The Laryngoscope

How I Do It

Minimally Invasive Approach to Laryngeal Cleft

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Laryngeal cleft is a rare congenital anomaly that is recently being diagnosed with increased frequency. The objective of this report is to present a comprehensive description of endoscopic laser repair of a laryngeal cleft, using both the carbon dioxide (CO_2) laser via a micromanipulator (Carl Zeiss Microimaging Inc., Thornwood, NY) and the flexible CO_2 laser fiber (OmniGuide, Inc.; Cambridge, MA), from both an anesthesia and surgical perspective.

Key Words: Laryngeal cleft, aspiration, carbon dioxide laser, flexible carbon dioxide laser fiber.

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INTRODUCTION

Laryngeal cleft is a rare congenital anomaly in which the posterior aspect of the larynx fails to fuse, resulting in an aberrant connection between the airway and the esophagus.[1] The incidence of laryngeal cleft is reported to be 1 in 10,000 to 20,000 live births; however, recently it is being diagnosed with increased frequency, with a greater number of patients with type 1 and type 2 clefts being diagnosed.[2] The diagnosis of type 1 laryngeal cleft, in which the cleft lies above the level of the true vocal cords,[3] can be challenging and requires a high level of suspicion; presenting symptoms are often nonspecific and can include feeding difficulties, cough with drinking thin liquids, wheeze, chronic cough, and recurrent respiratory tract infections requiring hospital admission.[4–7] Microlaryngobronchoscopy under general anesthesia, with specific palpation of the interarytenoid region, remains the gold standard in diagnosis (Fig. 1).

The primary goal of treatment is to resolve feeding difficulties and minimize respiratory complications related to aspiration.[5] Management is initially conservative, with antireflux medication, feeding therapy, and optimization of respiratory status. Endoscopic repair is possible for type 1, 2, and selective type 3 clefts.[6] Challenges to successful repair include adequate endoscopic visualization, tubeless anesthesia with spontaneous ventilation, and the often complex medical history associated with patients undergoing repair. Both syndromic (Opitz-Frias [G] and Pallister-Hall syndromes) and nonsyndromic anomalies of the cardiac, gastrointestinal, and genitourinary system have been described with laryngeal clefts.[8,9] Complications of repair include inadequate endoscopic access, making endoscopic repair difficult, and dehiscence of the repair site requiring revision procedure.

In this article, we comprehensively describe our technique of endoscopic laryngeal cleft repair using both the carbon dioxide (CO_2) laser via a micromanipulator (Carl Zeiss Microimaging Inc., Thornwood, NY) and the flexible CO_2 laser fiber (OmniGuide, Inc., Cambridge, MA). The laser fiber delivers the beam through flexible hollow-core photonic bandgap mirror fibers, allowing the laser to be wielded like any other surgical instrument.[10] It provides a reliable method of delivering CO_2 laser to previously inaccessible sites. This is the first description of the flexible CO_2 laser for laryngeal cleft repair. We also highlight the anesthesia and surgical pearls necessary for success.[5]

METHOD OF ENDOSCOPIC REPAIR

Preoperative Preparation

Of particular importance is appropriate microlaryngeal instrumentation to facilitate endoscopic repair. Our microlaryngeal set contains 10 instruments: three Kleinsasser needle holders (Karl Storz Endoscopy-America, Inc., El Segundo, CA) for suture manipulation, knot pusher (Karl Storz Endoscopy-America, Inc.), Jako probe (Pilling Surgical Instruments, Teleflex Medical, Durham, NC) for cleft palpation, Lindholm vocal cord retractor (Karl Storz Endoscopy-America, Inc.) to splay the cleft

