Reconstruction of Saddle Nose Deformity

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99.1 Introduction

Saddle nose deformity results from many different etiological factors. Trauma and previous surgeries are the most common reasons, whereas the intranasal foreign body, infections of the septum, and cocaine abuse should also be kept in mind [1]. Different types of etiologies are related to various types of deformities. The term "saddle nose" is attributed to this clinical outcome as it looks like a saddle from the lateral view. It may concern both the functional and cosmetic aspects of the nose. Various subtypes of the deformity lead to different treatment modalities. The first article about saddle nose management had been published by John Orlando Roe in 1887 entitled, "The deformity termed 'pug nose'" [2]. Robert F. Weir had implanted breastbone of a duck into a syphilitic nose [3] and Israel was the first physician who used a human bone graft in 1896 [4]. Penn G. Skillern, Jr. had published his article entitled, "Rib cartilage transplant for saddle-back nose" in 1918 [5]. Afterward, many studies had been performed concerning the etiology, degree, and management of saddle nose deformity.

99.2 Anatomy and Pathology

Nasal anatomy is comprised of bony and cartilaginous components stabilized by dense fibrous tissue and internally overlied by flexible mucoperichondrium and mucoperiosteum. Bony construction of the nose is formed by the nasal bone, bony septum, piriform aperture, and nasal floor. Quadrangular cartilage of the septum, upper and lower lateral cartilages, and variably existing sesamoid cartilages are main components of the cartilaginous architecture. The angle between the septum and upper lateral cartilage forms the internal nasal valve. Middle vault and the nasal tip are supplied by tight conjunctions between the cartilaginous septum, bony septum and nasal bone. Upper lateral cartilages are firmly connected to the overlying bony bridge, "the K area". These tight connections between the upper lateral cartilages and dorsal septum are supplied by their relations with lower lateral cartilages and nasal bone [1]. Caudal septum lies between the premaxilla and cartilaginous dorsum which are supplementary to nasal dorsum, columella, and the nasal tip. It should be straight and tight [6].

Tardy has subdivided the nasal tip support structures into two groups as major and minor. Major tip supporting mechanisms are reported as the size, shape, and resilience of the lower lateral cartilages, attachment of the footplate of medial crura to the caudal septum, scrolled attachment of cephalic margins of the lower lateral cartilages to the caudal margin of the upper lateral cartilages. Minor tip supports are specified as the dorsal septum, interdomal ligaments, membranous nasal septum, anterior nasal spine, attachment of the lower lateral cartilages to the skin soft tissue envelope, and lateral crural attachment to the pyriform aperture [7].

Characteristics of saddle nose deformity are depression and widening of the middle vault and dorsum, loss of tip support and definition, columellar retrusion and shortening, reduced vertical length, tip overrotation, deprojection and retrusion of the nasal and caudal spine [6, 8, 9]. On lateral view: hidden columella, rounded and long upper lip, and pseudo hump could be seen. On base view: rounded nostrils, short and broad columella with wide interdomal distance could be notified as possible findings of deformity [6].

Once the nasal skeleton has been destroyed, overlying skin and subcutaneous soft tissue become contracted [10]. This may result in cosmetic problems as well as physiological dysfunction due to the collapse of internal and external valve areas [11].

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The most common reason for saddle nose deformity in patients of previous rhinoplasty is overresection of the septum. Prior to the reconstructive surgery, assessment of remaining septal support is of vital importance. Interestingly, no correlation between septal defect and clinical findings has been demonstrated [12].

99.3 Classification

The severity of saddle nose deformity has been classified in various ways and authors tried to agree on a standard management algorithm but it is still not very practical to apply it in all cases [4, 13].

Tardy et al. [14] suggested a classification comprised of 3 categories:

(a) Minimal: Supratip depression more than the ideal 1–2 mm tip-supratip difference, slightly remarkable bony hump, wide dorsum, and minimal columellar retraction.
(b) Moderate: Moderate degree saddling due to loss of vertical length of quadrangular cartilage together with septal damage. Columellar retraction narrows the nasolabial angle.
(c) Major: Severe degree saddling together with major cartilage loss; major deformity.

Vartian and Thomas [4] classified saddle nose deformity as 4 categories according to existing cartilage damage:

- Type 1: Minor supratip or dorsal nasal depression with preserved lower 1/3 projection.
- Type 2: Moderate-severe depression with prominent lower 1/3.
- Type3: Lower 1/3 deficit and moderate-severe dorsal depression which leads to loss of tip support.
- Type4: Pannasal defect leading to moderate-severe dorsal deformity together with upper and lower 1/3 nasal deformity.

