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Comparison of Three Techniques for the Management of Concha Bullosa on Nasal and Olfactory Functions

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Abstract: Background: Different techniques were described for the management of concha bullosa. However there is still no consensus on which technique should be preferred. Objective: To evaluate the most effective technique for the management of concha bullosa in terms of improvement in nasal and olfactory functions. Study Design: Prospective, randomized controlled trial. Methods: A total of 95 patients were randomly divided into three groups; medial laminectomy (n = 31), lateral laminectomy (n = 32), and crushing of the middle turbinate (n = 32). Patients were evaluated using visual analogue score (VAS), sinonasal outcome test-22 (SNOT-22), peak inspiratory flow (PNIF), and Sniffin' Sticks Extended Test preoperatively and 3 months postoperatively. Results: The age range of the study patients was 18 and 56 years (mean age 35.2±9.4 years). There was no statistically significant difference between the baseline characteristics of the patients including age and gender. There was a statistically significant improvement in headache, obstruction, PNIF, SNOT-22 scores and olfactory performances of the patients 3 months after the surgery ($P < 0.05$ for all). All the groups were comparable in improvement of nasal and olfactory functions after surgical management of concha bullosa. However, the crushing of the middle turbinate was less effective, and, medial laminectomy resulted in better improvement in PNIF score compared to lateral laminectomy ($P = 0.011$). In addition, there was a significant improvement in odor discrimination in medial laminectomy group when compared to crushing of middle turbinate ($P = 0.011$). Conclusions: Although all three techniques are comparable with respect to improvement in nasal and olfactory functions, we recommend medial laminectomy as the surgical technique for the management of concha bullosa.

Keywords: Middle Turbinate Surgery, Obstruction, PNIF, SNOT-22, Extended Sniffin' Test

1. Introduction

Concha bullosa is the most common anatomic variation of middle turbinate seen in patients with sinonasal diseases [1-5]. Although it is generally observed in the middle turbinate, it can also be seen in the superior or inferior conchae [1, 5, 6]. Concha bullosa may completely fill the space between the septum and the lateral nasal wall, which subsequently leads to the blockage of the middle turbinate [7]. Since turbinates are responsible from hydration, lubrication of the upper respiratory system, arrangement of airflow, filtration, smelling and thermoregulation, the obstruction of the passage results in many symptoms negatively effecting the life quality of the patient; such as persistent headaches, nasal obstruction, impaired olfactory function, postnasal discharge and epistaxis [5, 7-9].

Concha bullosa is usually treated with turbinectomy, an endoscopic sinus surgery [6, 7]. Different techniques including medial or lateral laminectomy, crushing the middle turbinate, and transverse resection were described for the management of concha bullosa; however there is still no consensus on which technique should be preferred, or which side of the concha bullosa should be opened to improve nasal and olfactory functions in patients [4, 9-11]. There are a number of reports comparing the surgical outcomes of different techniques, mostly by evaluating and comparing the decrease in size, or the observed regrowth of concha bullosa.

There is only one study in literature comparing medial and lateral laminectomy of the middle turbinate with respect to nasal functions, nasal resistance, and olfactory functions using a visual analogue scale (VAS), sinonasal outcome test-22 (SNOT-22), peak inspiratory flow (PNIF), and Connecticut Chemosensory Clinical Research Center (CCCRC) smell test [9]. Here, for the first time in literature, we compared surgical outcomes in patients who undergone medial or lateral laminectomy or crushing of the middle turbinate, through VAS, PNIF, SNOT-22 and Sniffin' Sticks Extended Tests to evaluate the best technique for the management of concha bullosa in terms of improvement in nasal and olfactory functions.

2. Material and Methods

A total of 95 subjects (51 men, 44 women) aged over 18 years with a diagnosis of nasal obstruction due to aerated middle turbinate were included in this prospective study carried at the Yunus Emre Hospital (Istanbul, Turkey) between September 2014-May 2015. Patients with nasal septal deviation, previous sinus surgery, sinonasal polyposis, preexisting sinus disease or nasal allergies of any kind, preexisting subjective olfactory disturbance, smokers, and systemic disease such as diabetes mellitus were excluded from the study. A written informed consent was obtained from all the subjects. The study procedure was approved by the Ethics Committee of the Bakırkoy Research and Education Hospital and conducted according to the Declaration of Helsinki.

