Chondrolaryngoplasty

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KEYWORDS

• Chondrolaryngoplasty • Feminization laryngoplasty • Tracheal shave • Neck feminization • Facial feminization

KEY POINTS

- Chondrolaryngoplasty, commonly known by the misnomer "Tracheal Shave", is a cosmetic surgical procedure designed to reduce the anterior prominence of the thyroid cartilage, the "Adam's apple".
- When performed with direct visualization of the vocal cords, a maximum reduction can be achieved safely.
- Evaluation of outcomes associated with chondrolaryngoplasty demonstrates a high rate of satisfaction and a low rate of complications.
- Chondrolaryngoplasty may be performed safely in conjunction with other facial feminization procedures.

Video content accompanies this article at http://www.facialplastic.theclinics.com.

INTRODUCTION

An understanding of laryngeal anatomy and gender differences during development is necessary to maximize outcomes and perform chondrolaryngoplasty safely. The larynx undergoes significant developmental changes and often becomes a source of gender dysphoria for transgender patients. Until puberty, the male and female laryngeal frameworks are indistinguishable from one another. After puberty, all the cartilaginous components of a male larynx become larger than their counterparts in the female larynx. The anterior-posterior dimension of the thyroid cartilage, in particular, will double in size and the entire larynx is about 20% larger in men compared with women. This size increase in part accounts for the deeper voice typical to most men. As the larynx develops from the fourth and sixth branchial arch, the laminae of the thyroid cartilage migrate and fuse anteriorly in the midline leaving a gap in the superior-most part, otherwise known as the thyroid notch. The anterior projection of this notch or the thyroid prominence is greater in men and is often called the "Adam's apple."

Studies evaluating computed tomography images of the thyroid cartilage demonstrate significant gender-specific differences. The laminae in women are more flattened, ranging from 80° to 120°. In men, however, this angle is sharper, ranging between 63° and 90°.[1–7] Similarly, the anterior angulation of the thyroid cartilage, defined as the angle between two lines tangential to the cricothyroid membrane and the anterior face of the thyroid cartilage, is more acute (155°–167°) in men compared to women who have a more obtuse angle (168°–172°).[8] These studies demonstrate that the thyroid cartilage in men is more anteriorly rotated and the notch is sharper, creating a more prominent Adam's apple.

Chondrolaryngoplasty is more commonly, and rather inaccurately, known as a "tracheal shave", despite the fact that no intervention is performed on the trachea. It was first described by Wolfort and Parry in 1975 and further modified by Wolfort

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in 1990.[9–11] These initial approaches relied on elevating the perichondrium on the glottic surface of the thyroid cartilage to identify the thyroepiglottic ligament and thus the inferior extent of the resection. The cartilage was then reduced using a burr, however, other instruments including cautery and cold-cutting devices may also be used. Since then, the technique has been further modified to allow for more complete resection under direct visualization of the anterior commissure using a laryngeal mask and flexible laryngoscope.[12]

The absence of Adam's apple in a man is unnoticed, but the presence of Adam's apple in a woman is distinct and out of place. As a result, transgender patients seeking gender-reaffirming surgery may desire a chondrolaryngoplasty to reduce the size of their thyroid prominence. This procedure can be done safely in the operative room, oftentimes concurrently with other facial feminization procedures.

PATIENT EVALUATION

Before a surgical referral for chondrolaryngoplasty, patients must be evaluated by their medical and mental health care providers. Psychological well-being, reasonable expectations, and physical exam findings all play a role when determining who is a good candidate for chondrolaryngoplasty. For example, a patient with a slender neck and large prominent thyroid cartilage may have a more meaningful outcome than a patient with significant submental adipose tissue and a less obvious Adam's apple. On the other hand, it may be more difficult or impossible to completely remove the appearance caused by a larger thyroid cartilage on a more slender neck. The average distance between the thyroid notch and the anterior commissure is 7 mm, ranging on average between 5 and 11 mm.[13] If there is prominence of the thyroid cartilage inferior to this level, then complete removal of prominence may not be achieved without sacrificing voice quality, a tradeoff that is not acceptable and should be reinforced in patients. It is also important to realize that the degree of dysphoria does not necessarily correlate with the visibility or prominence of the thyroid notch. Additionally, sometimes the most prominent structure in the neck is not the thyroid cartilage but rather the cricoid cartilage and this must also be pointed out to patients when managing expectations as to what can be accomplished.

