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Title: Long-term structural and functional naso-maxillary evolution of mouth-breathing children after rapid maxillary expansion: An eight-year follow-up.

Authors: Raquel Harumi Uejima Satto Sakai[a], Emerson Taro Inoue Sakuma[b], José Dirceu Ribeiro[c], Eulalia Sakano[d]

[a]MD and PhD from Department of Pediatrics, Orthodontist, Faculty of Medical Sciences, State University of Campinas, Campinas, São Paulo, Brazil

[b]Radiologist, Department of Radiology, Faculty of Medical Sciences, State University of Campinas, Campinas, São Paulo, Brazil

[c]MD, PhD, Adjunct Professor, Department of Otolaryngology, Faculty of Medical Sciences, State University of Campinas, Campinas, São Paulo, Brazil

[d]MD, PhD, Paediatric Pulmonologist and Full Professor, Department of Pediatrics, Faculty of Medical Sciences, State University of Campinas, Campinas, São Paulo, Brazil

Corresponding author: Raquel Harumi Uejima Satto Sakai
Department of Pediatrics, Faculty of Medical Sciences, University of Campinas - UNICAMP, 126 Tessália Vieira de Camargo Avenue, Cidade Universitária Zeferino Vaz, Campinas, São Paulo, Brazil, 13083-887
Tel +55-19-35217193, e-mail clinicasatto@gmail.com

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Abstract

Objective: To evaluate the effects of rapid maxillary expansion (RME) on nasal patency and naso-maxillary dimensions in mouth-breathing children and adolescents through an eight-year clinical follow-up. Methods: RME was performed with a Hyrax orthodontic appliance in 28 mouth-breathers (6-13 y.o.). During follow-up, objective tests of nasal respiratory function were conducted: acoustic rhinometry provided minimum cross-sectional areas of the nasal cavity and active anterior computed rhinomanometry measured inspiratory nasal resistance. Also, tomographic widths of coronal sections of the nose and the maxilla were measured. Fisher's exact and Mann-Whitney tests were used to compare categorical and numerical variables, respectively, in mouth-breathers with and without allergic rhinitis. Temporal evolution was assessed using the Generalized Estimating Equation models. Statistical significance was set at $P < 0.05$. Results: There was a reduction in inspiratory resistance after ERM, with a stable improvement in nasal patency during the eight-year follow-up period ($P = 0.0179$). All nasal and maxillary tomographic widths had statistically significant increases in the short term ($P < 0.0001$), and most of them showed significant increases in the long term, when compared with the pre-expansion period. The tomographic measurements were not influenced by allergic rhinitis. Conclusion: Although limited by a small sample size and the lack of a control group, our study showed that RME promoted and maintained the widening of the posterior maxillary structure in mouth-breathing children and adolescents, with a decrease in inspiratory nasal resistance during the eight-year follow-up period. These findings highlight the importance of performing RME in mouth-breathers with maxillary atresia.
Keywords: child; mouth-breathing; palatal expansion technique

INTRODUCTION

Mouth-breathing may occur temporarily or persist chronically in the presence of an altered nasal breathing pattern.[1,2] Among the main causes of mouth-breathing in children and adolescents are allergic rhinitis refractory to clinical treatment and the enlargement of the pharyngeal tonsils.[3] However, even in the absence of nasal obstruction, mouth-breathing may become habitual.[4]

Transverse maxillary deficiency with high-arched palate is frequently observed in mouth-breathing children and adolescents, which can be corrected by rapid maxillary expansion (RME).[5,6] RME promotes transverse maxillary widening through the separation of the median palatine suture, thus correcting posterior crossbite. Palatal expansion is likely to improve nasal breathing function by increasing nasal dimensions. At an early age, RME can contribute to the reduction of complementary surgical interventions, especially if performed before the maturation of the midpalatal suture.[7,8]

Systematic reviews and meta-analyses have reported a widening of the naso-maxillary structures and upper airways, with a decrease in inspiratory resistance immediately after RME.[9–11] However, only a few studies contradict its long-term beneficial effects on nasal breathing.[12,13] In a non-controlled study, there was a decrease in nasal resistance 90 days after RME, but the values returned to those prior to RME within 30 months.[13] In another study, RME promoted objective (peak inspiratory nasal flow) and subjective (visual analogue scale) respiratory improvement, which remained stable at 27 months after RME.[12]

In view of the scientific literature researched, the main hypothesis generated is that RME can have different outcomes in the short and long term and with or without associated comorbidities, such as allergic rhinitis.

