Central Asian Journal of Medical Sciences
CAJMS

Original Article

Cent Asian J Med Sci. 2021 Dec;7(4):321-329. https://doi.org/10.24079/CAJMS.2021.12.003

Postoperative Subjective and Objective Evaluation of Septoturbinoplasy Surgery in Mongolian Patients with Nasal Obstruction Symptom

Munkhbaatar Purev[1], Han Young Hoon[1], Tsogtjargal Gombogaram[2], Tamir Lkhagvasuren[1], Temuulen Batsaikhan[1], Altanzul Bataa[1], Gantulga Batbayar[1], Nyamdulam Logshir[1], Tsend-Ayush Altangerel[1], Ganchimeg Palamdorj[1]

[1]Department of Otorhinolaryngology, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia, [2]Jargal ENT Clinic, Ulaanbaatar, Mongolia

Submitted: November 4, 2021
Revised: November 10, 2021
Accepted: December 16, 2021

Corresponding Author
Ganchimeg Palamdorj, PhD
Department of Otorhinolaryngology, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar 16081, Mongolia
Tel: +976-9907-0533
E-mail: ganchimeg@mnums.edu.mn

Objectives: The aim of this study was to explore the subjective and objective measurements in assessing before and after nasal septoplasty with and without turbinoplasty surgery. **Methods:** This was a hospital-based pre and post clinical trial study of 80 patients with nasal septal deviation treated with nasal septoplasty with or without turbinoplasty in 2019-2020. Nasal patency was recorded subjectively and objectively before and 2.5 months after surgical treatment using a visual analogue scale (VAS), nasal obstruction symptom evaluation (NOSE), sino-nasal outcome test (SNOT-23) questionnaires, peak nasal inspiratory flow (PNIF) measure and internal nasal valve (INV) grading. **Results:** Nasal septoplasty (38 patients) and septoplasty with turbinoplasty (42 patients) were performed on 80 patients (60 males; 20 females) with a mean age of 37.5 years. The results showed a significant improvement of nasal passage condition in scales of VAS, NOSE, SNOT-23, as well as INV grading, and PNIF values after surgery. Septoplasty with turbinoplasty showed greater improvement in VAS and PNIF scores than septoplasty alone and this was even more significant for bilateral PNIF scores. **Conclusion:** We found VAS, NOSE, INV grading and PNIF measures to be reliable instruments in reporting results of surgery.

Keywords: Nasal Obstruction, Peak Nasal Inspiratory Flow, Internal Nasal Valve, Septoplasty, Turbinoplasty

Introduction

The most common etiology of nasal obstruction is caused from septal deviation that can be treated surgically. This most frequent anatomical cause can be accompanied by hypertrophy of the turbinate mostly contralateral to the deviation [1]. If there is no effective result with medical treatment of nasal obstruction, septal deviation and turbinate hypertrophy should be corrected surgically by septoplasty and turbinate reduction surgery, respectively. But indications for these operations usually depend on the surgeon's clinical background alone without using objective measurements.

Septoplasty is surgical correction of the deviated nasal septum, and is the most common ear nose and throat (ENT) operation in adults [2]. Septoplasty is mainly performed in combination of turbinate reduction surgery which is called turbinoplasy. However, indications are often practice-based rather than evidence-based and internationally accepted guidelines are lacking [3]. In the United States, the annual septoplasty rate was 8.7 per 10,000 inhabitants in 2006 [4]. The main indication for septoplasty is nasal obstruction, commonly defined as an unpleasant sensation of insufficient airflow through the nose [4].

The goal of septoplasty (with or without concurrent turbinate surgery) is to widen nasal passages and thereby improve nasal airflow [5]. The results of surgery were not always satisfactory and preoperative objective measurements might therefore improve the selection of patients for surgery.

There are several objective measurements used in otorhinolaryngological practice in order to access state of nasal obstruction. In this case, rhinomanometry is regarded as the gold standard in objective measurements of nasal obstruction, but it is relatively expensive and time consuming and required some experience. Therefore, its use is not applicable to every level of ENT clinics, instead rhinomanometry is more often used in well-equipped clinical centers.

