



Anterior cricoid split

Peggy E. Kelley, MD, FACS, FAAP

From the Department of Otolaryngology, University of Colorado Denver School of Medicine, Denver and Health Sciences Center, Vascular Malformation Clinic, The Children's Hospital, University of Colorado, Denver, Colorado.

KEYWORDS:

Failed extubation;
 Subglottic stenosis;
 Cricoid split

The anterior cricoid split is an operation in the pediatric otolaryngologist's armamentarium for dealing with failed extubation in the neonate or very young infant. Successful extubation requires careful patient selection taking into account comorbidities and gestational age. This article describes the indications and technique for anterior cricoid split and explores limited indications and potential keys for success.

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Anterior cricoid split is an operation that has not changed much in technique as it was originally described in 1980.¹ It is used as an alternative for tracheotomy in the premature or young infant.² The realization that gastroesophageal reflux disease is a common cause of reactive edema of the airway and, the routine use of proton pump inhibitors to control this problem has increased the success of extubation. This has, however, shifted the remaining patients who fail extubation into more severe categories. Premature infants who fail extubation are sicker and have more comorbidities that have long been known to limit the success of the anterior cricoid split.¹ Any secondary airway abnormality decreases the chance of success and must be diagnosed and potentially treated before airway obstruction at the cricoid can be addressed. Examples of a secondary airway abnormality could be choanal atresia, retrognathia, vocal fold paresis, severe laryngomalacia, vallecular cysts, laryngeal cleft, and tracheomalacia.³ It is also necessary to be able to use steroids in the periextubation period that would not be possible if the patient is concurrently on treatment for congestive heart failure or hypertension. Another significant problem in many premature infants is bronchopulmonary dysplasia. To be successful after anterior cricoid split the patient must be fully weaned from the ventilator and be failing extubation solely based on subglottic stenosis. This eliminates many

infants who fail extubation in the neonatal intensive care unit. In fact, after original success rates of the 70%-80% more recent success rates for cricoid split are reported at 60% or less.⁴ Better success rates are observed in infants born full-term. It is suggested that if an older infant (either post dates in a premature infant or a full-term baby more than 2-weeks old) requires subglottic reconstruction, a cricoid split with augmentation using an ear conchal cartilage or thyroid ala should be considered. Furthermore, excellent communication with the neonatologist and care team is essential.

Indications

The indication for cricoid split is restricted to neonates or young infants whose pathology is limited to swelling of the glottis and/or subglottis that causes multiple failed extubation attempts.⁵⁻⁸ Normally, mobile vocal folds and adequate pulmonary reserve are required. In a premature infant there is a minimum weight requirement of 1500 g. Other requirements include (1) no ventilator support necessary for several days before repair, (2) minimal (less than 30%) supplemental oxygen requirement, (3) no congestive heart failure or antihypertensive medication use that could preclude the use of steroids, and (4) no acute respiratory infection at the time of the operation that could prolong the need for intubation after the cricoid split.

Address reprint requests and correspondence: Peggy E. Kelley, MD, FACS, FAAP, Department of Otolaryngology, The Children's Hospital, 13123 East 16th Ave, B455, Aurora, CO 80045.

E-mail address: kelly.peggy@tchden.org.

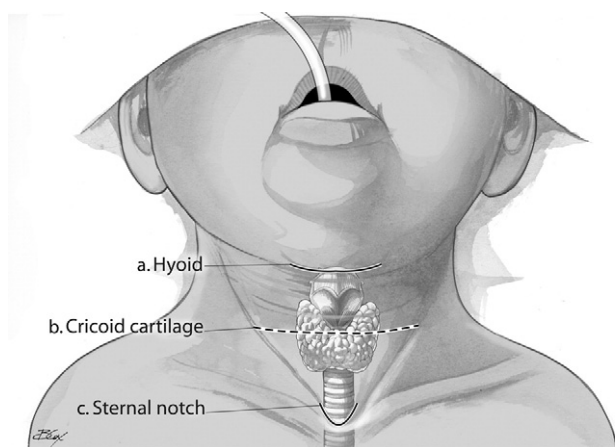


Figure 1 Intubated child with neck extended. Skin markings of (a) hyoid bone, (b) cricoid cartilage, and (c) sternal notch.

