Aesth Plast Surg
https://doi.org/10.1007/s00266-020-01993-8



# Posterior Cephalic Soft Triangle of the Nose: Surgical Implications

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Received: 1 April 2020 / Accepted: 20 September 2020


**Abstract**

*Background* The posterior cephalic soft triangle is formed between the posterior cephalic border of the lower lateral cartilage, posterior caudal border of the upper lateral cartilage, and the caudal edge of the nasal bone. PCST is an important component of the external nasal valve which provides resistance against dynamic collapse.

*Objectives* The objective of this study was to describe the anatomy of the PCST and to demonstrate its anatomic variations, dynamic interplays, and surgical implications.

*Methods* A retrospective review was conducted of 310 primary and 42 secondary cases who underwent extended open approach rhinoplasty by the first author. The structures that create the PCST of the nose were preserved unless resection/displacement of them was absolutely necessary. Whenever an external nasal valve pathology was found, it was corrected with one or combination of the following maneuvers: triangular PCST onlay graft, caudal bone outfracture, alar rim graft, lateral crural strut graft.

*Results* Twenty-four non-consecutive cases were identified in which PCST was intraoperatively confirmed to be weak or deformed. The most common pathology in the PCST was overresection of the posterior segments of the LLC during primary surgery (54.1%), followed by en bloc medialization of the PCST (33.3%). Triangular onlay grafting of the PCST was the most common corrective surgical intervention (83.3%), followed by corrective lateralization of caudal edge of nasal bone (29.1%). External valve function has been restored in 21 (87.5%) cases.

*Conclusions* PCST of the nose is an important anatomic landmark which has esthetic and functional significance in rhinoplasty.

*Level of Evidence IV* This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

**Keywords** Crural strut graft · Lower lateral cartilage · Outfracture · Nasal valve · Soft triangle · Upper lateral cartilage

## Introductions

Four areas in the human nose are devoid of cartilage or bone between inner and outer surface layers. These structurally weak areas are sensitive to negative airway pressure and perioperative deformational forces [1].

The first one is the anterior soft triangle, which is the web of soft tissue between caudal borders of lateral and medial crura. The second one is the posterior caudal soft triangle, the triangular area between the posterior caudal border of the lateral crus and the alar rim. The third one is

This study has been presented at The Rhinoplasty Society Annual Meeting 2019 in New Orleans, LA by Arda Kucukguven (author) who received The Best Resident Paper Award (The R.K. Daniel Resident Award).

**Electronic supplementary material** The online version of this article (https://doi.org/10.1007/s00266-020-01993-8) contains supplementary material, which is available to authorized users.

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Published online: 09 October 2020

the posterior cephalic soft triangle (PCST), the primary focus of this study. The fourth one is the membranous septum which is intranasal (Fig. 1).

The posterior cephalic soft triangle is formed between the posterior cephalic border of the lower lateral cartilage (LLC), posterior caudal border of the upper lateral cartilage (ULC), and the caudal edge of the nasal bone (Fig. 2). Pyriform ligament runs within this triangular area. The surface tension of the pyriform ligament provides resistance against dynamic collapse.

The posterior cephalic soft triangle is an important component of the external nasal valve. Primary anatomic variations and secondary surgical alterations in the posterior cephalic soft triangle both have clinical implications. The purpose of this study is to explore the anatomy and functional dynamics of this region. The association between PCST-related nasal deformations and correctional surgical maneuvers was assessed.

## Clinical Implications

1. Any developmental anatomic variability that increases the surface area of the posterior cephalic soft triangle, decreases the external valve resistance. Short nasal bones, hypoplasia of the lateral crus, vertical malposition of the lateral crus, hyperconvexity of the lateral crus, hypoplasia of the posterior parts of upper lateral cartilages are the examples of such variations.
2. Surgical release or acquired attenuation of the pyriform ligament decreases the essential surface tension in this region leading to intranasal dynamic collapse.
3. Surgical alterations that increase the surface area of the posterior cephalic soft triangle decrease the external valve resistance. Cephalic trim of the LLC, caudal trim of the ULC, and caudal nasal ostectomy are the examples of such alterations (Fig. 3).

