Anatomical Study of the Lateral Crural Strut Graft in Rhinoplasty and Its Clinical Application

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Abstract

Background: Lateral crural strut graft has been used in rhinoplasty to correct deformities such as bulbous nasal tip, lateral crus malposition, alar retraction, collapsed external valve, lateral crus concavity, and alar deformity after domal suture. Despite its widespread use, the lateral crural strut graft has not been the subject of studies that show its benefits objectively and statistically.

Objectives: To assess nasal anatomical variations in cadavers that underwent rhinoplasty using the lateral crural strut graft, considering the clinical applications of this graft.

Methods: The study was conducted with 16 human cadavers that underwent rhinoplasty with lateral crural strut graft. The variables were basilar nasal width, interalar width, columella-nasal tip height, nostril’s width, and length and width of the graft. Measurements were taken with a digital caliper before and after rhinoplasty, and nostril cross-sectional area was measured with a computer program. All measurements were submitted to statistical analysis.

Results: Most of the cadavers were young, male, and black. Variables values were increased, but only basilar nasal width, columella-nasal tip height, and nostril cross-sectional area showed statistically significant differences ($P < .05$), leading to changes in the alar base, the nasal tip projection and the external nasal valve.

Conclusions: Lateral crural strut graft improves external nasal valve and increases nasal tip projection and basilar nasal width.

Accepted for publication April 20, 2016.

The lateral crural strut graft is a versatile technique for reshaping, repositioning, and reconstructing the lateral crura while providing support for the external valve. It’s been widely used in rhinoplasty to correct deformities such as bulbous nasal tip, lateral crus malposition, alar retraction, collapsed external valve, lateral crus concavity, and alar deformity after domal suture.$^{1,2}$

Lateral crural strut grafts are strips of autogenous cartilage usually harvested from the septum and carved to 3 to 4 mm in width and 15 to 25 mm in length. The graft is placed in an undermined pocket between the undersurface of the lateral crus and the vestibular skin and stabilized by suturing it to the crus. The lateral end of the graft is usually placed in a pocket superficial to the piriform aperture rim and can also be inserted in the alar base or in the nostril rim.$^{3-5}$

It has been almost twenty years since the lateral crural strut graft has been published, and many authors have mentioned it in articles and books.$^{6-11}$ Despite its widespread use, the lateral crural strut graft has not been the subject of research that proves its benefits objectively and statistically. We conducted a study using a number of variables with the purpose of achieving results for the use of the lateral crural strut graft in rhinoplasty, its clinical applications, benefits, and anatomical changes.

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METHODS

The study was conducted at the Nina Rodrigues Forensic Medicine Institute after approval by the Ethics Committee from the Professor Edgard Santos University Hospital - Federal University of Bahia. An anatomical study was performed on 21 fresh cadavers between November 2014 and January 2015. After dissection, 5 were excluded according to the exclusion criteria. The exclusion criteria were: facial trauma, nasal septum fracture, and insufficient harvested cartilage from the septum.

The 16 cadavers with normal noses underwent an open approach rhinoplasty, with proper identification of the cartilages and detachment of their connections from the septal cartilage and upper lateral cartilages. Cartilage was harvested from the nasal septum, and the lateral crus was undermined from the underlying skin. Lateral crural strut grafts were carved and placed under the lateral crus, and then stabilized by suture (Figure 1). The lateral portion of the lateral crural strut graft was placed in a pocket previously dissected superficially to the piriform aperture. Then we performed transdomal and interdomal

Figure 1. The lateral crural strut graft sutured to the right lateral crus as demonstrated on a 27-year-old male cadaver.

Figure 2. Basilar nasal width as demonstrated on a 23-year-old male cadaver.

Figure 3. Interalar width as demonstrated on a 52-year-old male cadaver.

Figure 4. Nostril width as demonstrated on a 23-year-old male cadaver.
sutures, and closure of the incisions. All dissections and measures were performed by the same surgeon.