The position of the thyroid notch relative to the hyoid bone will determine how high the horizontal incision can be placed. Careful examination of the neck for pathology and skin quality is also paramount and if a patient has any abnormality in their voice quality, a preoperative flexible laryngoscope exam is warranted. The incision can be hidden in the cervicomental groove, a pre-existing scar, or other prominent neck rhytids. The degree of improvement based on these anatomical considerations versus the visibility of the scar should be weighed and discussed with patients to manage their expectations and achieve a satisfactory outcome. Documentation with standardized pre- and postoperative photographs will also help show patients how much change was achieved with the procedure. Chondrolaryngoplasty may also be performed through a trans-oral approach. Here, an incision is made in the labiogingival sulcus in front of the mandibular incisors and dissection is carried into the neck through this approach. Endoscopes, additional time, and special equipment are typically required for this approach which can obviate the need for the 1–2 cm incision on the neck.

SURGICAL TECHNIQUE

Patient Position

Chondrolaryngoplasty at the senior author's center is often coupled with other facial feminization surgeries and is performed at the beginning of the case. The patient is placed in a supine position on the operative table, anesthesia is induced, and a laryngeal mask airway (LMA) is placed for ventilation. The use of an LMA is crucial to allow for direct fiberoptic visualization of the larynx during and immediately after cartilage resection.[12] The head may be flexed to permit a higher incision placement. The incision, which is approximately 1.5 cm, is horizontal and marked high in the submental neck or in the submental crease. Commonly, it can be done at the superior edge of the hyoid bone. The thyroid cartilage is also marked and the area is injected with a local anesthetic containing epinephrine (**Fig. 1**). The neck is prepared with a non-alcohol-based solution such as betadine and the patient is draped sterilely leaving the LMA exposed for the flexible bronchoscopist. Direct closed-loop communication with the anesthesiologist and maintaining an inhaled oxygen concentration below 30% is crucial to minimizing the risk of airway fire. The team should nonetheless be prepared for such a possibility with saline and appropriate safety measures available.

Surgical Steps

An incision is made sharply through the skin. Cautery use is minimized as there is no desire to eliminate subcutaneous fat which can blunt the appearance of the eventual remaining superior

Fig. 1. Intraoperative view of the anterior neck marking the thyroid notch "V" and the superior horizontal incision "-". The area within the dotted line represents the extent of local anesthetic infiltration and undermining required for surgical exposure.

aspect of the laryngeal cartilage. Blunt vertical (sagittal) spreads are made between the strap muscles and through the midline raphe until the thyroid cartilage is encountered. The pretracheal fascia is incised and the perichondrium is lifted off the thyroid cartilage using a Cottle elevator. Exposure is accomplished using three-point retraction bilaterally and inferiorly, typically with Senn and Ragnell retractors. At this point, a flexible bronchoscope is inserted through the LMA to visualize the larynx, ideally on a video monitor positioned where the surgeons and anesthesia team can see it. Next, under direct endoscopic visualization of the true vocal folds, a 22 gauge needle is pierced through the anterior thyroid cartilage where one anticipates an appropriate degree of resection should occur (**Fig. 2**). The needle must be seen to be above (superior to) the true vocal folds at the level of the thyroepiglottic ligament and above the anterior commissure. This guides the inferior extent of a safe thyroid notch reduction (**Fig. 3**). The fraction of inspired oxygen is confirmed to be down to 30% to allow for the safe marking of the inferior extent of the resection with cautery. The fascia on the superior edge of the thyroid cartilage is also incised with cautery. Next, the needle and flexible scope are removed, and a double action Rongeur is used to resect the thyroid cartilage starting in a just paramedian position lateral to the true midline. The midline tends to be thicker and often more calcified and is better approached later when softer lateral cartilage is removed and there is more room for maneuvering of the instruments. Care is taken to not pivot or rock the Ronguers, especially if a patient has calcified laryngeal cartilage. Fracture of the thyroid cartilage may occur and would require plating to repair if this technique is not carefully executed.[13] Ideally, the Rongeur cuts and then the forceps are minimally released while pulling in a linear fashion. This allows the cartilage to be removed while leaving any soft tissue (including the inner perichondrium) behind (**Fig. 4**). At the conclusion of the procedure, the flexible bronchoscope is re-inserted and the vocal folds are confirmed to be in their proper position with a sharp glottic chink. Gentle external pressure is applied to the new superior surface of the thyroid cartilage to ensure no collapse of the glottis

