Comparison of Techniques Used to Support the Nasal Tip and Their Long-term Effects on Tip Position

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Objectives: To examine the indications for the use of septal extension grafts, columellar struts, and tongue-and-groove techniques to provide support and set the tip position during rhinoplasty, and to compare the strength of their support and analyze their long-term effects on tip position.

Methods: The medical records and photographs of patients who underwent external septorhinoplasty during a 2-year period were analyzed. Forty patients had photographs from short-term follow-up (<12 weeks) and were included in the study. The short-term and long-term (>52 weeks) tip positions were compared to determine the maintenance of tip position with each technique. Each stabilization technique was performed on 5 fresh cadavers, and the resistance to displacement of the tip was measured and compared.

Results: Objective measurements in the cadaver analysis show increased resistance to tip displacement with the use of caudal septal extension grafts and tongue-and-groove techniques. There was no difference in the maintenance of tip position between the techniques in analysis of the patients who have undergone rhinoplasty.

Conclusions: Many factors influence the maintenance of tip position in patients who have undergone rhinoplasty. One should consider using a stabilization technique to help resist displacement of the nasal tip. Clinical and operative findings, as well as secondary effects, are used to help determine which technique should be used.

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RHINOPLASTY REMAINS ONE of the most challenging facial plastic surgical procedures to perform. The surgeon must achieve a combination of aesthetic harmony with the surrounding facial features and preservation or development of nasal function and support. The ability to manipulate the nasal tip and achieve long-term harmonious form and function is one of the most difficult tasks of the rhinoplasty surgeon.

In his textbook Surgical Anatomy of the Nose, Tardy1 states that it is impossible to appropriately sculpt the nasal tip and predict ultimate healing without comprehending the vital tip support mechanisms of the nose, both major and minor (Table 1). Various support mechanisms will invariably be disrupted during tip contouring, and it is important for the surgeon to try and reestablish this support to maintain the desired tip contour and position and resist the contractile forces of healing. In an article summarizing concepts in nasal tip contouring, Toriumi2 describes the importance of reestablishing tip support. He states that before contouring the nasal tip, the surgeon must stabilize the base of the nose with a columellar strut, suturing the medial crura to a long caudal septum (tongue-and-groove), caudal extension graft, or an extended columellar strut graft. Stabilization of the nasal base through these techniques will help to ensure that tip projection is maintained postoperatively.

Beaty et al3 sought to quantify changes in tip support after disruption of some of the tip support mechanisms. The authors developed an instrument to objectively measure the nasal tip support before and after surgical modification of various tip support mechanisms in cadavers and patients. The postoperative measurements were taken immediately after the procedure, and no long-term data are available for overall maintenance of tip position or support.

In our practice, stabilization methods described by Toriumi are used to control long-term tip position, including the columellar strut, caudal septal extension graft, tongue-and-groove technique, or suture closure alone. In the present study, we objectively analyze the strength of these various stabilization techniques in a cadaver study. We evaluate the maintenance of tip position in patients undergoing each stabilization technique and examine the indications for the use of these techniques.
CLINICAL METHODS

A retrospective medical record review was performed for all patients undergoing external septrhinoplasty or rhinoplasty in 2006 and 2007. Forty patients had preoperative, short-term postoperative (<12 weeks), and long-term postoperative (>52 weeks) photographs and were included in the review.

The medical records were reviewed and the method of tip support (caudal septal extension graft, columellar strut, tongue-and-groove, or sutures alone) was documented. Other intraoperative characteristics that may affect tip position, including alteration of tip support mechanisms, placement of batten or rim grafts, and placement of tip grafts, were also documented.

Patients who had a history of prior trauma or other septrhinoplasties were identified as well.