2.1. Surgical Procedure

The patients were randomized to three groups as medial (n=31) or lateral (n=32) turbinectomy or crushing (n=32) of concha bullosa by a computerized random number chart for each day of the study. The study patients were subjected to surgery under general (n=12) or local (n=83) anesthesia. Routine surgical procedures for medial and lateral laminectomy and crushing of middle turbinate used in our department were performed by the same surgeon with a rigid endoscope. Concha size was determined during surgery in a 1 to 4 scale. A sickle knife was used to introduce a midline incision to the middle turbinate. Medial or lateral lamina was randomly cut out or middle turbinate was crushed. Nasal tampons were used to contain bleeding and removed 2 days after surgery. Patients did not receive any systemic or topical steroids and antibiotic treatment, and the surgical outcomes were followed clinically over the next 3 months. No major complications were observed except mild edema and crusting in some patients 1 week after the procedure.

2.2. Evaluation of Nasal Functions

The effect of surgical management of concha bullosa was determined preoperatively and 3 months postoperatively. Headache and obstruction was subjectively evaluated by VAS with a range from 0 (persistant headache or total obstruction) to 10 (no headache or fully opened passage). SNOT-22 which has recently been validated for Turkish population was used to evaluate sinonasal symptoms. The questionnaire contained 22 items graded in 6 levels (0 for no problem, 5 for worst possible symptom) and the final score was obtained by adding the individual scores for each item (range 0-110, from best to worst quality of life). Nasal inspiratory flowmeter (Clement Clark International; Harlow, Essex, UK) was used for evaluation of PNIF where the patients were asked to expire forcefully in upright sitting position, and then inspire forcefully through the nose with an anesthesia mask covering the mouth. Of the three consecutive measurements with a maximum difference of 10%, the highest measurement as liters per minute was recorded as PNIF score.

2.3. Olfactory Testing

The Sniffin' Sticks Extended Test kit (Burghart Messtechnik GmbH, Germany) was used for olfactory testing preoperatively and 3 months postoperatively [12, 13]. The assessment of olfaction involved tests for odor threshold (T) for n-butanol, odor discrimination (D) and odor identification (I). Odor thresholds (T) were evaluated using sixteen stairway dilution series starting from pure n-butanol. Two pens with solvent and a third pen with n-butanol at a certain concentration were presented to subjects who were asked to identify the odor-containing pen. The dilution was decreased after two successive correct answers. The test was repeated up to seven reversals and the mean value of the last four reversals was given as T score. Two pens with the same odorant and a third pen with different one were randomly presented to subjects in odor discrimination (D) task for the selection of the different odorant. In odor identification (I), subjects were asked to select the best label from a list of four descriptors for sixteen common odors. All three tasks were repeated for sixteen times and each correct answer was scored as one point (range 0 to 16 for each task). TDI score (range 1-48) was calculated as the collective scores of odor threshold (T), odor discrimination (D) and odor identification (I) for each subject [13].

2.4. Statistical Analysis

Statistical analysis was performed by the SPSS software package for Windows (Statistical Package for Social Sciences, version 12.0, SPSS Inc., Chicago, Illinois, USA). Categorical variables were given as numbers and percentages and quantitative variables as mean ± standard deviation (SD), median, minimum and maximum values. Student's t-paired test was used for comparison of quantitative parametric variables with a normal distribution. In group comparisons of quantitative parameters with normal distribution, One way ANOVA and Tukey HSD test for posthoc analysis were used. Kruskal-Walls test was applied for quantitative parameters that did not follow a normal distribution. Categorical variables were compared with chi-squared test. The level of significance was set at $P < 0.05$.