Technique

All children considered for a cricoid split should undergo an awake-flexible laryngoscopy to rule out vocal fold paresis or severe laryngomalacia. This needs to be performed during a trial extubation. The first step in a cricoid split is to perform a full rigid microlaryngoscopy or telescopic laryngoscopy and bronchoscopy to rule out any other airway abnormalities, particularly tracheomalacia. The procedure begins with the patient under general anesthesia with an endotracheal tube or rigid bronchoscope in place. The infant is placed in the supine position, on a shoulder roll to expose the neck. The anterior neck is prepped and draped exposing the chin to the sternal notch (Figure 1). The neck is palpated and the hyoid bone, cricoid cartilage, and sternal notch are marked (Figure 2). A skin incision is made in the skin fold just over the cricoid ring no wider than the sternocleidomastoid muscles and continued through the subcutaneous tissues. A subplatysmal flap is developed superiorly to the thyroid notch or hyoid bone (which may override the thyroid cartilage in infants) and inferiorly to expose about 2-3 tracheal rings by palpation (Figure 3). The strap muscles of the neck are divided along the midline raphe and reflected laterally exposing the cartilages (Figure 4). The thyroid isthmus is divided in the midline and reflected laterally if it overlies the upper tracheal rings (Figure 5). The cricoid cartilage and lower quarter of the thyroid cartilage are divided in the midline. Carefully remaining in the midline (and not pulling toward the side of the surgeon) the first one or 2 tracheal rings are divided exposing the existing endo-



Figure 2 Skin incision over cricoid cartilage.

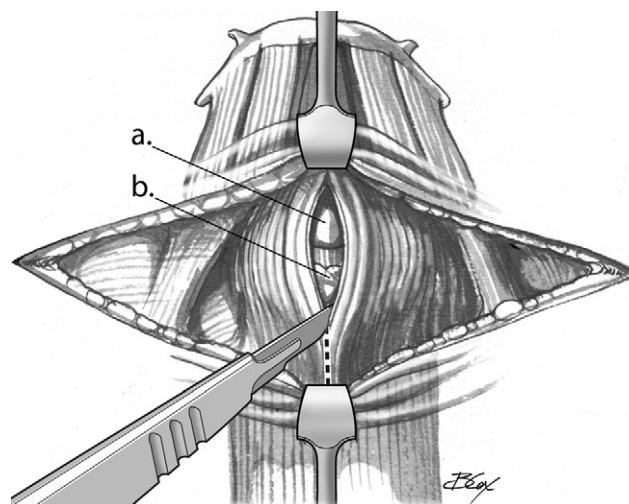


Figure 3 Incision over cricoid cartilage. Dissection of strap muscles laterally exposing (a) thyroid cartilage and (b) the thyroid gland.

tracheal tube. Two 4-0 prolene stay sutures are placed submucosally around the cricoid cartilage for retraction (Figure 6). The endotracheal tube is removed and replaced with a tube half a size larger than would be used for the expected age and weight. Approximate sizes to use are a 3.0 mm tube for babies <2000 g, a 3.5 for 2000-3000 g, and 4.0 for 3001-4000 g.⁶ The cricoid should be splayed by up to 3 mm at this point to accommodate the endotracheal tube. If it is not, a larger endotracheal tube should be chosen (Figure 4). The stay sutures may be removed at this point if the wound is partially closed or left in place in case of accidental extubation for ease of reinsertion if the wound is left more open. A rubber band drain is placed under the strap muscles and extended onto the skin where it is sutured in place. The

Figure 4 (a) Thyroid cartilage exposed, (b) strap muscles retracted laterally with sutures, and (c) thyroid gland overlying cricoid cartilage.

