

ORAL HEALTH-RELATED QUALITY OF LIFE AFTER RAPID MAXILLARY EXPANSION IN CHILDREN: A PROSPECTIVE STUDY

Qualidade de vida relacionada à saúde bucal após expansão rápida
maxila em crianças: um estudo prospectivo

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ABSTRACT

Aim: The aim of this study was to assess the impact of interceptive orthodontic treatment with rapid maxillary expansion (RME) on oral health-related quality of life (OHRQoL) in children with maxillary atresia. **Materials and Methods:** Twenty-seven children, mean age 9.1 years, with maxillary atresia and posterior crossbite underwent RME. The OHRQoL was assessed using the Child Perceptions Questionnaire (CPQ₈₋₁₀). **Evaluation time intervals were:** T0, initial; T1, stabilization day; T2, 3 months after T1; T3, immediately after expander removal (6 months of retention) and T4, 3 months after T3. Unadjusted multilevel Poisson regression analysis for repeated measures was used to compare general and domains questionnaire scores according to the evaluation time interval. **Results:** CPQ₈₋₁₀ total scores decreased by 22% in 3 months, 41% in 6 months and 50% after 9 months of follow-up ($p < 0.05$). The scores for the specific domains decreased significantly over time, with a greater effect being observed after 9 months of follow-up in the domains of functional limitation 66%, emotional well-being 45%, and social well-being 65%. **Discussion:** There was a decrease in the CPQ₈₋₁₀ total scores and regarding the specific domains functional limitation, emotional well-being, and social well-being, meaning an improvement in OHRQoL in patients after RME. **Conclusion:** From T1 to T3, there was a decrease in the CPQ₈₋₁₀ general and specific domains scores, indicating a gradual improvement in OHRQoL in children treated with RME. **Keywords:** Palatal expansion technique. Quality of life. Child.

RESUMO

Objetivo: O objetivo deste estudo foi avaliar o impacto do tratamento ortodôntico interceptativo com expansão rápida da maxila (ERM) na qualidade de vida relacionada à saúde bucal (QVRSB) em crianças com atresia maxilar. **Materiais e métodos:** Vinte e sete crianças, com idade média de 9,1 anos, com atresia maxilar e mordida cruzada posterior foram submetidas à ERM. A QVRSB foi avaliada por meio do Questionário de Percepção Infantil (CPQ8-10). Os intervalos de tempo de avaliação foram: T0, inicial; T1, dia de estabilização; T2, 3 meses após T1; T3, imediatamente após a retirada do expansor (6 meses de contenção) e T4, 3 meses após T3. A análise de regressão de Poisson multinível não ajustada para medidas repetidas foi utilizada para comparar os escores do questionário geral e dos domínios de acordo com o intervalo de tempo de avaliação. **Resultados:** Os escores totais do CPQ8-10 diminuíram 22% em 3 meses, 41% em 6 meses e 50% após 9 meses de acompanhamento ($p<0,05$). Discussão: Os escores dos domínios específicos diminuíram significativamente ao longo do tempo, sendo observado maior efeito após 9 meses de acompanhamento nos domínios limitação funcional 66%, bem-estar emocional 45% e bem-estar social 65%. Conclusão: De T1 para T3, houve diminuição nos escores dos domínios geral e específico do CPQ8-10, indicando melhora gradual na QVRSB em crianças tratadas com ERM. **Palavras-chave:** Técnica de expansão palatina. Qualidade de vida. Criança.

INTRODUCTION

The oral health-related quality of life (OHRQoL) is a multidimensional construct composed of psychological, cognitive, emotional and social aspects. It reflects the extent to which oral disorders interfere in the self-perception of daily life and well-being of individuals^{1,2} and it can be modulated directly or indirectly by oral health imbalances, in addition to the signs, symptoms and effects of treatments from the perception of the individuals.^{2,3} The subjective measurement of OHRQoL can serve as a relevant measure after oral health interventions and assist professionals in identifying patient concerns.^{2,3}

Transverse maxillary deficiency is a prevalent dentofacial deformity observed in the orthodontic clinic, due to constriction of the maxillary arch and its bone base in a transversal direction, often accompanied by an apparent posterior crossbite.⁴ In growing patients, maxillary atresia is corrected by performing rapid maxillary expansion (RME) that promotes transversal increase in the maxilla due to separation of the midpalatal suture.⁵ Previous studies have found that RME promoted: increased nasal width,⁶ improved breathing,^{6,7} and gains in the maxillary arch perimeter,^{5,8,9} and also improved oral health-related quality of life (OHRQoL) in children.¹⁰⁻¹²

