

Outcomes Following Rhinoplasty Using Autologous Costal Cartilage

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Objective: To describe the aesthetic and clinical outcomes following rhinoplasty using autologous costal cartilage, which is considered the best graft material for rhinoplasty requiring major reconstruction. Few studies have examined outcomes following rhinoplasty using autologous costal cartilage.

Methods: A retrospective review of the data from 108 patients who underwent rhinoplasty using autologous costal cartilage between April 2006 to May 2011. The study population consisted of 81 male and 27 female patients (mean age, 33.0 years). Each patient self-assessed their aesthetic outcomes for subjective satisfaction, and 2 independent surgeons assessed aesthetic outcomes from photographs. Associated complications were also analyzed.

Results: The patient self-assessment showed that 73 patients were satisfied; 16 patients stated that they felt bet-

ter than they did preoperatively; and 19 patients were dissatisfied. The independent surgeons judged that 43 patients had excellent outcomes, 37 patients had good outcomes, 24 patients had fair outcomes, and 4 patients had poor outcomes. There were 13 donor site complications: 9 seromas, 1 pneumothorax, 2 keloid formations, and 1 persistent pain. There were 19 recipient site complications: 9 infections, 5 resorptions, 2 visible graft contours, 2 graft fractures, and 1 warping.

Conclusions: The use of autologous costal cartilage in rhinoplasty was found to be associated with a relatively high complication rate and relatively poor aesthetic outcomes. Considering our results, autologous costal cartilage should be used with the possibility of complications in mind.

Arch Facial Plast Surg. 2012;14(3):175-180

LUPO¹ REPORTS THAT AUTOLOGOUS cartilage was first used in rhinoplasty in 1900 by Von Mangoldt for syphilitic noses. Although debate continues regarding the optimal graft material, autologous grafts such as septal cartilage, conchal cartilage, and costal cartilage are generally accepted as the gold standard for rhinoplasty.² Some clinicians believe that only autologous grafts should be used for nasal augmentation and reconstruction.³ However, each autologous cartilage has its advantages and disadvantages.

While septal and conchal cartilage can be easily harvested without significant concerns of donor site morbidity, a relatively limited quantity of those 2 types of cartilage can be harvested. This restricts their use in cases where a large graft is required, such as in reconstruction of severe deformities or in graft-depleted revision rhinoplasty. In such cases, autologous costal cartilage may be a viable alternative.^{4,5} However, despite the increasing use of autologous costal cartilage in rhinoplasty, few studies have examined the related outcomes and complications. Fur-

thermore, those studies were confined to dorsal grafts or enrolled only a small number of patients. The present study examines the outcomes of 108 rhinoplasty cases that involved the use of autologous costal cartilage.

METHODS

PATIENTS

We retrospectively analyzed data from 108 patients who underwent rhinoplasty using autologous costal cartilage between April 2006 to May 2011. The study population consisted of 81 male and 27 female patients (mean age, 33.0 years; age range, 11-63 years). The postoperative follow-up period ranged from 8 to 60 months (mean, 19 months). The study was approved by the institutional review board of the Asan Medical Center, and written informed consent was obtained from all patients.

SURGERY

All rhinoplasties were performed by a single surgeon (Y.J.J.) while the patients were under general anesthesia. An open rhinoplasty technique was used in all cases. A transcolumellar

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Table 1. Patient Diagnoses

Diagnosis	Patients, No. (N = 108)
Deviated nose	40
Saddle nose	29
Flat nose	25
Short nose	4
Contracted nose	3 (1 burn, 2 postrhinoplasty cases)
Postmaxillectomy deformity	2
Cleft lip nose	3
Hump nose	1
Intramuscular hemangioma of nasal dorsum	1
Total	108

inverted V-shape incision was connected to a bilateral marginal incision. The osseocartilaginous skeleton was exposed, and the septal mucoperichondrial flaps were elevated, beginning at the anterior septal angle. The upper lateral cartilages were separated and mobilized from the septum. The septal deviation was corrected, and the cartilage was harvested if there was available remnant septal cartilage. The procedure may have included medial and/or lateral osteotomies and placement of septal batten grafts, septal extension grafts, spreader grafts, columellar struts, tip onlay grafts, dorsal onlay grafts, and/or shield grafts. When autologous costal cartilage was used for dorsal augmentation, a mono-unit graft or a laminated graft was used, as previously described.⁶

