

Nasal Tip-Columella Subunits Infrastructural Reconstruction: 10th Rib Cartilage Graft Operative Technique

Wenbo Huang¹, Takkun Chow^{1,2,3}, Sikkuen Chow^{1,2,3}, Yangliu Liao¹

¹Division of Plastic and Reconstructive Surgery, Department of Surgery, The University of Hong Kong-Shenzhen Hospital, Shenzhen, China

²Department of Surgery, The University of Hong Kong, Hong Kong, China

³Hong Kong Holistic Cleft Lip & Palate Center, Hong Kong, China

Email: huangwb@hku-szh.org

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Abstract

Background: Reconstruction of Nasal Tip Columella (NTC) subunits is one of the most challenging aspects in functional aesthetic rhinoplasty. Moreover, racial variation for Asian nose rhinoplasty could even demand sophistication of tip and columella strut graft infrastructure enhancement. Various autogenous graft options such as 6th costal cartilage, septal cartilage and conchal cartilage are very commonly considered whilst the 10th costal cartilage is scarcely reported. **Objective and Method:** The purpose of this manuscript is to illustrate the detailed operative steps to harvest the 10th costal cartilage for infrastructural grafting at NTC subunits by a case illustration. The pros and cons of different cartilage options will be discussed, particularly its application in cleft nose rhinoplasty in Chinese patient. We have adopted the 10th rib as the key option for NTC reconstruction in 11 cases of Chinese cleft secondary rhinoplasty since 2019 and have achieved good and stable results without complications. **Conclusion:** The 10th costal cartilage is one of the best options in Nasal Tip Columella subunits reconstruction, particularly in complex cleft nose or failure revision aesthetic rhinoplasty cases, due to its safety of harvesting, and the sufficient quality and quantity of grafting materials it provides for simultaneous adjunctive augmentation purpose.

Keywords

Nasal Tip Columella Rhinoplasty, 10th Rib Cartilage, Cleft, Chinese

1. Introduction

Burget & Menick in 1985 initiated the principle of nasal subunits [1] for rhinoplasty

planning that obviously the nasal tip columella subunits contribute the key profile reconstruction. More anatomical studies of nasal structure revealed that lower lateral cartilage of the Asian nose is smaller and weaker than that of the Caucasian race so as thicker subcutaneous tissue. The weakness of the lower lateral cartilage leads to insufficient support for the columella and greater tension from the thick subcutaneous tissue of the nasal tip, resulting in flat and short nose projection and less defined contour [2] [3]. Therefore, in Asian rhinoplasty, it is often necessary to strengthen the nasal columella by cartilage strut or implant materials to secure a stable columella support for well-defined tip profile [4]-[7].

The ideal graft must be characterized by low rejection rates and high long-term patient satisfaction. Compared with artificial materials and allogeneic materials, autologous cartilage has better histocompatibility and lower incidence of complications, so it is considered as a better choice for rhinoplasty in Asia, especially for revision rhinoplasty [8].

Autologous costal cartilages (5 to 8th rib) were commonly used in nasal plastic surgery for strut, dorsal and tip graft augmentation due to their abundant quantity. However, donor morbidity such as scarring, pneumothorax, bleeding [9]-[11] warrant careful consideration as adjunct procedure. Kim & Song in 2015 first reported the use of 10th rib in aesthetic rhinoplasty and found it to have the advantages of safety, speed, simplicity, and good surgical results [12]. We have adopted the 10th rib as the key option for NTC reconstruction in our Chinese cleft secondary rhinoplasty since 2019 in Hong Kong then in Shenzhen regional cleft centers if there is no other peri-nasal augmentation. All 11 of our cleft patients who underwent rib graft for NTC reconstruction using the 10th rib achieved excellent and stable results. This paper will share our experience using the 10th rib technique with particular emphasis on its application in Asian rhinoplasty.

2. Surgical Techniques

2.1. Surgical Marking

Topographic location of Angle of Louis as sternocostal junction of second rib then by descending counting of ribs to lateral thoracic cage just medial to mid-axillar line by digital pressure may identify the 10th rib. We standardize the landmark according to Kim & Song technique by a dropping perpendicular to the line connecting Umbilicus and the anterior iliac spine to the intersection point with the lower lateral edge of the rib cage as the tip of the 10th rib (**Figure 1**). Then mark the incision within 2 cm - 3 cm long above the 10th rib.

2.2. Cartilage Harvesting

All procedures were performed under general anaesthesia. The incision marking was infiltrated with 2% lignocaine and 1:80,000 adrenaline subcutaneously, then skin was cut through by a No. 15 scalpel blade for full exposure of the external oblique abdominis muscle (EOAM). The 10th rib was located through finger palpation, then dissected to the periosteum of the tip of the rib with electrocautery.

