Nasal cavity size, airway resistance, and subjective sensation after surgically assisted rapid maxillary expansion: A prospective longitudinal study

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Introduction: The aims of this study were to measure changes in nasal minimum cross-sectional area and nasal airway resistance after surgically assisted rapid maxillary expansion and to explore a possible correlation with the subjective sensation of nasal obstruction. **Methods:** Minimum cross-sectional area and nasal airway resistance were measured in 39 consecutive patients treated with surgically assisted rapid maxillary expansion. Subjective nasal obstruction was assessed by a questionnaire at pretreatment and at 3 and 18 months postoperatively. **Results:** Subjective nasal obstruction had improved significantly by 3 months postoperatively. Minimum cross-sectional area increased and nasal airway resistance decreased. No correlations were found. In subjects with pretreatment subjective nasal obstruction and initially narrow anterior minimum cross-sectional area, there was a significant correlation between a moderate increase in anterior minimum cross-sectional area and improvement in perceived nasal obstruction. Eighteen months postoperatively, no changes were found from pretreatment values for subjective nasal obstruction, minimal cross-sectional area, or nasal airway resistance, and there were no correlations. Subjects with a sensation of nasal obstruction at treatment start reported a lasting significant subjective improvement. **Conclusions:** The postoperative effects of surgically assisted rapid maxillary expansion did not persist in the long term. No correlation was found between objective and subjective findings. Subjects with pretreatment nasal obstruction, however, reported a lasting sensation of improved nasal function after surgically assisted rapid maxillary expansion. (Am J Orthod Dentofacial Orthop 2011;140:641-51)

Surgically assisted rapid maxillary expansion is a recognized approach for correction of skeletal transverse maxillary deficiencies in skeletally mature patients.[1-7] In principle, the indications are the same as for conventional rapid maxillary expansion: ie, malocclusion associated with a narrow maxilla.[8-10]

Candidates for rapid maxillary expansion often exhibit a typical vertical skeletal pattern, with long anterior lower facial height, high palatal vault, low tongue posture, incompetent lips, and mouth breathing.[11] Similar dentofacial morphology was experimentally induced in rhesus monkeys: blocking the nasal passages led to the development of high palatal vaults and open bites.[12,13] The vertical growth pattern has thus been related to the functional matrix theory of Moss and Salentijn[14]: that growth in the craniofacial complex responds to specific functional demands—ie, there is a close relationship between dentofacial morphology and nasal breathing function.

It is generally accepted that orthopedic expansion (rapid maxillary expansion) and surgically assisted rapid maxillary expansion can affect the nasal passage.[15-20] According to Wriedt et al[21] and Warren et al,[16] enlargement of the nasal valve can result in improvement of nasal breathing. More controversial is the question of whether rapid maxillary expansion can achieve a shift from oral to nasal breathing modes and change the

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The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.
Supported by Futurum—The Academy for Healthcare, County Council, Jönköping Sweden and Medical Research Council of Southeast Sweden.
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Submitted, February 2010; revised and accepted, November 2010.
0889-5406/$36.00

doi:10.1016/j.ajodo.2010.11.024

subjective sensation of nasal obstruction.[22] The clinical appearance of a patient might indicate difficulty in breathing through the nose but does not necessarily correlate with rhinometric measurements or the patient's perception, and vice versa.[23]

The effects of surgically assisted rapid maxillary expansion on the nasal airway might differ from those of rapid maxillary expansion. Although Babacan et al[24] found no significant differences with respect to nasal volume, other parameters are also important in assessing nasal function: eg, cross-sectional area, nasal flow, nasal resistance, and subjective experience. Different methods of assessment capture different aspects and should perhaps be considered complementary.[25] Widening of the nasal valve is important and might be different in surgically assisted rapid maxillary expansion.[26] The surgical technique can also vary and influence the outcome with respect to changes in the hard and soft tissues as well as in subjective sensations. Age and growth are confounders with respect to the altered breathing pattern.[23,27]

