Current Otorhinolaryngology Reports (2021) 9:409–414
https://doi.org/10.1007/s40136-021-00372-4

RHINOLOGY: NASAL OBSTRUCTION (JV NAYAK, SECTION EDITOR)

# Management of Caudal Septal Deviation: Historic and New Techniques

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Accepted: 27 September 2021 / Published online: 9 October 2021
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## Abstract

**Purpose of Review** Septoplasty is one of the most commonly performed surgical procedures in otolaryngology. However, correction of the caudal septal deviation is the most difficult part of the septoplasty and a common cause of revision septoplasty. The aim of this paper is to review the various operative techniques described in the literature for caudal septal deviation, as well as surgical outcomes.

**Recent Findings** Many techniques, such as swinging door method, cross-hatching incision, scoring incision, septal batten graft, horizontal mattress suture, cutting and suture, crossing suture, septal cartilage traction suture, and anterior septal reconstruction have been used in managing caudal septal deviation. Each technique was used alone or in combination and reported 82 to 96.5% postoperative symptom improvement.

**Summary** There are a variety of operative techniques to correct caudal septal deviation. Both relatively simple suture techniques and more difficult techniques showed good surgical outcomes. Appropriate patient evaluation and selection of surgical techniques are important, and multiple surgical techniques may be considered simultaneously as necessary.

**Keywords** Nasal obstruction · Nasal septum · Nasal surgical procedures · Suture techniques · Patient outcome assessment · Postoperative complications

## Introduction

Septoplasty is one of the most commonly performed surgical procedures in otolaryngology [1]. It is most frequently indicated when the patient complains of partial or complete nasal obstruction caused by structurally deviated cartilaginous or bony portions of the nasal septum. However, more than 15% of patients who underwent primary septoplasty fail to relieve their symptoms [2, 3]. Recurrent nasal obstruction after septoplasty is attributed to the residual or recurrent septal deviation but also could be related to unaddressed turbinate hypertrophy, and/or nasal valve collapse [4•]. The most common sites of persistent septal deviation after septoplasty are dorsal or caudal septum [2, 5].

Caudal septal deviation is defined as deviation of the anterior portion of the nasal septum. Patients with caudal septal deviation account for 5 to 8% of patient with nasal septal deviation [6]. Caudal septal deviation is a major cause of nasal obstruction and causes significant cosmetic deformities of the nasal base. Deviated caudal septum may change the lobular and columellar shape and has a significant effect on tip position and symmetry [7]. It is difficult to correct caudal septal deviation using conventional technique of septoplasty because small residual deviation may cause severe nasal obstruction and the intrinsic memory inherent to the crooked cartilage is hard to overcome [8]. Furthermore, weakening of the caudal septum and separation from the anterior nasal spine are known to cause complications, including weakening of cartilages, overcorrection, and subsequent saddle nose deformity or tip ptosis [9].

Various surgical techniques, such as swinging door method, cross-hatching incision, scoring incision, septal batten graft, horizontal mattress suture, cutting and suture, crossing suture, septal cartilage traction suture, and anterior septal reconstruction, have been introduced for correction of caudal septal deviation [7–11, 12••, 13••]. Each technique was used alone or in combination, and postoperative

This article is part of the Topical Collection on *RHINOLOGY: Nasal Obstruction*

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symptoms were improved by 82 to 96.5% [7–11, 12••, 13••]. This article reviews the various surgical techniques and outcomes to correct caudal septal deviation described in the literature.

## Methods

A comprehensive literature review published over the past 20 years was carried out using PubMed and Google Scholar databases. A search was performed using the Medical Subject Heading terms "nasal septum/surgery" and "caudal septum." Afterward, keyword searches using the terms "suture," and "graft" and "reconstruction," were carried out to find additional articles. The search results were limited to articles in English. Related articles and citations were reviewed. Only articles published in peer-reviewed journals that were relevant to our study design, and which discussed caudal septoplasty techniques, applications, and outcomes, were selected. Personal opinions were excluded. The search resulted in 100 articles, of which 34 were considered relevant; these are discussed below.

## Surgical Technique

Given these myriad factors, traditional septoplasty methods usually prove insufficient. Therefore, several more advanced treatment strategies have been described to address caudal septal deviation successfully. Although all of these techniques have their own advantages and limitations, management of caudal septal deviation may be summarized with 2 major goals. First, the nasal obstruction should be improved through correction of the deviation. Second, repair must be done in a way such that nasal tip support is not jeopardized [14]. Regardless of which technique is selected, the same traditional septoplasty procedure applies for mild to moderate deviation of the mid or posterior septum. The different caudal septoplasty techniques and their results are discussed below (Table 1).

