

# Electromyographic Evaluation of Masticatory Muscles in a Young Patient with Crossbite Treated with Rapid Palatal Expander: A Case Report

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## ABSTRACT

**Aim and objective:** The purpose of this work is to investigate by electromyographic (EMG) surface analysis whether and how the variations in the occlusion due to the correction of the posterior crossbite using a rapid palatal expander (RPE) is accompanied by changes in the activity of the elevator muscles in the pediatric patients.

**Background:** Posterior crossbite is a disgnathic jaw relationship common in patients undergoing growth. In the last 10 years, several studies demonstrated the effectiveness and reproducibility of surface EMG in the objective evaluation of temporal muscle and masseter activity and how this evidence can be an interesting aid in dental clinical practice.

**Case description:** The case subject BF is an 11-year-old boy with a right I class relationship and a left II class relationship treated with a rapid palatal expansion protocol with a turn of the transversal screw twice a day (0.25 mm each turn) for a week. In this case report, EMG was used to evaluate the temporal muscle and masseter activity immediately before, immediately after, and 4 months after the RPE protocol.

**Conclusion:** Four months after the treatment, a condition of well-being and neuromuscular equilibrium such as that of starting was preserved.

**Clinical significance:** Electromyography is a noninvasive exam which evaluates the masticatory muscle activity by facial application of electrodes on masseter and temporal muscles. It can be an interesting aid in orthodontic clinical practice to evaluate preservation of a good muscular balance following orthodontic and orthognathic movements.

**Keywords:** Electromyography, Gnathology, Orthodontic, Posture, Temporomandibular joint.

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## INTRODUCTION

In the last 10 years, several studies demonstrated the effectiveness and reproducibility of surface EMG in the objective evaluation of temporal muscle and masseter activity and how this evidence can be an interesting aid in dental clinical practice.<sup>1-6</sup>

Electromyography is a noninvasive exam, which evaluates the masticatory muscle activity by facial application on the cleaned skin of electrodes, close to the masseter muscle, and anterior temporal muscle (Fig. 1).

The authors present a case in which an 11-year-old boy with unilateral posterior crossbite was treated with a rapid palatal expansion. Orthodontic movements were checked with surface EMG with BTS TMJoint® EMG (BTS Bioengineering) to control changes in masseters and temporal muscle balance.

Posterior crossbite is a disgnathic jaw relationship common in patients undergoing growth. The purpose of this work is to investigate by EMG surface analysis whether and how variations in the occlusion due to the correction of the posterior crossbite using an rapid palatal expander (RPE) are accompanied by changes in the activity of the elevator muscles in the pediatric patients.

This case is of particular interest because of the need to complete the correction of crossbite without functional modifications and because it can open the path to further studies checking orthodontic movements with oral EMG.

## CASE DESCRIPTION

The patient presented to our department to correct a dentoskeletal asymmetry because of monolateral crossbite. The subject was an

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11-year-old boy. The clinical inspection revealed a mixed dentition with a right I class relationship and a left II class relationship caused by mandibular left deviation and monolateral crossbite which involved the entire left dental arch distal to 23. This was visible as a slight facial asymmetry. Furthermore, the left dental arch showed an important transversal contraction.

The lateral telerradiograph of the skull and the cephalometric tracing showed skeletal and dental patterns of mild II class and quite low intermaxillary divergence. No anomalies of teeth number were visible on the orthopantomography. The rapid palatal expansion protocol required a turn of the transversal screw twice a day (0.25 mm each turn) for a week. At the end of the first week, the patient has been visited to evaluate the expansion managed so far and to decide whether to continue with the device activation. Since the expansion was not enough to solve the crossbite, the therapy