Sharp incision was made from the perichondrium to the periosteum of bony rib superiorly. The Ellis forceps grasped the tip of the rib, then the perichondrium was stripped along the whole length (Figure 2) by small periosteal elevator and occasionally assisted by electrocautery. Sometimes effort was required to separate the fibrous connection between the 10th and 9th ribs. A periosteal elevator was placed just deep to the 10th rib for protection before cutting and releasing the cartilage. The harvested cartilage was placed in a saline solution until the definitive carving began, which is a very important to avoid warping. Meticulous haemostasis was observed, and Valsalva maneuverer was conducted to confirm no pleural perforation. The wound was then closed in layers without any drain insertion. Local infiltration of 5% Marcaine provided overnight pain control, and the wound was covered by pressure dressing for 2 to 3 days.

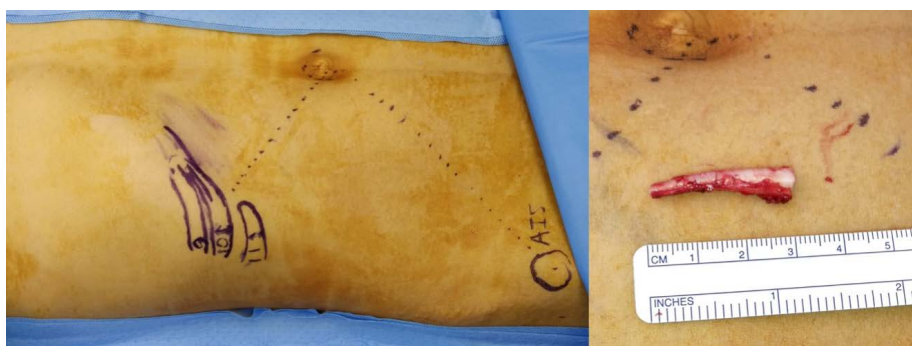


Figure 1. Topographic location of the 10th rib incision.

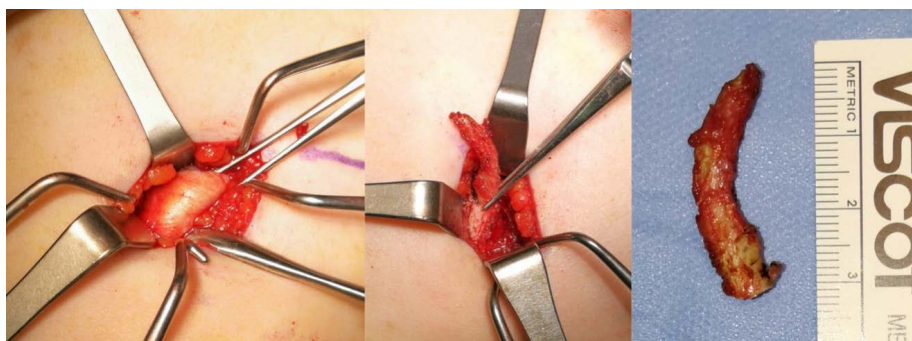


Figure 2. Dissection of 10th costochondral cartilage.

2.3. Carving of Rib Cartilage

The 10th rib cartilage we normally obtain was about 30 mm in length, 10 mm in width, and the thickness is about 4 to 5 mm. In order to enhance NTC infrastructure, it is generally unnecessary to insert the entire cartilage, as this would result in an oversized columella and unnatural aesthetic. Our goal is to carve the cartilage into a 3 mm thick strut that is straight without warping, which can be inseted between the medial cura with desirable length to support the re-oriented lateral cartilage domes, with or without additional tip grafting (Figure 3). It is crucial to carve on both sides based on the balanced cross-section to avoid the possible

warping at later stages. In some difficult secondary rhinoplasty, the residual medial cura foot-plate is too fragile for support then the full thickness cartilage strut should be considered. In order to secure the centrality of the strut, 4/0 PDS is used to anchor the strut cartilage base to the periosteum of the anterior nasal spine as a standard step. Any remaining cartilage strips and fragments should be retained for potential use as extension grafts or tip graft materials.



Figure 3. Carving of the cartilage strut as sandwiched strut and extension graft.

2.4. Nasal Tip-Columella NTC Subunits Reconstruction—A Case Illustration

Since 2019, we mainly adopted the 10th costal cartilage to repair cleft secondary nasal deformity, especially severe nasal tip columella deformities. Despite of primary lip repair by a meticulous cleft surgeon, the imbalance and pull of peri-nasal and orbicularis oral muscles may result in asymmetrical lower alar cartilage development, aligning with the growth vector of a deviated septum and contributing to the stigmatized cleft nose deformity.