Although some few studies have indicated improvement in OHRQoL after RME,¹⁰⁻¹³ the literature is scarce in describing the change in OHRQoL and its different domains (oral symptoms, functional limitation, emotional well-being, and social well-being)² during different follow-up periods and a long term after RME stabilization. Thus, the aim of the study was to evaluate the impact of interceptive orthodontic treatment with RME on children's OHRQoL and its domains in a period of 10 months of follow-up. The conceptual hypothesis was that patients undergoing RME would have improvement in OHRQoL specific domains during the follow-up.

MATERIALS AND METHODS

Subjects

Ethical permission was granted by the Federal University of Santa Maria Research Ethics Committee under the protocol number (CAAE:

66295617.7.0000.5346). Twenty-seven volunteer children from the city of Santa Maria, participated in the research from April 2019 to October 2020. The selection criteria included children and adolescents from 8 to 12 years old, in the mixed dentition stage, who had maxillary atresia and posterior crossbite. Patients with a history of previous orthodontic treatment, who needed other types of interceptive orthodontic treatment within the experimental period (10 months); who had systemic diseases that interfered with bone metabolism, or who used medications that alter bone metabolism; with craniofacial malformations; with suspected or diagnosis of oral cancer were excluded. Patients with gingivitis or active caries disease underwent treatment for promoting an adequate oral environment prior to their inclusion in the study.

Socioeconomic questionnaire

Demographic and socioeconomic variables were collected by applying a structured questionnaire, answered by the parents and/or guardians of the children, only once in the beginning of the study. Demographic variables included gender (female and male), age, skin color and family income. Age was collected in years and dichotomized into <9 and > 9 years of age. Skin color was determined by using the Brazilian Institute of Geography and Statistics criteria¹⁴ and dichotomized into white and non-white individuals. Income was measured in Brazilian Reais (R\$) and subsequently categorized according to the Brazilian Minimum Wage (BMW) as: $\geq$ 1BMW and < 1BMW.

Treatment Protocol

The patients included in the study underwent an initial assessment, in which anamnesis, intra and extra-oral clinical examination, and request for orthodontic documentation (intra and extra-oral photographs, plaster casts, panoramic radiography, lateral telerradiograph) were performed.

For the rapid maxillary expansion, a modified Hyrax expander was used. The Hyrax screw posterior segments were welded to the first permanent molar bands', and the anterior segments of the screw were welded to a segment of 0.9 mm CrNi

elastic hard steel wire (Morelli, Sorocaba, SP, Brazil) that was adapted along the palatal contour of the teeth up to the canines (Figure 1). The appliance was fixed by cementing the bands with glass ionomer cement (Meron C, VOCO do Brazil Ltda, Porto Alegre, RS, Brazil) and bonding the contoured segments using the acid conditioning protocol with 37% phosphoric acid (FGM, Joinville, SC, Brazil) for 30 seconds, application of the Transbond XT adhesive primer (3M ESPE, 3M Brasil, Sumaré, SP, Brazil), application of Transbond XT resin (3M ESPE, 3M Brasil, Sumaré, SP, Brazil) and light curing on each tooth for 40 seconds.

After cementing the expander, activation of the appliance began. At the time of installation, $\frac{1}{2}$ turn was activated and those responsible for the patient were instructed to activate $\frac{1}{4}$ turn 2 times a day on subsequent days.⁵ The device was activated until the maxillary expansion was overcorrected (the palatal cusps of upper first molars should occlude with the buccal cusps of the mandibular first molars). When overcorrection was observed, the device was stabilized with the use of light polymerized composite resin applied to the screw. The size of the expander screw varied between 9 and 11 mm, according to the size of each patient's palate, and amount of transverse gain required.

Outcomes

The OHRQoL was assessed by application of the Brazilian version of the Child Perceptions Questionnaire (CPQ8-10) that enabled the research participants to express their self-perception about the impact of the interceptive treatment performed on their quality of life.^{15,16} CPQ8-10 consists of 25 questions, subdivided into four domains: oral symptoms, functional limitation, emotional well-being, and social well-being. The response options vary on a Likert scale from 0 to 4. The final score is the sum of all items. The total result of the questionnaire can vary from 0 to 100 points. The higher the score obtained, the greater the impact of oral health conditions on the child's OHRQoL.

