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The Epidemiology of Autologous Tissue Grafting in Primary and Revision Rhinoplasty

Linda N. Lee, MD; Olivia Quatela, BS; Neil Bhattacharyya, MD, FACS

Objectives/Hypothesis: To determine the percentage of primary versus revision rhinoplasty cases that require an extra-nasal source of grafting, as well as age and gender-specific trends.

Study Design: Cross-sectional analysis of multistate ambulatory surgery and hospital databases.

Methods: Ambulatory rhinoplasty procedures were extracted from the State Ambulatory Surgery Databases for New York, Kentucky, North Carolina, Michigan, and Florida for 2014 to 2015. Cases were examined for simultaneous use of extranasal grafts.

Results: A total of 8,510 rhinoplasties were extracted (65.3% female, mean age = 35.6 years), and 11.9% were revision cases (95% confidence interval [CI]: 11.2-12.6). An extranasal, autologous source of grafting was required in 12.7% of cases (5.3% auricular, 95% CI: 4%-6.6%; 1.8% costal, 95% CI: 1%-2.6%). Revision cases were more likely to require a secondary source of grafting (24.4%, 95% CI: 21.8%-27.1%) vs. 11.1%, 95% CI: 10.3%-11.8%). In revision cases, the most common graft was auricular cartilage (14.4%, 95% CI: 12.2%-16.6%) followed by costal (7.1%, 95% CI: 5.5%-8.69%). Only 1.1% of primary cases required costal cartilage (95% CI: 0.88%-1.36%) compared to 7.1% of revision cases (95% CI: 5.52%-8.69%). Of the primary cases, 4.1% required auricular cartilage grafting (95% CI: 3.67%-4.57%) compared to 14.4% of revision cases (95% CI: 12.2%-16.6%). Patients who required a graft were older. Significantly more males required autologous grafting than females (P = .047).

Conclusions: Cartilaginous or bony grafting is a critical surgical technique in both primary and secondary rhinoplasties. This is the first study to examine percentages of site-specific autologous grafting from auricular and costal donor sites for primary and revision cases. Gender and age-specific trends associated with specific grafting sites are also identified. These data are important to help guide preoperative counseling and informed consent for all rhinoplasty surgeries.

Key Words: Rhinoplasty, cartilage graft, bone graft, auricular cartilage, ear cartilage, rib cartilage, autologous costal cartilage, revision rhinoplasty, nasal valve repair, septrhinoplasty.

Level of Evidence: NA

Laryngoscope, 129:1549–1553, 2019

INTRODUCTION

Rhinoplasty is one of the most commonly performed surgeries by facial plastic surgeons to treat nasal obstruction, nasal deformities, traumatic injuries, autoimmune deformities, and age-related structural changes of the nose. There is a plethora of data demonstrating the success of the procedure, including improvement in patient-reported outcome measures, as well as objective improvements in Nasal Obstruction Symptom Evaluation scores, and airflow measurements, and lay observer perceptions after rhinoplasty. Both primary and secondary rhinoplasty can require additional grafting materials to provide a structurally sound skeletal framework for nasal reconstruction or for improvement of nasal aesthetics. These grafts can include spreader grafts, alar batten grafts, lateral crural strut grafts, columellar and caudal extension grafts, dorsal onlay grafts, and tip grafts. In many cases, septal cartilage can be used without necessitating an additional donor site incision, but cases where septal cartilage is unavailable, or insufficient in either quantity or quality, may require an extranasal source of grafting material. In cases where an autologous source of grafting is desired over an implant, commonly used sources of extranasal grafting include autologous auricular cartilage, costal cartilage or bone, calvarial bone grafting, and composite grafts. Each of these types of grafting has unique benefits regarding intrinsic strength and warping potential, as well as risks associated with the donor site morbidity.

