

# Considerations for Optimal Grafting in Rhinoplasty

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## Abstract

A wide variety of grafting materials and techniques can be used to create functional and aesthetic changes in rhinoplasty. Choosing the optimal grafting approach is critical to achieving an optimal patient outcome. We present a review of autografts, allografts, and alloplasts used in primary and revision rhinoplasty and discuss factors that impact graft choice. Autologous grafts serve as the pillar for grafting material in rhinoplasty given their reliable long-term outcomes, low rates of infection, resorption, and extrusion, and ability to provide structural scaffolding as well as contour. Cadaveric allografts can be utilized as a source of grafting material in certain clinical scenarios including revision rhinoplasty and have been shown to be equally safe and effective as autologous grafts while avoiding donor-site morbidity. Alloplasts can prove useful in rhinoplasty in cases of iatrogenic nasal deformities or revision cases. Careful consideration of clinical scenario, patient factors, and outcome goals is necessary to choose the appropriate grafting approach to address functional and cosmetic outcomes.

## Keywords

- ▶ rhinoplasty
- ▶ grafting
- ▶ autograft
- ▶ costal cartilage
- ▶ allograft

The structure of the nose is important for both function and form, affecting nasal airflow as well as aesthetic appearance. In rhinoplasty, grafting is often necessary to address either or both factors. Over the long history of rhinoplasty, a wide variety of grafting materials have been used to create cosmetic and functional changes to the nose. Standard grafting materials have evolved over time, based on surgical experimentation and the evolution of knowledge and techniques in reconstructive and cosmetic rhinoplasty. While there exists a variety of graft choices, certain grafting materials are used more frequently to improve functional outcomes while others are primarily employed to optimize cosmetic outcomes. Furthermore, revision rhinoplasty presents a unique challenge in that native septal cartilage has often been previously resected. Choosing the optimal grafting material in rhinoplasty requires consideration of clinical scenario, patient factors,

and outcome goals. In this review, we discuss considerations for choosing the appropriate grafting material in primary and revision rhinoplasty. We provide an overview of the various types of grafts available and discuss factors that can impact graft choice.

Grafting materials in rhinoplasty can be divided into three primary categories: autografts, allografts, and alloplasts. Autografts are derived from the patient and are also referred to as autogenous or autologous grafts. Examples of autografts include: septal, conchal, and costal cartilage. Allografts are of cadaveric origin. Cadaveric costal cartilage is the most common allograft used in rhinoplasty. Alloplasts refer to synthetic materials and include products such as silicone, acellular dermal matrix such as AlloDerm, mersilene mesh (Ethicon), porous polyethylene (Medpor, Stryker Inc.), polydioxanone (PDS) plates, and expanded polytetrafluoroethylene (Gore-Tex, W.L. Gore & Associates Inc.).

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## Autologous Grafts

With reliable long-term outcomes, low rates of infection, resorption, and extrusion, and the ability to provide structural scaffolding and create contour, autologous grafts remain the workhorse for grafting material in rhinoplasty.<sup>1</sup>

### Septal Cartilage

It is widely accepted that autologous septal cartilage is the first-line grafting material for rhinoplasty. Literature has demonstrated the reliable long-term outcomes of using septal cartilage, and hence, it remains the workhorse of grafting materials in rhinoplasty. The septal cartilage is easily harvested in trained hands and there is very low chance of donor-site morbidity. Septal cartilage is most commonly used in primary rhinoplasty and can be manipulated for use as spreader grafts, columellar struts, alar batten grafts, dorsal augmentation, and alar rim grafts, among others. Septal cartilage grafts can provide structural scaffolding and create contour in rhinoplasty. Cartilage pieces can also be crushed or diced, which further broadens the versatility of this graft.

While septal cartilage is the grafting material of choice for rhinoplasty, poor surgical technique can result in a weakened nasal scaffold or the appearance of an overresected nose. Maintaining an adequate dorsal strut during septoplasty and cartilage harvest is essential to prevent these outcomes. As with all autogenous grafts, septal cartilage grafts carry a very low risk of infection as the grafting material is derived from the patient's own body.

