Current Otorhinolaryngology Reports (2022) 10:162–166
https://doi.org/10.1007/s40136-022-00398-2

FACIAL PLASTICS: FUNCTIONAL RHINOPLASTY(TD WANG AND CZ JOHNSON, SECTION EDITORS)

Management of the Deviated Caudal Septum

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Accepted: 17 March 2022 / Published online: 12 April 2022

Abstract

Purpose This article seeks to educate the reader regarding the prevalence, importance, and techniques to address caudal septal deviation (CSD).

Recent Findings Though techniques to address caudal septal deviation have been around for years, new technology has allowed us to understand the effect of CSD on airflow through the nasal cavity. Modification of previously used surgical techniques has also allowed surgeons to treat CSD with less morbidity and more consistent results.

Summary Caudal septal deviation is a relatively common but difficult to treat cause of nasal obstruction. Roughly one century has passed since Metzenbaum published one of the first articles describing how to treat CSD. Since Metzenbaum's manuscript, numerous techniques have been described to treat CSD, most of which are effective for mild to moderate cases. For more severe cases, the extracorporeal septoplasty technique was developed and has since been refined to what we describe herein as the modified anterior septal transplant.

Keywords Anterior septal transplant · Caudal septal deviation · Extracorporeal septal transplant · Septal deviation · Septoplasty

Introduction

Rhinoplasty and septoplasty are the two of the most common facial plastic and reconstructive procedures performed in the ambulatory surgery setting helping to account for $155 million in Medicare payments in 2016 [1, 2]. A common indication for both procedures is nasal obstruction. While nasal obstruction may be present at multiple sites along the nasal passageway, one particularly troublesome location is the caudal septum. Indeed, deviation of the caudal septum (CSD) is so difficult to treat that it was found in 31–72% of patients presenting for revision surgery [3, 4•]. The functional correlate to this clinical problem has been well described by Liu T. et al. in a study assessing the computational fluid dynamics of septal deviation. Liu and colleagues demonstrated that patients with deviation at the caudal septum experience the highest peak airflow velocity and nasal resistance and have the highest visual analog scale of nasal obstruction scores versus other sites of septal deviation [5].

Anatomy of the Nasal Septum

The nasal septum is an osseocartilaginous structure that divides the nasal cavity into two sides. It functions to direct airflow through the nasal cavities and provide support to the nasal dorsum, nasal tip, and nasal side walls, and is a central structure in directing midface growth. The cartilaginous component of the septum, termed the quadrangular cartilage, is the anterior most portion of the septum. The cartilaginous septum helps to provide support to the nasal dorsum, sidewalls, and nasal tip. Support to the cartilaginous septum is provided by attachment to the anterior perpendicular plate of the ethmoid bone and the nasal bones, the keystone area, and by attachment to nasal

This article is part of the Topical Collection on *FACIAL PLASTICS: Functional Rhinoplasty*

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spine, the maxillary crest, and the vomer inferiorly. Nasal tip support is supplied by indirect, ligamentous attachment of the medial crura of the lower lateral cartilages to the caudal septum. Nasal sidewall support is provided by the medial attachment of the upper lateral cartilages to the cartilaginous septum. Posteriorly, the septum is made of bony contributions from the perpendicular plate of the ethmoid bone, the maxillary crest, the vomer, and the nasal crest of the palatine bone. The perpendicular plate of the ethmoid bone attaches directly to the skull base while the vomer and the nasal crest of the palatine bone attach to the hard palate. The septum is covered with a mucosal lining which lies upon perichondrium or periosteum over the cartilaginous and bony septum respectively. The plane between the perichondrium and the cartilage as well as the periosteum and the bone comprises the dissection plane when accessing the nasal septum. For the purposes of this article, the caudal septum is the anterior, inferior most septum that constitutes the 1–1.5 cm strut commonly left in place for support during routine septoplasty.