There is no gold standard for measuring the nasal airway.[25] Acoustic rhinometry and rhinomanometry are 2 methods that can be categorized as objective measurements.[28] Acoustic rhinometry is a noninvasive tool that reflects the anatomic profile along the length of the nasal cavity.[29] This method is quite simple and has made it possible to estimate cross-sectional areas and volumes of the nasal cavity as a function of the distance from the nostril.[30] Rhinomanometry is a physiologic method that measures the pressure-flow relationship during respiration[31] and thus expresses nasal airway resistance.[32] Which of these objective measurements best reflects nasal function is unclear.[25,33-35]

A further common feature in candidates for surgically assisted rapid maxillary expansion is the subjective sensation of nasal obstruction. The subjective experience of postoperative nose breathing is difficult to measure and quantify, but nevertheless it is important.

Although many studies have evaluated the relationship between maxillary expansion and airway, none include the patient's subjective experience.[16-19,21,23,24,36-39]

The perception of obstruction can vary considerably, and correlations between objective and subjective findings are often contradictory.[25,33-35,40]

The nasal obstruction symptom evaluation scale and a nasal obstruction visual analog scale[41] are some examples of validated instruments for evaluating subjective experiences.

The purposes of this prospective longitudinal study were to use 2 objective methods, acoustic rhinometry and rhinomanometry, to evaluate short-term and long-term changes in the nasal airway after surgically assisted rapid maxillary expansion, and to compare and correlate these findings with the patient's subjective sensation of nasal obstruction.

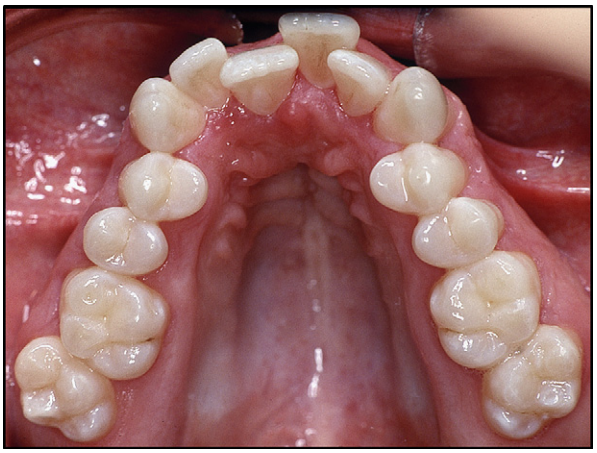

Fig 1. A skeletal maxillary transverse discrepancy exceeding 5 mm.

MATERIAL AND METHODS

This study was conducted on skeletally mature subjects scheduled to undergo surgically assisted rapid maxillary expansion for treatment of a skeletal maxillary transverse discrepancy exceeding 5 mm (Fig 1). The study was approved by the Research Ethics Committee, Faculty of Health Sciences, Linköping University, Sweden.

Forty subjects were recruited consecutively from the Department of Orthodontics at the Institute for Postgraduate Dental Education, Jönköping, Sweden, and from the Department of Dentofacial Orthopaedics, Maxillofacial Unit, University Hospital, Linköping, Sweden. Before treatment, all patients were examined by an otorhinolaryngologist (F.J.). One patient was excluded from the study because of a planned adenoidectomy. The sample thus comprised 39 patients (16 male, 23 female). The mean age at treatment start was 19.9 years (range, 15.9-43.9 years).

Measurements were taken before treatment and 3 and 18 months postoperatively. The treatment group was its own control group.

The orthodontic phase of treatment was undertaken at local orthodontic clinics under the supervision by the orthodontic departments in Jönköping and Linköping, Sweden. The maxillary expansion appliance consisted of a tooth-anchored device activated by means of a conventional hyrax expander (Hyrax II, Dentaurum, Ispringen, Germany) with a soldered framework and orthodontic bands (Fig 2). No acrylic pads were used. The appliance was scheduled for insertion as close as