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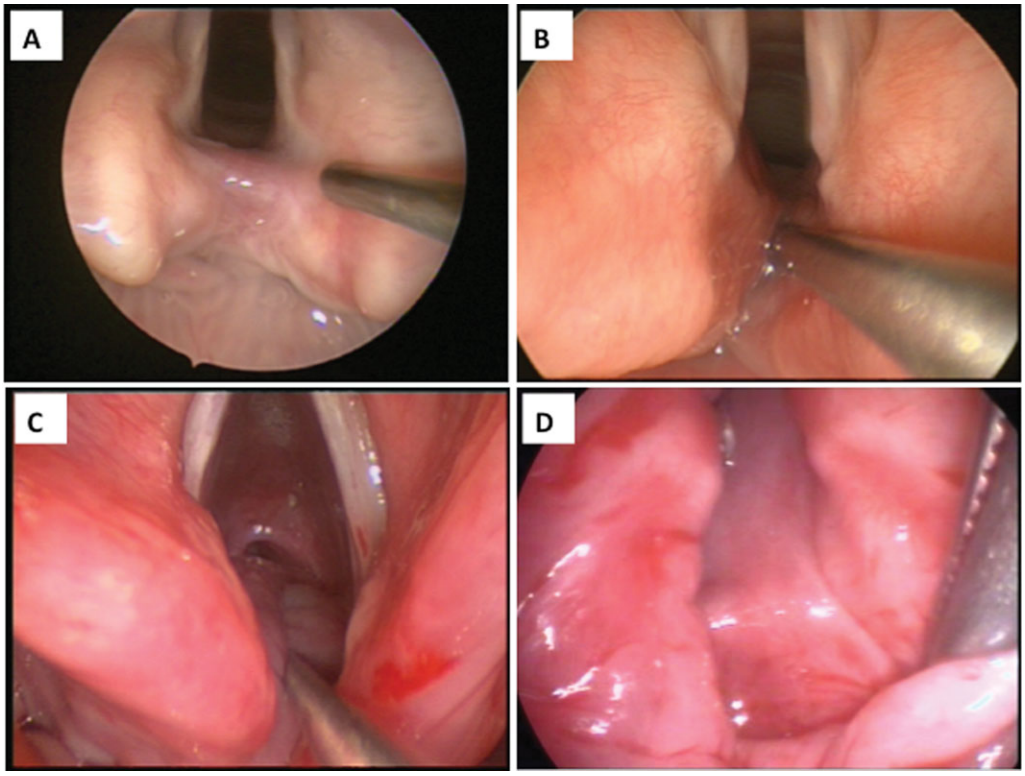

Fig. 1. Diagnosis of laryngeal cleft type 1 to 4 at microlaryngoscopy. (A) Type 1 laryngeal cleft extending to the level of the true vocal cords. (B) Type 2 laryngeal cleft extending into the cricoid cartilage. (C) Type 3 laryngeal cleft extending through the cricoid cartilage and into the cervical trachea. (D) Type 4 laryngeal cleft extending into the thoracic trachea.

open if excessive mucosa is present, two scissors (straight and curved), and two alligator forceps (small and large). A range of laryngeal suctions (Karl Storz Endoscopy-America, Inc.) should also be available (Fig. 2). CO_2 laser via a micromanipulator or the flexible CO_2 laser fiber should be ready for use in the operating room. A range of CO_2 laser fiber delivery channels are available depending on the length the fiber needs to travel and the angle at which the bean is applied (Fig. 3A,B).

Anesthesia

The success of the endoscopic approach depends on the otolaryngologist having complete access to the larynx and an unimpeded view of the cleft. We advocate the necessity of tubeless surgery, with spontaneous ventilation and avoidance of an endotracheal tube. This enables complete access to the airway for instrumentation and facilitates placement of the laryngeal sutures with greater precision. It also eliminates the risk of endotracheal tube-related damage to the suture line. Preoperative discussion and clear communication with an experienced anesthesiologist, who has a full understanding of the anatomy, is required for the maintenance of a smooth anesthetic state throughout the surgery. Anesthesia is best achieved by inhalation induction (sevoflurane, nitrous oxide) followed by administration of intravenous agents (propofol, remifentanil) to maintain unconsciousness. In addition, topical 4% (1% and 2% are insufficient) lidocaine is applied to the surgical site for analgesia. Oxygen can be continuously delivered to the larynx via a jet ventilation needle; however, jet ventilation is not used.