Assessment of Caudal Septal Deviation

Deviation of the caudal septum can result in deviation and ptosis of the nasal tip, external valve incompetence, and internal valve incompetence which may all lead to nasal obstruction. Caudal septal deviation can be identified on external exam and may manifest as deviation of the nasal tip to the left or right on frontal view, tip ptosis on profile view, and nostril asymmetry on base view. Palpation of the caudal septum during examination is critical in understanding the relationship between the caudal septum and the skeletal midline, the medial crura of the lower lateral cartilages, and the anterior septum. These relationships may be obscured when using a nasal speculum alone for anterior examination. During anterior examination, the relationship of the septum to the alar tissue, the lateral crura of the lower lateral cartilage, the caudal aspect of the upper lateral cartilage, and the head of the inferior turbinate should be noted as all these structures help to form the external and internal nasal valves. Overall stability of the nasal septum should also be assessed during examination.

The surgical pathology of caudal septal deviation can be appreciated as a function of one or more of three components. The first component is that of intrinsic curvature or deviation of the septal cartilage. The second component is the soft tissue memory and positioning which accompany deviation of the cartilage. The third is the age-old problem of the 6-ft person in a 5-ft box who cannot stand up straight. The excessive septal height relative to the space within the nasal cavity results in C-shaped deviation of the septum into nasal airway [6]. Surgical correction targets one or more of the forementioned components of caudal deviation to produce an acceptable functional and cosmetic outcome.

The myriad of techniques published to address CSD is evidence of the challenge correcting pathology in this location. Attempts at correction with removal or weakening of the caudal septum may result in loss of tip support mechanisms which may in turn result in ptosis of the nasal tip or deviation of the tip from midline [6]. Broadly, these techniques can be categorized as cartilage repositioning, grafting and splinting, incision with suturing, and extracorporeal septoplasty. Many articles describe an approach that may be a combination of the forementioned methods. A recent survey of North American Surgeons revealed that the majority, 69.5%, of respondents that address CSD employ the swinging door technique while 46% and 45% use extracorporeal septoplasty and scoring respectively. A substantial minority of survey respondents utilize grafting, 27%, and suturing, 8% [7].

Repositioning

One of the first descriptions of treating caudal septal deviation comes from Metzenbaum in a 1929 article in which he described the "swinging door" method of treating caudal septal deflection. In this article, Metzenbaum describes excising a small piece of cartilage at the area of deviation and repositioning the cartilage back in the midline, like closing a door, thereby correcting the intrinsic deviation of the cartilage [8]. Steffensen then sought to improve upon Metzenbaum's technique by including scoring, resection, and further release of quadrangular cartilage attachments to improve outcomes [9]. Subsequently, Pastorek again modified the swinging door technique for use when the caudal deviation results from excessive septal height. Pastorek describes disarticulating the caudal septum from the maxillary spine, shortening the septum as needed and positioning the septum on the side of the maxillary crest opposite the deviation, using the maxillary crest as a "door stop" [10]. Constantine and Rohrich described a similar technique but rather than using the maxillary crest as a door stop, they suggest removing all the excessive height from the inferior septum and securing it to the nasal spine in the midline [11]. Note that the referenced techniques in this section address either intrinsic deviation of the cartilage or excessive height, but not both.

Grafting and Splinting

One of the most well-known and commonly performed splinting methods for caudal deviation is the use of extended spreader grafts. When the deviation is minor and isolated to

the dorsal caudal septum, the use of spreader grafts alone may be sufficient to overcome the intrinsic curvature of the cartilage. When the deviation is more severe, clocking sutures may also be added to help improve the position of the caudal septum [12, 13]. Other splinting techniques attempt to place splints directly at the area of deviation that may be fashioned from cartilage or bone harvested from the septum [14–20]. Some authors have even advocated for the use of polydioxanone (PDS) foil. These techniques rely on the stability and longevity of the splinting material and the sutures that hold them in place. The advantage of these techniques compared to others is that they preserve the strength of the cartilage but unfortunately must also withstand its intrinsic forces. A relative disadvantage of splinting is potential increased width of the caudal septum resulting in reduced air flow.