In contrast, a peak nasal inspiratory flow (PNIF) meter is inexpensive, and measurements are quick and easy to perform [6]. It can be used at any level of ENT clinical practice and is suitable for serial measurements. Interestingly, PNIF sensitivity, specificity, and diagnostic accuracy are not significant different from active anterior rhinomanometry measurements [7]. Previous studies used mainly bilateral PNIF measurement alone [7, 8], however it can be more informative when it is measured unilateral, combined unilateral (left + right) PNIF and bilateral PNIF [9].

Moreover, other researchers have used objective method of analysing the static component of the internal nasal valve by measuring the degree of middle turbinate visualisation, which served as a marker for internal nasal valve (INV) obstruction. The INV is located approximately 1.3 cm from the nares and is typically the narrowest portion of the nasal cavity. It is a cross-sectional area bounded medially by the dorsal septum, laterally by the caudal portion of the upper lateral cartilage, and inferiorly by the head of the inferior turbinate [10]. Even though there is scanty data about using INV grading, we considered INV grading to be more practical and an easy evaluation of obstruction caused by the internal nasal valve [11]. It can be performed with any nasal speculum or 0 degree scope during anterior rhinoscopic examination.

Beside the importance of measuring objective outcomes, it is necessary to evaluate subjective outcomes before and after surgical treatment. For this purpose, international researchers report the use of additional subjective outcome measures such as visual analogue scale (VAS) [12, 13], nasal obstruction symptom score (NOSE) questionnaire [13] and the sino-nasal outcome test-23 (NOSE-23) [10].

None of the international scientific journals have published nasal patency subjective and objective measurement studies in Mongolia. Thus, the primary purpose of our study was to assess the clinical value of the above mentioned subjective and objective measurements in the evaluation of before and after septoplasty and septoplasty with turbinoplasty surgery.

Materials and Methods

Study design and patients recruitment

This hospital-based pre and post clinical trial study was performed on 80 patients (60 men and 20 women within 22-61 years old) with nasal septal deviation treated with nasal septoplasty with or without turbinoplasty at University Central Hospital of Mongolian National University of Medical Sciences from March 2019 to March 2020.

Exclusion criteria were patients under age of 16 years, inability to give informed consent, incomplete data and those undergoing concomitant procedures.

Septoplasty technique

Nasal septoplasty was performed under general anesthesia using nasal speculums and headlight illumination for better visualization. The nasal mucosa was decongested by topical 1:100,000 epinephrine soaked cotton pledges. One percent lidocaine solution with 1:100,000 epinephrine is then injected along the septum bilaterally in the subperichondral layer in an anterior to posterior direction until the mucosa is well blanched. The injection assists not only with local anesthesia and hemostasis but also with hydro-dissection. After a few minutes for vasoconstriction, either a Killian or hemi-transfixion incision was made using a 15 blade cutting the mucosa and

perichondrium but sparing the cartilage itself. The side of the incision depends on surgeon preference, but it was mostly on the left side. The Killian incision was made 0.5 - 0.7 cm posterior to the caudal septal margin, when the deviation involved only the middle to posterior aspect of the septum. A curved suction elevator used to dissect the perichondrium with mucosa from the cartilage in an intact fashion. The dissection continued broadly over and beyond the septal deformity, with care taken during flap elevation along the septal deviation or spur to avoid tearing the mucosa at these sites. Long nasal speculums were used when needed throughout the procedure to ensure adequate visualization of the most posterior part of the septum. After the ipsilateral flap was elevated, a15 blade is used to gently incise the cartilage anterior to the site of the deviation and the contralateral flap is elevated. Care was taken to avoid tearing through the contralateral mucosa at the time of the cartilage incision and contralateral flap elevation to prevent septal perforation. Of note, an adequate L-strut was preserved to prevent loss of external nasal support and subsequent external nasal deformity. Once both mucoperichondral flaps are elevated, true-cut Jansen Middleton forceps were used to incise the cartilage superiorly and inferiorly to isolate the segment of deviated septum. The remaining deformity was grasped using Craig septum forceps, separated from its posterior attachment using a rotational movement in an anteriorposterior axis, and subsequently removed. Any remaining posterior bony deviation was subsequently resected using True-cut Jansen Middleton forceps. After the septal deformity resection, the mucoperichondral flaps were reapproximated and the initial mucosal incision closed using an absorbable 4.0 vicryl suture. Disposable fingertip filled with gauze inside packing smeared with tetracycline 1% ophthalmic ointment was placed bilaterally to compress the flaps together. Anterior packings were removed after 48 hours postoperatively.

