# Assessment of Tooth Mobility Changes Following Active Orthodontic Treatment

*Gishchasith CHEEWAGON*[1], *Boonsiva SUZUKI*[1*], *Eduardo Yugo SUZUKI*[1]
[1]*Department of Orthodontics, Faculty of Dentistry, Bangkokthonburi University, Thailand*

*Corresponding Author:* ***Boonsiva SUZUKI*** *(E-mail:* ***boonsiva.suz@bkkthon.ac.th****)*

## Abstract

**Background:** Assessment of tooth mobility (TM) has been used to determine the optimum duration for Orthodontic retention.

**Objectives:** To assess the TM changes after orthodontic treatment.

**Methods:** This prospective cohort study included a sample of 27 orthodontic patients who finished non-extraction treatment with fixed appliances. Assessment of TM changes was performed after removal of the orthodontic appliance (T0) and during the monthly (T1, T3, T6, T12, T24) follow-up periods using the tapping method. Baseline values were used as a reference to determine in percentage the respective TM values. Data were recorded and analyzed.

**Results:** A gradual decrease in the overall TM values between T0-T24 was observed. A statistically significant difference between T0, T1, and T3 was identified. However, there were no statistical differences between T6, T12, and T24 ($p$<0.05).

**Conclusions:** The overall TM decreased after active orthodontic treatment but it did not return to the baseline values during the retention period.

**Keywords:** Tooth mobility, Fixed appliance, Retention period, Retainer

## Introduction

Successful orthodontic treatment is related to long-term stability. It is well known that teeth often tend to move back toward their original position after removal of the orthodontic appliances, with a relapse tendency of 33-90 % after at least 10 years post-treatment(1), which is the reason why a regimen of retention is necessary after orthodontic treatment. However, achieving long-term stability is very challenging, therefore several researchers have suggested the concept of a clinical study to obtained long-term stability that can be divided into 3 parts. First, the occlusion concept suggested by Kingsley, Angle, and Andrew.(2,3) Second, the position of the tooth in the bone that was revealed by the study of Lundstrom(4) and Tweed(5) and maintains the original arch form, particularly in the lower arch, as recommended by Mccauley(6) and Reidel.(7) From the biological and biomechanical point of view, when removing orthodontic force, biological changes have occurred, including an increase in cellular response, stiffness of PDL, increase bone remodeling, that complex system of biological response resulting in decrease TM of biomechanical response.(8) Therefore, the assessment of the TM can be used as an indicator of biological changes within the periodontal support.(9-12) Only a few studies have assessed TM after orthodontic treatment.(8,13,14) From longitudinal TM measurement, when the TM returns to its physiological levels, it can be defined as the most appropriate time for the retention period. Therefore, the purpose of this study was to assess the TM changes during the retention period.

## Materials and Methods

### 1. Subjects

In this prospective cohort study, 27 patients from Orthodontic Postgraduate Clinic, Faculty of Dentistry, Bangkok Thonburi University, who had finished their orthodontic treatment with fixed appliances, were recruited from August 2018 to March 2022. (The number of patients at each time point is shown in Table 1). During the retention period, an ideal post-treatment retention was indicated for the removable retainer and follow-up for 2 years. Approval for research activities was received from the human ethics committee of the Bangkok Thonburi University (approval number: 26/2561).

#### *Inclusion and exclusion criteria*

Patients with good general health and periodontal status, no dental spacing and good occlusal & proximal contact, good cooperation for routine follow up and wear the retainer as instructed, no teeth with extensive caries or restorations, teeth with complete root formation, and patients with a history of dental trauma and previous orthodontic treatment were included.

### 2. Assessment of TM

All teeth in both dental arches from the central incisor to the second molar were used for the assessment of tooth mobility. Briefly, assessment of TM changes was performed at baseline (before orthodontic treatment), immediately after removal of the orthodontic appliance (T0), and during the monthly (T1, T3, T6, T12, T24) follow up in retention periods using IMT-100 (AnyCheck, DMS Co., LTD. Gangwon-do, Korea). This device uses the tapping method, which measures the time the tapping rod of the device contacts the tooth.

To perform the measurement using this device, an investigator held a handpiece 0-30 degree of ground level and the long axis of the tooth that was nearly perpendicular to ground level, close to the mesiobuccal surface of the molar and the point at the middle of the incisal edge of the anatomical crown of incisor, canine, and premolar. The result of measurement was displayed in the iST scale (Implant Stability Test) with a higher scale representing greater stability and a lower scale representing low stability or high mobility. Thus, to reduce the measurement error, TM was measured two times, and the mean value was selected. The mean and standard deviation of TM values were calculated for each tooth. Baseline values (Protocol of TM measurement) were used as a reference to determine in percentage the respective TM values by considering the baseline value as zero. The intra-examiner reliability of the measurements was 0.98, as determined by the intraclass correlation coefficient.

### 3. Statistical analysis

The data of all variables studied, including different tooth numbers were first tested for normality by the Kolmogorov-Smirnov test and their distributions were found to be normal. TM values were analyzed using descriptive analysis. A one-way ANOVA was performed to determine the statistical significance of the differences of TM values in different time intervals.