The variables were basilar nasal width (Figure 2), interalar width (Figure 3), nostril width (Figure 4), columella-nasal tip height (Figure 5), and length and width of the graft. Measurements were taken with a digital caliper before and after rhinoplasty. Photographs of the basal view were taken to measure the nostril cross-sectional area with the engineering computer program AutoCAD (Autodesk, Inc., San Rafael, CA) (Figure 6). An illustration demonstrating the various measurements is shown in Figure 7. All variables were submitted to statistical analysis.

Initially, the first 5 cadavers were arranged in group 1 as a pilot study to verify feasibility. The measurements taken were basilar nasal width, interalar width, columella-nasal tip height, and length and width of the graft. The results achieved motivated a study with a larger number of cadavers. Then, 11 cadavers underwent rhinoplasty and were arranged in group 2. Measurements taken were basilar nasal width, interalar width, columella-nasal tip height, length and width of the graft, nostril’s width, and nostril cross-sectional area. They were divided in different groups because the last 11 cadavers were submitted further to the evaluation of the “nostril cross-sectional area” and “nostril’s width.”

Group 1: 5 cadavers (variables - basilar nasal width, interalar width, columella-nasal tip height, length and width of the graft)

Group 2: 11 cadavers (variables - basilar nasal width, interalar width, columella-nasal tip height, length and width of the graft, nostril’s width, and nostril cross-sectional area)

Group 3: cadavers of group 1 and 2 (common variables)

All variables were analyzed utilizing the software IBM Statistical Package for the Social Sciences (SPSS, Chicago, IL) 20.0. The Shapiro-Wilk test and the parametric - Student t test were performed at a significance level of 0.05.

RESULTS

Analysis was conducted from the results of 16 cadavers dissected. Most of the cadavers were male (75%), where 12 were male and 4 were female. The average age was 35 years (range, 20-64 years). The cadavers were mainly African-American (10; 62.5%), while 5 (31.3%) were “pardo” (mixed races) and 1 was white (6.3%). The mean graft length was 22.8 mm (range, 18-25.53 mm) and the mean graft width was 4.17 mm (range, 3-5 mm).

Results for the 5 cadavers of group 1 (pilot study) showed that the values of basilar nasal width and interalar width were increased after rhinoplasty without statistical significance ($P = .144$ and $P = .355$), and the columella-nasal tip height values were significantly higher ($P = .013$) than before rhinoplasty (Table 1).
For the 11 cadavers (group 2), the basilar nasal width and the columella-nasal tip height values were significantly higher (respectively, \( P = .001 \) and \( P = .003 \)) after lateral crural strut graft while the interalar width and the nostril’s width were not increased (Table 2).

Nostril-cross sectional area was analyzed as 22 independent areas, as a sum of 11 right areas and 11 left areas, showing higher statistically significant values (\( P = .014 \)) after lateral crural strut graft (Table 3).

The evaluation of all 16 cadavers (group 3) showed that basilar nasal width and the columella-nasal tip height presented higher statistically significant values (\( P < .001 \) and \( P < .001 \)), and the interalar width had increased without statistical significance (Table 4).

**DISCUSSION**

The lateral crus begins at the domal junction of the middle crus and ends at the junction with the accessory cartilage. Its cephalic border maintains a fibrous scroll junction with the upper lateral cartilage, and its caudal border usually is parallel with the nostril rim. Lateral crus can present smooth, convex, concave, or mixed shapes. It is covered by the nasal SMAS and the underlying mucosa.5

Cartilage grafts can increase tip projection, alter nostril contour, increase lobular volume, impart a different ethnic character, and enlarge the nasal base. Also they are essential to reinforce the lateral crus when employed along with tip suturing techniques in the correction of malpositioned,

**Table 1. Statistical Analysis of Group 1**

<table>
<thead>
<tr>
<th>Variables - Group 1 (5 cadavers)</th>
<th>Preoperative Rhinoplasty</th>
<th>Postoperative Rhinoplasty</th>
<th>Difference</th>
<th>Confidence Interval 95%</th>
<th>( P )-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basilar nasal width (mm)</td>
<td>37.12 ± 5.32</td>
<td>38.41 ± 5.32</td>
<td>1.28</td>
<td>(−0.68-3.25)</td>
<td>0.144</td>
</tr>
<tr>
<td>Interalar width (mm)</td>
<td>28.09 ± 5.21</td>
<td>28.59 ± 4.79</td>
<td>0.5</td>
<td>(−0.83-1.82)</td>
<td>0.355</td>
</tr>
<tr>
<td>Columella-nasal tip height (mm)</td>
<td>20.77 ± 2.33</td>
<td>24.02 ± 2.52</td>
<td>3.25</td>
<td>(1.15-5.36)</td>
<td>0.013</td>
</tr>
</tbody>
</table>