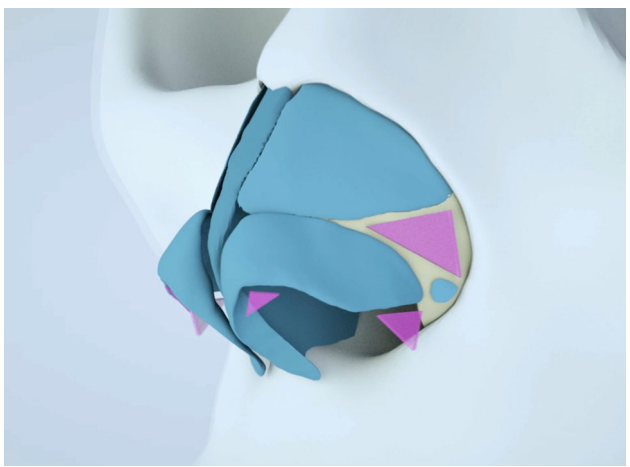

**Fig. 1** Overview of the soft triangles of the nose

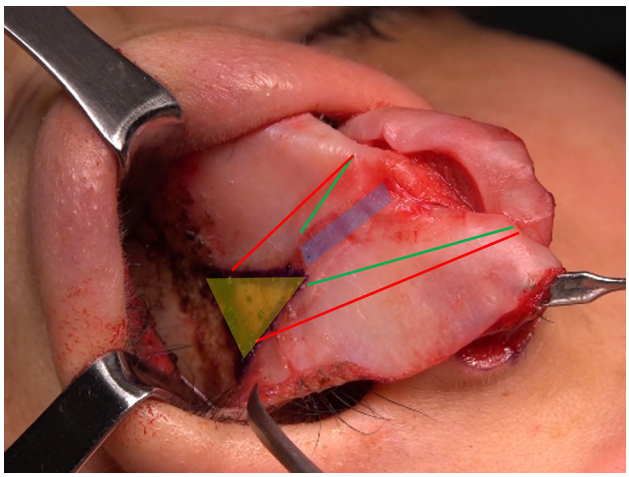

**Fig. 2** Posterior cephalic soft triangle forms between the posterior caudal edge of the upper lateral cartilage, the posterior cephalic edge of the lateral crus, and the pyriform rim. The posterior cephalic soft triangle is illustrated with a yellow transparent triangle. The scroll interface is illustrated with a blue transparent rectangle. Red resection lines should be avoided to create a larger soft triangle. Green resection lines are recommended by the authors

4. Medial displacement of the caudal edge of the nasal bone interferes with the posterior cephalic soft triangle dynamics. An intact pyriform ligament transduces the effects of bone displacement onto more mobile upper and lower cartilages by way of which the entire lateral nasal wall could become depressed (Fig. 4).

Based on these observations, the senior author (OB) favors the preservation of structures that create the posterior cephalic soft triangle of the nose *unless resection/displacement of these structures is necessary* (Fig. 5).

Likewise, we try to preserve an individualized extended caudal bony wedge, which is a significantly larger version of the classic Webster's triangle. The individualized caudal bony wedge is preserved by employing a high to low caudal osteotomy. The osteotomy is designed according to the anatomy of the posterior cephalic soft triangle in each case. It starts high at the junction of ULC and pyriform rim and goes down to the nasomaxillary buttress (Fig. 5).

If the posterior cephalic soft triangle of the nose is intraoperatively judged to be wider or weaker than its normal structure, then this area is onlay grafted with a very thin, triangular piece of cartilage to enhance its structural support (Fig. 6).