Tip projection at each time point was measured from the lateral view of the photograph by 2 of us (E.J.D. and V.T.) without knowledge of the type of tip support that was used. Measurements were recorded using Photoshop CS3 Extended, version 10.0.1 (Adobe, San Jose, California). The photographs were taken at different distances and zoom levels at different time points, so absolute measurements were not available for comparison. A constant distance at each time point was measured and used for comparison of the changing tip position (Figure 1). The distance from the anterior most point of the intertragal notch (point 1) to the anterior most portion of the cornea (point 2) was measured to represent the constant distance, because these areas were not changed and should remain constant over time. The distance between the anterior most point of the intertragal notch (point 1) and the nasal tip (point 3) was then measured as the variable distance. The ratio between the 2 measurements was determined at each time point by dividing the variable distance by the constant distance. The change in tip projection was then obtained by determining the difference of the ratios between 2 time points (Figure 2).

To evaluate the maintenance of tip position we compared the difference between the ratio at the short-term postoperative photograph and the long-term postoperative photograph. This way, we were able to determine the maintenance of position independent of whether the patient's tip position was increased, decreased, or unchanged from the preoperative position.

SURGICAL TECHNIQUE

All patients in this study underwent external rhinoplasty or septrhinoplasty performed by one of us (P.A.H.). Midcolumellar and bilateral marginal incisions were created, and the soft tissues were elevated in the sub–superficial muscular aponeu-rotic system plane. The soft tissues over the bony vault were elevated in a subperiosteal plane. Next, the interdomal ligament and medial crura were separated, and the caudal edge of the septum was identified. If a septoplasty was performed, the mucoperichondrial flaps were then raised, and the septal deformities were addressed. Cartilage grafts were harvested from the quadrangular cartilage, taking care to preserve a 1 - to 1.5-cm dorsal and caudal strut. Septal cartilage was used for grafting in all patients who underwent caudal septal extension grafts and all but 1 of the patients who had columellar struts placed. In 1 patient, auricular cartilage was used for a columellar strut.

Nasal deformities of the bony and middle vault, as well as the nasal tip, were then addressed. We then decided whether to perform a base support technique and which technique to use. Septal extension grafts were performed by securing a septal cartilage graft to the caudal end of the nasal septum using interrupted 5-0 polydioxanone absorbable sutures. Once the graft was secured, a 5-0 polydioxanone absorbable interdomal suture was placed leaving a long tail of the suture that could be grasped by the assistant who would then hold the lower lateral cartilages in place to set the tip position. Several through-and-through 4-0 chromic sutures were then placed to secure the medial crura to the septal extension graft, fixing the lower lateral cartilages in the desired position.

Columellar struts were performed by placing a septal or auricular (1 patient) cartilage graft into a pocket that was created caudal to the edge of the septum tracking down to the premaxilla anterior to the nasal spine. A 5-0 polydioxanone absorbable interdomal suture was placed, and the lower lateral cartilages were held in the desired position. Several through-and-through 4-0 chromic sutures were then placed to secure the floating columellar strut to the medial crura.

The tongue-and-groove technique was performed by completely freeing the medial crura and retrodisplacing them back over the caudal edge of the septum. Once the desired placement of the medial crura and tip was achieved, several through-and-through 4-0 chromic sutures are placed to secure the medial crura to the caudal septum. A 5-0 polydioxanone absorbable interdomal suture was then placed. With all base support techniques, other tip sutures may be placed before or after the placement of the interdomal suture.
CADAVER STUDY

Five fresh cadavers were used for this portion of the study. All the cadavers were examined to ensure that there was no evidence of prior external nasal surgical treatment. The available medical records were also reviewed to ensure that the patients had not had any prior nasal procedures.

An adjustable tensometer was created to measure the change in nasal tip projection with incremental increases in weight applied to the nasal tip. The adjustable tensometer is shown in Figure 3. The cadaver head was secured in place with the Frankfort horizontal plane perpendicular to the base. The base of the tensometer was then placed in position so it was just touching, but not displacing, the nasal tip. A series of increasing weights were then applied, and the amount of tip displacement indicated on the tensometer was measured. Weights from 5 to 50 g were applied with 5-g incremental increases in weight, and the amount of displacement at each point was measured. The weights were then removed and the process was repeated so that 2 measurements of displacement were obtained for each weight applied.

