



Original Research

Comparison Of Prescription Accuracy Of Commercially Available Molar Tubes Using A Custom Made Device - An Invitro Study

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ABSTRACT

Objective : The aim of this in vitro study was to verify the accuracy of torque prescription in the buccal tubes of three commercially available molar bands using Play and Torque Measuring device and to quantify the amount of torsional play present in them.

Materials and Methods: A total of thirty preformed bands with 0.022 slot and McLaughlin-Bennett-Trevisi prescription were selected equally from three different brands for this cross-sectional in-vitro analytical study. The torsional play and torque of the molar bands were measured using the PTM device. The play and torque values obtained using the PTM device were used to calculate the play and torque using a formula. The play and torque values were measured for all the three groups. The mean values of play and torque obtained between three groups were measured using One-way ANOVA.

Results: All three groups had variations in the torque and play that were above the standard torque and play values. There was a statistically significant difference in the play and torque values between all the groups evaluated.

Conclusions : Orthodontists should be aware of the inherent manufacturing defects in the bands as this can prevent the achievement of ideal treatment results. This simple method can help us in determining the torque and play of the molar bands giving us better control over treatment mechanics.

Keywords: molar bands, molar tube prescription, dimensional variability, torque, play.

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INTRODUCTION

In the earlier Edgewise appliances, brackets and molar tubes lacked pre-programmed tip or torque adjustments, necessitating the use of multiple bends for tooth movements. With the introduction of straight-wire appliances, bracket and molar tube slots were pre-programmed with tip and torque information, reducing the need for wire bending in orthodontics. Molar tube design on preformed bands plays a crucial role in achieving proper expression of preprogrammed tooth movements, particularly third-order (torque) adjustments. ^[1] The expression of the prescribed tip and torque values depends on topography of the bracket-wire interface, manufacturing accuracy and intraoral positioning of the attachments by the operator. ^[2,3]

Despite proper positioning of molar tubes orthodontists may find it difficult to finish a case ideally which can be due to inaccuracies in manufacturing of attachments. ^[4] Inaccuracies in the molar tube slot dimensions can also have an effect on the torque expression. The built in torque and play of buccal tubes needs to be measured as they will affect the treatment results. ^[5,6] Manufacturers usually claim that their molar tubes are based on specific standard prescriptions; however, it is important to verify or study the accuracy of slot dimensions as claimed by the manufacturers that are consistent with the standard values. Until now, only a limited number of studies have sought to evaluate how the angles found in various preset orthodontic appliance prescriptions affect molar torque. ^[7] Hence the aim of this study was to verify the accuracy of torque prescription in the molar tube of three commercially available molar tubes using custom made Play and Torque Measuring (PTM) device and to quantify the amount of torsional play present in them.

MATERIALS AND METHODS

This in-vitro study was designed to check the accuracy of molar tube prescription of commercially available molar bands with respect to the torque and play. This study was conducted at our department of orthodontics after the approval from the scientific review board. A sample of ten preformed maxillary right upper molar bands of 0.022” slot and MBT prescription from three different manufacturers were selected. Since size 36 bands are commonly used sizes of band, we selected this size for the study. The study samples were divided into three groups - Group 1 (Koden, *KCK Dental Pvt. Ltd, Calicut, Kerala, India*), Group 2 (JJ Orthodontics, *JJ Orthodontics Private Limited from Thrissur, Kerala, India*), and Group 3 (Centrino, *Libral Traders, India*). A custom made device was designed to measure the torque and play of the molar tubes (Figure 1A).



Figure 1A. PTM device top view.

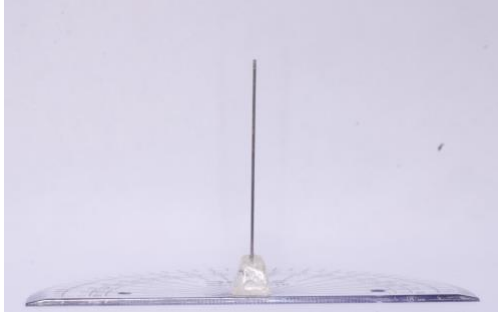


Figure 1B. PTM device view from the side.