A female Chinese patient aged 26 was referred to the senior authors (Chow TK & Chow SK) for radical correction of her bilateral cleft lip nose deformities. Clinically she presented with a short columella and complete absence of the nasal tip, as well as whistle lip deformity without vermilion tubercle (**Figure 4**). These types of deformities are not uncommon in patients with severe protruding premaxilla, which demand the primary cleft surgeon to repair the wide cleft defect through full release of prolabium for complete lip closure.



Figure 4. Bilateral Cleft lip nose deformities.

Given the complexity of this patient, we need to reconstruct the nasal tip and columella length without jeopardizing the length of the philtrum dimple. Therefore, we opted to harvest a 10th rib cartilage graft as a strut and extension graft to re-orientate the tip projection vector, followed by dorsal laminated graft placement to enhance the supratip and columella aesthetic. The lower lateral cartilages were dissected and a double dome mattress suturing of the crus dome by 4/0 PDS was performed, followed by anchoring the sandwiched strut graft with an extension cartilage strip to re-vector the nasal projection. The remaining concaved cartilage remanent was laminated over lower dorsum to outer columella as soft tissue support of the columella aesthetic (**Figure 5**). After meticulous haemostasis using bipolar diathermy and flushing with 3% H₂O₂ solution, nasal skin was redraped after trimming of nostril rim to reform the neo-nostril configuration. A stable and aesthetically pleasing result for her NTC subunits reconstruction could be observed in photos taken 18 months later (**Figure 6**).

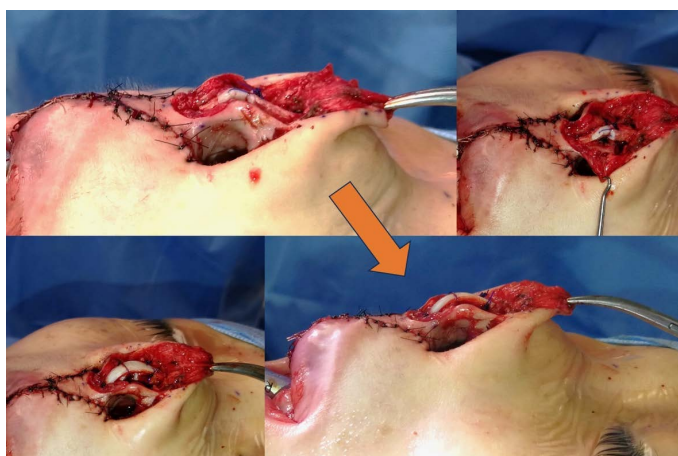


Figure 5. NTC reconstruction with 10th rib graft strut and extension graft only with laminated graft for supratip and columella aesthetic soft tissue support.



Figure 6. Pre and Post 1.5 years lateral and submental vertex view to show the Long term stability NTC subunits reconstruction.

3. Discussion

The inherent problem with artificial materials or allografts both carry a higher risk of infection, which may necessitate removal leading to a devastating consequence. The biocompatibility of artificial implant is not comparable to autologous graft. After years of direct support to nasal skin, local thinning of subcutaneous tissue may cause implant extrusion. Although the use of autologous cartilage also presents issues such as donor site deformity and surgical complications, including cartilage warping, it remains a more widely utilized choice for grafting in nasal columella and tip rhinoplasty [8].

The keystone for functional and aesthetic rhinoplasty lies in the meticulous assessment of the convex complex of Burget & Menick's aesthetic nasal subunits, including the tip, columella, and paired alae. Therefore, infrastructure reconstruction should target at this convex aesthetic complex. Further anatomical studies of nasal structure have revealed that the lower lateral cartilage of the Asian nose is smaller and weaker than that of the Caucasian race, as well as having thicker subcutaneous tissue. The weakness of the lower lateral cartilage leads to insufficient support for the columella and greater tension from the thick subcutaneous tissue of the nasal tip, resulting in flat and short nose projection and less defined contour [2] [3]. Therefore, in Asian rhinoplasty, it is often necessary to strengthen the columella by cartilage strut or implant materials to secure a stable columella support for well-defined tip profile [4]-[7]. The transdomal suture is utilized to decrease the alar domal arch and augment the tip projection, as well as providing tip support. Autologous cartilage is sandwiched between the medial crura and secured together to form a new columella strut complex, which effectively increasing length and reinforcing the columella for a more prominent and natural tip profile [12].

