A comparison of the long-term results of crushing and crushing with intrinsic stripping techniques in concha bullosa surgery

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Background: **A prospective endoscopic and radiologic evaluation of long-term outcomes of crushing and crushing with intrinsic stripping, 2 minimally destructive techniques used for the surgical treatment of concha bullosa.**

Methods: **Forty-two patients who underwent concha bullosa surgery (a total of 55 conchae surgeries) were included in the study. The patients were allocated consecutively to either of the 2 groups: Group 1 (crushing, n = 28) and Group 2 (crushing with intrinsic stripping, n = 27). All procedures were performed endoscopically. The presurgical and 1-year postsurgical endoscopic nasal cavity images and computed tomography (CT) scans of all patients were recorded. Preoperative and postoperative measurements were compared using paired *t* test and Student *t* test.**

Results: **Gender and mean age of the 42 patients (55 conchae bullosa) were as follows: 23 males, mean age 25.6 (range, 18 to 41) years; 18 females, mean age 24.2 (range, 18 to 33) years. The patients were followed for 12.5 ± 1.3 months. Comparisons of both the grading of endoscopic images and the concha bullosa volumes measured in CT images before and after treatment showed significant postsurgical reductions in both groups; comparison between groups showed significant postsurgical decreases for Group 2 in both concha bullosa volumes and in endoscopic scoring ($p < 0.05$).**

Conclusion: **Crushing with intrinsic stripping is an effective and easy technique; when compared to crushing alone; this technique provides a significantly more decrease in middle concha volumes as demonstrated both by the CT and by endoscopic evaluations.** © 2014 ARS-AAOA, LLC.

Key Words:
crushing; crushing with intrinsic stripping; concha bullosa; endoscopic; surgical; treatment; resection

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The middle concha is a significant anatomical structure that rises from the lateral wall of the nasal cavity, and carries various functions such as moistening, warming and filtering the air, organizing, and smelling.

Several types of middle concha were described such as the pneumatized, paradoxically curved, bifurcate, trifurcate, secondary, and accessory types; the pneumatized middle concha (concha bullosa) is the most frequently encountered variation among them.[1,2] The prevalence of concha bullosa ranges between 8% to 53%.[3,4] Concha bullosa, either by itself or together with other factors, may give rise to a number of pathologies like nasal obstruction, paranasal sinus infection, headache, facial pressure, and difficulty in breathing.[5] Several techniques have been defined for the surgical treatment of concha bullosa to counter the development of such pathologies; namely, partial resection, total resection, turbinoplasty, and crushing.[3,6,7]

Although the resection methods are widely applied surgical techniques, they also have various disadvantages such as bleeding, mucosal injury, olfactory dysfunction, deterioration of nasal functions, and synechia formation.[6,8,9] The crushing methods are quick and easy to perform, and preserve the mucosa.[10] Internal stripping of the concha bullosa in addition to crushing is thought to be effective in preventing recurrences.[6]

As far as we know, no comparative studies evaluating the results of crushing and crushing with intrinsic stripping techniques (CWIST) have been conducted so far. Here in this study we compare the outcomes of these 2 surgical

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techniques, using radiologic measurements and grading of endoscopic images for objective evaluation.

Patients and methods

This study received approval by the Bezmialem Vakıf University Local Ethics Committee for clinical studies. Forty-two patients (55 conchae bullosa), complaining of nasal stuffiness and headache, and were scheduled for turbinate pneumatization surgery were included in the study. The nasal cavities of the patients were evaluated in detail with a rigid nasal endoscope. Patients who had previous nasal surgery or nasal pathologies during surgery were not included in the study. All patients included in the study had septoplasty together with concha bullosa surgery.

Surgical technique

The patients were informed about the surgical procedures, the reasons for such interventions and the probable complications; their approval was asked for, and all patients signed the informed consent form. All patients were operated under general anesthesia. In the surgery room, after topical vasoconstriction of the nasal cavity with adrenaline solution (1/100,000), infiltration anesthesia with lidocaine HCl (2%) + adrenaline (0.1%) was applied to the anterior merging point of the middle concha, and also to the septum in necessary cases. Septoplasty was performed initially, and then we proceeded with surgery addressing the middle conchal pathology. The method for concha bullosa surgery was randomized according to the referral sequence of the patients. Patients were numbered as they were recruited; odd numbered patients (Group 1) were chosen for crushing, and even numbered patients (Group 2) were chosen for CWIST.