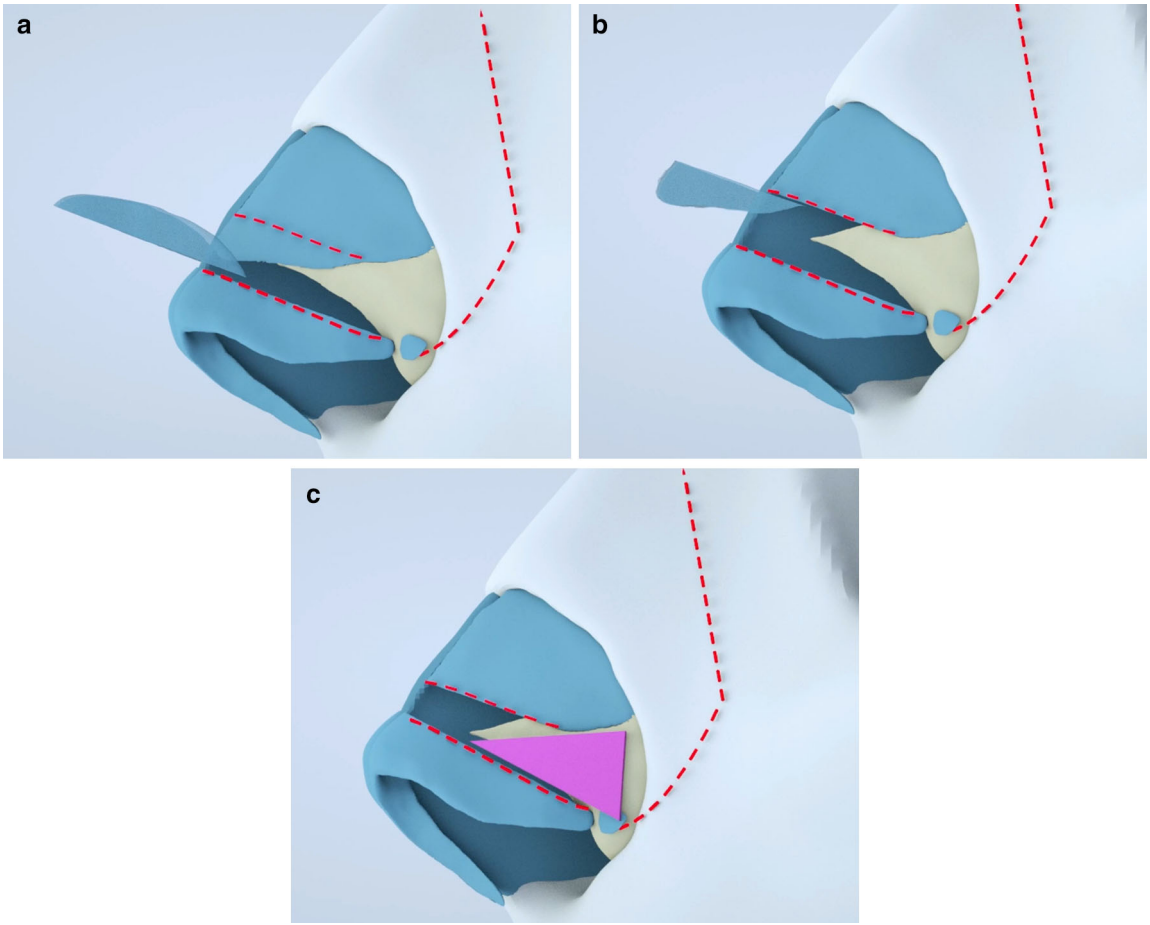


**Fig. 3** Posterior over-resection of lower lateral cartilages **a** and posterior over-resection of upper lateral cartilages **b** may create an enlarged posterior cephalic soft triangle **c**

## Materials and Methods

### Surgical Technique and Remarks *(supplemental digital content)*

The full open approach that we use in ultrasonic rhinoplasty enabled us to observe the anatomy of this region more often than before. The posterior cephalic soft triangle of the nose is the weakest area of the external nasal valve and the "niche of collapse" in some patients. A subset of these patients can even be identified preoperatively.

The posterior cephalic soft triangle is dissected in the immediate *supra*-perichondrial areolar plane. Gentle blunt sweeping is usually enough to extend and connect this plane with the immediate supra-pyriform ligament plane which is the correct dissection plane for the PCST. Lateral nasal artery and external nasal branches of the anterior ethmoidal nerve lie within the PCST in a more superficial position. Small perforating vessels usually pierce the interface between nasal bone and pyriform ligament. These vessels should be gently cauterized for a clear surgical field.

Whenever a larger than usual posterior cephalic soft triangle is found or created during surgery, the surface area of the soft segment can be decreased by using an anatomic triangular PCST onlay graft (Fig. 6).

### Patients and Indications

This study was a retrospective review of the recorded perioperative information to investigate the frequency of PCST problems that require surgical intervention. The study population consisted of 310 primary and 42 secondary open approach rhinoplasty cases performed by the first author (OB) between January 2016 and November 2018. All patients underwent extended open approach rhinoplasty with ultrasonic osteotomies were indicated. Patient data were obtained from standardized photographs, operating notes, and rhinoplasty datasheets. Photographs were obtained in compliance with previously published photographic standards in plastic surgery and mainly used

