

Systematic Review

Surgical Techniques for the Treatment of Concha Bullosa: A Systematic Review

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ABSTRACT

Objectives

As there is no defined technique for surgery of concha bullosa the aim of this article is to review the literature and compare different techniques used for concha bullosa reduction.

Methods

A structured review of the PubMed, Embase and Cochrane Collaboration databases (Cochran Central Register of Controlled Trials, Cochran Database of Systemic Reviews) was undertaken, using the terms: conchabullosa, turbinoplasty, partial middle turbinectomy and pneumatized middle turbinate.

Results

Total of 142 articles were found and only articles addressing surgical procedures of concha bullosa with available full-text articles were included, and only 16 articles were eligible for our criteria.

Conclusion

A variety of surgical techniques are described to deal with symptomatic concha bullosa. According to this review, the most preferred technique is lateral laminectomy of the middle turbinate. There is a need for larger populated and objectively evaluated comparison studies to be done.

Keywords

Conchabullosa; Middle turbinectomy; Turbinoplasty.

Abbreviations

FESS: Functional Endoscopic Sinus Surgery; MTHS: Middle Turbinate Headache Syndrome.

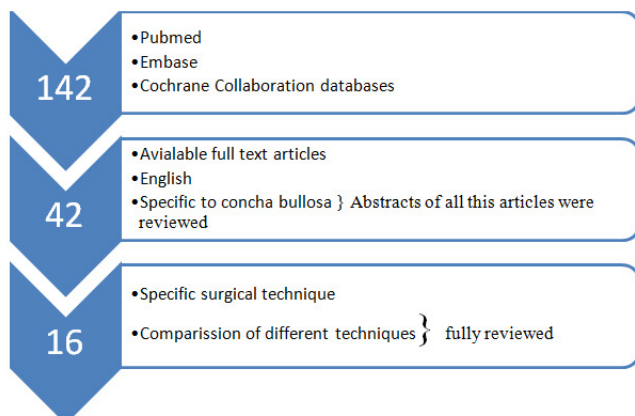
INTRODUCTION

Concha bullosa, a pneumatized middle turbinate, is one of the most common anatomic variants of the lateral wall of the nose. As previously described in literature the most common anatomical variations are ager nasi, septal deviation and concha bullosa respectively.

The incidence of concha bullosa was reported of 49.3% by Fadda et al,¹ 42.6% by Maru and Gupta,² 53.6 % by Bolger et al.³ Due to the difference of criteria used among investigators the reported prevalence of concha bullosa varies among studies. Concha bullosa causes crowded nose and obstruction of middle meatus. This can result in obstruction of the ventilation and mucociliary drainage of the maxillary, anterior ethmoid, and frontal sinuses or of nasal airflow. Additionally, the concha bullosa itself may cause a rhinogenic headache. There is no clear definition for pneumatization of concha³ and also there is no clear consensus on surgical indication for concha bullosa. The main purpose of this review is concha bullosa and its surgical intervention.

METHODS

A structured review of the PubMed, EMBASE and Cochrane Collaboration databases (Cochran Central Register of Controlled Trials, Cochran Database of Systemic Reviews) was undertaken, using the terms: “*conchabullosa*”, “*turbinoplasty*”, “*partial middle turbinectomy*” and “*pneumatized middle turbinate*”.



RESULTS

Total of 142 articles was found in the first step, only abstracts of 42 articles in English and available full-text articles were selected. In the second step describing surgical procedures of concha bullosa were included in this review article and fully reviewed. The main criteria for inclusion were the article must be describing the specific surgical technique or comparing different techniques, only 16 articles were eligible for our criteria and included in this review.

