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Airflow Considerations and the Effect of Webster's Triangle in Reduction Rhinoplasty

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Abstract

Background Reduction rhinoplasties, regardless of the methods used (structural or preservation), can cause a reduction in the internal nasal volume, which may lead to breathing problems. In 1977, Webster proposed preserving a little triangle in the beginning of the lower lateral osteotomy line to prevent breathing problem. However, its importance is still controversial.

Objectives and methods: This prospective randomized controlled study (level of evidence 1) included 46 patients without nasal breathing problem. High-to-low (Webster's triangle preservation) osteotomy (control group, $n = 23$) and low-to-low osteotomy (study group, $n = 23$) were performed. All operations were performed according to the proposed volumetric rhinoplasty steps (examination/measurement, prevention and treatment). Nasal obstruction symptom evaluation (NOSE) test, visual analog scale, acoustic rhinometry, rhinomanometry, peak nasal inspiratory flow (PNIF), and three-dimensional measurements were performed in all patients. Breathing tests were repeated before and 6 months after surgery with and without xylometazoline administration.

Results No statistically significant difference in NOSE and visual analog scale scores was found between the two groups. Acoustic rhinometry, PNIF, and rhinomanometry findings showed no statistically significant breathing difference between the two groups.

Conclusions In reduction rhinoplasties, a decrease in the internal volume may be expected as directly proportional with the reduction amount. The decrease in the internal volume may create nasal breathing problems. To prevent it, nasal airflow should be adjusted according to new anatomy. In this study, we discussed "volumetric rhinoplasty" steps to prevent breathing problems in reduction rhinoplasty. Following these steps, not preserving Webster's triangle (low-to-low osteotomy) has no effect on the nasal airway.

Level of Evidence II This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Rhinoplasty · Reduction rhinoplasty · Nasal breathing · Nasal osteotomy · Septum · Turbinate · Nasal airway

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Introduction

Rhinoplasties can simply be divided into four categories: reduction, augmentation, reduction–augmentation, and cartilage reshaping. Reduction rhinoplasties can cause a reduction in the internal nasal volume, which may lead to breathing problems. In 1977, Webster et al. proposed to preserve a little triangle in the beginning of the lower lateral osteotomy line to prevent breathing problems as a result of the narrowing in the internal nasal valve area [1].

However, there are controversial observations and findings about Webster's triangle. In 1995, Grymer examined 37 patients in whom she evaluated the minimum cross-sectional areas (MCA) and pyriform aperture cross-sectional areas (PACSA) with an acoustic rhinometry. She found 22% and 11%–13% narrowing in these areas, respectively [2]. Guyuron performed an intraoperative measurement study in 1998. He found that low beginning lateral osteotomy caused 28.38% and high beginning lateral osteotomy (Webster's triangle preservation) caused 15.38% narrowing in the airway, showing statistically significant difference [3]. Then, Grymer et al. conducted a cadaveric study in 1999. They compared Webster's triangle-sparing high lateral osteotomy with low lateral osteotomy and found no statistically significant difference between these groups [4]. However, they found narrowing in the MCA and PACSA of both groups. Many studies concluded that sparing Webster's triangle has no effect on the nasal airway [5, 6]. Hence, should we spare Webster's triangle? In this study, we discussed "volumetric rhinoplasty" to prevent breathing problems in reduction rhinoplasty.

Methods

This prospective randomized controlled study included 46 women (sample size was calculated a-priori to have power >0.90) who underwent surgery between 2016 and 2018 by first author. Randomization was maintained by consecutiveness. The first 23 patients were included in the control group (high-to-low lateral osteotomy, performed 3 mm–4 mm anterior to the aperture[3]), and the second 23 patients were included in the study group (low-to-low lateral osteotomy) (Fig. 1). All study participants provided informed consent, and the study was performed according to the Helsinki Declaration and local ethical board approval.

Patient Selection Criteria

Female patients who underwent reduction rhinoplasty had ≥2 mm dorsal hump (calculated with 3D Vectra^{TM} device), aged <50 years, and had nasal obstruction symptom evaluation (NOSE) score <20 were included. The exclusion criteria were as follows: history of rhinoplasty or septoplasty; history of concha or valve surgery; short nasal bone (the caudal margin of the nasal bones is ≥3 mm cephalic to