### Conchal Cartilage

When septal cartilage is inadequate for either reconstructive or cosmetic surgical needs, alternative grafting sources must be used. This scenario is especially common in patients undergoing revision surgery in which a septoplasty has previously been performed; however, this may also arise when quantity of native septal cartilage is inadequate. Autologous cartilage grafts can be harvested from the conchal cartilage of the ear. Conchal cartilage is more malleable and pliable than septal cartilage, which poses a challenge when carving grafts that require a degree of rigidity or contour; however, the natural curvature of auricular cartilage is ideal for reconstruction of the alar framework.<sup>2</sup>

Harvest of conchal cartilage can be achieved through an anterior or posterior incision, which heals well with minor or no donor-site morbidity. For an anterior approach to graft harvest, an incision is planned that follows the lateral border of the cymba and cavum conchae. For a posterior approach, the surgical incision is made in the postauricular skin overlying the eminence of the concha. While it has been suggested that an anterior approach allows for a larger graft, a recent study demonstrated that posteriorly harvested grafts tend to have greater surface area than those obtained from an anterior approach.<sup>3</sup> There is minimal auricular distortion with graft harvest from either approach and resulting scar lines are discreet with proper surgical technique.<sup>2,4</sup>

While donor-site morbidity is minimal with conchal cartilage grafts, it is important to consider patient-specific

factors when determining sidedness of donor site. Pertinent patient factors such as which side of their head they sleep on, or use of unilateral hearing aids or headsets may impact patient satisfaction and healing during the recovery period. Additionally, the symmetry of the patient's ears should be closely examined preoperatively.

A butterfly graft harvested from conchal cartilage may be used to correct internal nasal valve collapse in select patients.<sup>5</sup> First described in 2002 by Clark and Cook, the butterfly graft has been shown to provide almost double the reduction in nasal airflow resistance as compared with traditional spreader grafts in cadaveric models.<sup>6,7</sup>

### Costal Cartilage

Autologous costal cartilage provides ample grafting material for use in rhinoplasty. Frequently utilized in cases of revision rhinoplasty and nasal reconstruction after trauma, this grafting material is both versatile and robust. These grafts are routinely harvested through an inframammary or infrapectoral incision in the chest. Most common sites of harvest are the fifth, sixth, or seventh rib and segments range in size from 3 to 5 cm in length, providing an abundance of grafting material.<sup>8</sup>

Commonly cited disadvantages of costal cartilage include propensity to warp, calcification in older patients, donor-site morbidity, and associated operative risks. Less common but possible risks of autologous costal cartilage harvest include seroma, pneumothorax, and chest wall deformity.<sup>9,10</sup> Certain patients may require hospitalization for adequate pain control. With proper technique, however, the rate of donor-site complications is very low.<sup>11</sup> A systematic review by Varadharajan et al assessed complications in rhinoplasty associated with autologous costal cartilage grafting in 21 studies.<sup>12</sup> The authors found pooled donor-site complication incidence of 0.1% for pneumothorax and 0.6% for pleural tear or seroma.<sup>12</sup> The most common donor-site complication noted was scar-related complaints (2.9%). When examining pooled recipient site complications, the most frequent problem was warping of the graft (5.2%), followed by infection (2.5%). The incidence of graft resorption was less than 1% on pooled analysis.<sup>12</sup> Using the central portion of the costal cartilage may minimize warping of autologous costal cartilage grafts over time.<sup>9</sup> Additionally, removing the perichondrium may also help prevent warping.<sup>9</sup> No differences in warping with regard to level of rib harvest or use of oppositional suturing have been demonstrated.<sup>9</sup> Use of autologous costal cartilage is limited by patient age and potential ossification. Pain is another common concern for autologous rib grafting but can be reduced by limiting the use of bovie cautery and cutting of the abdominal muscle fibers.<sup>13</sup>

### Diced/Crushed Cartilage

While most harvested cartilage is carved to a desired shape for grafting, cartilage can also be finely diced or crushed, morphing the grafting material into a thin and soft consistency. This may be accomplished through purposeful weakening of the cartilage using a cartilage morselizer or Adson-Brown forceps. Diced cartilage can be used independently,

with fascial sleeves, or made into glue graft. Although typically used to camouflage dorsal irregularities, diced or crushed cartilage has been used for primary dorsal augmentation. However, unpredictable resorption rates and migration from the intended position are potential complications when crushed cartilage is utilized for dorsal augmentation.<sup>14</sup>