TECHNIQUES FOR COSTAL CARTILAGE HARVEST

For men and women with small breasts, a 3- to 4-cm incision was made over the right sixth-seventh costal cartilage. For women with large breasts, the incision was made under the breast crease over the fifth rib. The rib number was identified through palpation. After the skin incision was made and the subcutaneous tissue divided using electrocautery, the fascia over the external oblique muscle was opened and the fibers elevated to expose the underlying costal cartilage.

Two methods were used to harvest costal cartilage. In the first method, the cartilage was harvested with the perichondrium. Soft tissues and muscles around the costal cartilage were dissected using electrocautery. A rectangular-shaped incision was made through perichondrium along the outer surface of the selected costal cartilage, and dissection was performed. Once elevation was complete, the desired section of costal cartilage was harvested with the perichondrium. In second method, a longitudinal incision was made through the perichondrium, and a subperichondrial dissection was performed. The desired section of costal cartilage was harvested and the perichondrium was preserved at the donor site. The first method was used prior to October 2010 (86 patients), and the second method, which preserved the perichondrium, was used thereafter (22 patients).

After the graft was removed, the donor site was filled with water, and sustained positive pressure was then used to check for air bubbles, which would indicate a pleural tear. Subcutaneous fat was harvested to fill the dead space at the cartilage harvest site. A Jackson-Pratt drain was inserted to the supra-muscular layer in some cases. The donor site was closed layer by layer. The harvested costal cartilage was shaped as a vertical strip using a dermatome blade. We waited at least 15 minutes before inserting the grafts to allow most of the warping to occur. Straight vertical strips were usually used for septal re-

Table 2. Use of Cartilaginous Grafts

Graft Usage	Patients, No. (N = 108)
Dorsal augmentation	80 (69, laminated; 11, mono-unit)
Septal extension	78
Shield	73
Spreader	75
Columellar strut	38
Tip onlay	25
Backstop	22
Extracorporeal septal reconstructions	15
Lateral crural onlay	15
Septal batten	13

constructions. An upright chest radiogram was obtained for all patients after surgery.

POSTOPERATIVE ASSESSMENT

Two rhinoplastic surgeons not involved in the procedures (Jin-Young Min, MD, and Gye Song Cho, MD) assessed the aesthetic outcomes by comparing the earliest preoperative photograph with the postoperative photograph taken at the final follow-up. Outcomes were classified as excellent, good, fair, or poor. In addition, patients' subjective evaluations were obtained, and the classifications were satisfied, better than preoperation, or dissatisfied. Postoperative records were reviewed to assess surgical morbidity, including graft resorption, postoperative infection, visible graft contour, fracture due to trauma, warping, seroma, pneumothorax, keloid formation, and persistent pain at the donor site.

RESULTS

Of the 108 study subjects, 73 patients had undergone previous surgery, including rhinoplasty (n=34), septoplasty (n=37), medial maxillectomy with septoplasty (n=1), and total maxillectomy (n=1). The most frequent external deformities were deviated nose (n=40), saddle nose (n=29), and flat nose (n=25) (**Table 1**). Autologous costal cartilage was used for dorsal grafts (n=80), septal extension grafts (n=78), shield grafts (n=73), spreader grafts (n=75), columellar struts (n=38), tip onlay grafts (n=25), backstop grafts (n=22), extracorporeal septal reconstructions (n=15), lateral crural onlay grafts (n=15), and septal batten grafts (n=13) (**Table 2**). Of the 80 dorsal grafts that used autologous costal cartilage, 69 were laminated grafts, and 11 were mono-unit grafts.

