

Clinical Paper
Orthognathic Surgery

Assessment of nasal obstruction symptoms using the NOSE scale after surgically assisted rapid maxillary expansion

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Abstract. The Nasal Obstruction Symptom Evaluation (NOSE) scale is a reliable and valid instrument used widely in otorhinolaryngology to evaluate nasal obstruction symptoms in patients with nasal disorders. The purpose of this study was to assess nasal obstruction symptoms prospectively in patients undergoing surgically assisted rapid maxillary expansion (SARME) using the NOSE scale. Sixteen patients were studied (mean age 31 ± 7.7 years), 10 women and six men, all with a transverse maxillary deficiency and an indication for SARME. Hyrax type devices were placed preoperatively and SARME was performed using Kraut's technique. The NOSE scale was applied prospectively to assess nasal obstruction symptoms. The results were recorded for each score on a scale ranging from 0 to 4, and these scores were multiplied by 5, generating a balanced scale from 0 to 100. Data were stratified according to NOSE scores, and nasal obstruction was categorized as mild (0–25), moderate (26–50), or severe (>50). The questionnaire was administered twice, first preoperatively and then at 6 months after surgery, and the results compared. Data were analyzed statistically using SAS statistical package software and showed that patients experienced a subjective improvement or did not have a worsening of nasal obstruction symptoms after SARME.

Key words: upper airway; maxillary expansion; nasal obstruction.

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Transverse maxillary deficiency is a pathological condition that may be associated with other dentofacial deformities, with

resulting aesthetic and functional implications, including respiratory problems.^{1,2} Bailey et al.³ observed that the prevalence

of posterior crossbite in orthodontic patients is 37.2%, compared to 9.4% in the general population.⁴

The relationship between transverse maxillary deficiency and respiratory problems has received increasing attention in the recent scientific literature. Various studies showing nasal respiratory improvements after surgically assisted rapid maxillary expansion (SARME) have been published.^{2,5-10} Reports of breathing pattern improvements concomitant with the correction of the transverse maxillary deficiency are numerous and these have used many methodologies to evaluate nasal airflow, such as acoustic rhinometry,^{2,6,9,11,12} rhinomanometry,^{9,11,13-15} tomography evaluation,^{16,17} radiographs,² and others.¹⁰

In 2004, the Nasal Obstruction Symptom Evaluation (NOSE) tool was introduced. This consists of a questionnaire administered to patients before and after procedures for the treatment of nasal obstruction and was created specifically to evaluate the symptom of nasal obstruction. This tool was validated in a multicentre study supported by the American Academy of Otolaryngology – Head and Neck Surgery, and shown to be reliable and valuable in the prospective evaluation of nasal obstruction symptoms in patients undergoing surgical procedures.¹⁸

In 2013, Williams et al.¹⁹ used the methodology proposed by Stewart et al.¹⁸ in a prospective study to assess nasal obstruction symptoms after Le Fort I osteotomy.

The objective of the present study was to apply the NOSE scale to evaluate nasal obstruction symptoms in patients undergoing SARME.

Materials and methods

The present study was approved by the ethics committee of the Dental School of Araraquara (FOAR-UNESP). Informed consent was obtained from all participants prior to commencement of the study.

An initial sample of 17 consecutive patients was considered, however one patient was excluded because of a nasal septum deviation observed on preoperative rhinoscopy. Therefore, 16 adult patients (10 women and six men) who had already reached skeletal maturity, as confirmed by hand and wrist radiographs, were included in the study. Their mean age was 31 ± 7.7 years. All subjects presented a transverse maxillary deficiency with an indication for SARME as part of their treatment (Table 1).

The inclusion criteria were age over 20 years, literate, the presence of a maxillary transverse deficiency with or without other associated dentofacial deformities, and compliance with follow-up appointments.

Table 1. Demographic data of the sample.

