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What is This?
Costal Cartilage Is a Superior Implant Material than Conchal Cartilage in the Treatment of Empty Nose Syndrome

Jae Hoon Jung, MD¹, Mohammad Ariff Baguindali, MD², Jin Taek Park, MD¹, and Yong Ju Jang, MD, PhD¹

Abstract

Objective. The objective of this study was to evaluate the outcomes of endonasal microplasty in treating empty nose syndrome by comparing the use of costal and conchal cartilage implants to construct neoturbines.

Study Design. Case series with chart review.

Setting. Tertiary referral center.

Subjects and Methods. A total of 31 patients who were diagnosed with empty nose syndrome and underwent endonasal microplasty with conchal cartilage (n = 17) or costal cartilage implants (n = 14) were included. Each patient’s clinicodemographic profile was reviewed to compare the conchal cartilage group and the costal cartilage groups. Pre- and postoperative Sino-Nasal Outcome Test (SNOT-25) scores were also compared.

Results. Both groups showed a significant improvement in SNOT-25 scores following surgery (P <.05). The group who received costal cartilage implants demonstrated more significant improvements than the conchal cartilage group in terms of the mean difference between pre- and postoperative SNOT-25 scores (P = .023). Symptom outcomes related to depression demonstrated significant improvements in the conchal cartilage group (P <.05), while in the costal cartilage group, in addition to these 3 variables, 7 items related to functional problems also demonstrated significant improvements (P <.05).

Conclusions. Costal cartilage is a more useful material than conchal cartilage as implants for the treatment of empty nose syndrome patients.

Keywords
empty nose syndrome, endonasal microplasty, conchal cartilage, costal cartilage, neoturbinate, Sino-Nasal Outcome Test, turbinectomy, autologous, homologous

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Material used in rhinological grafts, in some patients, particularly Asians, there is usually not enough septal cartilage available for implants, especially in patients who have a prior history of septal surgery. Other than septal cartilage, conchal and costal cartilage are widely used in rhinological implants; however, their use in endonasal microplasty for the treatment of ENS has not been fully studied or documented. In the past few years, we have used these 2 types of cartilage as implants for endonasal microplasty, but we have observed different clinical outcomes in our patients. Currently, there are no studies that compare the clinical outcomes of using conchal and costal cartilage implants for endonasal microplasty. Thus, the objectives of our present study were to describe the clinical characteristics of this disease and compare the clinical outcomes of using these cartilaginous materials (ie, conchal vs costal) for the treatment of ENS.

Materials and Methods

A retrospective review of patients who underwent endonasal microplasty using conchal or costal cartilage implants between May 2008 and July 2012 was performed. This study was approved by the institutional review board of Asan Medical Center, and all patients provided informed written consent. Patients were diagnosed with ENS based on the following characteristics: (1) history of previous turbinate reduction procedure, including turbinoplasty or turbinectomy; (2) endoscopic examination revealing partially or totally resected inferior turbinate tissue and abnormally wide nasal cavities; and (3) the presence of characteristic symptoms, including excessive airflow, nasal obstruction, nasal discharge, nasal or facial pain on inspiration, and headache. Patients were excluded if they had been treated using other implant materials for neoturbinate construction, such as septal cartilage (n = 1), silicon (n = 1), homologous fascia (n = 1), or both conchal and costal cartilage (n = 1) or if they were lost on follow-up (n = 1; Figure 1). The remaining 31 patients who had been diagnosed with ENS were enrolled in this analysis and divided into 2 groups in accordance with the implant materials that were used for neoturbinate construction: a conchal cartilage group (n = 17) and a costal cartilage group (n = 14); autologous costal cartilage was used to treat 8 patients, and homologous costal cartilage was used to treat 6 patients. All 31 patients had failed to demonstrate symptom improvement using conservative nasal-moisturizing therapy. No specific protocol was employed to select the type of cartilage that was used. Instead, the selection of conchal or autologous costal cartilage was determined by the surgeon based on a preoperative assessment, which evaluated symptom severity and the extent of turbinate reconstruction required. The surgeon considered the use of conchal cartilage for turbinate reconstruction only if a small amount of tissue was required; otherwise, costal cartilage was considered because it can provide additional volume. Initially, the use of conchal cartilage was preferred; however, we have noted that its use can result in unsatisfactory clinical outcomes. Our use of costal cartilage has increased because we have observed better treatment outcomes using this tissue. The use of homologous costal cartilage was also considered after taking into account patient preferences and the anticipation of various comorbidities such as scarring.