Daniel and Brenner suggested another classification [12] comprised of 5 categories in 2006:

(a) Supratip depression and columellar retraction.
(b) Loss of tip projection and septal support.
(c) Total loss of cartilage vault integrity and flattening of nasal lobule.
(d) Progression including the bony vault.
(e) Advanced level catastrophic deformity.

Hyun modified this classification which could be also used in an Asian nose [15].

99.4 Preoperative Evaluation

Patient's nose should be elaborately examined both internally and externally. Structural abnormalities and weakened tissues must be carefully identified as the physician may decide whether any augmentation is needed or not. Graft materials should be concerned with convenient reconstruction. Residual supportive tissue should be assessed by palpation of the dorsum and nasal tip. Depression of supratip dorsal cartilage due to septal defect is a common finding. This defect leads to weakening of tip support which results in distorted tip rotation and shortened nose. Bony pyramid and soft tissue should also be assessed. Quality of the skin should be noted. Thin overlying skin firmly attaches to the osteocartilaginous skeleton and may fail to hide the underlying graft defects. Thick skin, however, may not cover the skeleton firmly but may hide the underlying tiny protrusions [10, 14].

In revision rhinoplasty procedure, the physician may notice lost cartilage support and weakening of ligaments due to prior surgery. Overresection of connective tissue between lateral crural cartilages, malpositioned dome structures due to scar contracture which leads to decreased tip projection, cephalic overrotation, and associated nasal valve collapse may be seen [16].

These patients should also be examined by using intranasal endoscopy. Synechia, septal perforation, turbinates, and possible nasal septal deviation must be concerned. Upper and lower lateral cartilages and the nasal valve must be carefully assessed. Any defect in these structures may result in nasal obstruction [17, 18].

Surgical approach to mild and severe deformities are different. Prior to surgery, the severity of the deformity should be evaluated and the patient should be clearly informed about the type of incision, any graft necessity, and its donor site. It is very important to take pictures of the patient before surgery.

99.5 Treatment

It is not easy to obtain a satisfying outcome after saddle nose surgery. Many classifications had been reported in order to form convenient surgical treatment algorithms, as we described earlier, but it may not be possible to adjust them to every patient.

The surgeon makes a preoperative assessment but the operation plan may be modified during surgery. Written informed consent is obtained from the patient for graft materials. The surgeon may use multiple materials when needed or may not use any of them.

99.5.1 Grafts and Implants

99.5.1.1 Grafts

Various types of grafts are frequently used in nasal reconstruction surgery. In time, materials used for grafting changed as required. Availability, durability, sufficiency, formability, low donor site morbidity, and low extrusion risk are characteristics of the ideal graft material. Grafts should not cause any immune or inflammatory reaction [4, 19]. Synthetic grafts and homografts have been used over time; but shifting, extrusion, and infection risks have limited their use [20, 21]. There are different donor site options for autografts, including iliac crest and calvarial bone.

In what way and from what source grafts are being used, it is important to ensure proper nasal support and to obtain an appropriate soft tissue tension. Grafts must be prepared and placed properly so they do not shift for obtaining a good function and aesthetic appearance. In our practice, we use autografts, mostly cartilage grafting and nasal septum cartilage comprises many of these, and because it is flat and easily shaped, it also exists in the same surgical field.

In minor deformities, nasal septum cartilage exists sufficiently in most of the cases, but if saddle nose was developed secondary to previous surgery, it is not always available. The availability and physical properties of the materials to be used gain importance in reconstruction, besides the existing deformity. Structure and shape of the nose to be established are decisive.

If there is not sufficient nasal septal cartilage, auricular conchal and rib cartilage grafts can be used. In cases of major deformities, rib cartilage is always a good option. In secondary rhinoplasties, according to the size of the remaining septal cartilage, fixation of the grafts is necessary to residual cartilages or nasal bones. Crashed or diced cartilage in temporalis fascia can be placed on the reconstructed nasal dorsum. Camouflage grafts help to create a better contour.