3. Results

A total of 95 patients were included in this prospective, randomized controlled clinical study on the effects of three commonly used techniques; i.e. medial or lateral laminectomy or crushing of middle turbinate for the management of concha bullosa on nasal and olfactory functions. There were a total of 51 males (53.7%) and 44 females (46.3%) with the age range of 18 and 56 years (mean age 35.2±9.4 years). The randomization of the study patients to three groups was performed by randomized blocks; therefore, the distribution of the patients to each study group was balanced with 31 patients in the medial laminectomy group (17 male, 14 female, age range of 18 and 56, mean age 35.6±9.9), 32 patients in lateral laminectomy group (17 male, 15 female, age range of 19 and 52, mean age 33.8±9.5) and 32 patients in the crushing (17 males, 15 females, age range of 20 and 52, mean age 36.1±8.8). Baseline characteristics of the patients according to the study group they were assigned were summarized in Table 1. There was no difference between the groups with respect to age, gender or surgery with general or local anesthesia ($P > 0.05$). The comparison of baseline values for headache and obstruction evaluated using VAS, PNIF, and SNOT-22 scores of the patients indicated no statistically significant preoperative differences between the groups ($P > 0.05$ for all, Table 1). There was no difference between the groups according to the mean concha size determined during the surgery ($P > 0.05$, Table 1).

Table 1. *Baseline Characteristics of the Study Patients.*

		All patients (n = 95)	Medial Laminectomy (n = 31, 32.6%)	Lateral Laminectomy (n = 32, 33.7%)	Crushing (n = 32, 33.7%)	*P* value*
Age (years, mean ± SD)		35.2±9.4	35.6±9.9	33.8±9.5	36.1±8.8	0.593[a]
Gender (n, %)	Male	51 (53.7%)	17 (54.8%)	17 (53.1%)	17 (53.1%)	0.988[b]
	Female	44 (46.3%)	14 (45.2%)	15 (46.9%)	15 (46.9%)	
Anesthesia (n, %)	General	12 (12.6%)	3 (9.7%)	5 (15.6%)	4 (12.5%)	0.777[b]
	Local	83 (87.4%)	28 (90.3%)	27 (84.4%)	28 (87.5%)	
Headache (VAS, mean ± SD)		5.8±1.3	6.1±1.4	5.5±1.5	5.8±1.1	0.244[a]
Obstruction (VAS, mean ± SD)		6.4±1.0	6.6±0.9	6.4±1.0	6.3±1.1	0.311[a]
PNIF (mean ± SD)		77.6±8.3	76.4±8.8	78.1±8.7	78.3±7.6	0.623[a]
SNOT-22 (mean ± SD)		52.3±7.5	52.5±6.7	52.2±7.6	52.2±8.3	0.984[a]
Concha size (cm, mean ± SD)		2.6±0.9	2.7±1.0	2.5±1.0	2.7±0.8	0.579[c]

* $P < 0.05$ was considered as statistically significant.

[a] One Way ANOVA

[b] Chi-squared test

[c] Kruskal-Wallis test

SD=standard deviation; VAS= visual analogue scale, PNIF=peak nasal inspiratory flowmeter, SNOT-22=sinonasal outcome test-22.

The effect of surgical management of concha bullosa on headache, obstruction, PNIF and SNOT-22 was determined by comparing preoperative and postoperative evaluations performed 3 months after the surgery (Table 2). Accordingly, there was a statistically significant improvement in all the factors considered ($P < 0.001$ for all, Table 2). The comparison of three techniques; i.e. medial or lateral laminectomy or crushing of middle turbinate for the management of concha bullosa was summarized in Table III. The comparison of medial and lateral laminectomy groups with respect to the improvement in headache ($P >0.05$), obstruction ($P >0.05$), and SNOT-22 ($P >0.05$) scores revealed that the two techniques were comparable, except PNIF ($P = 0.011$), where the improvement with surgical management of concha bullosa with medial laminectomy was higher than that of laminal laminectomy (Table 3). The improvement in obstruction ($P < 0.001$), PNIF ($P < 0.001$) and SNOT-22 ($P = 0.006$) scores were significant in medial laminectomy when compared to crushing of middle turbinate (Table 3). However, there was no statistically significant difference in the change in headache VAS score between the two groups ($P > 0.05$, Table 3). Comparison of lateral laminectomy and crushing of middle turbinate groups revealed statistically significant difference between the groups with respect to the change in headache ($P < 0.001$), obstruction ($P < 0.001$), PNIF ($P = 0.022$) and SNOT-22 ($P < 0.001$) scores with better improvement in lateral laminectomy group (Table 3).