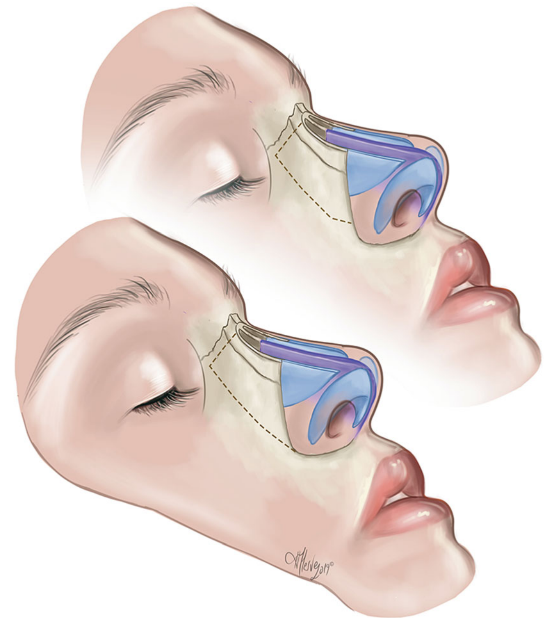

Fig. 1 High-to-low (Webster's angle sparing) (above) and low-to-low (below) lateral osteotomies

the mid-nasal length[3]); indication for nostril reduction; history of asthma, allergic rhinitis, atrophic rhinitis, and vasomotor rhinitis; chronic systemic disease; radiotherapy history to the head and neck region; any lower inspiratory tract disease such as sarcoidosis or Wegener granulomatosis; and patient refusal.

Measurements and Tests

After a detailed medical history assessment, a comprehensive physical examination was performed. Nasal cavities were examined with a speculum and a flexible endoscope (Storz CC-MAC, 8403ZX, Germany). Positions of the septum and concha, mucosal activity, and all irregularities were recorded. The lower conchas (tip position) were classified as anterior, normal, or posterior according to the pyriform aperture [3]. Valve insufficiency was assessed by a modified Cottle test and endoscopy.

All tests were conducted under a room condition of 22°C–25°C temperature and 50%–60% humidity after a 15-min resting period. Tests were performed 1 week before and 6 months after (for functional evaluation, 2–6 months were proposed in the literature [5–9]) the surgery and were repeated 15 min after intranasal application of topical xylometazoline 1 mg/ml (Otrivine, Novartis, Switzerland). By this standardization protocol, factors such as congestion, seasonal changes, and temperature changes were eliminated [10]. All tests were carried out by an experienced nurse blinded to the grouping. In addition, patients did not know their group allocation. All patients filled the NOSE questionnaire [11]. A visual analog scale (VAS, 1 worst, 10 best) score was obtained based on the appraisal of the patient and four laypersons.

Acoustic rhinometry measurements were conducted with GM™ (GM Instruments, Irvine, England) device. Measurement was performed for the right and left sides both prior and after decongestion. The device calculated the mean values of four measurements automatically. Peak nasal inspiratory flow measurement (PNIF) was also performed. The highest value after three measurements (liter/minute) was recorded. It was performed for both nostrils at the same time and each of them separately. Anterior rhinomanometry test was also performed. It was carried out under 150 Pa as previously defined by Mertz et al [12]. The system calculated the mean value of four repeated measurements (Pa/cm3/second). Because the results of these tests vary by age and sex and require patient cooperation as well as healthy lung capacity, female patients under 50 years old were selected for this study. In addition, tests were performed by the same experienced nurse with appropriate gentle mask placement to prevent the effects of the mask on the valve areas.

Standard two-dimensional imaging was carried out using a Canon D80 camera (Canon Inc., Japan) and two para-flashes. Three-dimensional measurements and imaging were conducted using Vectra XT™ device (Canfield Scientific, NJ, USA) which was validated in previous literature [13, 14].

Surgical Technique

All patients underwent surgery under general anesthesia. To obtain adequate hemostasis, infiltration of 1/100.000 of adrenalin solution was performed. Xylometazoline (1 mg/mL)-impregnated gauzes were applied for 20 min. Open rhinoplasty was performed in all patients. The lower conchas were treated with a radiofrequency device (Celon, Olympus Corporation, Tokyo, Japan). Then, they were lateralized with an Aufricht retractor. After the removal of the xylometazoline-impregnated gauzes applied at the beginning of the surgery, if there was no optimal shrinking observed in the lower concha, submucosal bone reduction was performed. Bullous middle conchas were treated with partial lateral excision and lateralization of the medial segment. Septoplasty was performed in all patients either for functional reasons or for harvesting of cartilage graft. Cartilage graft harvesting was performed over the maxillary crest area. A C-shaped septum at least of 1 cm–1.5 cm width (1.5 cm dorsal part, 1 cm caudal part) was preserved.

The dorsal bony hump (cap) was reduced using osteotomes and Piezotome device (ultrasonic bone cutter and micromotor combination, Acteon, France). Medial oblique or transverse osteotomies were performed with Piezotome, and lateral osteotomies were carried out endonasally or with a 2-mm osteotome externally (if the bony base was wide and the bones were very rigid during medial oblique osteotomy, external osteotomy was preferred to enhance control and to prevent ice-crack break, if they were not, endonasal osteotomy was performed.)

