

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900

Open access books available

186,000

International authors and editors

200M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



# Costal Cartilage Graft in Asian Rhinoplasty: Surgical Techniques

*Sarina Rajbhandari and Chuan-Hsiang Kao*

## Abstract

Asian rhinoplasty is one of the most difficult and challenging surgeries in facial plastic surgery. As many Asians desire a higher nasal bridge and a refined nasal tip, they undergo various augmentation procedures such as artificial implant grafting and filler injections. Autologous rib graft is a very versatile graft material that can be used to augment the nose, with lesser complications, if done precisely. In this chapter, we have discussed the steps of rib graft harvesting, carving and setting into the nose to form a new dorsal height.

**Keywords:** rhinoplasty, costal cartilage, Asians, warping

## 1. Introduction

Asian rhinoplasty is one of the most difficult and challenging surgeries in facial plastic surgery. In Asians, the most common complaints regarding appearance of the nose are a low dorsum and an unrefined tip. Thus, most Asian rhinoplasties include augmentation of the nasal dorsum using either autologous or artificial implant, and/or nasal tip surgery. Clients who have had augmentation rhinoplasty previously frequently opt for revision. Hence, when a client comes for augmentation or Asian rhinoplasty, the surgeon has to confirm whether the client has had any rhinoplasty (or several rhinoplasties) earlier. Artificial nasal implants for augmentation are still in vogue, owing to their simplicity and efficiency, but they are accompanied by several major and minor complications. Revision surgeries for these complications include correcting nasal contour deformities and fix functional problems, and require a considerable amount of cartilage. Revision surgeries are more complex than primary Asian rhinoplasty as they require intricate reconstruction and the framework might be deficient.

The debate regarding optimal graft material still persists. Silastic silicone implants cause a high incidence of early and late complications. There is a modern trend of minimal invasive rhinoplasty, such as threads insertion rhinoplasty and injectable filler rhinoplasty. But, these necessitate repeated procedures which may result in complications.

Autologous cartilage was first used in rhinoplasty in 1900 by Von Mangoldt for syphilitic noses [1]. Septal cartilage, conchal cartilage, and costal cartilage are the most common autologous graft materials used for augmentation. Each of these has their own advantages and disadvantages. Grafts with low resorption rates and sufficient strength for framework support offer consistent long-term results. Since alloplastic material increases the rate of infection, wound contracture and extrusion, autologous tissue is preferred [2].

We need to understand the characteristics of autologous grafts and consider where and how to apply them. Ear cartilage is highly elastic and has sufficient thickness and a natural curve. Hence, it can be used in areas requiring curvature, or can be manipulated by cutting in half and suturing the opposite sides; to be used as a straighter graft [3]. Septal cartilage may be abundant in Westerners but scarce and frail in Asians to be used for augmentation. Furthermore, in revision cases, patients might not have remaining or harvestable septal cartilage or even conchal cartilage. Costal cartilage has an advantage of providing a significant volume, but might cause warping, which is a common and unpredictable complication, and also leaves a scar in the chest [4, 5]. Grafts having low complication rates and high long-term patient satisfaction are considered ideal for grafting [6]. These qualities are noticed in autografts and are regarded as better alternatives for Asian rhinoplasty. Every Asian patient undergoing rhinoplasty must be properly evaluated as the outcome may vary in every patient.

In this chapter, we have discussed our techniques of harvesting and using the costal cartilage to augment and enhance the nose in Asians. Despite its abundance, costal cartilage also brings complications. But, when autologous rib cartilage rhinoplasty is performed by an experienced surgeon, it will provide an excellent, reliable, and lasting result with low risk [7]. Below, we have mentioned how to minimize the complications of harvesting and utilizing a costal cartilage and improve our surgical results.

## **2. Preoperative assessment**

An elaborate understanding of the client's expectations should be understood. What the surgeon might feel as an appropriate nasal dorsum height or nasal tip projection might not be satisfactory for the client. In these instances, simulation techniques to exhibit the probable post operative outcomes can be discussed with the client, but realistic results should be clarified.

Before surgery, we ask the client to carry out common investigations required for general anesthesia; such as complete blood count, bleeding profile, blood grouping, renal function tests, X-ray of the chest and electrocardiogram. Rib harvesting might also call for a CT scan of the chest to check for ossification of the rib, which is often seen in individuals over 40 years of age, although, we have experienced circumstances where even younger individuals presented with ossified ribs.