Surgical Technique

All surgeries were performed by a single senior surgeon (Y.J.J.) under general endotracheal anesthesia. Conchal cartilage was harvested via the postauricular approach and then molded and rolled into a spherical kidney-shaped structure that simulated a neoturbinate. Costal cartilage was harvested from between the sixth and eighth ribs via a 2.5-cm inframammary incision. Grafts (3-5 cm in length) were obtained from the central portion of the harvested rib cartilage. When a patient refused to have costal cartilage specimens harvested, homologous costal cartilage (Tutoplast-processed costal cartilage; Tutogen Medical GmbH, Neunkirchen am Brand, Germany) was used (n = 8). Both autologous and homologous costal cartilage specimens were carved into round shapes to simulate the structure of a neoturbinate. We manipulated every conchal and costal cartilage specimen to have an approximate volume of 2 cm³. The nasal mucosa was injected with 1% lidocaine containing adrenaline (1:200,000); an incision was made at the pyriform margin just anterior to the anterior attachment of the inferior turbinate stump. After the incision, the mucoperiosteal flap was posteriorly elevated to create a tunnel into the lateral nasal wall, not extending too posteriorly in order to confine the implant at the anterior half to simulate the missing head of the inferior turbinate. After elevating the submucoperiosteal flap, the pocket was filled with conchal or autologous/homologous costal cartilage to create a neoturbinate. Care was taken not to obstruct the nasolacrimal duct by reconstructing the front of the duct area. The pocket was closed with resorbable sutures (4-0 chromic sutures) to keep the implant in position, and merocel (Medtronic Inc, Jacksonville, FL), terramycin ointment, and gauze packing were kept in place overnight.
Outcome Measurements

Patients were asked to freely describe their symptoms and complete the Sino-Nasal Outcome Test (SNOT-25) in order to assess their symptoms both before and after cartilage implantation. SNOT-25 is a validated 25-item survey that quantifies general nasal symptoms and can be used to compare symptoms both before and after intervention. Each item is scored on a scale from 0 (no symptoms) to 5 (severe symptoms).3,10 Posttreatment symptoms were assessed 6 to 12 months after surgery. Patients were objectively assessed by endoscopic examination of the operative site at a follow-up postoperative visit to determine signs of implant infection, rejection, and allergic reactions that may have developed.

Statistical Analysis

Pre- and postoperative SNOT-25 scores and differences were compared between groups. Data are expressed as the mean with the 25% to 75% interquartile range (IQR). Categorical variables were evaluated using the 2-sided Fisher exact test or χ² test, whereas continuous variables were compared using the Mann-Whitney U test. All P values <.05 are considered significant.

Results

Clinical Manifestations

The 31 enrolled patients in this study consisted of 22 men and 9 women, with a mean age of 43.5 years (25%-75% IQR = 29.0-57.0 years). The baseline clinico-demographic characteristics of the 2 groups were not significantly different (P > .05; Table 1). The symptoms reported by these patients included excessive airflow (23 patients; 74.2%), nasal obstruction (22 patients; 71.0%), rhinorrhea or PND (22 patients; 71.0%), headache (20 patients; 64.5%), sleep disturbances (19 patients; 61.3%), and nasal or facial pain (18 patients; 58.1%). The mean preoperative SNOT-25 score of all 31 patients was 50.7 (25%-75% IQR = 37.0-63.0) points.

Treatment Outcomes

Among 31 enrolled patients, 29 patients completed the SNOT-25 6 months after the operation, and the other 2 patients completed the SNOT-25 at 11 months postoperation. Most of the patients included in this study demonstrated improvement after surgery in terms of their SNOT-25 scores, except for 3 patients who underwent treatment with conchal cartilage. No new symptoms were noted following implantation. Our assessment of the SNOT-25 scores is summarized in Table 2. Both groups demonstrated significant improvement in SNOT-25 scores following surgery: 54.0 (25%-75% IQR = 45.0-67.5) to 35.9 (25%-75% IQR = 24.0-51.5) points (P = .007) for the conchal cartilage group and 43.8 (25%-75% IQR = 27.0-57.8) to 21.9 (25%-75% IQR = 9.0-40.8) points (P = .002) for the costal cartilage group (Figure 2). The group who received costal cartilage implants demonstrated statistically more significant improvement than the conchal cartilage group in terms of the mean difference between their pre- and postoperative SNOT-25 scores (1.1, 25%-75% IQR = 0.6-1.7 vs 0.7, 25%-75% IQR = 0.3-1.1, respectively; P = .023). Patients in the conchal cartilage group demonstrated statistically significant improvement in SNOT-25 symptoms such as reduced productivity, reduced concentration, and frustration/irritability (all P < .05), while patients in the costal cartilage group, in addition to these 3 variables, demonstrated significant improvement in runny nose, postnasal discharge, waking up at night, dryness, difficulty with nasal breathing, and other symptoms.

