

Original Investigation

Costal Cartilage Lateral Crural Strut Graft vs Cephalic Crural Turn-in for Correction of External Valve Dysfunction

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← Invited Commentary

IMPORTANCE External nasal valve dysfunction (EVD) is a common cause of nasal obstruction.

OBJECTIVE To evaluate costal cartilage lateral crural strut grafts vs cephalic crural turn-in to support the weak lateral crus in patients with EVD.

DESIGN, SETTING, AND PARTICIPANTS In this prospective cohort study, patients with clinically diagnosed EVD were assessed at the Tertiary Rhinologic Center and underwent a costal cartilage underlay graft to the lateral crus or a cephalic turn-in cruralplasty.

MAIN OUTCOMES AND MEASURES Assessment of patient benefit was based on 22-Item Sinonasal Outcome Test (SNOT-22) and Nasal Obstruction Symptom Evaluation Scale (NOSE) scores. A Likert scale was also used to assess overall function and cosmesis. Objective assessment included postdecongestion nasal peak inspiratory flow, nasal airway resistance, and minimum cross-sectional area.

RESULTS Forty-one patients (mean [SD] 35.38 [12.73] years of age; 25 [61%] female) were assessed. Cephalic turn-in maneuver was used for 25 (61%) patients; costal cartilage lateral crural strut grafts, 16 (39%) patients. Costal cartilage grafts were used in patients undergoing revision but other baseline data were similar. Follow-up was mean 10.58 (7.52) months. All patients had significantly improved visual analog scale, SNOT-22, NOSE, patient-reported function, and cosmesis scores. The only objective test that improved was nasal peak inspiratory flow (114.76 [60.48] L/min vs 126.46 [61.17] L/min; $P = .02$).

CONCLUSIONS AND RELEVANCE Both techniques were effective in improving patient-reported outcomes and nasal peak inspiratory flow. Both are functionally and cosmetically viable options for correction of EVD.

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The nasal valve is the narrowest point for airflow. First described 1903, it is divided into an internal nasal valve (INV) and an external nasal valve (ENV). The ENV, anterior to the INV, is bound medially by the caudal nasal septum and medial crus of the lower lateral cartilage and laterally by the lateral crus of the lower lateral cartilage and the fibrofatty tissue of the alar rim. The floor of the ENV consists of the nasal sill. In a normal physiological state, the INV is the site of greatest airway resistance. The diameter of the nasal cavity is the most important variable in determining nasal airflow, explained by Poiseuille's Law [$Q = \pi Pr^4/8\eta l$], as minor radius decreases can have a large effect on flow. Additionally, acceleration of air through the ENV results in a decrease in intranasal pressure; a phenomenon described by Bernoulli.¹ The

inward force generated by this pressure gradient is balanced by the supporting cartilaginous and fibrous components, maintaining patency of the ENV and allowing air entry into the nose. In cases of ENV dysfunction (EVD), the ENV becomes the restriction point, and the lateral structures are directly held only by the strength of the cartilage and indirectly held by ligamentous attachments to the piriform aperture. External nasal valve dysfunction results when the ENV is narrower and obstructs normal nasal airflow. Reduced airflow leads to symptoms such as congestion, pressure, and fullness in the nose. Classification of EVD may be static or dynamic. Static ENV stenosis causes a constant obstruction that results from a greater intranasal pressure being required to facilitate airflow.¹ Dynamic ENV collapse causes more noticeable obstructive symp-

Figure 1. Lateral Crural Cephalic Turn-in Maneuver



Figure 2. Lateral Crural Underlay Strut Graft Using Costal Cartilage



toms on inspiration at lower transmural pressures.² These 2 types of dysfunction are not mutually exclusive; the narrower ENV at baseline may produce a greater Bernoulli effect, which results in ENV collapse. Surgery to correct EVD aims to overcome the intranasal pressure changes and prevent nasal obstruction. Techniques may vary widely but typically either increase rigidity and/or diameter.^{3,4}

The aim of this study was to evaluate the effectiveness of 2 commonly employed techniques of correcting EVD: cephalic crural turn-in maneuver and costal cartilage lateral crural strut grafts.