Given the controversy over long-term outcomes, this study aimed to investigate the impacts of RME on nasal patency and on the dimensions of the naso-maxillary structures through an eight-year clinical follow-up.

METHODS

A prospective non-controlled study was carried out during eight years of follow-up. In this study, 11 males (39.3%) and 17 females (60.7%) aged 6 to 13 years old were included (n=28). The inclusion criteria were clinically controlled mouth-breathers (MBs) with unilateral or bilateral transverse maxillary deficiency and posterior crossbite. Patients who received previous orthodontic treatment or speech therapy or presented serious comorbidities or craniofacial syndromes were excluded**.** A control group was not included in order to avoid exposure of CT radiation in children and adolescents and due to ethical reasons, as RME is a routine clinical procedure prescribed for individuals with maxillary atresia, especially among the young population.

Mouth-breathing was diagnosed by an otorhinolaryngologist through a clinical medical evaluation and nasal endoscopy. The findings included allergic rhinitis or increase in adenotonsillar structures, which were previously treated and controlled according to the ARIA guidelines (Allergic Rhinitis and its Impact on Asthma).[14] There was no selection bias regarding the allergic rhinitis factor. The convenience sample was obtained from the multidisciplinary centre for research on mouth-breathing disorders at the university hospital, following rigorous screening methods during 12 months.

Informed Assent and Informed Consent were signed by the participant and guardian, respectively. The study was approved by the institution's Research Ethics Committee (CAAE:0015.0.146.000-11; #41/2011).

A Hyrax orthodontic appliance was installed by the first author of this study, made with four orthodontic bands cemented onto the first permanent molars and first permanent premolars (or first deciduous molars) and welded to the median expander screw (Morelli®). The orthodontist performed a 2/4-turn after its installation and instructed parents/guardians to activate it at home: 1/4-turn in the morning and 1/4-turn in the evening. Patients were followed up on a weekly basis. When the bite was uncrossed with overcorrection of the buccal cusps of the first molars, by 2mm, the Hyrax screw was locked with a 0.012-inch wire (Morelli®) and acrylic resin. The Hyrax device was removed four months after the expansion screw was locked. Ultimately, the palatal acrylic resin containment device with a Hawley arch (0.7 mm, Morelli®) was installed, to be used during six months.

Acoustic rhinomanometry and active anterior computed rhinomanometry

Anterior acoustic rhinometry (AR) and active anterior computerized rhinomanometry (AAR) examinations were performed in compliance with the Consensus Report on Acoustic Rhinometry and Rhinomanometry of 2005[15], using the A1/NR6 measurement equipment (GM Instruments®, Kilwinning, Scotland, United Kingdom). Nasal vasoconstrictor [oxymetazoline hydrochloride (0.5 mg/mL)] was administered in two steps: (i) two sprays of 50 g into each nostril, (ii) one spray into each nostril after 5 min. Measurements were obtained 15–30 min after the last administration of the vasoconstrictor. All examinations were performed by the same professional and carried out on patients without rhinitis exacerbation.

In AR, patients were instructed to hold their breath for three seconds to perform three cycles of nasal measurements. AR provided data about the minimum nasal cross-sectional areas located in the areas of the inferior turbinates (MCA1) and middle turbinates (MCA2).

In AAR, patients were instructed to close their mouth and breathe normally until four curves of inhalation and exhalation were obtained. Inspiratory nasal resistance (cm3/s) was set at a pressure of 150 Pa. The values obtained in the right and left nostrils were summed up and only the total values were used.

AR and AAR examinations were performed before RME (initial time − T1), 6 months (T2), 10 months (T3), 14 months (T4), 18 months (T5), and 8 years (T6) after RME. Twenty-eight children and adolescents performed AR and AAR examinations at T1, T2, and T3. Also, 27 and 25 individuals underwent the tests at T4 and T5, respectively. At T6, of the total 28 participants, only 19 individuals performed the tests and nine individuals were not able to do the tests due to travel time/distance or personal reasons.