Table 1. Baseline clinico-demographic characteristics of the 31 patients analyzed in this study with empty nose syndrome who were treated using endonasal microplasty.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Patients (n = 31)</th>
<th>Conchal Cartilage (n = 17)</th>
<th>Costal Cartilage (n = 14)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>22 (70.9)</td>
<td>13 (76.5)</td>
<td>9 (64.3)</td>
<td>.693</td>
</tr>
<tr>
<td>Female</td>
<td>9 (29.1)</td>
<td>4 (23.5)</td>
<td>5 (35.7)</td>
<td></td>
</tr>
<tr>
<td>Mean age, y (25%-75% IQR)</td>
<td>43.5 (29.0-57.0)</td>
<td>44.4 (31.5-54.5)</td>
<td>42.3 (26.0-59.3)</td>
<td>.719</td>
</tr>
<tr>
<td>Previous turbinate surgery side, n (%)</td>
<td>2 (6.5)</td>
<td>3 (17.6)</td>
<td>4 (28.6)</td>
<td>.671</td>
</tr>
<tr>
<td>Unilateral</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral</td>
<td>29 (93.5)</td>
<td>14 (82.4)</td>
<td>10 (71.4)</td>
<td></td>
</tr>
<tr>
<td>Symptom, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excessive airflow</td>
<td>23 (74.2)</td>
<td>14 (82.4)</td>
<td>9 (64.3)</td>
<td>.412</td>
</tr>
<tr>
<td>Nasal obstruction</td>
<td>22 (71.0)</td>
<td>12 (70.6)</td>
<td>10 (71.4)</td>
<td>.959</td>
</tr>
<tr>
<td>Rhinorrhea or PND</td>
<td>22 (71.0)</td>
<td>11 (64.7)</td>
<td>11 (78.6)</td>
<td>.456</td>
</tr>
<tr>
<td>Headache</td>
<td>20 (64.5)</td>
<td>12 (70.6)</td>
<td>8 (57.1)</td>
<td>.477</td>
</tr>
<tr>
<td>Nasal or facial pain</td>
<td>18 (58.1)</td>
<td>10 (58.8)</td>
<td>8 (57.1)</td>
<td>.925</td>
</tr>
<tr>
<td>Sleep disturbance</td>
<td>19 (61.3)</td>
<td>11 (64.7)</td>
<td>8 (57.1)</td>
<td>.667</td>
</tr>
<tr>
<td>Mean preoperative SNOT-25 score (25-75% IQR)</td>
<td>50.7 (37.0-63.0)</td>
<td>54.0 (45.0-67.5)</td>
<td>46.6 (27.0-57.8)</td>
<td>.241</td>
</tr>
</tbody>
</table>

Abbreviations: IQR, interquartile range; PND, postnasal drip; SNOT, Sino-Nasal Outcome Test.
*Assessed using the 2-sided Fisher exact or χ² test, except age and SNOT-25 score, which were assessed using the Mann-Whitney U test.
nose being too open, and nasal crusting (all \( P < .05 \)). Postoperative endoscopic examinations indicated good mucosal healing with no signs of implant infection, rejection, or allergic reaction in either group, and no patients demonstrated displaced implants on endoscopic examination or postoperative computed tomography (CT) during the follow-up period (Figure 3).