**Table 2. Statistical Analysis of Group 2**

<table>
<thead>
<tr>
<th>Variables - Group 2 (11 cadavers)</th>
<th>Preoperative Rhinoplasty</th>
<th>Postoperative Rhinoplasty</th>
<th>Difference</th>
<th>Confidence Interval 95%</th>
<th>( P )-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basilar nasal width (mm)</td>
<td>40.61 ± 4.24</td>
<td>42.86 ± 3.91</td>
<td>2.24</td>
<td>(1.24-3.25)</td>
<td>0.001</td>
</tr>
<tr>
<td>Interalar width (mm)</td>
<td>32.37 ± 4.01</td>
<td>32.31 ± 3.97</td>
<td>−0.06</td>
<td>(−0.84-0.72)</td>
<td>0.871</td>
</tr>
<tr>
<td>Columella-nasal tip height (mm)</td>
<td>19.37 ± 1.87</td>
<td>22.00 ± 3.32</td>
<td>2.63</td>
<td>(1.12-4.14)</td>
<td>0.003</td>
</tr>
<tr>
<td>Left nostril’s width (mm)</td>
<td>14.94 ± 1.71</td>
<td>14.41 ± 2.27</td>
<td>−0.52</td>
<td>(−1.32-0.27)</td>
<td>0.174</td>
</tr>
<tr>
<td>Right nostril’s width (mm)</td>
<td>15.17 ± 2.42</td>
<td>14.95 ± 2.84</td>
<td>−0.22</td>
<td>(−0.99-0.55)</td>
<td>0.537</td>
</tr>
<tr>
<td>Nostril cross-sectional area - left nostril (mm²)</td>
<td>69.81 ± 21.92</td>
<td>75.82 ± 20.55</td>
<td>6</td>
<td>(−2.22-14.22)</td>
<td>0.135</td>
</tr>
<tr>
<td>Nostril cross-sectional area - right nostril (mm²)</td>
<td>75.82 ± 23.05</td>
<td>83.22 ± 25.27</td>
<td>7.4</td>
<td>(−0.53-15.34)</td>
<td>0.064</td>
</tr>
</tbody>
</table>
weak, and concave lower lateral crus to prevent external valve dysfunction.\textsuperscript{12,13}

Lateral crural strut graft can reshape, reposition, and reconstruct the lateral crus while providing support for the external valve. It can be applied for prevention and correction of alar deformities, correction of malpositioned lateral crura and alar rim retraction, prevention of alar rim collapse, and treatment of concave lateral crura resulting in nasal valve incompetency. The lateral crural strut grafts will stiffen the lateral crura and minimize the degree of buckling and lateral convexity of the lateral crus seen after placement of the dome sutures.\textsuperscript{14-17}

The technique was conducted is a similar manner as described by Gunter. To achieve the results for using only lateral crural strut grafts in rhinoplasty, we used cadavers because rhinoplasty in patients is a dynamic surgery and usually involves many techniques. As a limitation, studies in cadavers differ from that of patients because of the rigidity of the specimen and method of preservation. It is possible that configuration of the lateral crura were altered after dissection and detachment of the ligaments. Our study cannot determine with certainty whether would be any discrepancy in the variables values if it was conducted with patients in a clinical setting. Besides, we used standard measurements for all cadavers, and African-American may present alar malposition when compared with another ethnicity.\textsuperscript{18-22}