Operative Technique

Once anesthesia is satisfactory, examination of the entire upper airway is first performed using a Parson's laryngoscope and a 0° Hopkins-rod 4-mm telescope (Karl Storz Endoscopy-America, Inc.), to confirm the diagnosis and identify any coexisting airway pathology. The cleft is identified by palpation of the posterior glottis using the Jako probe (Fig. 4A). Care must be taken not to apply excessive force and inferior pressure to the posterior glottis with the probe, as this may lead to an incorrect diagnosis.

Exposure. Suspension laryngoscopy (Karl Storz Endoscopy-America, Inc.) is performed with an appropriate-size Lindholm laryngoscope, ensuring the interarytenoid region is visualized in the center of the microscopic field. Adequate endoscopic exposure of the cleft is vital for success.

Repair. The mucosal margin of the cleft is denuded using the CO_2 laser under microscopic vision at a setting of 3 to 5 W, 0.1 to 0.3-second intermittent mode (Fig. 4B). To prevent fistula formation, extreme care is taken to completely remove the mucosa at the depth of the cleft. Care must also be taken not to past-point the laser beam and inadvertently injure tracheal mucosa. Where it is not possible to use the standard CO_2 laser in the apex

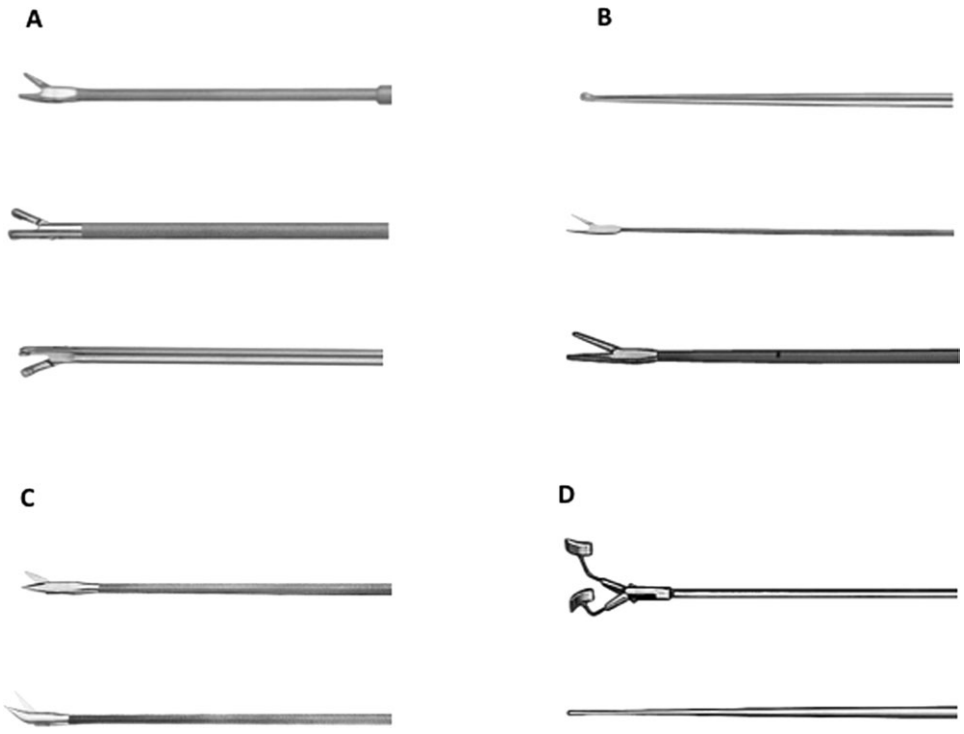

Fig. 2. Ten-piece instrumentation set for endoscopic laryngeal cleft repair (courtesy of Karl Storz Endoscopy-America, Inc., El Segundo, CA). (A) Kleinsasser needle holders (straight, right and left). (B) Knot pusher, small and large alligator forceps. (C) Straight and curved scissors. (D) Vocal cord retractor and Jako probe.