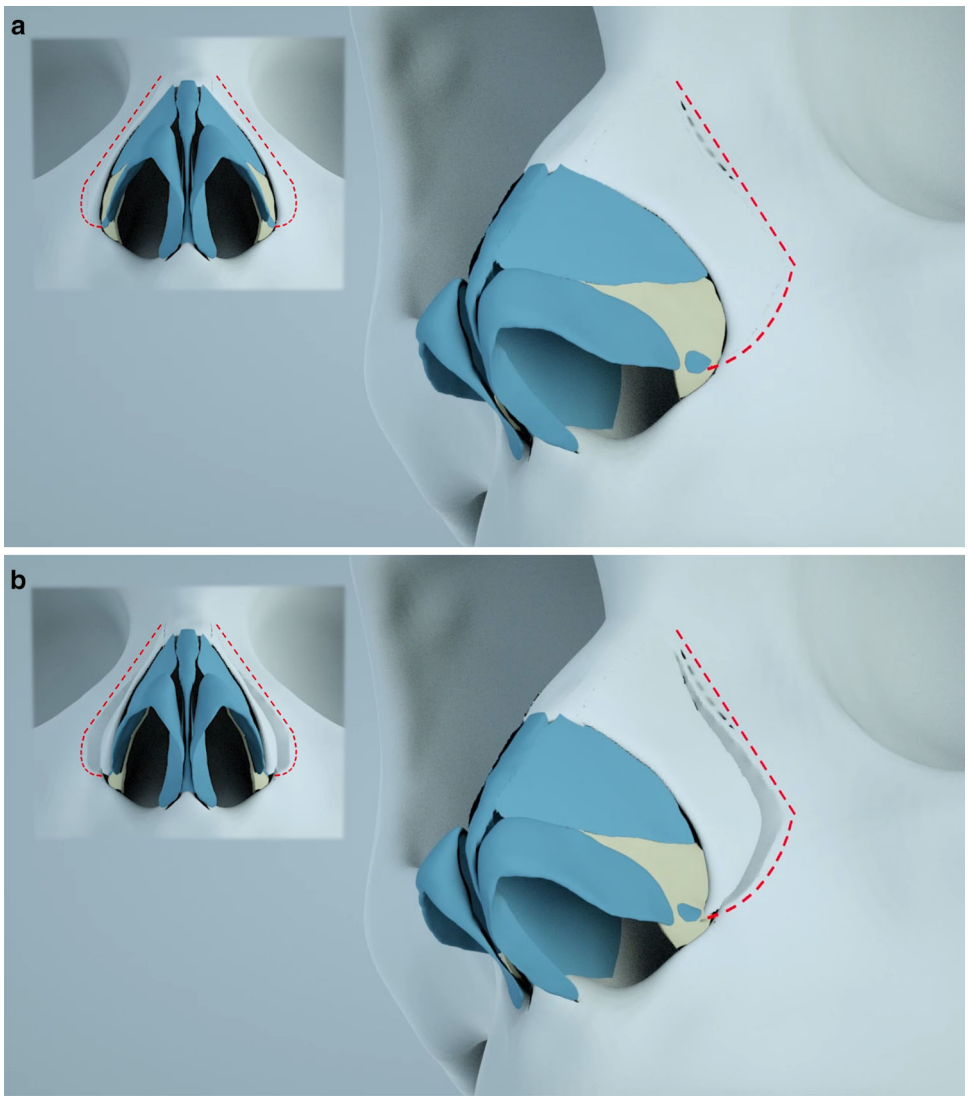


**Fig. 4** Low to low osteotomy design **a** and aggressive medialization of the bony base **b** can create en bloc medialization of the entire posterolateral nasal wall. Pyriform ligament transduces the effect of bony medialization toward the posterior edges of upper and lower lateral cartilages. This type of external valve collapse originates from bone and cannot be corrected by using lateral wall grafts alone

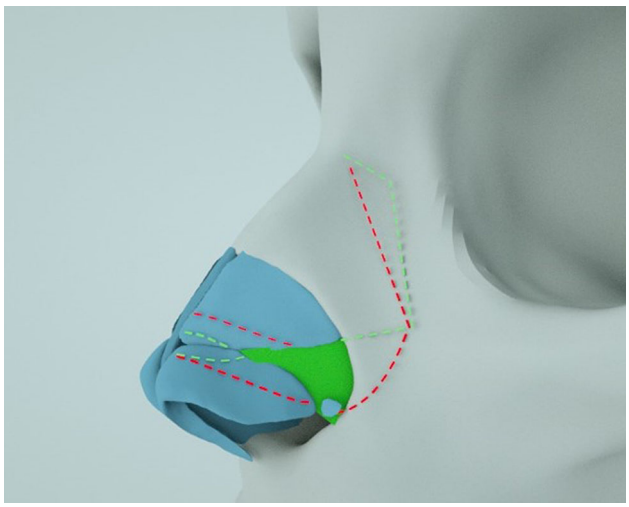

**Fig. 5** The author's recommended lines for cartilage resection and nasal osteotomy are illustrated in bright green. An extended Webster's triangle is preserved according to the anatomy of the PCST in every individual patient. Authors try to avoid red lines to preserve external valve function

to screen for static external valve/alar wall deformities [2]. Patient demographics, type of PCST deformity, and type of cartilage graft were assessed.

