

# Gingival crevicular fluid alkaline phosphate activity during the retention phase of maxillary expansion in prepubertal subjects: A split-mouth longitudinal study

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**Introduction:** The aim of this study was to monitor the alveolar bone formation at the tension sites of teeth supporting the appliances for rapid maxillary expansion (RME) during the retention phase according to the local gingival crevicular fluid (GCF) alkaline phosphatase (ALP) activity. **Methods:** This split-mouth prospective study included 23 prepubertal subjects (15 girls, 8 boys; mean age,  $9.0 \pm 1.4$  years) who had a constricted maxillary arch and were undergoing RME. Periodontal parameters, including probing depth, were recorded at 3 and 6 months after RME. Furthermore, the GCF ALP activity was measured at the tension sites of the supporting test teeth (TT) and at the antagonist control teeth (CT) sites. **Results:** Periodontal parameters were generally similar between the TT and CT sites during the study, with the exception that probing depth underwent a slight increase at the TT sites. At baseline, the GCF ALP activity was similar between the TT and CT sites; however, at both 3 and 6 months, significantly greater enzymatic activity was seen at the TT sites. The overall probing depth changes were not significantly correlated with the corresponding GCF ALP activity changes for either the TT or the CT sites. **Conclusions:** Alveolar bone formation at the tension sites would last up to 6 months of retention after RME. These results warrant more comprehensive studies to assess whether the GCF ALP activity has potential as a diagnostic tool for bone formation during the retention phase of RME. (Am J Orthod Dentofacial Orthop 2015;148:90-6)

When a skeletal constriction of the maxillary arch is diagnosed, orthopedic skeletal expansion involving separation of the midpalatal suture is the treatment of choice. The most common treatment is rapid maxillary expansion (RME).<sup>1</sup> It has been reported that mainly skeletal effects of RME are seen if this treatment is performed before

puberty,<sup>2</sup> whereas at later development stages, more dental effects are to be expected, with possible tissue damage.<sup>3</sup> However, even when treatment is performed during the optimal skeletal maturation phase—ie, prepubertal—some dentoalveolar effects appear to occur.<sup>1,2,4</sup> Moreover, there is always some degree of skeletal or dentoalveolar relapse after RME, thus requiring hypercorrection followed by 4 to 5 months of retention.<sup>1,5</sup> Although most previous studies on RME treatment focused on the effects on the midpalatal suture or other sagittal and vertical changes<sup>1</sup> regarding dentoalveolar effects, a decrease in the buccal bone plate thickness of the supporting teeth has been reported at the end of active RME followed by a significant recovery of the original thickness after a retention period of 6 months.<sup>4</sup>

Gingival crevicular fluid (GCF) is a transudate with constituents from a variety of sources, including microbial dental plaque, host tissues, and serum, with a high site specificity.<sup>6</sup> A number of GCF constituents including host enzymes have been proposed as diagnostic indicators of periodontal status.<sup>7</sup> Among these enzymes, one of the first to be identified was alkaline phosphatase

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(ALP).<sup>8</sup> GCF ALP has a primary role in bone mineralization,<sup>9</sup> and it has been shown to be sensitive to alveolar bone formation during orthodontic tooth movement.<sup>10-12</sup> To date, only a few studies have investigated the levels of GCF constituents during maxillary expansion.<sup>13-15</sup> In particular, the levels of the inflammatory mediators interleukin-1 $\beta$  and  $\beta$ -glucuronidase<sup>13</sup> and prostaglandin E2<sup>15</sup> in GCF retrieved from the maxillary teeth of adolescents undergoing RME were increased. Interestingly, a few investigations on the GCF ALP activity changes during or after RME treatment have been reported,<sup>14</sup> in spite of the primary role of this enzyme in alveolar bone formation.<sup>7</sup> Moreover, none of these studies included prepubertal subjects.