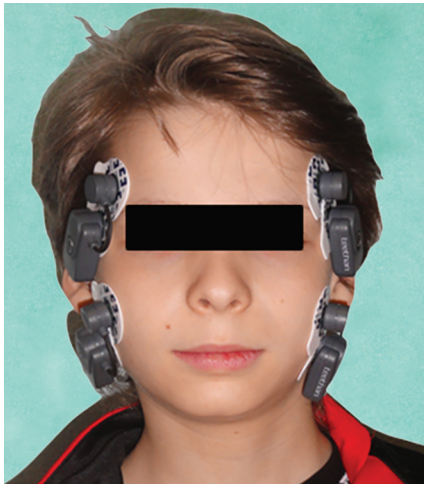


Fig. 1: Probes on masseter and temporal muscles

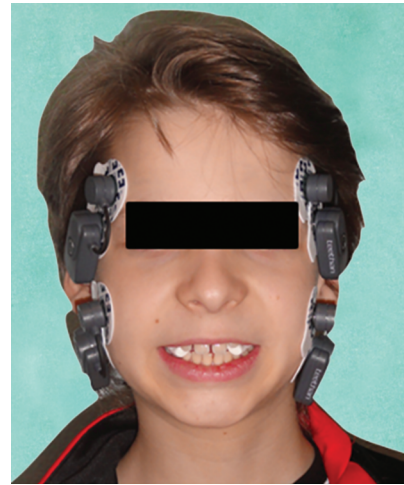


Fig. 2: Electromyographic test on cotton rolls

continued, with another week of screw activation for a total of 14 activations, after which the crossbite correction has been achieved. Two more days of activation (four total screw turn) were required in order to obtain an overcorrection and prevent a relapse of the palatal contraction after treatment.

However, the overcorrection was achieved in the right side only, and the left dental arch only reached the crossbite correction. This condition was basically related to the mandibular left deviation, which mildly persisted after RPE protocol; in fact, by matching upper and lower midline, the dental arch became symmetric.

As seen in the intraoral pictures at T1 period, the RPE protocol led to an upper incisor diastema solved 2 months after the end of the activations (T2 period). The crossbite correction had permitted a mandibular repositioning as seen in T1 pictures and clinical inspection. The improvement in midline matching between upper and lower incisors (3 more mm asymmetry observed at T2) led to a left I class molar relationship and to an incomplete right I class molar relationship.

The RPE treatment protocol paved the way to a more harmonious craniofacial growth because of the correction of the mandible placement against the jaw and the entire skull.

The second step of the orthodontic treatment will improve bilateral I class molar relationship, dental space closing, and midline matching by using a fixed appliance.

An oral EMG was then performed with Teethan® (Teethan S.p.A.) device. The first Teethan® record provides electrical information of the muscular system by cotton roll interposition between the dental arch; the second one is carried out in maximum voluntary clenching (MVC) on teeth (Fig. 2).

The first test (T0—before any treatment) shows a good global muscular activity, without any parameters out of normal range. Therefore, even with a left crossbite, masseter muscle and anterior temporal muscle activity are symmetric and regular. This condition is attributable to the great adaptability of the neuromuscular system of the child in which mandibular position can change up to intercuspal contacts with a minimum effort and a maximum muscular balance (Fig. 3).

A month of RPE treatment ended up with the resolution of crossbite. The exam is performed again (T1 period) in order to

evaluate the muscular activity change as a result of occlusal contact variations.

The second test, performed during active treatment with RPE immediately after the crossbite resolution, revealed some distorted parameters (signed in red), out of the normal range. Specifically the center of balance is shifted posteriorly instead of the anterior center of balance indicated in the first exam [a positive variation for the temporomandibular joint (TMJ) health]; a minimal left torsion is graphically represented by the blue and pink arrows; then a decrease in clenching strength. This changes are justified by the rapid occlusal variations and the subsequent muscular adaptation requested to the system. So the occlusal reprogramming needs a new muscular pattern, which can take some time (Fig. 4).

Then 4 months after the malocclusion resolution (T2), a third record is carried out in order to examine any differences that eventually occurred in muscular pattern.

The third record testifies about the good rehabilitation of a muscular coordination, even if it is slightly worse than the first one. So 4 months after the treatment, a condition of well-being and neuromuscular equilibrium was preserved (Fig. 5).

