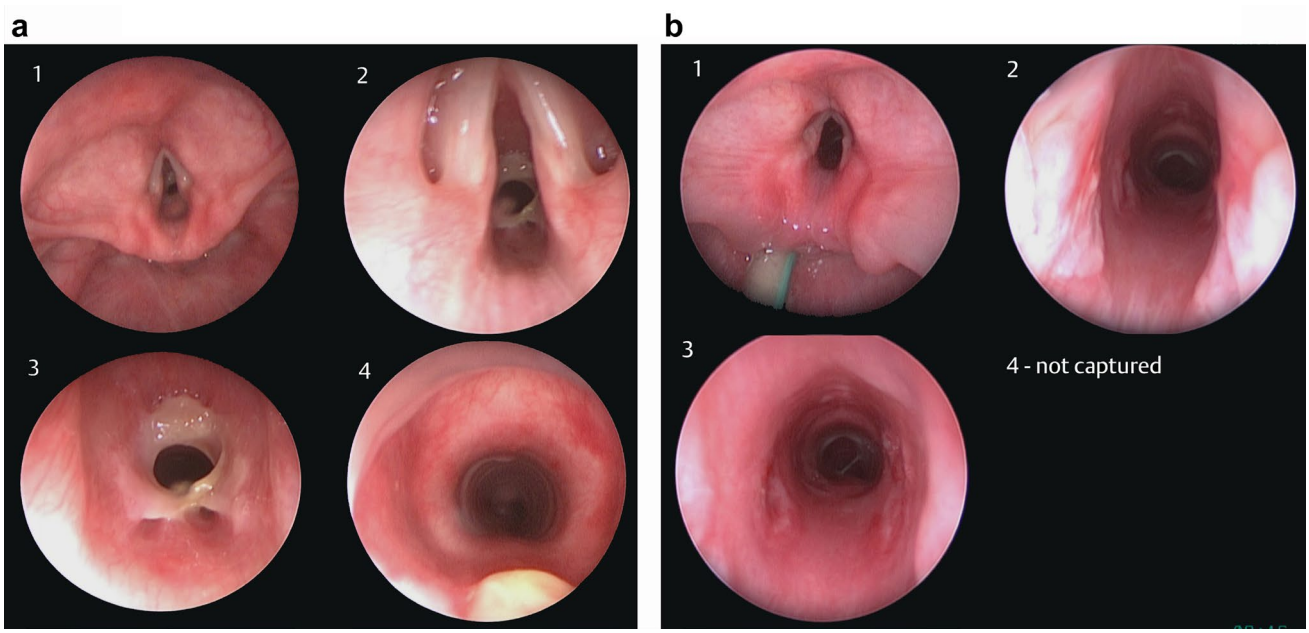

Fig. 1 Endoscopic images of the larynx of an otherwise healthy 7-year boy following traumatic intubation for elective tonsillotomy. Status prior transglottic steroid injection (**a**), and 72 h post treatment (**b**)