To measure the play and torque, the molar bands were customized using a straight length 0.021” x 0.025” SS wire soldered on the occlusal surface of the band in a buccolingual direction. This straight length wire acts as a perpendicular to the long axis of the molar teeth. This will help in measuring and identifying the play and torque of the molar tube.

The customized PTM device was fabricated using a geometric protractor, an acrylic attachment and straight length 0.021” X 0.025” stainless steel (SS) wire. A good quality geometric protractor was used as the base template of the device to measure the angle of play and torque incorporated into the molar tubes. An acrylic attachment was fixed to the center of the protractor in a perpendicular direction using a resin adhesive to hold the 0.021” x 0.025” SS straight length wire into the acrylic attachment (Figure 1B). A hole was drilled into the center of the acrylic attachment and the wire was held securely using self-cure acrylic material. The wire was placed in such a way that 0.025” dimension (width) was placed in line with the horizontal (0 Degree) line of the protractor and 0.021” dimension along the median (90 degree) line of the protractor.

Whenever the dimension of wire is less than the dimension of the slot, there exists a play between the wire and the bracket slot. Play or deviation angle is defined as a rotational movement of the rectangular archwire from its passive position to a position where two opposite edges of the archwire contact two opposite walls of the bracket slot. [8] 0.021” x 0.025” SS wire of the PTM device, the bands rotate to extreme sides of play. The extension of the horizontal wire on the protractor readings helps us to measure the degree of maximum deviation angle and minimum deviation angle. The passive position between the maximum and minimum deviation angle is the torque incorporated in a molar tube. The torque incorporated into the molar tubes can be calculated by calculating the average value of the maximum and minimum deviation angles where the wire rests passively.

The play of the molar tubes were measured using the following formula:

Play = Difference between the extreme values

The play of the bands was measured from the difference between the extreme values when the buccal tube slot moves in both clockwise and anticlockwise directions (Figure 2A and 2B).

The formula for torque was given by the formula:

Torque = Sum of both extreme values

2

The operator was calibrated and trained by an experienced faculty who was involved in this study to measure the play and torque using the PTM device.

The measurements of all samples were repeated after 1 week by the same examiner to verify intra-examiner variability.



FIGURE 2 A. Bracket - arch wire play measurement (maximum play)



FIGURE 2 B. Bracket - arch wire play measurement (minimum play)

Data Analysis

Statistical analysis was performed using SPSS software version 23.00 (IBM Corporation, USA, 2012). For evaluating the error of the method, 10 bands were randomly selected and measured twice at a 1-week interval. The random error between the two sets of measurements was calculated using the Dahlberg formula. The systematic errors were evaluated using Bland-Altman plots. Descriptive statistics were performed for all the variables. A one way ANOVA

was used to detect the significant differences in play and torque between the three groups. P value ≤ 0.05 was considered to be significant.

Results

The mean average play present in group 1 (Koden), group 2 (JJ) and group 3 (Centrino) was found to be 10.90 ± 1.91 , 7.00 ± 2.05 and 4.40 ± 0.96 respectively. The mean difference in play between the three groups was found to be statistically significant with a p value of 0.000 (Table I). The play measurements of bands from all the three groups were more than the standard play specifications of MBT prescription.

TABLE I - Descriptive statistics for play between the groups.

Brand	Mean and standard deviation	Standard Error	p value
Group 1	10.90 ± 1.91	.605	
Group 2	7.00 ± 2.05	.650	0.000
Group 3	4.40 ± 0.96	.306	

*The mean difference is significant at the 0.05 level.

The mean average torque incorporated into the bands of group 1 (Koden), group 2 (JJ) and group 3 (Centrino) was found to be -25.45 ± 0.68 , -18.40 ± 1.07 and -17.30 ± 0.71 respectively. The mean difference in torque between the three groups was found to be statistically significant with a p value of 0.000 (Table II). The torque measurements of bands from all the three groups were more than the standard torque specifications of MBT prescription.

TABLE II - Descriptive statistics for torque between the groups.

