Extended L-Framework: An Innovative Technique for Reconstruction of Low Nasal Dorsum by Autogenous Costal Cartilage Graft

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**BACKGROUND**

The establishment of a symmetric and smooth nasal dorsum that fulfills the criteria of adequate form and function remains a principal challenge during primary orsecondary rhinoplasty. Congenital, iatrogenic, and traumatic etiologies can produce a deficient or deformed nasal dorsum requiring dorsal augmentation. Traditional techniques for dorsal augmentation as onlay dorsal graft, cantilever graft, or conventional L-framework usually have less stability and produce a rigid lobule if the single unit framework extends to the tip. Because of abundant volume and relative ease of harvest and carving, the autogenous rib cartilage has been considered the graft of choice for dorsal nasal augmentation when structural support is necessary and sufficient septal cartilage is not available.

**Methods:** Eighteen patients with congenital, iatrogenic, and posttraumatic low nasal dorsum were reconstructed with the extended L-cartilage framework over the past 3 years with an average postoperative follow-up of 15 months. The framework was reconstructed from 3 carved cartilaginous pieces. If needed, columellar strut, spreader, and tip grafts were also provided.

**Results:** All the 18 patients were generally satisfied with the cosmetic and functional outcomes at around 1-year follow-up. The nasal projection and dorsal aesthetic lines were pleasing and maintained over a prolonged postoperative follow-up period. There was free natural movement of the lobular part of the nose. No major complications were encountered.

**Conclusions:** Consistent, reproducible results were achieved with using the extended L-framework in primary and secondary rhinoplasty and in posttraumatic dorsal nasal deformities as well. This technique has different advantages over the conventional techniques as the extended framework is more anatomical, preserves pliability of the lobule, maintains stability without any means of fixation, and offers good control of aesthetic needs.

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Many autologous and alloplastic graft materials have been used for dorsal nasal reconstruction. Autologous materials generally incorporate well into the surrounding tissues, permitting durability over time and the opportunity to replace “like tissue with like tissue.” Autologous cartilage is the most commonly used and preferred graft material; it remains the gold standard against which other materials are compared.

Although septal cartilage is the preferred grafting material in rhinoplasty with mild deficiencies in the projection of the nasal tip and dorsum, often there is an insufficient supply for more severe deformities as in very low nasal dorsum or in cases of graft-depleted revision rhinoplasty. In such cases, large quantities of grafting material are needed. As an alternative to septal cartilage graft, autogenous rib cartilage is the graft material of choice.

Costal cartilage is available in large quantity, undergoes minimal postoperative resorption when not morselized or crushed excessively, and is relatively easy to carve. Satisfactory and consistent long-term results rely on using grafts with low resorption rates and sufficient strength to offer adequate support. The rib cartilage fulfills these criteria as it provides the most abundant source of cartilage for graft fabrication and is the most reliable when structural support is needed. Autogenous augmentation with costal cartilage traditionally has been done either with dorsal onlay or conventional L-graft technique. In both these techniques, the framework extends to the tip, resulting in a rigid lobule.

An innovative technique of costal cartilage carving in the form of extended L-framework for reconstruction of low nasal dorsum was presented. This technique has been used not only in secondary rhinoplasty but also in primary rhinoplasty and in correcting posttraumatic deformities. Additional techniques were also used as columellar strut, spreader grafts tip graft, suture techniques, and cephalic trimming to reshape the nasal contours when necessary.

PATIENTS AND METHODS

Augmentation rhinoplasty was performed for 18 non-consecutive patients over 3-year’s period (2014–2017). All patients with very low nasal dorsum, secondary cases with an overresected dorsum, or other dorsal defects and posttraumatic cases with saddling deformities were included in this study.

Age, sex, preoperative and surgical findings and technique, postoperative findings, follow-up, and complications were documented in patient files. Photographic analysis of the patients was done on preoperative, postoperative first, third, sixth, 12th months, and yearly photographs. At first visit, anatomical defects resulting in the deformity and functional problems were assessed. A routine computed tomography with axial and coronal cuts was carried out for all patients. The data collected from the examination and the computed tomography findings were also documented. All patients received an open rhinoplasty approach for dorsal augmentation using a novel technique for carving of costal cartilage grafts in the form of an extended L-framework. Patients were asked to assess the functional and aesthetic outcome after the operation. All preoperative and postoperative photographs taken at the last follow-up were analyzed by 3 plastic surgeons who were not involved in any of the operations. On the basis of their consensus and the standard cosmetic indices, postoperative outcomes in terms of nasal deformity correction were classified as very good, good, and fair. Regarding the patients’ satisfaction postoperatively in terms of dorsal nasal correction, improvement of nasal airway and overall satisfaction were also documented and categorized into 3 categories: very satisfied, satisfied, and unsatisfied. All patients provided written consent for usage of their photographs in scholarly publications.

