Lateral Crural Tensioning for Refinement of the Nasal Tip and Increasing Alar Stability: A Case Series

Allen Foulad, MD1,2 Veronika Volgger, MD2 Brian Wong, MD, PhD1,2,3

1Department of Otolaryngology - Head and Neck Surgery, University of California-Irvine, Orange, California
2Department of Otolaryngology - Head and Neck Surgery, Beckman Laser Institute & Medical Clinic, University of California-Irvine, Irvine, California
3Department of Biomedical Engineering, Samuel School of Engineering, University of California–Irvine, Irvine, California

Facial Plast Surg 2017;33:316–323.

The objective of this study was to discuss the technical details and our experiences with lateral crural tensioning (LCT) in both functional and aesthetic rhinoplasties. A retrospective medical review was completed for all patients who underwent rhinoplasty with LCT from the years 2011 to 2014. The indications for LCT included correction of lateral crural convexity, boxy tip geometry, and dynamic collapse of the external nasal valve. The details of the rhinoplasty procedure and complications were evaluated. A total of 114 LCT rhinoplasty cases were included in this series. The most common adjunctive maneuvers included placement of spreader grafts (92% of cases) and alar rim grafts (78% of cases). Conventional classic cephalic trim was not performed in any subjects and conservative paradomal cephalic trim was performed in 48% of cases. As experience with the technique progressed, the use of onlay tip grafts decreased and the use of articulated rim grafts increased. Indications for revision were dissatisfaction with cosmetic outcome (4.4% of cases) and nasal obstruction (0.9% of cases). LCT combines traditional lateral crural steal with the use of a caudal septal extension graft to refine the broad tip and increase stability of the alar lobule. This maneuver is essentially cartilage sparing and does not rely on extensive grafting maneuvers that can reduce airway area.

Keywords
► rhinoplasty
► collapse
► convexity
► tensioning
► tip

Abstract

Shaping the nasal tip is one of the most complex and challenging components of rhinoplasty surgery. There has been a gradual progression away from cartilage splitting and morse-lization techniques to more conservative methods that rely on suturing or structural grafting to reshape and reinforce native tissue geometry. In parallel with these changes and the broad adoption of the open structure rhinoplasty approach, more emphasis has been placed on maintaining native cartilage structure. From the standpoint of structural dynamics and mechanics, rhinoplasty has further transitioned toward a paradigm where tensile and compressive forces are balanced to achieve stable structure, rather than relying upon structural grafting alone to alter tissue curvature or achieve stability.

Correction of the broad nasal tip due to convexity of the lateral crura has remained a challenge, and multiple techniques have been developed to address excessive curvature in this region.1 Contemporary methods include the use of lateral crural mattress sutures;2,3 lateral crural turn-in and turn-over flaps;4–7 lateral crural strut grafts;8,9 lateral crural splitting;10 and lateral crural repositioning.11,12 Excisional techniques, such as cephalic trim, weaken structural support mechanisms and can lead to retraction and collapse.13 In contrast, suturing techniques preserve structure and are in principal adjustable and reversible, which is particularly important as rhinoplasty has a historically high revision rate.

Davis has recently published an innovative approach for correcting convexity of the lateral crus, referred to as lateral crural tensioning (LCT).13–15 This technique involves performing an aggressive lateral crural steal maneuver16–19 in tandem with using a caudal septal extension graft (CSEG).
The lateral crural steal advances a portion of the lateral crura to the medial crura and creates a new dome along the lateral crus cartilage. This recruitment increases tension across the lateral crural length and eliminates the excess cartilage that accounts for curvature. The key to stabilization of this modified structure is securing the new domes to a CSEG, or in certain cases to the native septum (e.g., tongue in groove). The CSEG is also valuable because it enables comprehensive control of tip projection, rotation, supratip break, infratip break point, and columellar show.\(^{20}\)

The LCT technique flattens curvature and increases stability of the alar lobule mainly through suturing techniques. Because the technique does not require the resection of significant amounts of cartilage or lateral crural division, structural compromise of the crural integrity is avoided. Increased tension along the lateral crura tightens the alar lobule and thus reduces dynamic collapse of the nasal alae. Also, in contrast to strut-based techniques, the inner cross-sectional area of the external nasal valve is maintained and the intranasal narrowing that may potentially occur particularly in small vestibules due to the occupation of airspace by lateral crural strut grafts is avoided.