External valve collapse was the most important variable in this study. A patient was diagnosed with a "static" external valve collapse if there was; (1) a visible depression on the lateral nasal wall, (2) a collapsed nostril on the basal view, or (3) abnormal mucosal contact between the alar wall and nasal septum on the intranasal examination. A patient was diagnosed with a "dynamic" external valve collapse if; (1) Cottle maneuver was positive or (2) total nostril collapse was observed on the mask PNIF (peak nasal inspiratory flowmeter) below a peak flow rate of 100lt/min.

The study was conducted according to the guiding principles delineated in the declaration of Helsinki. Written informed consent was obtained from all patients.

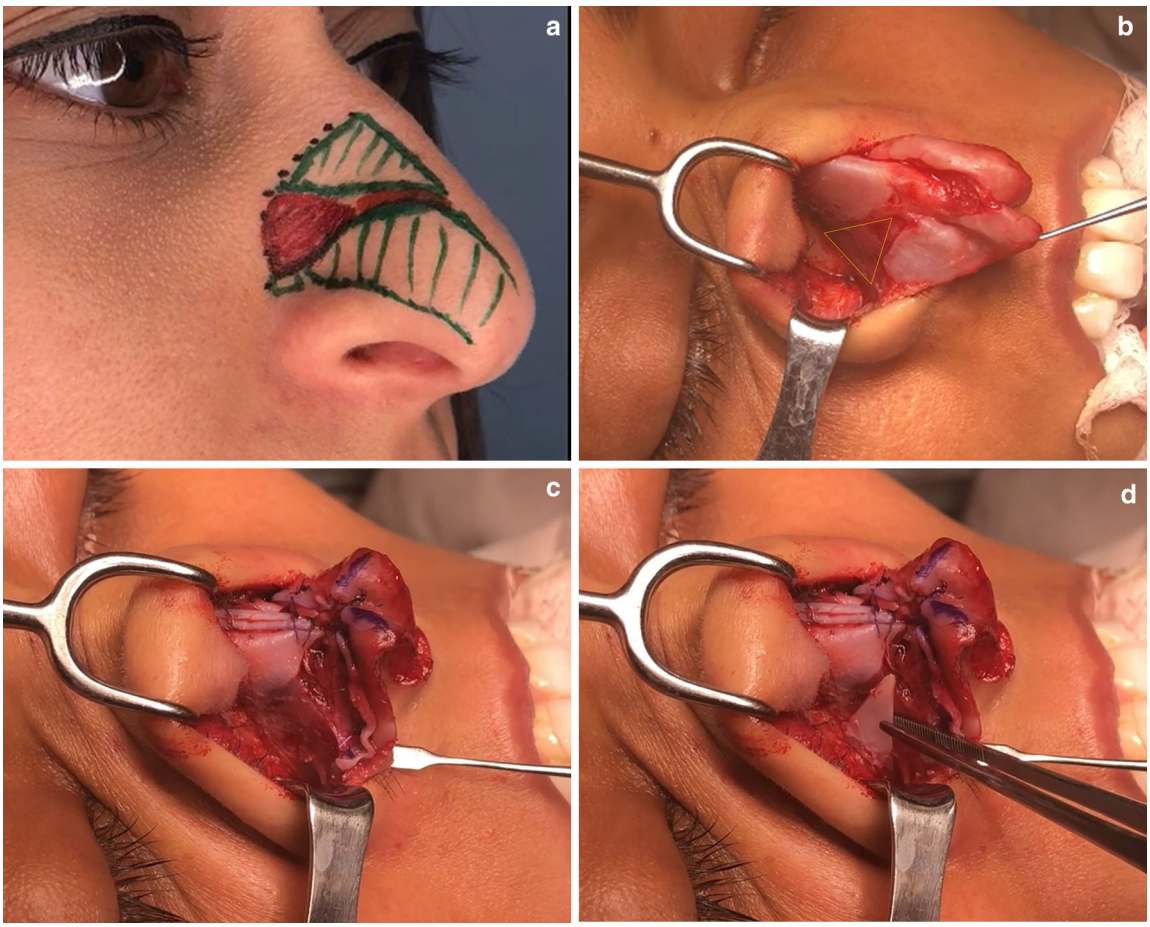


**Fig. 6** Triangular anatomic onlay grafting of the posterior cephalic soft triangle. **a** Preoperative markings of a patient with short nasal bones, short upper lateral cartilages, convex lateral crus, and a large posterior cephalic soft triangle. The amount of external valve collapse of the same patient can be seen in the supplemental digital content. **b** Intraoperative view of the same patient. The posterior cephalic soft triangle is highlighted with a yellow triangle. **c** Intraoperative view after lower lateral cartilage cephalic turn-on flap. The cephalic turn-on flap eliminates lateral crural convexity and reinforces the lateral crus but also increases the PCST surface area. **d** Anatomic triangular onlay grafting of the PCST reduces the surface area of the niche of external valve collapse

## Results

Twenty-four non-consecutive cases (6.8% of the study population) were identified (19 female, 5 male) in which PCST was intraoperatively confirmed to be weak, deformed, and surgically managed. Of these 24 cases; 6 (25%) were primary, 16 (66%) were secondary, 2 (8%) were tertiary. The median age was 26.3 years (range; 17–44 years). The median postoperative follow-up was 14 months (range; 3–37 months).