Methods

A clinical surgical cohort was studied. Patients complaining of nasal obstruction and with clinically diagnosed EVD who were undergoing functional reconstructive rhinoplasty were recruited. The diagnosis of EVD free of rhinitis symptoms or lack of relief of obstruction to intranasal corticosteroid was made clinically by the patients' clinical history along with an endoscopy and/or anterior rhinoscopy that demonstrated a medi-

ally displaced lateral crus with dynamic collapse on mild to moderate inspiratory effort.⁵ Patients underwent either a lateral crural cephalic turn-in alone (Figure 1) or a lateral crural underlay strut graft using costal cartilage surgery (Figure 2). All surgical interventions were performed by a single surgeon (G.N.M.) and the technique was chosen on clinical grounds and surgeon preference.

The data was collected prospectively as part of routine care for patients undergoing rhinoplasty surgery. All patients provided written informed consent. This study was approved by the St Vincent's Hospital Human Research Ethics Committee.

Surgical Intervention

Open structured rhinoplasty for correction of clinically diagnosed EVD included concomitant correction of septal deformities⁶ and concomitant turbinoplasty.⁷ Cosmetic alteration was always an additional surgical aim.

For the patients undergoing primary surgical intervention, the lateral crura were augmented by a cephalic turn-in maneuver. The procedure requires a scoring incision made parallel to the caudal edge of the lateral crura at approximately the mid cephalic-caudal distance to allow the cephalic por-

tion to fold inwards under the caudal portion. These are then sutured together providing additional support (Figure 1).

For the patients undergoing revision, the lateral crura were augmented or replaced with underlay strut grafts using costal cartilage. Approximately 5 cm of costal cartilage was harvested from the right fifth to eighth rib, and the perichondrium was removed and used to assist in general cosmetic alteration. The harvested cartilage was remodeled and either replaced or provided underlay support to the lateral crus. The lateral crural strut grafts were designed, with some patient variability, to be 1.5 mm thick and 25 mm long with a tapered width (8 mm lateral to 3 mm medial). The lateral edge of the strut graft is inserted into a pocket formed lateral to the piriform aperture in a more caudal orientation. The medial edge lies under the domes for a full bridge of the valve (Figure 2).

Assessment of Surgical Outcome

Five tools to assess patient-perceived functional benefit, 3 objective measures of the nasal airway (in the postdecongested state), and a cosmesis score as perceived by the patient were used as assessments of the surgical outcomes. These outcomes were assessed at baseline and then again at least 6 months postoperatively.

Patient-Reported Nasal Function

Five tools were used to assess patient-perceived benefit. A visual analog scale (VAS) asked patients to rate ease of breathing on each side on a scale of 0 mm (or not blocked) to 100 mm (totally blocked). A number was then obtained from 0 to 100 for severity of nasal obstruction on each side. A 5-point Likert score was used to assess nasal obstruction from no problem (1) to problem as bad as it can be (5). Additionally, a validated Nasal Obstruction Symptom Evaluation (NOSE) Scale and a 22-Item Sinonasal Outcome Test (SNOT-22) were completed by the patient.^{8,9} A global score of nasal function was assessed on a 13-point Likert scale from -6 (terrible) to +6 (excellent), with 0 representing neither good nor bad.

Objective Assessment of Airflow

Three tools were used to assess objective parameters of nasal breathing. The tests were performed 15 minutes after 0.15 mg of oxymetazoline was applied to each nasal cavity topically. This was to ensure that the structure component of the nose was assessed on the testing day and mucosal factors were minimized. This was performed to try to decrease the contribution of vascular mucosal changes before and after surgical intervention. Collapsibility of the airway was assessed with a nasal peak inspiratory flow (NPIF), which was measured with the patient seated using an In-Check Nasal inspiratory flow meter (Clement Clarke International) with an attached anesthetic mask. A tight seal was ensured without compressing the external nares, and the patient was instructed to take a maximal forced inspiratory effort through the nose with the mouth closed. The best recorded result of 3 attempts was used, according to previous studies.¹⁰⁻¹²

