



CLINICAL RESEARCH:

Effects of Maxillary Expansion on Mastication and Muscle Activity: Case Series

Efectos de la expansión maxilar sobre la masticación y la actividad muscular: informe de casos

Livia Maria Alves Valentim da Silva¹ <https://orcid.org/0000-0001-7189-4417>

Daniela Micheline dos Santos¹ <https://orcid.org/0000-0001-6297-6154>

Victor Perinazzo Sachi¹ <https://orcid.org/0000-0002-9044-737X>

Beatriz Miwa Barros Nakano¹ <https://orcid.org/0000-0003-1120-0203>

Bruna Mike Barros Nakano¹ <https://orcid.org/0009-0008-0420-2415>

Marcelo Coelho Goiato¹ <https://orcid.org/0000-0002-3800-3050>

Wirley Gonçalves Assunção¹ <https://orcid.org/0000-0002-8903-0737>

André Pinheiro de Magalhães Bertoz¹ <https://orcid.org/0000-0002-1746-3138>

¹São Paulo State University (UNESP), School of Dentistry, Araçatuba, São Paulo, Brazil.

Correspondence to: Livia Maria Alves Valentim da Silva - llivaa@hotmail.com

Received: 11-II-2026

Accepted: 7-III-2026

ABSTRACT: This case series evaluated three children with maxillary transverse deficiency and a habitual unilateral mastication preference who were treated with rapid maxillary expansion (RME). Considering the growing recognition of functional alterations in children with transverse deficiencies, RME has been proposed as a therapeutic approach capable of remodeling skeletal structures and influencing muscular dynamics. Electromyographic activity of the bilateral masseter, temporalis, and upper and lower orbicularis oris muscles was recorded during rest, dental clenching, suction, swallowing, and non-habitual mastication at baseline (T0), six months (T1), and eighteen months (T2). By six months, transverse deficiencies were corrected in all patients, with increases in anterior and posterior arch widths and closure of the anterior open bite, and these skeletal and dental changes remained stable throughout the 18-month follow-up. Functionally, an initial increase in orbicularis oris activity and improved muscular symmetry were observed at six months; partial asymmetry reappeared at 18 months, reflecting the persistence of habitual right-sided unilateral mastication. RME produced stable skeletal and dental outcomes and promoted early functional adaptations in these three patients, but when used in isolation, it was insufficient to induce lasting modifications of their established unilateral masticatory patterns, highlighting the need for multidisciplinary management to achieve long-term functional stability.

KEYWORDS: Electromyography; Palatal expansion technique; Open bite; Mastication; Children; Case reports.



RESUMEN: Esta serie de casos evaluó a tres niños con deficiencia transversal maxilar y preferencia habitual de masticación unilateral que fueron tratados con expansión rápida del maxilar (ERM). Considerando el creciente reconocimiento de las alteraciones funcionales en niños con deficiencias transversales, la ERM ha sido propuesta como un enfoque terapéutico capaz de remodelar las estructuras esqueléticas e influir en la dinámica muscular. La actividad electromiográfica de los músculos masetero y temporal bilaterales, así como del orbicular de los labios superior e inferior, fue registrada durante el reposo, el apretamiento dental, la succión, la deglución y la masticación no habitual en el momento inicial (T0), a los seis meses (T1) y a los dieciocho meses (T2). A los seis meses, las deficiencias transversales fueron corregidas en todos los pacientes, con aumento de las anchuras de los arcos anterior y posterior y cierre de la mordida abierta anterior, manteniéndose estos cambios esqueléticos y dentales estables durante el seguimiento de 18 meses. Desde el punto de vista funcional, se observó un aumento inicial de la actividad del orbicular de los labios y una mejoría en la simetría muscular a los seis meses; sin embargo, a los 18 meses reapareció parcialmente la asimetría, reflejando la persistencia de la masticación unilateral habitual del lado derecho. La ERM produjo resultados esqueléticos y dentales estables y promovió adaptaciones funcionales tempranas en estos tres pacientes, pero, cuando se utilizó de forma aislada, fue insuficiente para inducir modificaciones duraderas en los patrones masticatorios unilaterales establecidos, lo que resalta la necesidad de un abordaje multidisciplinario para lograr una estabilidad funcional a largo plazo.

PALABRAS CLAVE: Electromiografía; Técnica de expansión palatina; Mordida abierta; Masticación; Niño; Informes de casos.

INTRODUCTION

Several non-surgical approaches, including rapid maxillary expansion (RME), have been recommended for the treatment of maxillary transverse deficiency in children due to their significant effects on adjacent structures, particularly the midpalatal suture, the temporomandibular joint, and the anterior and posterior maxillary teeth (1,2).

However, beyond correcting transverse deficiency, RME positively influences speech and hearing, enlarges the nasal cavity, increases the sagittal dimension of the oropharyngeal region, and contributes to tongue elevation. Nevertheless, its impact on masticatory muscle activity remains unclear, as most available investigations predo-

minantly focus on respiratory and airway-related functional outcomes (3). Some evidence suggests that orthodontic interventions, including RME, modulate orofacial muscle function in children, indicating that functional adaptations accompany the skeletal changes induced by expansion (4-7). Although RME demonstrates a significant influence on the electromyographic activity of the anterior temporal and superficial masseter muscles during swallowing and mastication, with these effects maintained throughout follow-up (8), little is known about its impact on children with maxillary transverse deficiency who exhibit unilateral mastication preference. This subgroup is particularly relevant because asymmetric chewing patterns may alter neuromuscular responses and compromise the functional stability of orthodontic outcomes.

By investigating how RME modified muscle activity and masticatory dynamics in these patients, the present study aimed to clarify the functional adaptations associated with transverse maxillary correction. Such information may contribute to more personalized treatment strategies, ensuring not only skeletal correction but also optimization of neuromuscular function and long-term stability.

CASE PRESENTATION(S)

The study was previously submitted to and approved by the Human Research Ethics Committee (CAAE: 86014425.7.0000.5420) and was conducted in accordance with the CARE Checklist (Case Report) to ensure complete and transparent reporting of all relevant information. The participants and their legal guardians signed an informed consent form, agreeing to the disclosure of their cases for academic purposes.

Three patients (7.67 ± 0.58 years) were recruited. All sought care due to concerns regarding dental alignment and presented misaligned teeth as their chief complaint. None had a relevant medical, family, or psychosocial history, and none had undergone previous orthodontic treatment.

Inclusion criteria comprised children in the mixed dentition stage presenting clinically and radiographically confirmed maxillary transverse deficiency, Angle Class I malocclusion, and unilateral masticatory preference identified through direct clinical observation during standardized chewing tasks. Exclusion criteria included systemic diseases, craniofacial syndromes, previous orthodontic or orthopedic treatment, diagnosed temporomandibular disorders, ongoing myofunctional therapy, presence of deleterious oral habits, and clinical signs suggestive of mouth breathing or airway obstruction.

CLINICAL FINDINGS

At the initial clinical examination, all patients presented with a Class I molar relationship, negative overbite, visibly narrow maxillary arches, and mild to moderate dental crowding. No clinical signs of periodontal pathology or evident parafunctional habits were identified during the assessment. However, any basic dental needs, such as caries treatment or other clinical demands, were referred to the Pediatric Dentistry Clinic of the institution prior to the start of orthodontic therapy.