Herein, we review our early experience with the LCT technique in both functional and aesthetic rhinoplasties. We discuss the technical details of the procedure, including commonly performed adjunctive maneuvers. We also describe our complications, revisions, and the evolution of our expertise with this approach in 114 cases.

**Methods**

**Patients**

Medical record review was performed on all patients who underwent rhinoplasty using the LCT method within a 3-year period (2011–2014). The indications for LCT were lateral crural convexity or dynamic collapse of the external nasal valve. Preoperative and postoperative digital photographs, as well as the medical records, were analyzed.

**Surgical Technique**

The procedure is performed via the open approach, with wide marginal incisions extending to at least the most lateral curvature of the lower lateral crus along its caudal border. These marginal incisions are extended substantially more lateral than the incisions required for most conventional open rhinoplasty operations, and closely follow the caudal margin of the lower lateral cartilages. The external soft tissue envelope is conventionally elevated off the osteocartilaginous structural framework; no dissection along the vestibular surface of the lower lateral cartilage is necessary for the LCT technique. If the lateral crura are found to be discontinuous, such as from previous transection, the cartilage should be reapproximated before performing LCT. The nasal septum is exposed and the anterior septal angle is identified from the anterior approach by separating the medial crura.

The LCT technique is illustrated schematically in Fig. 1. Fig. 1A depicts a native broad tip from oblique and base views. LCT requires a stable central point for attachment of the neo-dome that will be subsequently created. This typically involves placement of a CSEG,\(^{21}\) but a direct tongue-in-groove approach can be occasionally performed when there is excess caudal septum. Figs. 1B and 2 illustrate a CSEG placed end-to-end to the caudal septal extension graft with a “boomerang” extension. This type of CSEG envelopes the anterior septal angle further stabilizing the CSEG, which in theory reduces risk of projection loss. The CSEG is usually harvested from the quadrangular cartilage of the nasal septum, which is ideal due to its appropriate thickness, flat shape, strength, and resistance to warping. However, if septal cartilage is limited, then the graft can be harvested from the cavum concha or...
costal cartilage. In this circumstance, the senior author’s preference is typically for costal cartilage, especially with revision cases. The CSEG can be secured in either a side-to-side or end-to-end fashion to the caudal septum. A side-to-side technique creates broad overlap of the two cartilage surfaces and increases stability. However, care must be taken to ensure that the additional thickness to the caudal septum does not compromise the airway and that the caudal end of the graft remains midline. Polydioxanone absorbable plates can also be used to secure the CSEG. The most anterior and caudal element of the CSEG is placed exactly at the point where the new tip-defining points should reside. A slightly larger than necessary CSEG can be initially sutured to the native septum, and the anterior–caudal region can be subsequently trimmed to the appropriate size as needed.

In order to tense and flatten the lateral crus, this cartilage is recruited from lateral to medial, and neo-domes are created lateral to the natural domes (as in conventional lateral crural steal). This is shown in Fig. 1C, D, where the blue circles mark the native domal flexure point, while the red triangles denote the location of the new dome. The amount of recruitment is typically 4 to 6 mm but can be greater depending on the degree of curvature reduction required. Transdomal mattress sutures are then customarily placed at the new flexure point and must be precise to ensure symmetry. Mattress-type sutures must be placed with caution because they may excessively narrow the caudal aspect of the new interdomal region.

The neo-domes are attached to the CSEG or septum, such that the tip-defining point is at the locus of the caudal most point of the neo-domes (Fig. 1E). To avoid unwanted narrowing, a simple interrupted suture alone can be used to attach the dome to the CSEG. It is extremely important to balance the forces as best as possible between the left and right sides. The recruitment of lateral crural tissue shortens the lateral crura, creates tension, and reduces convexity. The resulting increase in length of the medial crura is beneficial for increasing projection. However, if increased projection is not desired, the excess cartilage tissue that is transferred to the medial crura can typically be redistributed along the path of the medial crura. If needed, the medial crus can be dissected free along its length and repositioned more inferiorly. In extreme cases, medial crural resection or overlap can be performed. The medial crura, along with the recruited tissue, are then sutured to the CSEG, and emphasis can be placed on precisely establishing the columellar double-break point, columellar show, and subnasale.