All variables underwent statistical analysis. Nostril width and interalar width had values were raised independently without statistical significance. The basilar nasal width values were significantly higher in group 2 and 3, respectively, in 11 and 16 cadavers. This occurred because after placement of the lateral crural strut grafts, the alar tended to flare, changing the alar base. So, the nose of patients should be assessed from each view, with particular attention to the profile and basal views. The nose may require resection of the alar base to account for the new soft tissue excess. If not addressed, alar excess or flaring can compromise an otherwise good result. Reduction of the alar base, while not altering the absolute tip position, will influence the

Table 3. Statistical Analysis (Nostril Cross-sectional Area) of Group 2

<table>
<thead>
<tr>
<th>Variables - Group 2</th>
<th>Pre-rhinoplasty</th>
<th>Post-rhinoplasty</th>
<th>Difference</th>
<th>Confidence Interval 95%</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nostril cross-sectional area (mm\textsuperscript{2})</td>
<td>72.81 ± 22.16</td>
<td>79.52 ± 22.80</td>
<td>6.70</td>
<td>(1.49-11.92)</td>
<td>0.014</td>
</tr>
</tbody>
</table>

Table 4. Statistical Analysis of Group 3

<table>
<thead>
<tr>
<th>Variables - Group 3</th>
<th>Pre-rhinoplasty</th>
<th>Post-rhinoplasty</th>
<th>Difference</th>
<th>Confidence Interval 95%</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basilar nasal width (mm)</td>
<td>39.52 ± 4.72</td>
<td>41.47 ± 4.72</td>
<td>1.94</td>
<td>(1.13-2.76)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Interalar width (mm)</td>
<td>31.04 ± 4.71</td>
<td>31.15 ± 4.45</td>
<td>0.12</td>
<td>(−0.49-0.72)</td>
<td>0.688</td>
</tr>
<tr>
<td>Columella-nasal tip height (mm)</td>
<td>19.81 ± 2.06</td>
<td>22.63 ± 3.16</td>
<td>2.83</td>
<td>(1.73-3.92)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Figure 8. Inferior segment of the external nasal valve (highlighted areas) from the basal view as demonstrated on a 23-year-old male cadaver.
overall balance of the nose with regard to projection proportions.\textsuperscript{23,24}

The columella-nasal tip height represents the nasal tip projection. Measured values were significantly higher after rhinoplasty in all groups (pilot study, 11 and 16 cadavers). Lateral crural strut grafts reshaped and repositioned the lateral crus, stiffening it, increasing the tip projection and improving nasal tip shape with aesthetical benefit.\textsuperscript{25-28}

The nostril cross-sectional area is intimately related to external valve functionality. It represents the inferior segment of the external nasal valve (Figure 8). External nasal valve collapse can be corrected by placing structural grafts into the alar lobule to provide support and prevent collapse. Lateral crural strut grafts reinforced the lateral crus, providing support to the external nasal valve. Nostril cross-sectional area was analyzed only in group 2. Values of 22 areas from 11 cadavers were significantly higher after lateral crural strut grafts placement. We could not prove lateral crural strut graft prevented collapse for it was an anatomical study, but after improving nostril cross-sectional area, it may increase nasal airflow.\textsuperscript{29-33}

Lateral crural strut grafts reshape and contour the lateral crus, flattening it (Figure 1). After rhinoplasty, the lateral crura lost their convex and concave shapes, assuming the flat form of the lateral crural strut graft. In the front and profile view, this brought aesthetic improvement (Figures 9 and 10).\textsuperscript{1,2,4,6}

The study improved the knowledge about the lateral crural strut graft, and contributed to evidence the consequences after its use, objectively and statistically. It helps to understand the indications and it may extend the clinical applications for using lateral crural strut grafts, not only correcting the insufficient external nasal valve, but also correcting tip deformities, convex crura shape, and improving tip projection.

**CONCLUSION**

Lateral crural strut graft is a versatile technique with many clinical applications. It improves external nasal valve by increasing the nostril cross-sectional area and stiffening the lateral crus. It increases tip projection and flattens the lateral crus, resulting in aesthetic improvement. However, it can increase basilar nasal width and may demand reduction of the alar base.

**Disclosures**

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.
Funding
The authors received no financial support for the research, authorship, and publication of this article.

REFERENCES