

# Slide Cricotracheoplasty: A Novel Surgical Technique for Congenital Cricotracheal Stenosis

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**Purpose:** The aim of this study was to introduce a new surgical technique for the correction of congenital cricotracheal stenosis.

**Methods:** A 5-day-old girl presented with esophageal atresia and congenital cricotracheal stenosis. After successfully correcting her esophageal atresia, the authors chose to use a type of slide cricotracheoplasty, which was a modification of slide tracheoplasty and anterior cricoid split.

**Results:** The postoperative period was remarkably uneventful except for minor subcutaneous emphysema, and the midterm results were excellent.

**Conclusions:** Slide cricotracheoplasty produced a good result and offered the same advantages as slide tracheoplasty. The authors believe that the described technique offers an efficient surgical procedure for the single-staged correction of congenital cricotracheal stenosis.

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**INDEX WORDS:** Congenital tracheal stenosis, congenital cricoid stenosis, slide cricotracheoplasty, slide tracheoplasty.

**C**ONGENITAL UPPER AIRWAY stenosis such as congenital tracheal stenosis and congenital subglottic stenosis, is a rare malformation. Although it was originally felt to be uniformly fatal, advances in techniques have made surgical repair and survival possible. However, the very rare combination of congenital tracheal stenosis and congenital cricoid stenosis (a congenital cricotracheal stenosis) still presents a difficult challenge. Slide tracheoplasty as used for the correction of congenital tracheal stenosis, and originally described by Tsang et al,<sup>1</sup> was reported to produce good results recently.<sup>2-9</sup>

We report a novel surgical technique, slide cricotracheoplasty, for the treatment of congenital cricotracheal stenosis.

## CASE REPORT

A girl was born by cesarean section at the gestational age of 41 weeks at another hospital, and a diagnosis of esophageal atresia with distal tracheoesophageal fistula was made. Attempted endotracheal intubation for the corrective surgery of the esophageal atresia failed on the fifth day of life because of a suspected subglottic narrowing. The baby was transferred to our hospital because of progressive respiratory difficulty. Endotracheal intubation in our hospital with 2-mm (inner diameter) intubation tube was performed successfully, but with much difficulty. Total correction of the esophageal atresia and the distal tracheoesophageal fistula was performed on the eighth day of life. After successful surgery for the esophageal atresia, the patient was kept intubated and the airway obstruction further evaluated.

Bronchoscopic examination found that the stenosis extended from 0.5 cm below the vocal cords to 2.7 cm above the carina. A spiral computed tomography CT scan showed that the length of the stenosis represented 30% of the total length of the laryngotrachea (Fig 1). On the 31st day of life, slide cricotracheoplasty was performed successfully. After the slide cricotracheoplasty, the 2-mm intubation tube was replaced with a 3.5-mm intubation tube. The neck was maintained in a

flexed position with a prefabricated neck brace. The baby was extubated 3 days after the slide cricotracheoplasty. Mild subcutaneous emphysema occurred but resolved without specific treatment. The patient was discharged 18 days after the slide cricotracheoplasty and has remained well to date (15 months after the slide cricotracheoplasty).

## Surgical Technique

After endotracheal inhalation anesthesia, the neck was extended and a transverse collar neck incision made. The upper airway was exposed from the cricoid cartilage to the carina (Fig 2A). The extent of the stenotic segment was determined accurately by bronchoscopic observation of a needle tip inserted from the outside of the airway. The stenotic segment was found to extend from the cricoid cartilage to the upper fifth tracheal cartilage, with maximum stenosis at the cricoid cartilage. After defining the stenotic segment, the isthmus of the thyroid gland was mobilized from the trachea, doubly clamped, and divided. The isthmuses on each side then were sutured with continuous interlocking 4-0 Vicryl sutures. Retraction of both thyroid lobes laterally exposed the lower border of the cricoid and the upper tracheal rings. The trachea then was divided at the level of the midpoint of the stenotic segment, and ventilation provided across the operative field with the endotracheal tube passed beyond the stenosis. The cephalad portion of the trachea and the cricoid was split on their anterior surface up to the cricothyroid membrane. The splitting showed markedly hypertrophied cricoid cartilage that narrowed the lumen of the larynx. The caudal segment of the stenotic trachea was similarly split on its posterior wall