TIMELINE

A structured clinical timeline was established for all patients: baseline clinical and electromyographic evaluation (T0), active expansion phase (7 days), passive retention period (6 months), first follow-up evaluation (T1-6 months), continued observation without adjunctive myofunctional therapy, and final follow-up assessment (T2-18 months).

The 6-month evaluation corresponded to the end of the retention phase, allowing assessment of skeletal stabilization after maxillary expansion. The 18-month follow-up was selected to investigate longer-term neuromuscular adaptation after orthopedic correction and occlusal reorganization.

DIAGNOSTIC ASSESSMENT

The diagnostic evaluation included a medical history review, physical examination, clinical analysis of occlusion, and comprehensive orthodontic records, as well as an assessment of skeletal, dental, and soft-tissue relationships. The Korkhaus analysis was used to confirm maxillary transverse deficiency, which was evidenced by negative values for both anterior and posterior transverse widths in all cases (9).

The final diagnosis for all patients was maxillary transverse deficiency associated with Angle Class I malocclusion in the mixed dentition, confirmed clinically and through Korkhaus analysis. The main associated findings included negative overbite, dental crowding, and aesthetic and functional alterations related to transverse maxillary narrowing. No diagnostic limitations or relevant alternative diagnoses were identified, as clinical and imaging findings were consistent.

Patient 1-Dental Analysis: The patient was in the mixed dentition stage and presented with Angle Class I malocclusion, negative overbite, and mild anterior crowding in both the maxillary and mandibular arches. **Soft-Tissue Analysis:** The facial profile was straight and symmetric, although lip seal was slightly strained. The nasolabial angle was within normal proportional limits. **Radiographic Analysis:** Imaging revealed a slightly protrusive maxilla associated with a vertical growth pattern (Figure 1).

Patient 2-Dental Analysis: The patient presented with Angle Class I malocclusion in the mixed dentition stage and a negative overbite. **Soft-Tissue Analysis:** A mildly convex facial profile was observed, with no asymmetries. The patient exhibited an adequate lip seal. **Radiographic Analysis:** Imaging showed a slightly protrusive maxilla and a vertical facial growth pattern (Figure 2).

Patient 3-Dental Analysis: The patient exhibited an Angle Class I relationship in the mixed dentition stage, with a negative overbite. **Soft-Tissue Analysis:** The facial profile was convex, with no signs of asymmetry. A forced lip seal was observed, and the nasolabial angle was within normal limits. **Radiographic Analysis:** Imaging showed a protrusive maxilla and a predominantly vertical facial growth pattern (Figure 3).

THERAPEUTIC INTERVENTION

RME using a tooth-borne Hyrax appliance was selected as the treatment of choice due to the confirmed diagnosis of maxillary transverse deficiency in growing patients in the mixed dentition stage. Early orthopedic intervention was indicated to correct the transverse skeletal discrepancy, re-establish occlusal balance, and prevent progression of functional and neuromuscular imbalance. Considering the patients' age and cervical vertebral maturation stage (CVM III), corresponding to the ascending phase of the pubertal growth spurt, the midpalatal suture was expected to be highly responsive to orthopedic stimulation (Figure 4). Furthermore, the absence of systemic or dental comorbidities that could interfere with treatment execution or stability contributed to a favorable prognosis for skeletal correction.

The RME protocol was performed by a single experienced orthodontist. The Hyrax appliance was activated one full turn per day (2/4 turn in the morning and 2/4 turn at night) for seven consecutive days. The initial mean maxillary transverse deficiency was -1.60 mm (± 0.85), with a greater posterior deficiency (-4.67 mm ± 1.27), justifying an approximate 7-mm expansion to achieve transverse overcorrection. Activation was discontinued upon clinical achievement of overcorrection and the appearance of an interincisal diastema, indicating midpalatal suture separation.

After completion of active expansion, the appliance was maintained as passive retention for six months to allow skeletal consolidation and soft tissue adaptation. No adjunctive myofunctional therapy was initiated during the observation period, in order to allow isolated evaluation of the effects of RME on neuromuscular activity and minimize potential confounding influences. Patients recei-

ved oral hygiene instructions and were followed monthly to monitor adaptation, appliance stability, and occlusal development. No adverse events were observed during the treatment and follow-up period.

ELECTROMYOGRAPHIC ASSESSMENT OF MASTICATORY MUSCLES

The electromyographic activity of the bilateral masseter, temporalis, and upper and lower orbicularis oris muscles was evaluated at baseline, six months, and eighteen months after RME. The six-month evaluation corresponded to the end of the passive retention phase, allowing assessment of skeletal and dental stabilization following expansion, whereas the eighteen-month follow-up was selected to investigate longer-term neuromuscular adaptation and occlusal reorganization after orthopedic correction. Recordings were obtained during rest, dental clenching, suction, swallowing, and non-habitual mastication. Signals were captured using a DelSys electromyograph (DelSys Inc., Boston, MA, USA) with Trigno Mini surface electrodes, and LabChart 8 software (AD Instruments; DelSys Inc., Boston, MA, USA) was used for visualization and processing. Signal processing included a sampling frequency of 2000 Hz, band-pass filtering between 20 and 450 Hz, full-wave rectification, smoothing, and analysis over a time window of 5 seconds. EMG signals were normali-

zed to maximum voluntary clenching and expressed as a percentage of MVC (%MVC). To optimize signal quality, participants washed their face with soap and water, and electrode placement areas were cleaned with 70% alcohol to reduce skin impedance (10).

Participants were seated upright with back supported and feet touching the floor to standardize posture and maintain a consistent respiratory pattern. Unilateral mastication preference was assessed using structured clinical observation and a validated questionnaire based on the protocol by Pastana, Costa, and Chiappetta (11), which evaluates chewing side, oral habits, and functional patterns. Although none of the patients presented unilateral crossbite, this standardized assessment was applied to systematically document masticatory behavior. Participants with prior orofacial myofunctional therapy, occlusal interferences, or systemic conditions that could influence EMG activity were excluded to minimize confounding factors.

EMG signals were normalized to the maximum voluntary isometric contraction, recorded with and without three folds of Parafilm® M (Amcort Flexibles North America, Inc.; Neenah, WI, USA) over the occlusal plane. Descriptive EMG data were recorded for each patient, muscle, side, and functional task to allow objective interpretation of the results despite the limited sample size.