Because of the small amount of data available on the metabolic changes at the palatal (tension) alveolar sites during the retention phase after RME treatment, the aim of this split-mouth prospective study in prepubertal subjects was to monitor alveolar bone formation at the tension sites of the first molars undergoing RME treatment. GCF ALP activity was used as a biomarker of tissue remodeling to determine the existence and duration of active alveolar bone formation during the retention phase.

## MATERIAL AND METHODS

The study sample consisted of 23 healthy white children (15 girls, 8 boys; mean age,  $9.0 \pm 1.4$  years; range, 6.7-11.9 years) who sought orthodontic treatment at the unit of orthodontics of the School of Dentistry at the Second University of Naples in Italy. The experimental protocol was approved by the institutional ethical committees, and voluntary informed consent was obtained from the patients after they received detailed information about the clinical trial.

Subjects were included according to the following criteria: (1) constricted maxillary arch with a unilateral or bilateral posterior crossbite; (2) prepubertal stage assessed by the cervical vertebral maturation method (stage 1 or 2),<sup>16</sup> (3) good general health, (4) variable degree of crowding, and (5) no use of anti-inflammatory drugs in the month preceding the beginning of the study.<sup>11</sup> Further periodontal inclusion criteria were (1) probing depth (PD) values not exceeding 3 mm in the whole dentition, (2) no radiographic evidence of periodontal bone loss evaluated by panoramic x-ray examination, and (3) full-mouth plaque and full-mouth bleeding scores of 20% or less. The full-mouth plaque and full-mouth bleeding scores were recorded as the percentages of tooth surfaces with supragingival plaque or bleeding within 15 seconds after probing with a 20-g controlled force probe (Vivacare

TPS Probe; Vivadent, Schaun, Lichtenstein). Exclusion criteria were (1) absence of maxillary first molars; (2) previous or current periodontal disease, or attachment loss in the posterior teeth; and (3) previous orthodontic treatment.

The study design is shown in [Figure 1](#). A preliminary visit took place 1 month before the baseline visit when the RME treatment began. At this preliminary visit, after the periodontal examination, full-mouth supragingival and subgingival scalings were carried out, and oral hygiene instructions were given to all patients. Moreover, in the month preceding the study and throughout it, all subjects received repeated oral hygiene instructions about the correct use of the toothbrush, dental floss, and interdental brush, and were not allowed to take any anti-inflammatory drugs that could have affected the results.<sup>11</sup> Moreover, they rinsed twice with 0.012% chlorhexidine mouthwash during the 2 weeks before the baseline visit and before the times when the GCF was sampled.<sup>17</sup>

At the baseline visit, the periodontal parameters were recorded, and the GCF was sampled immediately before the beginning of treatment, which consisted of mounting a hyrax rapid maxillary expander ([Fig 2, A](#)) cemented on the maxillary permanent first molars. The appliance was constructed with plain bands with a lowered vertical dimension such that they did not reach, or minimally entered, the crevicular sulcus. Laser welding was used, and the wires were modeled so that they were not in direct contact with the palatal gingival margins. An expansion screw with reduced dimension (model AO-0630-10; Leone, Sesto Fiorentino, Italy) was used and activated at 2 turns per day (0.20 mm per turn) for 16 to 23 days, thus reaching the total amount of expansion of 6.4 to 9.2 mm in all subjects (mean expansion, 7.5 mm). According to an in-vitro study, the force exerted by the screw used here, with arms orthogonal to the screw guide, is generally about 16 N per turn.<sup>18</sup> Then the screw was tied off with a ligature wire, and the expander was kept on the teeth as a passive retainer for 2 months. Immediately after the removal of the maxillary expander, a passive palatal bar ([Fig 2, B](#)), also constructed on plain bands with a reduced vertical dimension, was cemented on the maxillary permanent first molars. The palatal bar had short mesial arms on both sides and was kept for a further 4 months as a retainer.

The same clinical recordings and GCF samplings were repeated at 3 and 6 months after the RME active phase. The maxillary left and right permanent first molars were considered the test teeth (TT), and the mandibular left and right permanent first molars were considered the control teeth (CT).

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