Brand	Mean and standard deviation	Standard Error	p value
Group 1	$- 25.45 \pm 0.68$	0.217	
Group 2	$- 18.40 \pm 1.07$	0.340	0.000
Group 3	$- 17.30 \pm 0.71$	0.226	

*The mean difference is significant at the 0.05 level.

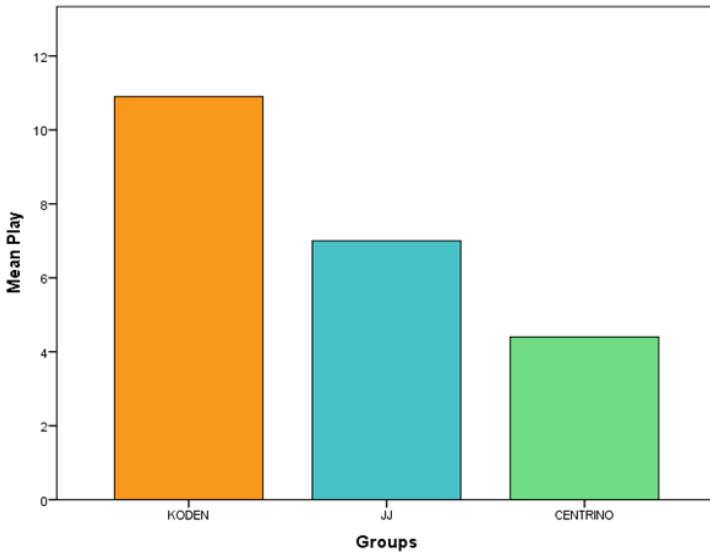
There was a statistically significant difference in the play and torque values between all the three groups (Table III). The mean play and torque value of bands are plotted in the Graph 1 and Graph 2.

TABLE III- One way ANOVA for play and torque between the groups

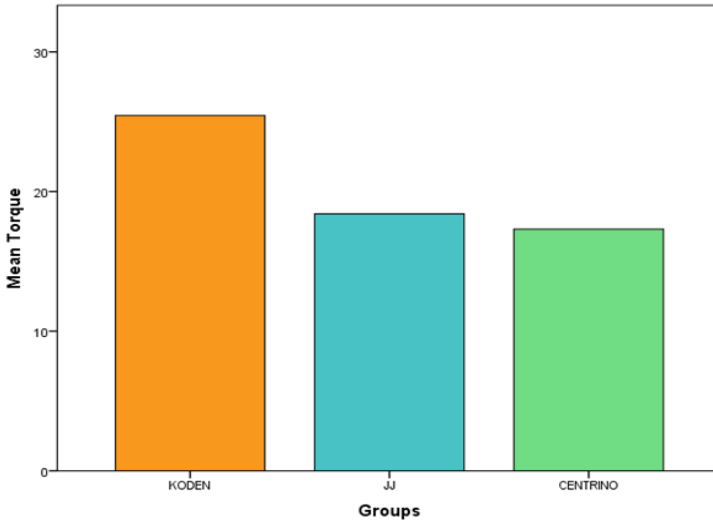
	Play			Torque		
Comparison	Mean Difference	Standard Error	p Value	Mean Difference	Standard Error	p Value
Group 1 and Group 2	3.900*	0.766	0.000*	7.050*	0.377	0.000*
Group 2 and Group 3	2.600*	0.766	0.006*	1.100*	0.377	0.019*
Group 3 and Group 1	6.500*	0.766	0.000*	8.150*	0.377	0.000*

*The mean difference is significant at the 0.05 level.

GRAPH 1 - Graph showing the mean value of play between the groups



GRAPH 2 - Graph showing the mean value of torque between the groups



The Dahlberg formula was used to assess the error of the method; it revealed a random error of 0.71 ± 3 mm, -1.47 ± 4.27 mm and 0.1 ± 3.1 mm. Bland-Altman plots revealed no systematic error in all three groups.