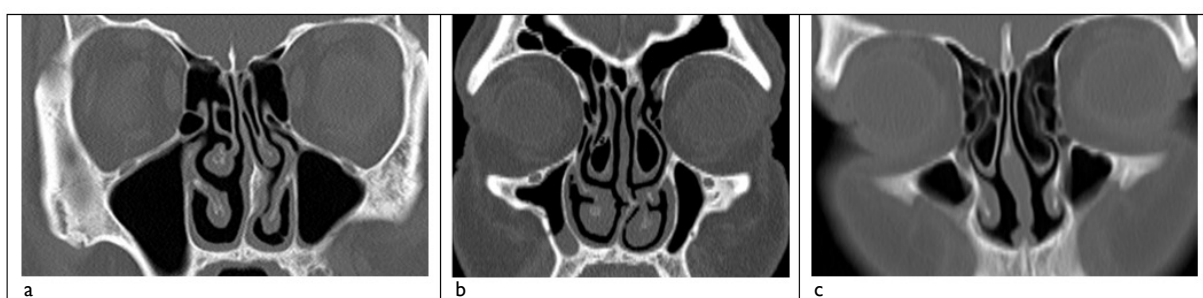
DISCUSSION

Structurally, the middle turbinate can be divided into three segments. The anterior third attaches vertically to the skull base just lateral to the cribriform plate. The middle segment, the ground or basal lamella, turns laterally, attaching to the orbital plate of the ethmoid bone (lamina papyracea) and divides the ethmoid sinus into an anterior and a posterior group of cells. The posterior segment of the middle turbinate is oriented horizontally and inserts onto the perpendicular process of the palatine bone. The anterior superior portion of the middle turbinate is an important surgical landmark and forms the medial boundary of the frontal recess. The only used classification is described by Bolger et al and classified them into three types of concha bullosa: 1) lamellar type concha bullosa; pneumatization is localized to the vertical lamella of the middle turbinate. 2) bulbous type concha bullosa; pneumatization of the inferior bulbous part of the middle turbinate. 3) true or extensive type concha bullosa is pneumatization of both the vertical lamella and the inferior part of the middle turbinate (Figure 1).³

Middle turbinate can lead to structural narrowing of the frontal sinus outflow tract and frontal sinusitis. Middle turbinate is part of osteomeatal complex which is a key area for chronic rhinosinusitis.

There is a separate function of the middle turbinate, mainly deflection of inspired air superiorly towards olfactory epithelium, providing moisture to inspired air and aeration of sinuses, and mucociliary transport. Enlargement of middle turbinate has a negative consequence on nasal physiology such as obstruction and impaired mucociliary clearance which leads to local inflammation and eventually chronic inflammation. It is known that middle

Figure 1. a) Lamellar Type Concha Bullosa. b) Bulbous Concha Bullosa. c) Extensive Type Concha Bullosa



turbinate has a role in the olfactory function and the precise anatomical distribution of olfactory neuroepithelium is unknown. Although, there are many studies on the olfactory epithelium of nasal cavity, only Apuhan et al⁴ studied olfactory epithelium of concha bullosa and found more nerve tissues on a lateral surface of concha. Recent studies show that olfactory mucosa is distributed more anteriorly and inferiorly than previously described dorsoposterior and also is presented in the surface epithelium of the lower medial surface of the middle turbinates.⁵

There are studies pointing out that the size of concha bullosa is important for the presence of symptoms. Although, there was no significant relationship detected between nasal septal deviation, concha size and rhinosinusitis, several studies reported that rhinosinusitis was detected more frequently in cases with extensive type concha bullosa.⁶ Unlu et al⁷ did not detect any relationship between concha bullosa and disease of ostiomeatal complex. However, they found that the bulbous type of concha bullosa had more effect on osteomeatal complex disease than other types of concha bullosa.

Bolger and Lloyd described specifically that recurrent sinus disease occurred through concha bullosa's compressing the uncinat process or through narrowing or obstructing the middle meatus and infundibulum.³ The mucociliary transport of concha bullosa is most frequently in the frontal recess and rarely to the adjacent air cells and hiatus semilunaris. However, Yousem et al⁸ put forward that concha bullosa was not one of the elements that led to rhinosinusitis and also reported that its size was significant. Nevertheless, Stallman et al reported that there was no significant relationship between the concha bullosa size and development of rhinosinusitis.⁹ Zinreich et al and Calhoun et al^{10,11} stated that concha bullosa is found more frequently in a symptomatic group of patients with sinusitis compared with the asymptomatic group.

The other pathological condition of concha bullosa is when it causes contact points that can trigger a rhinogenic headache. The nerve supply of middle turbinate derives from the sphenopalatine ganglion and its branches, except for the anterior extremity, which is supplied by the anterior and ethmoidal nerves. This indicates the role of concha bullosa on rhinogenic headache. Morgenstein and Krieger¹² described a middle turbinate headache syndrome (MTHS) that produces a typical pain pattern without being associated with any infectious process in the facial sinuses. Morgenstein and Krieger used the term middle turbinate syndrome and categorized as a pain and obstruction syndromes caused by middle turbinate also they used this for surgical indication criteria.

