Anesthesia management for a case of laryngeal keel placement

ABSTRACT
Congenital laryngeal web is a rare anomaly with incidence of 1 in 10,000 births. Its clinical presentation may range from an asymptomatic patient or mild hoarseness of voice to severe respiratory stridor. The primary goals of surgical intervention for congenital laryngeal web are to establish a patent airway and to achieve a good voice quality. As recurrence rate after plain excision of laryngeal web is very high, its removal may be coupled by placement of a silastic keel in between vocal cords. Endolaryngeal placement of a keel is definitely less invasive than laryngofissure, but little is known about its anesthesia management. Frequent ventilatory adjustment and endotracheal tube (ETT) manipulations are needed along with vigilant monitoring. Risk of perforation or accidental dislodgment of the ETT and laryngeal edema are other concerns in management. We report a case.

Key words: Laryngeal keel; pediatric; stenosis

Introduction
Laryngeal web is a rare condition consisting of a membrane‑like structure that extends across the laryngeal lumen close to the level of the vocal cords. Its incidence is 1 in 10,000 live births and comprises only 5% of congenital laryngeal anomalies.\textsuperscript{[1,2]} It may be congenital or acquired and may cause airway obstruction of varying degree. Accordingly, clinical presentation may range from an asymptomatic patient or mild hoarseness of voice to severe respiratory stridor. The primary goals of management for congenital or acquired laryngeal webs are two: to establish a patent airway and to achieve a good voice quality.\textsuperscript{[3]} Here, we are reporting anesthesia management of a case of anterior laryngeal web repaired by excision of web and insertion laryngeal keel by endolaryngeal approach.

Case Report
This 12-year-old, 23 kg male was admitted with a history of husky voice since childhood. His voice and poor performance in school sports due to breathing difficulty while running made his parents seek medical help. He did not have any other congenital anomaly. Other milestones of development were normal too. History revealed that laser excision of the laryngeal web was done using CO\textsubscript{2} laser 4 months before. Following this, his breathing had improved, but the symptoms recurred after a few weeks. Voice quality did not improve. Indirect laryngoscopy showed adhesions in anterior half of the larynx suggesting reformation of the laryngeal web. Laryngeal examination was done with fiber‑optic bronchoscope under local anesthesia. It revealed that the

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laryngeal chink was very small, and it would accommodate endotracheal tube (ETT) of no. 5 or less only. It was decided to put a laryngeal keel after excision to prevent restenosis.

Systemic examination and investigations were within normal limits. The patient had adequate mouth opening and Mallampati classification grade-2 status. Informed anesthesia consent and tracheostomy consent were obtained.

In operation theater, standard monitors including electrocardiogram, SpO₂, and noninvasive blood pressure were attached, and an intravenous catheter was secured. Emergency tracheostomy preparation was confirmed. Preoxygenation was started on close circuit. Premedication was given simultaneously which included injection glycopyrrolate, injection ondansetron, injection midazolam, and injection fentanyl. Dexamethasone was given in anticipation of laryngeal edema. The patient was induced with injection propofol 50 mg and sevoflurane. Adequate bag-mask ventilation was possible, so injection succinylcholine was given. On direct laryngoscopy, the larynx was sprayed with 10% lignocaine. We attempted to pass cuffed Portex ETT of 5 no. through the larynx, but it could not be negotiated through the web. Therefore, an ETT of 4.5 size was put. Bilateral air entry was confirmed. ETT was fixed on the left corner of the mouth to provide adequate space for surgical manipulation. Anesthesia was maintained with O₂ + N₂O and sevoflurane on circle absorber system and injection atracurium intermittently. Low tidal volume (Vt) (130 ml) and high respiratory rate (R/R) (25/min) ventilation strategy were followed as ETT size was small and resistance was more. ETCO₂ and airway peak pressure were monitored closely throughout the surgery, and ventilation was adjusted accordingly.

The DL scope was inserted by the surgeons, and camera was adjusted to fix view of vocal cords on monitor. The web was removed gradually with help of an electrical cautery [Figure 1]. This widened the laryngeal aperture due to which gasses started leaking around the ETT. Initially, we compensated by increasing the fresh gas flow and Vt. Later, we had to replace the ETT with larger one. As flexometallic ETT was not available, 5.5-sized cuffed Portex ETT was inserted successfully. After complete resection of the web, mitomycin C was applied on margins of the resected area. This was followed by insertion of two needles for keel placement. Passage of needles was guided by anatomical landmarks externally and endoscope camera internally.