The surgery can be carried out by a single team or could be a two team approach where one team works on the nose and the other focuses on harvesting the rib. The second approach accounts for a lesser operative time and the rib is generally harvested from the left side, since the surgeon operating on the nose is usually on the right. In our practice, we have the same team operating on the nose and harvesting the rib, hence, we harvest the rib from the right chest wall.

## **3. Harvesting the rib cartilage**

The incision site is normally over the right sixth or seventh rib. Some surgeons also prefer the floating rib at the inferolateral costal margin [8]. Similarly, when additional cartilage is required, we also harvest the eighth or ninth rib. The medial portion of the seventh rib cartilage is long enough for a caudal septal extension graft or a columellar strut and a dorsal implant can be easily carved from its midrib portion, which is wide and thick enough. A premaxillary graft can be carved from its lateral portion. Our incision is a short linear inframammary incision. The incision site scar is the most major concern while harvesting a rib, but a smaller incision with detailed suturing and hiding the scar in the inframammary fold conceal the post operative scar and settle the client's

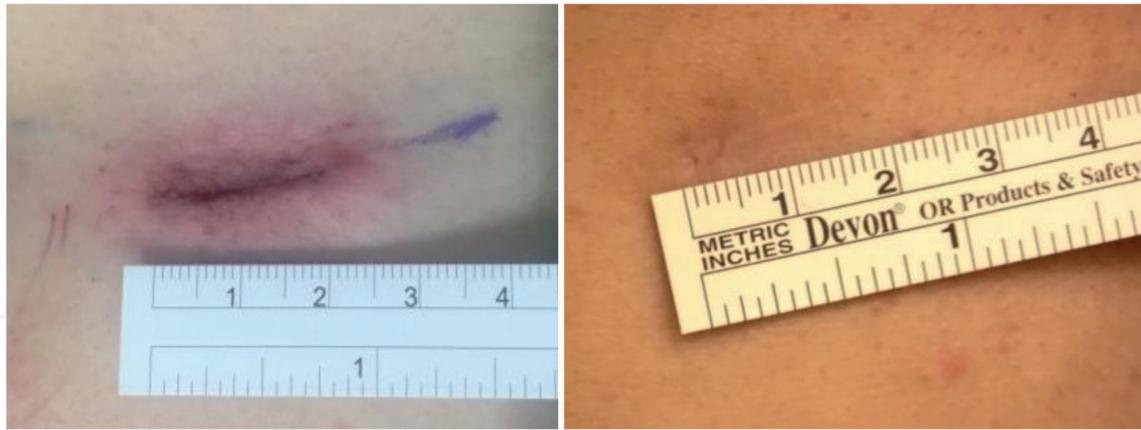
issues regarding it. After infiltrating local anesthesia, we make an incision with a No. 10 or 15 blade, at the middle of the inframammary fold, around 2–3 cm in length, although in beginners, it is better to make a longer incision for better view and ease. In males, the incision is made directly over the concerned rib. To avoid exaggerated scarring, it is better to not extend the incision beyond the vertical line from medial nipple-areola-complex [9]. When a female client has decided to have a breast augmentation in the future, we make sure to place out incision 7.5–8 cm below the nipple, which is generally the anticipated new inframammary fold. In a female who has already undergone breast augmentation, we have to be careful to not rupture the capsule of the implant.

We then perform meticulous dissection along the subcutaneous tissue and muscle fascia plane, reaching and dividing the extracostal muscle directly over the rib. The oblique abdominis and rectus abdominis muscle are vertically split and retracted. The underlying rib is identified and checked for ossification by pricking it with a syringe needle. Medially, our dissection is the junction of the rib cartilage with the sternum and laterally is the osteochondral junction. The selected rib is thus exposed, followed by a longitudinal incision through its perichondrium, along the length of its central axis. Careful circumferential subperichondrial dissection is carried out underneath the rib, exposing its posterior aspect. One must be cautious to not injure the perichondrium, which might cause complications such as pneumothorax. From the superior aspect of the rib, we also harvest some perichondrium to use as graft material. Under direct vision, a curved or right angled elevator is used to lift the rib from the underlying perichondrium. The rib is incised halfway through its thickness with a knife and proceeded with an elevator. Medially, the rib is incised at its attachment near the sternum and laterally, at the bony rib junction. This harvested rib measures 4.5–6 cm in length (**Figure 1**). In revision cases, we may require to harvest a part of the adjacent rib as well. These graft materials are submerged in normal saline with gentamicin solution. While operating on the nose, the graft remains in this solution and is observed for warping.

