Processed Costal Cartilage Homograft in Rhinoplasty

The Asan Medical Center Experience

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Objective: To report our experience using a commercially available homograft (Tutoplast-processed costal cartilage [TPCC]; Tutogen Medical GmbH, Neunkirchen am Brand, Germany) in augmentation rhinoplasty.

Design: Retrospective review.

Setting: Tertiary care academic center.

Patients: The study population comprised 35 patients who underwent rhinoplasty with TPCC between November 2003 and October 2004.

Interventions: The TPCCs were used for full-length dorsal grafts in all 35 patients, as well as for septal batten, spreader graft, septal extension, tip onlay, and shield grafts.

Main Outcome Measures: Surgical outcomes were evaluated in 35 patients who underwent rhinoplasty in which TPCC was used. Anthropometric measurements of the nose were made on lateral photographs and compared with preoperative measurements. Postoperative complications were also assessed.

Results: Anthropometric measurements, expressed as mean (SD), documented postoperative increases in tip projection (5% [9%]), nasal length (10% [10%]), nasolabial angle (1.5° [8.7°]), and nasofrontal angle (3.1° [8.7°]). The overall complication rate was 31% (11 of 35 patients). Complications included resorption (17%), warping (9%), visible graft contour (3%), and graft fracture (3%).

Conclusion: Although TPCC could serve as an alternative graft material for rhinoplasty, the high complication rates of this material may preclude its use for dorsal augmentation.


Autologous cartilages, including septal, conchal, and costal cartilages, have been the graft material of choice for rhinoplasty. The availability of costal cartilage is critically important for revision rhinoplasties that require sound reconstruction of cartilaginous support and severe saddle-nose deformity. Furthermore, because dorsal augmentation is required in most cases of rhinoplasty performed on Korean noses, the availability of sufficient costal cartilage for both the nasal tip and the nasal dorsum is of utmost importance. However, autologous costal cartilage is difficult to harvest and may be associated with significant donor site morbidity and prolongation of time in surgery as well as with patient refusal to consent to an additional scar.

Homologous costal cartilage, which is not associated with harvesting morbidity or additional operation time, could serve as an alternative to autologous cartilage as a graft material. For example, homologous costal cartilage harvested from cadaveric donors and processed in various ways has been shown to be useful in rhinoplasty. The efficacy of Tutoplast-processed costal cartilage (TPCC; Tutogen Medical GmbH, Neunkirchen am Brand, Germany) in rhinoplasty, particularly for Asian noses, has not been determined. Tutoplast processing is a tissue-processing method that has provided commercially available grafts for more than 30 years. To our knowledge, this article represents the first report about augmentation rhinoplasty using TPCC. We have therefore documented the outcomes and complications in 35 rhinoplasty cases in which this graft material was used.
METHODS

After receiving approval from the institutional review board of our institution, we retrospectively evaluated outcomes in 35 patients (23 men and 10 women; age range, 17-57 years) who underwent rhinoplasty with TPCC between November 2003 and October 2004. Written informed consent was obtained from all patients. Postoperative follow-up ranged from 9 to 35 months (mean [SD], 15.6 [9.0] months).

Table. Anthropometric Measurements

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Preoperative/Postoperative Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasofrontal angle, °</td>
<td>135.7</td>
<td>138.8</td>
<td>3.1 (8.7)</td>
</tr>
<tr>
<td>Nasolabial angle, °</td>
<td>97.8</td>
<td>99.3</td>
<td>1.5 (8.7)</td>
</tr>
<tr>
<td>Nasal length, %a</td>
<td>NA</td>
<td>NA</td>
<td>10 (10)b</td>
</tr>
<tr>
<td>Tip projection, %a</td>
<td>NA</td>
<td>NA</td>
<td>5 (9)b</td>
</tr>
</tbody>
</table>

Abbreviation: NA, not assessed.

a Postoperative length was assessed relative to preoperative values.

b P < .05.

RESULTS

Tutoplast cartilage is processed by numerous steps, depending on tissue type, including delipidization, osmotic treatment, oxidative treatment, solvent dehydration, double-sterile packaging, and terminal gamma irradiation (17.8-25.0 kGy). Tutoplast cartilage is provided in double-sterile packaging, and terminal gamma irradiation (17.8-25.0 kGy). Tutoplast cartilage is processed by numerous steps, depending on tissue type, including delipidization, osmotic treatment, oxidative treatment, solvent dehydration, double-sterile packaging, and terminal gamma irradiation (17.8-25.0 kGy). Tutoplast cartilage is provided in double-sterile packaging, and terminal gamma irradiation (17.8-25.0 kGy). Tutoplast cartilage is provided in double-sterile packaging, and terminal gamma irradiation (17.8-25.0 kGy).