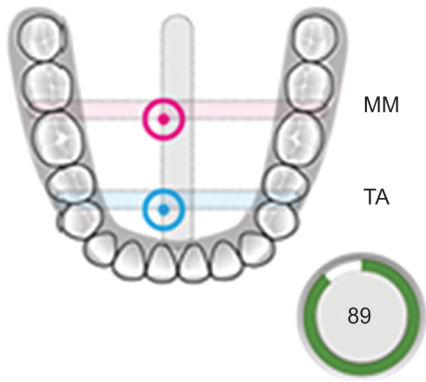
One year follow-up did not show any sign of recurrence of the orthognathic problem.

## DISCUSSION

Transversal discrepancies are an important topic for growing children in orthodontic practice. The maxillary contraction appears as an altered relationship between dental arch in occlusion which is shown by a posterior unilateral or bilateral crossbite.

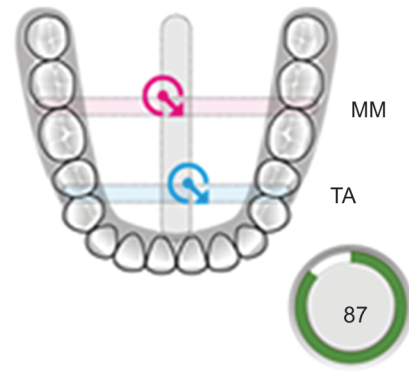
Proffit reports an incidence of 7.1% of crossbite in the US children between 8 years and 11 years of age; Huynh indicates a prevalence of this malocclusion in 8–23% of the population, of which less than 16% of them is corrected. The crossbite may involve one or more teeth and it could be a skeletal pattern or a dental one depending on a dental discrepancies or on a relative or absolute deficit between maxillary bases. In this case, the crossbite is basically a skeletal pattern.<sup>6,7</sup>

An important factor to be considered is the anterior–posterior posture of the maxillary bones, that is, to assess whether the posterior crossbite is related to a maxillary retrusion or to a mandibular protrusion. In this case, the mandibular posture leads



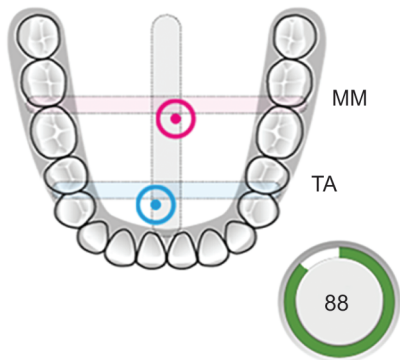
Indlci	Prova	Nonnafta
POCTA	86.72% R	83≤(% )≤100
POCMM	87.30% R	83≤(% )≤100
BAR	90.41% A	90≤(% )≤100
TORS	92.04%	90≤(% )≤100
IMP	99.83%	85≤(% )≤115

Fig. 3: Good global muscular activity at T0 before orthodontic treatment



Indlci	Prova	Nonnafta
POCTA	84.48% L	83≤(% )≤100
POCMM	87.06% R	83≤(% )≤100
BAR	87.69% P	90≤(% )≤100
TORS	89.14% L	90≤(% )≤100
IMP	81.73%	85≤(% )≤115

Fig. 4: Changes in T1 justified by the rapid occlusal variations and the subsequent muscular adaptation requested to the system



Indlci	Prova	Nonnafta
POCTA	90.02% R	83≤(% )≤100
POCMM	87.54% L	83≤(% )≤100
BAR	84.79% A	90≤(% )≤100
TORS	91.84%	90≤(% )≤100
IMP	92.41%	85≤(% )≤115

Fig. 5: Progressive improvement in muscular activity until the initial balance is restored

to a crossbite relationship, because of a relative deficit between dental arch, which enlarges themselves in the anterior-posterior direction.

The therapeutic program should consider the dental arch shape, the transpalatal width, axis inclination of the teeth, the functional, and esthetic problems detectable in these patients. Furthermore, it is important to examine the sagittal or vertical malocclusion often associated with the transversal one.<sup>8,9</sup>

The RPE is an orthodontic device that provides a combination of dental and skeletal expansion of maxillary bone. The classic conformation is composed of a central double guide screw linked with four arms to the orthodontic bands placed on deciduous

second molars or permanent first molars; there are many different expanders.