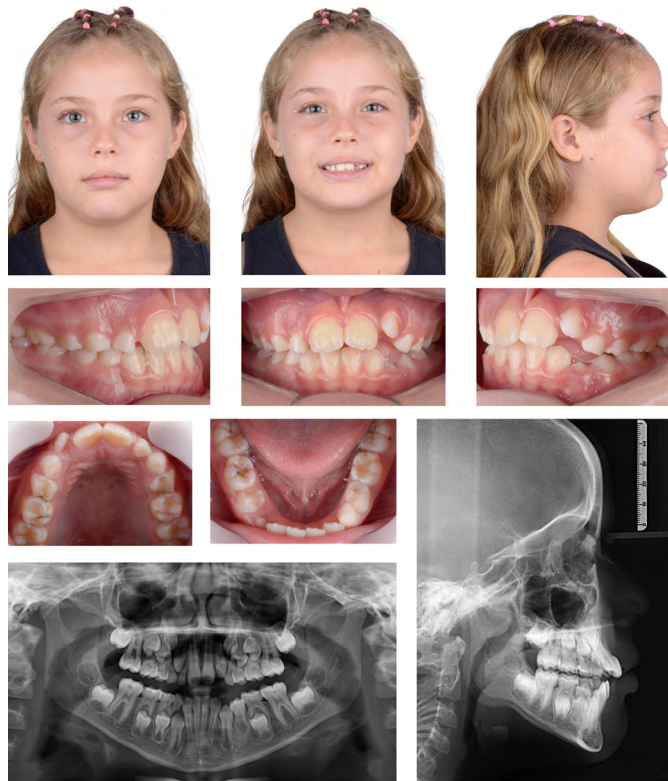


Figure 1. Pre-treatment records of Patient 1, including intraoral and extraoral photographs, panoramic radiograph, and lateral cephalometric radiograph.



Figure 2. Pre-treatment records of Patient 2, including intraoral and extraoral photographs, panoramic radiograph, and lateral cephalometric radiograph.



Figure 3. Pre-treatment records of Patient 3, including intraoral and extraoral photographs, panoramic radiograph, and lateral cephalometric radiograph.

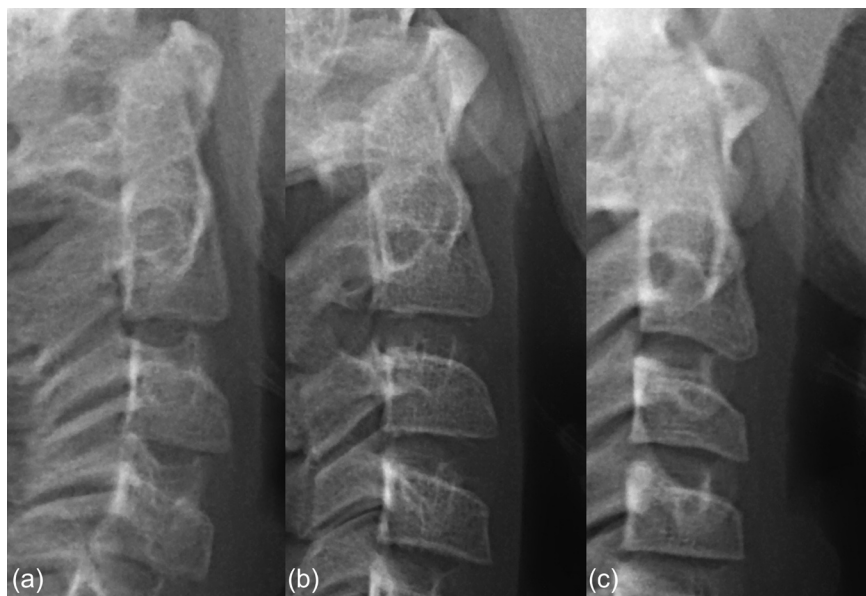


Figure 4. Assessment of cervical vertebral maturation (CVM Stage III) of the patients: (a) Patient 1, (b) Patient 2, (c) Patient 3. All patients show concavity at the inferior borders of C2 and C3, indicating the ascending phase of the pubertal growth spurt, which suggests a favorable skeletal response potential to rapid maxillary expansion (RME).

FOLLOW-UP AND OUTCOMES

During the activation period, patients reported only discomfort during the first three days, which resolved spontaneously. Throughout the entire follow-up period, adherence to the protocol was excellent, with proper appliance maintenance and consistent attendance at monthly appointments. No significant changes to the intervention or adverse events were recorded, except in one case in which the appliance required recementation at four months.

All three patients initially presented transverse maxillary deficiency, which can be observed from the negative anterior and posterior width values (Table 1). After six months of RME, correction was achieved in all patients, with anterior and posterior widths becoming positive in most cases, indicating effective clinical correction of the transverse deficiency. At 18 months, a slight relapse in the measurements was observed; however, these reductions were minimal and did not compromise the corrected transverse dimensions of the maxilla, both anteriorly and posteriorly. These findings confirm the long-term stability of RME outcomes and highlight the importance of overcorrection in these cases to compensate for potential relapse and ensure lasting results.

In addition, improvements were observed in dental alignment and vertical overbite. Parents also reported noticeable enhancement in tooth positioning, corroborating the clinical findings, with closure of the anterior open bite achieved in all three patients (Figure 5). Overall, all patients exhibited a homogeneous cephalometric pattern throughout follow-up (Individual cephalometric values for each patient at baseline (T0), 6 months (T1), and 18 months (T2) following RME) (Table 2).

The sagittal relationship between the skeletal bases remained stable, with SNA, SNB, and ANB values virtually unchanged at 6 and 18 months, indicating that correction of the transverse deficiency did not produce significant changes in the anteroposterior position of the maxilla or mandible. All patients maintained a Class I molar relationship, with no evidence of undesirable dental compensations.

Vertical measurements also followed a similar pattern among the cases, with slight increases in SnGoMe and FMA angles over time. These variations are consistent with the initial opening of the midpalatal suture and natural craniofacial growth, without negative clinical repercussions for facial esthetics or occlusion. The position of the lower incisors (IMPA) remained stable, with no relevant tendency toward protrusion or retroclination.

Taken together, the results demonstrate that, in addition to correcting maxillary transverse deficiency, RME did not significantly alter sagittal skeletal patterns or occlusal relationships, showing predictable and stable behavior at 6 and 18 months. These findings reinforce that both transverse correction and initial functional adjustments were maintained throughout the follow-up period. It is important to note that no additional orthodontic appliances were used after appliance removal, and no side effects associated with the intervention were observed. Additionally, mandibular arch dimensions remained stable, and the initial mild negative overbite of the patients improved after RME and was maintained with excellent results at 18 months. Midline deviations, which were primarily observed in patients 2 and 3, were almost completely corrected after 6 months and remained stable at 18 months (Figure 6, Figure 7, and Figure 8).

Table 1. Individual anterior and posterior transverse widths measured by Korkhaus analysis for each patient at baseline (T0), 6 months (T1), and 18 months (T2) following RME.

