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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.

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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.

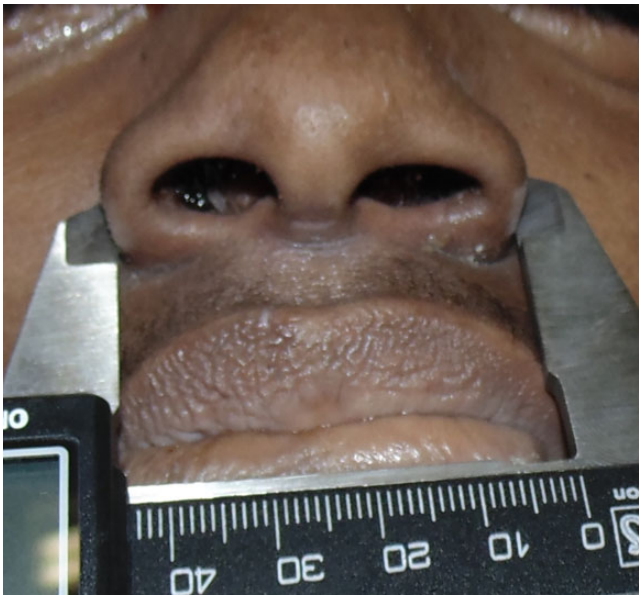

Figure 2. Basilar nasal width as demonstrated on a 23-year-old male cadaver.

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.

Figure 5. Columella-nasal tip height as demonstrated on a 20-year-old male cadaver.

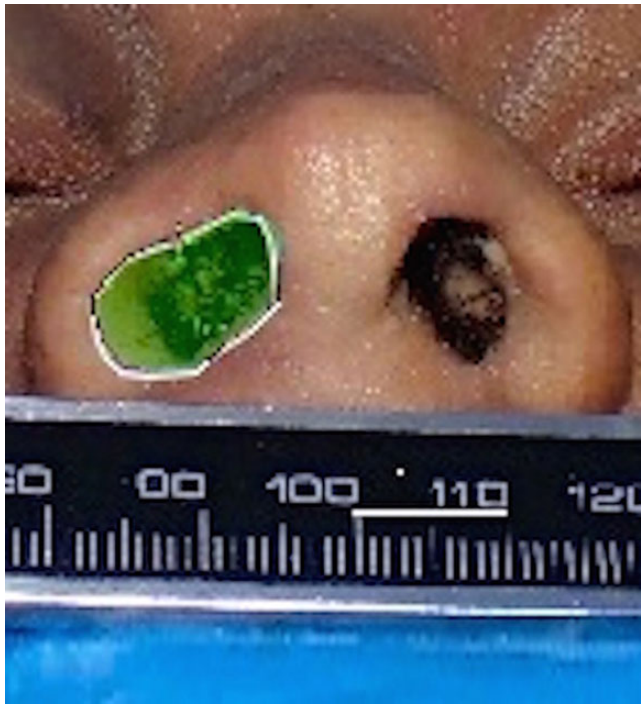

Figure 6. Nostril cross-sectional area from the basal view (shaded area) as demonstrated on a 20-year-old male cadaver. White line length in caliper: 1 cm.

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).

