Assessment of Tooth Mobility in the Different Skeletal Patterns

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Abstract

Background: Skeletal pattern variation was often accompanied by particular dentoalveolar compensation. However, the effect on tooth mobility (TM) has never been performed.

Objectives: To assess the influence of different skeletal patterns on TM values.

Methods: The prospective study included data of 80 female patients (mean age 22.46±5.53 years). ANB and mandibular plane, Jarabak's ratio (FMA, SnGoGn, PFH/AFH) values were used to define the anteroposterior and vertical skeletal relationships, respectively. Assessment of TM was performed using the tapping method which measures the time of the tapping rod of the device contact the tooth. The result of the measurement was displayed in IST scale (Implant Stability Test) with a higher scale representing greater stability or lower mobility. Data was recorded and one-way analysis of variance was used.

Results: Significant differences in TM value in the different anteroposterior and vertical relationships were observed. In the vertical relationship, significant differences in TM were observed with open vertical configuration > normal vertical configuration. In the anteroposterior relationship, significant differences in TM were observed with Class I, III > Class II ($p<0.001$).

Conclusions: Within the limitation of the study, the skeletal relationship affected TM due to the differences in the periodontium property of skeletal patterns.

Keywords: Tooth mobility, Vertical skeletal relationship, Anteroposterior skeletal relationship

Introduction

Mobility is one of the diagnostic parameters for clinicians of integrity, functional status, and disease of the periodontium both in static and dynamic conditions. TM is a property for measuring the degree of tooth stability. TM is related to many theories, simple tension, support by compression, hydrodynamic theory, and viscoelasticity.(1-4) TM can become a non-invasive tool for the study of clinical intervention.

The differences in skeletal relationships have influenced the different properties of the periodontium tissue such as PDL width, bone density, and bone thickness. Previous studies indicated that patients with a skeletal open bite have a lower bite force(5), lower cortical bone thickness(6) and lower alveolar bone density(7) when compared to the normal skeletal pattern. In the anteroposterior skeletal relationship, the patients with skeletal Class II had lower alveolar bone density(8) and higher cancellous bone thickness compared to the patients with skeletal Class I and Class III.(9) It is important to understand the effect of each factor that might affect TM. However, there is no information about the correlation between the different types of skeletal relationships and TM. This understanding might be useful for clinicians when planning for orthodontic tooth movement.

Materials and Methods

The prospective study was conducted at the Orthodontic Postgraduate Clinic, Faculty of Dentistry, Bangkok Thonburi University. The protocol was approved by the

Human Experimentation Committee, Faculty of Dentistry, Bangkok Thonburi University (Ref 26/2561).

Female patients who follow the inclusion criteria were selected by a consecutive sampling method. The inclusion criteria were: 1) patients with age range 18-25 years old, 2) no history of dental trauma or previous orthodontic treatment, 3) no missing teeth or large restoration of the crown, 4) excellent, healthy periodontal status, 5) no transverse skeletal discrepancy, 6) no temporomandibular joint problem, 7) not having systemic disease or pregnancy, and 8) no use of anti-inflammatory drugs (NSAIDs) during the study. In the present study, in order to reduce the confounding factors and provide more homogeneity to the sample, only female subjects were included. In a previous study, we had observed a significant lower TM in males compared to the female subjects.(10) Study groups were divided into Skeletal Class II (ANB<4°), Skeletal Class I (ANB= 0-4°) and Skeletal Class III (ANB>4°) according to their anteroposterior relationship and deep vertical configuration (FMA<20°, SNGoGn<28°, PFH/AFH<59), normal vertical configuration (FMA=20-30°, SNGoGn=28-36°, PFH/AFH=59-63) and open vertical configuration (FMA>30°, SNGoGn>36°, PFH/AFH>63) in the vertical relationship. The procedure of the study was described and informed consent was obtained before beginning the study. Assessment of TM was performed before any orthodontic treatment.

TM measurement

A damping capacity analysis (DCA), Anycheck® (Neobiotech, Korea) was used to measure TM. The result of the measurement was displayed in IST scale (Implant Stability Test) with a higher scale representing greater stability or lower mobility (range from1-99). This device uses the tapping method, which measures the time of the tapping rod of the device contact to the tooth. The patients were in an upright position. The point of application was at the incisal 1/3 of the tooth and positions perpendicular to the long axis of the tooth. The contact angle was parallel to ground level or not more than 30 degrees.

Data collection

Assessment of TM was performed on all teeth. IST value of each tooth was measured from the right and left sides of the maxillary and mandibular arch and then averaged.