## Results

At debonding (T0) a mean 14.6%±5.6% decrease in overall TM values was found. (Figure 1) A gradual decrease in the TM values between T1 (12.9±5.8%), T3 (10.3±5.2%), T6 (9.3±5.6%), T12 (5.6±2.6%) and T24 (5.1±6.0 %) was observed. A statistically significant difference between T0, T1, and T3 was observed. ($p$<0.05). However, there were no statistical differences between T6, T12, and T24. (Table 1).

**Table 1:** Means and standard deviation of TM value (%) at the different time points Time n Overall (Mean±SD).

| | Time | n | Overall (Mean ± SD) |
|---|---|---|---|
| TM Value (%) | T0 | 27 | 14.6±5.6 |
| | T1 | 24 | 12.9±5.8 |
| | T3 | 25 | 10.3±5.2 |
| | T6 | 19 | 9.3±5.6 |
| | T12 | 15 | 5.6±2.6 |
| | T24 | 6 | 5.1±6.0 |

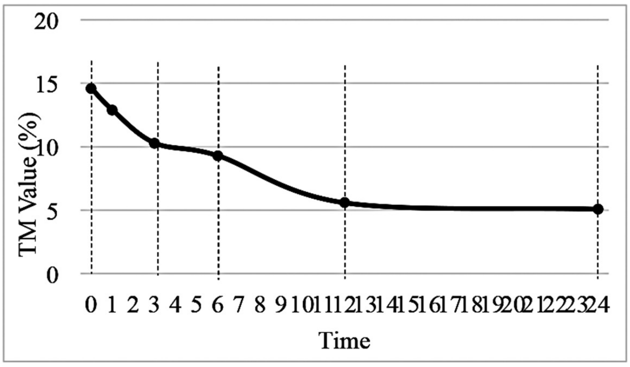


**Figure 1:** Overall TM values changes (%).

## Discussion

TM is an important clinical indicator of the reestablishment of periodontal health conditions.[13] Therefore, the main purpose of the present study was to evaluate the TM changes throughout the retention phase of the orthodontic treatment. For the reliability of the measuring device, comparisons of the reliability of the Anycheck and Periotest M devices for the assessment of TM had been performed in our previous study.[15] A strong correlation between the Periotest M and Anycheck values was observed. Moreover, the use of incisal edges for tooth stability measurements provided reliable and consistent tooth stability measurements.(15) Therefore, we performed the investigation of TM using Anycheck.

Overall results show a particular pattern of TM changes at the end of the active treatment phase. Therefore, the overall TM changes were divided into 4 distinct phases according to the pattern of a slope. (Figure 1).

In phase 1 (T0-T3) the highest TM decrement change during this phase, series of complex healing processes occurred simultaneously. The reorganization of the PDL(16), an adaptation of the gingival fibers(16), the reorganization in bone density(17), the reestablishment of occlusal relationships(18), and readaptation of the masticatory muscles occurs.(19) Therefore, this series of events dictated the main changes in TM recovery during this initial phase. It should be considered that both the reorganization of the PDL and reestablishment of a new occlusal environment were completed within 3-month. Reitan *et al*.(16) observed that a gradual increase in tooth stability was obtained as the result of a complete reorganization of the PDL occurring over a three to four-month period, which is consistent with the finding of Haydra *et al*.(18) who reported increasing the occlusal contacts at the end of 3-month retention.

In phase 2 (T3-T6), a lower rate of TM changes than those in phase 1 can be explained by the fewer healing processes that occurred in this phase. This is consistent with the finding of Reitan *et al*.(16) who reported the reorganization of collagenous fibers of the gingiva in 3-6 months. In addition, according to the study of Hagg, the masticatory muscles adapted to the new environment with increase forces to pretreatment level in 6 months.(19)

In phase 3 (T6-T12), an increase in the rate of TM changes was observed, which has been associated with the reorganization of supracrestal fiber. Reitan *et al*.(16) histologically demonstrated the persistence of distention of connective tissue fibers in the periodontium of the supracrestal area at seven months after the cessation of orthodontic tooth movement. Moreover, alveolar bone healing might be the main recovery of this period as suggested in the study of Farina.(20) However, the alveolar bone is still increasing its density to the pre-treatment values. For complete bone healing, it would take from 6 to 24 months for a full recovery.(17)