Often adjunctive tip maneuvers are performed, such as paradomal cephalic trim, lateral crural spanning sutures, and alar rim grafts. The rim grafts are either conventional free floating, cantilevered (overlaps the medial aspect of the lateral crura), or articulated (sutured to the medial aspect of the lateral crura). The cantilevered and articulated rim grafts are typically fashioned in the shape of a long isosceles or right triangle, with the base measuring approximately 5 mm in length and the other two sides measuring 15 to 20 mm in length. The base of the triangular-shaped graft is placed at the medial-most aspect of the lateral crura (Fig. 3). These grafts are heavily beveled along the medial and cephalic borders to create a smooth and seamless transition with adjacent native tissues such as the dome. Although often unnecessary, it would not be unreasonable to cover the edges with a very thin layer of fascia or fascia-type substitute in thin-skinned patients. Articulated or cantilevered rim grafts are of particular importance, as they supply additional stability across the soft triangle region and alar margin. They are exceptionally useful for addressing deformity and weakness in the alar rim associated with lower lateral cartilage malposition. Occasionally, tip grafts are placed to provide additional projection and enhancement of light reflexes, but this is generally unnecessary with proper design of the CSEG and appropriate attachment of the domes. Classic cephalic trim is rarely, if ever, performed. Therefore, the continuity of the lower and upper lateral cartilages at the scroll region is preserved, which aids in maintaining the support and structural integrity of the alar lobule. A paradomal cephalic trim is frequently utilized to reduce fullness in the midline supratip region and encompasses a small (typically 2 × 6 mm) amount of crural cartilage adjacent to the new domal flexure point. A lateral crural spanning suture can be placed as well, which serves to reduce supratip dead space and also gently changes orientation of the caudal border of the lower lateral cartilage.
Results

The LCT maneuver was performed in 114 rhinoplasty cases between August 2011 and August 2014. Of these, 90 were primary rhinoplasty cases and 24 were revision cases. There were 47 males and 67 females ranging in age from 20 to 77 years (mean: 43 years). Indications for LCT were either: (1) only cosmetic concern due to convexity of the lateral wall or broadness of the tip (6 cases), (2) only functional concern due to collapse (45 cases), or (3) both cosmetic and functional concerns (63 cases).

Fig. 4 is a montage of a representative case that illustrates the outcome of LCT in a thin-skinned primary rhinoplasty patient. The patient sustained trauma with resultant nasal deformity and airway injury. An end-to-end CSEG and articulated alar rim grafts were placed. To straighten the dorsum and align the profile, osteotomies and
spreader grafts were utilized. Fig. 5 demonstrates preoperative and postoperative image pairs of the nasal base view, which highlights change in convexity. Fig. 5A–D are photographs from 6, 14, and 18 months postoperatively, respectively. Fig. 5A–D are cases where LCT was performed for refinement of a boxy tip. The patient in Fig. 5E, F had evidence of previous dome division, with subsequent pinching and severe alar retraction. The split domes were suture reconstructed, and LCT was performed to reconstitute a triangular base without the need for crural strut grafts. Because this was a revision case with limited septal cartilage, costal cartilage was used for spreader, CSEG, and rim grafts.

LCT was often combined with spreader grafts (92% of cases), alar rim grafts (68% of cases), and lateral crural spanning sutures (50% of cases). Conservative paradomal cephalic trim was performed in 55 (48%) cases, but conventional classic cephalic trim was not performed in any of the cases. A CSEG was used in 109 (96%) cases, while a tongue-in-groove maneuver was able to be performed in 5 (4.4%) cases.

Tip grafts (shield, cap, and peck) were used more frequently during the first half of the case series (30% of cases) as compared with the second half of the case series (12% of cases). In addition, cantilevered and articulated rim grafts were more commonly used later in the case series; classic free-floating rim grafts were employed earlier in our series. A total of 28% of the rim grafts were cantilevered or articulated in the first half of cases, while 67% of the rim grafts were cantilevered or articulated in the second half of cases.