Computed tomography

Computed tomography (CT) scans were performed at three time points: initial time (T1), six months after RME (T2), and eight years after RME (T6). OsiriX® (Pixmeo, Geneva, Switzerland), an image-processing software programme for displaying and processing DICOM image data, was used to visualise the digital three-dimensional volumetric image (3D) on axial, sagittal, and coronal planes. All CT measurements were taken by the main researcher and validated by a senior radiology specialist in sinonasal imaging. The tangent axial plane to the lower margins of the orbits was parallel to the axial plane of the hard palate, passing through the anterior and posterior nasal spines. The sagittal and coronal planes were orthogonal to the axial plane (Fig. 1).

The CT scans were analysed through three coronal sections located in the head of the inferior turbinates, in the head of the middle turbinates, and in the maxilla. In the first coronal section, nasal width 1 **(N1)** and maxillary width 1 **(M1)** – located at the height of the inferior turbinates and at the nasal base, respectively – were measured. In the second coronal section, measurements were taken for nasal width 2 **(N2)** at the height of the middle turbinates **and** maxillary width 2 **(M2)** was measured at the outer edges of the maxillary bone passing through the nasal base. Maxillary width 3 **(M3)** was measured by the deepest points of the maxillary concavity bilaterally, in the region of the first permanent molar (Fig. 1).

CT examinations were performed **at before RME (initial time – T1), 6 months (T2) and 8 years (T6) after RME.** Twenty-eight children and adolescents performed CT examinations at T1 and T2. At T6, only 16 individuals underwent the test, nine individuals were not able to perform the tests due to travel time/distance or personal reasons, and three parent/legal guardians did not authorize the test due to radiation exposure.

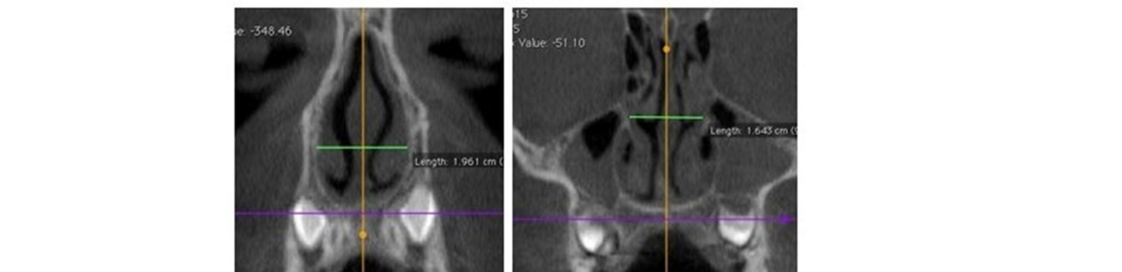

Figure 1: Nasal and maxillary widths measured in coronal sections of CT scans: nasal width 1 (N1), nasal width 2 (N2), maxillary width 1 (M1), maxillary width 2 (M2) and maxillary width 3 (M3).

Statistical analyses

Descriptive and inferential statistical analyses were managed using the Statistical Analysis System (SAS), version 9.4, from SAS Institute Inc., 2002-2012, Cary, NC, USA, with graphical representation using the Origin (Pro) software, version 8.1 SR3, OriginLab Corporation, USA.

Data with categorical distribution indicated absolute frequency (N) and relative frequency (%). Data with numerical distribution was presented as mean ± standard deviation, median (95% confidence interval for the median), and minimum and maximum values.

Statistical analyses were performed on two distinct stages: 1) analysis including all participants, and 2) comparative analysis between groups with and without allergic rhinitis.

The groups of MBs with and without allergic rhinitis were compared using the Fisher's Exact Test for categorical variables and the Mann-Whitney Test for numerical variables. Temporal evolution was assessed using the Generalized Estimating Equation models due to data loss over time. The data was transformed into ranks due to the lack of normal distribution. Multiple pairwise corrections were performed with Tukey's test to control type I error. Statistical significance was set at $P < 0.05$.