As it is seen, no consensus on this matter has been achieved yet. Also, there is no described absolute indication for surgery. It depends on the clinic and radiologic symptoms of the patient. Surgical management is recommended if concha bullosa is felt to be contributing to the patient's symptoms or the patient's disease. The main aim of surgery is to remove the pathology caused by enlarged middle turbinate. And to alleviate the nasal obstruction in extremely large concha cases. Sometimes it becomes necessary to facilitate visualization of the osteomeatal complex during endoscopic sinus surgery. Besides, concha bullosa surgery is

done for a rhinogenic headache, unfortunately, information about this concept is very limited due to the diagnostic and therapeutic difficulty and mostly this surgery is done together with septoplasty and functional endoscopic sinus surgery.¹³

SURGICAL TECHNIQUES

Today there are many different approaches for the surgical treatment of concha bullosa, such as lateral or medial partial resection, total resection, turbinoplasty, crushing and crushing with intrinsic stripping but there is no clear consensus for the best surgical technique yet. (Summarized in Table 1).

Total middle turbinectomy was not used specifically for concha bullosa. Medial excision of the concha bullosa was first described by Pirsig¹⁴ and Huizing¹⁵, removing only the medial lamella of the middle turbinate. As described by Canon et al¹⁶ the rationale for this was to leave a mucosal covered surface to face the middle meatus of the nose when functional endoscopic sinus surgery (FESS) is performed and this technique is best used for cases of nasal obstruction without sinus disease. One advantage of this technique is nasal packing is not used unless concomitant septal surgery is done. Kumral et al compared the functional outcomes of medial and lateral turbinectomy and did not find any significant difference between the two techniques. They evaluated the patient's olfactory function and postoperative synechia. Medial excision of concha bullosa has the advantage of preventing the development of frontal sinusitis by preventing the formation of frontal recess synechia.¹⁷

Lateral excision of the middle turbinate is the most used technique in isolated concha bullosa. The concha bullosa has been described to drain the frontal sinus recess. Braun and Stammberger¹⁸ supported lateral excision of concha bullosa and crushing if necessary rather than medial excision because of middle turbinate is attached to the skull base medially and medial excision causes destabilization of the middle turbinate. All concha bullosa have an ostium and their own mucociliary transport, this ostium should always be included in the resection of the lateral lamella to avoid persisting circular transport of the mucus. In their study on different techniques of endoscopic concha bullosa surgery Canon et al preferred this technique because of lateral excision technique has the advantage of facilitating drainage from the frontal sinus recess into the middle meatus.¹⁹ The disadvantage of this technique is a risk of synechia formation especially when FESS is performed. The rate of synechia for isolated concha bullosa reduction surgery is very low; Canon et al and kumral et al reported no synechia while Doğru et al reported synechia rate of 27%.¹³ But this was not isolated concha bullosa surgery same patients had the extra intervention of osteomeatal complex. The rates of synechia are low when the mucosa is preserved (Table 2). Har-el and H slavit²⁰ described a new technique by removing only medial lamella of the concha while preserving mucosa, their focus was preventing the formation of synechia, with synechia rate of 6.9% (3 of 43 cases) in their four years follow-up. Singston et al²¹ described a similar technique by preserving posteroinferior pedicled flap and reported that this significantly reduces adhesions, may be because it covers the main potential contact surface. Similarly, Dogru et al¹³ compared later-