Surgical Technique

All rhinoplasty operations were performed under general hypotensive anesthesia with open approach using columellar labial V-incision and bilateral infracartilaginous incisions. Local infiltration of adrenaline 1:100,000 and lidocaine 1% was performed 15–20 minutes before operation to minimize bleeding. Antibiotic prophylaxis was given.

The skin and soft tissues overlying the osseocartilaginous framework were elevated in a submusculoaponeurotic plane. The periosteum over the median nasal bones was elevated.

Beginning at the anterior septal angle, complete submucoperichondrial and submucoperiosteal septal flaps were elevated bilaterally; then the upper lateral cartilages were separated from the septum. In secondary cases, careful dissection was done to avoid perforation. Examination of the septum for the necessity for septoplasty was carried out. If the nasal bones are too narrow, medial osteotomies are performed with application of spreader grafts when needed. On the other hand, if they were too wide, medial and lateral osteotomies were done with infracture of the nasal bones.

Preparation of the dorsum to be as flat and smooth as possible to give the greatest surface area for contact. The dorsal septum and upper lateral cartilages were smoothed, and any contour irregularities of the bony dorsum were removed by rasping. A uniform surface of the dorsal recipient bed aids the graft to adhere solidly to the osseocartilaginous framework. This prevents postoperative movement of the graft after healing is complete, as is often seen in grafts placed in soft-tissue envelopes. To prepare for the columellar strut, a pocket was dissected between the medial crura to expose the nasal spine.

Rib Cartilage Harvesting

The choice of rib to harvest was determined depending on the planned use and the amount of cartilage required. The cartilaginous portion of the sixth rib usually provides more or less a straight segment and enough amount of cartilage to construct all required grafts.

Our approach was through inframammary fold and the incision measures around 5 cm in length in female patients. In male patients, the incision is usually placed directly over the chosen rib to facilitate the dissection. The
cartilaginous portion was harvested in the subperichondrial plane and placed in sterile saline until fabrication.

**Fabrication of the Extended L-framework**

The extended L-shaped costal cartilage framework is fabricated from 3 pieces of cartilage as follow. Dorsal onlay piece measures from nasofrontal junction till or a little shorter than the anterior septal angle for dorsal augmentation and is best carved from the central core of the rib to minimize the effect of warping.\(^{19,20}\) Carving should be symmetrical to ensure uniformity in thickness and width with a gradual taper toward both ends. The thickness and height were determined based on clinical judgment. The second one is the cephalic extension piece in the radix area and is carved out with a gradual taper toward the cephalic end. This piece makes the transition zone between the frontal and nasal area smooth and avoids stepping in this area and acts as a fulcrum for stabilization of the dorsal onlay piece. The third one is the caudal part of the L-framework and measures from the dorsal septum antero-superiorly till the maxillary crest postero-inferiorly. This piece acts as another caudal fulcrum and stabilizer for the dorsal onlay piece. A fourth piece is carved for the columellar strut in dimensions about 2–2.5 cm in length, 3 mm in width, and 2 mm in thickness. Tip graft is also created in a Beck fashion. If there is a need for spreader grafts, 2 pieces are also carved (Fig. 1).

**Insertion of the Framework**

The grafts were placed in their anatomic position in a sequence of: The dorsal onlay piece with cephalic extension placed in a narrow dorsal midline and symmetric pocket. The integration between the two pieces was done before insertion. This was followed by the caudal part of the L-framework to be integrated into a notch in the dorsal onlay piece as in mortise and tenon configuration after adjusting the length and the angle with fixation sutures. Any further shaping required was carefully done until the exact desired size, shape, and contour were obtained. If there is any collapse of the internal nasal valve, we can hook it to the dorsal onlay piece bilaterally. This will relieve the constriction and obstruction in the valve area (Fig. 2).

Tip support was provided by using a separate columellar strut sutured to the medial crura. Then tip graft was applied after tip modifying sutures. The dorsal L-framework and columellar strut grafts are not connected in the area of the membranous septum to allow a small amount of movement when upward or side-to-side pressure is placed on the tip. Routine skin closure, septal splint, nasal packs, and nasal cast were performed.