Turbinoplasty technique

The inferior turbinates were infiltrated with an intra-thecal 22 gauge needle delivering lidocaine 1% and 1:100 000 epinephrine solution for additional anaesthesia and haemostasis.

A longitudinal incision was made running inferiorly from the caudal end of the inferior turbinate up to the anterior portion, using a sickle knife or number 11 blade, and completed with a turbinate scissors when necessary. The medial mucoperiosteal layer of the turbinate was elevated from the bony part of the turbinate in an antero-posterior direction, and from the inferior to the superior border of the turbinate, using a Freer elevator and the tip of the suction tube. In cases in which the inferior incision failed to completely release the mucoperiosteal flap, we additionally used turbinate scissors to cut the bone.

After elevation of the flap, the turbinate bone was completely denuded on its medial surface. Turbinate scissors were introduced perpendicular to the dissected inferior turbinate and cut off an adequate volume of the turbinate, working in an antero-posterior direction. After partial excision of the turbinate bone with its attached lateral mucosa, the posterior end of the turbinate was cauterised to avoid late bleeding. The previously elevated medial mucosal flap was then laterally rotated and repositioned to cover the remaining denuded turbinate bone and mucosal stump.

This mucosal flap was secured in place by the introduction of a disposable glove fingertip packing and the whole unit smeared with tetracycline 1% ophthalmic ointment. The anterior packing was removed after 48 hours.

Pre and post-operative subjective and objective measurement

Pre- and postoperatively all patients completed the Nasal Obstruction Symptom Evaluation (NOSE) score and Sinonasal Outcome Tool (SNOT-23) questionnaires alongside a Visual Analogue Scale (VAS) comprising a 10-cm linear scale in which patients rated their nasal obstruction (unilateral and bilateral). The SNOT-23 and NOSE scores were chosen for scoring systems in pre- and post-operative evaluation of the surgery.

Prior to the clinical examination which included nasal endoscopy, peak nasal inspiratory flow (PNIF) measurements were performed using a Youlten PNIFmeter (Clement Clark International). The patient was seated, rested for 15 minutes and cautiously blew his nose. The airflow was first measured bilaterally, then on the right, and finally on the left side. Three readings were recorded for each of the measurements, but only the best was used for the evaluation. We used nonpermeable silk tape to close the non tested nasal nostril taking care not to deform the shape of the nostril. All PNIF scores are expression in L/minute. The internal nasal valve (INV) was graded according to the degree of middle turbinate visualisation. On endoscopic imaging, this was assessed in each nostril at rest and at the level

of the head of the inferior turbinate. On anterior rhinoscopy, INV was graded based on a horizontal line at the level of the head of the inferior turbinate. Grade 0 signifies that the head of the middle turbinate is easily visible. Grade 1 signifies that the middle turbinate is partially obscured. Grade 2 signifies that the middle turbinate is not visible. A maximum grade 2 was given for each nostril (Fig. 1). INV grading was documented on the day of surgery and at the patient's second postoperative visit. Two and half months postoperatively the patients were recalled for a clinical examination. The patient first completed the postoperative version of the nasal surgical questionnaire with NOSE and SNOT-23 questionnaires followed by the PNIF and INV measurements.

Statistical analysis

Continuous data were presented as means with standard deviations (SD) and categorical variables in numbers (percent) (Table 1). Paired-sample t-tests were used to analyse pre- to postoperative changes in NOSE, SNOT-23, VAS, PNIF and INV scores (Table 2, 3). Group comparisons of pre and postoperative VAS and PNIF measures were performed with independent-sample t-tests (Table 4). A p-value less than 0.05 was considered statistically significant. All analyses were conducted using SPSS for Windows, version 19.0 (IBM Corp, Armonk, NY).

Ethical statement

The study was approved by the Research Ethics Committee of the Mongolian National University of Medical Sciences) (No13-03/1A). All patients provided written informed consent before participating in this study.