Incisional and Suturing Techniques

Incisional and suturing techniques rely on incision of the cartilage to weaken the intrinsic deviation or to allow for an adjustment of height due to excessive cartilage with sutures to hold the cartilage in position. Thus, these techniques rely on the strength of the suture to resist the memory of the tissues to provide lasting results. The cartilage must also be able to withstand the force the suture places on it and resist cheese-wiring. In cases where the cartilage is scored or excised, the cartilage integrity is compromised which may result in loss of support. Several authors have reported good results using incision and suturing techniques [21–26]. However, these techniques appear to be less popular compared to other techniques [7].

Extracorporeal Septoplasty

In an effort to address persistent and/or severe deviation of the septum and external nose, Ashley and King were the first to describe removal of the entire cartilaginous septum, creating a straight septum extracorporeally, and subsequently replacing the cartilage and suturing it to the columellar tissues [27]. Thirty years later, Gubisch described a similar procedure, using enhanced suturing techniques, and reported good outcomes in over 1000 patients [28]. Gubisch did note that 8% of his patients complained of dorsal irregularities. Given the complexity of the extracorporeal septoplasty and the cited rate of dorsal irregularity, many surgeons try to avoid the operation. Despite the difficulties and risks inherent to extracorporeal septoplasty, it remains one of the most effective techniques to address caudal septal deviation. To simplify the procedure and obtain more consistent results, several authors have described techniques of subtotal resection of the cartilaginous septum with subsequent reconstruction of the vital dorsal and caudal septal struts. Toriumi was the first to describe targeted resection and reconstruction of the deviated caudal and dorsal portions of the L strut [29]. The technique was then modified and refined by others, including the senior author T.D.W. [30, 31••].

The senior author's technique of addressing caudal septal deviation is presented herein:

- Preoperative examination typically determines the necessity of the anterior septal transplant and the patient is informed and counseled appropriately.
- An external rhinoplasty approach is performed through an inverted-V transcolumellar incision and dissection carried out in the sub-SMAS plane to the rhinion or nasion if dorsal hump reduction is to be performed.
- The medial crura and interdomal ligaments are then divided and the septum approached from its caudal most aspect.
- Submucoperichondrial flaps are then raised from the septum bilaterally and the upper lateral cartilages are disarticulated from the septum.
- At this point, hump reduction is performed if indicated and the open roof closed.
- Exposure of the maxillary crest is then performed, and the caudal septum is resected typically leaving the anterior septal angle in situ. Care is taken to leave 1.5–2 cm of cartilaginous septum at the bony cartilaginous junction for adequate support.
- Sharp dissection is then performed just posterior to the columellar skin to create a pocket between the medial crura down to the nasal spine for a columellar strut graft. During exposure of the septum, care is taken to leave intact fascia between the medial crura so the columellar strut is bound inferiorly by the skin, laterally by the medial crura, and superiorly by connective tissue to maximize stability.
- The domes of the lower lateral cartilages are then placed into appropriate position, and the distance from the nasal bones to the caudal edge of the domes and from the nasal spine to the cephalic edge of the domes is measured. These measurements provide an assessment of length required to construct extended spreader grafts and a columellar strut, respectively.
- The extended spreader grafts are then affixed to the septum with horizontal mattress sutures.
- A speculum is then used to expose the nasal spine through the previously created columellar pocket, and monopolar cautery is used to divide the overlying tissues and periosteum of the nasal spine creating a notched area to support the columellar strut (Fig. 1).