Table 1. Summary of Surgical Techniques

Eren et al ²⁷	42 patients and 55 concha	Prospective	Long-term outcomes of crushing and crushing with intrinsic stripping.	Intrinsic stripping with crushing showed significant reduction according to the other group.
Mandour and Kalza ³¹	42 patients	Prospective	Using crusher (Kressner turbinate crushing forceps (4 mm wide, 21 cm, Inka™ Surgical Instruments))	The technique is best used when the air cells within the turbinates are large. Resective techniques, on the other hand, may be used when enlargement of the turbinates is due to hypertrophy of its tissues rather than the presence of air cells.
Kocak et al ²⁶	71 patients	Prospective study	Is it effective to use the crushing technique in all types of concha bullosa	Crushing technique in an effective method in all types of concha bullosa and it appears to be more potent in volume reduction on bulbous type. Compliance
Song et al ³²	4 patients	Case report	Concha bullosa crusher	After a one year follow up, there has been no regrowth of the middle turbinate, no evidence of mucocele formation, and no clinical evidence of sinus disease or nasal obstruction
Har-el and H slavit ²⁰	36 patients	Prospective	Turbinoplasty for concha bullosa: A non-synechiaforming alternative to middle turbinectomy	A 4-year experience with this procedure showed almost complete elimination of the synechiae problem.
Dogru H et al ¹³	131 patients	Prospective	Turbinoplasty was performed by a modified Har-El and Slavit technique	Advantageous because it results in minimal mucosal injury, plus it evenly brings the conchal walls together.
Kumral et al ¹⁷	72 patients	Randomized controlled trail	Comparison of medial and lateral laminectomy group 1: medial laminectomy (n=34) and group 2: lateral laminectomy (n=38).	This study revealed that medial laminectomy for aeration of the middle turbinate was as effective as lateral laminectomy.
Sigston et al ²¹	47 patients	Prospective controlled	A mucosa-preserving posterior pedicled flap.	A mucosa-preserving posterior pedicled flap is a minor modification to partial lateral turbinectomy for concha bullosa reduces adhesions while speeding recovery.
Canon et al ¹⁶	242 patients	Retrospective	Endoscopic management of conchabullosa	The only study comparing different techniques. But being retrospective and small number of patients are greatest handicaps but the author prefers excision of the lateral portion of the pneumatized turbinate. Procedure can be carried concomitantly with septal or FESS procedures, and has been free of any significant complications.
Mehta and Kaluskar ²⁸	36 patients	Prospective	Endoscopic turbinoplasty of Concha Bullosa: Long Term Results	States that endoscopic turbinoplasty is safe and effective procedure for concha bullosa. It preserves middle turbinate anatomically and physiologically and treats the concha with negligible complications.
Morgenstein and Kreiger ¹²	36 patients	Prospective	Experience in middle turbinectomy	Good to excellent with no long-term adverse sequel. There has been no crusting, drying, or infection as a result of our middle turbinectomies. Careful patient selection is critical.
Tanyeri et al ²⁴	22 patients	Prospective study	Endoscopically and radiologically evaluated whether a surgically crushed concha bullosa can form again	Concha bullosa crushing technique is an easy, conservative treatment modality. As the concha bullosa does not appear to reform after crushing, this technique can be considered a definitive treatment. Nevertheless, these patients should be followed for the long-term.

Table 2. Rate of Synechia Reported in Turbinectomy and Turbinoplasty

Author	Lateral turbinectomy	Turbinoplasty
Dogru et al ¹³	27 %	9.7%
Shih et al ²⁹	16%	12.9%
Ramadan and Allen ³⁰	5.3%	9.3%

al turbinectomy and turbinoplasty by modified Har-El and Slavit technique by cutting the concha both superiorly and inferiorly to allow the lamella adhere evenly and preventing the formation of mucocele.

The least used technique is the transverse excision of the turbinate. This technique is reported by Canon et al for only

middle turbinate that attached to the skull base with the narrow pedicle. There is no specific study describing the use of transverse excision of concha bullosa. Choby et al reported in their systematic meta-analysis on clinical effects of middle turbinate resection, that no significant difference was found in total resection of middle turbinate and partial resection of the middle turbinate.²² Studies in favor of middle turbinate resection believe that it leads to decreased post-operative synechia formation and improved sinus outflow tract patency. Middle turbinate resection may allow for better intra-operative and post-operative visualization of the paranasal sinuses. Its biggest drawback is the loss of surgical landmarks.

In recent years several studies report that olfactory dysfunction is encountered less with the crushing technique than with

other techniques. However, crushing is not applied for large concha bullosa, which requires partial resection. In performing the crushing technique, several instruments are used.²³ While the technique is easy and conservative, there are studies which reported recurrence. Tanyeri et al did prospective study enrolled 14 adults with concha bullosa and did not find any recurrence of pneumatization of concha bullosa.²⁴ Most studies expressed short time follow-up. Only one study with long-term follow-up reported that the middle concha pneumatized again. Kieff and Busaba²⁵ have reported concha bullosa recurrence after crushing. They reported 10 cases of recurrence between 2 and 15 years after the initial surgery. However, their data was limited to re-pneumatization after crushing, they didn't mention about whether the patients' symptoms recurred again, also they did not state the total number of patients who underwent crushing. Kocak et al applied crushing to 95 concha bullosa cases and followed them for approximately 2 years and have not encountered a reformation in any of the cases. Also according to the other types of concha bullosa they concluded that bulbous type has more effective result than other types of concha bullosa.²⁶ Most of the recent studies documented that in none of the cases the concha bullosa regressed to its original form in short-term follow-ups after crushing.