Patient	Age, years	Gender	Race
1	37	Female	Caucasian
2	22	Female	Caucasian
3	21	Female	Caucasian
4	22	Male	Caucasian
5	41	Female	Caucasian
6	21	Female	Caucasian
7	32	Male	Caucasian
8	37	Female	Caucasian
9	33	Female	Black
10	36	Female	Caucasian
11	38	Female	Caucasian
12	25	Male	Caucasian
13	40	Male	Caucasian
14	23	Male	Caucasian
15	28	Male	Caucasian
16	40	Female	Caucasian

Patients with craniofacial anomalies, those who had undergone previous maxillary or nasal surgery, and those with intranasal findings that could cause nasal obstruction, such as turbinate hypertrophy, nasal polyps, septal deviation, and others, were excluded from the study.

Hyrax (tooth-borne) maxillary distractors were installed in all patients by banding the first molars and first premolars. The SARME procedure was performed according to the technique of Kraut²⁰ (with pterygomaxillary separation). Maxillary expansion was confirmed by intraoperative activation of the distraction device, which was then brought back to the neutral position. Activation was then restarted after the seventh postoperative day and was maintained at a rate of one quarter turn (0.25 mm) three times daily (every 8 h), giving a total 0.75 mm expansion per day, until the target expansion was achieved. All subjects were evaluated three times a week to verify the correct Hyrax activation. After the expansion was achieved, the devices were stabilized and kept in place for 4 months.

The NOSE scale allows prospective and subjective evaluation of nasal obstruction.¹⁸ It is based on a questionnaire with

five questions related to the symptoms of nasal obstruction: nasal stuffiness, nasal obstruction, trouble breathing through the nose, trouble sleeping, and inability to get sufficient air through nasal breathing during exercise or exertion (Table 2).

For use in this study, the questionnaire was translated from the original English into Portuguese. It was administered twice, by a surgeon who did not take part in the surgery (FM), first on the day of the surgery, prior to the procedure, and then at 6 months after surgery. Each response was graded on a scale from 0 to 4, according to the symptom severity. The resulting scores were multiplied by five, creating a balanced scale from 0 to 100. Data acquired during the study were stratified according to the NOSE topics, and the nasal obstruction was classified as mild (0–25), moderate (26–50), or severe (>50).¹⁹

Data were then tabulated in Excel 2007 worksheets (Microsoft Corp., Redmond, WA, USA) and analyzed statistically using the SAS 9.02 software package (SAS Institute Inc., Cary, NC, USA).

Results

The mean maxillary expansion achieved was 7.3 ± 3.2 mm, measured as the distance between the mesiopalatal cusps of the first upper molars, while the mean relapse was 0.7 ± 1.5 mm. The average score for nasal obstruction was 41.6 ± 35.2 before SARME and 10 ± 15.7 after SARME.

As the measurements were paired, the difference between the preoperative and postoperative scores was calculated, and the result was used as the NOSE improvement index (Table 3).

The average values acquired for each parameter are shown in Fig. 1. The parameter presenting the highest score preoperatively was nasal obstruction during sleep (9.7). This was also the parameter that presented the highest decrease postoperatively (2.5), showing a difference of 7.2 points. Nasal obstruction during exercise

Table 2. NOSE scale used in the study.^a

Symptom	Not a problem	Very mild problem	Moderate problem	Fairly bad problem	Severe problem
Nasal stuffiness	0	1	2	3	4
Nasal obstruction	0	1	2	3	4
Trouble breathing through the nose	0	1	2	3	4
Trouble sleeping	0	1	2	3	4
Unable to get enough air through the nose during exercise or exertion	0	1	2	3	4

NOSE, Nasal Obstruction Symptom Evaluation.

^a Adapted from Stewart et al.¹⁸

Table 3. NOSE scores pre- and postoperatively.

	NOSE score		
	Preoperative	Postoperative	Difference
Average	41.6	10	31.6
Median	50	0	27.5
Variation	0–95	0–55	0–95
IQR	61.3 (0–61.3)	20 (0–20)	56.3 (0–56.3)

IQR, interquartile range.