The groups with and without allergic rhinitis were compared according to each marker assessed. Initially, the groups with and without allergic rhinitis were compared at baseline using the Mann-Whitney test. Subsequently, the generalized estimating equations method was used to verify the influence of the allergic rhinitis and time factors, individually, and the effect of the interaction between both factors, simultaneously.

RESULTS

Twenty-eight children and adolescents were included in this study: 64.9% with allergic rhinitis, 39.3% male, mean age of 10.07±1.82 years, and median age of 10.46 years.

At T1, the mean age of MBs with allergic rhinitis was 10.3±1.5 years and the median age was 10.5 years (7.8–13.2 years). The mean and median ages of MBs without allergic rhinitis at T1 were 9.7±2.3 and 10.1 years (6.1–12.1 years), respectively.

No statistically significant differences were found between MBs with and without allergic rhinitis at T1 when comparing the mean ages ($P = 0.4868$) and sexes ($P = 0.4443$).

The flowchart shows the examinations performed and the number of participants at each time throughout the eight-year follow-up period (Fig. 2).

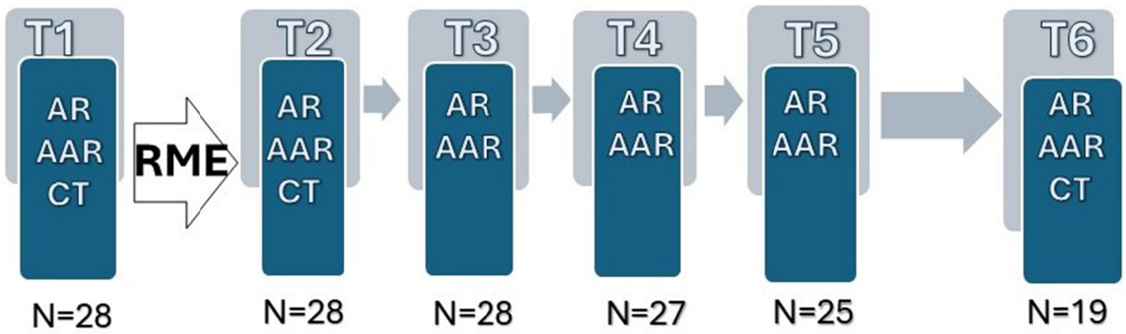

Figure 2: Flow chart with the examinations performed and the number of participants at each follow-up time, before and after rapid maxillary expansion (RME); T1 (initial time); T2 (6 months after RME); T3 (10 months after RME); T4 (14 months after RME); T5 (18 months after RME); T6 (8 years after RME); AR (acoustic rhinometry); AAR (active anterior computerized rhinomanometry); CT (computed tomography); N (number of participants).

In the long-term follow-up of eight years (T6), 19 participants underwent AR and AAR examinations, with a mean age of 17.92±1.84 years and a median age of 17.92 years. Of these participants, only 16 underwent CT at T6.

Acoustic rhinometry and active anterior computed rhinomanometry

The descriptive analysis of the data obtained from AR (MCA1 and MC2) and AAR (inspiratory resistance) is shown in Tables 1 and 2, respectively.

In the pre-orthodontic disjunction phase (T1), no significant differences were found between MBs with and without allergic rhinitis in any of the minimum cross-sectional areas of nasal cavity evaluated *($P \geq 0.05$)*.

In the temporal analysis of MCA1 without vasoconstrictor, statistically significant influences of the time ($P = 0.0187$) and allergic rhinitis factors ($P = 0.0277$) were found separately; however, these factors combined did not have a statistically relevant influence ($P = 0.20$).

The data for MCA1 without vasoconstrictor and all data for MCA2 did not show statistically significant differences in the temporal analysis.