**Discussion**

The principle behind the management of ENS is to replace missing tissue, rehabilitate airway resistance, and control symptoms. The implantation of graft materials below the nasal mucosa is a practical way to reconstruct the deficient intranasal anatomy in ENS patients.\(^9\) Saafan\(^9\) performed a comparative study on the efficacy and safety of treatments with the implantation of acellular dermal grafts and silastic sheets. In that study, both materials demonstrated significant results in terms of SNOT-25 scores, but no significant differences between these materials were indicated. Rice\(^8\) injected hydroxyapatite cement into the subperiosteal tunnel to secure the entire anteroposterior length of the lateral nasal wall to the site of inferior turbinate, and significant results were obtained. Moreover, Modrzynski\(^7\) also reported positive results in his study on the use of hyaluronic acid gel implants, and he recommends this implant for the treatment of less severe forms of ENS. Although all of these synthetic implants may be effective, the use of autologous or homologous materials, such as cartilage, is considered ideal by many surgeons and researchers because of its high level of biocompatibility. General evidence indicates that long-term positive outcomes are associated with the use of cartilage implants in rhinological surgeries.\(^11,12\) Although septal cartilage is the most commonly used material in rhinological grafts, there is usually not enough of this type of cartilage available for use as a neoturbinate implant in patients with history of septal surgery. Other alternative types of cartilage are widely used in nasal implant surgeries, including conchal and costal cartilage, but at present there are no published studies that describe or evaluate the clinical outcomes of these types of cartilage for the treatment of ENS.

Because ENS is a recently acknowledged area of interest and research, several protocols have been developed to evaluate treatment outcomes. SNOT-20 and -25 have been used in previous studies to evaluate the subjective outcomes of patients with ENS,\(^9,13\) and the visual analog scale was used in another study.\(^6\) In the present study, subjective evaluation was performed by reviewing the SNOT-25 results, both before and after surgery, of the 31 patients who were grouped into the conchal and costal cartilage groups. The results of the present study demonstrate significant improvements following surgery in both groups in terms of the mean total SNOT-25 scores. However, the costal cartilage

### Table 2. Improvement in subjective symptoms based on SNOT-25 results.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Conchal Cartilage Group (n = 17)</th>
<th>Costal Cartilage Group (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean SNOT-25 Score (25%-75% IQR)</td>
<td>Mean SNOT-25 Score (25%-75% IQR)</td>
</tr>
<tr>
<td></td>
<td>Before Surgery</td>
<td>After Surgery</td>
</tr>
<tr>
<td>Runny nose</td>
<td>1.8 (0-3.5)</td>
<td>1.2 (0-2.0)</td>
</tr>
<tr>
<td>Postnasal discharge</td>
<td>2.3 (0-4.0)</td>
<td>1.3 (0-2.5)</td>
</tr>
<tr>
<td>Waking up at night</td>
<td>2.7 (1.0-4.5)</td>
<td>1.5 (0-3.0)</td>
</tr>
<tr>
<td>Reduced productivity</td>
<td>3.2 (2.5-4.0)</td>
<td>1.8 (1.0-3.0)</td>
</tr>
<tr>
<td>Reduced concentration</td>
<td>3.5 (3.0-4.0)</td>
<td>2.1 (1.0-3.0)</td>
</tr>
<tr>
<td>Frustration/irritability</td>
<td>3.1 (2.0-5.0)</td>
<td>1.7 (0.5-2.5)</td>
</tr>
<tr>
<td>Dryness</td>
<td>2.8 (1.5-4.0)</td>
<td>2.4 (1.0-4.0)</td>
</tr>
<tr>
<td>Difficulty with nasal breathing</td>
<td>3.7 (3.0-5.0)</td>
<td>3.0 (2.0-4.0)</td>
</tr>
<tr>
<td>Nose is too open</td>
<td>3.0 (1.0-5.0)</td>
<td>2.0 (0.5-3.0)</td>
</tr>
<tr>
<td>Nasal crusting</td>
<td>1.8 (1.0-3.0)</td>
<td>1.5 (0-3.0)</td>
</tr>
<tr>
<td>Total SNOT-25</td>
<td>54.0 (45.0-67.5)</td>
<td>35.9 (24.0-51.5)</td>
</tr>
</tbody>
</table>