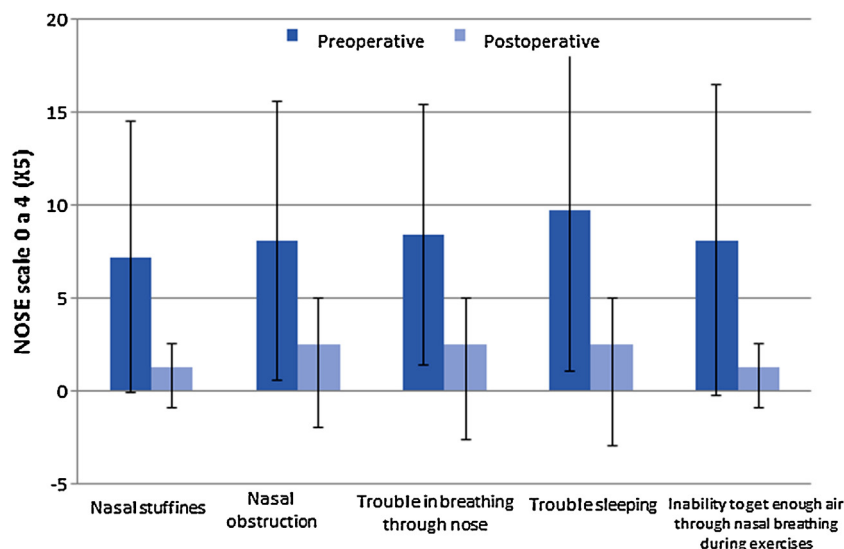


Fig. 1. Individual average NOSE score values pre- and postoperatively ($N = 16$).

was the second parameter to show a large improvement, with a difference of 6.8 points between the preoperative and postoperative values. The smallest variation between preoperative and postoperative values was found for the nasal obstruction item, where the difference was 5.6 points.

For the general analysis, data were categorized according to the NOSE scores, with nasal obstruction classified as mild (0–25), moderate (26–50), or severe (>50). During the preoperative evaluation, eight patients (50%) were classified as having severe nasal obstruction, six (37.5%) as having mild obstruction, and two (12.5%) as having moderate obstruction. In the postoperative assessment, 6 months after SARME, 15 patients were classified as having mild obstruction (93.7%) and only one as having severe obstruction (6.3%).

The non-parametric Wilcoxon test for paired data was used, giving a P -value of 0.0033, which indicates a statistically significant difference between the NOSE scores obtained before and after surgery ($P \leq 0.05$).

Patients with NOSE scores equal to zero preoperatively ($n = 5$) maintained this result after surgery. Six patients remained

in the mild nasal obstruction classification, seven moved from the severe category to mild, and two from moderate to mild, while only one patient continued to be classified as severe (Fig. 2).

Discussion

The NOSE scale is a reliable and validated tool for analyzing quality of life and health status regarding nasal obstruction. Although the validation process was designed for a population with nasal septal deviation, excluding craniofacial anomalies,¹⁸ and therefore not validated for this sample of transverse maxillary deficiency patients, the study hypothesis was that nasal breathing would improve after SARME and that the NOSE scale would be capable of showing the improvement.

The results confirmed this hypothesis. Nasal airway function improved in most patients and remained unaltered in those presenting no symptoms preoperatively. Only one patient who presented a high score for nasal obstruction before surgery had unaltered symptoms.

When stratified by the degree of obstruction, patients who presented the highest scores of nasal obstruction preoperatively, i.e. those classified as severe ($n = 8$), were the ones who presented the greatest levels of improvement; seven of them were classified as having mild obstruction at 6 months postoperative.