The lower puncture was made through the cricothyroid membrane. A 20-gauge needle was inserted and manipulated so as to emerge into the larynx just below the vocal cords. A monofilament thread was passed through the needle and was brought out through the mouth. Upper needle was then inserted roughly a centimeter higher and manipulated so as to emerge through the petiole/base of the epiglottis, just above the vocal cords [Figure 2]. A monofilament suture was similarly passed through it and brought out through the mouth. A thin silastic sheet of roughly 2 cm × 2 cm size [Figure 3] was railroaded on the first thread and was pushed through the endoscope into the larynx and positioned vertically between the vocal cords adjacent to the ETT [Figure 4]. Oral ends of both the threads were tied together in a thin knot. The second thread was pulled out through the upper needle which was followed by the knot and first thread. The knot was cut and the second thread was removed. Both free ends of the first thread were tied together on a button in front of the neck with multiple tight knots. Hemostasis was checked. Airway was cleared with proper suction. After noting good spontaneous attempts, neuromuscular blockade was reversed. The patient was extubated only when fully awake with utmost care to avoid displacement of the keel. Postoperative period was uneventful. The keel was removed after 3 months under general anesthesia. Follow-up for next 6 months was encouraging with no restenosis.

Discussion

Etiology of congenital laryngeal web is failure of recanalization of the glottic airway in the early weeks of embryogenesis. Almost 95% of congenital web are anterior, and more than 50% of the patients have chromosome 22q11.2 deletion syndrome. These patients should undergo genetic screening and a thorough cardiovascular evaluation in preoperative period, including imaging of the aortic arch.

Neonate usually presents with an abnormal cry or respiratory distress. Symptom may be subtle at birth and may exacerbate over the first few months of infancy.
Open keel placement by laryngofissure and open glottic reconstruction are the preferred options for repair of a congenital anterior glottic web in infant. It may be preceded or followed by tracheostomy. Endoscopic procedures such as laser division of the web or endoscopic keel placement are preferred in older child as in our case.[2,5]

Lichtenberger and Toohill[6] published a series of 12 patients of laryngeal web operated successfully by endolaryngeal keel placement using a special needle holder. Zhang et al.[7] published a study of 14 cadavers and twenty patients to determine reasonable extra-endolaryngeal puncturing sites and angles for implantation of laryngeal silastic sheet.

Enough data are available about surgical part of this procedure, but references regarding its anesthesia management are very few. Most of articles published about congenital laryngeal web are regarding unexpected difficult intubation caused by asymptomatic web.[8]

Preoperative fiber-optic bronchoscopy helped us to predict the size of the ETT. The time between induction and intubation was curtailed by the use of succinylcholine and adequate preoxygenation. Fortunately, bag-mask ventilation was easy in our case. Portex ETT was used only because flexometallic tube of appropriate size was not available. Wrapping the ETT with aluminum foil was not done as surgeons decided to use a fine-tipped cautery instead of laser and that too was though endoscope. Covering glottic and subglottic portion of ETT was obviously not possible. Instead, we asked surgeons to place thin wet cotton patties on oral and pharyngeal portion of ETT. Nasal intubation was not done as most of the surgical manipulations were going to take place in perinasal area.

Various ventilatory adjustments had to be done throughout the surgery and were guided by peak airway pressure and ETCO$_2$ level. As the small-sized ETT offers great resistance, our initial strategy of ventilation was low Vt and high R/R. The leak around the ETT kept increasing as the laryngeal cleft kept widening due to cautery. Small increments in Vt were done initially to compensate for it. Fresh gas flow had to be increased multiple times. Manual ventilation was used in later half of web excision. However, ETT had soon to be replaced by a larger, cuffed ETT as ventilation was getting wasted and ETCO$_2$ started rising. Furthermore, depth of insertion of ETT had to be adjusted carefully so that adequate space remained between its cuff and vocal cords for manipulation of the needles avoiding endobronchial passage at the same time. This minimized the risk of puncture of cuff by the needle. Endobronchial intubation and compression of ETT due to manipulation of DL scope were cautiously watched by observing ETCO$_2$, airway pressure, and frequent bilateral lung auscultation. As insertion of throat pack is not possible, one has to be vigilant about the bleeding and suction and has to instruct the surgeon accordingly. Accidental extubation...
and puncture of the ETT by needle are other important complications we had to watch for.

Mitomycin C, an antineoplastic antibiotic derived from Streptomyces caespitosus, inhibits DNA synthesis, cell division, and fibroblast proliferation and thereby reduces postoperative granulation and scar tissue formation. However, its usefulness in prevention of postoperative glottic stenosis is still in doubt.\[9\]

Extubation and postoperative period were also crucial. Laryngeal edema was a major concern in postoperative period. Preparation for emergency intubation including small-sized ETT, boogie, and tracheostomy was kept ready. On follow-up, the patient was able to breathe comfortably, but voice quality improved only a little. As there was no restenosis, the keel was removed after 3 months.

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Conflicts of interest
There are no conflicts of interest.

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