Acoustic Rhinomanometry

		MCA1										MCA2									
		with vasoconstrictor					without vasoconstrictor					with vasoconstrictor					without vasoconstrictor				
Time	N	Mean	SD	Min.	Median	Max.	Mean	SD	Min.	Median	Max.	Mean	SD	Min.	Median	Max.	Mean	SD	Min.	Median	Max.
T1	28	2.80	1.87	0.98	2.32	7.38	1.52	1.00	0.74	1.24	6.06	5.45	2.98	1.99	4.65	12.28	3.21	1.99	0.72	2.56	10.77
T2	28	1.75	0.90	0.78	1.35	4.21	1.15	0.49	0.57	1.08	2.96	3.49	1.59	0.94	3.06	7.71	2.40	1.40	1.07	1.94	7.36
T3	28	1.49	0.59	0.81	1.37	3.46	1.14	0.59	0.52	1.02	3.80	3.34	1.77	1.29	2.99	10.48	2.44	1.67	0.49	1.91	8.47
T4	27	1.89	1.10	1.03	1.51	5.21	1.16	0.60	0.68	1.04	3.97	4.14	1.77	1.91	3.70	8.76	2.92	1.65	1.30	2.56	9.00
T5	25	1.66	0.84	0.86	1.44	4.32	1.40	0.96	0.96	1.18	4.32	1.40	0.96	0.63	1.18	4.32	3.27	1.89	0.90	2.34	7.60
T6	19	2.47	1.19	1.05	2.11	5.24	1.75	0.88	0.90	1.52	4.67	5.16	2.64	1.68	4.77	11.02	2.64	1.37	0.44	2.20	5.42

Table 1: Results of acoustic rhinometry examinations carried out over an 8-year follow-up period. T1 (initial time); T2 (6 months after RME); T3 (10 months after RME); T4 (14 months after RME); T5 (18 months after RME); T6 (8 years after RME); N (number of participants); SD (standard deviation).

Inspiratory nasal resistance did now show statistically significant differences between MBs with and without allergic rhinitis at the initial time (T1) using the Mann-Whitney test ($P = 0.1873$).

In the comparative temporal analysis between groups of MBs with and without allergic rhinitis, time proved to be a statistically significant factor when analysed separately ($P = 0.0399$); however, the allergic rhinitis factor alone ($P = 0.3065$) and the rhinitis and time factors altogether ($P = 0.7534$) did not have a significant influence on inspiratory nasal resistance.

Considering the total sample, there was a decrease in the inspiratory nasal resistance values with vasoconstrictor and stability of nasal respiratory improvement in the 14-month, 18-month, and 8-year follow-up periods ($P < 0.05$).

		Active Anterior Computed Rhinomanometry									
		Inspiratory nasal resistance									
		with vasoconstrictor					without vasoconstrictor				
Time	N	Mean	SD	Mininum	Median	Maximum	Mean	SD	Minimum	Median	Maximum
T1	28	0.31	0.15	0.15	0.27	0.82	0.64	0.56	0.21	0.49	3.17
T2	28	0.27	0.12	0.13	0.25	0.64	0.43	0.16	0.23	0.40	0.91
T3	28	0.24	0.09	0.16	0.21	0.63	0.41	0.24	0.24	0.34	1.49
T4	27	0.22	0.05	0.14	0.20	0.35	0.41	0.17	0.18	0.35	0.91
T5	25	0.23	0.06	0.15	0.22	0.35	0.39	0.22	0.21	0.33	1.33
T6	19	0.22	0.14	0.00	0.19	0.61	0.40	0.34	0.00	0.27	1.44

Table 2: Results of active anterior computed rhinomanometry examinations carried out over an 8-year follow-up. T1 (initial time); T2 (6 months after RME); T3 (10 months after RME); T4 (14 months after RME); T5 (18 months after RME); T6 (8 years after RME); N (number of participants); SD (standard deviation).

Figure 3 includes the graphs with AR and AAR mean measurements taken throughout the eight-year follow-up. The graphs show statistically significant results for MCA1 without vasoconstrictor (AR) and inspiratory nasal resistance (AAR) with vasoconstrictor.