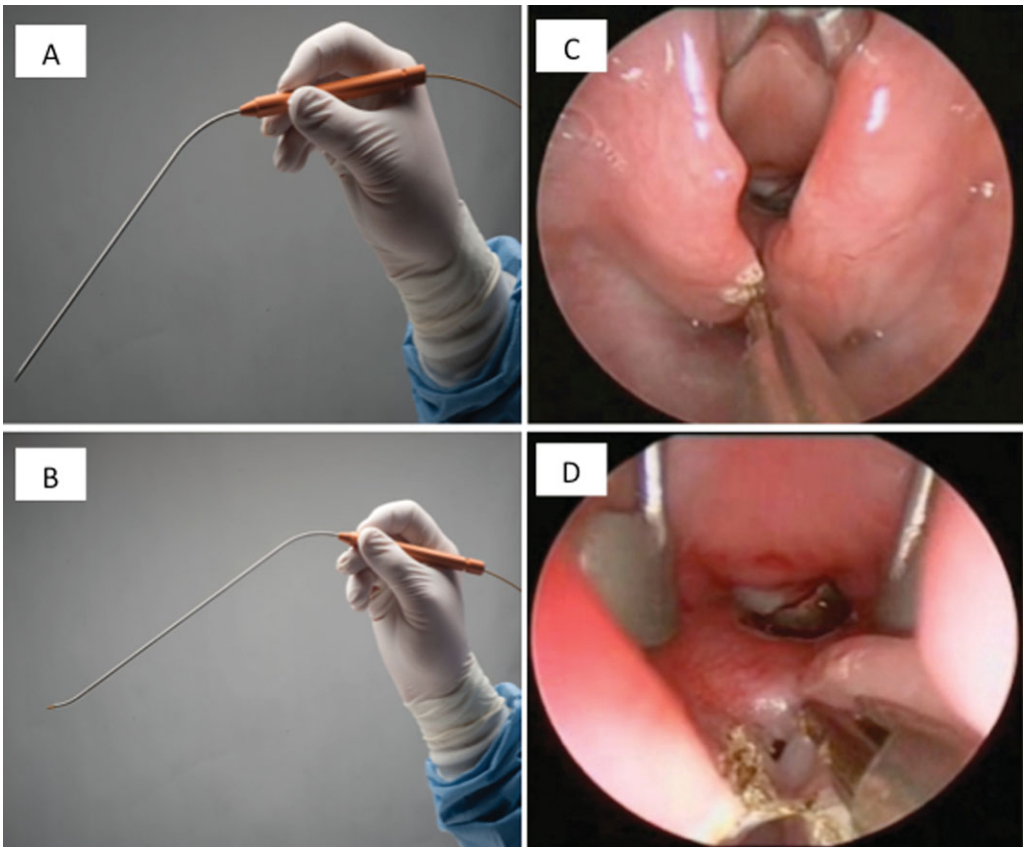

Fig. 3. (A,B) Delivery channels for the CO_2 laser fiber (courtesy of OmniGuide, Inc., Cambridge, MA.). (C) Using the flexible laser fiber to denude the mucosa at the apex of a type 3 laryngeal cleft. Note: the vocal cord retractor is present to improve access. (D) The tip of the flexible laser fiber is seen at the apex of the cleft.