The assessment by 2 independent surgeons found that the rhinoplasty outcomes were excellent in 43 cases (**Figure 1**), good in 37 cases, fair in 24 cases, and poor in 4 cases. The patient subjective satisfaction assessments showed that 73 patients were satisfied; 16 stated that the results made them feel better than they did preoperatively; and 19 patients were dissatisfied. The reasons given for dissatisfaction were columellar scar (n=6), low radix and dorsum (n=5), nostril asymmetry (n=3), remnant nasal deviation (n=3), progressive nasal deviation (n=1), and high radix (n=1). Of the 19 dissatisfied patients, 9 patients underwent revision rhinoplasty, and 2 patients un-

derwent scar revision. Although others of the 19 dissatisfied patients expressed a desire for minor changes, only those 11 patients underwent revision surgery.

Of the 13 patients with donor site complications, 9 patients had a seroma in the chest wound several days after surgery (Table 3). All were treated conservatively using aspiration and wound compression. The seromas only developed in those patients who underwent the first harvesting method; no seromas developed in those who underwent the second harvesting method, in which the perichondrium was left completely intact and less dam-

age was done to the fascia and the muscle (Table 4). One patient developed a pneumothorax, which was discovered intraoperatively, and the pleural tear area was sutured. The pneumothorax resolved after 2 days without requiring chest tube insertion. Two patients developed a keloid scar of the chest incision and were treated conservatively with steroid injections (Figure 2). One patient developed persistent pain at the chest wound and was treated with intercostal nerve blocks.

Recipient site complications occurred in 19 patients (Table 3), 9 patients with infection (Figure 3 and Table 5), 5 patients with graft resorption (Figure 4), 2 patients with a visible graft contour, 2 patients with a graft fracture due to nasal trauma, and 1 patient with warping (Figure 5). The overall infection rate was 8.3% (9 of 108), with the infection rate for primary rhinoplasty being 5% (4 of 74) and that for revision rhinoplasty being 15% (5 of 34). In cases of infection, all patients were treated with wound debridement, inflamed cartilage removal, and intravenous antibiotics. There were no long-term sequelae in any patients with infection. The 5 resorption cases included 3 dorsal onlay graft resorptions, 1 septal extension graft resorption, and 1 tip graft resorption. Eleven of the 108 patients underwent revision rhinoplasties (10.1%) to treat graft resorption (n=5), graft fracture after nasal trauma (n=2), remnant nasal deviation (n=1), uncorrected congenital nostril stenosis (n=1), warping (n=1), and a high nasal dorsum (n=1). For the 2 graft fracture cases, both patients were satisfied with their rhinoplasty outcomes but had to undergo revision to treat the nasal trauma.

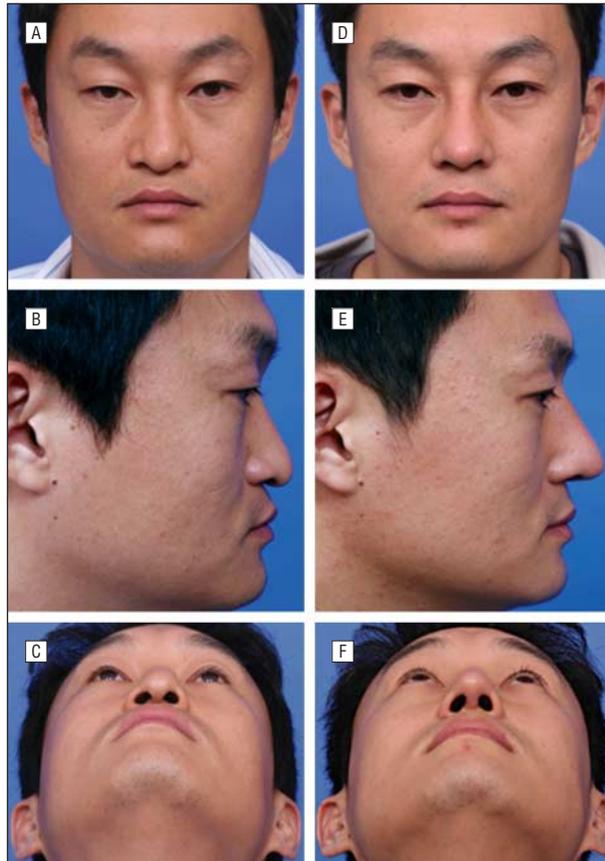


Figure 1. Example of an excellent surgical outcome. Preoperative (A-C) and 3-month postoperative (D-F) photographs of a 31-year-old man with a deviated nose and a tip ptosis. The patient underwent rhinoplasty involving a dorsal onlay graft, paired septal extension grafts, paired spreader grafts, and multilayer shield grafts.