Rhinoplasty is largely viewed as one of the most challenging facial plastic procedures, and although primary rhinoplasty is usually successful, there is a significant rate of revision, with percentages reported from 8% to 15% in the literature. Revision rhinoplasty is generally more challenging than primary rhinoplasty, because of scar tissue, absent septal cartilage, fractures or ossification of cartilage, and loss of nasal support, and...
may prompt surgeons to prepare for a potentially higher chance of requiring extranasal grafting.

Deciding whether additional grafting material is needed and choosing the ideal grafting material is critical to the surgical outcome. Each potential donor site brings associated morbidity and low, but possible, risk of complications. Choosing whether a second source of grafting material is needed, as well as which source to use, is a decision that is discussed in the preoperative setting with the patient, but ultimately made intraoperatively after surgically examining the areas of the nose that need structure, camouflage, or cosmetic improvement.

Although this is one of the most critical decisions during any rhinoplasty surgery, estimates of the percentage of primary and revision rhinoplasty that require grafting is currently unknown in the literature. The proportion of cases requiring auricular versus costal or other grafting sites has not previously been reported for primary or revision rhinoplasty. In addition, there may be age and gender-specific trends associated with grafting needs, which have not yet been studied. Current reports of grafting estimates are limited to reports by individuals or small groups,\(^9,18-21\) and these can vary widely based on surgeon experience and skill, as well as referral patterns for revision rhinoplasty cases. With the expanded use of electronic medical records,\(^22\) we are increasingly realizing the benefit of analyzing larger datasets that can provide a more representative analysis of surgical procedures to provide information from a broader data group. To our knowledge, this study is the first cross-sectional analysis of a large cohort, multistate database using standardized procedural coding to examine the overall and specific grafting needs in both primary and secondary rhinoplasty. We also examine gender and age-specific trends in autologous tissue grafting.

**MATERIALS AND METHODS**

All cases of primary and revision rhinoplasty were extracted from the individual State Ambulatory Surgery Databases (SASD) from New York, Kentucky, North Carolina, Michigan, and Florida, Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality, for calendar years 2014 to 2015.\(^23\) Cases were restricted to those aged ≥14 years. This study was deemed exempt from review by the Partners Committee on Clinical Investigations as it utilizes publicly available, deidentified datasets. For each case, standard demographic data were extracted as well as primary or revision rhinoplasty status as determined by Current Procedural Terminology (CPT) code. Additional CPT codes were examined to determine whether or not extranasal grafting occurred for bone, rib, auricular, or composite grafts. The proportions of cases undergoing any type of grafting were determined for the overall cohort as well as for primary versus revision cases and according to sex and age. Similar subgroup analyses were conducted for each of the extranasal grafting types. Individual percentages and 95% confidence intervals (CI) were computed for proportions.

**RESULTS**

A total of 8,510 rhinoplasties were extracted; 1,015 were revision cases (11.9%). Overall, 1,077 (12.7%, 95% CI: 12%-13.4%) of the cases required an extranasal, autologous source of grafting (5.3%, 95% CI: 4%-6.6%) auricular cartilage and (1.8%, 95% CI: 1%-2.6%) costal. Revision rhinoplasty cases were significantly more likely to require a secondary source of grafting compared to primary cases.

Table I presents the distribution of graft use in primary versus revision cases. Auricular cartilage was used in 4.1% of primary cases and 14.4% of revision cases. Costal grafting was used in 1.1% of primary cases and 7.1% of revision cases. Composite grafts were used in less than 1% of primary and revision cases.

Table II presents the distribution of grafts across genders. Across all rhinoplasty cases, there was a slight female preponderance at 65.3%. However, overall, more males required an extranasal graft than females. Of the cases that required auricular cartilage grafting, there was also a higher male preponderance (\(P = .001\)). There was no significant gender difference noted for other types of grafts examined.