After these maneuvers, the cartilage dorsum was closed with 5/0 polyglyconate suture (Maxon, Covidien Ltd., Dublin, Ireland) using the spreader flap technique. After performing appropriate tip maneuvers, redundant septal mucosa was re-draped in the posterocephalic direction with continuous 5/0 polyglactin 910 (Rapide Vicryl, Ethicon, Bridgewater Township, NJ, USA) and 5/0 polyglyconate (Maxon, Covidien) (Fig. 2) sutures. During dorsum closure, the lateral wall inclination angle was kept the same. Then, Doyle splints were placed and fixed. To support the lateral wall position and angle, 3% bismuth tribromophenate-impregnated gauzes (Xeroform–Kendall, Medtronic, Ireland) were placed over these splints (Fig. 3). The size of the splints was depended on the reduction degree. For example, it is smaller for 2 mm dorsal reduction than 5 mm reduction. After splinting, the dorsum position and lateral wall angles were checked again. If there was any irregularity, they were rasped with a high-speed ball head micromotor (Acteon, France). Skin and mucosal closures were performed using 6/0 polypropylene (Prolene, Ethicon, USA) and 5/0 polyglactin 910 (Rapide Vicryl) sutures, respectively. External splinting was performed with Denver thermoplastic splint (Denver Splint Co., Centennial, CO, USA).

Statistical Analysis

Paired sample t test, independent sample t test, Mann–Whitney U test, and Wilcoxon sign tests were used for statistical analysis. P value <0.05 is accepted as significant. SPSS version 25 (IBM Corp., Armonk, NY, USA) was used for these analyses.

Results

This study analyzed 46 female patients, who were divided into the control group (n = 23) and study group (n = 23) (Fig. 1). The follow-up period was 6–24 (mean 12.3±5.8) months, and the patient age ranged from 18 to 48 (mean 29.1±6.9) years.

In the control group, 13 patients had anterior and six patients had posterior lower concha position, while four of them had normally located concha. In study group, 12

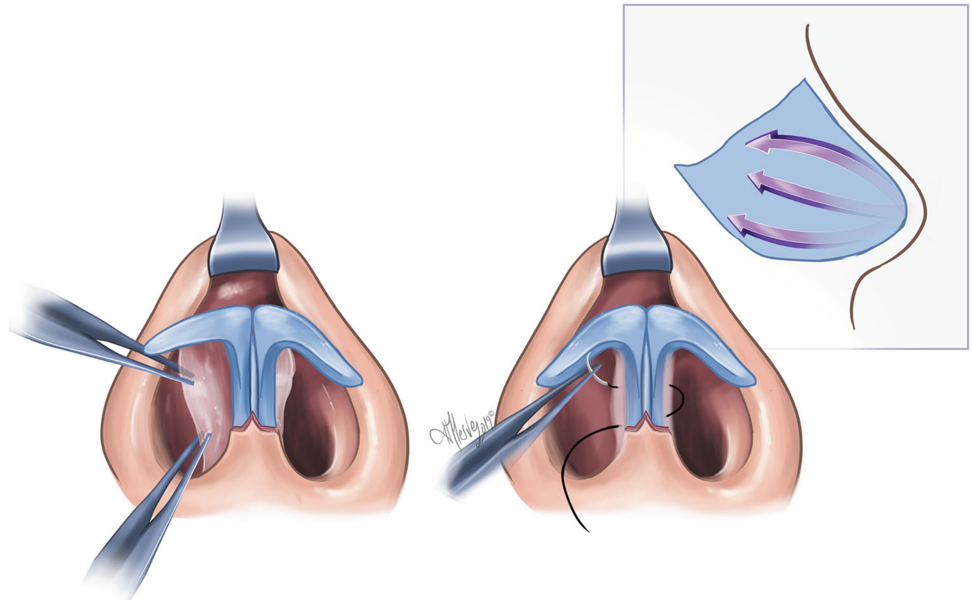

Fig. 2 Re-draping of the septal mucosa in the posterocephalic direction. If needed, caudal trimming can be added in selected cases. This technique is a good option in the presence of septal swell body as well