Nasal airway resistance (NAR) was measured by active anterior rhinomanometry with a NR6 rhinomanometer (GM Instruments Ltd) using a fixed reference level of 150 Pa as per

international standardization of rhinomanometry.¹³ The patient was seated and allowed to rest for 15 minutes prior to testing, which was performed in a climate-controlled room. An airtight anesthetic mask was held by the patient over the nose with the nostril opposite to the testing side sealed. The patient was instructed to breathe smoothly and consistently through the nose with the mouth closed while measurements were recorded. The other side was then tested using the same method. Once both sides were tested, the entire process was repeated again until 2 consistent baseline total NAR measurements were produced.¹⁴

Minimum cross-sectional area (MCA) was measured with an A1 acoustic rhinometer (GM Instruments). Patients were seated upright and the sound tube was applied to the caudal end of the nostril with the appropriately sized nose piece. Once an airtight seal was established, the patient was instructed to breathe in and hold his or her breath. This was repeated at least 3 times until 2 consistent MCA results were obtained.¹⁵ The process was then repeated for the other side.

Assessment of Cosmesis

At baseline and 6 months, global score of nasal cosmesis was assessed by patients on a 13-point Likert scale from -6 (terrible) to 0 (neither good nor bad) to +6 (excellent).

Statistical Analysis

To perform statistical analysis SPSS version 21 (SPSS Inc, Chicago) was used. A 2-tailed paired sample *t* test was used to analyze presurgical and postsurgical values for VAS scores, NOSE scores, SNOT-22 scores, NPIF values, NAR values, and MCA values. All continuous data was assessed as parametric and expressed as mean (SD). Global function, cosmesis, and nasal obstruction scores were ordinal scores and assessed by Kendall's τ -b.

Results

Forty-one patients (21 [61%] female) with a mean (SD) age of 35.38 (12.73) years; (range, 16-62 years) were assessed preoperatively and at a minimum 6 months follow up (median, 6.90 months; range, 6-39 months). Sixteen patients underwent costal cartilage lateral crural strut grafts for correction of EVD, and twenty-five underwent cephalic crural turn-in maneuvers. Sixteen (39%) procedures were revision rhinoplasties. The mean (SD) patient body mass index (calculated as weight in kilograms divided by height in meters squared) was 22.81 (3.30); height, 168.44 (10.83) cm; and weight, 65.29 (14.54) kg.

Baseline Characteristics Between Groups

When evaluating the 2 groups at baseline, the costal cartilage lateral crural strut group was older and was made of a greater proportion of males (Table 1). The crural strut group were all undergoing revision rhinoplasty vs all primary rhinoplasty in the cephalic crural turn-in group. The VAS (left), NOSE scores, and the total NAR were higher in the crural strut group (Table 1). Nasal obstruction scores were significantly worse in the crural strut group (Kendall's τ -b = 0.011). Both global scores were

Table 1. Baseline Characteristics Between Groups

Baseline Characteristic	Procedure ^a		P Value
	Cephalic Turn-in (n = 25)	Costal Strut (n = 16)	
Age, y	32.06 (11.77)	40.57 (12.78)	.04
Women, No. (%)	19 (76)	6 (38)	.01
Revision, No. (%)	0	16 (100)	<.001
VAS			
Left	22.24 (19.84)	44.94 (23.59)	.002
Right	33.80 (25.18)	41.94 (21.45)	.29
NOSE	53.53 (20.85)	70.00 (19.05)	.02
SNOT-22	1.48 (0.73)	1.82 (0.58)	.13
NPIF, L/min	119.40 (51.97)	107.50 (73.08)	.55
NAR, Pa/cm ³ /s	0.29 (0.08)	0.40 (0.17)	.01
MCA, cm ²	1.22 (0.36)	1.10 (0.40)	.34

Abbreviations: MCA, minimum cross-sectional area; NAR, nasal airway resistance; NOSE, Nasal Obstruction Symptom Evaluation scale (0-100); NPIF, nasal peak inspiratory flow; SNOT-22, 22-Item Sinonasal Outcome Test (0-5)^{8,9}; VAS, visual analog scale (0-100).