The one patient who was classified with severe obstruction who did not have a change in status referred to an improvement in his perception of the obstructive symptoms. His score changed from 60 to 55. Despite this, when reviewing the patient's pre- and postoperative history, taking into account his records, clinical findings, and imaging, it was not possible to find an anatomical cause for

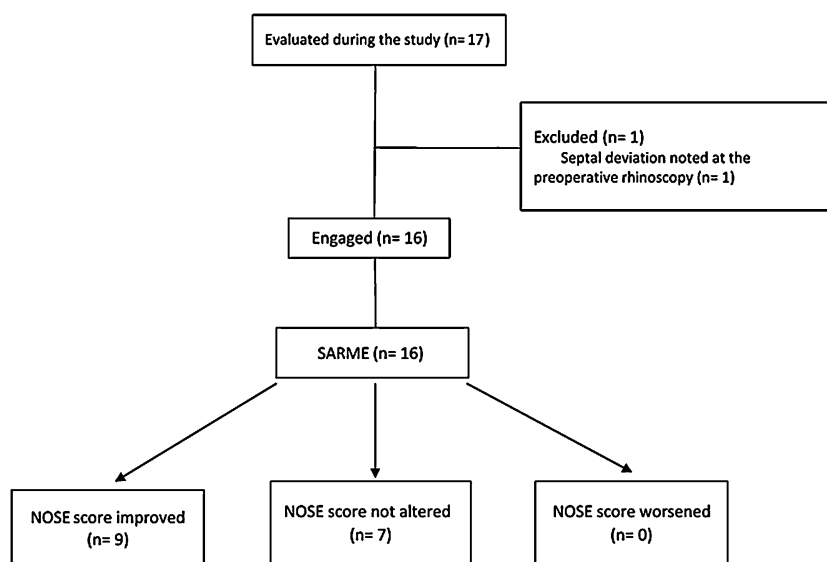


Fig. 2. Study flowchart: assessment of the nasal airway after surgically assisted rapid maxillary expansion (SARME).

this situation. A possible explanation for this isolated case is empty nose syndrome,²¹ which happens occasionally after Le Fort I osteotomies associated with turbinectomy, where the excessive tissue removal paradoxically leads to a sensation of nasal congestion. However, there is no tissue removal during SARME, and no other nasal surgery, such as septoplasty or turbinectomy, was done for this patient.

The present study had some limitations. The average follow-up time of 6 months was relatively short. A longer follow-up could potentially have shown some additional improvement in the NOSE scores, although most studies have shown minimal alterations after the first 3 months.^{18,22} In addition, an increase in the sample size could possibly have generated more consistent data for the comparisons between the nasal obstruction categories.

Previous studies have correlated factors such as body mass index, systemic morbidities, smoking, obstructive sleep apnoea syndrome (OSAS), and other entities, which could have altered results.^{19,23} However, the aim of the present study was to evaluate the SARME procedure alone and its subjective influence on nasal breathing function. In addition, the surgeon responsible was not involved in the data collection, minimizing possible bias.

The NOSE scale is an important tool in the subjective evaluation of nasal obstruction symptoms. Although there are various studies in the literature showing structural alterations in the nasal cavity after SARME using objective methodologies such as anatomical measurements, nasal airway flow, and even image examination measurements,^{2,6,9–17} the data obtained by these objective methods do not always correlate with the patient's perception of their symptoms.^{1,7}

One of the few studies in this field¹ used the evaluation proposed by Löth et al.,²⁴ employing a questionnaire with 10 yes/no questions in association with 10 visual analogue scales. The results when compared with the objective data collected in the same study were conflicting. The authors reported huge variations in individual answers and no correlation between the nasal alterations and the subjective improvements.

The present study found that it was possible to observe a consistent subjective improvement in nasal obstruction symptoms at 6 months after SARME, which is corroborated by several studies.^{1,10,11,15,17,25} The results of this study contribute to the growing evidence that

SARME produces beneficial effects in nasal breathing function.

Within the limits of the methodology applied, it is possible to conclude that the patients with a maxillary transverse deficiency who underwent SARME experienced a subjective improvement or did not have worsening of nasal obstruction at 6 months following the procedure.

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Competing interests

Nothing to declare.

Ethical approval

Ethical approval was given by the Ethics Committee of the Dental School of Araquara – 26/2010.

Patient consent

Not applicable.

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