In the past, nasal septal cartilage and ear cartilage were commonly used for nasal tip columella grafting, with numerous clinical studies confirming favorable surgical outcomes [13]-[17]. However, there has been limited clinical evidence on the use of 10th costal cartilage for nasal tip columella reconstruction. Kim & Song in 2015 described a very thorough techniques in their 64 rhinoplasty cases using the 10th rib cartilage graft with very promising results and minimal complications, followed by the anatomical study comparing abdominal CT scan with cadaver to qualify the position of the 10th costal cartilage in rhinoplasty [18].

Harvesting of the 10th rib cartilage is relatively safe and convenient. The 10th costal cartilage is located lateral to the rectus abdominis muscle. The dissection of this thick muscle is not required during harvesting so the donor site morbidity and postoperative pain are decreased. The thickness of the transverse abdominal muscle below the 10th costal cartilage was 1.9 ± 0.5 mm at the osteochondral junction (OCJ), 2.9 ± 1.1 mm at the midpoint, and 3.7 ± 1.4 mm at and tip, respectively. Therefore, even if there is laceration of the muscle during harvesting of cartilage, it will not expose the pleural cavity but may pose a risk of pneumothorax or vascular damage at this level [19].

The 5th and 6th rib are relatively thick and straight, but such a large costal cartilage is not necessary for columella strut. The 5th and 6th costal cartilage is located below the pectoralis major muscle, posing a potential risk of pneumothorax and vascular damage during the acquisition process. The risk of pneumothorax or vascular damage to 7th and 8th rib cartilages is small, but it requires dissection of thick rectus abdominis (RAM), leading to larger incisions and increased incidence of complications and postoperative pain [20] [21]. Additionally, the thicker cartilage of the 5th to 8th ribs plays a more important supporting role in maintaining the shape of the chest, while the smaller size of the 10th rib contributes less to chest contour.

Nasal septal cartilage is a common choice in nasal columella and nasal tip plasty due to its anatomical vicinity and ease to access. However, the nasal septum cartilage in Asians is relatively weak, with an average thickness of only 0.97 ± 0.15 mm [22], in contrast the 10th costal cartilage is much thicker than that of the nasal septum therefore it serves for a stronger support. According to an anatomical study, the length of the 10th rib cartilage of the Asian race was 60.6 ± 22.5 mm, the width of the 10th rib cartilage was 9.9 ± 2.0 mm, 7.1 ± 2.0 mm, and 2.7 ± 0.5 mm at the OCJ, midpoint, and tip, respectively. The thickness is 7.0 ± 2.2 mm, 5.1 ± 1.7 mm, and 2.3 ± 0.5 mm at each point [19].

Due to its unique bowl-shaped structure, ear chondral cartilage is commonly utilized for tip or lateral alar augmentation. It seems not the first choice using the ear chondral cartilage as columella stent unless it is conformed in double folding. According to anatomical studies, the thickness of ear cartilage ranged from 0.77 mm to 1.79 mm in females (mean = 1.15 ± 0.26 mm) and from 0.95 mm to 1.45 mm in males (mean = 1.25 ± 0.23 mm) [23]. Obviously the 10th rib cartilage offers advantages over either septum or ear cartilage, particularly for complex tip-columella reconstruction such as cleft or other secondary rhinoplasty revisions.

After the 10th rib cartilage is cut to form the columella strut, the surplus cartilage slices can be deployed as tip onlay, extension graft or spreader graft if needed. From both quantitative and qualitative perspectives, the diverse and flexible nature of 10th rib cartilage makes it an excellent choice for lower nose reconstruction grafting material.

In many studies, one-third of the cleft lip nose deformities are mainly attributed to the dislocation of alar cartilage and the deformation of the nasal septum and soft tissue, resulting in asymmetric dome height, horizontal and flat nostrils, and downward displacement of the alar edge. In non-cleft rhinoplasty, the translocation of nasal septal cartilage has demonstrated promise as a technique for maintaining the protrusion and position of the nasal tip. Some surgeons opt to fix the translocated cartilage anteriorly, anchoring it or using it as extended nasal septal cartilage in secondary rhinoplasty, which has also proven to be an effective method for correcting asymmetry of the nasal tip [24]-[28]. However, an adequate volume of harvested septum is a pre-requisite as a graft, and the remaining septal structure should be sufficient to support the nasal profile in order to avoid dorsal

nasal collapse. The 10th costal cartilage is considered superior to septal cartilage in both quality and quantity for NTC reconstruction in cleft lip nose deformity [29], as well as in cases of previous septal graft failure in secondary rhinoplasty.

4. Conclusion

The 10th costal cartilage is one of the best options in Nasal Tip Columella subunits reconstruction, particularly in complex cleft nose or failure revision aesthetic rhinoplasty cases, due to its safety of harvesting, and the sufficient quality and quantity of grafting materials it provides for simultaneous adjunctive augmentation purpose.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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