Auricular conchal cartilage is useful due to its comparative proximity to the surgical field. The thin and curved structure of this cartilage is its disadvantage [22]. Anterior and posterior approaches can be used while the graft is harvested. In the anterior approach, after the incision was made right in front of antihelix, cymba or cavum concha is dissected according to the degree of bending required. In the preauricular approach, it is easier to harvest a larger conchal cartilage. After controlling the bleeding, through and through suturation is made through the pinna with gauze or cotton roll bolsters to maintain contact of cartilage and the soft tissue on it for both sides of concha to reduce the possibility of possible auricular hematoma.

Rib cartilage graft can be easily shaped; its strength and abundance are reasons for its preference. Its main disadvantages are the risk of pneumothorax, warping, and donor site morbidity. In elder patients, it is sometimes ossified and this can be a limitation [23, 24]. Grafts can be harvested from the sixth or seventh ribs. The fifth or sixth ribs can be preferred for female patients [25]. Rib cartilage has a tendency for warping, and ninety percent of warping occurs in the first 1 h after harvesting. That is why it should be harvested in the early minutes of surgery and waited in sterile saline so we can predict its possible future shape more accurately [26]. Insertion of K wires and combining the warped cartilages together [counterbalancing technique [27]] were options to get better results [28]. When preparing the rib cartilage graft, oblique split technique [29] can be used or middle layer of rib cartilage can be preferred. The surface of rib cartilage is prone to warp more than the middle layer. Accordion technic is another method to reduce the risk of warping [25, 30].

If there is not sufficient autogenous cartilage, homografts or synthetic materials can be used in such a need. Irradiated costal cartilage and alloplastic materials are options for this purpose. Irradiated rib cartilage can be provided enough for reconstruction and does not cause donor site morbidity. Migration, resorption, and warping are its disadvantages [31].

When structural support has been provided, various materials can be used for additional dorsal augmentation and a better aesthetic appearance. Various fillers are also present and have been used (autogenous, biological, synthetic).

99.5.1.2 Biotechnology and Cartilage Culture

Many autologous and synthetic materials are used for augmentation rhinoplasty. However, inadequacy or impropriety of these has led to another quest. In a study, Yanaga et al. used cultured autologous human auricular chondrocytes for grafting. They cultured auricular conchal cartilage of 1 cm^2 into a gel-type mass of a chondrocyte and transplanted this into surgically created subperiosteal skin pocket on nasal dorsum by injection. They have found satisfactory results [32].

99.5.1.3 Alloplasts

Alloderm, Gore-Tex®, silicone, Medpor®, etc. are some options. Tissue reactions, infection, and the risk of shifting are the main disadvantages of alloplasts.

The silicone implants for dorsal augmentation are easy to use and remove. Without the integration of the implant with surrounding tissues, a fibrous capsule occurs around them, so implant shift may occur [33]. Extrusion of implants and infection are the potential risks [34, 35]. Expanded polytetrafluoroethylene also has been used for soft tissue nasal defects [36, 37]. A porous high-density polyethylene material shows more integration with connective tissue [33]. Tissue integrates with the implant as it enters into the porous structure. It is used for support and easy to be shaped and cut, and can be sutured. Richardson et al. modified Turkish Delight [38] and used morselized polyethylene as a dorsal graft in rhinoplasty [39].

99.6 Surgery

In nearly all saddle nose cases, we prefer an open approach for a better exposition and easy detection and reconstruction of deformity.

Minor defects in the caudal nasal septum can be reconstructed with autogenous septal cartilage. When there is not available or proper cartilage for grafting, nasal septal bone or autogenous auricular conchal or rib cartilage can be used. Narrowing nasal bony pyramid and repairing caudal septal cartilage defect may be enough to elevate dorsum.

When additional augmentation is required, dorsal onlay cartilage graft is an option. A pocket on dorsum should be made so the graft will not move, and it is better to shape the graft so it is not going to cause irregularities under the skin. Dorsal onlay graft must be secured to the septum, graft used to reconstruct septum or upper lateral cartilages. The caudal part of dorsum graft can be designed as a fork so it can be integrated into a strut graft. By this way, retraction of columella disappears and support is provided for lower lateral cartilage. Dorsal onlay grafts can be enough, if there is not any nasal valve pathology, in minor deformities in which there is powerful septal support.