For each cadaver, preoperative measurements were obtained before any manipulation of the nose. An external septorhinoplasty was then performed as previously described. The nose was degloved, and a portion of the quadrangular cartilage was harvested, taking care to preserve the 1- to 1.5-cm dorsal and caudal strut. The interdomal ligament was divided in all patients while identifying the caudal border of the septum, before performing a septoplasty. Measurements were then taken to determine the loss of tip strength that was incurred after soft tissue elevation (STE). Next, a columellar strut, septal extension graft, tongue-and-groove, or suture-only stabilization technique was performed. The soft tissue envelope was closed and measurements were obtained. The order that each base stabilization technique was performed was varied on each cadaver, so that one technique was not consistently first or last.

A repeated-measures analysis of variance procedure was used to analyze the results of the cadaver study. The Tukey method of multiple comparisons was then used to determine the differences between the stabilization techniques performed on the cadavers. For the clinical portion of the study, a Fisher exact test was used to compare the other characteristics that may affect tip position, including alteration of tip support structures, tip or batten grafts, and previous trauma or rhinoplasty. For the photographic analysis, a Pearson correlation coefficient test was used to compare agreement among observers. A repeated-measures analysis of variance was used to compare changes in tip position.

RESULTS

CADAVER STUDY

Two measurements of tip displacement were recorded for each weight applied. Figure 4 shows the mean amount of displacement for each cadaver as indicated by each symbol on the graph. Each graph represents one of the techniques performed, including a preoperative measurement, a measurement performed after STE, and closure with sutures only. A line is drawn on each graph...
representing the mean displacement for all 5 cadavers for the technique. The range of displacement between the cadavers tended to be small at lower weights and increased with greater application of weight. The range of displacement varied by technique, with the open nose and columellar strut having the largest variability and tongue-and-groove having the smallest amount of variability.

The lines representing the mean displacement for each technique are compared in Figure 5. The techniques are shown in decreasing order of resistance to tip displacement (the top line represents the weakest support). The preoperative and STE measurements are included as well. As expected, the STE represents the least resistance to displacement. Of the stabilization techniques, sutures alone provided the least resistance to displacement followed by the columellar strut. The septal extension graft and tongue-and-groove technique
provided the greatest resistance to tip displacement. Closure with sutures alone and use of a columellar strut provided less resistance than the preoperative level, and the septal extension graft and tongue-and-groove technique provided more resistance than the preoperative level.

Results of statistical analysis comparing the techniques are presented in Table 2. To perform statistical analysis, the mean tip displacement was determined for all the weights applied (5-50 g) for each technique measured. The mean order of resistance to tip displacement is the same as that indicated graphically in Figure 4. The repeated-measures analysis of variance showed a statistical difference between techniques ($P<.001$). The resistance provided by septal extension grafts and tongue-and-groove were equivalent to the preoperative resistance to tip displacement. These techniques provided greater resistance than the columellar strut and sutures alone. The resistance provided by the columellar strut was similar to that of sutures alone and the preoperative resistance.

**CLINICAL ANALYSIS**

We first analyzed the other intraoperative characteristics that may influence tip support or projection to determine if these factors could influence the maintenance of tip position in the photographic analysis. A Fisher exact test was performed to determine if any differences existed among the various groups of patients. The results are shown in Table 3. There was a significant difference in the alteration of major tip support mechanism among the groups.

Table 2. Analysis of the Mean Nasal Tip Displacement for Each Technique Performed on 5 Cadavers

<table>
<thead>
<tr>
<th>Technique Measured</th>
<th>Tip Displacement, mm</th>
<th>Tukey Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open nose</td>
<td>3.41 (0.78)</td>
<td>A</td>
</tr>
<tr>
<td>Suture closure</td>
<td>2.80 (0.43)</td>
<td>A and B</td>
</tr>
<tr>
<td>Columellar strut</td>
<td>2.43 (0.82)</td>
<td>B and C</td>
</tr>
<tr>
<td>Preoperative</td>
<td>2.03 (0.49)</td>
<td>C and D</td>
</tr>
<tr>
<td>Septal extension graft</td>
<td>1.57 (0.47)</td>
<td>D</td>
</tr>
<tr>
<td>Tongue-and-groove</td>
<td>1.53 (0.24)</td>
<td>D</td>
</tr>
</tbody>
</table>

