The Maxillary First Permanent Molar As A Causative Factor In Arch Length Deficiency

ROBERT R. FORESMAN, D.D.S., M.S.
Pomona, California

Rotation of the maxillary first permanent molar has frequently been discussed or referred to in orthodontic literature. It has been cited as evidence of mesial drift in the maxillary denture. It can cause or is at least associated with cusp-to-cusp occlusion of the premolars and mesiolabial deflection of the maxillary canines. Again it can cause or is at least associated with increased incisal overjet and resultant deep overbite.

Failure to correct upper molar rotations during treatment is an all-too-frequent cause of posttreatment relapse in the buccal occlusion with resultant undesirable changes among the anterior teeth.

Both the frequency of occurrence and the magnitude of rotation in degrees has been investigated and reported. To date no study known to this investigator has been undertaken to determine the amount of lineal increase in occlusal arch length which may be associated with any given degree of rotation of the maxillary first permanent molar.

REVIEW OF THE LITERATURE

Angle[1] described the relation of the upper first molar to the lower first molar as the key to occlusion and upon this based his system of classification of malocclusion.

In 1920, Hellman[2] observed that in a very high percentage of malocclusions the upper first permanent molars are rotated. He also observed that, "The pivotal point of rotation is in the region of the longitudinal axis of the mesiolingual cusp." And further, ". . . that the effect of such deviation is to allow the mesiobuccal cusp to assume a more mesial position. . . ."

Strang[3] commented on, ". . . the importance of the mesiolingual cusp of the upper first permanent molar in maintaining and designating a normal relationship of the maxillary and mandibular arches." And he concluded that, ". . . hence such a malposition becomes an interest and aid in case analysis for classification and treatment." Strang further stated, ". . . this mesiolingual cusp on the maxillary molar resists displacement so strongly that it often maintains its normal location on the mandibular first molar long enough to cause the maxillary first molar to rotate bodily around this tenacious portion of its crown. When this occurs, the crown of the maxillary first molar will, of course, occupy a much greater space, mesiodistally, than when unrotated. Such a malposition will disturb the normal plane relationship of the maxillary premolars and canine on that side, producing an end-to-end contact with the mandibular teeth. . . ."

In 1947, Nance[4] stated, "It is obvious that unless the anatomic contact points of the molars and premolars are in normal relationships, more arch length is required for these teeth than would be necessary if they were properly rotated into place. While the accomplishment of these necessary rotations seldom gives enough additional room to simplify treatment, failure to rotate these teeth often disturbs the balance of an otherwise well-treated case. This is particularly true with respect to maxillary first permanent molars. . . ."

"This molar, because of its rhomboidal shape, then claims too much room in the maxillary arch, often as much as 1.5 to 2 mm more than its actual width."

In 1949, Dewel[5] commented on the characteristic rotation of the upper first molar that usually accompanies its forward displacement as being a diagnostic aid in analyzing mesial movement of upper posterior teeth. He stated that, "The upper first molar is probably the most defamed tooth in the denture, in that its so-called immobile or stationary position has been referred to so often." And further that, "The upper first molar is rhomboidal in form and wider buccolingually than mesiodistally. This means that its greatest diameter is not through the contact areas, but instead on a line extending diagonally across the tooth from the distolingual cusp to the mesiobuccal cusp. . . ." "Consequently, more space is required between adjacent teeth when the upper first molar is rotated than when normal contact relations are maintained in the dental arch."

In 1956 Henry[6] reported on a study on rotations in which he found the upper first permanent molars to be rotated in eighty-three per cent of the one hundred and fifteen cases studied.

Rotation of the maxillary first permanent molar and methods for its correction have been discussed many times in the literature. There have been, however, three fairly recent studies reported in the literature which I would like to discuss in somewhat more detail because of their similarity in approach but differences in conclusions.

The first of these studies, and the one which somewhat set the pattern for method of approach, was by Friel[7] in 1959. In this study the degree of rotation of the maxillary first permanent molar was determined by the angle formed by a line passing through the points of the mesiobuccal and mesiolingual cusps and the midpalatal raphe. A simple but well-designed instrument was made for the purpose of quite accurately measuring this angle for both the right and left maxillary first permanent molars. An excellent description, including photographs, of this instrument may be found in Friel's original work published in *Dental Practitioner* in 1959. "The investigation consisted of 34 cases of normal occlusions in the premolar-molar area. The second group consisted of 30 cases of post-normal (Class II) occlusion with labioclination of upper incisors. . . ." "The results of this investigation showed that in the first group (the normals) the mean angle on the right side was 60 degrees and on the left side 57 degrees. In the second group (postnormals) the mean angle on the right side was 52 degrees and on the left side 51 degrees. . . ." This gave a mean difference between the normals and the postnormals of 7 degrees.