*Abbreviation: IQR, interquartile range; SNOT, Sino-Nasal Outcome Test.
\(^a\)Assessed using the Mann-Whitney \( U \) test.*
group demonstrated statistically more significant improvement than the conchal cartilage group in terms of the mean difference between the pre- and postoperative SNOT-25 scores. In addition, only 3 items related to depression (reduced productivity, reduced concentration, and frustration/irritability) tended to demonstrate improvement in the conchal cartilage group, whereas functional problems (runny nose, postnasal discharge, waking up at night, dryness, difficulty with nasal breathing, nose being too open, and nasal crusting) demonstrated improvement in the costal cartilage group in addition to the 3 items related to depression. In fact, SNOT-20 has been accepted as a more validated tool for evaluating nasal symptoms, while SNOT-25 was recently devised to include 5 additional ENS-specific questions. When analyzing our patients by the SNOT-20, the result was similar to SNOT-25: 40.0 (25%-75% IQR = 32.5-51.5) to 25.2 (25%-75% IQR = 16.5-33.5) points ($P = .004$) for the conchal cartilage group and 31.6 (25%-75% IQR = 18.3-47.8) to 15.8 (25%-75% IQR = 2.5-33.0) points ($P = .016$) for the costal cartilage group, and the mean difference between pre- and postoperative SNOT-20 scores showed statistically more significant improvement in the costal group (1.0, 25%-75% IQR = 0.5-1.3 vs 0.6, 25%-75% IQR = 0.3-0.9, respectively; $P = .022$). SNOT-20 and SNOT-25 showed resembled results; however, 4 items among 5 additional items of SNOT-25 that are not included in SNOT-20 demonstrated statistically significant improvement in only costal cartilage group. Therefore, we assume that SNOT-25 may be a more useful tool for symptomatology when analyzing ENS patients.

The differences between the 2 groups in the outcomes measured in this study may be explained by the structural characteristics of each material. A sufficiently durable structure and desirable soft-tissue volume are imperative to constructing better implants that can provide the mechanical functions that are ordinarily provided by turbinates. Regarding conchal cartilage, it is not easy to obtain enough material for turbinate augmentation because conchal cartilage is usually thin and oftentimes the cartilage must be constructed using several spherical layers. It is difficult to construct at least a 2-cm$^3$ implant out of conchal cartilage that can be used as neoturbinate. Costal cartilage, on the other hand, can be used in this situation. When confronted with severe turbinate loss or turbinate reconstruction that involves both nasal cavities, the harvesting of costal cartilage is inevitable. Costal cartilage is round, ovoid, can be harvested in a sufficient volume to create neoturbinates and can be easily carved into appropriate shapes that mimic the structures of the missing turbinates. In addition, because of its length, costal cartilage can even be used to augment the entire inferior turbinate sufficiently. Although the costal cartilage technique may result in donor-site morbidities such as
iatrogenic pneumothorax and chest wall deformities, none of these complications developed in our study groups.\textsuperscript{14}

The drawbacks of the current study are that the results are limited to pre- and postoperative objective measurements and the study lacked randomization, both of which are due to the retrospective design of this study. Evaluation of the measured outcomes was subjective and mainly dependent on SNOT-25, which only reflects the impact of each patient’s perception of disability. Pre- and postoperative CT scans should have been performed on all of our patients to provide a better objective evaluation. However, only 18 of 31 patients (57.1\%) underwent preoperative CT scans, and only 3 patients (9.7\%) underwent postoperative CT scans. Postoperative CT is important for determining the location of the implant and identifying signs of inflammation. Moreover, postoperative SNOT-25 was performed just once within 6 to 12 months after surgery to determine the extent of symptom improvement; thus, long-term symptomatic improvement was not evaluated. The long-term use of serial SNOT-25 surveys is recommended in order to achieve better measured outcomes. A prospective and randomized control study should be performed in the future to overcome the limitations of the present study. Despite these drawbacks, this study does compare the effectiveness of using conchal and costal cartilage implants for the management of ENS.

**Conclusion**

The use of costal cartilage demonstrated better treatment outcomes. Thus, costal cartilage may be more useful than conchal cartilage in endonasal microplasty implants and in the treatment of patients with ENS.

**Author Contributions**

**Jae Hoon Jung**, conception and design, acquisition of data, analysis and interpretation of data, drafting the article, approval of the version to be published; **Mohammad Ariff Baguindali**, conception and design, interpretation of data, revising the article critically for important intellectual content, approval of the version to be published; **Jin Taeck Park**, acquisition of data, interpretation of data, revising the article for important intellectual content, approval of the version to be published; **Yong Ju Jang**, conception and design, interpretation of data, revising the article for important intellectual content, approval of the version to be published.

**Disclosures**

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**References**