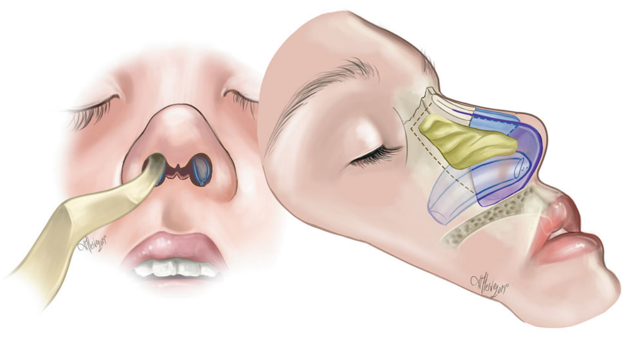

Fig. 3 Position of the splint and petroleum gauze dressing. These Doyle splints are produced for septoplasty procedure, and with routine use, they may lack adequate lateral wall support. Petroleum gauze dressings are placed as shown

patients had anterior, six patients had normal, and five patients had posteriorly located lower concha. All lower conchas were ablated with radiofrequency device and then lateralized. Nine patients (five patients in group 1 and four patients in group 2) had additional submucosal bone resection. Postoperative bleeding, scarring or anthropic rhinitis was not encountered in this study. Transient dryness was seen 21% of the patients which resolved in 3–6 months. Moreover, five patients (two patients in group 1 and three patients in group 2) had endoscopic middle concha reduction. Twelve patients (six in each group) had septoplasty for functional reasons. In the remaining 34 patients, septal resection was performed to harvest cartilage graft (Table 1).

All patients' NOSE scores were <20 preoperatively. Postoperatively, NOSE scores were still <20 in both groups, and no statistically significant difference was found between them. In addition, no statistically significant difference was found between the two groups preoperatively and postoperatively based on the data presented in Table 2. Moreover, no statistically significant difference in VAS scores was noted between the two groups. The inter-rater reliability was high (Table 3).

Acoustic Rhinometry Findings

The vestibular volume was increased in both groups according to the acoustic rhinometry findings, but no statistically significant difference was noted between the groups (Table 4). According to the findings of acoustic rhinometry under xylometazoline, the vestibular volume of both groups was higher postoperatively. Compared with their preoperative volumes, it was statistically significant in both sides of the study group and on the left side of the control group, but no statistically significant difference was found between the two groups (Table 4). The preoperative and postoperative MCAs in both groups were comparable. In addition, no statistically significant difference was found between the two groups (Table 5). As regards the MCA of the nostril distance, a statistically significant difference on the left side was found between the two groups. However, no difference was noted on the right side. In the xylometazoline-induced tests, the MCAs were closer to the nostril rim in both sides of the two groups. A statistically significant difference was found in group 2, but not in group 1. In addition, a statistically significant difference was found between the two groups as shown in Table 6.

Table 1 Lower concha positions, Concha and septal treatments

Lower concha position anterior	Lower concha position normal	Lower concha position posterior	Submucosal lower concha bone reduction	Endoscopic middle concha surgery	Septoplasty due to functional reasons	Septoplasty due to cartilage harvest
13	4	6	5	2	6	17
12	6	5	4	3	6	17

Table 2 NOSE questionnaire results

Nose test	Preop median (min;max)	Postop median (min;max)	*p* value preop-postop	*p* value difference preop–postop
Group 1	10 (0;20)	5 (0;20)	0.546	0.752
Group 2	0 (0;20)	0 (0;20)	0.346	

Table 3 Postoperative visual analog scale scores

Visual analog scale	Median (min;max)	Cronbach's alpha	*p* value
Group 1	9 (8.20;10)	0.925	0.859
Group 2	9 (8;10)	0.922	

Table 4 Acoustic rhinometry, Vestibular volume

Vestibular volume (cm^3)	Preop volume mean ± std. deviation	Postop volume mean ± std. deviation	Differential proportion ((postop-preop)/preop) mean ± std. deviation	*p* value	Differential proportion ((postop-preop)/preop) median (min;max)
Right group 1	4.24 ± 1.00	4.63±1.01	0.16±0.43	0.232	0.03 (−0.34;1.20)
Right group 2	4.05 ± 1.06	4.84±1.13	0.26±0.41	0.025	0.21 (−0.42;1.06)
Right *p* value					0.277
Left group 1	4.36 ± 1.07	4.77±1.00	0.12±0.22	0.031	0.11 (−0.25;0.74)
Left group 2	3.96 ± 0.97	5.14±1.25	0.35±0.4	0.001	0.31 (−0.23;1.21)
Left *p* value					0.057
Right group 1 (xylometazoline)	5.02 ± 0.95	5.44±1.26	0.12±0.36	0.223	−0.006 (−0.41 ; 1.39)
Right group 2 (xylometazoline)	5.31 ± 1.04	5.6±1.22	0.07±0.22	0.241	0.033 (−0.04; 0.42)
Right *p* value (xylometazoline)					0.974
Left group 1 (xylometazoline)	4.97 ± 0.98	5.53±1.26	0.13±0.26	0.039	0.13 (−0.44; 0.67)
Left group 2 (xylometazoline)	5.22 ± 1.21	5.75±1.08	0.14±0.30	0.085	0.14 (−0.27; 1.04)
Left *p* value (xylometazoline)					0.801