Crushing was performed on patients in Group 1. This technique was carried out with a Bruening forceps with blinded blades, and crushing was performed beginning at the upper merging point of the middle concha, and proceeded first to the inferior and then to the posterior. Care was taken to avoid mucosal injury.

CWIST[8] was performed in patients on Group 2. In these patients, first a vertical incision was made with a sickle knife on the anterior face of the bullous middle concha, and then a 4-mm 0-degree rigid endoscope was inserted inside the bullous cavity; microelevators and cup forceps employed in ear surgery were used to elevate and completely remove the inner mucosa of the concha bullosa. The bony lamellae were kept intact, and later the medial and lateral lamellae were brought together with the help of the same Bruening forceps and were squeezed from superior to inferior, and anterior to posterior. Care was taken to avoid mucosal injury.

Evaluation methods

Before surgery and approximately 1 year after surgery axial and coronal paranasal sinus computed tomography (CT) scans were taken from all patients. Endoscopic nasal cavity photographs of all patients were also recorded before the study, and approximately 1 year after surgery.

TABLE 1. Endoscopic clasification of concha bullosa

Grade	Description
Grade 1	The sphenoethmoid recess and uncinate process are both clearly visible
Grade 2	The sphenoethmoid recess is invisible; the uncinate process is visible
Grade 3	The sphenoethmoid recess and uncinate process are both invisible
Grade 4	Giant concha bullosa occupying the entire middle meatal area, extending to the inferior meatus

Patients scheduled for surgery had their paranasal sinus CTs taken. Using a 64-section double-detector Aquilion (Toshiba Medical Systems, Tokyo, Japan) tomograph, the cross-sections were taken with 3-mm intervals, with the patient in supine position, beginning from the frontal sinus roof and proceeding down to the maxillary sinus floor, and from the frontal sinus anterior wall proceeding back to the sphenoid sinus posterior wall. Concha bullosa volumes were measured and recorded preoperatively and postoperatively by a blinded otorhinolaryngologist, using the Vitrea v6 (Toshiba Medical Systems, Tokyo, Japan) imaging program.

The preoperative and postoperative nasal examinations of all patients, and the positional relationship of the middle concha with neighboring anatomic structures were photographed and recorded. Karl-Storz's 4-mm 0-degree rigid endoscope was employed for endoscopic examinations and during surgery (Karl Storz, Endoscopy (UK) Ltd., Slough, Berks, UK). Conchae bullosa were evaluated during endoscopic examination with regard to their size and their relationship with neighboring structures, according to the classification cited in relevant literature[10] (Table 1). The preoperative and postoperative endoscopic middle concha images were evaluated by a blinded otorhinolaryngologist. The area occupied by the middle concha in the nasal cavity was determined according to relevant literature and was recorded.

The patients were asked before and approximately 1 year after surgery if they suffered from headaches, and the answers were recorded.

Statistical analysis

Statistical analysis was carried out using the Statistical Package for the Social Sciences, version 13.0 software for Windows (SPSS Inc, Chicago, IL). All quantitative variables were estimated using measures of central location (ie, mean and median) and measures of dispersion (ie, standard deviation [SD]). Student *t* test was used for comparing variable data in between groups. Paired *t* test

TABLE 2. The concha bullosa CT volumes

Group	CT-preoperative (mean ± SD)	CT-postoperative (mean ± SD)	Paired Student *t* test (*p* value)[a]
Group 1: Crushing (n = 28)	0.69 ± 0.42	0.37 ± 0.27	**0.0001**
Group 2: CWIS (n = 27)	1.08 ± 0.68	0.23 ± 0.18	**0.0001**
Unpaired Student *t* test (*p* value)[a]	**0.017**	**0.025**	

[a]Paired Student *t* test for dependent samples, unpaired Student *t* test for independent samples ($p < 0.05$). Bold values are significant.
CT = computed tomography; CWIS = crushing with intrinsic stripping; SD = standard deviation.

was used for comparisons inside each group. Chi-square test was used for comparing qualitative data. Pearson's correlation analysis was used in comparing the endoscopic and tomographic data. Values of $p < 0.05$ were accepted as statistically significant.

Results

Forty-two patients (55 conchae bullosa) were included in the study. All 42 patients underwent septoplasty. Twenty-eight patients had unilateral concha bullosa, 13 patients had bilateral concha bullosa. Mean age of the patients were 25.6 (range, 18 to 41) years in Group 1, and 24.2 (range, 18 to 33) years in Group 2.