The questionnaire was applied in 5 stages: T0 - pre-treatment phase (before expander installation), T1 - on the day of the screw stabilization, T2 - 3 months after the screw stabilization, T3 - immediately after the expander was removed (6 months

after stabilization of the screw) and T4 - 3 months after removing the expander (and after 9 months of monitoring subsequent to the date of screw stabilization). The patients answered the questionnaire in the form of a structured interview conducted by the examiners.

Sample size

The sample size calculation was performed using data published by Katyal et al.¹⁰ who have found a difference of means in the OHRQoL scores of 39.9 (SD: 15.6) and 28.4 (SD: 13.3) before and after RME in individuals at high risk for pediatric respiratory sleep disorders. For the sample size calculation, a significance level of 5%, power of 80% and a 1:1 ratio of unexposed and exposed subjects was used. Thus, the minimum total sample required to assess the effect of RME on OHRQoL was 26 participants.

Statistical analysis

The data were analyzed using the Stata 14.1 software (StataCorp. 2014. Stata Statistical Software: Release 14.1. College Station, TX: StataCorp LP). Descriptive analysis of the sample was carried out according to the demographic and socioeconomic characteristics. Paired T-test was performed for comparing the CPQ8-10 scores over the experimental time intervals. Unadjusted multilevel Poisson regression analysis for repeated measures was performed to compare the total scores, according to each domain of CPQ8-10 and according to the evaluation time interval. Unadjusted multilevel Poisson regression analysis for repeated measures was also performed to compare CPQ8-10 pain question according to the evaluation time interval. In the structure of the analysis, repeated measures (level 1) were nested in children (level 2). The data are presented as Incidence Rate Ratio (IRR) and 95% confidence interval (95% CI); $p < 0.05$ was considered significant.

RESULTS

Patient recruitment started in April 2019 and ended in October 2020. Approximately 63% of the total sample were of the female sex, and 83% of white skin

color. The mean age in the sample was 9.1 (SD 1.46) years (Table 1). The amount of activation of the expander screw varied according to the need for transverse gain for each patient. The average activation time was 18 days, with a minimum of 15 and a maximum of 22 days.

Table 1 - Demographic and socioeconomic characteristics at baseline of the individuals included in the study (n = 27).

Variables	Total
Sex [n (%)]	
Female	17 (63.0)
Male	10 (37.0)
Age [n (%)]	
≤ 9 years	18 (66.6)
> 9 years	9 (33.4)
Skin color [n (%)]	
White	20 (83.3)
Non-white	4 (16.7)
Household income [n (%)]	
≥ 1 BMW	3 (13.6)
< 1 BMW	19 (84.4)
CPQ8-10 [mean (SD)]	15.7 (12.5)

Values less than 27 are due to missing data; BMW, Brazilian minimum wages (approximately US\$200); SD, standard deviation; *Fisher's exact test; † T-test.

Table 2 presents the total scores according to each domain of CPQ8-10 and the time of assessment. The overall scores for each CPQ8-10 domain decreased gradually during all follow-up periods (from 15.7 SD 12.5 to 7.8 SD 8.1). Oral symptoms domain had a significant reduction from T2 to T4 (from 3.8 SD 2.9 to 3.5 SD 3.1).

Table 2 - Mean and standard deviation of CPQ8-10 overall and subscales scores according to time of assessment.

CPQ ₈₋₁₀ scores	Overall [mean (SD)]
Overall	
T0	15.7 (12.5)

CPQ₈₋₁₀ scores	Overall [mean (SD)]
T1	14.8 (15.4)
T2	12.3 (8.8)
T3	9.3 (6.4)*
T4	7.8 (8.1)*
Oral symptoms	
T0	4.0 (2.3)
T1	4.7 (3.1)
T2	3.8 (2.9)*
T3	4.5 (2.5)*
T4	3.5 (3.1)*
Functional limitation	
T0	5.4 (4.4)
T1	5.6 (4.3)
T2	4.2 (3.7)*
T3	2.5 (3.1)
T4	1.8 (2.4)
Emotional well-being	
T0	1.8 (3.2)
T1	1.5 (4.3)
T2	1.0 (3.0)
T3	0.6 (1.8)
T4	1.0 (2.1)
Social well-being	
T0	3.0 (7.3)
T1	2.1 (5.5)
T2	2.2 (2.9)
T3	1.0 (1.9)
T4	1.1 (3.2)

CPQ, Child Perception Questionnaire; SD, standard deviation; *p-value <0.05 from paired t-test.