Before closure, we irrigate the donor site with thermal saline and check for absence of air bubbles when positive pressure ventilation is provided. This will help us ensure that there is no injury to the lung pleura/or absence of pneumothorax. Closure is done in layers. To reduce post operative pain and to facilitate proper drainage of blood, the fascia over the muscle is closed with interrupted sutures, using vicryl 3-0 sutures. Subcutaneous closure is done by vicryl 4-0 sutures and skin closure by nylon



**Figure 1.**  
*Perichondrium is harvested along with the 7th rib cartilage. The cymba and cavum concha are also harvested.*



**Figure 2.**  
*The scar immediately after wound closure is almost invisible 1 year after surgery.*

6-0 interrupted sutures. 5-0 PDS or vicryl may be used subcutaneously to avoid suture removal (**Figure 2**).

#### **4. Dissection of the nose**

We make an inverted V incision along the midcolumella, which is connected with bilateral marginal incisions. The skin flap is elevated to the level of perichondrium of the lower lateral cartilage. We use tenotomy scissors and elevators for this step. In presence of excess subcutaneous tissue in thick skin clients, it may be removed (but not aggressively) for more post operative tip definition. Septum is approached by separating the two medial crura and the subperichondrial plane of the caudal septum is identified. The septum is exposed by elevating bilateral mucoperichondrial flaps and separated from the upper lateral cartilage. A dorsal-caudal L-shaped strut of the septum is preserved for septal support. This harvested septal graft may be used as caudal septal extension graft (CSEG) or splint grafts, but they may be deficient in revision cases.

#### **5. Harvesting the conchal cartilage**

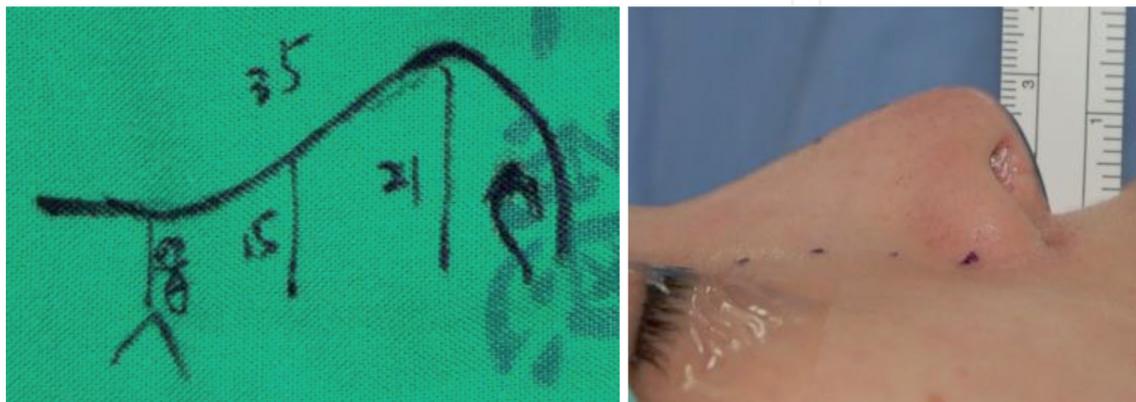
Cavum and cymba conchal cartilage is preferred for tip grafts and lateral crura strut grafts (LCSG) due to its curvature and elasticity. This is done via a post auricular approach, making an incision with a no. 15 blade. Skin and perichondrium are elevated from the underlying perichondrium and dissection is proceeded using appropriate scissors or also blunt dissection can be done with cotton-tip applicators. We should stop the dissection short of the cartilage of the external auditory canal. We generally preserve the radix helix, to preserve the ear position. The cymba and cavum conchal are harvested as two separate entities and put in the saline-gentamicin solution along with the harvested rib and septum. The incision is sutured using nylon 6-0 running mattress sutures.