Table 5 Acoustic rhinometry, Minimum cross-sectional area

Minimum cross sectional area (MCA) (cm^2)	Preop MCA mean ± std. deviation	Postop MCA mean ± std. deviation	Differential proportion ((postop-preop)/preop) mean ± std. deviation	*p* value	Differential proportion ((postop-preop)/preop) median (min;max)
Right group 1	0.39±0.15	0.36±0.14	0.05±0.62	0.438	−0.13 (−0.65;1.76)
Right group 2	0.34±0.18	0.40±0.16	0.35±0.72	0.277	0.12 (−0.76;2.42)
Right *p* value					0.51
Left group 1	0.38±0.18	0.43±0.24	0.30±0.79	0.326	−0.08 (−0.42;2.53)
Left group 2	0.39±0.16	0.39±0.26	0.20±0.84	0.973	−0.03 (−0.92;2.38)
Left *p* value					0.468
Right group 1 (xylometazoline)	0.42±0.14	0.40±0.12	0.09±0.68	0.579	0.03 (−0.59;2.63)
Right group 2 (xylometazoline)	0.43±0.16	0.42±0.13	0.09±0.57	0.618	0.09 (−0.58;2.18)
Right *p* value (xylometazoline)					0.886
Left group 1 (xylometazoline)	0.47±0.15	0.44±0.15	-0.002±0.38	0.424	−0.07 (−0.58;0.90)
Left group 2 (xylometazoline)	0.50±0.35	0.54±0.38	0.03±0.52	0.754	0.05 (−1.50; 1.41)
Left *p* value (xylometazoline)					0.368

Table 6 Acoustic rhinometry, Minimum cross-sectional area distance

Minimum cross sectional area (MCA) distance (cm)	Preop MCA distance mean ± std. deviation	Postop MCA distance mean ± std. deviation	Differential proportion ((postop-preop)/preop) mean ± std. deviation	*p* value	Differential proportion ((postop-preop)/preop) median (min;max)
Right group 1	1.93±0.37	1.73±0.22	−0.07± 0.20	0.023	−0.08 (−0.39;0.43)
Right group 2	2.16±0.31	1.81±0.21	−0.13±0.26	0.000	−0.16 (−0.39;0.99)
Right *p* value					0.101
Left group 1	1.82±0.4	1.84±0.41	0.01±0.64	0.896	0(−0.87;2.42)
Left group 2	2.16±0.4	1.80±0.39	−0.35±0.56	0.007	−0.35 (−1.03;1.04)
Left *p* value					0.006
Right group 1 (xylometazoline)	1.90±0.36	1.77±0.17	−0.04±0.17	0.059	−0.08 (−0.31;0.43)
Right group 2 (xylometazoline)	2.11±0.15	1.69±0.22	−0.19±0.10	0.000	−0.17 (−0.50;0)
Right *p* value (xylometazoline)					0.02
Left group 1 (xylometazoline)	1.84±0.33	1.81±0.29	−0.02±0.39	0.732	−0.17 (−0.52;1.00)
Left group 2 (xylometazoline)	2.17±0.56	1.86±0.53	−0.31±0.70	0.044	−0.51 (−2.43;1.38)
Left *p* value (xylometazoline)					0.07

PNIF Findings

No statistically significant difference was found between the preoperative and postoperative PNIF of nostrils, right nostril, and left nostril. Additionally, no statistically significant difference was found between the two groups (Table 7).

Rhinomanometric Findings

The right and left nasal airways were evaluated separately. No statistically significant difference was found between the preoperative and postoperative measurements of both airways and between the two groups (Table 8).

Discussion

Nasal breathing is a complex process in which not only the nasal cavity volume is important, but also the mucosal structural properties (vasomotor siklus, secretions), sensation receptors, and psychological factors[15–19]. As known, the most important section of the nasal cavity for breathing is the lower 1/3 part. Nasal breathing is most effectively evaluated by detailed nasal examination and VAS [17, 20]. In this study, we used the NOSE test and VAS. Additionally, acoustic rhinometry, rhinomanometry, and PNIF provided quantitative information about nasal breathing status. Acoustic rhinometry shows the static geometry of the nasal cavity, whereas rhinomanometry and PNIF provide functional information [21, 22]. These are accepted as scientifically reliable and sufficient in the literature [15–17, 23–25]. .With this scientific sufficiency of these tests, no other one such as computer-assisted tomography was needed although preoperative scanning was performed routinely in our surgical planning.