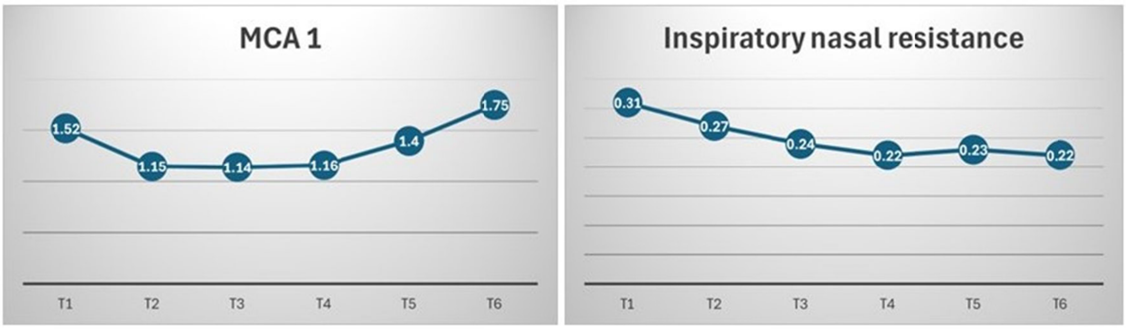

Figure 3: Graphs representing statistically significant results for MCA1 and inspiratory nasal resistance over eight years of follow-up. T1 (initial time); T2 (6 months after RME); T3 (10 months after RME); T4 (14 months after RME); T5 (18 months after RME); T6 (8 years after RME).

Computed tomography

The descriptive analysis of the data obtained from the CT examinations (nasal widths 1 and 2; maxillary widths 1, 2, and 3) is shown in Table 3. Figure 4 shows the graphs illustrating the CT mean measurements of nasal and maxillary transverse widths at the three time points.

The tomographic nasal width N1, which represents the distance between the head of the inferior turbinates, showed a statistically significant increase between T1 and T2 ($P < 0.0001$) and between T1 and T6 ($P = 0.0002$). However, there were no statistically significant differences between T2 and T6 ($P = 0.3162$) (Fig. 4A).

The tomographic nasal width N2 showed a statistically significant increase between T1 and T2 ($P < 0.0001$), with a statistically significant decrease between T2 and T6 ($P = 0.1398$). No statistically significant differences could be evidenced between T1 and T6 ($P = 0.0295$) (Fig. 4B).

In the tomographic maxillary width M1, statistically significant increases were found between T1 and T2 ($P < 0.0001$), with a statistically significant decrease from T2 to T6 ($P = 0.0295$) but without a statistically significant difference between T1 and T6 ($P = 0.0854$) (Fig. 4C).

In the tomographic maxillary width M2, considering the total sample of MBs, statistically significant increases were found between T1 and T2 ($P < 0.0001$) and between T1 and T6 ($P = 0.0002$) but no statistically significant differences between T2 and T6 ($P = 0.1097$) (Fig. 4D).

In the temporal analysis between the groups with and without allergic rhinitis, the tomographic maxillary width M3, a measurement of the posterior maxillary width, showed a statistically significant difference only for the time factor alone. Statistically significant increases were found between T1 and T2 ($P < 0.0001$) and between T1 and T6 ($P < 0.0001$), with no statistically significant differences between T2 and T6 ($P = 0.2317$) (Fig. 4E).

Moreover, in the temporal analysis between the groups with and without allergic rhinitis, statistically significant differences were found in all tomographic widths for the time factor alone. However, no statistically significant differences were found for the rhinitis factor analysed separately or when the rhinitis and time factors were considered altogether.

		Computed Tomography																								
		Nasal and Maxillary Transverse Coronal Widths																								
		N1					N2					M1					M2					M3				
Time	N	Mean	SD	Min.	Median	Max.	Mean	SD	Min.	Median	Max.	Mean	SD	Min.	Median	Max.	Mean	SD	Min.	Median	Max.	Mean	SD	Min.	Median	Max.
T1	28	2.02	0.20	1.61	2.00	2.54	1.86	0.27	1.41	1.80	2.46	2.50	0.58	1.21	2.57	3.87	4.25	0.58	3.47	4.07	5.62	5.84	0.55	3.69	5.87	6.60
T2	28	2.18	0.26	1.73	2.12	2.94	2.01	0.27	1.56	1.99	2.60	2.67	0.60	1.57	2.73	3.96	4.42	0.62	3.48	4.30	5.94	6.09	0.59	3.78	6.12	7.01
T6	16	2.16	0.21	1.83	2.15	2.56	1.95	0.25	1.43	1.97	2.54	1.86	0.49	1.02	2.00	2.47	4.65	0.90	3.45	4.24	6.47	6.40	0..45	5.63	6.42	7.39

Table 3: Nasal and maxillary tomographic transverse widths at different measurement points assessed over three time points. T1 (initial time); T2 (6 months after RME); T6 (8 years after RME); N1 (nasal width 1); N2 (nasal width 2); M1 (maxillary width 1); M2 (maxillary width 2); M3 (maxillary width 3); N (number of participants); SD (standard deviation); Min. (minimum values); Max. (maximum values).