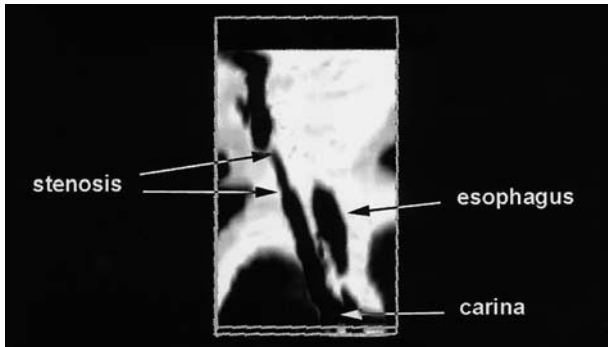
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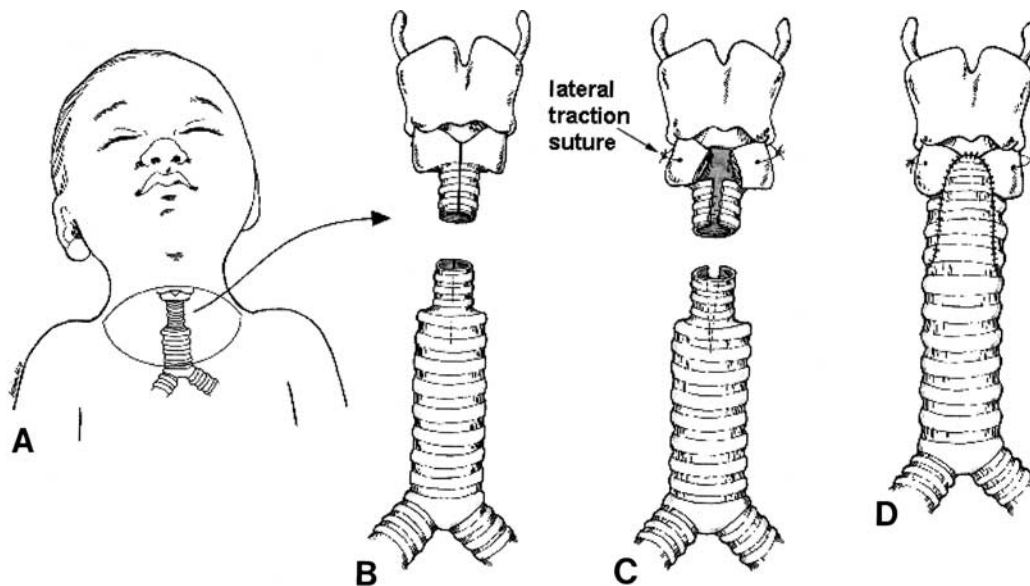
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**Fig 1.** Reconstruction image of a spiral CT scan shows that the length of the stenotic segment represented 30% (1.19 cm) of total length of the laryngotrachea (3.97 cm).

and extended until the normal segment of the trachea was encountered caudally (Fig 2B). Posterior dissection allowed the sliding of both segments. The excessive hypertrophied portion of the anterior cricoid arch was resected, and the right-angled corners of 2 segments were trimmed. Because of the stiffness of the cricoid cartilage and the relative flexibility of the tracheal cartilage, 2 lateral traction sutures of cricoid cartilage to prevertebral fascia were necessary to maintain enough space to accommodate the slide caudal portion of the trachea (Fig 2C). After flexing the neck, the superior tracheal segment was anastomosed, first posteriorly, with interrupted 5-0 Vicryl sutures, to the inferior segment. The operative field endotracheal tube then was exchanged for an oral endotracheal tube, by first passing a pediatric feeding tube through the upper portion of the trachea and out of the baby's mouth as a guide. The endotracheal tube then was passed under direct vision past the posterior reconstruction, after which the anterior anastomosis was completed (Fig 2D). The cervical incision was closed



**Fig 2.** (A) The baby was placed with her neck extended and a transverse collar incision made. (B) After dividing the stenotic segment at the midpoint of the stenosis, the upper segment was split at the anterior midline and the lower segment at the posterior midline. (C) The excessive cartilage of the anterior cricoid plate was resected and the vertical split of the cricoid cartilage was kept enlarged with two lateral traction sutures of cricoid cartilage to the prevertebral fascia to accommodate the caudal portion of the trachea. (D) The upper segment then was slid behind the lower segment with a wedge from the upper segment placed into the split made on the lower. The anastomosis was constructed with multiple interrupted sutures.

layer by layer and a SILASTIC® (Dow Corning, Midland, MI) drain inserted.

