CHAPTER 5

DISCUSSION

Orthodontic tooth movement produces dental and periodontal remodeling which is induced by mechanical force. Monitoring changes in GCF constituents is a non-invasive and rapid biochemical assessment for evaluating metabolic changes in periodontal tissue. Various biochemical markers have been used to assess bone remodeling and to monitor periodontal health. CS comprises approximately 94% of the total GAGs in alveolar bone,[14] 60% of the total GAGs in cementum,[89] 17% of the total GAGs in gingival tissue[90] and a minor component in PDL.[91,92] The high concentration of CS in human alveolar bone suggests that this tissue may be the main source of CS in GCF.[14,16] Therefore, the author was interested in CS, because it is a potent marker of bone activity and is also the major component of alveolar bone.

The effects of force magnitude on tissue reaction during orthodontic tooth movement had been studied in various experiments,[5,7,10,29,32,33,35-40,93,94] in which species of the subjects, ranges of force magnitude, the specific teeth chosen for the experiment, directions of tooth movement, durations of experiment, and force reactivation intervals varied. The force magnitudes used in those studies ranged from 1.2 to 1200.0 grams, but no evidence-based force magnitude could heretofore be recommended for appropriate efficiency in clinical orthodontics.[34] Anyway, a range of force magnitude of 70 to 120 grams has been suggested for bodily tooth movement (translation); causing a maximum rate of tooth movement, most comfort for patients and minimal tissue damage.[31] Thus, the suggested lower limit of force magnitude (70

grams) and the upper limit (120 grams) were selected for comparison in this study. In addition, well-aligned canines and the passive bracket position of the canines were selected in the research design in order to eliminate a reaction in the CS (WF6 epitope) levels due to the force which was exerted on the teeth and periodontium during the leveling and aligning phase of orthodontic treatment.

The results of this study show that the medians of CS (WF6 epitope) levels around both the right and the left control mandibular canines, during the unloaded period (8 weeks) were not significantly different from each other, whereas the medians of CS (WF6 epitope) levels around the experimental maxillary canines, which were loaded with 70 (left experimental maxillary canines) and with 120 (right experimental maxillary canines) grams retraction force during the loaded period, were significantly greater than those during the unloaded period ($P<0.05$). These findings are supported by the studies of Last *et al.*,[17] and Kagayama *et al.*,[20] which reported that the increase in the CS levels in GCF was associated with the compression condition of teeth during orthodontic movement. However, these studies analyzed quantification of CS levels by the electrophoresis and immunohistochemically method, respectively; whereas ELISA with WF6 monoclonal antibody was used in our study. Furthermore, our findings also coincide with those of Jaito *et al.*,[24] which showed an increase in the CS levels in GCF around canines during orthodontic movement, and no significant increase in the CS levels in GCF around incisors which served as control teeth.

In this study, the median CS (WF6 epitope) level was highest after one week of force application with 70 or 120 grams retraction force, and then it gradually decreased. After four weeks, the wire was removed, and force application stopped. Then, impressions for study models were made in order to measure the amount of

canine movement. The CS (WF6 epitope) levels increased and reached peak levels again one week after force reactivation (5^{th} week), then they gradually decreased again. Those results showed a cyclical pattern of bone activity in the four-week loaded period (experimental maxillary canines), in contrast to the unloaded period (control mandibular canines), which showed a non-cyclical pattern. Although, NiTi coil springs generate continuous force, the alveolar bone degradation or bone resorption, which were represented by CS (WF6 epitope) levels, showed a cyclical pattern. These findings reflect the biological activity of alveolar bone remodeling, which are similar to those in the study of Jaito *et al.,*[24] which reported that there was a cyclical changes in CS (WF6 epitope) levels at the 3 to 5 week periods during the canine movement phase under 125 to 140 grams retraction force, consistent with the bone turnover rate.

The differences between the medians of CS (WF6 epitope) levels around experimental maxillary canines affected with 70 and with 120 grams of force magnitude during each one-week period (unloaded and 1^{st} to 8^{th} loaded week) were not significant. The explanation may be that both force magnitudes (70 and 120 grams) were within the optimal range, so the alveolar bone degradation or bone resorption activities were not different.

The results showed that the rate of tooth movement under the two selected force magnitudes (70 and 120 grams) were not significantly different. However, the left experimental maxillary canines which were moved by 120 grams retraction force showed increased tipping movement in comparison to the right maxillary experimental canines which were moved by 70 grams retraction force.

Perception of pain is difficult to measure and is subject to a wide range of individual response, so we used the VAS scores because it was a simple method and widely used for evaluating pain intensity in many research studies.[94-97] The results show that the VAS scores for patient discomfort under 120 grams retraction force were significantly greater than those under 70 grams retraction force. Therefore, during orthodontic canine retraction, 70 grams of force should be more suitable than 120 grams of force from the points of view of no difference in biochemically assessed bone resorption activity, same rate of tooth movement, reduced pain, better comfort and less tooth tipping.

The results imply an essential role for CS (WF6 epitope) levels in GCF as a biomarker of alveolar bone remodeling around orthodontically-moved canines and as a chair-side diagnostic tool during orthodontic treatment. In addition, higher force magnitude used during orthodontic tooth movement did not necessarily produce more efficient tooth movement. On the other hand, it might cause negative effects, such as undesired tooth movement, and pain or patient discomfort.

Limitations of the study

1. As a result of specific criteria for the volunteers, a rather small sample size was used.
2. As a result of the limited financial support, only one bone resorption marker was used.
3. Periodontal status was monitored but plaque index and gingival index were not recorded.

Suggestions for further study

1. The sample size of the experiment should be increased, if possible.
2. Other biomarkers, such as an osteoclastic marker, a root resorption marker and a potent cytokine, should be monitored to clarify biologic activity in the periodontium during orthodontic tooth movement.
3. Plaque index and gingival index should be recorded before the GCF collection.
4. Monitoring changes in GCF constituents during orthodontic tooth movement should be focused in the first four-week period.
5. There should be a greater frequency of GCF collection.