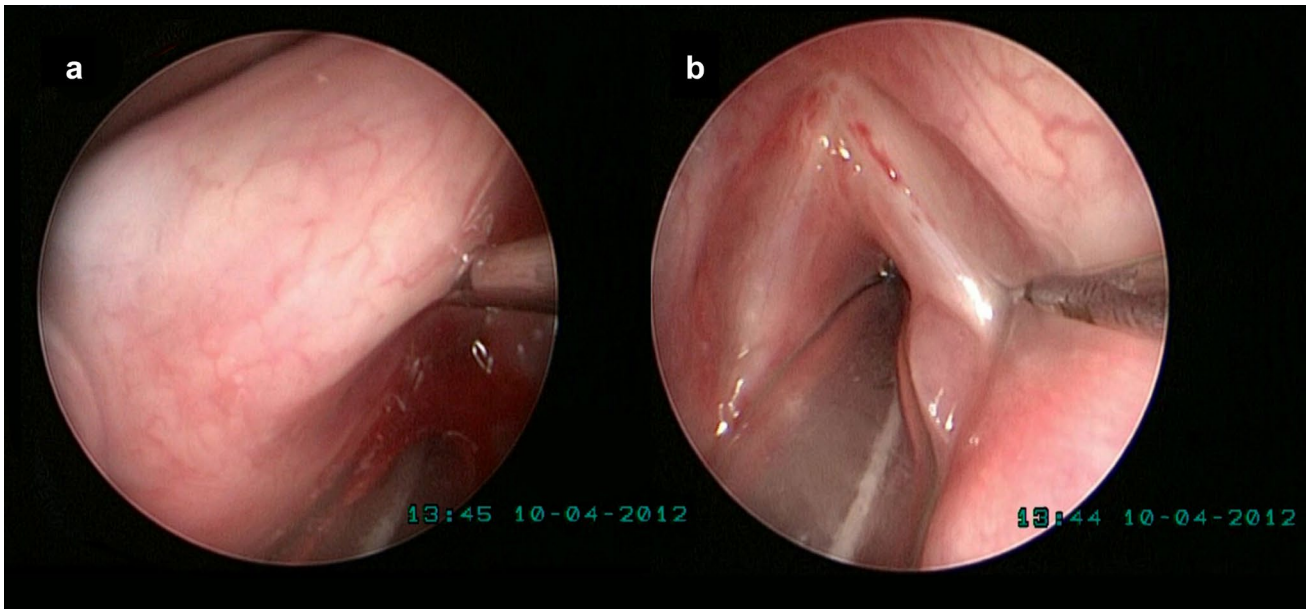

Fig. 2 Technique of transglottic injection into the larynx at the outer edge of the left (**a**) and right (**b**) vocal cord

Table 1 Demographic data of the included children

	Range	Median
All children ($n=26$; $f=10/m=16$)		
Age (years)	0.02–7.72	1.17
Weight at endoscopy (kg)	1.8–25.0	7.7
Premature born children ($n=10$; $f=4/m=6$)		
Gestational age at birth (weeks)	22–33	26.0
Birth weight (g)	460–1600	743
Weight at endoscopy (kg)	1.8–15.5	2.9

the submucosa leads to a reduced or absent air leak. The child requires ventilation for 3–5 days during which a larger leak than before the injection should occur. If the air leak prevents effective ventilation, the child might be extubated without endoscopic control investigation. Otherwise extubation is scheduled 3–5 days after the injection under endoscopic control.

Results

A total of 26 subsequent patients with severe post-operative stridor resistant to inhalational treatment after endotracheal intubation receiving transglottic injection of corticosteroids were identified. Twelve of these patients were aged less than 1 year at the time of intervention with ten of these born prematurely (Table 1). The reasons for previous endotracheal intubation varied but were most commonly for surgical interventions or respiratory failure. Clinical information (presence of stridor, dyspnoea and oxygen supply prior and post intervention) was available for all patients (Table 2). A total of 19% of patients still had mild stridor and 15% had minimal dyspnoea immediately after treatment and extubation which resolved within a few hours except in patients who ultimately underwent further surgical intervention (4/26). No patient had worse clinical or endoscopic findings than before. Endoscopic images of the pre-interventional endoscopy were available for 22 of the 26 children. Post-treatment endoscopies were performed in 12 children with endoscopic images available for 10.

A total of 22 children (85%) required no further interventions and were discharged without stridor or any impairment (Table 3). The remaining four children (15%) required tracheostomy for bridging until surgical expansion of the subglottis. Only one of five children with a MCC = 3 and one of five children with inevitable expected need for surgical interventions (ENSI = 1) actually required surgical treatment.

Discussion

In 85% of the children with severe stridor and impairment of breathing resistant to inhalational treatment, the transglottic corticoid injection was able to fully resolve all problems. Even in those cases with proven severe stenosis (MCC 3), still 80% were cured.

Since the introduction of paediatric endotracheal intubation in the 1940s [9], reports of laryngeal trauma and subglottic stenosis became available [10–12]. The incidence of traumatic endotracheal intubation varies

Table 2 Pre- and post-interventional clinical observations and endoscopic judgement

	Pre-intervention	Post-intervention
Clinical data		
Number of cases with data available	26	26
Stridor	26 (100%)	5 (19.2%)
Dyspnea	22 (84.6%)	4 (15.4%)
Oxygen requirement (> 21%)	18 (69.2%)	5 (19.2%)
Oxygen requirement (> 30%)	10 (38.5%)	5 (19.2%)
SpO_2 (mean)	97.1%	97.3%
$SpO_2 < 90\%$	2 (7.7%)	0 (0%)
Endoscopic images		
Number of cases with images available	22	10
Myer–Cotton classification (MCC)[a]; number of cases (%)		
MCC grade 1	6 (27.35%)	3 (30.0%)
MCC grade 2	11 (50.0%)	6 (60.0%)
MCC grade 3	5 (22.7%)	1 (10.0%)
Expected need for surgical intervention (ENSI)[b]; number of cases (%)		
ENSI 1	5 (22.7%)	2 (20.0%)
ENSI 2	11 (50.0%)	1 (10.0%)
ENSI 3	2 (9.1%)	4 (40.0%)
ENSI 4	4 (18.2%)	3 (30.0%)