### Calvarial Bone

Calvarial bone grafts can be useful for reconstruction of the nasofacial skeleton in instances of a compromised wound beds in the setting of prior infection, inflammation, or radiation.<sup>15</sup> As membranous bone, calvarial grafts exhibit a low resorption rate with the ability to withstand infection and establish an osseous union.<sup>15,16</sup> For nasal reconstruction, a split-thickness bone graft size of 1 × 4 cm is typically harvested, although much larger grafts can be harvested when necessary. Calvarial bone grafts can be useful in the repair of significant nasal deformity such as saddle nose and have a low risk of warpage but can fracture. A systematic review of reconstructive techniques for saddle nose deformity in patients with granulomatosis with polyangiitis (GPA) found that the use of split calvarial bone grafts had a lower complication rate in these patients than costal cartilage.<sup>17</sup> This grafting choice produces excellent reconstructive outcomes in patients with saddle nose due to GPA.<sup>18,19</sup>

### Cadaveric Costal Cartilage

Autologous costal cartilage ossifies with age and may become too rigid for use in older patient populations and some patients do not want the scar or postoperative discomfort associated with autologous rib grafting. Some may find irradiated homologous costal cartilage (IHCC) beneficial for reconstruction in these scenarios. IHCC grafts have been shown to be equally safe and effective as autologous grafts, with no donor-site morbidity.<sup>20</sup> A recent meta-analysis by Kadakia et al examined complications related to IHCC in rhinoplasty. The pooled complication rates of 13 studies were <1.5% for resorption, warping, infection, mobility, and need for graft removal.<sup>21</sup> Considering all studies, zero patients experienced allergic reactions or systemic disease associated with IHCC grafting.<sup>21</sup> There have been no reports of disease transmission from cadaveric costal cartilage. Another meta-analysis of 10 studies found similarly low complication rates associated with IHCC grafting in patients with long-term follow-up.<sup>22</sup> In patients undergoing cleft rhinoplasty, a study examining outcomes of 165 patients found no difference in complication rate or complications requiring operative intervention between those receiving IHCC and those receiving autologous costal cartilage grafts.<sup>20</sup>

Fresh frozen nonirradiated cartilage presents a developing source of grafting material for use in revision rhinoplasty. In a study of 50 patients undergoing revision rhinoplasty by a single surgeon using this graft type, the authors reported good results with no cases of warping or extrusion.<sup>23</sup> A recent retrospective review of 226 patients similarly demonstrated good long-term outcomes with a low complication

rate.<sup>24</sup> Surgeons may choose to use fresh frozen cartilage to avoid the harsh processing methods found with IHCC.<sup>24</sup> However, several limitations for broad utilization of fresh frozen grafts exist. Fresh frozen cartilage grafts can only be harvested from donors who meet a set of strict criteria and must be stored and transported in a distinct manner.<sup>23</sup>

The decision to proceed with autologous versus cadaveric costal cartilage depends on both patient preference and surgical characteristics. Importantly, studies have shown no significant differences in quality of life between patients receiving autologous versus cadaveric costal cartilage grafting at 12-month postoperatively.<sup>11</sup> A recent systematic review and meta-analysis reinforced these findings, demonstrating no significant differences in warping, resorption, irregularity, or infection between autologous and homologous rib grafts in dorsal augmentation rhinoplasty.<sup>25</sup> A cost analysis of using autologous and cadaveric grafts in rhinoplasty demonstrated comparable costs for both except when a complication was incurred from rib harvest.<sup>26</sup>

### Alloplasts

Iatrogenic nasal deformities caused by overresection of native cartilage often require a multimodal approach to revision. The use of alloplasts may be of benefit in certain clinical scenarios, although the superiority of autologous material is clear. Alloplasts are synthetic materials that can be used for grafting. Common alloplasts include silicone, acellular dermal matrix such as AlloDerm, Mersilene mesh (Ethicon), porous polyethylene (Medpor, Stryker Inc.), PDS plates, and expanded polytetrafluoroethylene (Gore-Tex, W.L. Gore & Associates Inc.). The biomechanical characteristics of alloplasts vary in regard to porosity, malleability, and consistency.