Two years later in 1961, Lamons and Holmes[8] duplicated the Friel study in part using the same method. In this study, two groups of fifteen and sixteen satisfactory or normal occlusions were selected and measured. Concerning these they stated, "It seems rather significant that the measurements of our two groups were almost identical, although, when compared with Friel's normals, our series does not show as wide a range of deviation or as much difference between the angles on the right and left sides as his studies show. A thorough study of all measurements does indicate that there is no significant difference between them." They thus concluded, "After analyzing our figures very carefully, we are led to the very safe conclusion that the angles of the normally-positioned molars are 61 degrees, plus or minus 4 degrees. . . ."

Lamons and Holmes did not attempt to duplicate Friel's studies of postnormal cases. Instead they studied an almost equally divided group of twenty-five Class I and Class II, Division 1 malocclusions. Concerning this group they stated, "The cases were not subjected to a strict classification, however, since this was not considered significant." Yet after evaluating this group as to frequency of rotations in each classification they stated that, "It seemed significant to us, then, that out of twenty-five cases selected for study, eight could be considered to have normal molar positions, whereas in the remaining thirteen cases, molars would be rotated to some degree." And further that, "It also seemed significant that in all of the Class II, Division 1 cases, with the possible exception one case, there would be rotated molars."

Such an inconsistent attitude toward classification must surely be considered as weakening the value of their study concerning the rotation of molars as an etiological factor in Class II malocclusions as opposed to Class I malocclusions. I should like to refer again to this matter of classification when reviewing the third of these more recent studies.

Before completing the discussion of their report, Lamons and Holmes quite properly reminded the reader that, "One important aspect of abnormally rotated molars is the extra space which they occupy in the arch." And further that, "A great deal of space may be gained by correction of abnormally rotated molars. . . ."

In 1961 Lifschiz[9] reported in the *Angle Orthodontist* on a study titled "A Comparison Of Upper First Molar Rotation In Class II, Division I and Class I." The opening statement of the Lifschiz paper defines the area of contention as follows: "It has been commonly assumed that a Class II, Division I malocclusion is characterized in part by a forward drift in the maxillary denture, and that a diagnostic sign of such drift is the rotation lingually of the mesial portion of the upper first molar. It is presumed that this rotation takes place about the larger lingual root of the tooth. Moreover, it is charged that failure to restore this tooth to its proper rotation decreases arch length and develops faulty occlusion in the cuspid area. If mesial drift is usually accompanied by mesiolingual rotation of the first molar about the lingual root, a significantly greater amount of rotation in Class II, Division I cases would lend support to this concept of etiology."

In this study the author reviewed the findings of Friel. The method utilized in this study was, for all practical purposes, the same as that employed by Friel in that the same landmarks and relationships were used; however, photographs of the plaster casts were used in preference to the casts themselves. Groups of seventy-seven untreated Class II, Division I cases and one hundred Class I cases were studied. Concerning his findings, Lifschiz states, "In view of Friel's finding significant differences between the two sides, separate means for the left and right were calculated in this study. Among the four mean values, the largest difference is obtained by comparing lefts and rights in Class II, Division I." In conclusion Lifschiz further states, "Unless one discards them [his own findings] altogether in order to accept Friel's—based on a sample one-third the size of this one—it seems evident that mesiolingual rotation of the maxillary first molar is no more prevalent in Class II than in Class I."

There is a point here which has been overlooked, one that bears some discussion. The samples used in the Friel and the Lifschiz studies are not comparable. Friel compared his Class II, Division I

cases with cases having, ". . . normal occlusion in the premolar-molar area.", whereas Lifschiz compared his Class II, Division I's with Class I's. These Class I cases were not stated to be selected cases and if they were an average sample of Class I malocclusions, many, if not the majority, would be cases in which the canines and premolars were in or approaching a cusp-to cusp relationship.

When considered in this new light, it would appear that the findings of the Lifschiz study do not justify the conclusion nor substantiate its opening thesis.

It should be a matter of concern to all of us that frequently individual malocclusions are assigned a classification with little or no thought to other than a quick glance at the occlusal relationships. It might be said that there is a serious weakness in a classification system which is based solely on occlusal relationship. Classification could be considered a matter of semantics and actually of little importance when evaluating an individual case preparatory to forming a treatment plan. However, when grouping cases into samples for scientific investigation such as the studies just commented upon, the entire validity of a study can be seriously compromised, if not completely nullified, by improper or careless classification or even by employing simple classification at all without further restrictive definition.

Material and Method

Inasmuch as this investigation was designed to determine the amount of increase in arch length to be gained by correction of upper first molar rotations during orthodontic treatment, it was considered advisable to repeat the earlier studies of normal rotational relationship but this time on well-treated orthodontic cases. This would allow a comparison between the two groups. For this purpose, two groups of cases were used. The first consisted of fifteen cases treated by Doctor Sydney L. Meek of Claremont, California. The plaster casts used were those taken at the time of retention and again approximately five years later. The second group of fifteen cases was taken from my own practice and, just as in the first group, retention and postretention casts were used. The angle of rotation for the upper right and left first permanent molars was taken from each cast using the same method as that employed by Friel.