COMMENT

The present report describes our use of autologous costal cartilage in 108 rhinoplasty cases. We used costal cartilage in revision rhinoplasty patients who required major septal reconstruction and in primary rhinoplasty patients who had a severely flat nose with thick skin and poor tip definitions.

Dorsal onlay graft procedures using autologous costal cartilage were performed in 80 patients using laminated forms (n=69) and mono-unit forms (n=11). Other grafts included spreader, septal extension, septal batten, tip onlay, shield grafts, and columellar struts.

Table 3. Complications When Using Autologous Costal Cartilage in Rhinoplasty

Site of Complication	Complication	Patients, No. (%) (N = 108)
Donor site	Seroma in the chest wound	9 (8.3)
	Pneumothorax	1 (0.9)
	Keloid scar in the chest wound	2 (1.8)
	Persistent pain in the chest wound	1 (0.9)
	Total	13 (12.0)
Recipient site	Resorption of graft	5 (4.6)
	Infection (overall/primary/revision)	9/4/5 (8.4/5/15)
	Visible graft contour	2 (1.8)
	Graft fracture due to trauma	2 (1.8)
	Warping of graft	1 (0.9)
	Total	19 (17.6)

Table 4. Incidence of Seroma According to the Method of Costal Cartilage Harvest

Method of Costal Cartilage Harvest	Seromas, No. (%)
Intracapsular dissection (n = 22)	0 (0)
Extracapsular dissection (n = 86)	9 (10)



Figure 2. Example of keloid scar. Postoperative photograph of a 27-year-old man who underwent surgery to repair cleft lip nose deformity. There is a keloid scar in the chest wound.

Aesthetic results were assessed by independent rhinoplastic surgeons and also by the patients themselves. The surgeons judged that 74% of patients had excellent or good results (n=80), and 68% of patients felt satisfied with the outcome (n=73). This poor aesthetic result may reflect that these patients had severe deformities in which aesthetic outcomes are unlikely to be as good as in cases involving simple rhinoplasty. Araco et al⁷ reported that aesthetic results were better for auricular and septal cartilage grafts and less so for costal and composite grafts. In contrast, some authors have reported excellent outcomes and low complication rates with autologous costal cartilage grafts.^{8,9} However, those studies were confined to dorsal grafts or enrolled only a small number of patients.

In the present study, we experienced a higher than expected complication rate. Donor site complications occurred in 13 of the 108 cases, with most of those complications being due to seromas (9 of 13). All such patients were treated and showed no sequelae. Seromas arise when serous fluid collects in cavities generated by surgery. Several factors have been linked to this fluid accumulation in dead spaces. Previous studies on mastectomy and axillary dissection have reported that seromas can be formed as a result of acute inflammatory exudates released in response to surgical trauma or from the lymph.¹⁰⁻¹² Eliminating the dead space formed during surgery and reducing the leakage from surrounding vessels can eliminate

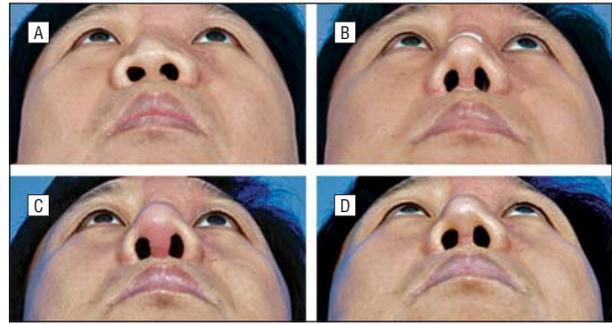


Figure 3. Example of infection (patient 3 in Table 5). Preoperative and postoperative photographs of a 41-year-old man who underwent surgery for a flat nose. A, Preoperative basal view. B, Postoperative basal view 3 weeks after rhinoplasty involving a laminated dorsal onlay graft, spreader graft, septal extension graft, and multilayer shield grafts. C, Basal view showing infection of the columella and marginal incision site 3 months after surgery. D, Basal view 1 month after wound debridement.

seroma formation. In our study, modifying our harvest procedure such that the perichondrium remained completely intact at the donor site and minimal damage was caused to the fascia and muscle resulted in no further incidents of seroma complication. It appears that preserving and repairing the outer perichondrium in costal cartilage harvesting can play a role in reducing the dead space and hence seroma formation.