Results

Study population involvement

A total of 80 patients were followed up with 60 male (75%), 20 female (25%) and a mean age of 37.5 ± 9.56 years (95% CI 22 – 61). Mean follow-up was 78 days. Patients within age group 20 - 29 years were 18, 30 - 39 years were 30, 40 - 49 years were 22, 50 - 59 years were 8, 60 - 69 years were 2, respectively. Patients with age ≥ 35 years were 46, and with age < 35 years were 34, respectively. There were 32 daily smokers, 54 patients with trauma history, 40 patients were daily using decongestant, and 20 reported having had nasal allergic symptoms at one time or another during the past year. Detailed information of

Table 1. Descriptive statistics of participant's age and gender.

Variables	Male (n = 60) Mean ± SD	Female (n = 20) Mean ± SD	Total (n = 80) Mean ± SD
Age, years	36.33 ± 10.17	40.8 ± 6.83	37.45 ± 9.56
	N (%)	N (%)	N (%)
Age groups			
20-29	18 (30)	-	18 (22.5)
30-39	22 (36.7)	8 (40)	30 (37.5)
40-49	10 (6)	12 (60)	22 (27.5)
50-59	8 (4.8)	-	8 (10)
60-69	2 (1.2)	-	2 (2.5)
Age ≥ 35	32 (53.3)	14 (70)	46 (57.5)
Age < 35	28 (46.7)	6 (30)	34 (42.5)
With rhinitis medicamentosa	28 (46.7)	12 (60)	40 (50)
Without rhinitis medicamentosa	32 (53.3)	8 (40)	40 (50)
Allergic	10 (16.7)	10 (50)	20 (25)
Nonallergic	50 (83.3)	10 (50)	60 (75)
With trauma	44 (73.3)	10 (50)	54 (67.5)
Without trauma	16 (26.6)	10 (50)	26 (32.5)
Smoker	26 (43.3)	6 (30)	32 (40)
Nonsmoker	34 (56.7)	14 (70)	48 (60)

Table 2. Pre- and postoperative measures.

Measure	Preoperative (n = 80) Mean ± SD	Postoperative (n = 80) Mean ± SD	p-value
NOSE	50.38 ± 22.99	8.50 ± 11.45	0.000
SNOT 23	24.82 ± 15.73	4.42 ± 4.62	0.000
Bilateral VAS	6.13 ± 2.31	0.38 ± 0.54	0.000
Right VAS	4.45 ± 2.54	0.45 ± 0.59	0.000
Left VAS	5.53 ± 2.63	0.65 ± 0.62	0.000
PNIF bilateral	148.37 ± 45.10	209.50 ± 41.63	0.000
PNIF right	96.87 ± 36.49	133.87 ± 26.52	0.000
PNIF left	79 ± 33.80	128.87 ± 28.90	0.000
INV right	0.8 ± 0.85	0.05 ± 0.22	0.000
INV left	1.25 ± 0.89	0.13 ± 0.33	0.000

PNIF measured in l/min

Table 3. Postoperative improvement in PNIF scores.

Measure	Number	Preoperative (n = 80) Mean ± SD	Postoperative (n = 80) Mean ± SD	Improvement	p-value
Septoplasty only					
PNIF bilateral	38	151.05 ± 46.18	203.16 ± 48.08	52.11	0.001
PNIF right	38	101.58 ± 45.00	131.05 ± 28.46	29.47	0.001
PNIF left	38	75.79 ± 39.76	120.53 ± 26.56	44.74	0.001
PNIF right + left	38	177.37 ± 60.17	252.10 ± 46.37	74.73	0.001
Septoplasty with turbinoplasty					
PNIF bilateral	42	145.95 ± 45.10	216.19 ± 40.18	70.24	0.001
PNIF right	42	92.62 ± 27.09	136.90 ± 25.81	44.28	0.001
PNIF left	42	81.90 ± 28.04	137.38 ± 28.53	55.48	0.001
PNIF right + left	42	173.57 ± 46.02	269.52 ± 41.53	95.95	0.001
Total sample					
PNIF bilateral	80	148.38 ± 45.09	209.50 ± 41.63	61.12	0.001
PNIF right	80	96.88 ± 36.49	133.88 ± 26.52	37.00	0.001
PNIF left	80	79 ± 33.80	128.88 ± 28.90	49.88	0.001
PNIF right + left	80	175.37 ± 52.54	260.50 ± 44.36	76.73	0.001

PNIF measured in l/min

participant's age groups and gender differences are shown in Table 1.