Table 7 Peak nasal inspiratory flow measurements

PNIF (L/min)	Preop mean ± std. deviation	Postop mean ± std. deviation	Differential proportion ((postop-preop)/preop) mean ± std. deviation	*p* value	Differential proportion ((postop-preop)/preop) median (min;max)
Group 1	89.91±17.70	93.26±19.40	0.06±0.20	0.262	0.06 (−0.28;0.54)
Group 2	104.56±35.25	106.95±37.68	0.04±28	0.683	−0.05 (−0.25;1.00)
p value					0.312
Right group 1	50.43±11.27	53.47±10.81	0.09±0.26	0.238	0 (−0.27;0.63)
Right group 2	63.47±29.01	65.65±27.35	0.07±0.23	0.508	0 (−0.32;0.70)
Right *p* value					0.783
Left group 1	50.00±13.31	52.60±13.80	0.08±0.31	0.431	0.07 (−0.41;0.63)
Left group 2	50.43±15.21	56.73±17.16	0.16±0.37	0.085	0.07 (−0.29;1.25)
Left *p* value					0.560
Group 1 (xylometazoline)	102.39± 19.06	105.43±18.64	0.04±0.14	0.393	0.06 (−0.29; 0.30)
Group 2 (xylometazoline)	123.26±38.09	122.83±38.48	0.01±0.15	0.903	−0.04 (−0.28; 0.45)
p value (xylometazoline)					0.333
Right group 1 (xylometazoline)	59.56±16.30	60.43±13.04	0.06±0.26	0.796	0.07 (−0.38;0.56)
Right group 2 (xylometazoline)	74.34±26.55	75.43±28.91	0.03±0.20	0.670	0 (−0.31;0.67)
Right *p* value (xylometazoline)					0.619
Left group 1 (xylometazoline)	59.13±14.74	55.65±14.00	0.08±0.26	0.281	0.09 (−0.37;0.56)
Left group 2 (xylometazoline)	66.52±20.41	62.17±19.29	0.09±0.29	0.132	0 (−0.25;1.14)
Left *p* value (xylometazoline)					0.947

Table 8 Rhinomanometry. Inspiratory Resistance

Inspiratory resistance	Preop resistance mean ± std. deviation	Postop resistance mean ± std. deviation	Differential proportion ((postop-preop)/preop) mean ± std. deviation	*p* value	Differential proportion ((postop-preop)/preop) median (min;max)
Right group 1	0.535±0.348	0.481±0.229	0.11±0.61	0.429	−0.004 (−0.72; 2.01)
Right group 2	0.412±0.235	0.427±0.177	0.20±0.57	0.790	−0.005 (−0.67; 1.24)
Right *p* value					0.606
Left group 1	0.499±0.193	0.571±0.323	0.29±0.86	0.351	0.01 (−0.69;3.03)
Left group 2	0.623±0.524	0.623±0.487	0.36±1.23	0.997	−0.03 (−0.83; 3.48)
Left *p* value					0.517
Right group 1 (Xylometazoline)	0.464±0.294	0.415±0.229	0.04±0.58	0.377	0 (−0.75;2.15)
right group 2 (Xylometazoline)	0.310±0.184	0.298±0.095	0.08±0.37	0.733	0.09 (−0.58; 1.03)
Right *p* value (xylometazoline)					0.398
Left group 1 (xylometazoline)	0.417±0.171	0.431±0.243	0.20±0.85	0.837	−0.06 (−0.72; 3.00)
Left group 2 (xylometazoline)	0.407±0.191	0.390±0.143	0.13±0.61	0.760	−0.06 (−0.76; 1.84)
Left *p* value (xylometazoline)					0.956

In reduction rhinoplasties, a decrease in the internal volume may be expected as directly proportional with the reduction amount. According to Sheen, this situation can be seen approximately in 75%–85% of the patients [26]. Generally, 10% of the patients are expected to develop subjective nasal obstruction symptoms after rhinoplasty [27, 28]

In contrast to the studies that were mentioned in the Introduction section, some other studies claim that lateral osteotomies have no effect on the nasal airways [5, 6, 8, 29]. Erdogan et al. examined 40 septorhinoplasty patients, and according to their findings, patients breathe better after surgery, which was similar to that in healthy individuals in the control group [5]. In 2012, Zoumalan and Constantinides investigated 31 patients who had undergone septorhinoplasty and lower concha laser-assisted reduction procedure and evaluated them by acoustic rhinometry [6]. Although 22 of them had low-to-low lateral osteotomy, subjective nasal breathing improved by 38%. Additionally, 55% improvement (statistically significant) was found in the significant obstructed MCAs. Adamson et al.,[29]. Edizer et al.,[8], and Celebi et al [7]. found that rhinoplasty with high-to-low lateral osteotomies has no negative effect on nasal breathing.

In our study, no statistically significant difference was found between high-to-low and low-to-low lateral osteotomies, as in Grymer et al. [4] report. This finding is also similar with that of Zoulaman et al.,[6] which was associated with combined procedures involving the nasal airway. In the present study, the volumetric rhinoplasty, of which some part of it is prophylactic functional surgery, was performed and presented.