### Swinging Door Method

Metzenbaum was one of the first to describe a procedure for correction of the caudal septum [15]. The caudal septum is dislocated from the attachment of the anterior nasal spine by wedge resection of the excessive vertical cartilage along the maxillary crest and fixed with an absorbable suture to the periosteum on the opposite side of the nasal spine using a figure-of-eight suture [16]. This method has been modified by Pastorek and Becker, who introduced the "doorstop" technique [17]. It involves the transposition of the deviated caudal septum over the anterior nasal spine to the opposite nasal cavity without further cartilage resection. However, the septum may slip from the midline of the maxillary crest when the suture loosens or when the soft tissue stretches out, which can lead to undercorrection of the caudal septum. Furthermore, there is a possibility of saddle nose deformity when excessive resection is made.

### Cross-hatching Incision

The cross-hatching incision based on the theory of interlocked stress was demonstrated by Gibson and Davis in 1957 [18] and by Fry in 1966 [19]. Multiple crossing incisions are performed on the concave side of the septal cartilage preserving intact contralateral cartilage alignment. Although incisional technique is more conservative than cartilage wedge resection or cutting, it could be ineffective and induce cartilage weakness or overcorrection [20]. Furthermore, it is difficult to predict the effect of this technique because the eventual straightening of the septum is completed by a secondary healing process.

### Scoring Incision

A partial-thickness scoring incision is made on the concave cartilage surface, which affects the interlocked cartilaginous stress and bends the tissue to the opposite side. Because the scoring incision alone does not provide sufficient correction and the cartilage returns to its original deviation, applying 2-octylcyanoacrylate (2-OCA) tissue adhesive onto scoring incision may increase efficacy and prevent concavity recurrence [21]. The percentage of straight septum by postoperative anterior rhinoscopy and postoperative symptom score for nasal obstruction were significantly better in the scoring+OCA group than scoring alone group [21]. However, a temporary foreign body reaction characterized by septal swelling occurred in 12.5% of the scoring+OCA group [21].

### Septal Batten Graft

Batten graft has been introduced for correction caudal deviation due to the weakening of the caudal septal support. The graft is inserted submucosally on the concave side of the nasal septum and fixed to the septum to correct the curvature. Caudal septal batten grafting using septal cartilage or bone has been reported to straighten and strengthen the deviated caudal septum [4•, 9, 22]. Furthermore, several alloplastic implants have been introduced to replace autologous implants. Silicone, Gore-Tex, Medpor, and polycaprolactone are currently available and have been used with variable success rates [23]. A previous study showed a 90% of patient improvement in nasal obstruction after caudal batten graft using septal cartilage. Bony batten grafting

**Table 1** Surgical techniques for correction of caudal septal deviation

| Parameter | Scoring incision with 2-OCA [21] | Septal batten graft [9] | Horizontal mattress suture technique [24] | Cutting and suture technique [8] | Partial cutting and suture technique [26] | Crossing suture technique [12••] | Septal cart. Traction suture technique [13••] | Ant. Septal reconstruction [28] |
|---|---|---|---|---|---|---|---|---|
| **Incision type** | Hemitransfixion | Hemitransfixion | Hemitransfixion | Hemitransfixion | Hemitransfixion | Modified Killian | Modified Killian | Hemitransfixion and Open rhinoplasty |
| **Flap elevation** | Unilaterally | Bilaterally | Bilaterally | Bilaterally | Bilaterally | Unilaterally | Unilaterally | Bilaterally |
| **Resection** | Selective resection of deviated parts and boomerang-shaped cartilage excision | Selective resection of deviated parts | Selective resection of deviated parts | Selective resection of deviated parts | Selective resection of deviated area | Selective resection of deviated parts and excessive cartilage wedge excision | Selective resection of deviated parts and vertical caudal cartilage excess excision | Subtotal resection of septum |
| **Structural reinforcement** | Not specified | Yes | Not specified | When needed | Not specified | Not specified | Not specified | Yes |
| **ANS dislocation** | Not specified | When needed | Not specified | Not specified | Not specified | Not specified | Not specified | Yes |
| **Remarks** | Scoring incision with 2-OCA application | - | It is more effective when combined with cross-hatching incision | - | An incision is made obliquely at the most curved cartilage portion. Two vertical sutures in the middle and posterior portion of the L-strut and 1 horizontal suture on the overlapped septum are applied | Commencing at the convex side, 4 crossing sutures are placed and the tie is secured on the convex side | The caudal septum is tightly sutured on the incision site mucosa at two or more points | A dorsal strut of the 10 to 15 mm of septal cartilage is left attached to the keystone area |
| **Results** | VAS score decreased from 7.25 ± 1.9 to 3.10 ± 1.4 ($p$<0.001) | Mean NOSE score decreased from 70.5 to 28.7 ($p$<0.001) | Total nasal resistance decreased from 0.23 ± 0.07 Pa/cm$^3$/s to 0.13 ± 0.01 Pa/cm$^3$/s | VAS score decreased from 7.93 to 3.63 ($p$<0.001) | NOSE scale score decreased from 43.5 to 11.0 ($p$ < 0.001) and MCA increased from 0.49 to 0.65 cm$^2$ ($p$ < 0.006) | Mean NOSE score decreased from 13.46 to 3.97 ($p$ < 0.001) | VAS and NOSE scale score decreased from 7.3 ± 1.6 and 52.9 ± 26.5 to 1.4 ± 1.0 and to 5.8 ± 7.2, respectively ($p$<0.001) | VAS and NOSE score decreased from 7.2 ± 1.8 and 68.2 ± 17.4 to 2.1 ± 2.6 and to 21.1 ± 19.8, respectively ($p$<0.001) |