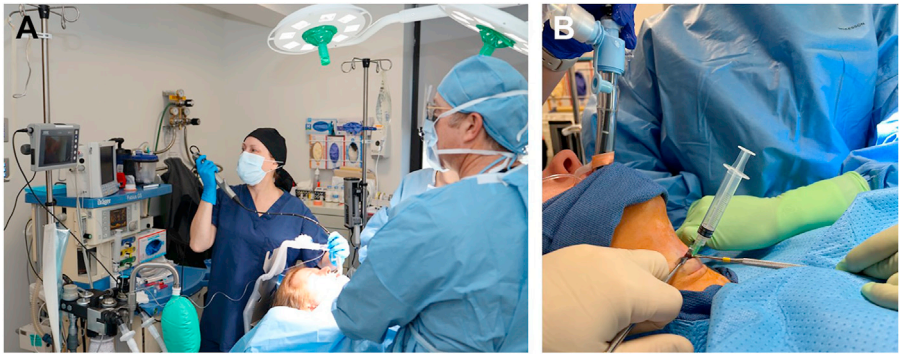

Fig. 2. (*A*) Effective closed-loop communication between the surgical team and the anesthetist in this case who is performing laryngoscopy through an LMA to visualize the glottis in preparation for needle insertion. (*B*) Anterior neck with a three-point retraction and a 22 gauge needle inserted through the thyroid cartilage.

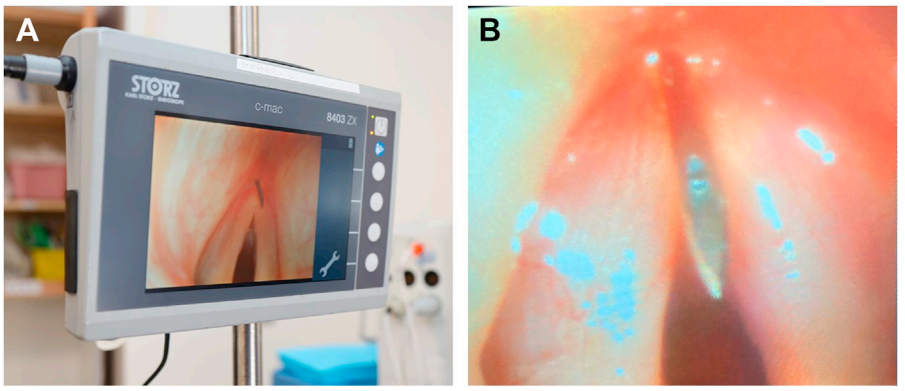

Fig. 3. (*A*) Video laryngoscopy during a chondrolaryngoplasty shows a 22 gauge needle above the level of the anterior commissure attachments, guiding the inferior extent of the thyroid cartilage resection. (*B*) Closer view of a different patient.

(Video 1). For closure, the strap muscles are re-approximated and the skin is closed in layers using 5 to 0 Vicryl and Dermabond. If other surgical procedures are to follow, at this time, the patient's airway may be secured with endotracheal intubation.