All rhinoplasties were performed by a single surgeon (Y.J.J.). For each patient, a trans columellar inverted V-shaped incision was connected to a bilateral marginal incision. The ossecartilaginous skeleton was exposed, and the sepal 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. Surgery may have included medial and/or lateral osteotomies, sepal batten grafts, sepal extension grafts, spreader grafts, columellar struts, tip onlay grafts, and/or shield grafts. The TPCCs were initially shaped with a fresh scalpel. A center-cut, balanced cross section was used to neutralize the mechanical vectors that give rise to warping. The grafts were also contoured and smoothed with a hand drill and a cutting burr. We delayed the insertion of cartilage grafts for at least 30 minutes to allow initial warping to occur. Dorsal onlay grafts using TPCC were performed in all cases. Special attention was given to minimal tension on the skin closure. All patients received antibiotics starting 12 hours before surgery and for 2 weeks after surgery.

To assess the amount of nasal augmentation, anthropometric measurements of the nose before and after surgery were made using lateral photographs. The distance between the eyebrows and the lips was used to standardize serial measurements for individual patients. Angular and linear measurements recorded included nasolabial angle, nasofrontal angle, nasal length, and nasal tip projection. Charted information from postoperative office visits was also evaluated. Preoperative and postoperative anthropometric measurements of the nose were compared statistically using a paired t test, with P < .05 considered statistically significant.

Surgical outcomes were evaluated by history and by comparison of preoperative and postoperative photographs. Each patient was evaluated clinically for the degree of resorption by comparing the earliest postoperative photograph with the latest postoperative photograph, taken at the last follow-up (mean [SD], 14.6 [9.0] months). Graft resorptions were classified as none (0%), minimal (0%-25%), moderate (24%-50%), near complete (50%-75%), or complete (75%-100%). Postoperative histories were reviewed to assess complications, including graft infection, fracture, warping, extrusion, and postoperative deformity.

Among the 35 rhinoplasty cases, there were 6 patients (17%) who had undergone previous surgery, including rhinoplasty (n = 2) and septrhinoplasty (n = 4). The most frequent external deformities were deviated noses (n = 20 [57%]), saddle noses (n = 9 [26%]) and dorsal flatness (n = 6 [17%]). Four patients with saddle-nose deformities had undergone septrhinoplasty, and 2 of them had septal perforation. Nasal cavity examination showed that 19 patients had nasal septal deviations and 2 had septal perforation. In all 35 patients, TPCC was used for full-length dorsal grafts, and each patient received 2 or more grafts, including sepal batten grafts (n = 13 [37%]), spreader grafts (n = 11 [31%]), sepal extension grafts (n = 9 [26%]), tip onlay grafts (n = 9 [26%]), and shield grafts (n = 8 [23%]), as well as columellar struts (n = 7 [20%]), as needed.
When we compared preoperative and postoperative anthropometric measurements, we observed significant increases in tip projection (mean [SD], 5% [9%]) and nasal length (mean [SD], 10% [10%]) (P=.02). The nasofrontal angle increased from 135.7° to 138.8° and the nasolabial angle from 97.8° to 99.3°, but neither increase was statistically significant (P=.12, Table). Increased tip projection was observed in 27 patients (77%). The remaining 8 patients (23%) had neither an increase nor a decrease in tip projection but showed an increase in radix height. The nasal length increased in 22 patients (63%) by 11% (8%), decreased in 3 patients (9%) by 9% (6%), and remained unchanged in 10 patients (29%) (Figure 1).

Eleven patients (31%) experienced complications, including 5 patients (17%) with graft resorption, all of which were moderate (24%-50%), with onset 2 to 7 months (mean [SD], 3.8 [1.8] months) after surgery (Figure 2). Warping of the graft was observed in 3 patients (9%), starting 1 to 5 months (mean [SD], 3.3 [2.1] months) after surgery (Figure 3 and Figure 4). All complications related to the use of TPCC are listed in the following tabulation:

<table>
<thead>
<tr>
<th>Complication</th>
<th>Cases, No. (%)</th>
</tr>
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<tbody>
<tr>
<td>Partial resorption</td>
<td>6 (17)</td>
</tr>
<tr>
<td>Warping</td>
<td>3 (9)</td>
</tr>
<tr>
<td>Graft fracture</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Visible graft contour</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Infection</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11 (31)</strong></td>
</tr>
</tbody>
</table>

Three patients underwent revision rhinoplasties because of warping (n=2) and graft fracture (n=1). The mean (SD) length of follow-up was 16.7 (10.2) months in complicated cases and 14.9 (8.3) in uncomplicated cases. There was no statistical difference between the 2 groups (P=.78). The relatively high rate of graft resorption occurred in cases involving saddle-nose deformity after septoplasty. Three of 6 cases (50%) with graft resorption involved saddle-nose deformity after septoplasty. None of the patients reported an infection at follow-up.