Volumetric Rhinoplasty

A good preoperative nasal breathing is not a guarantee of same postoperative breathing. The main idea behind volumetric rhinoplasty is as follows: If the size of the nose is reduced, the internal elements should be adjusted even if the patient has no complaint about nasal breathing for an adequate nasal airway. Minimal septal deviations, enlarged lower concha, bullous middle concha, weak lateral cartilages, or any other potential breathing problem that is not obvious before surgery may lead to nasal breathing problems. Basically, the volumetric rhinoplasty consists of three main parts: examination/measurement, prevention, and treatment.

Detailed examination includes nasal breathing tests, endoscopic examination, and computed tomography (CT). At present, with reduction in X-ray doses, [30]. CT can be performed in every case preoperatively. Bullous middle concha, posterior septal deviations, adenoids, need for sinus surgery, and tumors may not be detected with anterior rhinoscopy in 29%–39% of patients; this emphasizes the importance of endoscopic examinations [31–33]. In addition, performing the modified Cottle test before and after intranasal administration of a decongestant is very important. [33]. In this way, potential valve insufficiency that may occur after surgery may be prevented during surgery. Constantinides et al. reported 94.7% better nasal breathing after they added Cottle maneuver in their routine examination in functional surgery patients.

Second part is the preventative surgery. Basically, rhinoplasty is about control. However, some points cannot be controlled, such as tissue healing. Especially, dead spaces are prone to uncontrolled healing. In most of the reduction rhinoplasties, the whole nose is reduced over the neo-septum. Re-draping of relatively large mucosa over the neo-septum is expected. This mucosal excess may be a problem especially in the internal valve region. Uncontrolled healing under this mucosa may lead to thickening due to small hematomas and scar tissue. To prevent this problem, excessive mucosa may be trimmed, but this is possible just in the caudal edge. In volumetric rhinoplasty, this mucosa is re-draped (Fig. 2).

Another prevention technique is sparing the upper lateral cartilages with proper tension in order to prevent nasal valve insufficiency during structural rhinoplasty. For optimal nasal breathing, there should be minimum 10 °C–15 °C internal nasal valve angle [34, 35]. On the other hand, sufficient tension on these cartilages is very important to maintain their position against negative pressure during breathing. The recommendation of using upper lateral cartilages as *auto-spreader flaps* is a cornerstone in structural rhinoplasty [36, 37]. In addition, several suture techniques have been defined to maintain sufficient tension on these cartilages. In this study, all upper lateral cartilages are preserved and folded-in to maintain proper angle and tension. In the presence of asymmetric upper lateral cartilages, mucosal release under the thick side, use of additional spreader grafts, or flaring sutures may be used.

Another prevention technique focuses on the preservation of the lateral wall angle after lateral osteotomy. The length of the nasal bones has a tremendous impact on the potential functional effect of narrowing the bony nasal vault. This was clearly demonstrated by Guyuron et al [3]. Because of this, short nasal bone patients were excluded in the study design. In frontal view, there should be a harmony between the dorsal and basal aesthetic lines. Advancement in basal aesthetic lines towards the midline should be proportional with dorsum closure (Fig. 4 – Video, SDC 1–3). To maintain the correct position of the lateral walls, Doyle splints were supported with petroleum gauze dressings (Fig. 3). This is important in the patients who had a hump more than 3 mm. In these patients, if there is not enough tissue under the dorsal part of the nasal bones, medialization of the lateral nasal walls may create a step on the lateral nasal wall—radix junction, and may

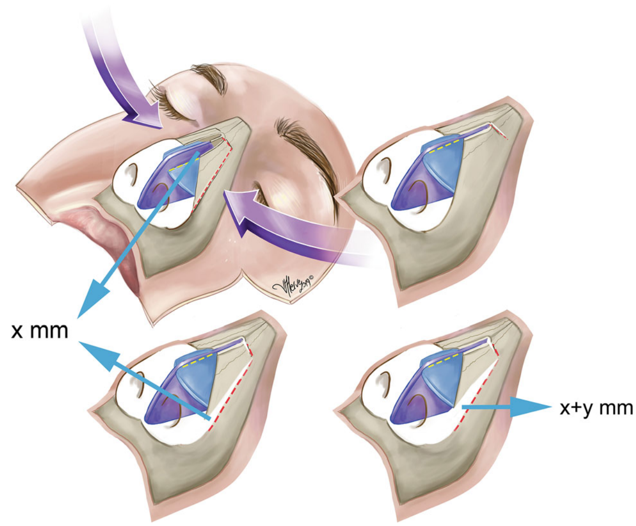

Fig. 4 Preserving the lateral wall inclination angle. If there is a 1-mm gap between the nasal bone and the midline and also basal aesthetic lines are fine, the dorsum can be closed with only a medial oblique osteotomy (top, right) and a transcutaneous trans-osseous cerclage suture as defined by Haack. 45 By contrast, if dorsum closure by >1 mm is needed in each side or a basal advancement is necessary towards the midline, lateral osteotomies are recommended. For example, if an *x mm* dorsum closure was needed on one side, the advancement in the lateral osteotomy line should not be more than *x* mm (below, left). More advancement in the lateral osteotomy line, like x+y mm, may result with problems such as verticalization of the lateral walls, disturbing the proportion between the dorsal and basal aesthetic lines as well as narrowing the isthmus area (below, right). For further narrowing in basal aesthetic lines, rhino-sculpting with ultrasonic Piezo or micromotor devices is preferred