Pre- and postoperative outcome measures

Table 2 summarises pre- and postoperative outcome measures. This demonstrates statistically significant reductions in subjective scores (SNOT-23, NOSE, VAS) postoperatively.

There was statistically significant improvement in unilateral and bilateral PNIFs postoperatively. In addition, the internal valve grading was significantly reduced postoperatively (Figurs 2, 3).

Septoplasty with turbinoplasty was performed on 42 of the patients, while septoplasty alone was performed on the remaining 38 patients. The pre- and postoperative and change scores for the VAS and unilateral, combined unilateral (i.e., left + right), and bilateral PNIF for septoplasty, septoplasty with turbinoplasty, and total sample are shown in Table 3.

There were statistically significant improvements in VAS and all PNIF scores after surgery in all three groups. Septoplasty with

Table 4. Preoperative and postoperative VAS and PNIF scores by patient characteristics.

Characteristic	n	VAS			PNIF		
		Preoperative (n = 80) Mean ± SD	Postoperative (n = 80) Mean ± SD	p- value	Preoperative (n = 80) Mean ± SD	Postoperative (n = 80) Mean ± SD	p- value
Male	60	6.43 ± 2.09	0.50 ± 0.63	0.001	150.66 ± 45.78	214.33 ± 41.41	0.001
Female	20	5.20 ± 2.78	0.30 ± 0.48	0.001	141.50 ± 44.60	195.00 ± 40.89	0.003
Age ≥ 35 years	46	6.00 ± 2.54	0.35 ± 0.49	0.001	138.04 ± 39.91	208.70 ± 36.34	0.001
Age < 35 years	34	6.29 ± 2.02	0.41 ± 0.62	0.001	162.35 ± 49.06	210.59 ± 49.05	0.001
With rhinitis medicamentosa	40	7.00 ± 2.29*	0.45 ± 0.51	0.001	143.25 ± 47.47	204.50 ± 35.61	0.001
Without rhinitis medicamentosa	40	5.25 ± 2.02*	0.30 ± 0.57	0.001	153.50 ± 43.20	214.50 ± 47.29	0.001
Allergic	20	6.60 ± 2.59	0.20 ± 0.42	0.001	147.00 ± 46.44	207.00 ± 30.93	0.001
Nonallergic	60	5.97 ± 2.23	0.43 ± 0.57	0.001	148.83 ± 45.44	210.3 ± 45.06	0.001
With trauma	54	5.81 ± 2.18	0.48 ± 0.58	0.001	146.30 ± 46.10	209.63 ± 44.42	0.001
Without trauma	26	6.77 ± 2.52	0.15 ± 0.38	0.001	152.69 ± 42.36	209.23 ± 36.85	0.001
Smoker	32	6.94 ± 2.20	0.56 ± 0.63	0.001	158.13 ± 58.33	220.00 ± 32.66	0.001
Nonsmoker	48	5.58 ± 2.26	0.25 ± 0.44	0.001	141.88 ± 33.45	202.50 ± 45.10	0.001

* p value was < 0.05 by the independent-sample t-test on group comparison

turbinoplasty showed even more improvement in VAS and all PNIF scores. For bilateral PNIF ratings this was significant (p = 0.01).

As shown in Table 4, the preoperative VAS score was lower in group of non-rhinitis medicamentosa patients than in rhinitis medicamentosa patients (p = 0.015). When we checked the independent-sample t-test, there were no statistically significant differences in mean preoperative, postoperative, or change in PNIF scores between groups of males and females (p = 0.092), between between older (≥ 35 years) and younger patients (p = 0.48), between patients reporting rhinitis medicamentosa and without (p = 0.479), between patients reporting and not