Defects in thin-skinned patients after nasal dorsum surgery are challenging. Usually, dissatisfied patients complain about the thickness and texture of the skin in the surgical area, with residual defects and sometimes scar retraction particularly in secondary cases. The use of crushed and diced cartilage reemerged after several years thanks to Erol [38] that used as a wrapping for a "bean bag" of oxidized regenerated cellulose (Surgicel®, Johnson and Johnson Medical, Arlington, TX, USA) calling his innovative technique "Turkish Delight". Cakmak [40], Huising [41] De Souza, and Settani [42] saw an increase of cartilage death and fibrosis correlated with the degree of crushing so they suggest an overcorrection during rhinoplasty. Opposite, Breadon [43] and Yilmaz [44] demonstrate the same viability both on intact than in crushed form after the implant. Daniel published the use of diced cartilage wrapped in fascia to facilitate the positioning and stability of the graft [45]. As can be seen in other reports, a bean bag graft can also fit a wide range of defects and can be corrected with external manipulations up to 10 days postoperatively. Taping is removed from our patients several times to guide the tissue ingrowth with accurate palpation. Surgical revisions mainly consist of shape shaving with a 16 G needle or the use of an injectable filler [46]. This graft can correct defects of at least 3−5 mm in thickness. The graft is not subject to warping and to infection, unlike other allografts.

If there is a slight depression in the supratip region, diced cartilage grafts can be sufficient alone [47]. Lateral crus rotation (flying wings) is also a good method for minor supratip depressions [48].

In the situation of weakened upper lateral cartilages, middle vault integrity and support must be provided besides the function of the internal nasal valve. Spreader grafts, batten grafts, and/or dorsal onlay grafts can be utilized for both support and function [12]. In nasal tip deformity, strut and onlay grafts are helpful.

Spreader grafts are frequently used in middle vault reconstruction [49]. They are placed under the nasal bones cranially and along the dorsum, between upper lateral cartilages and septum, and fixed with 5–0 polydioxanone sutures. Septum cartilage is the first option for spreader grafts and if it is not properly available, auricular and rib cartilages are alternative sites to harvest graft. A long spreader graft can be combined with a caudal septal extension graft. Extension graft is fixed to nasal septum cartilage, spreader grafts, and anterior nasal spine. Extended spreader graft can be placed on both sides of septum, and also batten grafts can be additionally used. If spreader grafts are put bilaterally, caudal extension grafts can be sutured between them. Tongue-in-groove fixation is sometimes needed [12].

In major deformities, extracorporeal reconstruction of the nasal septum is also sometimes required [50]. When we need major structural support, osseocartilaginous rib graft can provide good support [12] (Figs. 99.1, 99.2, 99.3, 99.4, 99.5, 99.6, 99.7, 99.8, 99.9, 99.10, 99.11, 99.12, 99.13, 99.14, 99.15, 99.16, 99.17, 99.18, 99.19, 99.20, and 99.21). The

Fig. 99.1 Preoperative frontal view. Inverted "V" deformity. Depression and widening of the bony vault and dorsum. Nasal cartilaginous deviation