**Table 3. Other Intraoperative Procedures That May Influence Overall Tip Support**

<table>
<thead>
<tr>
<th>Technique</th>
<th>No. of Patients</th>
<th>Per Patient</th>
<th>No. (%) of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Major Tip Support</td>
<td>Minor Tip Support</td>
<td>Tip Graft</td>
</tr>
<tr>
<td>Columellar strut</td>
<td>11</td>
<td>1.72</td>
<td>1.54</td>
</tr>
<tr>
<td>Sutures alone</td>
<td>4</td>
<td>2.00</td>
<td>2.25</td>
</tr>
<tr>
<td>Septal extension graft</td>
<td>13</td>
<td>1.15</td>
<td>2.00</td>
</tr>
<tr>
<td>Tongue-and-groove</td>
<td>12</td>
<td>1.67</td>
<td>1.91</td>
</tr>
</tbody>
</table>

$^a$ Mean (SD) tip displacement for all weights measured (5-50 g).

$^b$ Group means that do not share the same letter are statistically significantly different from each other ($P<.05$).

Table 4. Comparison of the Maintenance of Tip Position With Long-term Photographic Analysis

<table>
<thead>
<tr>
<th>Technique</th>
<th>No. of Patients</th>
<th>Postoperative Ratio</th>
<th>Change in Tip Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columellar strut</td>
<td>11</td>
<td>12.67 (1.59)</td>
<td>0.26 (0.47)</td>
</tr>
<tr>
<td>Sutures alone</td>
<td>4</td>
<td>13.11 (0.45)</td>
<td>0.10 (0.20)</td>
</tr>
<tr>
<td>Septal extension graft</td>
<td>13</td>
<td>13.56 (1.03)</td>
<td>0.24 (0.33)</td>
</tr>
<tr>
<td>Tongue-and-groove</td>
<td>12</td>
<td>12.20 (1.50)</td>
<td>0.11 (0.39)</td>
</tr>
</tbody>
</table>

$^a$ Values listed are the mean ratio between the variable and constant measurements obtained from the photograph for each time point for all patients in the group.

$^b$ Difference in the mean ratio from short-term to long-term postoperative photographs.

Controlling the long-term shape and position of the contoured nasal tip is one of the most challenging aspects of rhinoplasty. The surgeon must anticipate the contractive forces of healing and account for this in the surgical plan to achieve an aesthetically pleasing and functional long-term result. The surgeon must also understand the various tip support mechanisms and...
Figure 6. A batten-type septal extension graft is shown in a cadaver. The graft is extended from the caudal septum and is secured to it with a series of horizontal mattress sutures (A and B). The medial crura are then secured to the graft with sutures to set and stabilize the tip position (C).

should account for the disruption or alteration of these structures during routine rhinoplasty maneuvers. In this study, all patients underwent an external approach. During this approach, minor tip support mechanisms are weakened when the skin and muscles are dissected off the alar cartilages and the interdomal ligaments are divided. While contouring the nasal tip, the surgeon may alter the size, shape, and resilience of the lateral crura. The cephalic border may be trimmed as well, disrupting the attachment between the lateral crura and the upper lateral cartilage. In this instance, 2 of the major tip support mechanisms have been altered. In patients with severe caudal septal deformity, the medial crural footplate attachment will often need to be disrupted to treat the deformity, thus altering another major tip support structure. Reduction of the dorsal cartilaginous septum represents another common alteration of a minor tip support mechanism.