*ANS*, anterior nasal spine; *MCA*, minimal cross sectional area; *NOSE*, Nasal Obstruction Symptom Evaluation; *2-OCA*, 2-octylcyanoacrylate; *VAS*, visual analog scale

improved subjective nasal obstruction evaluated by the Nasal Obstruction Symptom Evaluation (NOSE) scale in all patients. On endoscopic examination, 90.8% of patients had a straight septum, and 9.2% had improved but residual caudal deviation [9]. The ratio of the convex side area to concave side area in the anterior portion of the nasal cavity on computed tomography was significantly improved after endoscopic septoplasty with a batten graft [22]. However, elevating bilateral flap, harvesting graft, and drilling bone may prolong the operation time. Furthermore, the use of the cartilage or bone on the caudal septum can make the caudal septum and nose too thick and stiff, which can be anatomically unnatural and lead to nasal obstruction [4•].

### Horizontal Mattress Suture Technique

This technique utilizes in reverse the procedure popularized by Mustarde for managing the prominent ear. The curvature of the caudal septum is straightened with a vertical force generated by the suture [24]. Subjective nasal obstruction and nasal resistance by anterior rhinomanometry improved during the 6-month follow-up [24]. It is more effective when combined with cross-hatching incision. If the cartilage is thin or weak, it is better to apply a reinforcement implant such as a batten graft. However, this technique may weaken the support of caudal septum and may lead to a high failure rate [25].

### Cutting and Suture Technique

The cutting and suture technique maintains stability between the caudal septum and maxillary crest. The most curved portion of the caudal septum is cut horizontally and reconnected with slight overlapping of the cut ends of the caudal L-strut [8]. Subjective nasal obstruction using visual analog scale (VAS) was much improved in 68% of patients, improved in 15%, and no change in 17%. Endoscopic examinations showed that 51% of patients had near-complete correction, and 47% had improved but a little persisting caudal deviation [8]. Although these techniques completely eliminate the cartilage bending memory, too much overlap or loosening of the suture may shorten the caudal septal height, resulting in a saddle nose deformity. If the stability of the overlapped cartilage is insufficient, a septal batten graft is needed to strengthen the support.

### Partial Cutting and Suture Technique

The partial cutting and suture technique are a modification of the cutting and suture technique. Partial cutting is performed horizontally, preserving 2 mm of the caudal end intact, which may prevent nasal tip lowering and make suturing easily [26]. The cut ends are overlapped, and 2 vertical sutures and 1 horizontal suture are applied in the midline. Two vertical sutures may straighten the septum with maximal overlapping of the upper and lower cut ends at the midline. The horizontal suture avoids the development of a saddle nose, as overlap at the posterior caudal cut end continues with time. The NOSE scale score and minimal cross-sectional area (MCA) on the convex side were significantly improved 3 months postoperatively. Although this technique is simple and easy to correct for caudal deviation, it is not useful if the caudal septum is displaced from the maxillary crest or is accompanied by a deviated nose.