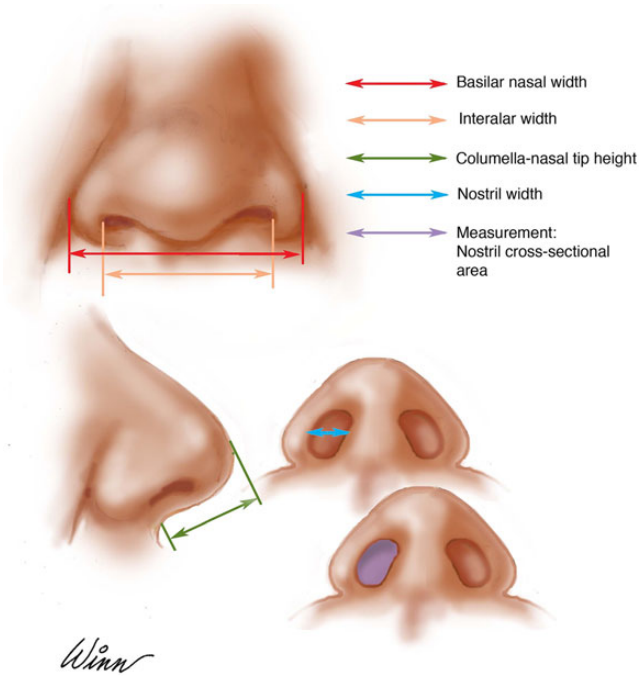

Figure 7. Illustration demonstrating the measurements shown in Figures 2-6.

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

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

Table 2. Statistical Analysis of Group 2

Variables - Group 2 (11 cadavers)	Preoperative Rhinoplasty	Postoperative Rhinoplasty	Difference	Confidence Interval 95%	*P*-values
Basilar nasal width (mm)	40.61 ± 4.24	42.86 ± 3.91	2.24	(1.24-3.25)	0.001
Interalar width (mm)	32.37 ± 4.01	32.31 ± 3.97	−0.06	(-0.84-0.72)	0.871
Columella-nasal tip height (mm)	19.37 ± 1.87	22.00 ± 3.32	2.63	(1.12-4.14)	0.003
Left nostril's width (mm)	14.94 ± 1.71	14.41 ± 2.27	−0.52	(−1.32-0.27)	0.174
Right nostril's width (mm)	15.17 ± 2.42	14.95 ± 2.84	−0.22	(−0.99-0.55)	0.537
Nostril cross-sectional area - left nostril (mm^2)	69.81 ± 21.92	75.82 ± 20.55	6	(−2.22-14.22)	0.135
Nostril cross-sectional area - right nostril (mm^2)	75.82 ± 23.05	83.22 ± 25.27	7.4	(−0.53-15.34)	0.064

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

Group 2 (11 cadavers / 22 cross-sectional areas)	Pre-rhinoplasty	Post-rhinoplasty	Difference	Confidence Interval 95%	*P*-value
Nostril cross-sectional area (mm^2)	72.81 ± 22.16	79.52 ± 22.80	6.70	(1.49-11.92)	0.014

Table 4. Statistical Analysis of Group 3

Variables - Group 3 (16 cadavers)	Pre-rhinoplasty	Post-rhinoplasty	Difference	Confidence Interval 95%	*P*-values
Basilar nasal width (mm)	39.52 ± 4.72	41.47 ± 4.72	1.94	(1.13-2.76)	<0.001
Interalar width (mm)	31.04 ± 4.71	31.15 ± 4.45	0.12	(−0.49-0.72)	0.688
Columella-nasal tip height (mm)	19.81 ± 2.06	22.63 ± 3.16	2.83	(1.73-3.92)	<0.001

weak, and concave lower lateral crus to prevent external valve dysfunction.[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.[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.[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