Eren SB et al²⁷ compared crushing technique with crushing with intrinsic stripping and stated that faces of their conchae completely adhered to each other. These findings may be due to the excision of the inner lamella, thus allowing the two mucosal surfaces to come together. Mehta R et al also described a similar technique by removing bony lamella and preserving mucosa of middle turbinate and reported very low rate of synechia 7.6% according to other studies and also healing is quicker without usual postoperative crusting.²⁸ This technique is more manipulative and time-consuming according to the other techniques.

CONCLUSION

Because of development of diagnostic tools nowadays the importance of concha bullosa in rhinology is rising and surgical intervention is easier and favorable than it was before. But there is no clear consensus about criteria for surgical indication of concha bullosa and lack of more objectively evaluated and a long period followed-up studies comparing the surgical procedure of concha bullosa. Preference of which technique to use is dependent more on surgeon's experience. There is no specific study comparing all techniques and as is seen in this literature review most preferred technique is lateral laminectomy of the middle turbinate. There are several modified techniques of lateral excision of middle turbinate to reduce the rate of synechia. The crushing technique of concha bullosa with traumatizing instruments is effective in nonextensive types of concha bullosa. There is a need for larger populated objectively evaluated comparison studies to be done.

CONFLICTS OF INTEREST

We affirm that there is no actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations.

REFERENCES

1. Fadda G, Rosso S, Aversa S, Ondolo C, Succo G. Multiparametric statistical correlations between paranasal sinus anatomic variations and chronic rhinosinusitis Correlazione statistica multiparametrica tra variazioni anatomiche rinosinusalì e rinosinusite cronica. *ACTA Otorhinolaryngol Ital.* 2012; 32: 244-251.
2. Maru YK, Gupta Y. Concha bullosa: Frequency and appearances on sinonasal CT. *Indian J Otolaryngol Head Neck Surg.* 1999; 52: 40-44. doi: 10.1007/BF02996431
3. Bolger WE, Butzin CA, Parsons DS. Paranasal sinus bony anatomic variations and mucosal abnormalities: CT analysis for endoscopic sinus surgery. *Laryngoscope.* 1991; 101(1): 56-64. doi: 10.1288/00005537-199101000-00010
4. Apuhan T, Yıldırım YS, Şimşek T, Yılmaz F, Yılmaz F. Concha bullosa surgery and the distribution of human olfactory neuroepithelium. *Eur Arch Otorhinolaryngol.* 2013; 270: 953-957. doi: 10.1007/s00405-012-2173-6
5. Richtsmeier WJ, Cannon CR. Endoscopic management of concha bullosa. *Otolaryngol Neck Surg.* 1994; 110(4): 449-454. doi: 10.1177/019459989411000419
6. Tunçyürek Ö. The relationship among concha bullosa, septal deviation and chronic rhinosinusitis. *J Med Updat.* 2013; 3(1): 1-7. doi: 10.2399/jmu.2013001002
7. Unlu HH, Akyar S, Caylan R. Concha bullosa. *J Otolaryngol.* 1994; 23(1): 23-27.
8. Yousem DM, Kennedy DW, Rosenberg S. Ostiomeatal complex risk factors for sinusitis: CT evaluation. *J Otolaryngol.* 1991; 20: 419-424.
9. Stallman JS, Lobo JN, Som PM. The incidence of concha bullosa and its relationship to nasal septal deviation and paranasal sinus disease. *AJNR Am J Neuroradiol.* 2004; 25(9): 1613-1618.
10. Zinreich SJ, Mattox DE. Concha bullosa: CT evaluation. *J Comput Assist Tomogr.* 12(5): 778-784.
11. Calhoun KH, Waggenspack GA, Simpson CB, Hokanson JA, Bailey BJ. CT evaluation of the paranasal sinuses in symptomatic and asymptomatic populations. *Otolaryngol Head Neck Surg.* 1991; 104(4): 480-483. doi: 10.1177/019459989110400409
12. Morgenstein KM, Krieger MK. Experiences in middle turbinectomy. *Laryngoscope.* 1980; 90(10): 1596-1603. doi: 10.1288/00005537-198010000-00002
13. Doğru H, Tüz M, Uygur K, Cetin M. A new turbinoplasty technique for the management of concha bullosa: Our short-term outcomes. *Laryngoscope.* 2001; 6: 172-174. doi: 10.1097/00005537-200101000-00030