#### **6. Carving the rib cartilage**

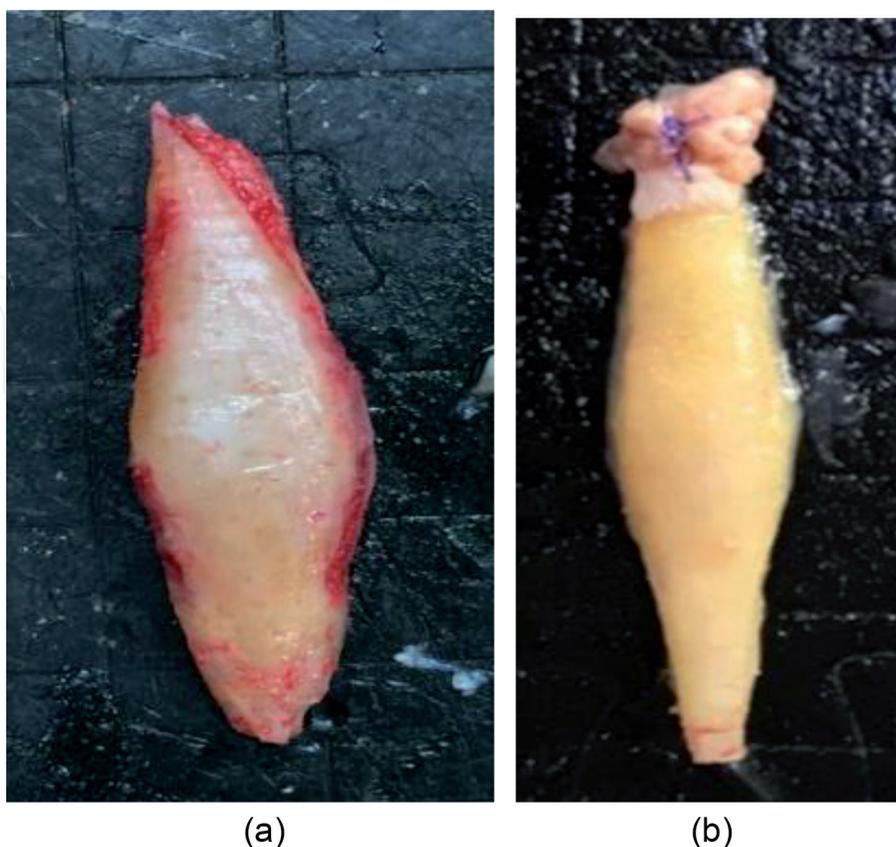
Before carving the costal cartilage graft, we measure the height of the nose at the nasion, rhinion and nasal tip. This helps us to decide the extent of carving of our graft. The dorsal graft and spreader grafts are carved from the middle portion of the harvested rib. The client's skin thickness is kept in consideration while carving the graft. In thick skinned people, the final outcome may not be as obvious as in thin skinned people. Sharp lines and angles appear blunted under a thick skin (**Figure 3**).

We carve the graft into a “fusiform” shape; which is tapered off at both ends with a wider mid region (**Figure 4**). The concave portion of the graft acts as the bottom of the implant. Precise carving and smoothening, with serial checking by inserting the graft inside the nasal skin-soft tissue flap is done, to determine the suitable height and width of the anticipated nasal shape. Balanced cuts are made in the cartilage in several directions to prevent warping. Most warping occurs within 15–60 min of harvesting and it is important to wait for early warping and reshape the graft before placement [10, 11]. Thus, the graft is carved equally on both sides, maintaining a balanced cross section of the graft.

The superior aspect of the graft to be placed over the radix is placed in an uphill converging manner to rest over the underlying bone (**Figure 5**). An additional rib cartilage may be assembled underneath the onlay graft for extended augmentation.



**Figure 3.**  
*Measurement of the nose is taken at the nasion, rhinion and nasal tip to determine the pre operative and post operative differences.*



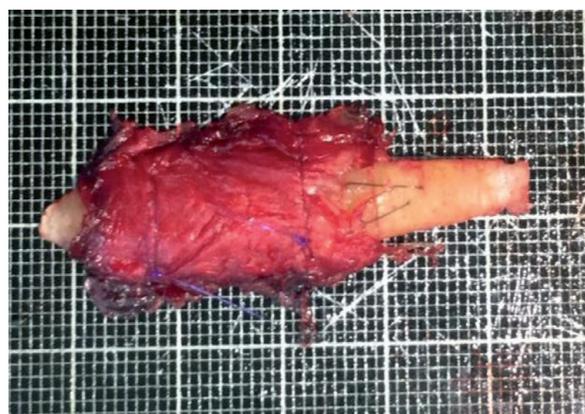
**Figure 4.**  
*(a) Rib graft is carved in a fusiform shape. (b) Perichondrium is sutured to the cephalic end of the graft to augment the radix height.*