Potential Risks

The most commonly seen risks of chondrolaryngoplasty are minor and include scar from the cervical incision, unsatisfactory changes in the prominence of the thyroid notch, and temporary pain, sore throat, or hoarseness in the immediate postoperative period. The most serious risk is of permanent voice changes caused by disruption of the attachment of the vocal cords to the thyroid cartilage at the anterior commissure. Transient hoarseness, when present, is usually a result of swelling. A hematoma that affects airway patency during surgery may also occur but typically would resolve quickly.[13] Another hazardous but less common risk that can occur during surgery is laryngospasm (1.5%) and a plan must be in place and communicated between the anesthesiologist and surgeon before surgery.[14]

Fig. 4. Segments of thyroid cartilage removed with Rongeurs. Notice that only cartilage is removed. The soft tissue and fascia surrounding the cartilage are left in vivo.

Permanent vocal changes are a devastating risk of chondrolaryngoplasty and are a major reason why the procedure was modified so that the maximum excision of cartilage was guided by direct visualization of the larynx. Vocal phonation frequency, or pitch, behaves similarly to a piano string. Fletcher described the ideal string law in 1964, which determined that frequency is directly related to longitudinal stress, among other variables.[12] By disturbing the anterior commissure, one introduces laxity to the vocal cords and decreases longitudinal stress leading to decreased vibration frequency, and therefore, reduced pitch, significantly adversely affecting the patient's voice. This is an outcome that would not be acceptable to any woman, cis or trans. The incidence of voice changes after chondrolaryngoplasty is exceedingly rare and most often transient.[15] A systematic review of 69 patients who underwent aesthetic chondrolaryngoplasty found that no patients had permanent voice concerns post-operatively. The most common temporary complications cited in this review included odynophagia and hoarseness. Of the patients with hoarseness, 96% had resolution within 20 days and over 98% of patients reported satisfaction with the outcome.[11] Of note, permanent hoarseness has been noted by other surgeons using methods that do not involve visualization of the anterior commissure during the time of resection.

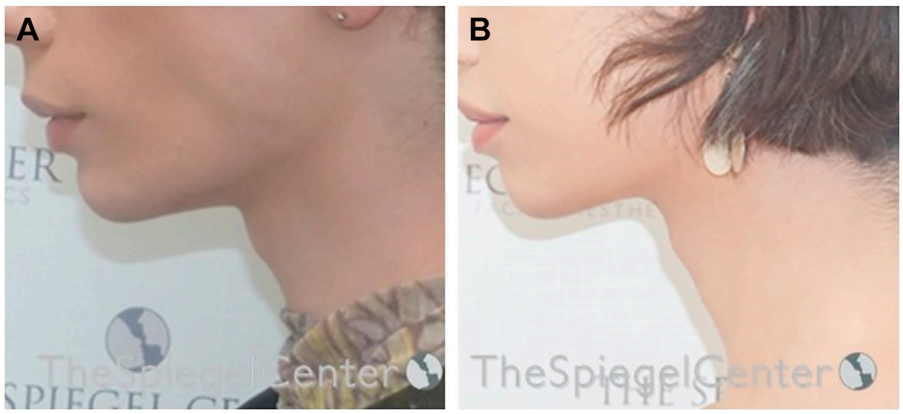

Fig. 5. (*A*) Pre- and (*B*) postoperative left lateral views of a patient with a slender neck and a larger thyroid prominence in which a smoother contour was achieved but a prominence (although smaller) is still visible.

Another retrospective survey on 48 of 198 patients who underwent aesthetic chondrolaryngoplasty found that 80% were "very" or "completely" satisfied with the appearance of their neck after surgery, while only 13% were "not at all'' satisfied. The most frequent comments from less satisfied patients were of persistent prominence and size or location of the scar. No patients had permanent voice changes. All of these patients underwent chondrolaryngoplasty with direct visualization of the true vocal folds during and immediately after the procedure.[15] It is important to counsel patients that the extent of the Adam's apple resection is limited by the attachment of the vocal folds and that function must not be jeopardized over aesthetic results.