Figure 1 presents a histogram of the distribution of ages for all rhinoplasty cases that required grafting. Across all rhinoplasty cases, the mean age was 35.6 years (95% CI: 34.9-36.4). The mean patient age of cases that required grafting was older at 41.5 years (95% CI: 39.4-44.0). The mean age for rib graft cases was similar to the age for overall grafting at 41.2 years (95% CI: 34.7-47.7), with the upper end of the range at 78 years. The mean age of cases that underwent auricular cartilage grafting was older at 47.2 years (95% CI: 42.9-51.5), with the upper end of the range at 92 years.

**DISCUSSION**

To our knowledge, this is the first study to examine overall autologous tissue grafting needs during primary and revision rhinoplasty, as well as compare the use of ear versus rib donor sites on a large population scale. This is also the first study in the literature to examine gender and age-specific trends for autologous tissue grafting during rhinoplasty.

Examining overall cases of rhinoplasty, the rate of revision rhinoplasty in this larger data group was 11.9%, which is consistent with multiple published reports from individual surgeons or small groups in the current literature that report a range of 8% to 15%.\(^9,18-21\) Intuitively,
one would expect revision rhinoplasties to have a higher likelihood of requiring additional structural grafting from an extranasal source, as primary rhinoplasty may have resulted in loss of quadrangular cartilage from the septum, loss of nasal support from overresection, more scar tissue and contractile forces to resist, and other factors associated with a previous insult to the nose. Given the large number of rhinoplasties performed annually, an 11.9% revision rate represents a significant number of revision surgeries for which additional cartilage grafting must be considered. It is not surprising that our data showed revision cases were more than twice as likely to require a secondary source of grafting material. One-fourth of all revision rhinoplasty cases required an extranasal source of grafting material. It is interesting, however, that even 11% of primary cases required an extranasal source of grafting. As such, the informed consent process should always include a discussion about the possible need for a second donor site, whether primary or revision.

One of the known challenges in recording accurate revision rates is that patients can be lost to follow-up or choose to have revision surgery with a different surgeon. Also, surgeons who are more specialized in revision rhinoplasty may see a higher than normal percentage of patients requiring revision, similar to a tertiary care hospital that may see higher numbers of certain cases than private hospitals. Thus, estimates of revision rhinoplasty may vary significantly across different practices. One strength of this study is that it provides a cross-sectional analysis across multiple states in a deidentified database format, which may better represent the overall percentage of revision cases that are being performed on a broader level across multiple states. In addition, analyzing a larger set of deidentified data from electronic records based on standardized procedural coding can eliminate potential publication bias, in which individual surgeons or physician groups may be more inclined to publish lower revision rates and better outcomes in the literature, and higher rates of revision may be viewed as

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<td>168</td>
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<tr>
<td>Composite*</td>
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*Data are reported as ≤10 to protect privacy and confidentiality in accordance with the data-use agreement. 
CI = confidence interval.

Fig. 1. Histogram of age distribution for rhinoplasty patients requiring an autologous graft. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]
complications and may not be reported as frequently. Although these data are limited to a cross-sectional analysis and not a true national revision rate, the 11.9% rate is consistent with multiple smaller reports in the existing literature.

Across both primary and revision rhinoplasty cases, ear cartilage grafts are the most common donor site. Auricular cartilage was used four times more than rib in primary cases, and twice as much as rib in secondary cases. Costal grafting was used in only 1.1% of primary cases. In revision cases, the use of rib grafting increases to 7%, but this is still significantly less than ear cartilage (14%). The decision of which donor site to use is multifactorial, and includes structural needs, patient medical factors, and patient preference.

Of note, the data in this study include only autologous sources used for structural grafting. Alloplastic implants, absorbable materials such as a polydiaxanone plate, and irradiated homologous costal cartilage have also been studied extensively in the literature. Although these can be used instead of, or in addition to, autologous grafts, this study is focused solely on autologous cartilaginous and bony grafts.