^a Unless otherwise indicated, all values are reported as mean (SD).

Table 2. Measured Effect of Surgical Intervention for EVD^a

Measurement (n = 41)	Preoperative	Postoperative	Change	P Value
VAS				
Left	31.10 (23.88)	24.80 (25.11)	-6.29	.04
Right	36.98 (23.86)	17.27 (17.71)	-19.71	<.001
NOSE	60.00 (21.50)	29.75 (24.75)	-30.25	<.001
SNOT-22	1.61 (0.69)	0.82 (0.74)	-0.79	<.001
NPIF, L/min	114.76 (60.48)	126.46 (61.17)	11.71	.02
NAR, Pa/cm ³ /s	0.333 (0.132)	0.368 (0.149)	0.035	.20
MCA, cm ²	1.17 (0.38)	1.17 (0.36)	-0.01	.93

Abbreviations: EVD, external nasal valve dysfunction; MCA, minimum cross-sectional area; NAR, nasal airway resistance; NOSE, Nasal Obstruction Symptom Evaluation scale (0-100); NPIF, nasal peak inspiratory flow; SNOT-22, 22-Item Sinonasal Outcome Test (0-5)^{8,9}; VAS, visual analog scale (0-100).

^a Unless otherwise indicated, all values are reported as mean (SD).

Table 3. Effect of Surgical Intervention Between Groups

Measurement	Change, Mean (SD)		P Value
	Cephalic Turn-in (n = 25)	Costal Strut (n = 16)	
VAS			
Left	-8.76 (16.97)	-2.44 (21.78)	.30
Right	-20.92 (26.33)	-17.81 (26.78)	.72
NOSE	-29.73 (23.05)	-31.25 (25.33)	.84
SNOT-22	-0.78 (0.84)	-0.80 (0.81)	.93
NPIF, L/min	17.00 (34.34)	8.13 (30.33)	.40
NAR, Pa/cm ³ /s	0.08 (0.17)	-0.04 (0.16)	.03
MCA, cm ²	-0.14 (0.43)	0.21 (0.33)	.01

Abbreviations: MCA, minimum cross-sectional area; NAR, nasal airway resistance; NOSE, Nasal Obstruction Symptom Evaluation scale (0-100); NPIF, nasal peak inspiratory flow; SNOT-22, 22-Item Sinonasal Outcome Test (0-5)^{8,9}; VAS, visual analog scale (0-100).

also statistically worse in the crural strut group for function (Kendall's τ -b = 0.006) and cosmesis (Kendall's τ -b = 0.031).

Effect of Surgical Intervention for EVD

All patients had significantly improved VAS (both left and right), NOSE, SNOT-22, global function, and cosmesis scores postoperatively (Table 2). The only objective test that statistically improved was NPIF (114.76 [60.48] L/min vs 126.46 [61.17] L/min; P = .02).

Effect of Surgical Intervention Between Groups

When evaluating outcomes between the 2 techniques, statistically significant results were found in total NAR and total MCA favoring the crural strut group (Table 3). The nasal obstruc-

tion score (Kendall's τ -b P = .18) and global score for function (Kendall's τ -b P = .55) were similar between the 2 groups. Change in global cosmesis score favored the cephalic turn-in group (Kendall's τ -b P = .007). Improved cosmesis was seen in 100% of the cephalic crural turn-in group whereas 75% of the lateral crural strut group reported improvement.

Discussion

A variety of surgical options are available to improve nasal airflow in patients with EVD. The underlying pathophysiology is assumed to be resulting from weak or deficient lower lateral crura and their attachments to the piriform aperture. Surgery

to correct EVD aims to resist the negative intranasal pressure with subsequent collapse by increasing diameter, rigidity, or both.^{3,4} External valve stenosis is often a part of EVD and although the concept of widening the nasal passage to improve patency may appear to be a goal, it may also lead to undesirable cosmesis. Improved rigidity alone may potentially result in the nasal passage becoming stiffer as the primary effect of EVD surgery.¹⁶ A compromise between improving nasal function and preserving or improving cosmesis is often made when performing EVD surgery. Some patients may like an overly narrow or pinched appearance to their lower third, but this may be at the expense of function. In this study, rib or costal cartilage strut reconstruction had a lesser improvement in cosmesis but higher objective improvement in airflow (MCA and NAR). No patient was deemed to have a poor cosmetic result by the authors.