The most common pathology in the PCST was overresection of the posterior segments of LLC's during primary surgery (54.1%), followed by en bloc medialization of the PCST (33.3%). (Table 1).

Triangular onlay grafting of the posterior cephalic soft triangle was the most common corrective surgical intervention (83.3%), followed by corrective lateralization of the caudal edge of nasal bone (29.1%). Although not employed for the correction of PCST deformities, alar rim grafts (54.1%) were commonly used to address posterior *caudal* soft triangle deformities and lateral crural strut grafts (20.8%) were commonly used to address lateral crural–alar ring deficiencies. The cartilaginous nasal septum was the most common graft donor site.

Dynamic external nasal valve collapse was universally present in all 24 cases before surgery. Static lateral wall collapse was present in seven cases (29.1%) before surgery. External valve function has been restored in 21 (87.5%) cases. Three cases remained symptomatic. The reason behind failure was inadequate lateralization of the previously over-medialized and impacted caudal nasal bone during correctional surgery in two cases. Grafting the alar wall was found to be counterproductive unless the caudal bony edge is in correct anatomical position and inclination. The reason behind failure was almost total resorption of all costal cartilage grafts in one case.

**Table 1** Overview of clinical data. *LCx* Lateral Crus, *ULC* Upper Lateral Cartilage, *PCST* Posterior Cephalic Soft Triangle *ENV* External Nasal Valve

| | Age/Gender | Rhinoplasty Stage | External Nasal Valve Pathology | Corrective Surgical Intervention |
|---|---|---|---|---|
| 1 | 24 F | Primary | Short Nasal Bones | Triangular PCST Onlay Graft (Septal) |
| | | | Dynamic ENV Collapse | |
| 2 | 20 F | Primary | ULC Hypoplasia | Triangular PCST Onlay Graft (Septal) |
| | | | Dynamic and Static ENV Collapse | |
| 3 | 38 M | Secondary | Caudal Bone Medialization | Caudal bone outfracture |
| | | | Vertical Malposition LCx | Horizontal repositioning with LCx strut |
| | | | Dynamic and Static ENV Collapse | |
| 4 | 18 F | Secondary | Overresection of LCx | Triangular PCST Onlay Graft (Septal) |
| | | | Dynamic ENV Collapse | |
| 5 | 22 F | Secondary | Overresection of LCx | Caudal bone outfracture |
| | | | Caudal Bone Medialization | Triangular PCST Onlay Graft (Septal) |
| | | | Dynamic and Static ENV Collapse | Alar Rim Graft |
| 6 | 22 F | Primary | Hypoplasia of the LCx | Triangular PCST Onlay Graft (ULC kaudal trim) |
| | | | Dynamic and Static ENV Collapse | Alar rim graft |
| 7 | 25 F | Secondary | Overresection of LCx | Triangular PCST Onlay Graft (Septal) |
| | | | Overresection of ULC | Alar rim graft |
| | | | Dynamic and Static ENV Collapse | |
| 8 | 18 M | Secondary | Caudal Bone Medialization | Caudal bone outfracture |
| | | | Dynamic and Static ENV Collapse | |
| 9 | 19 F | Secondary | Caudal Nasal Ostectomy | Triangular PCST Onlay Graft (Conchal batten) |
| | | | Dynamic ENV Collapse | |
| 10 | 42 F | Secondary | Overresection of LCx | Triangular PCST Onlay Graft (Septal) |
| | | | Dynamic ENV Collapse | Alar rim graft |
| 11 | 19 F | Primary | Short Nasal Bones | Triangular PCST Onlay Graft (Septal) |
| | | | Dynamic ENV Collapse | Alar rim graft |
| 12 | 21 F | Secondary | Caudal Bone Medialization | Caudal bone outfracture |
| | | | Dynamic ENV Collapse | |
| 13 | 24 F | Secondary | Overresection of LCx | Triangular PCST Onlay Graft (Septal) |
| | | | Dynamic and Static ENV Collapse | Alar rim graft |
| 14 | 28 F | Secondary | Overresection of LCx | Triangular PCST Onlay Graft (Septal) |
| | | | Dynamic and Static ENV Collapse | LCx Strut |
| 15 | 26 M | Primary | Congenital Absence of left LCx | Reconstruction with double conchal cartilage grafts |
| | | | Dynamic and Static ENV Collapse | Alar Rim graft |
| 16 | 34 F | Secondary | Overresection of LCx | Triangular PCST Onlay Graft |
| | | | Vertical Malposition of the LCx | Horizontal repositioning with LCx Strut |
| | | | Dynamic and Static ENV Collapse | |
| 17 | 24 F | Secondary | Short Nasal Bones | Caudal bone outfracture |
| | | | En bloc medialization | Triangular PCST Onlay Graft (Septal) |
| | | | Dynamic and Static ENV Collapse | Alar Rim graft |
| 18 | 24 F | Secondary | Overresection of LCx | Caudal bone outfracture |
| | | | Caudal Bone Medialization | Triangular PCST Onlay Graft (Conchal Batten) |
| | | | Dynamic and Static ENV Collapse | |
| 19 | 31 F | Tertiary | Overresection of LCx | Triangular PCST Onlay Graft |
| | | | Overresection of ULC | LCx Strut graft |
| | | | Caudal Bone Medialization | Alar Rim graft |
| | | | Dynamic and Static ENV Collapse | Caudal bone outfracture |