The RPE works on the intermaxillary suture not completely ossified, with a fracture and a new bone deposition in the space created: this process is named "distraction osteogenesis" and may require some week or month depending on the initial palatal contraction.

The activation of the screw is managed in the first weeks after RPE positioning and the orthodontist will look for an overcorrection, in order to prevent any relapse of the contraction after removing the device.<sup>10-16</sup>

The surface EMG allows to calculate the electric field potential resulting from the overlap of the action potentials of every single active muscle fiber. In clinical practice, the evaluation of the recorded signal, defined "rough," permits to identify only any decrease or increase in muscle contraction in a specific period or the muscle turn off. The advantage from the modern electrical devices is to process the rough signal and put the muscle contraction into a graphic.<sup>4,5</sup>

The signal detection is recognized by a bipolar electrode put on the skin surface upon the belly of the muscle. The potential variation in the single motor units represents the electric activity of the muscle, which passes from release to contraction. Compared to the needle EMG, this surface technique gives a more global information about muscle activity, because the action potentials detected are the summation of different motor unit potentials that reach the skin-electrode surface. The surface technique has been preferred for a lower invasiveness, the capacity of evaluate the complete muscle activity, and the absence of muscle tension caused by electrode-needle attaching. In order to evaluate the occlusion role and influence on muscle activity, the MVC record is compared to an EMG record in centric relation, without considering occlusion interference. This process, named normalization, is conventionally achieved putting cotton rolls distal to canines, so that occlusion may be excluded, and muscle activity is the only information revealed. The reference point is represented by an imposed stability

condition; any other state to analyze is automatically related to this reference condition, which gives the percentage between every single canal and the reference one expressed as microvolt. This method allows to delete every external perturbations in the electric signal.<sup>1,2,4,5,17,18</sup>

It can be stated that in this specific case, the palatal expansion treatment allowed a harmonious repositioning of the mandible to the upper jaw and the establishment of a correct occlusal engram, an optimal cusp to fossa relationship between the molars and a good canine key. From the muscular point of view, we witnessed an unfavorable modification of the muscular pattern from T0 to T1 due to the rapid occlusal variation to which the patient is subjected, but we noted a progressive improvement in muscular activity until the initial balance is restored in T2, showing the child's ability to return in T2 to a condition of well-being and neuromuscular equilibrium such as that of starting in T0, bypassing the T1 phase of neuromuscular instability characterized by slight deteriorations though not statistically significant. We can therefore confirm what is reported in the literature by different studies regarding the greater benefits obtained by maxilla expansion with ERP in early mixed dentition, both for the child's best ability to adapt muscularly to the occlusal change and find the neuromuscular balance early and for the greater effectiveness of the skeletal treatment and the lesser parasitic effects at the dental level.<sup>6,19-25</sup>

## CONCLUSION

The resolution in mixed dentition of the mandibular deviation represents a fundamental factor for the child to experience a harmonious skeletal, dentoskeletal, dentodental, and facial development and to prevent a functional malocclusion becoming structural.

With the analysis of muscle activity by surface EMG, the clinician is provided with important information regarding muscle balance changes as the occlusal relationships change.

This case report allows to underline how the child's nervous system is characterized by high neuroplasticity or the ability to be modified by experience; therefore, the child is able to quickly change his motor patterns to learn easily and to adapt plastically to the stimuli he receives. This observation suggests the opportunity of an early intervention to solve crossbites in order to surf the high plasticity and adaptability of the young musculoskeletal system of the young patients.

The finalization of this case with improvement in bilateral I class molar relationship, dental space closing, and midline matching by using a fixed appliance will also provide a palatal retainer to prevent relapse.

No comparison with other EMG orthodontic analysis was made since this is a preliminary observation. Electromyographic evaluation can be stated to be an interesting aid in orthodontic clinical practice, even though further studies in this direction will be necessary to improve the sample size.

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