There was no statistically significant difference between the groups regarding age and gender ($p > 0.05$). There was no statistically significant difference between the 2 groups regarding follow-up periods (12.7 ± 1.2, 12.3 ± 1.8 months, respectively) ($p > 0.05$).

The postoperative concha bullosa volumes of patients in both Group 1 and 2 were significantly reduced as compared to their preoperative values ($p = 0.0001$) (Table 2; Figs. 1 to 3).

The preoperative concha bullosa volume of Group 2 was significantly greater than the preoperative volume of Group 1 ($p = 0.017$) (Fig. 3). The postoperative concha bullosa volume of Group 2 was significantly lower than that of Group 1 ($p = 0.025$) (Table 2; Fig. 3).

No patient in Group 1 had a postoperative zero CT volume. In Group 2, there were 5 conchae with postoperative zero volumes, which indicated that the 2 bony leaves of the concha adhered to each other.

The concha bullosa scores of endoscopic image classification for both Group 1 and Group 2 patients were significantly lower postoperatively when compared to their preoperative scores ($p = 0.0001$) (Fig. 4).

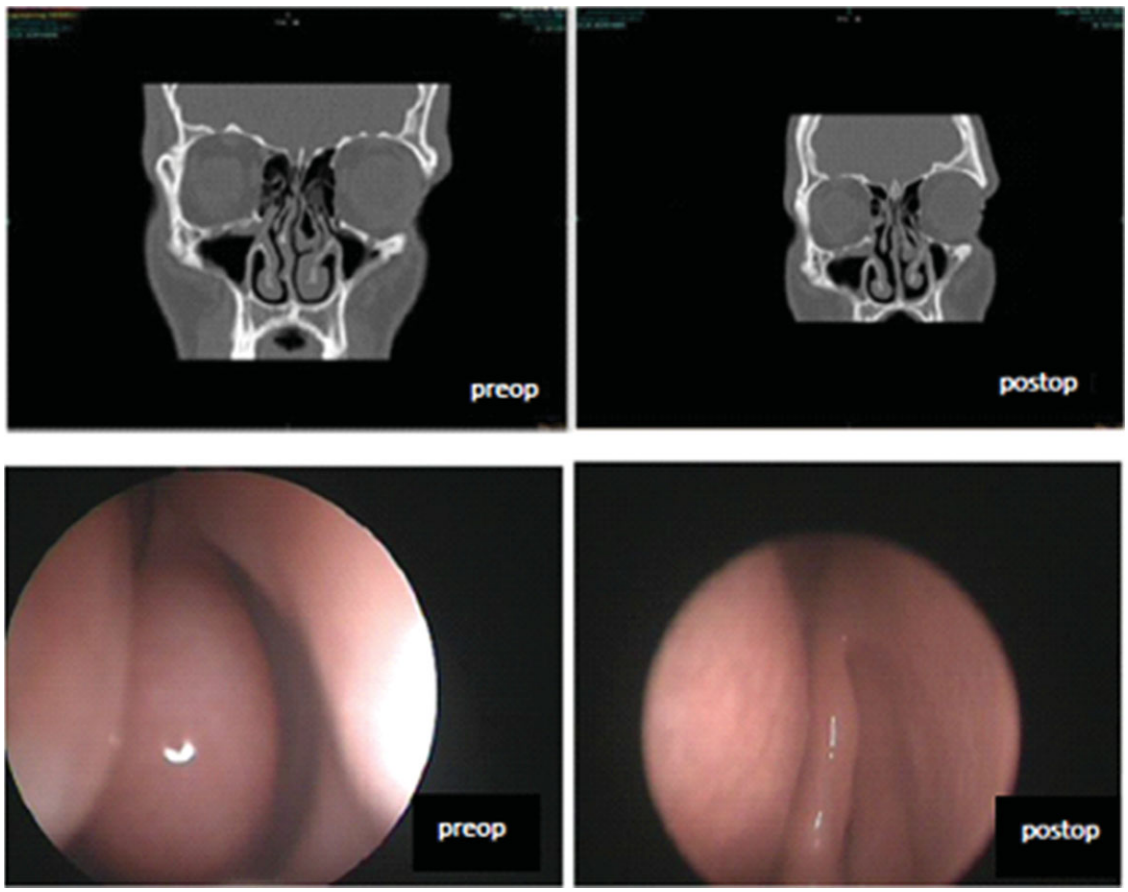

FIGURE 1. The crushing with intrinsic stripping technique: preoperative and postoperative CT and endoscopic images. CT = computed tomography.