POST-OPERATIVE CARE

Care required by patients after a chondrolaryngoplasty is minimal. A majority of these cases are combined with other facial feminization procedures and these other procedures dictate the perioperative care. Pain is typically minimal and may include a sore throat from intubation. As the incision is closed with Dermabond, no incision care is needed. Patients are typically discharged home the same day from the post-anesthesia care unit.

ALTERNATIVE APPROACHES

One drawback of this traditional approach is the potential for an unsightly scar. Although scar revision and resurfacing techniques largely mitigate these potential complications, recent publications have begun to emerge describing trans-oral transvestibular approaches that obviate the need for a cervical incision. In these cases, the approach is similar to a trans-vestibular endoscopic thyroidectomy and once the thyroid prominence is encountered, a burr is used to shave down the notch until the desired aesthetic outcome is achieved. Due to the need for straight instruments, a bulky LMA is not possible, therefore, direct visualization of the true vocal cords is limited during the procedure. Also, one can imagine how difficult it may be to remove the lateral lamina of the thyroid notch. Although a scar can be avoided, there is a risk of

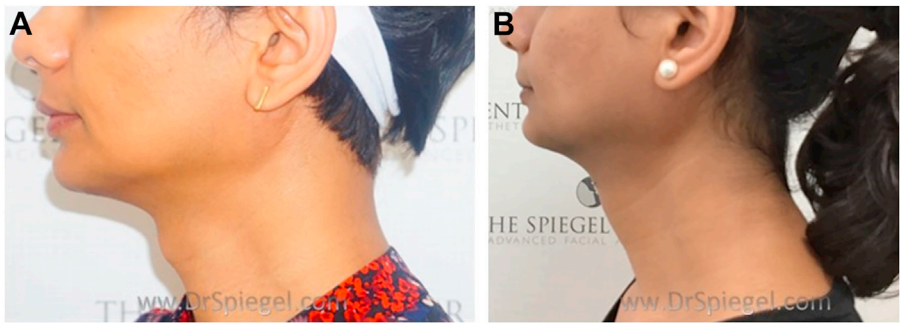

Fig. 6. (*A*) Pre- and (*B*) postoperative left lateral views of a patient with anatomy that allowed for maximal resection of the thyroid cartilage resulting in a completely smooth anterior neck.

leaving behind thyroid cartilage that could have otherwise been removed or removing more than should have been removed. With blind removal of the thyroid cartilage, the exact position of the anterior commissure in relation to the burr is not known and may increase the risk of permanent voice injury.[16–18]

CLINICAL OUTCOMES

Although most patients are satisfied with their outcome, one of the most common reasons for dissatisfaction is residual prominence. Proper preoperative counseling helps manage expectations and a softer contour can still be achieved (**Fig. 5**). Other patients may have anatomy that allows for maximum reduction in the thyroid cartilage creating a smooth anterior neck without shadowing from the thyroid notch (**Fig. 6**).

SUMMARY

Chondrolaryngoplasty is a safe and effective surgical procedure that reduces the prominence of the thyroid notch. It is most commonly performed on transgender (man to woman) patients with gender dysphoria and may be performed alone or in combination with other facial feminization procedures. Overall, patients are very satisfied with the outcomes of chondrolaryngoplasty and risks are low. Although scarless methods have been described, there is a tradeoff and direct visual guidance is made more difficult if not impossible.

CLINICS CARE POINTS

- Chondrolaryngoplasty is a safe and effective procedure for removing the prominence of the thyroid cartilage.
- Preoperative evaluation and management of expectations are crucial to patient satisfaction.
- Direct visualization of the anterior commissure using a laryngeal airway and flexible bronchoscope allows surgeons to remove most of the cartilage without jeopardizing vocal quality.
- Postoperative complications from chondrolaryngoplasty are rare and patients are most often dissatisfied with a residual prominence or scar.
- Though scarless methods have been described, they are limited by the inability to guide maximum resection through direct visualization of the anterior commissure.

DISCLOSURE

The authors report no conflicts of interest.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.fsc.2023.03.001.

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