Recently, some authors have reported excellent outcomes and low donor site morbidity with central segment harvest technique of costal cartilage.¹³ To reduce donor site morbidity, this technique could be the alternative to classic harvest technique.

In addition to donor site morbidity, recipient site morbidity is a critical issue in rhinoplasty. Others have reported that warping is the foremost graft-related complication in rhinoplasty using autologous costal cartilage.¹⁴⁻¹⁶ However, such warping can be overcome by using balanced carving and allowing 15 minutes for maximal warping to occur, using a laminated dorsal graft, or using a diced cartilage graft.^{5,6,17,18} In our study, we mostly used laminated grafts for dorsal augmentation and had only 1 patient develop warping. But the resorption rate was greater in the present study than studies reported by others using mono-unit cartilage graft only.⁸

The rate of infection was higher in our study than those reported in previous studies.^{8,17} Although the reason for this remains unclear, a number of factors may have been influential. First, the characteristics and amount of graft material may play a role. In our experience, costal cartilage shaped as a thin vertical strip can be fragile and have insufficient bearing capacity. Therefore, we used relatively thick vertical strip costal cartilage grafts. In septal reconstruction, those thick grafts were overlapped, and fixing required numerous sutures. Multiple overlapping of costal cartilage may disturb the nutrient/waste exchange diffusion process, which is essential for cartilage survival¹⁹ and hence contribute to infection. In addition, suture materials are foreign bodies, and the large amount required may provide a source of infection.

Some Asian patients seek a Western aesthetic nose, and surgeons sometimes need more graft material even in the primary rhinoplasties of those cases. In the present

Table 5. Cases of Infection

Patient No./ Sex/Age, y	Diagnosis	Primary or Revision Rhinoplasty	Grafts Usage	Aesthetic Outcome	Patient Satisfaction
1/F/35	Deformed nose	Primary (s/p total maxillectomy)	Dg, Cs, Sh, Sp	Poor	Dissatisfied
2/M/63	Deformed nose	Primary (deformed due to measles)	Dg, Sh, Ec	Fair	Dissatisfied
3/M/41	Deviated and flat nose	Primary (deviation due to trauma)	Dg, Se, Sp, Sh, Bs	Good	Satisfied
4/F/50	Saddle nose	Primary (s/p septoplasty)	Dg, Se, Sp, Sh, To	Fair	Dissatisfied
5/F/27	Short nose	Revision	Dg, Se, Bt, Sp, Sh	Fair	Dissatisfied
6/M/22	Flat nose	Revision	Dg, Se, Bt, Sp, Sh, Bs	Fair	Dissatisfied
7/F/29	Short nose	Revision	Se, Sp, To, Lc	Good	Satisfied
8/F/30	Short nose	Revision	Se, Sp, Sh, Bs	Good	Satisfied
9/F/45	Deviated nose	Revision	Se, Sp, Sh, Bs	Good	Better than preoperative

Abbreviations: Bs, backstop graft; Bt, batten graft; Cs, columellar strut; Dg, dorsal graft; Ec, extracorporeal septal reconstruction; Lc, lateral crural graft; preop, preoperative appearance; Se, septal extension graft; Sh, shield graft; Sp, spreader graft; s/p, status post; To, tip only graft.