## DISCUSSION

Congenital cricoid stenosis is a very rare malformation of the larynx in which excessive cartilage causes narrowing of the larynx lumen.<sup>10</sup> In cases of severe congenital cricoid stenosis, the patients usually have respiratory distress after birth, and an emergency surgical procedure has to be performed. Various surgical techniques including endoscopic cauterization, anterior cricoid split, and autogenous cartilage graft have been attempted to correct congenital cricoid stenosis.<sup>10</sup> However, the final outcomes of all these procedures are not always satisfactory, mainly, because they often result in the formation of granulation tissue, which requires long-term stenting with an intubation tube and repeated bronchoscopies and tracheostomy. Moreover, they may produce recurrent stenosis. Congenital tracheal stenosis is caused by a complete tracheal ring that usually requires corrective surgery. Few surgical options for correcting congenital tracheal stenosis were available previously. Those available included resection with end-to-end anastomosis<sup>11,12</sup> and various types of tracheoplasties, such as, esophageal wall patch graft,<sup>13</sup> cartilaginous support graft,<sup>14</sup> and pericardial patch.<sup>15</sup> However, many serious problems prevented their widespread use. The first report by Tsang et al<sup>1</sup> on the use of slide tracheoplasty for the correction of the long segment of congenital tracheal stenosis has

allowed congenital tracheal stenosis to be corrected satisfactorily.<sup>2-9</sup>

Slide tracheoplasty has many advantages: the stenotic segment is halved with less anastomotic tension; the circumference of the stenotic trachea is doubled; the luminal cross section quadruples; the approach is cervical with or without partial sternotomy without cardiopulmonary bypass; and the blood supply is not impaired, which results in excellent healing and minimal complications.<sup>2</sup> Growth of the reconstructed hemitracheal rings after the slide tracheoplasty also has been shown.<sup>16</sup>

Although it has been reported that a congenital upper airway anomalies, such as tracheomalacia, congenital tracheal stenosis, and congenital cricoid stenosis are occasionally associated with esophageal atresia,<sup>17-19</sup> we were unable to find a reported case of congenital cricotracheal stenosis associated with esophageal atresia in the English-language literature. Because of the lack of cases and no experience of this rare combination of upper airway anomalies, no optimal repair has been reported for congenital cricotracheal stenosis. To correct this rare combined upper airway anomaly in our case, we chose to use a modification based on slide tracheoplasty and anterior cricoid split.

We believe that our new surgical technique has all the advantages of slide tracheoplasty for the correction of

congenital tracheal stenosis and additional advantages for the correction of congenital cricoid stenosis. It should be noted that the previously reported autogenous costal cartilage graft for congenital cricoid stenosis is not a vascularized graft, and may result in graft necrosis.<sup>10</sup> However, the slide caudal segment of the trachea in our surgical technique actually is a kind of vascularized graft and on this basis is expected to result in improved graft survival. Moreover, the costal cartilage graft has perichondrium on the luminal side instead of the normal respiratory mucosa, which may result in poor mucosal healing. However, the slide caudal segment of the trachea in our surgical technique has normal respiratory mucosa. The normal respiratory mucosa will promote more excellent and rapid healing than the perichondrium.

The slide cricotracheoplasty achieved successful laryngotracheal reconstruction in our case by using the patient's own tracheal tissues and with all the potential benefits of slide tracheoplasty, including the avoidance of cardiopulmonary bypass, immediate or early postoperative extubation, and the near-complete absence of granulation tissue formation. We believe that slide cricotracheoplasty is an efficient single-stage surgical procedure for the correction of congenital cricotracheal stenosis.

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