There was no difference between the groups with respect to preoperative olfactory functions ($P > 0.05$, Table 4). The preoperative olfactory functions and the changes in the olfactory performance of the study patients evaluated by the Sniffin' Sticks Extended Test with respect to T (odor threshold), D (odor discrimination), I (odor identification) and TDI values were summarized in Tables 4 and 5, respectively. The comparison of results in each group indicated that except the change in odor discrimination 3 months after crushing of middle turbinate ($P = 0.134$), olfactory functions of the patients were significantly better after surgical management of concha bullosa ($P < 0.05$ for all, Table 5). The comparison of three techniques; i.e. medial or lateral laminectomy or crushing revealed no significant differences between the groups with respect to improvement in olfactory functions, except the significant improvement in odor discrimination in medial laminectomy group when compared to crushing of middle turbinate ($P = 0.011$).

Table 2. *Operational Outcomes of Three Techniques Used in the Management of Concha Bullosa Evaluated at the Third Month After Surgery.*

	All patients			Medial Laminectomy		
	Pre-op	**3rd month**	**P value***	**Pre-op**	**3rd month**	***P* value***
Headache (VAS, mean ± SD)	5.8±1.3	3.6±1.2	*<0.001*	6.1±1.4	3.5±1.3	*<0.001*
Obstruction (VAS; mean ± SD)	6.4±1.0	4.4±0.9	*<0.001*	6.6±0.9	4.1±0.7	*<0.001*
PNIF (mean ± SD)	77.6±8.3	128.3±6.5	*<0.001*	76.4±8.8	132.4±5.2	*<0.001*
SNOT-22 (mean ± SD)	52.3±7.5	39.3±5.8	*<0.001*	52.5±6.7	38.2±4.5	*<0.001*

Table 2. *Continued.*

	Lateral Laminectomy			Crushing		
	Pre-op	**3rd month**	***P* value***	**Pre-op**	**3rd month**	***P* value***
Headache (VAS, mean ± SD)	5.5±1.5	3.0±1.0	*<0.001*	5.8±1.1	4.2±1.0	*<0.001*
Obstruction (VAS; mean ± SD)	6.4±1.0	4.2±0.5	*<0.001*	6.3±1.1	5.0±1.0	*<0.001*
PNIF (mean ± SD)	78.1±8.7	128.2±6.9	*<0.001*	78.3±7.6	124.3±4.8	*<0.001*
SNOT-22 (mean ± SD)	52.2±7.6	37.1±4.7	*<0.001*	52.2±8.3	42.4±6.5	*<0.001*

* $P < 0.05$ was considered as statistically significant. Data were analyzed by student t-paired test.
Pre-op=pre-operation; SD=standard deviation; VAS= visual analogue scale, PNIF=peak nasal inspiratory flowmeter, SNOT-22=sinonasal outcome test-22.

Table 3. *Comparison of Three Techniques for the Management of Concha Bullosa with Respect to Operational Outcomes for Headache, Obstruction, PNIF and SNOT-22.*

	Medial vs. Lateral Laminectomy	**Medial Laminectomy vs. Crushing**	**Lateral Laminectomy vs. Crushing**
Headache	0.152	0.058	*<0.001*
Obstruction	0.951	*<0.001*	*<0.001*
PNIF	*0.011*	*<0.001*	*0.022*
SNOT-22	0.706	*0.006*	*<0.001*

* $P < 0.05$ was considered as statistically significant. Data were analyzed by Tukey HSD test.
PNIF=peak nasal inspiratory flowmeter, SNOT-22=sinonasal outcome test-22.

Table 4. *Baseline Olfactory Functions of the Study Patients.*

	All patients	**Medial Laminectomy**	**Lateral Laminectomy**	**Crushing**	***P* value***
Odor threshold (T, mean ± SD)	11.9±0.8	11.7±0.9	12.0±0.7	12.0±0.6	0.294
Odor discrimination (D, mean ± SD)	12.7±0.7	12.7±0.8	12.6±0.6	12.7±0.6	0.670
Odor identification (I, mean ± SD)	12.7±0.5	12.7±0.5	12.7±0.5	12.7±0.5	0.860
TDI (mean ± SD)	37.3±1.1	37.1±1.1	37.2±1.1	37.4±1.1	0.519

* $P < 0.05$ was considered as statistically significant. Data were analyzed by OneWay ANOVA.
SD=standard deviation.

