Evaluation of masseter muscles in relation to treatment with removable bite-blocks in dolichofacial growing subjects: A prospective controlled study

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Introduction: The aim of this prospective study was to evaluate the effects of posterior bite-blocks on masseter muscles and on facial growth in prepubertal dolichofacial subjects. **Methods:** The treatment group comprised 21 consecutive prepubertal dolichofacial patients treated with rapid maxillary expansion followed by mandibular removable bite-blocks. Lateral cephalograms and ultrasonographic scans of the masseter muscles were made before (T1) and after (T2) treatment with bite-blocks. The treatment group was compared with a control group of 21 subjects matched for sex, age, and skeletal vertical pattern. An independent samples *t* test was used to compare the T1 to T2 changes in ultrasonographic scan measurements between the treatment group and the control group, and the T1 to T2 cephalometric changes in the treatment group. Regression analysis was performed to investigate associations between masseter muscle thickness and cephalometric treatment outcomes. **Results:** Masseter muscle thickness showed a statistically significant decrease (−0.7 mm) in the treatment group compared with an increase (+0.6 mm) in the control group. A significant anterior rotation of the mandibular plane was observed in the treatment group as well as significant increases in overbite (1.8 mm) and total posterior facial height (1.5 mm). No significant associations were found between masseter muscle thickness and treatment outcomes apart from a tendency for overbite to increase more in subjects with thicker muscles. **Conclusions:** Treatment with removable bite-blocks produced a decrease in masseter muscle thickness and a reduction in vertical facial dimensions due to upward and forward rotation of the mandible. No significant correlation was found between the pretreatment masseter muscle thickness and the T1 to T2 cephalometric changes in the treatment group. (Am J Orthod Dentofacial Orthop 2017;151:1058-64)

In patients with high-angle mandibular patterns, the treatment strategy is based on the inhibition of vertical development or the intrusion of buccal dentoalveolar structures with various kinds of bite-blocks (BBs) or extraoral appliances. The purpose is to induce upward and forward rotation of the mandible to express a more horizontal growth direction, rather than vertical.[1] A functional treatment approach is indicated before the completion of growth to guide the vertical forces developed during mastication against the posterior teeth and the alveolar process.[2] If muscle strength can affect facial form, increasing the activity of the muscles of mastication with the help of BBs could positively affect the skeletal pattern of long-faced children.[3,4]

In this respect, masseter muscle thickness, an indicator of the functional capacity of the masticatory apparatus, may be an important functional factor in the treatment of vertical skeletal discrepancies with functional appliances.[5]

A strong relationship between muscle activity, mandibular form, and craniofacial growth pattern has been demonstrated in several studies.[6-8] Clinical investigations, mostly performed in adults, have shown that thicker masseter muscles and those with increased

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muscle activity are associated with smaller gonial angles and shorter faces.[9-12] Eckardt and Harzer[13] observed that masseter muscle volume has a negative correlation with the steepness of the mandibular plane and the size of the gonial angle, and a positive correlation with posterior face height and ramus height. They concluded that an increased volume of the masseter muscles in adults was related to an anterior growth direction of the mandible.[13] In addition to the influence of the masticatory muscles on facial morphology, Antonarakis and Kiliaridis[14] in a prospective study demonstrated that the functional capacity of the masticatory muscles can also influence treatment outcomes during functional appliance therapy in Class II Division 1 growing children. Therefore, one can hypothesize that differences in masticatory muscle capacity may influence treatment outcome with posterior BB because of their role in controlling the vertical dimension.

Little is known, however, about the association between the characteristics of the masticatory muscles and treatment effects when using posterior BBs and, inversely, the effects of BB treatment on the masticatory musculature. Limited knowledge exists in this area, and most studies have been carried out using electromyography, which may not be the most suitable method to investigate the true activity of the muscles under investigation.[15,16]

A reliable method available for the evaluation of masticatory muscle capacity is ultrasonography, by measuring the cross-sectional thickness of the muscles. The superficial position of the masseter muscles allows for easy access for thickness measurements with this method.[17]

The hypothesis underlying this investigation is that the insertion of a removable posterior BB influences the morphology of the mandible during growth, and that this influence depends on the thickness of the masticatory muscles. Therefore, the aim of this study was to evaluate the effects of treatment with removable posterior BBs on masseter muscle thickness and on dentoskeletal structures in dolichofacial growing subjects.

MATERIAL AND METHODS

The sample of this prospective study included a treatment group (TG) and a control group (CG), each comprising 21 subjects. A sample of 21 subjects was chosen after a sample size calculation to detect at least a difference of 0.8 mm in masseter muscle thickness between the 2 groups, with a standard deviation of 0.9 mm,[14] an alpha value of 0.05, and a power of 0.8, using specific software (SigmaStat version 3.5; Systat Software, Point Richmond, Calif).

Fig 1. Mandibular removable posterior BB.

A TG of 21 consecutive patients (12 girls, 9 boys) who sought orthodontic treatment at the Department of Orthodontics at the University of Rome "Tor Vergata," in Italy with a mean age of 9.9 ± 1.4 years (range, 8.5-11.1 years) was selected according to the following inclusion criteria: prepubertal stage of development (CS1-CS3 in cervical vertebral maturation),[18] mixed dentition, negative posterior transverse interarch discrepancy,[19] and a skeletal hyperdivergent pattern (sella nasion to mandibular plane angle, ≥35°).[20] Exclusion criteria included absence of the first molars, skeletal asymmetries, temporomandibular joint diseases, facial clefts or congenital craniofacial anomalies, previous facial trauma, and previous orthodontic treatment.

This project was approved by the ethical committee at the University of Rome "Tor Vergata" (protocol number 79/15), and informed consent was obtained from parents.

Each patient underwent a standardized protocol with rapid maxillary expansion in the form of a butterfly palatal expander[21] cemented through bands on the maxillary permanent first molars, followed by a mandibular removable BB (Fig 1).[22] The expansion screw was activated 2 turns per day (0.25 mm per turn) until the desired expansion was achieved. The expander was kept in place as a passive retainer for 6 months. At the end of the retention period, the expander was removed, and a removable mandibular BB was applied for 12 months to control the vertical dimension. The thickness of the posterior BB was 5 mm. Patients were instructed to wear the appliance full time except for meals and for toothbrushing. As in studies involving any removable device, compliance with the instructions of the orthodontist and staff varied among patients. Therefore, compliance was appraised with a 3-point Likert scale (poor, moderate, good).[23] Poor compliance was reported when the patient wore the BB at night only; moderate compliance occurred when the patient wore