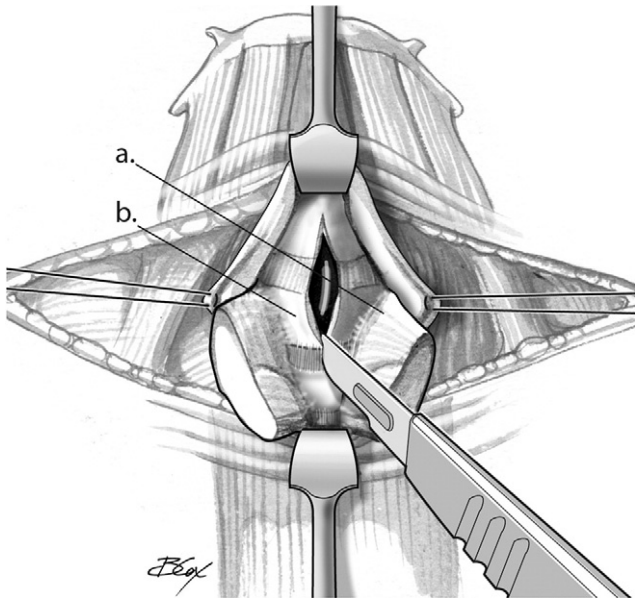


Figure 5 (a) Thyroid divided and reflected laterally exposing (b) cricoid cartilage.

strap muscles can be loosely closed with interrupted absorbable suture, such as 4-0 Vicryl. The platysmal layer is closed in a similar manner, and if the stay sutures have been removed, the skin is closed using a running subcuticular suture such as a 5-0 Monocryl leaving adequate opening laterally for an air leak around the drain.

The neck can be dressed with a stretchy woven net such as is used for burn dressings over a lateral 2×2 gauze around the drain or left with no dressing. This allows for easy observation of the incision site for subcutaneous emphysema.

The patient is started on a proton pump inhibitor twice daily. Prophylactic antibiotics are not routinely used. The patient is left intubated for 7-14 days. Smaller infants (<2000 g) may be intubated for the full 14 days. Decadron at 1 mg/kg is used the day before and for 4 days after extubation. If steroids are needed for longer than 5 days a taper is used.

When the infant is ready for extubation is best performed in the operating suite with microlaryngoscopy, bronchoscopy to confirm a healed anterior wall of the subglottis. An endotracheal tube half-size smaller than the one removed is placed in the airway, the patient is awakened, and when fully awake and stable in the newborn intensive care unit, the tube is removed as an awake extubation. Racemic epinephrine's as nebulized treatments are commonly needed to bridge the first few hours of extubation and airway distress.

Complications

Complications of anterior cricoid split can be divided into those related to immediate surgery and postoperative stenting, those related to the patient's medical problems, and those related to sedation during intubation. The most com-

monly reported complications are atelectasis, malposition of the endotracheal tube, and accidental extubation.⁹

Those related directly to the surgery with the resultant open trachea are emphysema, (subcutaneous or mediastinal), pneumothorax, aeroceles, tracheocutaneous fistulas, and wound infection. Endotracheal tube complications such as mucus plugging, pneumonia, tracheitis, or accidental extubation as well as atelectasis are consequences of sedation and have been improved with better sedation regimens. Another improvement in the care of the intubated patient is the use of the in-line suction that is used for any intubated intensive care patient to decrease infections caused by open suctioning.

Persistent subglottis stenosis or failure at extubation may also be considered a complication of anterior cricoid split. If the infant fails extubation, the airway is reassessed. If an infant tolerates extubation for several hours but then fails, reintubation with a half size smaller tube than the original stenting endotracheal tube and a few more days of steroid may result in successful extubation.³ If further surgical intervention is needed for multiple failed attempts of extubation, tracheotomy or an augmentative airway reconstructive procedure will be required.