	Patient 1			Patient 2			Patient 3		
	Initial	6 months	18 months	Initial	6 months	18 months	Initial	6 months	18 months
Anterior	-0.8	2.8	2.3	-2.5	3.5	3.0	-1.5	2.8	2.8
Posterior	-3.7	0.3	0.8	-6.1	0.9	0.4	-4.2	2.2	1.3

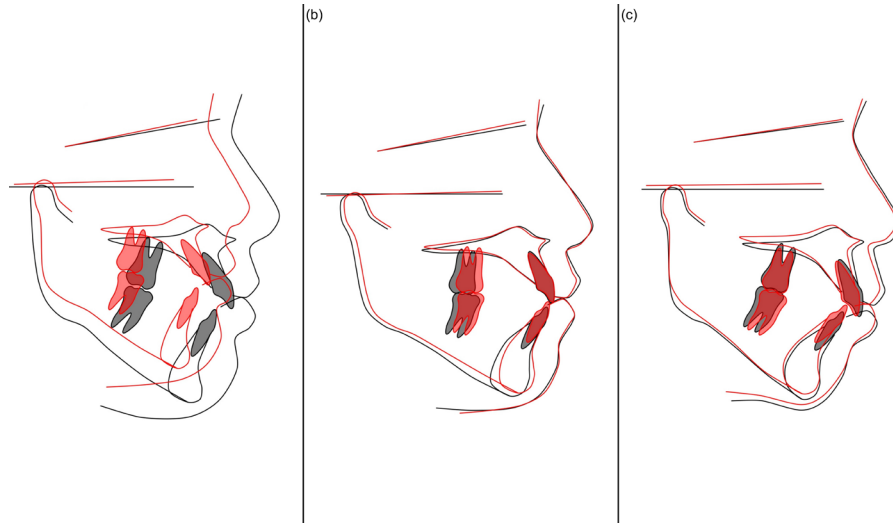


Figure 5. Superimposition of initial and 18-month post-treatment lateral cephalometric tracings for the three patients: (a) Patient 1, (b) Patient 2, and (c) Patient 3. Red tracings represent the 18-month outcomes, while black tracings correspond to the baseline measurements.

Table 2. Individual cephalometric values for each patient at baseline (T0), 6 months (T1), and 18 months (T2) following RME.

	Patient 1			Patient 2			Patient 3		
	Initial	6 months	18 months	Initial	6 months	18 months	Initial	6 months	18 months
SNA	79.1	77.8	77.8	86.1	84.5	84.6	85.6	85.0	83.4
SNB	75.0	76.6	75.7	81.2	81.3	80.5	76.7	77.0	75.8
ANB	4.1	1.2	2.1	4.9	3.1	4.1	8.8	8.0	7.6
SnGoMe	45.3	41.6	43.9	40.4	41.0	40.2	44.4	44.3	45.7
FMA	33.9	31.6	33	29	30	29.5	35.9	35.1	37.4
IMPA	82.5	83.5	84	92.5	82.6	89.9	90.7	94.8	93.9

SNA: angle between Sella-Nasion-A point, indicating maxillary anteroposterior position; SNB: angle between Sella-Nasion-B point, indicating mandibular anteroposterior position; ANB: difference between SNA and SNB, indicating sagittal maxillomandibular relationship; SnGoMe: angle between Subnasal-Gonion-Menton, indicating mandibular plane inclination; FMA: angle between Frankfurt plane and mandibular plane, indicating vertical facial growth; IMPA: angle between lower incisor and mandibular plane, indicating lower incisor inclination.

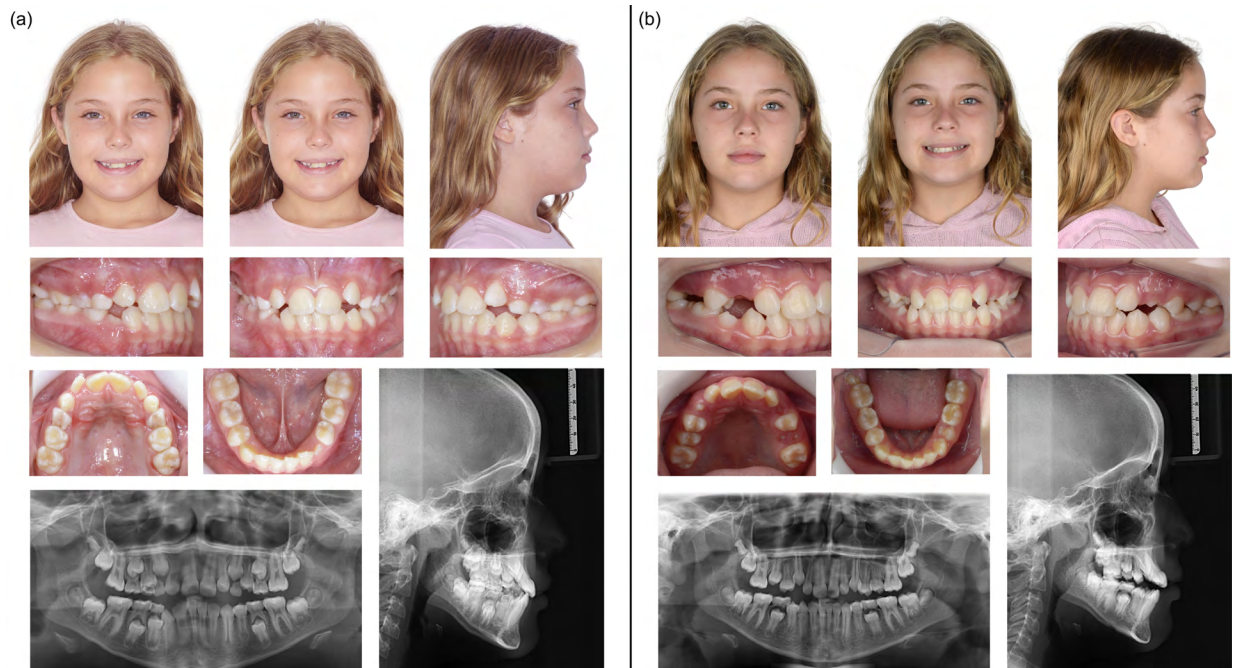


Figure 6. Post-treatment records of Patient 1 at six months (a) and 18 months (b) after rapid maxillary expansion (RME).

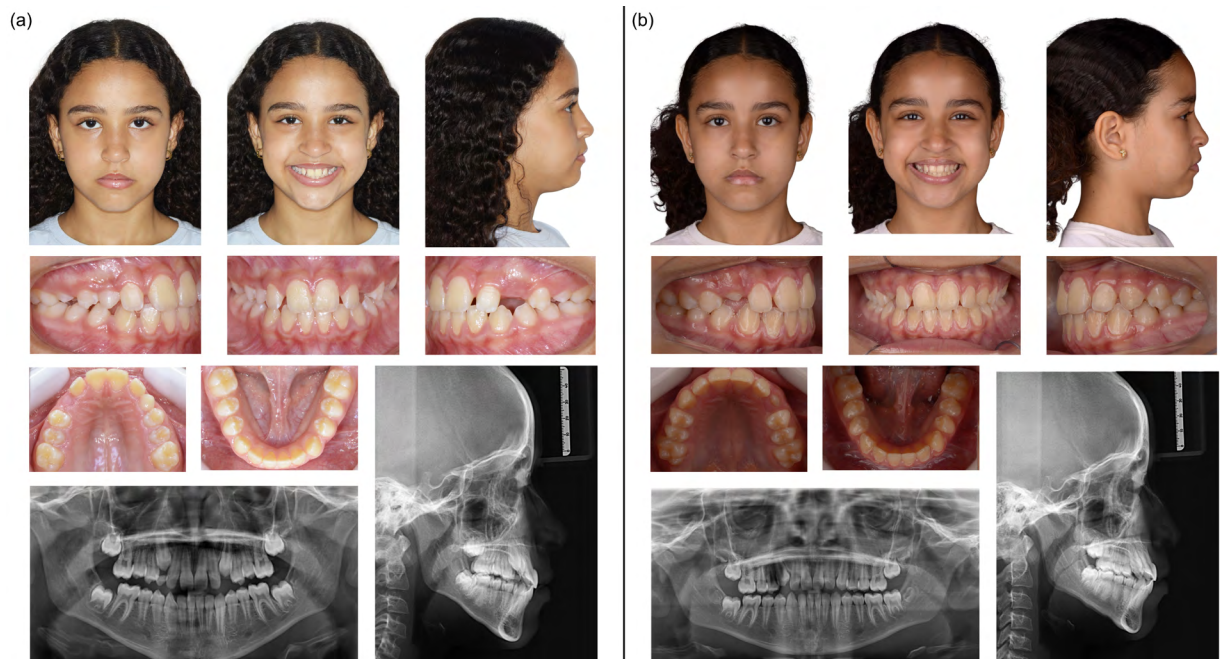


Figure 7. Post-treatment records of Patient 2 at six months (a) and 18 months (b) after rapid maxillary expansion (RME).