When making the structural components of the ENV more rigid, other components of the lateral nasal wall, such as the internal valve, may be affected. There is no way to isolate the effects of the interventions described, and it is highly likely that the surgical maneuvers affect components of both the internal and external valve. Murakami et al¹⁷ described the cephalic turn-in flap technique, and the need to combine this technique with other maneuvers, such as spreader grafts, has been emphasized by surgeons.¹⁸ Multiple maneuvers is commonplace in rhinoplasty surgery, as patients, especially those undergoing revision, present with a number of problems, and more than 1 surgical technique is applied. It is difficult to isolate improvements due to a single technique, an aspect of rhinoplasty research that is often acknowledged.¹⁹ In this study, the impact of correcting any residual septal deformity or revision of turbinate hypertrophy cannot be isolated. However, these patients were deemed to have EVD as their primary cause of their nasal obstruction on clinical assessment by 2 experienced rhinoplasty surgeons in line with consensus statements, and the correction of septal abnormalities and turbinate reduction was applied consistently across both groups.

Objective outcomes following surgical management of EVD have historically been lacking in the literature^{3,20} and have actually been discouraged or dismissed due to poor correlation with subjective measures.²¹ This is in contrast to patient-

reported outcomes, which have been deemed more important and correlate well with patient satisfaction.⁵ However, improvements in subjective results can align with improved airway outcomes in EVD patients with NPIF being the most robust tool to assess improvement in collapsibility.¹⁶ In this study, we found value in both subjective and some objective airflow measures. Nasal peak inspiratory flow was improved across the entire group as seen in prior study. However, it was only the revision patients in the costal strut group that demonstrated an improvement in MCA (1.10 [0.40] to 1.31 [0.39]; $P = .02$). Previous observation by us has not found that MCA improvements have been a feature of successful interventions but improved resistance to collapsibility (as defined by NPIF).¹⁶ This increase in MCA, while improving function, may come at a cosmesis compromise. The 6-month follow-up was chosen on the clinical assessment that all corrections are structurally sound by 6 months, although some soft-tissue settling may continue to occur and affect the overall results. The postoperative duration was consistent for both groups.

There was an inherent allocation bias in this study. The costal or rib struts were performed on the revision patients with both worse nasal obstruction and cosmesis. This skews the results against the costal strut group, but the results show that costal struts are at least as good even in a more difficult setting. These results are important in the decision-making process, and we now maintain a low threshold for the use of costal cartilage lateral crural strut grafts even in primary cases.

Conclusions

Cephalic crural turn-in and costal cartilage crural strut grafts to correct EVD resulted in reduced collapsibility of the airway as demonstrated by improvements in NPIF and patient-reported benefit. Costal cartilage strut grafts can increase the size of the airway and improve collapsibility but may come with a perceived cosmetic compromise for some patients. Both cephalic crural turn-in and costal cartilage crural strut grafts provide rigidity to the ENV, in primary and revision patients, respectively, and are functionally and cosmetically acceptable options for correction of EVD.

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Study concept and design: Knisely, Marcells, Harvey.
Acquisition, analysis, or interpretation of data: Barham, Knisely, Christensen, Sacks, Marcells, Harvey.

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Statistical analysis: Barham, Harvey.

Administrative, technical, or material support: Christensen, Marcells.

Study supervision: Barham, Sacks, Marcells, Harvey.

Conflict of Interest Disclosures: Dr Harvey has served on an advisory board for Schering Plough and Glaxo-Smith-Kline, previous consultant with Medtronic, Olympus and Stallergenes, speakers' bureau for Merek Sharp Dolme, and Arthrocare and has received grant support from NeilMed. No other conflicts are reported.