The association between the time of evaluation with CPQ8-10 overall and subscales scores over time is shown in Table 3. As regards the total CPQ8-10 scores of the sample, there was a significant reduction after the RME indicating an improvement in OHRQoL. The overall score decreased by 22% in 3 months after screw stabilization (IRR 0.78; 95% CI 0.68-0.90) and 41% in 6 months (IRR 0.59 95% CI 0.50-0.69). Positive impacts in OHRQoL were also observed in the long term, with a 50% reduction of CPQ8-10 total scores after 10 months of follow-up (IRR 0.50; 95% CI 0.42-0.59).

Table 3 - Unadjusted association of CPQ 8-10 overall and subscales scores over time, using multilevel Poisson regression analysis for repeated measures

Variables	CPQ ₈₋₁₀ scores				
	Overall	Oral symptoms	Functional limitation	Emotional well-being	Social well-being
	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)
Time					
T0	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
T1	0.97 (0.84-1.12)	1.17 (0.89-1.54)	1.03 (0.81-1.31)	0.82 (0.52-1.29)	0.74 (0.51-1.06)
T2	0.78 (0.68-0.90)*	0.96 (0.73-1.25)	0.78 (0.61-0.99)*	0.56 (0.35-0.88)*	0.73 (0.52-1.02)
T3	0.59 (0.50-0.69)*	1.12 (0.87-1.46)	0.46 (0.35-0.62)*	0.32 (0.18-0.56)*	0.32 (0.21-0.50)*
T4	0.50 (0.42-0.59)*	0.86 (0.65-1.14)	0.34 (0.25-0.48)*	0.55 (0.34-0.89)*	0.35 (0.23-0.54)*

IRR, incidence rate ratio; CI, confidence interval; *p<0.05.

With regard to the specific domains, functional limitation, emotional well-being, and social well-being showed a significant reduction in scores over time, with a more significant long-term effect (T4) being observed in the functional limitation (IRR 0.34; 95% CI 0.25-0.48), emotional well-being (IRR 0.55; 95% CI 0.34-0.89), and social well-being (IRR 0.35; 95% CI 0.23-0.54) domains.

A Post hoc test to verify the sample power in the study was performed. The calculation considered an alpha error probability of 0.05 and the difference in overall CPQ8-10 scores from T0 to T4 of the 7.9, resulting in a total sample power of 80%.

DISCUSSION

The results obtained in this research partially confirmed the conceptual hypotheses. There was a decrease in the CPQ8-10 total scores and regarding the specific domains functional limitation, emotional well-being, and social well-being, meaning an improvement in OHRQoL in patients after RME. This indicates that correction of the maxillary atresia, in addition to masticatory,¹⁷ respiratory,^{6,18} and esthetic benefits,¹⁹ also changed children's self-perception of OHRQoL, since oral health influences nutrition, the smile, speech, and socialization.³

Previous studies have also observed an improvement in OHRQoL after RME. Izuka et al.¹¹ evaluated mouth breathing children before and immediately after the RME overcorrection and demonstrated that the total OHRQoL scores were significantly lower after the maxillary expansion. Considering a longer period of evaluation, Gonçalves et al.¹³ assessed the OHRQoL of children with sleep-disordered breathing (SDB) before and 6 months after RME using the Obstructive Sleep Apnea-18 questionnaire (OSA-18). The authors concluded that the total scores reduced significantly (from 90.95 to 46.68), with a decrease in snoring and apnea in all cases. Whereas Katyal et al.¹⁰ assessed the OHRQoL after RME, in an evaluation period lasting between 7 and 9 months. The authors compared the change in OHRQoL after RME in children with low and high risk of developing sleep-disordered breathing and found that children at high risk had an improvement of over 14% in OHRQoL scores when compared with the low risk group. Pithon et al.¹² also evaluated the OHRQoL after RME comparing a treated and a non-treated group

during 8 months. The authors concluded that the correction of transverse maxillary deficiency using Hyrax expander in children aged 8-10 years improves OHRQOL.