**Table 1** continued

| | Age/Gender | Rhinoplasty Stage | External Nasal Valve Pathology | Corrective Surgical Intervention |
|---|---|---|---|---|
| 20 | 47 F | Secondary | Overresection of LCx | Triangular PCST Onlay Graft |
| | | | Dynamic and Static ENV Collapse | Alar Rim graft |
| 21 | 21 F | Secondary | Overresection of LCx | Triangular PCST Onlay Graft |
| | | | Dynamic ENV Collapse | Alar Rim graft |
| 22 | 28 M | Primary | Hypoplasia of the LCx | LCx Strut graft |
| | | | Dynamic and Static ENV Collapse | Triangular PCST Onlay Graft |
| 23 | 33 M | Tertiary | Overresection of LCx | Caudal Ostectomy |
| | | | Overresection of ULC | Triangular PCST Onlay Graft |
| | | | Caudal Bone Medialization | LCx Strut graft |
| | | | Dynamic and Static ENV Collapse | Alar Rim graft |
| 24 | 25 F | Secondary | Overresection of LCx | Triangular PCST Onlay Graft |
| | | | Vertical malposition of the LCx | Alar rim graft |
| | | | Dynamic and Static ENV Collapse | LCx sliding derotation |

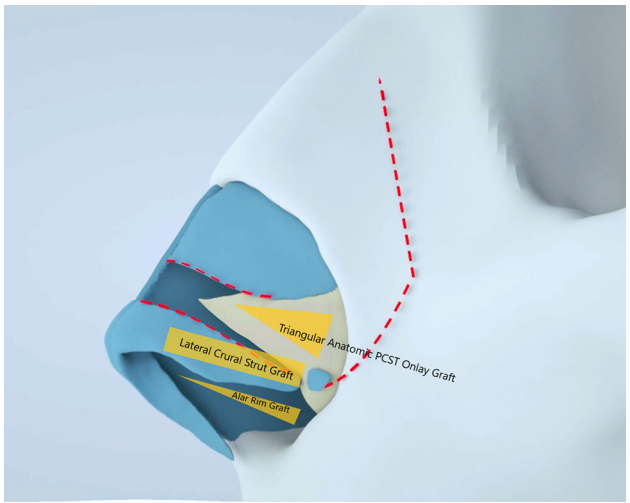


**Fig. 7** Compartments of the posterolateral nasal wall and our proposed structural grafting algorithm. An anatomic triangular onlay graft is used to decrease the excessive surface area of the posterior cephalic soft triangle. Lateral crural strut grafts are used to reinforce the remaining lateral crux. Alar rim grafts are used to reinforce the posterior caudal soft triangle. Each graft type has a specific compartment, indication, and orientation

Two patients had mild alar rim asymmetry that was corrected under local anesthesia using a unilateral alar contour graft. Although not quantified or measured, it was our observation that triangular PCST onlay grafts have lost their initial volume and strength after 3–6 months. Most septal grafts that were initially palpable, have resorbed partially over time, and eventually became softer.

## Discussion

What is the external nasal valve? What is dynamic collapse and how does it happen? Why some of our patients cannot breathe well enough despite straight septums and removed/ablated turbinates? What is the relationship between osteotomies and external nasal valve?

It is crucial to understand the surgical anatomy of the posterolateral nasal wall to answer these questions.