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**Fig. 1.** Framework construction (A). Multiple pieces carved from costal cartilage. From left to right, cephalic extension piece, dorsal augmentation piece and caudal piece. Two more additional pieces: Columellar strut and tip graft. B, The extended L-framework assembly. C, The dorsal and caudal pieces are integrated in a mortise and tenon fashion at a suitable angle.

**Fig. 2.** A, The inset of integrated L-framework in a patient with low nasal dorsum. B, A diagram shows the assimilation of the 3 parts of the extended L-framework and the exact site of each part inside the nose.
RESULTS
Eighteen patients were included, 2 male and 16 female. Their ages ranged from 20–55 years with a mean age of 37.5 years. There were 2 patients with congenital low dorsum, 12 patients with posttraumatic saddling, and 4 patients were secondary cases. Average postoperative follow-up was 15 months. All patients were generally satisfied with the cosmetic and functional results of the surgery. The projection of the dorsum as well as the tip and dorsal definition was aesthetically pleasing. There was free natural movement of the lobular part of the nose. There was also maintenance of dorsal height and contour during the follow-up period in all cases. No major complications as extrusion, displacement, warping, resorption, or infections were encountered. In the assessment of the consensus of the 3 independent plastic surgeons, among the 18 patients, there were 12 very good outcomes (66.7%), 5 good outcomes (27.8%), and 1 fair outcome (5.5%).

Only 1 patient experienced an exaggerated supra-tip break due to short dorsal piece of cartilage, yet she was satisfied with the result. The results were stable over a prolonged postoperative follow-up period, and revision surgery was not needed to any of the patients.

CASE REPORTS

Case 1
Figure 3 shows a 20-year-old woman whose operative course and results reveal the general efficacy of the operative technique described above.

The patient desired cosmetic rhinoplasty to augment her nasal dorsum and refine the shape of her nasal tip. She had no history of nasal airway obstruction, sinus disease, or nasal trauma. On nasal analysis and examination, she had a very low nasal dorsum with a slightly wide bony nasal base. Her nasal tip was bulbous and lacked definition. The patient underwent uncomplicated cosmetic open rhinoplasty. Following surgical exposure of the nose, she underwent nasal osteotomies and dorsal augmentation using our technique the extended L-framework dorsal graft carved and fabricated from costal cartilage. Other routine procedures to enhance the tip was done. A cephalic trim was performed to improve her tip definition and slightly increase tip rotation. The columnellar strut was fashioned from the costal cartilage and sutured into place with medial crural sutures. Transdomal and interdomal sutures were used to refine the tip and improve symmetry. Her postoperative course was uneventful. Pre- and postoperative photographs are shown in the figures.

Case 2
A 55-year-old woman underwent augmentation rhinoplasty. Physical examination demonstrated a posttraumatic nasal disproportion with markedly low dorsum (saddling deformity), and there was no breathing problems (Fig. 4). The surgical procedure included an external approach with correction of the dorsum using the costal cartilage graft carved in the form of extended L-framework after osteotomy and in-fracture of the nasal bones. Also, spreader grafts and a columnellar strut were carved from the costal cartilage. In addition,
cephalic trim, domal sutures, and interdomal suture were done.

Case 3
A 34-year-old male patient with congenital low dorsum and saddle nasal deformity manifested as broad and flat nose in frontal view and significant saddling lateral view. Correction was made using the extended L-framework carved from the sixth costal cartilage. Osteotomies were also done. Postoperative frontal view shows good correction with improved definition, lateral view shows better projection and a good profile line and smooth transition of the dorsum. The pliability of the lobule was also maintained (Fig. 5).

Case 4
A 32-year-old woman with postrhinoplasty low nasal dorsum and loss of tip support, oblique lateral, and lateral views manifest the deformities she underwent secondary rhinoplasty using the extended L-framework costal cartilage graft for dorsal augmentation. Postoperative pictures show a good correction, better dorsal projection, definition, and good tip support along with good mobility of lower one-third of the nose (Fig. 6).

DISCUSSION
The rib offers an ample supply of cartilage for use in every aspect of rhinoplasty especially when rigid support is necessary. It has been shown to have long-term viability,
with minimal resorption after implantation. Dorsal augmentation with rib cartilage grafts has proved useful in the secondary rhinoplasty patient. It is also useful in patients with congenital deformities, posttraumatic deformities, or even in primary rhinoplasty patients who require a significant amount of dorsal augmentation.