**Age- and Gender-Related Trends in Grafting During Rhinoplasty**

Aging of the facial and nasal structure has been well-documented in the literature, and the need for reconstructive rhinoplasty to address age-related changes is increasing as the population grows older. With aging, support structures around the upper and lower lateral cartilages weaken, resulting in loss of nasal tip support and nasal obstruction. As our population ages and it is increasingly common to perform rhinoplasty on older patients, it is intuitive to think that older patients may also be more likely to require grafting to reconstruct decreased nasal tip support. Our data showed that patients who required a graft were older than the overall group of rhinoplasty patients, and the oldest group were those patients who underwent auricular grafting. In 2017, Riedler et al. compared age-associated biochemical and histologic changes in auricular versus septal cartilage, and showed auricular cartilage may have superior integrity and viability over septal cartilage, and may be less susceptible to age-related cartilage degradation. Their data showed higher cell density and more stable glycosaminoglycan content in ear cartilage with older age compared to septal cartilage in age-matched controls.

Across all primary and revision rhinoplasties, the mean age of patients undergoing rib graft was younger than those undergoing auricular grafting (41.2 years, with a range of 14–78 years). This may be secondary to ossification of costal cartilage at an older age, or the low but possible risk of pneumothorax or other donor site morbidity may be more significant in patients with increased age or medical comorbidities.

Ultimately, the choice of graft site is dependent on many factors, and the surgeon should consider age-related changes in both intrinsic nasal anatomy and the donor graft site, but these data may help guide preoperative discussions and patient education of age-related trends.

Examining the data across genders, it is notable that there is a statistically significant gender difference in the percentage of males who required extranasal grafting compared to females. Overall, more males required grafting than their female counterparts. In both males and females, auricular cartilage was used more commonly than rib. Of the cases that required ear cartilage grafts, there was a statistically significant male preponderance. There were no significant gender differences noted for other types of grafts examined. The underlying reasons for the differences in gender-specific trends in overall grafting are unclear from these data, and it would be interesting to develop a follow-up study to further examine possible differences to explain whether this is driven by patient preferences, nasal trauma, intrinsic gender differences in nasal anatomy, or possibly gender-specific anatomic differences at the donor site.

Several limitations of the current analysis merit mention. First, the analysis relies on coded diagnoses in a secondary dataset. All codes for nasal valve repair, rhinoplasty, and revision rhinoplasty were included in this data analysis. However, it is possible that some cases may not have been accurately coded as revision, and the true revision rate could be slightly higher than the coded procedures show. However, the revision rate for this large dataset is consistent with the range documented in existing literature. Second, although auricular and costal harvest are linked to specific and discrete codes used for these procedures, the codes for bony grafts are more generalized. Thus, whereas bony grafts are most likely composed of calvarial bone grafts and possibly iliac crest, other types of bony grafts may be included. Although the data for auricular and costal grafts are specific enough to allow further analysis, a more detailed breakdown of bony grafts was not able to be performed in this study.

A strength of this study is that the data were extracted from multistate SASD databases, which are part of the broader HCUP, and include all patients regardless of payer. Therefore, the data are felt to provide a representative picture of broader grafting trends. Although grafting for rhinoplasty is not rare, it is not extremely common. Therefore, large sample sizes are required to allow for statistically meaningful comparisons between groups. These databases provide access to a large volume of deidentified patient data from multiple states and institutions, allowing for adequate sample sizes while also removing biases that may arise from single institution studies.

**CONCLUSION**

Both functional and cosmetic rhinoplasty cases often utilize grafting techniques to achieve optimal surgical results. This is, to our knowledge, the first study to perform a large cross-sectional analysis of primary and revision rhinoplasty analyzing site-specific use of autologous grafting material from auricular and costal donor sites. The need for grafting is noted to be significantly higher in
revision rhinoplasty cases. Gender- and age-specific trends associated with specific grafting sites were also identified. These data are important to help guide patient education during preoperative counseling for all rhinoplasty surgeries.

**BIBLIOGRAPHY**