The caudal end of the harvested rib graft is tapered and it should stop right above the lower lateral cartilages, for mobility of the lower one third of the nose. The final result should be a nose that is in tone with the rest of the Asian facial features. The onlay graft is secured in position by fixing with 2 or 3 fixation sutures with PDS 5.0, around the graft and through bilateral upper lateral cartilages. Capsule from a previous silicone implant is preserved during nasal dissection and used as a camouflage graft. Similarly, the harvested perichondrium from the rib or temporalis fascia can also be used to wrap around the rib and hide irregularities (**Figure 6**).

From the remaining portions of the rib, splint grafts, lateral crura strut grafts, caudal septal extension grafts (CSEG), columellar struts, etc. are carved (**Figure 7**). A CSEG is approximately 2 mm in thickness and trapezoidal in shape. If the septal cartilage is sufficient, a CSEG may be carved from the harvested septal cartilage. It can be fixed to the nasal L-strut in an end to end or overlapping fashion. Splint grafts are used on either side of the CSEG/L-strut complex to preserve the strength and resilience of the lower third of the nose. Extensive osteotomy may require spreader grafts as well to prevent internal valve collapse. In our experience, we have concluded that Asian clients rarely require osteotomies. Intranasal medial and lateral osteotomies are done for crooked bony dorsum. Medial osteotomy is done from the beginning of junction of upper lateral cartilage and nasal bone at a paramedian position; it is gently curved outwards at an angle of 10–15° as it proceeds upwards



**Figure 5.**  
*CSEG and splint grafts carved from the remaining portion of the harvested rib.*



**Figure 6.**  
*Deep temporal fascia wrapped around the graft to hide irregularities.*



**Figure 7.**  
*Case 1. A young female underwent open rhinoplasty with autologous rib cartilage augmentation. The pictures are taken before and 1 year after surgery.*

to connect with the lateral osteotomy. Lateral osteotomy is started just above the level of the inferior turbinate and is usually performed in a low-low-high fashion in Asians.

When augmentation is done, the client might not need an alar flare reduction afterwards, but in some cases, it may be performed.