narrow dorsal aesthetic lines. This may be obvious if a bone suture technique [38]. is used to close the dorsum. Incomplete fractures, rhino-sculpting without complete osteotomies [39, 40], spreader grafts, or composite spreader grafts (as we published before[41]) would be other options in these patients. However, trying to close the dorsum without complete osteotomies in large hump patients would be problematic. Preservation of lateral wall angle is especially helpful in long nasal bone patients. If further narrowing in basal aesthetic lines needed, further osteoplastic techniques (preferably with Piezo device) like lateral wall rasping before osteotomy is recommended.

Third part of volumetric rhinoplasty is the functional treatments during surgery. The main growth region of the nose during adolescence is the septum. When the septum grows more than the growth capacity of the lateral walls, there may be a dorsal cap/hump [40, 42]. This excessive growth may lead to septal buckling from its weakest point like the middle part or a tilt to one side over the maxillary crest. This mechanism explains the mild to severe septal deviations in reduction rhinoplasty patients. In this report, although the patients are selected according to their NOSE scores, we encountered asymptomatic septal deviation in

26% of the patients. The critical point is that if the mild septal buckling or tilt does not result in a functional problem before surgery, it does not mean that it would not cause any functional problem after nasal volume reduction surgery. Even just to harvest cartilage may have positive effect on functional status[43], appropriate septoplasty should be performed in every case if needed, even if there is no patient complaint.

The other important point in the third aspect is the concha. Approximately two-thirds of airway resistance in the valve region during breathing is caused by the anterior head of the lower turbinate [44]. Mucosal collagen accumulation and concomitant glandular hypertrophy due to nasal inflammation may cause an irreversible mucoperiosteal hypertrophy [45]. In reverse thinking, spontaneous reduction of an inferior turbinate which is adapted to a larger nasal airway is not easy. So, adjustment of the turbinate to the new is very important. In this study, the combination of radiofrequency ablation and lateralization was used. With the sequence of first ablation and then lateralization, bleeding was not encountered. Scaring is another risk in concha ablation. In other to prevent it, an auto shut-off device was preferred to prevent mucosal damage. Also, atrophic rinitis is another potential problem in concha ablation. It was not encountered in this study which may be due to limited application on the anterior head and medial part of the lower concha. Anterior head was the largest portion, and medial part was the possible future largest portion of the concha. Dryness was observed in some patients but resolved in all of them. The efficacy of the radiofrequency treatment is similar with submucosal reduction using microdebrider[46] or laser ablations [47]. Also, new piezo-assisted techniques would be preferred for this purpose [48]. Although some studies recommend treatment of the turbinates concomitantly with rhinoplasty,[45, 49, 50]. to our knowledge, no study has recommended prophylactic reduction of the turbinates to adjust their sizes according to the new airway. Additionally, we recommend significant treatment of the bullous middle conchas which cause septal tilt, even if they do not cause any symptom.

Limitations of the Study

Based on our volumetric rhinoplasty, which involved examination, prevention, and treatment, Webster's triangle preservation is not necessary. However, to clarify solely the importance of the Webster's triangle, none of the volumetric rhinoplasty steps should be performed, which may theoretically lead to nasal breathing problem in the study group. Because such treatment plan is not ethical, we performed exactly the same volumetric rhinoplasty steps in both groups, except the level of the osteotomy.

Conclusion

This study stresses the importance of volumetric considerations in rhinoplasty. By the help of the techniques that were discussed above, control of the nasal breathing can be enhanced during rhinoplasty. Additionally, we found that negative airflow effect of Webster's triangle in low-to-low osteotomy mentioned in the literature can be prevented by appropriate application of volumetric rhinoplasty steps (examination/measurement, prevention and treatment). By that way, not preserving Webster's triangle has no effect on the nasal airway. One may like to combine discussed volumetric rhinoplasty steps with his/her preferred high-to-low (Webster's triangle preserving) osteotomy as well. In that case, these steps would also be helpful to minimize the risk of nasal airflow problems after surgery. On the other hand, it is highly recommended to combine these steps in low-to-low osteotomies.

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Compliance with ethical standards

Conflict of interest Authors have nothing to conflict of interest.

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