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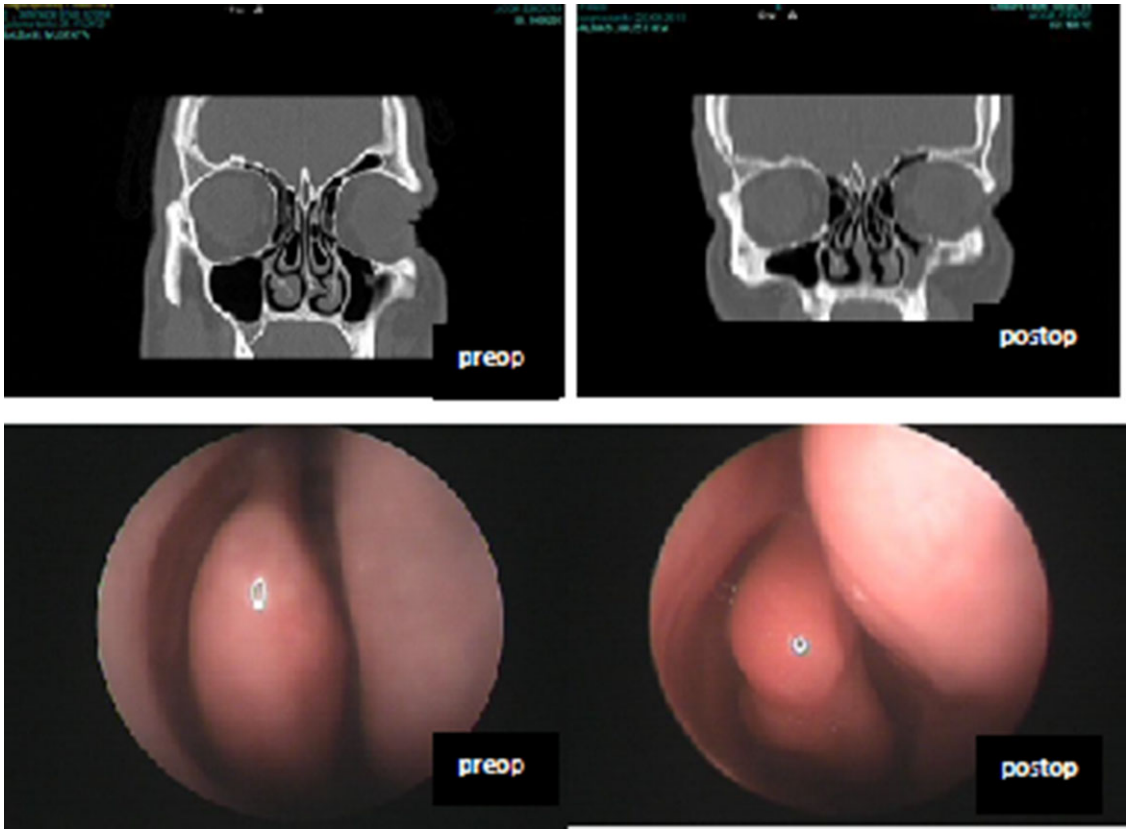

FIGURE 2. The crushing technique: preoperative and postoperative CT and endoscopic images. CT = computed tomography.

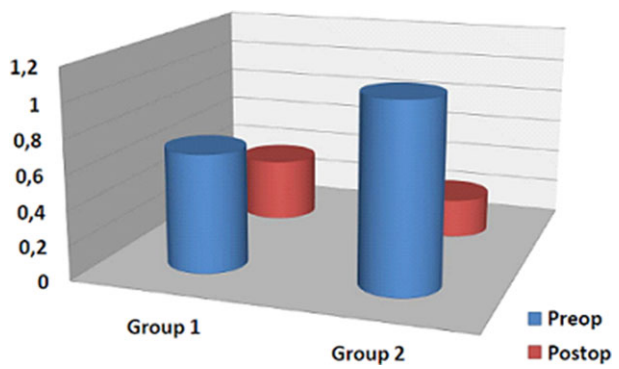

FIGURE 3. The concha bullosa CT volumes, preoperative and postoperative. CT = computed tomography.