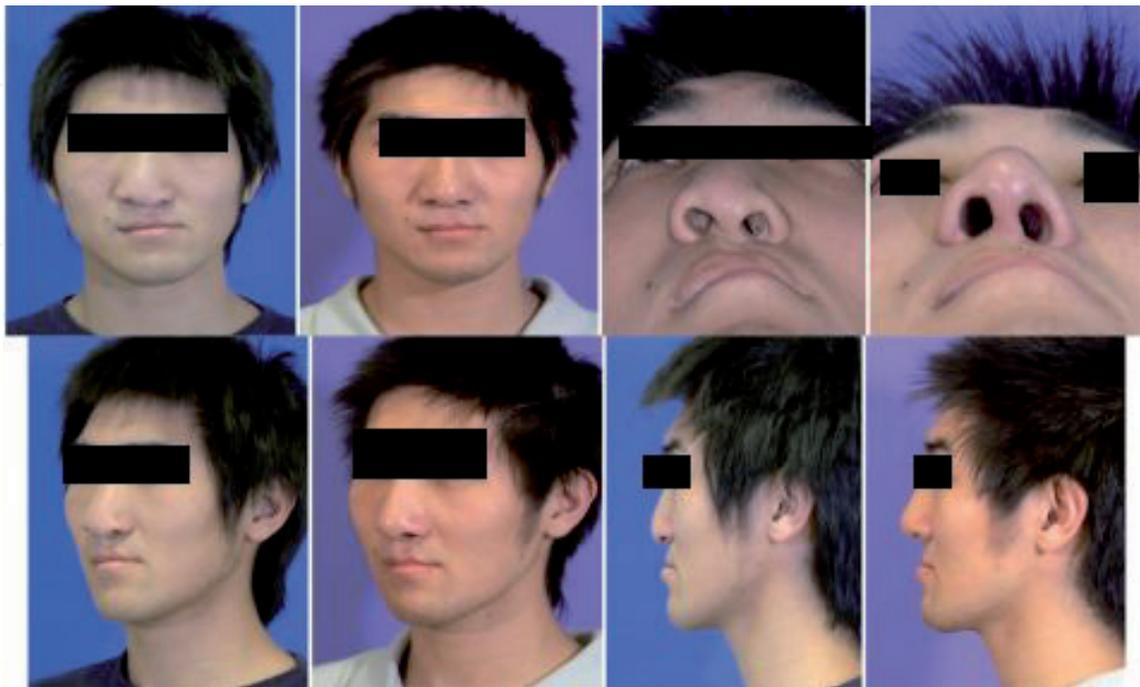
## 7. Discussion

Artificial nasal implants (silicone, goretex) and filler injections have widely been used to augment the dorsum, increase the length of the nose and project the nasal tip in Asians. However, these render complications of their own such as a shrunken nose, an artificial appearance and hard feel of the nose, skin discoloration, and migration of implants, skin erosion and extrusion [12]. Asians expect a facially harmonized look and thus undergo more than three revision surgeries, to correct previous surgeries, improper use of implants, or surgical complications [13]. Rib graft is an ideal material for primary or revision rhinoplasty, owing to its abundant supply and rigid support (**Figures 8–10**). Chances of skin infection, necrosis and shrinkage are less with the use of costal cartilage. Many surgeons prefer harvesting the rib from the sixth, seventh or occasionally the eighth rib [14]. In female clients, the sixth costal cartilage is preferred as the oblique incision scar to harvest it may be hidden in the inframammary fold, and females generally would not prefer a long nose. In males, we harvest the seventh rib for a longer dorsum. Some Asian clients seek a Western esthetic nose; hence, surgeons may need to harvest more than one rib. The most common complications of rib grafting are the chances of warping and infection. Precise carving as mentioned above and soaking the rib in saline-gentamicin solution may reduce the risk of post surgery warping. Meticulous dissection during surgery, effective antibiotics and postoperative care are important. Multiple

grafts may affect skin tension, and scar tissues from previous surgeries can reduce the vascular supply to the graft and increase probability of infection [15].



**Figure 8.**  
*Case 2. This female underwent open rhinoplasty with autogenous costal cartilage grafting and ear cartilage grafting for tip refinement. These pictures are taken before and 3 months after surgery.*



**Figure 9.**  
*Case 3. A case of cleft nasal deformity underwent open rhinoplasty with autologous rib cartilage grafting. These pictures are before and 1 year after surgery.*



**Figure 10.**

*Case 4. A case of saddle nose deformity who had augmentation with silicone implant previously. Two ribs were harvested for nasal dorsal, premaxillary and paranasal augmentation.*

Cadaver rib may also be used for rhinoplasty, but since it is not live, autologous tissue, it may form a capsule due to unassimilated tissue, has higher long term absorption rate, risk of transmitting diseases such as HIV, hepatitis, etc. and possibility of soft tissue loss if infection control is delayed [16, 17]. Calvarial bone grafts are also becoming popular with the advances in craniofacial surgery. When morphologically compared with endochondral bone, membranous bone has a thicker cortical plate, smaller endocortical cancellous area, and stronger intracortical struts [18]. Hence, calvarial bones are also a good material of choice for augmentation rhinoplasty. This bone also resembles the other facial bones and can be easily incorporated into the nasal framework. The risk of significant absorption is less, however, there is a possibility of injury to the dura and intracranial structures, hematoma/seroma, with inadequate training [19].

The fundamental strength of the osseocartilaginous rib graft lies in replacing like with like [8]. A rib graft allows for bony integration with the nasal dorsum, immobilizes the graft and allows for meticulous sculpting of the nasal tip. However, autologous costal cartilage should be used keeping the possibility of complications in mind, especially when a large amount of graft material is required.

### **Conflicts of interest**

There are no conflicts of interest.

### **Authors' contributions**

Dr. Chuan-Hsiang Kao made contribution to the conception and design of the study and provided cases and material for the study.

Dr. Sarina Rajbhandari made contribution to the presentation of the text and concept of the study.

## Declarations

None to be made.

## Financial support and sponsorship

None.