14. Pirsig W. Reduction of the middle turbinate. *Rhinology*. 1972; 10: 103-108.
15. Huizing EH. Functional surgery in inflammation of the nose and paranasal sinuses. *Rhinol Suppl*. 1988; 5: 5-15.
16. Cannon CR. Endoscopic management of concha bullosa. *Otolaryngol Neck Surg*. 1994; 110(4): 449-454. doi: [10.1177/019459989411000419](https://doi.org/10.1177/019459989411000419)
17. Kumral TL, Yıldırım G, Çakır O, et al. Comparison of two partial middle turbinectomy techniques for the treatment of a concha bullosa. *Laryngoscope*. 2015; 125(5): 1062-1066. doi: [10.1002/lary.25065](https://doi.org/10.1002/lary.25065)
18. Braun H, Stammberger H. Pneumatization of turbinates. *Laryngoscope*. 2003; 113(4): 668-672. doi: [10.1097/00005537-200304000-00016](https://doi.org/10.1097/00005537-200304000-00016)
19. Richtsmeier WJ, Cannon CR. Endoscopic management of concha bullosa. *Otolaryngol Neck Surg*. 1994; 110: 449-454. doi: [10.1177/019459989411000419](https://doi.org/10.1177/019459989411000419)
20. Har-el G, Slavik DH. Turbinoplasty for concha bullosa: A non-synechia-forming alternative to middle turbinectomy. *Rhinology*. 1996; 34(1): 54-56.
21. Sigston EAW, Iseli CE, Iseli TA. Concha bullosa: Reducing middle meatal adhesions by preserving the lateral mucosa as a posterior pedicle flap. *J Laryngol Otol*. 2004; 118(10): 799-803. doi: [10.1258/0022215042450814](https://doi.org/10.1258/0022215042450814)
22. Choby GW, Hobson CE, Lee S, Wang EW. Clinical effects of middle turbinate resection after endoscopic sinus surgery: A systematic review. *Am J Rhinol Allergy*. 2014; 28(6): 502-507. doi: [10.2500/ajra.2014.28.4097](https://doi.org/10.2500/ajra.2014.28.4097)
23. Dogru H, Uygur K, Tuz M. Concha bullosa squeezer for turbinoplasty (Doğru forceps). *J Otolaryngol*. 2004; 33(2): 111-113.
24. Tanyeri H, Aksoy EA, Serin GM, Polat S, Türk A, Unal OF. Will a crushed concha bullosa form again? *Laryngoscope*. 2012; 122(5): 956-960. doi: [10.1002/lary.23234](https://doi.org/10.1002/lary.23234)
25. Kieff DA, Busaba NY. Reformation of concha bullosa following treatment by crushing surgical technique: Implication for balloon sinuplasty. *Laryngoscope*. 2009; 119(12): 2454-2456. doi: [10.1002/lary.20640](https://doi.org/10.1002/lary.20640)
26. Kocak I, Gokler O, Dogan R. Is it effective to use the crushing technique in all types of concha bullosa. *Eur Arch Oto-Rhino-Laryngology*. 2016; 273(11): 3775-3781. doi: [10.1007/s00405-016-4097-z](https://doi.org/10.1007/s00405-016-4097-z)
27. Eren SB, Kocak I, Dogan R, Ozturan O, Yildirim YS, Tugrul S. A comparison of the long-term results of crushing and crushing with intrinsic stripping techniques in concha bullosa surgery. *Int Forum Allergy Rhinol*. 2014; 4: 753-758. doi: [10.1002/alf.21360](https://doi.org/10.1002/alf.21360)
28. Mehta R, Kaluskar SK. Endoscopic turbinoplasty of concha bullosa: Long term results. *Indian J Otolaryngol Head Neck Surg*. 2013; 65(Suppl 2): 251-254. doi: [10.1007/s12070-011-0368-6](https://doi.org/10.1007/s12070-011-0368-6)
29. Shih C, Chin G, Rice DH. Middle turbinate resection: Impact on outcomes in endoscopic sinus surgery. *Ear Nose Throat J*. 2003 [cited 2018 May 2]; 82: 796-797.
30. Ramadan HH, Allen GC. Complications of endoscopic sinus surgery in a residency training program. *Laryngoscope*. 1995; 105: 376-379. doi: [10.1288/00005537-199504000-00007](https://doi.org/10.1288/00005537-199504000-00007)
31. Mandour Z, Kalza R. A simple minimally invasive technique to reduce the size of pneumatized middle turbinate (Concha Bullosa). *Otolaryngology*. 2016; 6: 3-5. doi: [10.4172/2161-119X.1000242](https://doi.org/10.4172/2161-119X.1000242)
32. Song B, Tang C, Campano R, et al. The concha bullosa crusher: A novel technique. 2013; 27: 2454.