Table 5. *Changes in Olfactory Functions of the Study Patients Evaluated Three Months After the Surgical Management of Concha Bullosa.*

	All patients			Medial Laminectomy		
	Pre-op	**3rd month**	***P* value***	**Pre-op**	**3rd month**	***P* value***
Odor threshold (T, mean ± SD)	11.9±0.8	13.4±0.9	*<0.001*	11.7±0.9	13.1±0.9	*<0.001*
Odor discrimination (D, mean ± SD)	12.7±0.7	12.8±0.7	*0.034*	12.7±0.8	13.0±0.6	*0.003*
Odor identification (I, mean ± SD)	12.7±0.5	12.8±0.5	*<0.001*	12.7±0.5	12.9±0.5	*0.012*
TDI (mean ± SD)	37.3±1.1	39.2±1.2	*<0.001*	37.1±1.1	39.1±1.1	*<0.001*

Table 5. *Continued.*

	Lateral Laminectomy			Crushing		
	Pre-op	**3rd month**	***P* value***	**Pre-op**	**3rd month**	***P* value***
Odor threshold (T, mean ± SD)	12.0±0.7	13.5±0.8	*<0.001*	12.0±0.6	13.6±0.8	*<0.001*
Odor discrimination (D, mean ± SD)	12.6±0.6	12.8±0.6	*0.003*	12.7±0.6	12.5±0.6	0.134
Odor identification (I, mean ± SD)	12.7±0.5	12.8±0.5	*0.044*	12.7±0.5	12.8±0.5	*0.044*
TDI (mean ± SD)	37.2±1.1	39.3±1.2	*<0.001*	37.4±1.1	39.1±1.2	*<0.001*

* $P < 0.05$ was considered as statistically significant. Data were analyzed by student t-paired test.
Pre-op=pre-operational; SD=standard deviation.

4. Discussion

Concha bullosa, the pneumatization of the concha, is an obstructive anatomical variation with high prevalence (80%) in patients with chronic sinusitis [2, 6]. There are several techniques described for the management of concha bullosa including radical excision of middle turbinate to minimal excision of medial or lateral lamella, crushing of the middle turbinate, transverse excision, microdebrider turbinoplasty and diathermy [8, 10, 11, 14-21]. Almost all techniques result

in the improvement of life quality of the patient, whereas there are only a number of reports comparing these techniques with respect to surgical outcome on nasal and olfactory functions, mostly with contrary results. For example, Cannon [10] specified lateral excision of turbinate for treatment of concha bullosa; however, Braun and Stammberger [17] preferred lateral lamella removal over excision of medial lamella or crushing of the middle turbinate. Comparison with respect to concha bullosa volume a year after surgery showed that crushing with intrinsic stripping is more effective than crushing alone [22]. Kumral et al. [9] have recently compared medial and lateral laminectomy in 72 consecutive patients using VAS and PNIF for obstruction, SNOT-22 for sinonasal symptoms, and CCCRC smell test for olfactory functions before and 3 months postoperatively. They did not observe a significant difference between the groups for all parameters they have evaluated and concluded that the effectiveness of both methods were comparable[9]. Koçak et al. preferred crushing technique in all types of concha bullosa and founded that there was no recurrence in long term outcomes [23]. In this study, we used VAS, PNIF, SNOT-22 and Sniffin' Sticks Extended Tests to evaluate and compare the three different techniques; i.e. medial and lateral laminectomy, and crushing of the middle turbinate, in the management of concha bullosa in 95 patients.