Fig. 99.2 Postoperative frontal view

Fig. 99.4 Postoperative right lateral view

Fig. 99.3 Preoperative right lateral view. Depression of radix and bony vault

Fig. 99.5 Preoperative left lateral view. Depression of radix and bony vault

Fig. 99.6 Postoperative left lateral view

Fig. 99.8 Postoperative right oblique view

Fig. 99.7 Preoperative right oblique view. Depression of radix and bony vault

Fig. 99.9 Preoperative left oblique view. Depression of radix and bony vault

Fig. 99.10 Postoperative left oblique view

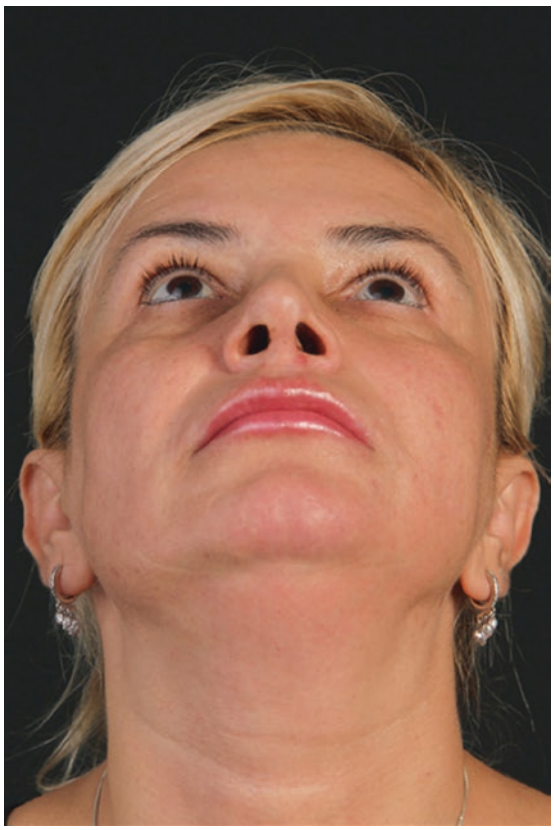

Fig. 99.12 Postoperative basal view

Fig. 99.11 Preoperative basal view. Asymmetric nostrils

Fig. 99.13 Peroperative photograph of the same patient

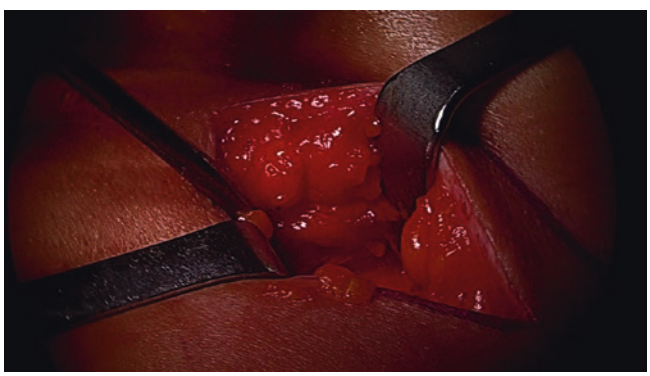

Fig. 99.14 Harvesting the cartilage graft from the right sixth rib for the same patient. Exposition of the rib cartilage

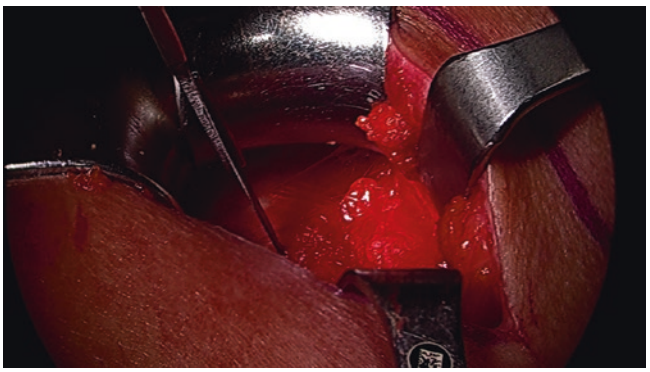

Fig. 99.15 Harvesting the cartilage graft from the right sixth rib for the same patient. Incision of the rib perichondrium

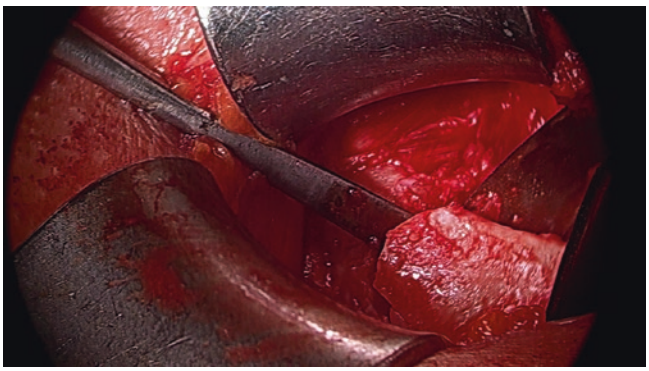

Fig. 99.18 Harvesting the cartilage graft from the right sixth rib for the same patient. Further dissection between the rib and its perichondrium

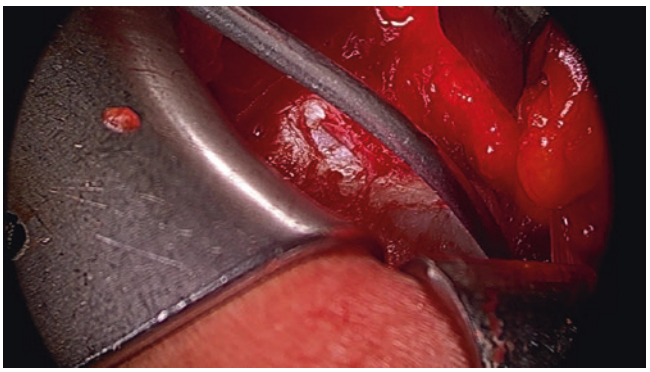

Fig. 99.16 Harvesting the cartilage graft from the right sixth rib for the same patient. Elevation of the rib perichondrium