Discussion

Anterior cricoid split is an airway procedure that can be performed on the premature or young infant in an attempt to avoid a tracheotomy. At best, it is successful about 80% of the time.^{4,5} Achieving even that modicum of success requires careful patient selection. Any child with vocal fold paresis and inadequate weaning parameters from the ventilator is contraindicated for a cricoid split operation. The patient should be able to tolerate pressure support trials and

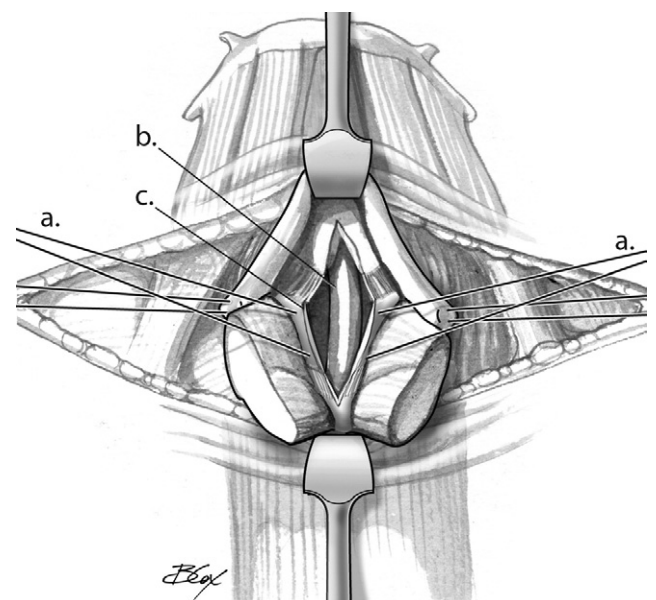


Figure 6 (a) Stay suture in divided cricoid cartilage, (b) exposed endotracheal tube through split, and (c) airway incision through lower one-fourth thyroid cartilage, cricoid, and first tracheal ring.

have FiO_2 of less than 30%. Other exclusion criteria are severe laryngomalacia or other airway lesions that would require reconstruction or otherwise prevent extubation, such as tracheomalacia, vascular rings, mandibular hypoplasia, choanal atresia, etc.⁵ Finally, any medical condition that would preclude steroid use such as hypertension or congestive heart failure should be excluded.

Cricoid splits should not be attempted in infants below 1500-g weight who should progress to tracheotomy if needed. However, any infant less than 2 kg may not tolerate a 3.5-mm internal diameter tracheotomy tube. The 3.0-mm tracheotomy tube can only be suctioned with the 5 of 6 French sized catheters and has more difficulties with mucus plugging leading to more morbidity and possibly mortality.

Originally, the cricoid split technique was reported with dividing the thyroid cartilage much higher—up to 2 mm from the thyroid notch opening. This was thought to be important to accommodate glottic stenosis. However, concern about damage to the anterior commissure and the use of proton pump inhibitors medications has made this practice much less common. Avoiding dividing the anterior commissure of the vocal folds is preferred to minimize complications from anterior commissure blunting caused by the endotracheal tube and resulting hoarseness.

Another technical consideration is the timing of drain removal. Because the endotracheal tube is stenting the trachea open, a significant air leak through the wound might be expected. There is often an air leak with coughing on the tube or inadequate sedation but usually after 3 days the air leak subsides. Leaving the stay sutures or the drain for several days until the air leak subsides increases the risk of an aerocele or a tracheocutaneous fistula. Therefore, close monitoring of the wound and early removal of the stay sutures and drain with better approximation of the wound

layers is desirable. It is the prolonged separation of the wound layers that can lead to an aerocele formation or the development of a tracheocutaneous fistula.

Further there is a difference in the type of healing of the cricoid in the preterm or early infant versus the older infant. In preterm infants the cricoid split has been shown to heal with cartilage.¹ In the older infant and child the cricoid split heals with fibrous tissue unless cartilage augmentation is placed. Therefore, the success of extubation after anterior cricoid split may increase if the procedure is limited to infants of 40-42 weeks gestational age.

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