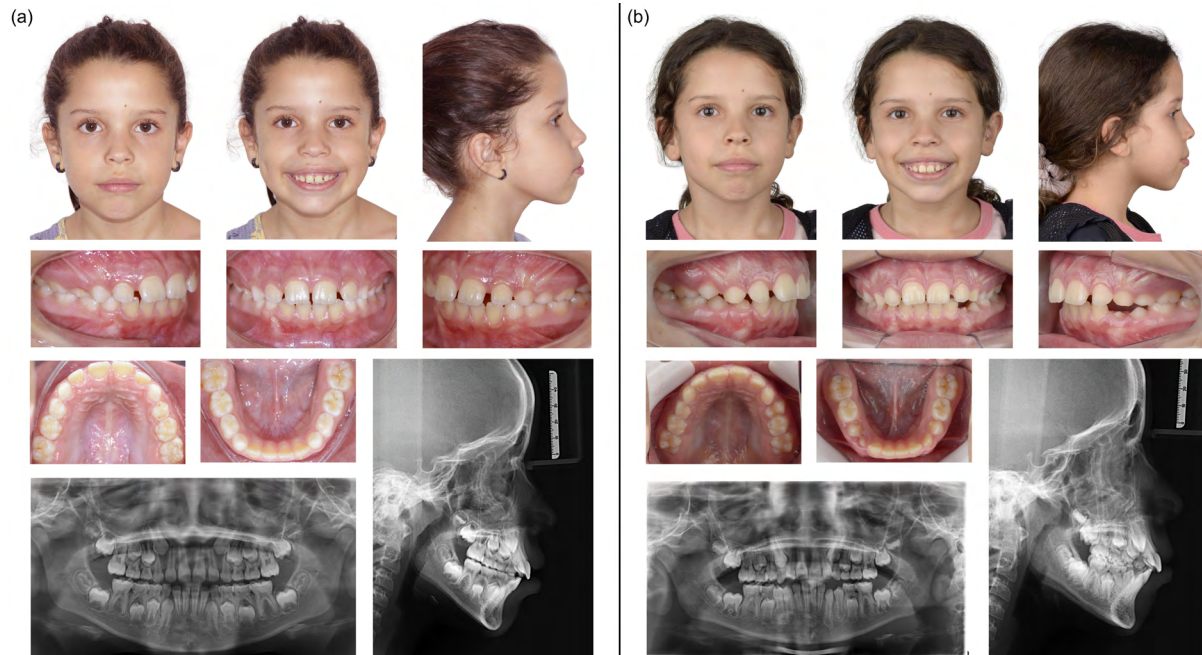


Figure 8. Post-treatment records of Patient 3 at six months (a) and 18 months (b) after rapid maxillary expansion (RME).

ASSESSMENT OF UNILATERAL MASTICATORY PATTERNS AND MUSCLE ACTIVITY

Electromyographic activity of the bilateral masseter, temporalis, and orbicularis oris muscles (upper and lower) was assessed at baseline (T0), six months (T1), and eighteen months (T2) after RME. The six-month evaluation corresponded to the end of the passive retention phase, allowing assessment of skeletal and dental stabilization, whereas the eighteen-month follow-up was selected to investigate longer-term neuromuscular adaptation and occlusal reorganization.

Analysis of the quantitative EMG data revealed that masseter and temporalis activity remained relatively stable across all patients, sides, and tasks over the three time points, indicating minimal influence of RME on these muscles. In

contrast, the orbicularis oris muscles exhibited greater variability, particularly on the right side, consistent with the habitual unilateral mastication pattern observed in all patients. For example, in Patient 1 (Table 3), the right lower orbicularis muscle increased from 0.32 μV at rest at T0 to 1.87 μV at T1, returning to 1.35 μV at T2. Similar trends were observed during functional tasks such as chewing gum and biscuits, where right-side orbicularis activity was higher than left-side activity, reflecting functional adaptation to unilateral chewing. Patient 2 (Table 4) showed comparable patterns, with the right upper orbicularis increasing from 0.27 μV during gum chewing at T0 to 0.58 μV at T1, and partially decreasing to 0.24 μV at T2. Patient 3 (Table 5) exhibited increases in right lower orbicularis activity at T1 across most tasks, except for gum and biscuit chewing, where values remained similar to baseline. At T2,

activity increased during rest and most functional tasks, while values during maximum habitual intercuspation with Parafilm returned to levels similar to T0.

These descriptive EMG results demonstrate that RME led to transient increases in perioral

muscle activity, particularly in muscles directly associated with oral sealing and chewing. Despite partial improvements observed at six months, the right-side predominance in orbicularis activity persisted at eighteen months, suggesting that RME alone did not fully modify established unilateral masticatory patterns.

Table 3. Electromyographic activity (μV) of the masseter, temporalis, and orbicularis oris muscles (both upper and lower) on the right and left sides of Patient 1, recorded at baseline (T0), six months (T1), and eighteen months (T2) after RME.

		Temporal R	Temporal L	Masseter R	Masseter L	Orbicular RU _p	Orbicular LU _p	Orbicular RL _o	Orbicular LL _o
Initial	Rest	0.01	0.01	0.01	0.00	0.03	0.00	0.32	0.03
	MHI	0.09	0.06	0.03	0.02	0.04	0.01	0.39	0.06
	MHI+Parafilm®	0.04	0.03	0.02	0.01	0.03	0.00	0.30	0.09
	Suction	0.01	0.01	0.01	0.01	0.07	0.08	0.12	0.07
	Swallowing	0.01	0.01	0.01	0.01	0.03	0.02	0.55	0.41
	Gum-chewing	0.04	0.03	0.02	0.02	0.08	0.07	0.60	0.44
	Biscuit-chewing	0.03	0.02	0.02	0.02	1.33	0.17	0.85	0.53
6 months	Rest	0.01	0.02	0.01	0.01	3.82	0.04	1.87	0.02
	MHI	0.07	0.08	0.09	0.08	3.41	0.03	1.64	0.02
	MHI+Parafilm®	0.05	0.06	0.06	0.06	1.76	0.01	0.69	0.01
	Suction	0.01	0.02	0.01	0.01	1.40	0.08	0.19	0.08
	Swallowing	0.01	0.03	0.01	0.01	3.41	0.07	1.77	0.10
	Gum-chewing	0.04	0.04	0.06	0.05	2.17	0.08	0.85	0.16
	Biscuit-chewing	0.02	0.03	0.04	0.04	2.17	0.11	0.86	0.45
18 months	Rest	0.06	0.11	0.01	0.01	0.02	0.57	1.35	1.72
	MHI	0.08	0.12	0.05	0.03	0.03	0.50	1.22	1.60
	MHI+Parafilm®	0.08	0.12	0.05	0.03	0.03	0.29	1.24	1.51
	Suction	0.05	0.08	0.01	0.01	0.03	0.22	0.22	0.38
	Swallowing	0.05	0.08	0.01	0.01	0.18	0.58	1.22	1.29
	Gum-chewing	0.06	0.09	0.02	0.02	0.03	0.84	1.57	1.60
	Biscuit-chewing	0.05	0.08	0.03	0.02	0.03	1.07	1.33	1.17

R=right; L=left; Up=upper; Lo=lower.