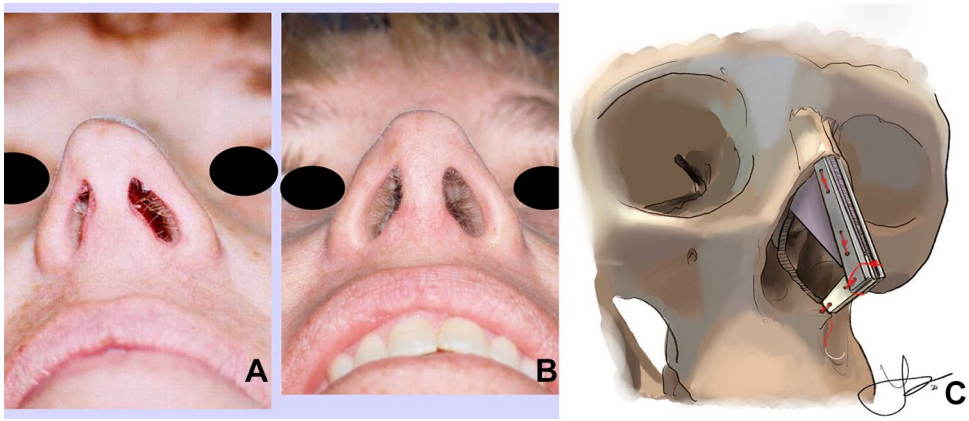

Fig. 1 **A** Base view of a patient with caudal septal deviation resulting in narrowing of the right nasal airway and deviation of the nasal tip. **B** Base view of the same patient at follow-up after modified anterior septal transplant. Note improve nostril symmetry, resolution of right nasal obstruction, and midline nasal tip with improved tip symmetry. **C** Depiction of modified anterior septal transplant with spreader graft placement and columellar strut secured to the nasal spine

- A long-lasting monofilament suture on a P-2 needle is then used to secure the columellar strut to the nasal spine with a half mattress stitch.
- The columellar strut is then secured to the extended spreader grafts just inferior to the anterior septal angle using a figure of eight stitch with the loop inferior to the columellar strut and posterior to the extended spreader grafts and the knot superior to the columellar strut. If further rotation is required, then the anterior septal angle may be shortened and the strut rotated superiorly.
- The columellar strut is then secured to the dorsal septum with a horizontal mattress suture.
- The upper lateral cartilages are then secured to the extended spreader grafts and septum with horizontal mattress sutures using clocking if further correction of deviation is needed.
- The medial crura are then secured to the columellar strut in tongue-in-grove fashion setting the tip projection and rotation.
- Further grafting and refinements are then performed as indicated.

The senior author reported on his experience with the modified anterior septal transplant with excellent cosmetic and functional outcomes [31••]. The extracorporeal septoplasty and modified anterior septal transplant function to remove all or as much of the deviated cartilage as possible. The septum is then reconstructed with intrinsically straight pieces of cartilages, thereby removing the tendency of deviation to reoccur. Keeler et al. demonstrated that the greatest degree of correction is obtained by using anterior septal transplant and clocking sutures[13]. This modified technique strikes a balance between technical difficulty, removal of intrinsically deviated cartilage, excessive cartilage height, and consistent outcomes.

Conclusions

In summary, caudal septal deviation is a difficult nasal deformity to treat and not infrequently overlooked during primary procedures. Owing to the difficulty in addressing caudal septal deviation, a myriad of procedures has been devised to address the issue. Many procedures produce reasonable results in mild cases but fail to address all the dimensions of caudal deviation in moderate to severe cases. Extracorporeal septoplasty successfully addresses all aspects of caudal septal deviation but is a technically difficult procedure to perform. Subsequently, extracorporeal septoplasty has been modified into a technically easier and more consistent procedure, the modified anterior septal transplant. In the senior author's hands, the modified anterior septal transplant is a reliable and consistent method of addressing caudal septal deflection producing both cosmetic and functional improvement without undue destabilization of the nasal skeleton.

Author Contribution Dr. Tom D Wang is responsible for the article concept and critical revision of the article. He also participated in drafting of the work and provided the photographs. Dr. Chris Z. Johnson is responsible for drafting of the article, reviewing the literature, and assisting with critical revision. Dr. Luke Edelmayer is responsible for assisting with artwork and critical revision.

Compliance with Ethical Standards

Conflict of Interest The authors declare no competing interests.

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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• Of importance
•• Of major importance

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