DISCUSSION

In the MBT system the prescribed torque incorporated into the buccal tube brings about the desired change in the buccolingual inclination of the molars which helps in achieving proper treatment results. However, variations in the slot dimensions and defects in manufacturing of the molar tubes can cause improper expression of the torque. The ideal built-in torque values of the straight wire appliance, reduces the need for wire bending and hence decreases clinical chair side time.^[9]

A standard $0.021'' \times 0.025''$ SS wire inside a $0.022''$ MBT slot has a play of 2-3 degrees^[10]. From our study the play found in group 3 (Centrino) bands were the least and they were closest to the standard play values.^[10] The play was found to be highest in Group 1 (Koden). The standard deviation overall was the least in the group 3 (Centrino) which was less than one degree variation in the molar tubes and overall, all the molar tubes had variation in the standard deviation in the play up to 2 degrees, indicating no gross manufacturing defects among all the groups. The play between the arch wire and the band might have a significant impact on the torque expression. If the play between the archwire and the slot increases it may compromise the torque expression.^[11] The increased play may be due to the oversized molar tube slot manufactured by the companies in order to facilitate the ease of insertion of the archwires into the slots. Other studies on bracket slot dimensions have also found that the bracket slots were manufactured oversized by the manufacturers.^[3,12]

According to the MBT prescription, the standard torque value for upper molars is -14 degrees.^[13] The mean torque values found in all the brands in our study were greater than the standard torque values. Overall, bands from Group 3 had torque values which were closest to the standard MBT torque values. The torque incorporated in molar tubes was

highest in group 1 and lowest in group 3. The increased torque values in group 1 and decreased torque in group 3, might be a compensation incorporated by the manufacturers to offset the variations in play present in these tubes.

Few studies have expressed doubts about the validity of data reported by the different manufacturers. [14,15-17] In a study done by Kusy et al, the 0.018 inch bracket slots, actually measured close to 0.0209 inch. [18] From our study, it is evident that the values claimed by manufacturers might not always be accurate, hence it is recommended to check the molar tube prescriptions before putting them to clinical use. Our literature search did not reveal any studies related to measurement of play and torque present in bands hence our results could not be compared with other studies. However, there were various studies on brackets that showed a statistically significant difference in the play and torque value of brackets between various brands and materials. [19,20] Few studies have shown that even with the use of the same wire, the brackets of different companies exhibited different play and torque, and in all the brackets evaluated, the dimensions of the slot were larger than those reported by the manufacturers. [19,21-23]

The extra torque or play present in molar tubes can cause variations in the torque and tip of the bands, which can affect the treatment outcome as the slot size variations can cause the inability of the wire to express its proper torque and tip. [12] In certain cases where molars might require toe-in adjustments at the end of treatment indicates loss of torque in the transverse dimension and thus increasing treatment time. [23]

The slot size and dimensional variations of the buccal tubes need to be taken into consideration while choosing bands for achieving the desired results. Any defects or variations might lead to delay in finishing stages as compensatory bends have to be incorporated to overcome the variations in the buccal tube to achieve proper torque expression. Proper crown angulation and crown inclination is a must to achieve perfect occlusion according to Andrew's six keys of occlusion. [24] The improper torque and tip variation in bands can lead to torque loss and hinder finishing. So, these defects in the molar tubes should be taken into consideration as it can hamper the treatment results.

Any defect or difference in the dimensions of the wire can also affect the variability of the play and torque values. We had used the same wire for evaluating the torque and play of molar tubes in all the groups in our study and also we have microscopically evaluated the dimension of the wire for any gross alterations in the dimension of the wire before the use of the wire for testing the molar tubes to prevent any bias caused due to the variation in the wires. Since this was a pilot study our sample size was limited.

To evaluate the torque and play of molar tubes this method is practically feasible. This is a simple method that can give a practically relevant measure of the torque and play which can be of clinical significance. The study also suggests that the manufacturers need to adhere more closely to the prescribed torque values which will help to reduce the treatment duration as well as the clinical chair side time during the finishing stages.

CONCLUSIONS

In the present study, we have introduced a simple, quick and effective chair side technique for evaluating the play and torque incorporated in commercially available preformed molar bands. Using this technique, we have found that the torque and play values present in all the three commercially available preformed bands were more than the standard prescribed values which might cause inadvertent delay in finishing and detailing.

CONFLICT OF INTEREST

None.

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No external source of funding was as the study was self-funded.

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