The postoperative follow-up duration ranged from 8 days to 41 months (mean: 8.7 months). Based on chart review performed over the follow-up period, six patients (5.3%) desired and/or underwent revision. Indications for revision were dissatisfaction with cosmetic outcome (five cases) and nasal obstruction (one case). The first patient requiring reoperation was early in the case series (January 2012), and was due to a persistent bulbous tip and a hanging columella. The reoperation involved additional LCT and refinement of the columella, and the patient was subsequently satisfied with the results. The remainder of cases requiring cosmetic revision included a small residual dorsal hump at the superior terminus of a spreader graft, rim graft asymmetry, nasal tip deformity secondary to infection, and...
dissatisfaction with tip rotation. The one revision due to nasal obstruction involved reoperation in order to thin a side-to-side CSEG and bind the medial crural footplates. Of note, one reoperation case was not included in the statistics because the nasal deformity occurred due to acute postoperative trauma. Reoperation of this case involved correction of septal deformity and excision of synchiae.

A total of two (1.8%) cases had a complication. Both complications were from postoperative nasal infections that were negative for methicillin-resistant Staphylococcus aureus. In both cases, autologous costal cartilage had been used due to insufficient septal cartilage in the setting of prior rhinoplasty and necessity of a relatively abundant grafting source. The infection in one of the patients resolved after medical management without lasting nasal deformity, but the other patient who was an active tobacco smoker required revision surgery using previously banked costal cartilage.

**Discussion**

The contour of the nasal tip and resilience of the external valve are highly variable and relate to the shape and strength of the lower lateral cartilages. Excess convexity, malposition, and weakness of the lateral crura can lead to aesthetic or functional deformities such as a broad tip or external valve collapse. To date, most rhinoplasty maneuvers aimed at treating the nasal tip involve excisional techniques that can weaken the cartilaginous support structure or use structural grafts (e.g., battens and lateral crural struts) that can add undesired bulk.

The LCT maneuver described in this case series treats the broad nasal tip while following cartilage-sparing principles of maintaining the native integrity of the nasal tip cartilage framework. The approach aims to create a triangular nasal tip base, and corrects convexity and collapse of the lateral crus without the use of lateral crural grafts or lateral crural cartilage division. The foundation of the LCT maneuver leverages the power of the lateral crural steal technique in tandem with the use of a CSEG. Compared to a traditional lateral crural steal, focus is placed on increasing tension across the alar lobule by performing more substantial recruitment of the lateral crus in the medial direction. Intradomal sutures are placed in a conventional fashion to secure the new domes at the more lateral position along the lateral crura, which forms the tip-defining points. The key maneuver in LCT is to secure the newly created domes to a rigid midline structure typically created with a CSEG. This central support stabilizes the tip and counteracts the downward forces from the lateral crura (► Fig. 6). While ► Fig. 6 illustrates an increase in projection, LCT can be performed without extending the tip. By using a CSEG, there is no compensatory trade-off between rotation and projection, which is a consequence of the classic lateral crural steal maneuver and the cornerstone of Anderson's nasal tripod concept. The CSEG is an extremely powerful graft that provides the surgeon with absolute control over nasal tip projection, rotation, supratip break, and infratip lobule position. CSEG placement may be a technical challenge, and it is important to maintain symmetry with respect to their placement and to avoid unnecessary bulk creation in the columella that compromises aesthetics or the external valve region.

Considerable refinement of the nasal tip can be accomplished using the LCT method without the use of a classic cephalic trim. In our series, only paradoxal cephalic trim was utilized, and classic cephalic trim was not performed in any of the cases. In a paradoxal cephalic trim, a very small section of tissue is excised from the cephalic border of the interdental region without interrupting the scroll region. This is typically required because the more lateral region of the lateral crus is broader, and this region is advanced medially toward the dome during tensioning. By avoiding a classic cephalic trim, the strength of the lower lateral cartilage is maintained, continuity between the upper lateral cartilage and the lateral crus is preserved, and the creation of supralar dead space is eliminated. This reduces the possibility of collapse, pinching, and alar retraction that are known to accompany classic cephalic trim.