**COMMENT**

Tutoplast-processed costal cartilage, a homologous costal cartilage, retains most of the general characteristics of autologous cartilage. It is commercially available and is preserved in 0.9% sodium chloride solution in double-
plasty has yielded conflicting results regarding the rate of resorption in individual patients. We used TPCC in cases involving revision rhinoplasty, in female patients who were reluctant to have their autologous cartilage harvested, and in patients who lacked sufficient autologous cartilages. Dorsal onlay grafts using TPCC were performed in all patients with deviated, flat, or saddle noses. In Asian patients, the principal objective of rhinoplasty is augmentation of the existing structures, including the low dorsum and the receded nasal tip. Also, dorsal augmentations in deviated noses were used to treat dorsal irregularities and to overcome the soft tissue component of deviation. Besides dorsal onlay, TPCCs were used for other structural grafts, including spreader, septal extension, septal batten, tip onlay, and shield grafts, and for columellar struts.

Our nasal anthropometric measurements confirmed the statistically significant postoperative changes in nasal length and tip projection. Since we did not assess the actual length, we used the distance between eyebrows and lips to standardize serial measurements in individual patients.

The use of homologous costal cartilage in rhinoplasty has yielded conflicting results regarding the rate of resorption and warping. Although it is difficult to directly compare the surgical outcomes of previous reports with ours because of the differences in follow-up period and preparation processing of cartilage, the rate of resorption, but not of warping, was higher in our study than in previous studies. The factors responsible for increased graft resorption and warping are not clear, but they may include the size and site of the implant, the carving of the graft and the nature of the host recipient site, thermal and mechanical damage during carving, and the timing of implant surgery. In our series, saddle nose after septoplasty showed a relatively higher resorption rate. Poor cartilaginous dorsal support may contribute to the acceleration of graft resorption.

Warping may depend on the amount of radiation to which the cartilage has been exposed and has been encountered when the irradiation dose was lowered to 20 kGy. We observed an inverse relationship between dose of irradiation and rate of resorption or warping. High-dose irradiation (30-60 kGy) may alter the antigenicity of cartilage in such a way that it is resorbed more slowly. Tutoplast processing included irradiation with a dose of 17.8 to 25 kGy, which is lower than the 30- to 40-kGy dose used in a report in which no cartilage warping was observed.

One patient experienced delayed graft fracture owing to postoperative nasal trauma, an uncommon complication, which may have been caused by mechanical damage to the cartilage during carving. Unlike preventable complications, such as graft fracture and visible graft contours, resorption and warping cannot be predicted. Therefore, surgeons should notify patients of the risks of these postoperative complications before surgery.

Because dorsal augmentation is required in most cases of rhinoplasty for Korean noses, the use of TPCC may be an attractive option. However, our finding that 9 patients (26%) had unpredictable complications, such as resorption or warping, may preclude its use for full-length dorsal grafts. In contrast, during postoperative follow-up (mean, 12 months) in a previous study involving the use of the Tutoplast-processed fascia lata (30×40 mm), the only complication noted was major resorption, which occurred in 3 of 69 cases (4%). Considering the relatively higher complication rates in the present series, we are pessimistic about the use of TPCC for dorsal augmentation and structural nasal reconstruction. Although our study was limited by the small number of patients and the relatively short follow-up period, our results indicate that unexpected complications due to the use of TPCC may frequently occur during augmentation rhinoplasty.

Figure 4. Preoperative and postoperative photographs of a 26-year-old woman with a deviated nose. A, Preoperative lateral view. B, Postoperative lateral view 3 months after surgical treatment with a dorsal onlay graft, a spreader graft, a septal batten graft, and a shield graft. C, Tip deprojection caused by vertical warping of graft is seen 6 months after surgery. D, Postoperative lateral view 3 months after revision surgery. After the Tutoplast-processed costal cartilage was removed, the Tutoplast-processed fascia lata was implanted in the dorsum. Also, the Tutoplast-processed costal cartilage that was removed was used to perform an onlay graft of the tip.
In conclusion, TPCC could be used as an alternative graft material for rhinoplasty. However, the high complication rates of this material indicate that care should be taken before augmentation rhinoplasty using TPCC is performed.

Submitted for Publication: March 22, 2007; final revision received July 3, 2007; accepted October 2, 2007. Correspondence: Yong Ju Jang, MD, PhD, Department of Otolaryngology, Asan Medical Center, 388-1 Pungnap-2dong, Songpa-gu, Seoul, Korea 138-736 (jangyj@amc.seoul.kr).

Author Contributions: Drs Song and Jang had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Song, Lee, and Jang. Acquisition of data: Song and Jang. Analysis and interpretation of data: Song, Lee, and Jang. Drafting of the manuscript: Song and Jang. Critical revision of the manuscript for important intellectual content: Song and Jang. Study supervision: Lee.

Financial Disclosure: None reported.

REFERENCES