The use of PDS plates for L-strut stabilization has been examined in several studies and found to be safe and efficacious in providing stability in rhinoplasty.<sup>27,28</sup> Typically used in patients with fracture or severe deviation of the L-strut, PDS plates can decrease the need for rib grafting in patients who have undergone prior septoplasty. In analysis of a prospective cohort of 88 patients, Fuller et al found that the mean preoperative Nasal Obstruction Symptom Evaluation (NOSE) score significantly decreased for patients in which PDS plates were used for rigid support.<sup>27</sup> These outcomes remained stable postoperatively, after the PDS plate had dissolved. The crystalline polymer of PDS plates is completely resorbed by approximately 25 weeks postoperatively.<sup>28</sup> While prior studies have warned against the use of nonperforated PDS plates due to potential risk of vascular compromise of the septum, Fuller et al 0.25-mm nonperforated PDS plates were used unilaterally on the septum in nearly all cases without any instances of vascular compromise.<sup>29</sup>

In revision rhinoplasty, the septum may not be able to be supported by autologous grafts due to patient preference, prior surgery, donor-site morbidity, or poor cartilage quality. PDS plates can serve as a useful resource in such situations to restore integrity to the dorsal and caudal L-strut. PDS plates may be especially useful for patients with persistent nasal obstruction in which widening of the septum by autologous

grafts should be avoided to prevent narrowing of the nasal valves.<sup>27,30</sup>

Alloplastic implants are used frequently in Asian countries for dorsal augmentation rhinoplasty. All implants can lead to complications such as displacement, extrusion, contracture, and infection. Being synthetic materials, alloplasts confer a greater degree of risk compared with autologous grafts. Adverse events such as infection, extrusion, and absorption have been reported.<sup>31</sup> Most alloplastic implants used in rhinoplasty are silicone. Silicone is considered a safe implant material as it is nontoxic, nonimmunogenic, and biocompatible; however, delayed cosmetic changes are often seen with silicone implants due to calcification of the implant or contracture of the surrounding tissues leading to capsule formation.<sup>31,32</sup> Incidence of reported complications due to silicone implants in rhinoplasty is widely variable, ranging from approximately 4 to 36%.<sup>32</sup>

## Nasal Obstruction and Graft Considerations

While spreader grafts can improve nasal obstruction by improving nasal valve function, historical literature has warned against their use due to potential widening of the nasal dorsum, presenting an aesthetic consideration. A recent study examined patient-perceived nasal appearance and overall patient satisfaction after functional septorhinoplasty with spreader grafts.<sup>33</sup> With a prospective cohort of over 150 patients, the authors compared preoperative and postoperative NOSE and FACE-Q scores, providing validated patient-reported outcome measures for analysis.<sup>33</sup> Results showed that patient satisfaction with both nasal appearance and nasal obstruction were improved postoperatively with the use of spreader grafts.<sup>33</sup>

Nasal valve compromise can be caused by lateral nasal side wall insufficiency, narrowing of the internal nasal valve, external nasal valve, or nasal floor. To address lateral nasal side wall insufficiency, lateral crural strut grafts, alar rim grafts, or alar batten grafts are often employed. For an effective lateral crural strut graft, a sufficient cartilage must be available for use, typically approximately 2.5 cm.<sup>34</sup> While septal cartilage is preferred for such grafts, rib cartilage may be necessary to achieve adequate graft size.<sup>35</sup> An alternative to lateral crural strut grafts are alar rim grafts, which necessitate less cartilage.<sup>35</sup> A recent study by Hismi et al demonstrated through a longitudinal study of over 700 patients that lateral crural strut grafts and alar rim grafts can be used to address lateral nasal side wall collapse without negatively impacting nasal aesthetics.<sup>35</sup> Utilization of rib graft may be necessary in revision cases to address nasal obstruction. Butterfly grafts, first described by Clark and Cook in 2002, employ conchal cartilage to address nasal valve collapse.<sup>7</sup> This grafting technique has shown good functional and aesthetic outcomes for both primary and revision rhinoplasty.<sup>5</sup>

## Conclusion

When selecting grafting material in rhinoplasty, decisions must reflect surgical indications as well as patient-specific

factors. Septal cartilage remains the pillar of grafting materials in rhinoplasty, but surgeons must consider alternate grafting materials when necessary to fully address to functional, reconstructive, or aesthetic goals of surgery.

### Conflict of Interest

None declared.

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