A disadvantage of using the LCT maneuver alone is that it does not optimally treat weakness in the soft triangle region and alar margin. To counteract this instability, articulated alar rim grafts can be placed to establish stability. Our indications for rim graft use are evolving, with a trend toward using these grafts with increasing regularity. These grafts provide additional support of the external valve, help reduce alar margin collapse and retraction, and can inferiorly displace a retracted alar rim to a modest extent. In addition, rim grafts improve alar flaring, reduce alar notching, and diminish lobular pinching. Initially, the senior author adopted the approach of using classic free-floating rim grafts by creating a narrow tunnel several millimeters parallel to the rim that extends from the

---

**Fig. 6** Lateral crural tensioning force vector diagram. (A) Native lateral crura and septum. (B) Lateral crural tensioning creates opposing and balanced forces along each lateral crus. The solid arrows represent the overall force vector and the dashed arrows represent the force components. The horizontal force component is balanced by the opposing lateral crura and the vertical downward force component is countered by secure attachment to the caudal extension graft.
region of soft triangle to the alar lobule. However, as experience progressed, the use of cantilevered and articulated alar rims grafts became much more prevalent in this series. The fundamental technique of using these grafts is that their medial terminus is positioned to overlap the most medial aspect of the lateral crura. The difference between articulated rim grafts and cantilevered rim grafts is that articulated rim grafts are sutured to the lateral crura for additional stabilization. These grafts may function to provide stability to the most caudal aspect of the alar lobule and rim, analogous to a lateral crural repositioning maneuver, however, are much easier to perform and do not require degloving and transposition of the lateral crus.

The use of tip grafts (shield, cap, and peck) was more frequent during the beginning of the case series and was mainly a consequence of the learning curve associated with LCT. As experience was gained, precision improved and reliance on tip grafts decreased because specification of projection, rotation, supratip break, and infratip lobule position was more consistently achieved.

The 1.8% infection rate is similar to that described in the literature. The cases had involved the use of costal cartilage grafts in patients with a prior rhinoplasty history, and one patient was an active tobacco smoker. The site of both infections was at the region of the columella, adjacent to the costal cartilage CSEG. The infections were treated with oral and topical antibiotics, and required drainage. One of the cases resolved without nasal deformity, but the other case required revision surgery using banked costal cartilage.

The 5.3% revision rate of the case series included patients dissatisfied with the cosmetic outcome (five cases) and a patient with nasal obstruction (one case). Among the cosmetic revisions, one case was associated with a persistent bulbous tip, which was successfully revised with more substantial LCT. This revision was very early in the case series and likely occurred due to inadequate initial tensioning. Another revision that was associated with LCT involved nasal obstruction due to a side-to-side CSEG. The reoperation involved thinning the CSEG, as well as scoring and binding the medial crural footplates. Since then, we have been very meticulous in thinning the CSEG and beveling the CSEG when it is used in a side-to-side fashion.

We have also transitioned to using the CSEG in an end-to-end fashion more frequently. In order to increase the contact area and bond strength between the end-to-end CSEG and septum, we have implemented construction of the CSEG in a boomerang shape as depicted in Figs. 1B and 2. This enables the CSEG to wrap around both the caudal and dorsal edges of the septum, which we feel reduces the potential for displacement and dropping of the CSEG over time. Buttress grafts made of very thin cartilage shavings are also useful for further stabilizing an end-to-end CSEG.

The impact of LCT alone cannot be clearly delineated because this technique was not used in isolation. Other adjunctive maneuvers that improve tip shape and reduce alar collapse, such as rim grafts and lateral crural spanning sutures, were often used. It is especially hard to attribute functional outcomes to tensioning alone because spreader graft placement and septal deformity correction were almost always performed. Another limitation of this study is the short follow-up period, which was an average of 8.7 months. Although the case series begins with cases performed over 4 years ago, many patients opted not to follow-up long term. Presumably, these patients are satisfied with outcomes, albeit we do not have objective data to support this. In addition, not all patients provided permission to publish their photographs.

Although LCT alone is not sufficient for every rhinoplasty operation, optimizing sidewall tone is a worthwhile objective in virtually any patient. There is a learning curve with respect to implementing LCT, which this article recounts; however, we found the process quite tractable. This safe technique is essentially cartilage sparing and is reversible intraoperatively, allowing for refinement and adjustment with minimal risk.

Summary

Lateral crural steal has been described for many years, but the potential mechanical changes that can be achieved by this technique in conjunction with a CSEG are only recently recognized. The LCT maneuver corrects the broad tip and increases stability of the ala without significant excision of tissue or use of extensive grafts that can lead to airway reduction. The method is technically demanding but empowers the surgeon with greater control over tip geometry.

References

4. Tellioglu AT, Cimen K. Turn-in folding of the cephalic portion of the lateral crus to support the alar rim in rhinoplasty. Aesthetic Plast Surg 2007;31(03):306–310