Statistical analysis

Descriptive statistics were used to determine the means and standard deviations of the mobility of the teeth. ANOVA was used to determine the statistical differences. Post hoc test was analyzed with TUKEY HSD. The statistical analyses were obtained at $p \leq 0.05$ level of significance. The mean of IST value was used to test normal distribution. Kolmogorov-Smirnov test was used to assess the normality of distributions. The result showed that there were no statistical differences at $p \leq 0.05$ level of confidence. Therefore, the IST value was a normal distribution.

Results

80 Female patients age 18-25 years (mean 22.46±5.53 years) were included in the study. Demographic data were presented in Table 1.

Table 1: Demographic data.

Antero-posterior Relationship (ANB) (n)	Vertical Relationship (FMA)(n)			
	Deep vertical configuration	Normal vertical configuration	Open vertical configuration	Sum
Class I	8	10	10	28
Class II	8	10	7	25
Class III	8	10	9	27
Sum	24	30	26	80

Vertical relationship

The average IST values of all teeth were 72.4±6.2, 71.5±5.6, and 71.4±7.1 in normal vertical configuration, deep configuration, and open configuration respectively. Normal vertical configuration group had the highest IST value or the highest tooth stability. There was a statistical difference in the mean of IST value in the normal vertical configuration and open configuration patterns at p=0.000. The graph of IST value is shown in Figure 1.

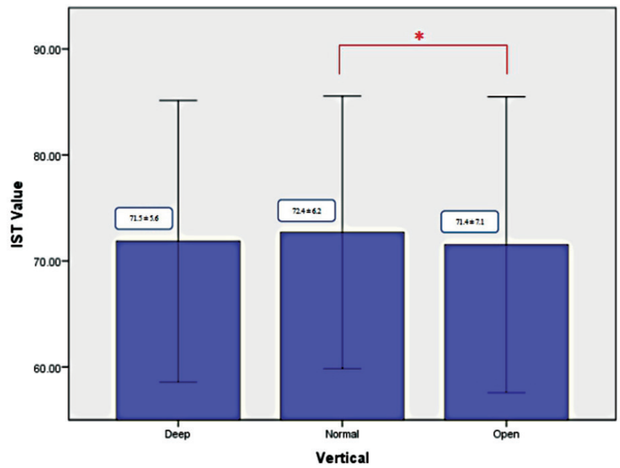

Figure 1: Mean of IST value in different vertical skeletal relationship (Average IST value in Overall teeth), *$p<0.05$.

Anteroposterior relationship

The average IST values of all teeth were 72.3±6.2, 71.4±7.2, and 72.9±6.4 in Class I, Class II, and Class III, respectively. Class II had the highest TM. There was a statistical difference in the mean of IST value in Class I–Class II, Class II–Class III at p=0.001. The graph of IST value is shown in Figure 2.

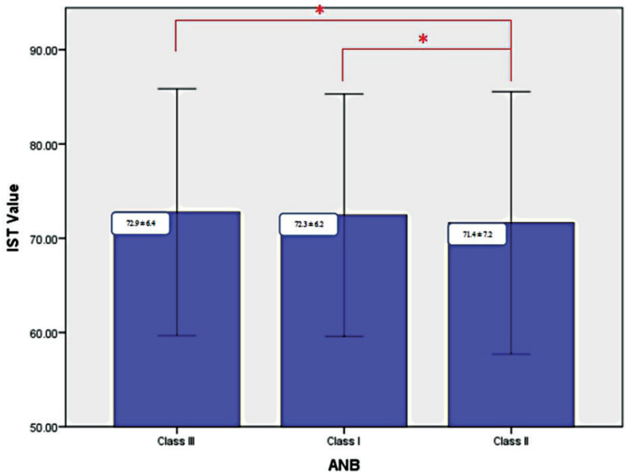

Figure 2: Mean of IST value in different anteroposterior skeletal relationship (Average IST value in Overall teeth), *p<0.05.