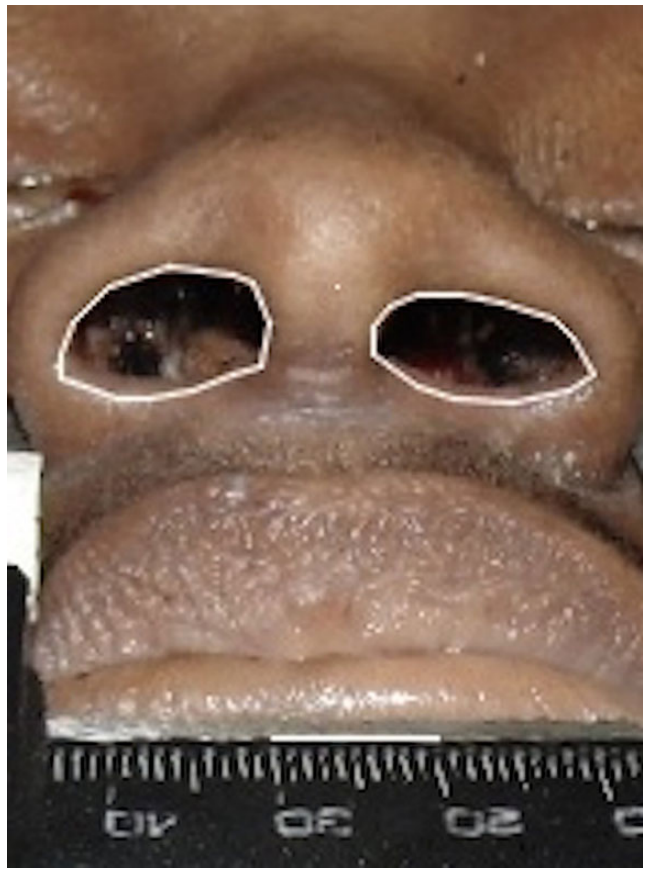

Figure 8. Inferior segment of the external nasal valve (highlighted areas) from the basal view as demonstrated on a 23-year-old male cadaver.

Figure 9. Convex lateral crus shape before rhinoplasty from the profile view as demonstrated on a 20-year-old male cadaver.

Figure 10. Flattening of the lateral crus after lateral crural strut graft from the profile view as demonstrated on a 20-year-old male cadaver.

overall balance of the nose with regard to projection proportions.[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.[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.[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).[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 aesthetical improvement. However, it can increase basilar nasal width and may demand reduction of the alar base.