IntechOpen

## Author details

Sarina Rajbhandari<sup>1</sup> and Chuan-Hsiang Kao<sup>2\*</sup>

1 Department of Otolaryngology-Head and Neck Surgery, Starr Hospital, Kathmandu, Nepal

2 Department of Otolaryngology-Head and Neck Surgery, Tri-Service General Hospital, Taipei, Taiwan

\*Address all correspondence to: [chuanhsiang@yahoo.com.tw](mailto:chuanhsiang@yahoo.com.tw)

## IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

## References

- [1] Lupo G. The history of aesthetic rhinoplasty: Special emphasis on the saddle nose. *Aesthetic Plastic Surgery*. 1997;**21**(5):309-327
- [2] Marin VP, Landecker A, Gunter JP. Harvesting rib cartilage grafts for secondary rhinoplasty. *Plastic and Reconstructive Surgery*. 2008;**121**:1442-1448
- [3] Endo T, Nakayama Y, Ito Y. Augmentation rhinoplasty: Observations on 1200 cases. *Plastic and Reconstructive Surgery*. 1991;**87**(1):54-59
- [4] Jang YJ, Alfanta EM. Rhinoplasty in the Asian nose. *Facial Plastic Surgery Clinics of North America*. 2014;**22**(3):357-377
- [5] Sajjadian A, Rubinstein R, Naghshineh N. Current status of grafts and implants in rhinoplasty: Part I. Autologous grafts. *Plastic and Reconstructive Surgery*. 2010;**125**(2):40e-49e
- [6] Kao CH, Hsu CH, Lee JC, Wang HW, Tsai KK. Customized material choice for Asian rhinoplasty: How we do it. *Clinical Otolaryngology*. 2011;**36**:165-170
- [7] Toriumi DM, Pero CD. Asian rhinoplasty. *Clinics in Plastic Surgery*. 2010;**37**:335-352
- [8] Christophel JJ, Hilger PA. Osseocartilagenous rib graft rhinoplasty. *Archives of Facial Plastic Surgery*. 2011;**13**(2):78-83
- [9] Tebbetts JB. The inframammary approach for augmentation. In: *Augmentation Mammoplasty*. St. Louis, MO: Mosby; 2010. pp. 251-288
- [10] Adams WP, Rohrich RJ, Gunter JP, et al. The rate of warping in irradiated and nonirradiated homograft rib cartilage: A controlled comparison and clinical implications. *Plastic and Reconstructive Surgery*. 1999;**103**:265-270
- [11] Cakmak O, Ergin T. The versatile autogenous costal cartilage graft in septorhinoplasty. *Archives of Facial Plastic Surgery*. 2002;**4**:172-176
- [12] Lam SM. Revision rhinoplasty for the Asian nose. *Facial Plastic Surgery*. 2008;**24**(3):372-377
- [13] Suh MK, Ahn ES, Kim HR, Dhong ES. A 2-year follow-up of irradiated homologous costal cartilage used as a septal extension graft for the correction of contracted nose in Asians. *Annals of Plastic Surgery*. 2013;**71**(1):45-49
- [14] Gunter JP, Cochran CS. Dorsal augmentation with autogenous rib cartilage. *Seminars in Plastic Surgery*. 2008;**22**:74-89
- [15] Holt GR, Garner ET, McLarey D. Postoperative sequelae and complications of rhinoplasty. *Otolaryngologic Clinics of North America*. 1987;**20**:853-876
- [16] Song HM, Lee BJ, Jang YJ. Processed costal cartilage homograft in rhinoplasty: The Asian medical center experience. *Archives of Otolaryngology-Head & Neck Surgery*. 2008;**134**(5):485-489
- [17] Welling DB, Maves MD, Schuller DE, Bardach J. Irradiated homologous cartilage grafts. Long-term results. *Archives of Otolaryngology-Head & Neck Surgery*. 1988;**114**(3):291-295
- [18] Hardesty RA, Marsh JL. Craniofacial onlay bone grafting: A prospective

evaluation of graft morphology,  
orientation, and embryonic origin.  
*Plastic and Reconstructive Surgery.*  
1990;**85**:5-14

[19] Cheney ML, Gliklich RE. The use of  
calvarial bone in nasal reconstruction.  
*Archives of Otolaryngology-Head &  
Neck Surgery.* 1995;**121**:643-648

IntechOpen

IntechOpen