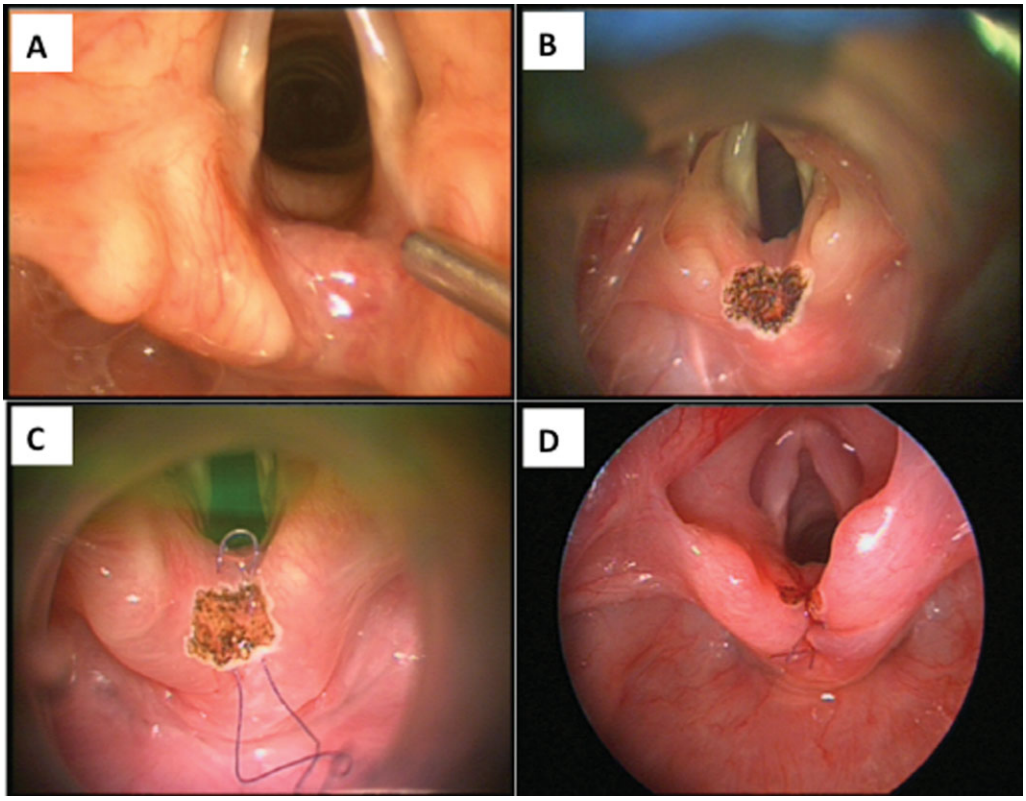

Fig. 4. (A) Palpation of a type 1 laryngeal cleft using a Jako probe. (B) CO_2 laser to denude the mucosa of the cleft. (C) Placing the first suture in the apex of the cleft. (D) Repaired type 1 laryngeal cleft.

of the cleft due to poor visualization, we recommend using the flexible CO_2 laser fiber to allow more precise application of the laser beam (Fig. 3C,D). The flexible CO_2 laser can be applied at a setting of 6 to 8 W, 100-ms single pulse, using either the microscope or 4-mm 0° Hopkins telescope for visualization. We recommend removing charred tissue using $^1/_8$-in oxymetazoline-soaked pledgets to prevent excessive heat.

The mucosal layers are then apposed with absorbable interrupted sutures, 6-0 Vicryl for an infant or 5-0 Vicryl for an older child (polyglactin; Ethicon, Somerville, NJ) on a reverse cutting needle using the Kleinsasser needle holder and tied using the knot pusher. A reverse cutting needle greatly reduces the incidence of tissue damage and cutout. The first suture is the most important and must be placed at the most inferior extent of the cleft to prevent persistence of a fistula (Fig. 4C). When placing sutures, care must be taken not to inadvertently injure the epiglottis with the needle tip, as this will cause bleeding and make visualization difficult. Simple interrupted sutures are used passing the needle from posterior to anterior, and then anterior to posterior. Occasionally a figure of eight-type suture is used if there is difficulty placing an interrupted suture; this involves passing the needle from posterior to anterior on both sides of the cleft. Sutures are tied on the posterior surface of the cleft to prevent the formation of granulation tissue in the airway. Generally, two to three sutures are required to close a type 1 or 2 cleft (Fig. 4D). Once the repair is complete, a 0° Hopkins-rod telescope is passed into the trachea, and blood or secretions that may have pooled are suctioned.

Postoperative care. The patient is awaken at the end of the procedure and admitted to the intensive care unit for the first 24 hours for close airway observations, then transferred to the floor for the second 24 hours. Intravenous antibiotics (ampicillin/sulbactam) are administered for 48 hours and then continued orally for 10 days. Three doses of intravenous steroid (dexamethasone 0.5 mg/kg) are given. Antireflux medication is commenced and continued for 4 weeks. Preoperative feeding regime is restarted when the patient is fully awake postoperatively. Flexible laryngoscopy is performed in the clinic at 1 week to inspect the repair site. A modified barium swallow study is performed in 2 to 3 months. It is important to counsel the family, that often feeding issues may continue for a short time postoperatively, despite successful surgical repair of the cleft, due to neuromuscular discoordination of the swallowing reflex.

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