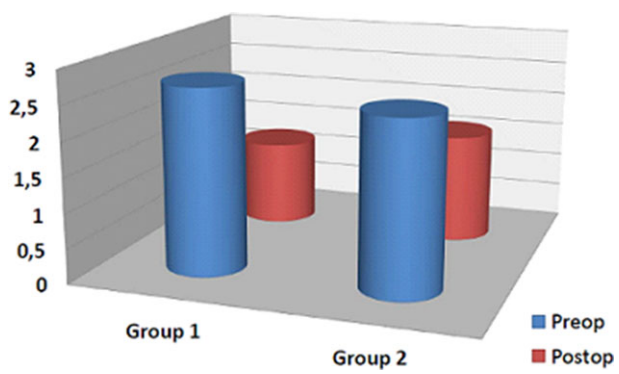

FIGURE 4. The concha bullosa scores of endoscopic image.

No significant difference was found between the preoperative endoscopic image classification scores of Groups 1 and 2 ($p = 0.128$) (Fig. 4). The postoperative endoscopic image scores of Group 2 were significantly lower than those of Group 1 ($p = 0.031$) (Table 3; Fig. 4).

The correlation analysis of the groups showed significant correlation in Group 1 for both the preoperative and the postoperative endoscopic concha scores and CT volumes ($p = 0.003$ and $p = 0.0001$, respectively). There was also significant correlation in Group 2 for both the preoperative and the postoperative endoscopic concha scores and CT volumes ($p = 0.011$ and $p = 0.001$, respectively). Headache complaints in Group 1 were 12 in 21 before surgery, and 4 in 21 after surgery. Headache complaints in Group 2 were 13 in 20 before surgery, and 5 in 20 after surgery. Both groups showed significant reduction in headache complaints after surgery ($p < 0.05$). No significant difference was observed between the 2 groups regarding headache complaints, either preoperatively or postoperatively ($p > 0.05$).

No patients in either group presented with bleeding, synechia, conchal destruction, or smelling dysfunction.

Discussion

The pneumatization of concha nasalis media is called the concha bullosa.[3] If the concha bullosa is not very large,

TABLE 3. The concha bullosa scores of endoscopic image classification

Group	Endoscopy-preoperative (mean ± SD)	Endoscopy-postoperative (mean ± SD)	Paired Student *t* test (*p* value)[a]
Group 1: Crushing (n = 28)	2.50 ± 0.5	1.60 ± 0.68	**0.0001**
Grade (endoscopic description), n (%)			
Grade 1	0 (0%)	14 (50%)	
Grade 2	14 (50%)	11 (39.2%)	
Grade 3	14 (50%)	3 (10.7%)	
Group 2: CWIS (n = 27)	2.70 ± 0.46	1.25 ± 0.44	**0.0001**
Grade (endoscopic description), n (%)			
Grade 1	0 (0%)	20 (74.1%)	
Grade 2	8 (29.6%)	7 (25.9%)	
Grade 3	19 (70.4%)	0 (0%)	
Unpaired Student *t* test (*p* value)[a]	0.128	**0.031**	

[a]Paired Student *t* test for dependent samples, unpaired Student *t* test for independent samples ($p < 0.05$). Bold values are significant.
CWIS = crushing with intrinsic stripping; SD = standard deviation.

it does not present as a pathology by itself. But if there are coexisting anatomic or mucosal pathologies, then even a small concha bullosa may cause osteomeatal complex (OMC) obstruction, cause an existing infection to become chronic, or significantly aggravate nasal obstruction.[7,11–13]

Various surgical techniques are used for concha bullosa surgery. Those techniques are: total turbinectomy, lateral/medial partial resection, submucoperiosteal resection, crushing, and crushing together with inner mucosa removal.[3,6,7,14,15]

The reason for the existence of such numerous techniques is the drive to find the least invasive technique with fewer complications and better results. The crushing technique[10] is quicker and easier to perform than the resection techniques; CWIST[8] was developed later to avoid the crushing technique's potential for recurrences, and potential for the development of mucocele. In our study we compared the results of crushing and CWIST for concha bullosa surgery, by measuring the concha bullosa volumes as measured in CTs and the scoring of concha bullosa in endoscopic imaging. There is no other study comparing the results of those 2 techniques in medical literature so far.

The preoperative concha bullosa volumes of Group 2 were significantly greater than those of Group 1 as measured in CT scans ($p = 0.017$). However, the postoperative concha bullosa volumes of Group 2 were significantly lower than those of Group 1 as measured in CT scans ($p = 0.025$) (Fig. 4). Those data indicate that concha bullosa volumes can be decreased more with the CWIST than the crushing technique alone.

In both groups, the preoperative and postoperative endoscopic scoring values showed a significant difference ($p = 0.0001$). The preoperative scoring values of Group 1 and Group 2 were statistically similar, but there was a statistically significant difference in their postoperative values ($p = 0.031$). In Group 2, concha bullosa volumes were reduced more significantly. The difference is attributed to the stripping of the mucosa.