While performing these routine maneuvers, the surgeon should anticipate the resultant changes in overall tip support. Taking into account the patient’s innate resilience to tip displacement noted on the preoperative assessment of manual tip retrodisplacement with the surgeon’s finger, the surgeon should then develop a plan to try and optimize the maintenance of the desired tip position that has been achieved. Surgeons will often rely on various types of stabilization grafts or suture techniques to achieve this goal. Toriumi describes the importance of stabilizing the base of the nose through the use of a columellar strut, suturing the medial crura to a long caudal septum (tongue-and-groove), a caudal extension graft, or an extended columellar strut graft. Others describe the use of caudal septal advancement or a dynamic, adjustable, rotation tip tensioning (DARTT) technique.

We prefer the use of columellar struts, septal extension grafts, tongue-and-groove, or suture closure to provide stabilization. Columellar struts are placed as floating grafts that are secured to the medial crura and generally extend from the premaxilla to the infratip. Septal extension grafts, as described by Byrd et al. may be performed in 3 different variations: (1) extension of a spreader graft, (2) overlapping the caudal edge of the septum (batten), and (3) direct extension of the caudal septum without overlap. We use the batten variation of the septal extension graft, as shown in Figure 6. The tongue-and-groove technique described by Kridel et al. is performed through cephaloposterior displacement of the medial crura onto the caudal septum. Depending on the width of the columella, soft tissue may need to be excised to facilitate narrowing. Caudal septal trimming is rarely needed, but may be performed if there continues to be excessive columellar show. Finally, the external rhinoplasty incisions may be closed with sutures only. In these cases, the surgeons will generally perform through-and-through chromic sutures to approximate the divided medial crura and interdomal ligament.

It is important to note that rhinoplasty does not conform to simplified rules, and oftentimes multiple techniques are used to achieve the desired tip contour. The dynamics of the nasal tip are complex, and an explanation of all the techniques used to alter nasal projection is beyond the scope of this discussion. The stabilization techniques previously described are intended to provide resistance to the contractive forces of healing and help to preserve the tip contour that is achieved through various suture, cartilage reduction/repositioning, or tip-grafting techniques used in tip contouring.

It is also important to note that each rhinoplasty technique will generally have multiple effects. The stabilization techniques described provide added structure and support to the tip; however, they also may be used to achieve other surgical goals as well. The columellar strut may be used to help correct deformities or buckling of the medial crura. The septal extension graft and tongue-and-groove techniques may be used to rotate the tip or help straighten the caudal septum. The septal extension graft may be used to increase columellar show, whereas the tongue-and-groove technique may be used to decrease columellar show.

Taking into consideration all of these variables influencing the surgeon’s choice of stabilization technique, we sought to explore these various techniques purely on the basis of their ability to provide structure and support the nasal tip and base. We objectively analyzed the resistance to retrodisplacement of the nasal tip with each technique in a cadaver study. We then determined if the resistance provided by these techniques correlates with
maintenance in long-term tip projection in patients undergoing rhinoplasty using the various techniques.

The differences in the innate stability of the patient’s cartilaginous framework and tip support structures are noted in Figure 4. The preoperative measurements show an increase in the range of displacement of the nasal tip between each cadaver with greater application of weight. Of interest, the range in tip support between cadavers decreased with the application of the tongue-and-groove technique, and the range actually increased with the use of a columellar strut. This graphical representation is confirmed with analysis of the standard deviation of the mean values of all the cadavers (Table 2). These results indicate that one may be able to overcome some of the innate difference in stability of the patient’s framework with the tongue-and-groove technique but also highlight the differences in native support that the surgeon must consider when choosing a technique.

The overall resistance to tip retrodisplacement is significantly stronger with the tongue-and-groove technique and septal extension graft. These techniques provide tip support that is statistically similar to the preoperative support. This difference is intuitive because these techniques provide stability by suturing the medial crura to the caudal septum or to a graft that is secured to the caudal septum. With a columellar strut, the medial crura are secured to the graft, but the graft is otherwise not secured to other structures of the nose.