In phase 4 (T12-T24), no significant changes in the TM changes were observed. During this phase, the full recovery of oral muscles and function is completed.(19) These changes, associated with the complete healing of the PDL and alveolar bone and occlusal function provides the balance of the masticatory system.(16,17,21,22) Therefore, the stability of the TM values is observed. However, the most important finding is TM values did not return to the baseline values. These might be explained by the undesirable effects of the regular use of removable retainers during the retention period. However, further studies to elucidate the influence of the retainer usage regimen are necessary. In this study, detailed information regarding the TM recovery during the whole 2-year retention period was performed. A similar study involving the analysis of tooth mobility during the recovery period was performed by Hwang *et al*.(14) using the Periotest. Moreover, only the upper arch was assessed since the lower arch was retained with fixed retainers. In a similar study by Tanaka *et al*.(13), the assessment of tooth mobility was performed only before treatment, debonding (T0) and at 2 years follow-up (T24). Consequently, no data regarding the changes that could occur during the recovery period was obtained. Moreover, only the central and lateral incisor on both arches was assessed since the lower arch was retained with fixed retainers. In the present study, the assessment of the TM recovery was the only criteria used to define the stability during the retention period. Important information regarding the amount of tooth movement during the orthodontic treatment, assessment of dental arch width, and length discrepancy were not taken into account. Moreover, the effects of the clinical approach to seating the bite by the end of the active phase of orthodontic treatment were not evaluated. These are considered the limitations of the present study. Therefore, further studies to address such limitations are necessary.

## Conclusions

1. Assessment of TM changes during the retention phase of the orthodontic treatment provides important information regarding the particular recovery conditions of the periodontal support.

2. Our protocol for TM measurement can be considered as a practitional use for measurement TM after orthodontic treatment to find a proper time of retention period.

3. The overall TM changes did not return to the baseline values during the retention period.

## References


1. Chakrapani S, Goutham M, Krishnamohan T, Anuparthy S, Tadiboina N, Rambha S. Periotest values: Its reproducibility, accuracy, and variability with hormonal influence. Contemp Clin Dent. 2015;6(1):12.
2. Andrews LF. The six keys to normal occlusion. Am J Orthod. 1972;62(3):296-309.

3. Angle E. Classification of Malocclusion: Dental Cosmos. St Louis. 1899:248-64.
4. Lundström AF. Malocclusion of the teeth regarded as a problem in connection with the apical base. Int J Orthodont Oral Surg Radiography. 1925;11(10):933-41.
5. Cross J, editor The Tweed philosophy: the Tweed years. Seminars in Orthodontics; 1996.
6. Mccauley DR. The cuspid and its function in retention. Am J Orthod Oral Surg. 1944;30:196-205.
7. Riedel RA. A review of the retention problem. Angle Orthod. 1960;30(4):179-99.
8. Watted N, Wieber M, Teuscher T, Schmitz N. Comparison of incisor mobility after insertion of canine-to-canine lingual retainers bonded to two or to six teeth a clinical study. J Orofac Orthop. 2001;62(5):387-96.
9. Burstone C, Pryputniewicz R, Bowley W. Holographic measurement of tooth mobility in three dimensions. J Periodontal Res. 1978;13(4):283-94.
10. Muhlemann HR. Tooth mobility: the measuring method. Initial and secondary tooth mobility. J Periodontol. 1954;25(1):22-9.
11. Tanne K, Inoue Y, Sakuda M. Biomechanical behavior of the periodontium before and after orthodontic tooth movement. Angle Orthod. 1995;65(2):123-8.
12. Tenshin S, Tuchihashi M, Sou K, Lew H-s, Hayashi H, Tanimura I, *et al*. Remodeling mechanisms of transseptal fibers during and after tooth movement. Angle Orthod. 1995;65(2):141-50.
13. Tanaka E, Ueki K, Kikuzaki M, Yamada E, Takeuchi M, Dalla-Bona D, *et al*. Longitudinal measurements of tooth mobility during orthodontic treatment using a periotest. Angle Orthod. 2005;75(1):101-5.
14. Hwang H-S, Kim W-S, Kim J-M, McNamara JA. Longitudinal measurements of tooth mobility following orthodontic treatment. Korean J Orthod. 2010;40(1):34-9.
15. Suzuki EY, Suzuki B. Protocol for Tooth Stability Measurement During Active Orthodontic Treatment. JDAT (in press).
16. Reitan K. Principles of retention and avoidance of posttreatment relapse. Am J Orthod. 1969;55(6):776-90.
17. Yu JH, Huang HL, Liu CF, Wu J, Li YF, Tsai MT, *et al*. Does orthodontic treatment affect the alveolar bone density? Medicine. 2016;95(10).
18. Haydar B, Ciğer S, Saatçi P. Occlusal contact changes after the active phase of orthodontic treatment. Am J Orthod Dentofacial Orthop. 1992;102(1):22-8.
19. Du X, Hägg U. Muscular adaptation to gradual advancement of the mandible. Angle Orthod. 2003;73(5):525-31.
20. Farina R, Trombelli L. Wound healing of extraction sockets. Endodontic Topics. 2011;25(1):16-43.
21. Sultana M, Yamada K, Hanada K. Changes in occlusal force and occlusal contact area after active orthodontic treatment: a pilot study using pressure-sensitive sheets. J Oral Rehabil. 2002;29(5):484-91.
22. B P, Jain R, Chaturvedula BB. Comparison of occlusal contact changes during retention between Hawley-type retainers and other retention appliances: A Systematic Review. JIOS. 2020;54:92-9.