The external nasal valve is basically the entire posterolateral nasal wall caudal to the bone and upper lateral cartilages. The posterolateral nasal wall contains two soft triangles: posterior cephalic and posterior caudal soft triangles of the nose. Between these soft triangles, there reside the posterior parts of the lateral crus and sesamoid cartilages. These three compartments are anatomically different. Ideally, the posterior parts of the lateral crus and sesamoid cartilages are wide and strong, soft triangles are small. However, developmental and/or surgical deformities may affect each compartment creating larger soft triangles and deficient/weak posterior lateral crux.

We propose a very simple, algorithmic approach for graft selection in external valve problems based on the pathologic anatomy of the deformity.

We use a triangular anatomic onlay graft to decrease the surface area of the posterior *cephalic* soft triangle when it is too large. We use an alar rim graft to decrease the surface area of the posterior caudal soft triangle when it is too large. We use a lateral crural strut graft to support the lateral crural structure when it is weak or deficient. These three grafts can be combined based on the specific reconstructive need for every individual patient (Fig. 7).


**Fig. 8** Before and 7 months postoperative photographs of a 31 years old, female, tertiary rhinoplasty patient. Structural grafting of the posterolateral nasal wall was performed on both sides. She had right bilateral triangular anatomic PCST onlay grafts, bilateral LC strut grafts, and a right-sided alar rim graft. The external valve function was restored along with the esthetic surface landmarks of the posterolateral nasal wall

It is very important to understand that excessive medialization of the caudal nasal bone creates en bloc medialization of the posterior lateral nasal wall through its connection with the posterior cephalic soft triangle [3]. This type of deformity cannot be corrected with lateral wall grafts but can be made worse. The caudal nasal bone should be repositioned by outfracture or caudal ostectomy where necessary.

Alar batten graft is the "conventional" alternative for posterior cephalic soft triangle defects. However, it is non-anatomic. Batten grafts usually span the "area." The alar batten graft frequently onlays and camouflages the edges of upper lateral cartilage, lower lateral cartilage, or the nasal bone at some point [4, 5]. Therefore, surface esthetic landmarks are obscured [6]. The triangular anatomic onlay graft that we use rests on the pyriform ligament. It does not overlay the ULC, LLC, or caudal bony edges. The shape and dimensions of the triangular graft can be adjusted according to the pathologic anatomy.

Lateral crural strut grafts and alar rim grafts have been frequently used in our series to address external valve problems [7, 8]. We favor these grafts only in the right indication, right orientation, and the right anatomic compartment.

The anatomy of the pyriform ligament has been described previously [9]. The pyriform ligament is one of the main tensioning structures of the posterolateral nasal wall. An intact pyriform ligament transmits the bony support across the posterolateral nasal wall [10]. It also transmits the upper lateral cartilage tension across the posterolateral nasal wall [11]. Its clinical significance becomes even more important in cases where the lateral crural alar ring is weak [12]. We strongly advocate against the release of this structure in primary rhinoplasty. The surgical release of the pyriform ligament has been used to narrow the alar base [13]. The cost is moving the alar soft tissues inside the vestibule which would inevitably disrupt external valve resistance and hamper breathing [14].

We were able to achieve functional and cosmetic improvement in 87.5% of our cases. Anatomic grafting of the posterolateral nasal wall helped us preserve the surface landmarks and esthetic contours while increasing the structural support of the external nasal valve (Figs. 8, 9).

Unfortunately, external valve problems are difficult to objectively measure and display. Acoustic rhinometry or CT imaging may measure the internal volume however they fail to show the dynamic collapse. Techniques such as rhinomanometry and PNIF (peak nasal inspiratory flow)


**Fig. 9** Before and 4 months postoperative photographs of a 24 years old, female, primary rhinoplasty patient. Her preoperative and intraoperative video can be found in the supplemental digital content. She had convex and vertically malpositioned lateral crus and short nasal bones. Lateral crural convexity was corrected by using lateral crural cephalic turn-on flap, which further enlarged. She had bilateral triangular anatomic PCST onlay grafts. The external valve function was restored along with the esthetic surface landmarks of the posterolateral nasal wall

require the use of masks which act as an external splint that reduces external valve collapse. Up to date, no airway measurement technique has emerged as "the standard" for evaluating the external valve competence. Therefore, we had to rely on our clinical assessment, which is subjective.

## Conclusion

In conclusion, the posterior cephalic soft triangle of the nose is an important subunit of the external nasal valve. Anatomic variations, dynamic interplays, and surgical implications of this region should be recognized by rhinoplasty surgeons.

**Funding** The authors have no financial interest to declare in relation to the content of this article.

**Compliance with Ethical Standards**

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical Approval** All procedures in studies involving human participants were performed under ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Patient Consent** Patients provided written consent for the use of their images.

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