Concha bullosa is long to known to cause headache and obstruction due to narrowing of middle turbinate [5, 24, 25]. The headache caused by concha bullosa is characterized by recurrent pain in the periorbital area, between the eyes, or in the cheeks and frontal bone [3]. Pain intensity is different between individuals and lasts between few hours up to several days [3]. Yarmohammadi et al. [25] in their randomized double blind clinical trial study with 44 patients proved the effectiveness of turbinoplasty in management of concha bullosa patients on relieving pain in rhonogenic headaches. In this study, we compared the surgical outcome of the use of medial or lateral laminectomy, or crushing on headache 3 months postoperatively using VAS, which was reported to be applied for the evaluation of nasal obstruction in patients with compromised nasal patency [26]. The results indicated that surgical management of concha bullosa with all three techniques caused less headache in the study patients (Table 2). The improvements observed after medial or lateral laminectomy, and medial laminectomy or crushing of middle turbinate were comparable ($P > 0.05$, Table 3). The comparison of VAS scores for nasal obstruction before and 3 months after the surgery with medial or lateral laminectomy, or crushing of the middle turbinate indicated that all techniques caused significant improvement in obstruction. When the three techniques were compared, the improvement in nasal obstruction with medial or lateral laminectomy was comparable ($P = 0.951$); however, the crushing of the middle turbinate was not as effective as the other techniques ($P < 0.001$ for both comparisons, Table 3).

PNIF is a cheap, easily performed and reproducible method suggested for evaluation of nasal airway obstruction in pediatric, adult and elderly population [26-31]. In this study, there was improvement in PNIF scores of the study patients with all three techniques ($P < 0.001$ for all, Table II), and the comparison of the techniques indicated significant difference between the groups ($P < 0.05$, Table 3). The best improvement in PNIF score was observed in the patients treated with medial laminectomy (Table 2).

In the comparison of the effect of three techniques in improvement of sinonasal symptoms was performed using SNOT-22 test. The comparison of SNOT-22 scores before and 3 months after the surgery with medial or lateral laminectomy or crushing of the middle turbinate indicated that all techniques caused significant decrease in sinonasal symptoms. When the three techniques were compared, the improvement in sinonasal symptoms with medial or lateral laminectomy was equally effective ($P = 0.706$); however, crushing of the middle turbinate was not as effective as the other techniques ($P < 0.05$ for both comparisons, Table 3).

The middle turbinate is responsible from deflecting the inspired air toward the olfactory epithelium, which is located within the olfactory cleft of the nasal cavity and covers the upper portion of the nasal septum and the superior and middle turbinates [11, 32]. Concha bullosa, therefore, results in impaired olfactory function, which is a very important factor for enjoying life, and personal mood behavior directly affecting the quality of life of the patient [9]. The location of middle turbinate olfactory neurofibers is not clear yet; however, Apuhan et al. [11] suggested the opening of the medial part of middle concha in turbinectomy, since olfactory marker staining of nerve tissue mainly observed in the medial part of concha. Apuhan et al. had found olfactory nerve tissue at least in the medial part of the middle concha bullosa than the other parts of concha in their research and they suggest to open medial part of the concha bullosa in concha bullosa surgery. We agree with their opinion. But in cases of concha bullosa with chronic sinusitis, the main problem could be obstruction of the middle meatus from concha bullosa. To solve this problem, we must choose the lateral lamella of the concha bullosa to open. In situation like this, lateral lamella of the concha bullosa could be sacrificed.

In this study, we evaluated the effect of three techniques used in the management of concha bullosa on olfactory functions using the Sniffin' Sticks Extended Test. There was improvement in olfactory functions of the study patients after surgical management of concha bullosa with all three techniques with respect to odor threshold, odor discrimination and odor identification (Table 5); however, there was no statistically significant difference between the techniques with respect to the improvement in olfactory abilities of the study patients, except the significant improvement in odor discrimination in medial laminectomy group, when compared to crushing of middle turbinate ($P = 0.011$, Table 5).

5. Conclusion

In this study, we aimed to compare the surgical outcome

of the three most commonly used techniques, i.e. medial or lateral laminectomy, or crushing of the middle turbinate for the management of concha bullosa on nasal and olfactory functions. Although the number of patients was limited, here we showed that all three techniques were comparably effective in improving the quality of life of the study patients with fewer headaches, less obstruction and better olfactory functions. The comparison of the three techniques, however, indicated the crushing of the middle turbinate was less effective than medial or lateral laminectomy in terms of improvement in nasal and olfactory functions, and, although comparable in terms of other factors, medial laminectomy resulted in better improvement in PNIF score. Therefore, we conclude that medial laminectomy should be considered as the surgical technique for the management of concha bullosa.

Conflict of Interest

The authors declare that they have no competing interests.

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