Table 4. Electromyographic activity (μV) of the masseter, temporalis, and orbicularis oris muscles (both upper and lower) on the right and left sides of Patient 2, recorded at baseline (T0), six months (T1), and eighteen months (T2) after RME.

		Temporal R	Temporal L	Masseter R	Masseter L	Orbicular RUp	Orbicular LUp	Orbicular RLo	Orbicular LLo
Initial	Rest	0.01	0.01	0.01	0.00	0.03	0.00	0.59	0.09
	MHI	0.07	0.14	0.04	0.03	0.03	0.02	0.62	0.10
	MHI+Parafilm®	0.04	0.09	0.03	0.03	0.03	0.02	0.01	0.09
	Suction	0.01	0.01	0.01	0.01	0.28	0.17	0.01	0.10
	Swallowing	0.01	0.01	0.01	0.01	0.13	0.10	0.88	0.15
	Gum-chewing	0.03	0.04	0.02	0.02	0.27	0.18	0.83	1.04
	Biscuit-chewing	0.03	0.04	0.02	0.02	0.31	0.21	0.84	1.38
6 months	Rest	0.04	0.03	0.01	0.02	0.02	0.01	0.02	0.01
	MHI	0.09	0.07	0.08	0.08	0.17	0.01	0.04	0.02
	MHI+Parafilm®	0.05	0.05	0.04	0.06	0.07	0.01	0.05	0.02
	Suction	0.04	0.03	0.01	0.01	0.50	0.20	0.11	0.03
	Swallowing	0.04	0.03	0.01	0.01	0.02	0.07	0.09	0.02
	Gum-chewing	0.04	0.04	0.03	0.04	0.58	0.21	0.20	0.07
	Biscuit-chewing	0.05	0.05	0.03	0.05	0.23	0.17	0.39	0.09
18 months	Rest	0.07	0.03	0.01	0.01	0.03	0.02	0.60	0.12
	MHI	0.10	0.08	0.10	0.06	0.03	0.02	0.66	0.12
	MHI+Parafilm®	0.09	0.06	0.06	0.04	0.03	0.01	0.46	0.03
	Suction	0.09	0.02	0.01	0.01	0.16	0.10	0.24	0.18
	Swallowing	0.08	0.03	0.01	0.01	0.04	0.02	0.63	0.15
	Gum-chewing	0.09	0.04	0.06	0.04	0.24	0.14	1.18	0.34
	Biscuit-chewing	0.08	0.05	0.05	0.05	0.27	0.18	0.69	0.51

R=right; L=left; Up=upper; Lo=lower.

Table 5. Electromyographic activity (μV) of the masseter, temporalis, and orbicularis oris muscles (both upper and lower) on the right and left sides of Patient 3, recorded at baseline (T0), six months (T1), and eighteen months (T2) after RME.

		Temporal R	Temporal L	Masseter R	Masseter L	Orbicular RUp	Orbicular LUp	Orbicular RLo	Orbicular LLo
Initial	Rest	0.02	0.02	0.01	0.01	0.40	0.01	0.01	0.02
	MHI	0.02	0.02	0.01	0.01	0.17	0.04	0.03	0.04
	MHI+Parafilm®	0.07	0.12	0.04	0.05	0.77	0.07	0.04	0.05
	Suction	0.01	0.01	0.01	0.01	0.29	0.04	0.03	0.03
	Swallowing	0.02	0.02	0.04	0.03	0.24	0.11	0.07	0.06
	Gum-chewing	0.05	0.07	0.03	0.03	0.74	0.06	2.04	0.49
	Biscuit-chewing	0.06	0.06	0.05	0.04	1.24	0.17	2.12	1.12
6 months	Rest	0.01	0.01	0.01	0.00	0.03	0.01	0.65	0.01
	MHI	0.18	0.11	0.09	0.11	0.03	0.01	1.02	0.01
	MHI+Parafilm®	0.07	0.05	0.03	0.04	0.03	0.01	0.56	0.01
	Suction	0.03	0.01	0.01	0.01	0.08	0.07	0.34	0.04
	Swallowing	0.02	0.01	0.01	0.01	0.04	0.02	0.83	0.02
	Gum-chewing	0.07	0.05	0.02	0.04	0.07	0.05	1.01	0.24
	Biscuit-chewing	0.05	0.04	0.03	0.04	0.13	0.05	0.63	0.67
18 months	Rest	0.08	0.08	0.01	0.02	0.03	0.01	1.03	0.07
	MHI	0.22	0.25	0.04	0.08	0.03	0.01	1.06	0.06
	MHI+Parafilm®	0.35	0.37	0.11	0.17	0.03	0.01	0.01	0.07
	Suction	0.08	0.07	0.01	0.01	0.15	0.12	0.83	0.05
	Swallowing	0.08	0.09	0.01	0.01	0.03	0.02	1.03	0.06
	Gum-chewing	0.12	0.13	0.03	0.05	0.17	0.09	2.54	0.17
	Biscuit-chewing	0.14	0.14	0.05	0.06	0.22	0.11	2.94	0.25

R=right; L=left; Up=upper; Lo=lower.

DISCUSSION

Maxillary transverse deficiency is frequently associated with dental crowding, lip hypotonia, and altered swallowing patterns and is commonly treated with RME, an established orthodontic procedure that applies intense intermittent forces to separate the midpalatal suture, thereby increasing arch perimeter and correcting transverse malocclusions (12,13).

In the present study, RME proved effective in correcting transverse deficiency, promoting

increases in anterior and posterior arch widths and improving overbite. These transverse gains remained stable until the final 18-month evaluation, with only slight relapse observed in some measurements, which did not compromise the overall clinical outcomes. When performed before the pubertal growth spurt, RME contributes to balanced craniofacial development without significantly affecting anteroposterior growth or cephalometric measurements (14,15). This favorable response is likely related to reduced suture calcification and greater skeletal adaptability during growth, as observed in the three evaluated patients. The mild relapse

reinforces the biological rationale for overcorrection during expansion, highlighting its importance for achieving long-term transverse stability.