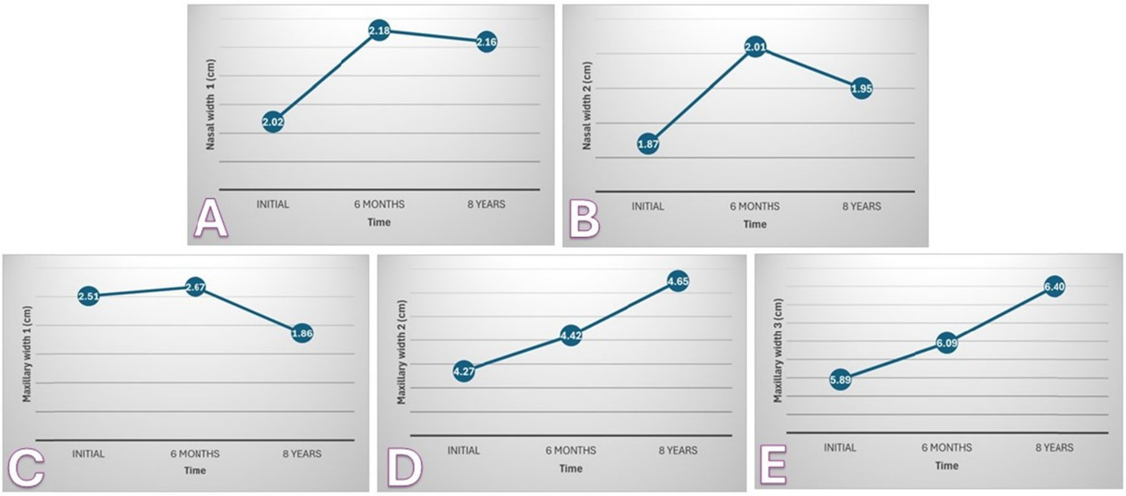

Figure 4: Graphs showing the CT mean measurements of nasal and maxillary transverse widths at initial time, 6 months after RME and 8 years after RME; A (nasal width 1); B (nasal width 2); C (maxillary width 1): D (maxillary width 2); E (maxillary width 3).

Angle's Molar Classification

In the initial phase of the study, 7/28 (25%) of children and adolescents had Angle Class I first permanent molars, 17/28 (60.7%) Angle Class II, and only 4/28 (14.2 %) Angle Class III (Fig. 5).

Six months after RME, six MBs with initial Angle Class II began to show Angle Class I.

Four MBs with initial Angle Class III maintained the molar pattern at six months after RME. However, it was observed that in the long-term follow-up of eight years, the number of Class III MBs increased, amounting to 26.3% of the final sample (Fig. 5).

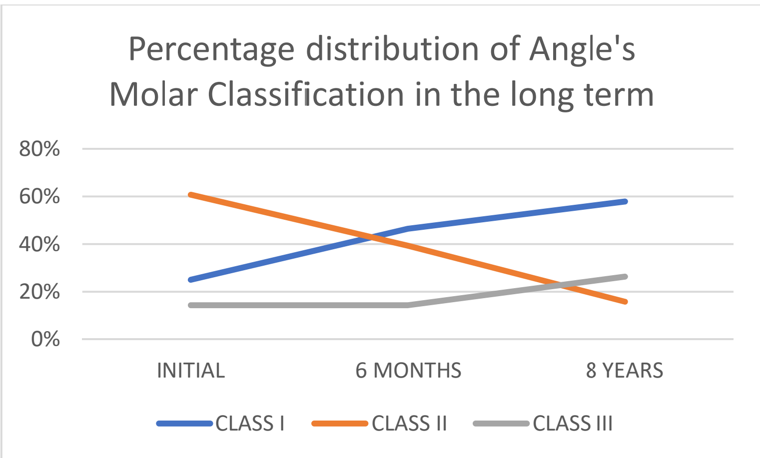

Figure 5: Percentage distribution of Angle´s Molar Class I, II, and III assessed at initial time, 6 months after RME, and 8 years after RME.