In the literature, few studies that analyzed transversally the impact of malocclusions in OHRQoL using CPQ8-10 were found^{12,20,21}. In two of these studies, patients had lower OHRQoL scores, 9.0 (SD: 6.2) for Piassi et al.²⁰, and 5.1 (SD: 5.1) for Kallunki et al.²¹, than those in the present study in T0 (15.7 SD: 12.5). In the study of Pithon et al.¹², they have found higher scores, median 59 (SD: 5.75). This could be attributed to methodological differences, such as study design, sample size, geographic region and malocclusion severity.

As a general rule, overall mean scores gradually decreased during the follow-up period.

Relative to the questionnaire domains: functional limitation, social well-being and emotional well-being showed significant improvements over time. The oral symptoms domain, which is related to pain, bad breath, mouth sores, and oral hygiene, showed no statistically significant changes from the beginning to the end of the treatment phase. A possible explanation for this result may be the ease of cleaning the modified Hyrax appliance, as it does not come into direct contact with the palate, making it more difficult for prolonged food retention and bad breath to occur. However, in the study of Pithon et al.¹², it was found an increase of pain scores during Hyrax activation period, discomfort and difficulties on Hyrax adaption, increasing the scores for this domain.

There were changes in both the functional and emotional well-being domains in T2, T3, and T4 when compared to T0, with significant improvements in OHRQoL. The first domain showed the extent to which the treatment influenced the patients' difficulty/ease of eating, chewing hard food, talking, and taking longer than others to finish a meal. The second domain referred to the extent to which the treatment interfered with the patient's feelings, sensations, and self-esteem.^{15,16} The positive changes in OHRQoL observed 3 months after expander stabilization (T2), 6 months after expander stabilization (T3) and 3 months after its removal (T4) could be explained as being due to closure of the diastema that occurred approximately four months after expansion¹⁹ and had direct influence on the smile esthetics. Moreover,

the impact of functional benefits previously known to result from RME, such as: improvement in breathing,⁶ chewing and speech,²² were possibly more significantly expressed in the children's OHRQoL during this period. In the study of Pithon et al.¹², there was also an improvement on both domains from Hyrax stabilization to the end of 7 months follow-up period.

The social well-being domain showed significant improvements in time intervals T3 and T4 in comparison to baseline. In this domain, the children answered questions related to interpersonal relationships, such as whether they stopped talking or playing, suffered any type of bullying, or were asked questions about why they used the appliance^{15,16}. In the last 6 and 9 months of patient's follow-up, the domain of social well-being improved by 65%. The expander removal, realized in T3, must have impacted in this result. This might have turned the patient more confident to interact with other children, without them asking about their orthodontic device. Moreover, the RME procedure promotes changes the dental positions and esthetics of the smile, possibly influencing on patients' self-esteem, making them feel more confident in long term.²³ Furthermore, favorable dental esthetics have positive impacts on these children's social interactions, avoiding episodes of exclusion and dental bullying^{24,25} which directly impacts well-being social and OHRQoL. This results were similar from the study of Pithon et al.¹², which showed an increase of social well-being scores during Hyrax activation period and its stabilization, followed by an improvement to the end of follow-up, after one month Hyrax removal.

As for the strengths of this research, the 10-month follow-up can be mentioned (active period of the RME, plus 9 months of monitoring). To date, only one study¹⁰ had evaluated the OHRQoL in a similar period but using the OHIP-14 questionnaire and without specifically evaluating the domains, and another study¹² had used CPQ8-10 questionnaire in a 8 month period not assessing OHRQoL during Hyrax retainer period. In the present study, not only the total scores were evaluated, but also the results of the domains in five experimental time intervals, including and evaluation of during Hyrax retainer period (3 months after the screw stabilization), which improvements were observed in different aspects of the OHRQoL.

As a limitation of this study, there is the absence of a non-treated group (control). Further studies are suggested for assessing OHRQoL for longer periods, using different questionnaires, evaluating patients of other ages, and through randomized clinical trials.

CONCLUSION

Rapid maxillary expansion had a beneficial effect on the OHRQoL of patients treated. There was a trend towards gradual improvement in the total scores and for each domain of CPQ8-10 during the course of the follow-up periods.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

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