Rib cartilage harvest has several disadvantages. As additional incision at a distant donor site, postoperative pain, the risk of pneumothorax, excessive calcification of rib cartilage, and the potential of rib cartilage to warp. Most of these complications are usually both surgeon and technique dependent. Fortunately, the resulting scar is relatively short and is generally inconspicuous in women due to its placement under the breast.

Graft warping can occur in autogenous rib cartilage and lead to long-term postoperative distortions of nasal shape. Following specific measures during carving as well-balanced cross-sections originally described by Gibson and Davis and later substantiated by Kim et al. usually alleviates the warping property of the rib cartilage.

To reduce the warping effect, Gunter et al. suggested to reinforce larger grafts (dorsal onlay graft and columellar strut) with a centrally placed Kirschner-wire to provide a more stable and predictable result.

Various types of alloplastic materials have been used for dorsal augmentation. They have the advantages of being easy to use, readily available, and an unlimited supply. Unfortunately, because of their permanent nature, many of these alloplastic materials are fraught with long-term complications such as infection, migration, extrusion, and palpability. Thus, autogenous tissue continues to be the preferred source of grafts.

Autogenous augmentation of low dorsal nasal deformities traditionally have been done either with dorsal onlay or conventional L-graft technique. In both these techniques, the framework extends to the tip, resulting in a

Fig. 6. A, A 32-year-old woman with postrhinoplasty low nasal dorsum and loss of tip support, oblique lateral, and lateral views manifest the deformities. B, More than 1 year after correction. The projection of the dorsum and the tip and dorsal definition were aesthetically pleasing.
rigid tip lobule. Second, these grafts do not provide adequate support to the internal valve with no relieve airway obstruction. As these grafts depend on the native skeleton for their support which is usually weak. Lack or weakness of an intact L-shaped septal strut and insufficient middle vault support usually result in settling down and descent of the onlay graft over time and are usually accompanied by airway obstruction.

In this technique, we developed the caudal piece of the extended L-framework that acts as an independent support and stabilizer for the dorsal onlay graft to prevent loss of height with time and displacement. Also the dorsal onlay piece can be used as dorsal stabilizer for the internal nasal valve when the latter is hooked to the dorsal piece.

Many advantages have been described for this technique that we developed. First, there was a smooth transition in the radix area with no stepping off because of the tapered cephalic piece of the L-framework. Second, there was a free mobility of the tip lobule complex in any direction as there was no connection between the tip skeletal complex and middle and upper vault in the area of membranous septum. Third, long-term outcome was maintained in the form of maintenance of high and straight dorsum with no displacement as there was a solid support that was not depending on the native skeleton, which is usually weak in these cases. This is due to the caudal strut of the L-framework that strongly supports the dorsal onlay piece. Fourth, there was a secure fixation and stabilization without any external or internal fixation; this was due to the cephalic and caudal fulcrums of the dorsal onlay piece. There was no need for sutures to attach the L-frame to the native skeleton.

Conventional L-framework has dorsal and caudal limbs. The caudal limb lies in the columella and not in the caudal septal area. The dorsal limb extends from the radix to the tip of the nose. The disadvantage is that the lobule becomes rigid with restriction of its mobility.27

The extended L-framework of the present technique is different from the conventional L-framework. The 3-piece construct mimics the structurally essential dorsocaudal part of the upper and middle vault. The dorsal component extends only till or slightly shorter than the anterior septal angle area and not up to the tip. Unlike the conventional L-framework, the caudal part of our framework inserted near caudal area of the septum. It keeps the membranous septum free as it lies cranial to the membranous septum and not in the columella. Columellar support is given by a separate strut. This can be considered as an anatomical framework reconstruction that maintains the pliability of membranous septum and lobule.

**CONCLUSIONS**

The extended L-framework costal cartilage graft for dorsal nasal augmentation provides the following benefits: sustained dorsal support, free mobility of tip lobule, improved nasal airflow, and a natural feel and appearance to the nose.

This technique is very useful not only in secondary rhinoplasty but also in primary rhinoplasty and in correcting posttraumatic deformities with low nasal dorsum.

Remarkable enhancement in nasal contours was achieved in all patients. No complications were encountered in any of the 18 patients. All patients were satisfied with the results. The outcome remained unchanged over time. These advantages make the extended L-framework cartilage graft excellent for dorsal nasal augmentation in patients with significant low nasal dorsum and can be considered a valuable contribution for the treatment of these cases due to any cause.

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