### Crossing-suture Technique

After resection of excessive cartilage to break the intrinsic recoil memory of cartilage, crossing suture starts from the superior region of the resected margin on the convex side and then passing the needle sequentially through the septal mucosa and septal cartilage. Next, the needle is passed in the opposite direction through the vertically inferior point of the first stitch above the resected margin, from the concave to the convex side. The same procedure is repeated below the resected margin. Finally, the knot was tightened and secured to straighten the deviated caudal septum. This technique is particularly effective for C-shaped caudal deviation and may correct the curvature easily without affecting the structural stability of the septum [12••]. Although the NOSE scores improved in all patients, residual caudal deviations were noted in 40% of patients. Furthermore, the tensioned suture may induce mucosal necrosis and nasal crusting.

### Septal Cartilage Traction Suture Technique

The surplus caudal L-strut cartilage at the bottom is resected without disarticulation from the anterior nasal spine to make a flexible relationship between caudal septum and nasal spine. The needle penetrating through the ipsilateral mucosa of incision site is passed through the cartilage of the most convex part of the caudal septum and then sutured through the opposite mucosa of incision site to pull into the concave side of the nasal cavity. The advantage of this technique is that it is more anatomically stable because it preserves the L-strut, avoiding the separation of the caudal septum from the anterior nasal spine. Furthermore, it can be performed easily and confirmed immediately after this procedure. This technique significantly improved subjective symptoms measured by VAS and NOSE scale score. Minimal cross-sectional area (MCA) and nasal cavity volume in the convex side were significantly increased after surgery. Endoscopic examinations of the nasal cavity showed that this technique resulted in complete correction in 91.0% of patients at 3 months post-surgery [13••]. However, the traction suture must be done at the most curved portion of caudal septum and should hold

the caudal septum tightly to the incision site mucosa to effectively overcome the bending force of the cartilage [13••].

### Anterior Septal Reconstruction

In the severe deviations of the caudal and/or dorsal septum, extracorporeal septoplasty may be required. One drawback of traditional complete extracorporeal septoplasty, wherein the entire quadrangular cartilage is removed and replaced, is the risk of saddling or notching of the dorsum. To minimize destabilization of the keystone area and preserve dorsal support, a modified form of extracorporeal resection called "anterior septal reconstruction (ASR)" has been described [27]. ASR is designed to concomitantly address nasal obstruction and the external contour deformities. In this technique, a dorsal strut of the 10 to 15 mm of septal cartilage is left attached to the keystone area. This allows both dorsal continuity and a support structure to the ASR graft is attached [28]. There was a significant improvement in NOSE and VAS scores postoperatively [27, 28]. Examination of postoperative photographs revealed aesthetic improvements [27]. However, it is very time-consuming and needs an open rhinoplasty incision to make a new extracorporeal L-strut.

## Conclusions

Nasal septal deviation is one of the most common findings in patients with symptomatic nasal obstruction. Although standard septoplasty is sufficient to correct the curvature of the middle or posterior part of the septum, it is often inadequate in cases of severe caudal septal deviation because excessive resection of caudal septum and destabilization of the keystone area may lead to saddle nose deformity or loss of tip support. Incomplete correction of the caudal septal deviation has been known as one of the main reasons for persistent septal deviation after primary septoplasty [4•].

Many different techniques for correction of caudal septal deviation have been proposed, depending on the septal deviation characteristics and surgeon preferences. Several methods require a technique of cutting or separating the caudal septum constituting the L-strut for correction of the caudal septal deviation. Some techniques require graft materials to reinforce the structural stability of the L-strut. On the other hand, various suture techniques have the advantage of correcting the caudal septal deviation while preserving the natural junction between the caudal septum and anterior nasal spine.

Herein, many different techniques to address the caudal septal deviation have been discussed. Although each technique has its own advantages and limitations, multiple strategies may be required to correct the caudal septal deviation. Preoperative careful evaluation for caudal septal deviation characteristics and selection of the appropriate surgical techniques according to the degree and direction of deviation may lead to satisfactory outcomes without postoperative complications.

**Acknowledgements** This work was supported by the year 2021 clinical research grant from Pusan National University Hospital.

**Author Contribution** Conceptualization: Kyu-Sup Cho, writing—original draft preparation: Sung-Dong Kim

Literature search and data analysis: Sung-Dong Kim, Writing—review and editing: Kyu-Sup Cho

Supervision: Kyu-Sup Cho

### Compliance With Ethical Standards

**Conflict of Interest** Sung-Dong Kim and Kyu-Sup Cho declare that they have no conflict of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

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