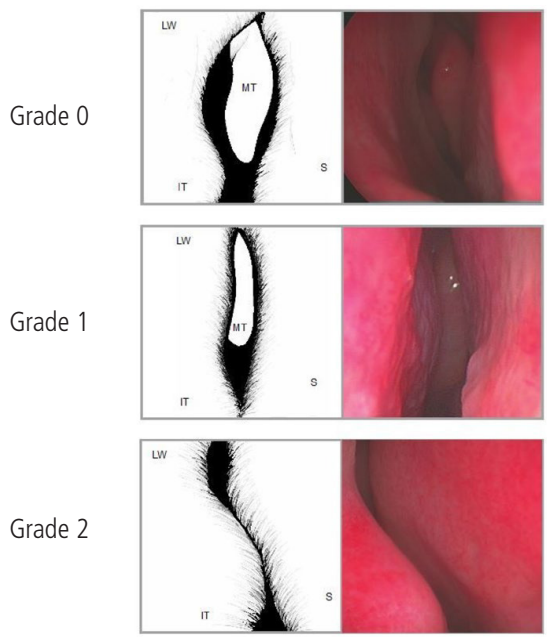

Figure 1. INV grading. *MT* Middle turbinate, *IT* inferior turbinate, S septum, *LW* lateral wall. Measurement is made using a Thudicum's speculum on anterior rhinoscopy or a 0° Hopkins rod placed at the level of the head of the inferior turbinate. Grade 0 the middle turbinate is easily visible including the head. Grade 1 the middle turbinate is partially obscured and in Grade 2 the middle turbinate is not visible.

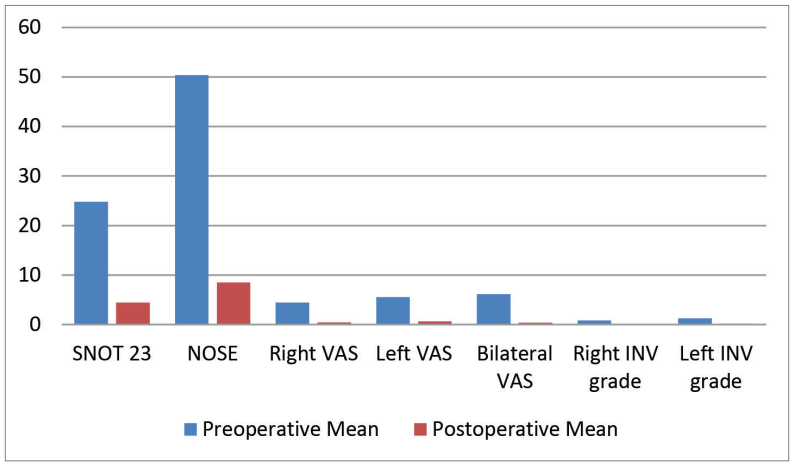

Figure 2. Pre- and postoperative measures.

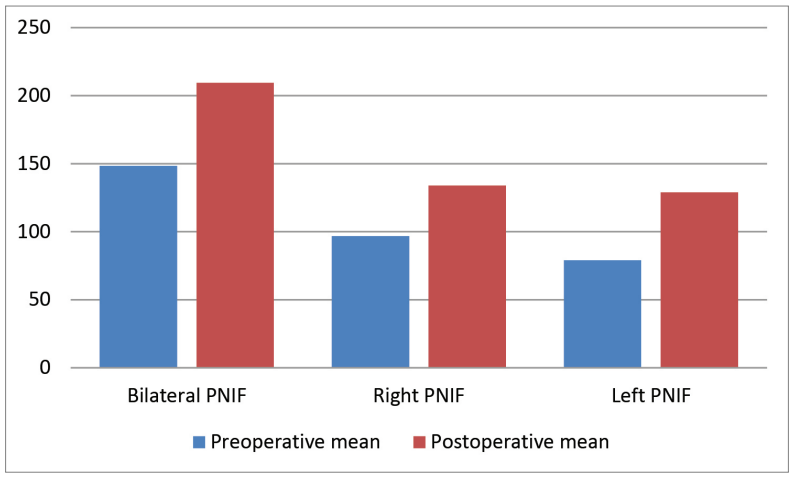

Figure 3. Postoperative improvements in unilateral and bilateral nasal inspiratory peak flow (PNIF 1/min).

reporting allergic rhinitis ($p = 0.91$), between patients with trauma history and without ($p = 0.68$), or between smokers and nonsmokers ($p = 0.27$).