The diagnosis and treatment planning of maxillary transverse deficiency may be supported by the Korkhaus analysis, which compares ideal and actual transverse widths of the maxillary and mandibular arches on study models (16,17). Negative values indicate the need for expansion and assist in determining appliance selection and activation protocols, contributing to more predictable outcomes (18). Consistent with this diagnostic approach, both anterior and posterior maxillary widths in the present study demonstrated adequate correction and maintained stability throughout the 18-month follow-up period.

Beyond skeletal and dental effects, RME also influenced muscular function, as evidenced by the electromyographic findings. The selected evaluation intervals were designed to reflect clinically relevant phases of treatment, encompassing immediate stabilization after expansion and subsequent neuromuscular adaptation during occlusal reorganization. This design allowed observation of both short- and longer-term functional responses to transverse correction.

The orbicularis oris muscles were the most responsive, exhibiting increased activity that may have contributed to improved occlusal contacts and closure of the anterior open bite. These findings are consistent with Spolaor (19), who reported positive effects of RME on muscle activity in different malocclusions, including patients with underdeveloped maxillary complexes without posterior crossbite.

Although the left lower orbicularis muscle showed a slight reduction in some patients, a gradual increase in activity was observed during suction, swallowing, and chewing, particularly in the right lower orbicularis in two patients and

the right upper orbicularis in one patient. These changes may reflect natural muscular asymmetries, occlusal or postural differences, and the predominant right-side chewing pattern, which can temporarily generate compensatory overload while occlusion stabilizes. These changes may reflect natural muscular asymmetries, occlusal or postural differences, and the predominant right-side chewing pattern, which can temporarily generate compensatory overload while occlusion stabilizes. Importantly, the persistence of this unilateral mastication pattern at 18 months aligns with findings reported by Pignataro, Bérzin, and Rontani (20), who observed that most individuals demonstrate a preferred chewing side during habitual mastication, which can be reliably detected using electromyography compared to visual inspection. In our study, unilateral mastication preference was similarly assessed using structured clinical observation and a validated questionnaire based on Pastana, Costa, and Chiappetta (11), corroborating the EMG findings.

In contrast, electromyographic activity of the masseter and temporal muscles remained low and virtually unchanged in all three patients at six months, both at rest and during functional tasks such as clenching, suction, swallowing, and non-habitual mastication. This suggested that RME did not overload the primary masticatory muscles while promoting adaptive responses in the perioral musculature and preserving baseline activity patterns. Neuromuscular adaptation was also evident in the masseter and temporal muscles during rest, clenching, suction, swallowing, and atypical mastication, as these muscles exhibited only minimal increases in activity. Right and left muscles remained close to 0 mV in most tests, with small variations in Patient 3. These discrete responses likely resulted from mild adaptation to the new occlusal pattern, indicating the absence of overload or substantial stimulation during testing. These findings corroborate the results of Di Palma (21), who demonstrated that RME does not disrupt

the balance of the masseter and temporal muscles, allowing symmetrical and functional muscular responses in children with good pre-existing coordination.

Individual variations in muscle activity may be associated with factors such as chewing technique, respiratory patterns, compensatory muscle recruitment, anatomical and functional characteristics, and electrode placement accuracy. Previous studies, such as De Rossi, de Rossi, Hallak, Vitti and Regalo (5), observed increased activity in the masseter and temporal muscles after appliance removal, whereas Maspero, Giannini, Galbiati, Kairyte and Farronato (22) highlighted that RME primarily modifies muscular tone without directly affecting masticatory muscles, benefiting patients particularly when posterior crossbite is associated with transverse maxillary deficiencies.

In the present study, these functional findings were consistent with the results observed at 18 months, when partial recurrence of asymmetry in the right orbicularis muscles was noted, reflecting the persistence of the patients' habitual unilateral chewing pattern. Despite this, it was important to emphasize that RME produced significant clinical improvements, including closure of the anterior open bite and correction of the negative overbite in all cases, with stability throughout follow-up. From a cephalometric perspective, the patients showed a homogeneous pattern, maintaining a Class I sagittal relationship and demonstrating a slight increase in vertical angles (SnGoMe and FMA) at 6 and 18 months. This mild vertical trend, expected after midpalatal suture opening, did not compromise open-bite closure or occlusal stability.

The small number of patients limits the ability to draw definitive conclusions, making future studies with larger samples and more rigorous designs, including randomized clinical trials and longitudinal follow-ups, essential. This is particularly relevant because even after correction of

maxillary transverse deficiency, patients with unilateral mastication patterns may maintain functional asymmetries with potential long-term implications.

In the present study, these functional findings were consistent with the results observed at 18 months, when partial persistence of asymmetry in the right orbicularis muscles was noted, reflecting the patients' habitual unilateral chewing pattern. These observations underscore that RME alone, while effective for transverse and dental corrections, does not fully modify established motor patterns, highlighting the importance of interdisciplinary management, including speech therapy, myofunctional therapy, or physiotherapy, to support long-term neuromuscular adaptation.

Despite these limitations, all patients reported satisfaction with treatment, highlighting functional and esthetic improvements, and caregivers also approved the outcomes. These findings reinforced the clinical relevance of RME for correcting transverse maxillary deficiencies during the mixed dentition phase and for enhancing muscular dynamics. However, expansion alone was insufficient to permanently modify habitual mastication patterns, as evidenced by the asymmetric electromyographic patterns at 18 months, underscoring the need for multidisciplinary management to support long-term functional adaptations.

From a public health perspective, although most pediatric emergency visits are related to dental caries and traumatic injuries (23), the high prevalence and functional impact of malocclusions justify the inclusion of preventive and interceptive orthodontics within public health policies. Given the limited access to regular oral health services and the perception of orthodontics as a treatment for privileged populations, expanding early orthodontic care may help reduce functional impairments and social inequalities associated with untreated malocclusions (24).

Although no concomitant devices were used, allowing the observed changes to be attributed exclusively to the RME protocol, the findings suggest that once malocclusion is established, the masticatory musculature may progressively adapt through compensatory mechanisms, potentially leading to persistent asymmetries over time (25). Moreover, structural correction alone does not necessarily guarantee full functional normalization, as comprehensive orthodontic treatment may not completely restore jaw motor patterns (26), reinforcing the importance of early and interdisciplinary management to ensure long-term functional stability.

CONCLUSION

RME promoted stable skeletal and dental improvements and facilitated early functional adaptations in the three children with unilateral mastication included in this study. However, when used in isolation, it was insufficient to induce lasting modifications of their established masticatory patterns, underscoring the importance of a multidisciplinary approach to achieve long-term functional stability. These observations are limited to the present cases, and future studies with larger sample sizes are recommended to confirm and extend these findings.

AUTHOR CONTRIBUTION STATEMENT: Conceptualization and Design: D.M.S., W.G.A. and A.P.M.B.; Literature Review: L.M.A.V.S. and V.P.S.; Methodology and Validation: L.M.A.V.S., V.P.S. and B.M.B.N.; Formal Analysis: L.M.A.V.S. and D.M.S.; Investigation and Data Collection: L.M.A.V.S., V.P.S. and B.M.B.N.; Resources: M.C.G., D.M.S., W.G.A., A.P.M.B.; Data Analysis and Interpretation: L.M.A.V.S., D.M.S.; Writing – Original Draft Preparation: L.M.A.V.S. and D.M.S.; Writing – Review & Editing: L.M.A.V.S., D.M.S. and W.G.A.; Supervision: M.C.G., D.M.S., W.G.A. and A.P.M.B.; Project Administration: D.M.S., W.G.A. and A.P.M.B.; Funding Acquisition: L.M.A.V.S.