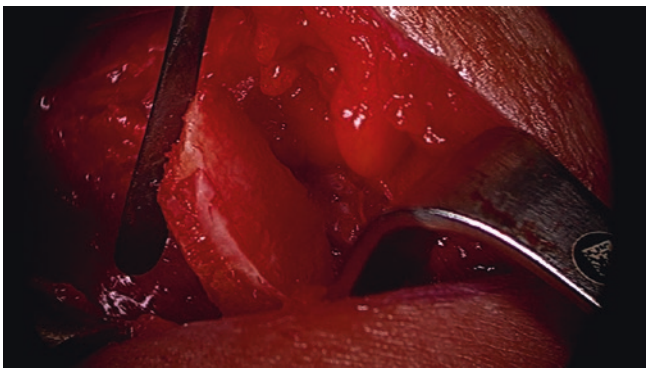

Fig. 99.19 Harvesting the cartilage graft from the right sixth rib for the same patient. Provided rib graft for reconstruction of saddle nose deformity

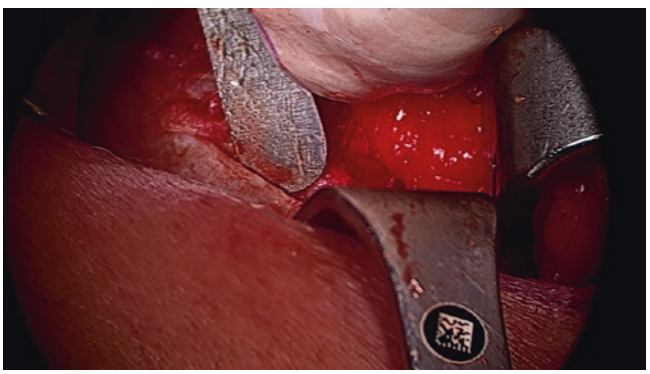

Fig. 99.17 Harvesting the cartilage graft from the right sixth rib for the same patient. Dissection between the rib and its perichondrium

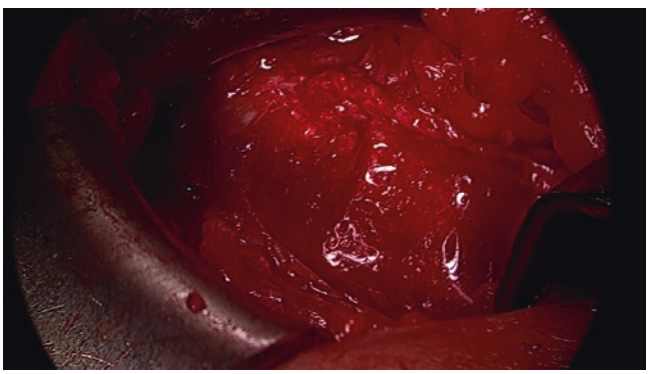

Fig. 99.20 Harvesting the cartilage graft from the right sixth rib for the same patient. Post-procedure control of the surgical field

implants are also useful in such a deformity. Expanded polytetrafluoroethylene (Gore-Tex®; Surgiform Technology, SC, USA) or polyethylene polymer (Medpor®; Stryker Corporate, MI, USA) can be used in the reconstruction.

After replacing the main supports, present cartilages are helpful as crashed or diced grafts, for a better aesthetic appearance. The cartilage is diced, with a scalpel as pieces of about 0.5 mm, and used alone or wrapped in a fascia graft. Using an injector makes it easy to place them. There are studies which mention about good survival and viability of these cartilages [47, 51, 52].

Synthetic materials used as coverings of the diced cartilages have been suggested to cause an inflammatory reaction and have a tendency for resorption [47]. The diced cartilages alone, or put in a fascia, are easily shaped for good aesthetic results at the end of the operation.

Fig. 99.21 Shaping the rib cartilage grafts. “L strut”, dorsal onlay graft and additional cartilage parts

For a better nasal tip definition and projection, onlay or shield-shaped tip grafts may be needed.

99.7 Summary

The degree of saddle nose deformity varies. Assessment of nasal function with aesthetic appearance is required. Grafts and implants are helpful for reconstruction. It is difficult to establish an algorithm for surgical treatment.

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