Whereas when we performed the paired sample t-test on pre and postoperative VAS and PNIF scores, there were changes in each consecutive group. They were all statistically significant ($p < 0.05$).

Discussion

In this pre and post study of the results of nasal septal surgery, we found statistically significant improvement in both subjective (VAS, NOSE, SNOT-23) and objective (INV, unilateral, combined and bilateral PNIF) measurements following nasal surgery whether septoplasty alone or septoplasty with turbinoplasty was performed. Septoplasty with turbinoplasty showed more improvement in all measurements than septoplasty alone. We believe this may be due to the surgical removal of more of the skeletal structures in the nose when turbinoplasty is also performed.

The improvement in subjective scores after nasal surgery in our study is similar to other studies of nasal surgery [9, 12, 14-16] both for septoplasty alone and for septoplasty with turbinoplasty. It is also beneficial for patients to see how their scores have improved following intervention. Especially visual analogue score is often thought to represent the best measure for identifying nasal obstruction [17].

The improvement in bilateral PNIF values after septoplasty is similar to one report [12] but lower than in another [15]. The degree of improvement in bilateral PNIF ratings in septoplasty

with turbinoplasty was similar to several other studies [18, 19] and also to studies on septorhinoplasty [16, 20]. In our study, the overall mean preoperative bilateral PNIF score was lower than the reference value of 120 L/min considered discriminative between obstructive and normal value [7], while the mean postoperative PNIF value was well above this reference.

Our study demonstrates significant postoperative improvements in INV alongside with subjective and objective measures. These data may be useful to highlight the efficacy of septoplasty and septoplasty with turbinoplasty surgery, particularly in view of increasing commissioning restrictions.

Internal nasal valve grading is a simple and reproducible grading to objectively assess nasal obstruction. These grades can therefore be affected by a multitude of pathologies such as septal deviation, turbinate hypertrophy, inferior displacement of the upper lateral cartilages or a narrowed pyriform aperture [11].

The American Academy of Otolaryngology reported that internal nasal valve plays a distinct role in nasal obstruction and the surgery is an effective treatment option [21].

Internal nasal valve obstruction can be caused by a static structural abnormality (high septal deviation

or an enlarged turbinate) or by a dynamic collapse abnormality of the upper lateral cartilage/lateral nasal wall on inspiration secondary to a weakness in the integrity of the upper lateral cartilage/nasal side wall. Static and dynamic INV collapses are distinct entities but can also coexist. Collapse of the internal nasal valve is thought to be a common cause for nasal obstruction [16] according to Bernoulli's principle.

In our study, preoperative VAS scores were higher in the rhinitis medicamentosa group than non-rhinitis medicamentosa group. Nasal medications influence the nasal mucous membrane. Nasal decongestants cause a detumescence of the mucosa. Daily use, however, causes rhinitis with a swelling of the mucosa. Thus, this condition may have caused a preoperative increase in nasal obstruction.

Compared to our study, the ratio of females to males was higher in two studies [12, 19] and similar in four other [16, 20, 22, 23]. In one study [15], the gender ratio was not reported.

The mean age was similar across all studies. Therefore, our sample seems to be demographically similar to other studies and likely representative of patients treated with septoplasty with or without turbinoplasty.

Two studies reported different effects of smoking on PNIF values [24, 25]. In our study, we did not find any significant difference in PNIF values in smoker, or those with allergy. The subjective obstruction scores and PNIF data in our and other studies are so similar that confounder items may only have a minor influence.

A limitation of our study is that we have not performed PNIF after decongestion and we recommend that this should be done in upcoming studies. Therefore, in future studies in order to obtain more realistic results without effects of the physiologic nasal cycle, we are planning to use decongestant on all patients before measuring unilateral and bilateral PNIF pre and post operatively.

Conclusion

Our findings of objective and subjective measurements are in line with most other studies. The subjective and objective improvements were significant showing that the subjective and objective instruments are valid. Septoplasty with turbinoplasty showed better improvement particularly with bilateral PNIF scores, indicating better improvement in breathing, than septoplasty alone.

Conflict of Interest

The authors declare that they have no conflict of interest.

Acknowledgements

We would like to express our sincere gratitude to the University Central Hospital of Mongolian National University of Medical Sciences.

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