Endoscopic resection can be performed totally or partially. However, the operation holds a risk for postoperative bleeding, synechia formation, and olfactory dysfunction.[6,9] The lateral lamel of the concha is resected in the lateral marsupialization technique. A recent study showed that olfactory mucosa had a tendency to cover the lateral lamel of the middle concha.[16] This finding made us think that the crushing technique may also preserve the olfactory function in addition to its known advantages of preserving mucosal integrity and causing less postoperative bleeding and synechia. Several studies report that olfactory dysfunction is encountered less with the crushing technique than with other techniques.[6,9] In our study, patients in neither group showed a deterioration of their olfactory functions. Because crushing techniques don't damage the conchae mucosa.

In performing the crushing technique, either a wide Blakesley forceps or some similar squeezing instrument is used.[7,17] While the technique is an easy and conservative one, recurrence of concha bullosa was reported.[17] One study found in the long-term follow-up that the middle concha pneumatized again.[13] However, a recent study of the crushing technique investigating short-term results reported no cases that returned to their preoperative volumes.[10] In this study there was no patients in either group whose concha returned to its preoperative volume. Besides, in 5 patients of the CWIST group the 2 faces of their conchae completely adhered to each other (Fig. 1). This finding may be due to the excision of the inner mucosa, thus allowing the 2 lamellae to come together.

One reason for modifying the CWIST was the concern whether the inner mucosa left in the middle concha after crushing might develop a mucocele. There are studies which suggest that not removing the mucosa may lead to developing a mucocele,[18,19] while others propose a counterview.[10] In our study we have not seen any mucocele development in any of our patients during the 12 months of follow-up, in either the crushing or the CWIST.

Since it is difficult to completely bring together the 2 leaves of the concha bullosa with only squeezing the concha, Har-EI and Siavit,[8] modifying Pirsig,[20] and Huizing's[21] techniques, proposed to scrape inside the concha bullosa. With stripping the mucosa, the 2 leaves of the concha will come together easily and there will be no recurrences.[8] Besides, taking off the mucosa will cancel the potential for the formation of a mucocele. They observed that with this technique postoperative synechia formation also descreased.[8] In our study we applied this technique to 27 conchae bullosa.

There were no recurrences or synechia in any of our cases during the 12-month follow-up.

Even though the preoperative concha bullosa volumes were greater in the CWIST group as compared to the crushing only group, after the 12 months of follow-up their mean concha volumes were smaller than the crushing-only group (Table 1). This finding indicates that when the mucosa is stripped off, the 2 leaves of the concha come together more adequately.

Manipulating the concha bullosa during stripping off the conchal mucosa does not require dexterity, yet after a short adaptation period the procedure becomes relatively easy. Conchal destabilization did not occur during surgical manipulation in any of our cases. Doğru et al.[17] also reported no destabilization during their mucosal resection study.

It is known that concha bullosa may cause rhinogenic headaches, and previous studies[22,23] showed that surgical treatment (turbinoplasty) was more effective and less costly than medical therapy. In both of our study groups, there was a significant correlation between the preoperative and postoperative CT volumes and endoscopic photography scores. This finding suggests that the volume occupied by the middle concha in the nasal cavity, be it preoperative or postoperative, may be reflected clinically. In our study, in both of the groups there was a significant decrease in headache complaints after surgery ($p < 0.05$), in accordance with relevant medical literature. However, neither technique was superior to the other regarding this symptom.

An important complication of the resection techniques in concha bullosa surgery is synechia formation, developing on the lateral side of the concha.[8,24] Synechia formation may lead to nasal obstruction or to chronic sinusitis due to OMC and obstruction of the frontal ostium, olfactory dysfunction, and headaches. Suturing the middle concha to the septum, establishing a synechia between the septum and the middle concha, and crushing techniques have been used to avoid this complication.[24,25] Suturing to the septum and synechia forming techniques are not compatible with, and alter, the normal nasal structure, and may negatively influence nasal physiology such as mucociliary clearance and olfactory function. However, the crushing technique is an easy physiologic technique, with very little probability of synechia formation.[8,10,17] Synechia formation was observed in any of the cases in either group.

Conclusion

CWIST is an effective and easy technique for treating concha bullosa cases; when compared with the crushing technique, CWIST significantly reduces the volume of the middle concha, as shown by both the CT data and the endoscopic photography scores.

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