REFERENCES

- Lee J, White WM, Constantinides M. Surgical and nonsurgical treatments of the nasal valves. *Otolaryngol Clin North Am*. 2009;42(3):495-511.
- Lindsay RW. Disease-specific quality of life outcomes in functional rhinoplasty. *Laryngoscope*. 2012;122(7):1480-1488.
- Spielmann PM, White PS, Hussain SS. Surgical techniques for the treatment of nasal valve

collapse: a systematic review. *Laryngoscope*. 2009;119(7):1281-1290.

4. Rhee JS, Kimbell JS. The nasal valve dilemma: the narrow straw vs the weak wall. *Arch Facial Plast Surg*. 2012;14(1):9-10.

5. Rhee JS, Weaver EM, Park SS, et al. Clinical consensus statement: diagnosis and management of nasal valve compromise. *Otolaryngol Head Neck Surg*. 2010;143(1):48-59.

6. Phillips PS, Stow N, Timperley DG, et al. Functional and cosmetic outcomes of external approach septoplasty. *Am J Rhinol Allergy*. 2011;25(5):351-357.

7. Barham HPKA, Harvey RJ, Sacks R. How I do it: medial flap inferior turbinateplasty. *Am J Rhinol Allergy*. In Press.

8. Browne JP, Hopkins C, Slack R, Cano SJ. The Sino-Nasal Outcome Test (SNOT): can we make

it more clinically meaningful? *Otolaryngol Head Neck Surg.* 2007;136(5):736-741.

9. Stewart MG, Witsell DL, Smith TL, Weaver EM, Yueh B, Hannley MT. Development and validation of the Nasal Obstruction Symptom Evaluation (NOSE) scale. *Otolaryngol Head Neck Surg.* 2004;130(2):157-163.

10. Jones AS, Viani L, Phillips D, Charters P. The objective assessment of nasal patency. *Clin Otolaryngol Allied Sci.* 1991;16(2):206-211.

11. Ottaviano G, Scadding GK, Coles S, Lund VJ. Peak nasal inspiratory flow; normal range in adult population. *Rhinology.* 2006;44(1):32-35.

12. Timperley D, Srubisky A, Stow N, Marcells GN, Harvey RJ. Minimal clinically important differences in nasal peak inspiratory flow. *Rhinology.* 2011;49(1):37-40.

13. Kern EB. Committee report on standardization of rhinomanometry. *Rhinology.* 1981;19(4):231-236.

14. Suzina AH, Hamzah M, Samsudin AR. Objective assessment of nasal resistance in patients with nasal disease. *J Laryngol Otol.* 2003;117(8):609-613.

15. Roithmann R, Chapnik J, Zamel N, Barreto SM, Cole P. Acoustic rhinometric assessment of the nasal valve. *Am J Rhinol.* 1997;11(5):379-385.

16. Palesy T, Pratt E, Mrad N, Marcells GN, Harvey RJ. Airflow and patient-perceived improvement following rhinoplastic correction of external nasal valve dysfunction. *JAMA Facial Plast Surg.* 2015;17(2):131-136.

17. Murakami CS, Barrera JE, Most SP. Preserving structural integrity of the alar cartilage in aesthetic rhinoplasty using a cephalic turn-in flap. *Arch Facial Plast Surg.* 2009;11(2):126-128.

18. Apaydin F. Lateral crural turn-in flap in functional rhinoplasty. *Arch Facial Plast Surg.* 2012;14(2):93-96.

19. Zoumalan RA, Constantinides M. Subjective and objective improvement in breathing after rhinoplasty. *Arch Facial Plast Surg.* 2012;14(6):423-428.

20. Rhee JS, Arganbright JM, McMullin BT, Hannley M. Evidence supporting functional rhinoplasty or nasal valve repair: a 25-year systematic review. *Otolaryngol Head Neck Surg.* 2008;139(1):10-20.

21. Passàli D, Mezzedimi C, Passàli GC, Nuti D, Bellussi L. The role of rhinomanometry, acoustic rhinometry, and mucociliary transport time in the assessment of nasal patency. *Ear Nose Throat J.* 2000;79(5):397-400.