[a]Classification of laryngeal stenosis due to Myer–Cotton classification: grade 1 = no obstruction to 50%, grade 2 = 51–70%, grade 3 = 71–99%

[b]Expected need for surgical intervention (tracheostomy or laryngeal surgery) was separated into four categories: 1 = inevitable, 2 = very likely, 3 = rather avoidable, 4 = most likely not necessary

Table 3 Outcomes in relation to pre-interventional endoscopic assessment

		Success rate[a]
Overall success rate		
Number of cases with data available	26	84.6% (22 of 26)
Success rate related to pre-interventional endoscopic images		
Number of cases with images available	22	90.9% (20 of 22)
Meyer-Cotton classification (MCC)[b]; number of cases (%)		
MCC grade 1	6	100% (6 of 6)
MCC grade 2	11	90.1% (10 of 11)
MCC grade 3	5	80.0% (4 of 5)
Expected need for surgical intervention (ENSI)[c]; number of cases (%)		
ENSI 1	5	80% (4 of 5)
ENSI 2	11	90.1% (10 of 11)
ENSI 1 or 2	16	87.5% (14 of 16)
ENSI 3	2	100% (2 of 2)
ENSI 4	4	100% (4 of 4)
ENSI 3 or 4	6	100% (6 of 6)

[a]Success rate related to pre-interventional observance is defined as proportion of children without any needed further treatment needed or compromise a few days after the intervention (transglottic corticosteroid injection)

[b]Classification of laryngeal stenosis due to Myer–Cotton classification: grade 1 = no obstruction to 50%, grade 2 = 51–70%, grade 3 = 71–99%

[c]Expected need for surgical intervention (tracheotomy or laryngeal surgery) was judged in four categories: 1 = inevitable, 2 = very likely, 3 = rather avoidable, 4 = most likely not necessary

dramatically from approximately 1:20,000 in adults [13], to 1:50 in neonates [14] and 1:20 in premature babies [15, 16]. While these facts merely illustrate the magnitude of this problem, all efforts should be undertaken to prevent a traumatic endotracheal intubation in these vulnerable patients, which includes suitable equipment, continuing practice, training and education [17].

Topical treatment of scars with corticosteroids is well established and practiced in other branches of medicine. The injection of corticosteroids is the most effective and feasible treatment for excessive scarring of the skin (keloids) [7]. Due to the attenuation of inflammatory reaction, reduction of collagen synthesis and increase of collagenase activity, the volume of scar tissue decreases and tissue becomes softer [18]. Several case reports are available for ENT patients where vocal fold lesions, polyps or nodules are treated with corticosteroid injections [19–21]. The successful injection of cortisone into soft laryngeal stenoses was first described in 1972 [22] and supportive corticosteroid injections following surgical interventions of the larynx and a tracheostomy recommended [23, 24]. Only one recent case series of 13 patients reported the successful treatment with corticosteroid injections for glottic stenosis in young adults [18]. However, a great variability of individual morphology, localization and severity of damage coupled with an immediate need for treatment has prevented a prospective randomized, controlled trial.

Surgical treatment is associated with a high rate of complications and a need for multiple interventions surgery. A case series of 21 patients who underwent a cricoid split reported a greater than 60% need of further surgical interventions such as tracheostomy, laryngeal extension plastic surgery [25]. This is in stark contrast to our findings with a high success rate as a first line of treatment.

We invented the ENSI score as described above, following the experiences of clinical routine care. Despite its subjectivity, we found out, that this is a helpful instrument to describe the necessity for the transglottic corticoid injection. Thereby, the ENSI score simplifies and clarifies the communication with parents and colleagues as well as the legally required patient documentation.

The retrospective nature of this current study report is a principle limitation. In addition to missing pre-injection endoscopic images, the lack of endoscopic post-interventional control can also be criticised. However, these children were extubated with massive air leaks after 3–5 days and displayed no stridor or dyspnoea following extubation negating the need for endoscopic control. Complete clinical observations were available for all children included into this current analysis until discharge.

Conclusion

The technique of transglottic injection of depot corticosteroids is easily feasible and represents an effective treatment option for children with traumatic subglottic stenosis preventing much more invasive surgical measures. It appears not to worsen a critical clinical situation and should be considered as first-line treatment in severe post endotracheal intubation stridor. Prospective multicentre clinical studies are required to validate the current findings.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Human rights and animal participants All procedures performed were in accordance with the ethical standards of the institutional research committee (waiver of formal ethical approval by Ethics Committee of University Witten/Herdecke, May 12th 2018 due to retrospective analysis with no personal data reported) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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