DISCUSSION

This study stands out for its long-term structural and functional evaluation of RME in mouth-breathing children and adolescents. The various objective measurements simultaneously assessed through computed tomography, acoustic rhinometry, and active anterior computed rhinomanometry allowed for a more robust analysis.

The results yielded an increase in nasal patency, with a decrease in mean nasal inspiratory resistance. This data was statistically significant in the 10-month, 18-month, and 8-year follow-up periods after RME. These findings highlight the importance of performing RME in mouth-breathers with maxillary atresia, with possible long-term improvement in mouth-breathing. These results are in line with previously published studies with follow-up periods of up to 30 months after RME.[12,16–18] However, it is important to note that some authors found opposite results.[13,19]

CT data showed posterior maxillary widening six months and eight years after RME. There was a positive evolution, with a statistically significant increase in all tomographic measurements assessed six months after RME, in agreement with other authors.[20,21]

The widening of the nasal structures with RME provided a short-term improvement in mouth-breathing. Transverse nasal tomographic widths showed significant increases in the short term – greater than in the long term. These results suggest the need for further studies including nasal volumetric assessments to better understand the three-dimensional effects of RME on the nasal cavity.

Among MBs without allergic rhinitis, only the nasal width located at the base of the middle turbinates increased in the long term. Allergic individuals showed a decrease in all nasal widths eight years after RME. However, the temporal statistical analysis found no statistically significant influence for the allergic rhinitis factor. Studies with larger samples, such as multicentre studies, could provide further clarification of these findings.

It is well known that RME can provide anterior and inferior mandibular positioning in up to 75% cases of Angle Class II.[22,23] This functional improvement was found in six Angle Class II patients in our study, amounting to 35% of the initial sample. However, patients with Angle Class III showed an increase in the frequency of this malocclusion in the long term, reinforcing the need for an orthodontic or complementary surgical procedure to RME. [24]

RME should, therefore, continue to be the first choice for the correction of transverse maxillary deficiency in MBs. Importantly, RME should be performed in conjunction with or after the treatment of the cause of nasal obstruction. MBs with allergic rhinitis should be watchful for allergy triggers, avoiding events of nasal turbinate hypertrophy.[25]

Improvement in mouth-breathing was more frequently reported by family members and MBs without allergic rhinitis, although without statistical evaluation. Patient's health outcome reports, such as (PRO) Patient-Reported Outcome and Patient-Reported Outcome Measures (PROM), were not used in a methodological manner. We would like to highlight that the use of these tools must be standardized in future intervention studies.

This study has potential limitations: (i) sample size, (ii) non-inclusion of **a** control-group with transverse maxillary deficiency and MBs not submitted to RME, and (iii) non-use of PRO and PROM. Admittedly, the inclusion of a control group would be important to clarify whether the obtained maxillary enlargement was related to RME or to natural growth in untreated children; however, due to ethical reasons, CT scans were avoided in children and adolescents because of radiation exposure.

Further research should include (i) multicentre studies with larger sample sizes involving MBs with and without allergic rhinitis; (ii) a control group; (iii) a quality of life questionnaire for parents and patients; (iv) patients with the same clinical characteristics of morbidity and comorbidities; (v) allocation of patients according to age groups; (vi) comparisons between groups; (vii) volumetric analyses of CT scans; and (viii) meta-analyses with prior standardization of CT, AR, and AAR measurements.

Therefore, the results of this study have a special relevance for further multicentre studies on mouth-breathing involving multidisciplinary research centres worldwide.

CONCLUSION

Although limited by a small sample size and the lack of a control group, our study showed that RME promoted and maintained the widening of the posterior maxillary structure in mouth-breathing children and adolescents, with a decrease in inspiratory nasal resistance during the eight-year follow-up. Transverse nasal tomographic widths showed significant increases in the short term – greater than in the long term. The tomographic measurements were not influenced by allergic rhinitis. These findings highlight the importance of performing RME in mouth-breathers with maxillary atresia.

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