Disclosures

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REFERENCES

1. Gunter JP, Friedman RM. Lateral crural strut graft: Technique and clinical applications in rhinoplasty. *Plast Reconstr Surg*. 1997;99:943-952.
2. Gunter JP, Landecker A, Cochran CS. Frequently used grafts in rhinoplasty: Nomenclature and analysis. *Plast Reconstr Surg*. 2006;118:14e-29e.
3. Pochat VD, Alonso N, Figueredo A, Ribeiro EB, Mendes RR, Meneses JV. The role of septal cartilage in rhinoplasty: cadaveric analysis and assessment of graft selection. *Aesthet Surg J*. 2011;31:891-896.
4. Daniel RK. *Mastering Rhinoplasty*. 2nd ed. Heidelberg, Germany: Springer; 2010.
5. Daniel RK, Palhazi P, Gerbault O, Kosins AM. Rhinoplasty: the lateral crura-alar ring. *Aesthet Surg J*. 2014;34(4):526-537.
6. Rohrich RJ, Raniere J Jr, Ha RY. The alar contour graft: correction and prevention of alar rim deformities in rhinoplasty. *Plast Reconstr Surg*. 2002;109:2495-2505.
7. Sajjadian A, Guyuron B. Primary rhinoplasty. *Aesthet Surg J*. 2010;30:527-539.
8. Kosins AM, Daniel RK, Sajjadian A, Helms J. Rhinoplasty: congenital deficiencies of the alar cartilages. *Aesthet Surg J*. 2013;33:799-808.
9. Kuran I, Oreroğlu AR. The sandwiched lateral crural reinforcement graft: a novel technique for lateral crus reinforcement in rhinoplasty. *Aesthet Surg J*. 2014;34(3):383-393.
10. Gunter JP, Yu YL. The tripod concept for correcting nasal tip cartilages. *Aesthet Surg J*. 2004;24:257-260.
11. Dayan SH, Arkins JP. The endonasal lateral crural underlay and sandwich grafts. Aesthet Surg J. 2011;31(1):30-39.
12. Constantian MB. Elaboration of an alternative, segmental, cartilage-sparing tip graft technique: Experience in 405 cases. *Plast Reconstr Surg*. 1999;103:237-253.
13. Daniel RK. Tip refinement grafts: The designer tip. *Aesthet Surg J*. 2009;29:528-537.
14. Janis J, Trussler A, Ghavami A, Marin V, Rohrich RJ, Gunter JP. Lower lateral crural turnover flap in open rhinoplasty. *Plast Reconstr Surg*. 2009;123:1830-1841.
15. Toriumi DM. Structure approach to primary rhinoplasty. *Aesthet Surg J*. 2002;22:72-84.
16. Toriumi DM. New concepts in nasal tip contouring. *Arch Facial Plast Surg*. 2006;8:156-186.
17. Gruber RP, Nahai F, Bogdan MA, Friedman GD. Changing the convexity and concavity of nasal cartilages and cartilage grafts with horizontal mattress sutures: part II. Clinical results. *Plast Reconstr Surg*. 2005;115(2):595-606; discussion 607-608.
18. Anari S, El Badawey MR, Carrie S. Accuracy of predissection assessment of the lower lateral cartilage configuration: a cadaveric study. *Aesthet Surg J*. 2010;30(1):36-38.
19. Gruber RP. "Commentary on: Anatomic and Anthropometric Analysis of 72 Lower Lateral Nasal Cartilages From Fresh Persian (Iranian) Cadavers". *Aesthet Surg J*. 2012;32(4);454-455.
20. Gruber RP, Weintraub J, Pomerantz J. Suture techniques for the nasal tip. *Aesthet Surg J*. 2008;28:92-100.
21. Farahvash MR, Ebrahimi A, Farahvash B, Farahvash Y. Anatomic and anthropometric analysis of 72 lower lateral nasal cartilages from fresh Persian (Iranian) cadavers. *Aesthet Surg J*. 2012;32:447-453.
22. Sazgar AA, Woodard C, Most SP. Preservation of the nasal valve area with a lateral crural hinged flap: a cadaveric study. *Aesthetic Plast Surg*. 2012;36:244-247.
23. Swartout B, Toriumi DM. Rhinoplasty. *Curr Opin Otolaryngol Head Neck Surg*. 2007;15:219-227.
24. Lee MR, Geissler P, Cochran S, Gunter JP, Rohrich RJ. Decreasing nasal tip projection in rhinoplasty. *Plast Reconstr Surg*. 2014;134:41e-49e.
25. Guyuron B, Ghavami A, Wishnek SM. Components of the short nostril. Plast Reconstr Surg. 2005;116:1517-1524.
26. Sajjadian A, Guyuron B. An algorithm for treatment of the drooping nose. *Aesthet Surg J*. 2009;29:199-208.
27. Tellioglu AT, Cimen K. Turn-in folding of the cephalic portion of the lateral crus to support the alar rim in rhinoplasty. *Aesthetic Plastic Surg*. 2007;31:306-310.
28. Silver WE, Zuliani GF. Management of the overprojected nose and ptotic nasal tip. *Aesthet Surg J*. 2009;29:253-258.
29. Toriumi DM, Josen J, Weinberger M, Tardy ME Jr. Use of alar batten grafts for correction of nasal valve collapse. *Arch Otolaryngol Head Neck Surg*. 1997;123:802-808.
30. Wulkan M, Sá AJ, Alonso N. Modified technique to increase nostril cross-sectional area after using rib and septal cartilage graft over alar nasal cartilages. *Acta Cir Bras*. 2012;27(10):713-719.
31. Lee MR, Tabbal G, Kurkjian TJ, Roostaeian J, Rohrich RJ. Classifying deformities of the columella base in rhinoplasty. *Plast Reconstr Surg*. 2014;133:464e-470e.
32. Cervelli V, Spallone D, Bottini JD, et al. Alar batten cartilage graft: Treatment of internal and external nasal valve collapse. *Aesthet Plast Surg*. 2009;33:625-634.
33. Amali A, Sazgar AA, Jafari M. Assessment of Nasal Function After Tip Surgery With a Cephalic Hinged Flap of the Lateral Crura: A Randomized Clinical Trial. *Aesthet Surg J*. 2014;34(5):687-695.