ACKNOWLEDGEMENTS: This study was supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) [Finance Code 001]; and by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) - [141068/2024-8]. The authors also thank Editage (www.editage.com.br) for English language editing.

REFERENCES

1. Patil G.V., Lakhe P., Niranjane P. Maxillary expansion and its effects on circummaxillary structures: A review. *Cureus*. 2023; 15 (1): 33755.
2. Belluzzo R.H.L., Faltin Junior K., Lascala C.E., Vianna L.B.R. Maxillary constriction: Are there differences between anterior and posterior regions? *Dent Press J Orthod*. 2012; 17 (4): 1-6.
3. Cerritelli L., Hatzopoulos S., Catalano A., Bianchini C., Cammaroto G., Meccariello G., et al. Rapid Maxillary Expansion (RME): An Otolaryngologic Perspective. *J Clin Med*. 2022; 11 (17): 5243.
4. Zhan Y., Yang M., Bai S., Zhang S., Huang Y., Gong F., et al. Effects of orthodontic treatment on masticatory muscle activity: A meta-analysis. *Ann Hum Biol*. 2023; 50 (1): 465-471.
5. De Rossi M., De Rossi A., Hallak J.E., Vitti M., Regalo S.C. Electromyographic evaluation in children having rapid maxillary expansion. *Am J Orthod Dentofacial Orthop*. 2009; 136 (3): 355-360.
6. Abate A., Lanteri V, Marcolongo L., Solimei L., Maspero C. Evaluation of masticatory muscles in adult patients with maxillary hypoplasia treated with surgically assisted rapid maxillary expansion (SARME): A retrospective study. *J Clin Med*. 2023; 12 (2): 607.
7. Szyszka-Sommerfeld L., Sycińska-Dziamowska M., Cernera M., Esposito L., Woźniak K., Spagnuolo G. Electromyographic assessment of muscle activity in children undergoing

- orthodontic treatment: A systematic review. *J Clin Med*. 2024; 13 (7): 2051.
8. Arat F.E., Arat Z.M., Acar M., Beyazova M., Tompson B. Muscular and condylar response to rapid maxillary expansion. Part 1: Electromyographic study of anterior temporal and superficial masseter muscles. *Am J Orthod Dentofacial Orthop*. 2008; 133 (6): 815-822.
 9. Rakosi T., Jonas I., Graber T.M. *Ortodontia e Ortopedia Facial: Diagnóstico*. Porto Alegre: Artes Médicas Sul, 1999.
 10. Merletti R., Hermens H. Introduction to the special issue on the SENIAM European Concerted Action. *J Electromyogr Kinesiol*. 2000; 10 (5): 283-286.
 11. Pastana S. da G., Costa S. de M., Chiappetta A.L. de M.L. Análise da mastigação em indivíduos que apresentam mordida cruzada unilateral na faixa-etária de 07 a 12 anos. *Rev CEFAC [Internet]*. 2007; 9 (3): 351-357.
 12. Morais-Almeida M., Wandalsen G.F., Solé D. Growth and mouth breathers. *J Pediatr (Rio J)* 2019; 95 Suppl 1: 66-71.
 13. Rutili V., Mrakic G., Nieri M., Franceschi D., Pierleoni F., Giuntini V., et al. Dento-skeletal effects produced by rapid versus slow maxillary expansion using fixed jackscrew expanders: a systematic review and meta-analysis. *Eur J Orthod*. 2021; 43 (3): 301-312.
 14. Zreagat M., Hassan R., Alforaidi S, Kassim N.K. Effects of rapid maxillary expansion on upper airway parameters in OSA children with maxillary restriction: A CBCT study. *Pediatr Pulmonol*. 2024; 59 (10): 2490-2498.
 15. Garrocho-Rangel A., Rosales-Berber M.Á., Ballesteros-Torres A., Hernández-Rubio Z., Flores-Velázquez J., Yáñez-González E., et al. Rapid maxillary expansion and its consequences on the nasal and oropharyngeal anatomy and breathing function of children and adolescents: An umbrella review. *Int J Pediatr Otorhinolaryngol*. 2023; 171: 111633.
 16. Aluru Y., Rng R., Gujar A.N., Kondody R. Correlation of palatal index with pharyngeal airway in various skeletal patterns. *Cureus*. 2023; 15 (5): e39032.
 17. Pedreira M.G., Almeida M.H.C., Ferrer K.J.N., Almeida R.C. Avaliação da atresia maxilar associada ao tipo facial. *Dent Press J Orthod*. 2010; 15 (3): 71-77.
 18. Schwarz A.M., Gratzinger M. *Removable orthodontic appliances*. Philadelphia: WB Saunders, 1966.
 19. Spolaor F., Mason M., De Stefani A., Bruno G., Surace O., Guiotto A., et al. Effects of rapid palatal expansion on chewing biomechanics in children with malocclusion: A surface electromyography study. *Sensors (Basel)*. 2020; 20 (7): 2086.
 20. Pignataro Neto G., Bérzin F., Rontani R.M.P. Identificação do lado de preferência mastigatória através de exame eletromiográfico comparado ao visual. *Rev Dent Press Ortodon Ortop Facial [Internet]*. 2004; 9 (4): 77-85.
 21. Di Palma E., Tepedino M., Chimenti C., Tartaglia G.M., Sforza C. Longitudinal effects of rapid maxillary expansion on masticatory muscles activity. *J Clin Exp Dent*. 2017; 9 (5): e635-e40.
 22. Maspero C., Giannini L., Galbiati G., Kairyte L., Farronato G. Neuromuscular evaluation in young patients with unilateral posterior crossbite before and after rapid maxillary expansion. *Stomatologija*. 2015; 17 (3): 84-88.
 23. Paschoal M.A.B., Gurgel C.V., Neto N.L., Kobayashi T.Y., da Silva S.M.B., Abdo R.C.C., et al. Perfil de tratamento de urgência de crianças de 0 a 12 anos de idade, atendidas no Serviço de Urgência Odontológica da Faculdade de Odontologia de Bauru da Universidade de São Paulo. *Odontol Clín Cient*. 2010; 9 (3): 243-247.
 24. Tomita N.E., Bijella V.T., Franco L.J. Relação entre hábitos bucais e má oclusão em pré-escolares. *Rev Saúde Pública [Internet]*. 2000; 34 (3): 299-293.

25. Trawitzki L.V.V., de Felício C.M., Puppini-Rontani R.M., Matsumoto M.A.N., Vitti M. Mastigação e atividade eletromiográfica em crianças com mordida cruzada posterior. *Rev CEFAC* 2009; 11, Supl 3, 334-340.
26. Alshammari A., Almotairy N., Kumar A., Grigoriadis A. Effect of malocclusion on jaw motor function and chewing in children: a systematic review. *Clin Oral Investig.* 2022; 26 (3), 2335-2351.