The difference that was noted between techniques in the cadaver study did not correlate with any difference of maintenance of tip support in the clinical study. In all cases, the tip projection decreased between the short-term and long-term photographs. This would be expected because the patients have swelling in the tip prior to 12 weeks that nearly completely resolves by 1 year postoperatively. If one technique was inferior at maintaining tip position through this healing phase, these patients should have a greater decrease in tip projection during this time period compared with the other groups that underwent resolution of swelling as well. This was not the case in our analysis. We believe that there are a few possibilities to explain the difference between the cadaver and clinical study results.

To determine the resistance to tip displacement, we used enough weight to cause tip up, and in some cases greater than, 3 mm of tip displacement. This resulted in significant differences in resistance between the techniques. Patients who have undergone rhinoplasty are subject to contractive forces of healing; however, these forces are significantly less likely than those forces that were applied during the cadaver study. The resistance to tip displacement at the lower weight range was similar for all of the techniques except the STE group. So, it is possible that the forces of healing after rhinoplasty do not become significant enough to require the increased tip strength that the septal extension grafts and tongue-and-groove techniques provide.

As stated, there are other factors that may influence tip support and projection other than the stabilization technique used, including disruption tip support mechanisms, tip or batten grafts, and previous surgical treatment or trauma. In this study, there was no difference in these factors between groups, except for the disruption of major tip support structures. It appeared that the suture-only group had a higher number of major tip support structures disrupted than the other groups. There were only 4 patients in this group, so we were not able to perform statistical analysis to compare among groups. However, the suture-only technique provided the least support in the cadaver study, so this group of patients was at an apparent disadvantage. Of interest, there was no difference in the suture-only group’s ability to maintain tip projection in patient photograh analysis. This leads us to consider the other factor that can significantly influence maintenance of tip projection and support that we were not able to analyze, the selection bias of the surgeon’s choice of technique based on the innate resistance of the patient’s cartilaginous framework.

The assessment by the senior surgeon (P.A.H.) of the innate resilience of the patient’s cartilage preoperatively and intraoperatively was used to determine which, if any, stabilization technique should be used. Patients with strong native cartilage may not require any support other than a suture closure, whereas patients with weaker cartilage require one of the stabilization techniques. It is likely that the maintenance of tip position in all groups demonstrated in the retrospective clinical study was influenced by the surgeon’s effective choice of stabilization techniques based on the innate differences in the patient’s tip support. Patients with greater native support may have received a columellar strut or suture-only closure, whereas patients with weaker native support received a septal extension graft or tongue-and-groove technique.

To further explore these possibilities, future studies should be performed with preoperative assessment of the patients’ native tip support. Objective measurements may be obtained with the use of the tensometer. Patients with varied levels of native support will likely still undergo different support techniques based on the native resistance; however, this may be taken into account in the statistical analysis allowing one to determine if the differences in native resistance have an overall effect on maintenance of tip projection.

CONCLUSIONS

To attain a well-defined and properly positioned nasal tip after rhinoplasty, the surgeon must have a fundamental understanding of the nasal tip support mechanisms and the long-term effects of alteration of these support structures. The surgeon should seek to reestablish support of the nasal tip to help maintain the tip position and contour that has been achieved during surgical treatment. Various stabilization methods exist, including columellar struts, septal extension grafts, tongue-and-groove, or suture-only techniques.

The patient’s clinical characteristics, intraoperative findings, and secondary effects of the technique should be considered when trying to determine which technique should be used. In this study, the septal extension
graft and tongue-and-groove technique provided a significantly greater amount of support in the cadaver study; however, this did not correlate to a difference in maintenance of tip position in the clinical arm of the study. Clinically, all of the techniques resulted in an equivalent maintenance of tip position. It is possible that this is owing to the surgeon’s selection of techniques based on differences in the native resistance of the cartilaginous framework.

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Additional Contributions: Philippe Gaillard, MS, Biostatistical Design and Analysis Center, University of Minnesota, assisted with the statistical analysis.

REFERENCES


Correction

Error in Byline. In the article titled “William Hogarth’s The Painter and His Pug: Defining the ‘Line of Beauty’,” in the March/April issue of the Archives (2010;12[2]:136-Cover 3), the author’s first name was spelled incorrectly. The correct spelling is Farhad.