Discussion

Vertical relationship

From our study, in a vertical relationship, the results showed that the tooth stability in the normal vertical configuration was the highest while in the open vertical configuration pattern TM was the highest and significantly higher than in the normal vertical configuration. A previous study reported the patient with the open vertical configuration profile has the lowest bite force.[5] The muscle activity and development of dentition could alter properties **72.9±6.4, 71.4±7.2, 72.3±6.2 of the bone such as shape, thickness, and mineralization.[11-13] Quiudini PR *et al.*[5] in 2017 studied the bite force between dolichofacial profile and brachyfacial profile, which is the phenotype of open vertical configuration pattern and deep vertical configuration pattern. The result showed that the bite force in a dolichofacial pattern was significantly lower than in a brachyfacial pattern. Furthermore, secondary tongue thrust habit was also found in people with open bite. The force from the tongue against the reciprocal force from the lip created a jiggling effect making the periodontal tissue worst.[14] Ozdemir F[6] and Sadek MM *et al.*[15] indicated that the cortical bone thickness was lowest for the high-angle group compared to the average and low-angle group. Ozdemir F *et al.*[7] in 2014 also reported female subjects in the open vertical configuration group showed significantly decreased bone density. The lower bone density would result in higher TM as found in this study. TM in the deep vertical configuration was also lower than the normal vertical configuration. This could imply that the normal vertical configuration had an optimum in oromuscular balance. Farronato G *et al.*[16] reported an improvement in muscle function. They reported an improvement in mean percentage overlapping coefficients (POC) that represent muscle balance between right and left. Besides, the maximum voluntary clenching also increased after surgical correction of the deep and open vertical configuration. Kronfeld R[17] in 1931 reported that the width of the periodontal ligament was the largest in a heavy function group. The researcher suggested that a heavy function acted as a stimulus for the periodontal tissues, which became hypertrophic. Thus, the tooth became adapted to stand the increased stress without damage. We supposed that the higher TM in the deep vertical configuration group than in the normal vertical configuration group might be from the property factor of the periodontal ligament to sustain a heavy muscular force.

Anteroposterior relationship

From our study, the results showed that in the Class II group, TM was significantly higher than Class I and Class III groups. In terms of skeletal factor, Coşkun İ *et al.*[9] in 2019 examined the relationship between anteroposterior facial pattern and thickness of alveolar bone in conjunction with root morphology of teeth. The result showed that root length and root width were not significantly different between the skeletal Class I, Class II, and Class III groups in a study. However, the cancellous bone thickness was significantly thicker between the groups especially in the posterior of the maxilla and the mandible in the skeletal Class II group. A similar result was also found in the study by Baysal A *et al.*[18] in 2013, where cancellous bone thickness was significantly thicker in Class II than Class I. The result of our study could imply that the wider cancellous bone and the low bone density would allow more TM, in other words, less tooth stability, as found in the Class II group. In the Class III group, our results showed no significant difference in TM compared to the Class I group. Although Araújo SCCSd *et al.*[19] measured the maximum bite force in the different anteroposterior relationship, they found the maximum bite force was significantly observed in normal occlusion, Class I, II, III malocclusion respectively. The lack of proper occlusal contact might consequently make the employment of bite force more difficult. But Cha BK[20] reported the difference in muscle activity due to skeletal anteroposterior and vertical facial types using EMG recording. The result showed that the more Class III malocclusion, the higher resting Temporal muscle activity (TMA), and the lesser increase of clenching Masseter muscle activity (MMA) were expressed. The researcher concluded that the morphological pattern of Class III malocclusion usually showed a well-developed mandibular body or ramus. Changes in the muscular action axis and increases in the gravitational component in Class III malocclusion might cause a higher stimulation of the temporal muscle, resulting in higher quality bone. Al-Masri M *et al*.[8] also reported the alveolar density in lower anterior teeth. A study showed that Class III had a significantly higher density on apical buccal, middle lingual bone than Class II. Considering TM during tooth movement, Tanne K *et al*.[21] found that a nonlinear increase in TM was observed at the end of tooth movement. The periodontal ligament and alveolar bone became more flexible at the end of tooth movement. Therefore, we might imply that the more the TM before the orthodontic treatment, the more flexible the periodontium tissue, the more probability of the tooth to move when receiving the orthodontic load. This correlated to the clinical outcome that due to certain anatomical characteristics, anchorage loss occurred much more easily in the Class II group.[22] We might suggest that, in the orthodontic aspect, the TM value might be a consideration when providing the orthodontic treatment plan in anchorage preparation and selection of a proper force level for the patient with the different types of skeletal patterns to achieve the optimum treatment outcome.

In the present study, although the bone density was not assessed, the indirect relationship between the quality of bone, in terms of cortical and cancellous bone density, and the skeletal pattern was assumed. Therefore, further studies to address the direct relationship between bone density and TM values are still necessary to clarify the results obtained in the present study. Comparisons of the reliability of the Anycheck and Peritest M devices for the assessment of TM had been performed in our previous study.[23] A strong correlation between the Periotest M and Anycheck values was observed. Moreover, the use of incisal edge for tooth stability measurements provided reliable and consistent tooth stability measurements.[23]

Conclusions

The skeletal relationship had a significant effect on TM property. In the vertical relationship, the tooth stability was observed normal and deep > open vertical configuration. In the anteroposterior relationship, the tooth stability was observed Class III and Class I > Class II.

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