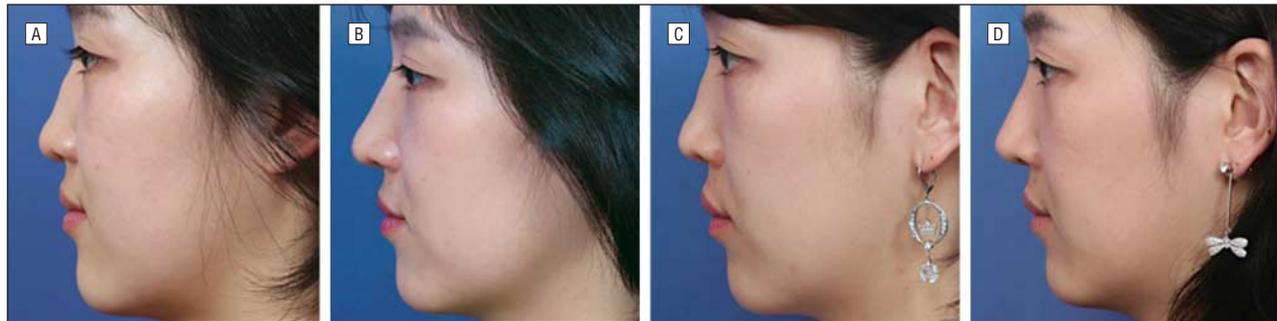


Figure 4. Example of resorption. Preoperative (A) and postoperative (B-D) photographs of a 29-year-old woman with a saddle nose. A, Preoperative lateral view. B, Postoperative lateral view 2 months after rhinoplasty involving a laminated dorsal onlay graft, spreader graft, septal extension graft, and tip only graft. C, Postoperative lateral view 2 years after surgery. Note the resorption. D, Lateral view 2 months after revision rhinoplasty.



Figure 5. Example of warping. A, Preoperative frontal view of a 39-year-old man with a saddle nose deformity. B, Postoperative frontal view 2 weeks after rhinoplasty involving a laminated dorsal onlay graft, paired spreader grafts, a septal extension graft, and a shield graft. C, Postoperative frontal view showing warping of the dorsal onlay graft 4 months after surgery.

study, all patients were Asian and therefore had relatively poor tip definition. Therefore, extensive cartilage grafting procedures were required for refinement of the tip area, including a multilayer cartilaginous tip grafting technique. In our group's previous report²⁰ on this technique, the postoperative infection rate was 5.1%. These relatively large masses of graft may affect the skin tension and again disturb the nutrient/waste exchange diffusion process.

A second potential reason for the relative high infection rate in the present study was the possibility of a poor blood supply in the recipient area, especially in the revision cases. Scar tissues from previous surgery can reduce the vascular supply to the graft site and increase the

probability of infection.²¹ In our series, 56% of infection complications were in revision rhinoplasty cases (5 of 9), and the infection rate for revision rhinoplasty was higher than for primary rhinoplasty (15% vs 5%).

We conclude that although the present study involved autologous grafts, which carry less risk of infection, the relatively high rate of infection probably reflected that the cases involved severe deformations and therefore required relatively large amounts of graft material. This was combined with a large proportion of revisions, which are more susceptible to infection. When a large quantity of grafting material is used, especially in revision rhinoplasty, costal cartilage grafts especially in the tip area might be vulnerable to infection, even though it is an autologous graft.

The number of revision rhinoplasty procedures appears to be on the increase, and therefore there is likely to be an increase in the use of autologous costal cartilage. Until now, every expert's dogmatic opinion on the safety and usefulness of costal cartilage has been accepted among rhinoplasty surgeons without any question. However, interestingly enough, very rarely have studies examined outcomes following rhinoplasty using autologous costal cartilage. In the present study based on our vast experience on the use of costal cartilage, contrary to conventional belief, we report that its use was associated with a relatively high complication rate and a relatively low aesthetic satisfaction outcome.

In conclusion, autologous costal cartilage is an indispensable and versatile implant material for rhinoplasty. However, the relatively high complication rate coupled with the relatively poor aesthetic outcomes in the present series suggests that autologous costal cartilage should be used with the possibility of complications in mind, especially when a large amount of graft material is needed.

Accepted for Publication: January 25, 2012.

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Author Contributions: Study concept and design: Lee and Jang. Acquisition of data: Moon, Lee, and Jang. Analysis and interpretation of data: Moon, Lee, and Jang. Drafting of the manuscript for important intellectual content: Moon and Jang. Administrative, technical, and material support: Moon, Lee, and Jang. Study supervision: Jang.

Financial Disclosure: None reported.

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