For the purpose of the measurement of lineal increase in occlusal arch length due to upper molar rotation, a sample of ninety untreated cases with at least one noticeable mesiolingually-rotated upper first molar was selected. Of these cases forty-five had Class I molar relationships and forty-five had Class II molar relationships. No cases were used in which either of the upper first molars had mesial surface restorations.

For each upper first molar three measurements were recorded: first, the included angle between the midpalatal suture and a line passing through the points of the mesiolingual and mesiobuccal cusps; second, a lineal measurement in millimeters from the mesial contact point to a line tangent to the buccal line of occlusion and passing through the point on the mesiolingual cusp (Fig. 1.).

In making the third measurement, which was again lineal, the following procedure was employed. A four-inch square piece of one-eighth inch plexiglass was scored and inked with two lines intersecting at 60°. The plexiglass was superimposed on the plaster casts in such manner that one line coincided with the midpalatal suture and the second line passed over the point of the mesiolingual cusp of the molar. A sec-

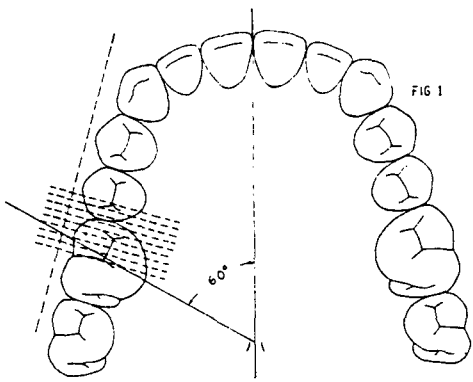

Fig. 1

ond sheet of sixteen-thousandths plexiglass was scored and inked with a millimeter scale. This sheet was interposed between the plaster cast and the one-eighth inch plexiglass in such a manner that the millimeter scale was parallel to the buccal line of occlusion and passed over the point of the mesiolingual cusp. Then without altering their relationship, the two sheets of plexiglass were rotated about the point of the mesiolingual cusp until the 60° line passed over the point of the mesiobuccal cusp as well (Fig. 2.). The lineal measurement between the point of the mesiolingual cusp and the mesial contact point was then recorded. All lineal measurements were read to the nearest one-fourth mm. The difference between these last two measurements was then calculated to determine the amount of increase in occlusal arch length caused by the mesiolingual rotation of the molar.

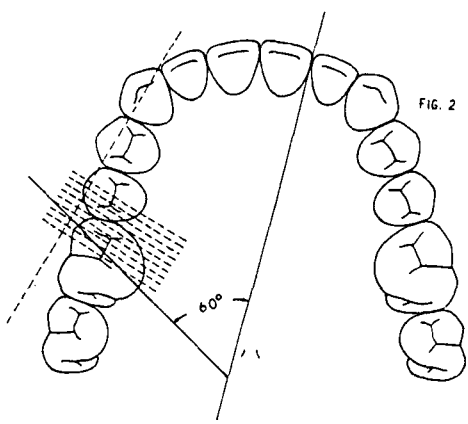

Fig. 2

Findings

The mean angles of molar rotation and the standard deviations for Dr. Meek's cases (see Table I) fell between the "normals" of Friel and those of Lamons and Holmes.

The mean angles of rotation for the cases from my own practice were almost identical to the Meek sample but the standard deviations were somewhat lower and the ranges a little narrower.

The findings for the Class I and Class II cases (Table II) are remarkably similar to each other with the exception of the ranges for both the angular and lineal measurements. If just one of the Class I cases were to be eliminated from its sample, these ranges would also be very similar.

Discussion

The mean angle of rotation of the upper first permanent molar reported in the literature by Friel and by Lamons and Holmes as well as the means for the two groups of treated orthodontic cases used in this investigation are remarkably similar. It would appear that this gives adequate justification for assuming an angular relationship of 60° to be ideal and it is upon this assumption that the main body of this investigation is based.

When comparing the statistical analyses of the forty-five Class I and the forty-five Class II malocclusions used in this study, it was found that there was only three-tenths of a degree difference in the mean angular relationship of the upper first molar to the midpalatal suture and that the standard deviations for each group were only

two-hundredths of a degree apart. The range of variation for the Class II group was from 40° to 58° and, if just one of the Class I cases were dropped from its group, the range for the Class I's would have been 40° to 56°, almost identical.

The mean amount of increase in occlusal arch length due to mesiolingual molar rotation in the Class II group was .73 millimeters, only eleven hundredths apart from the .84 millimeter mean for the Class I's. Here again, if the one case had been dropped from the Class I's, the ranges would have been almost identical.

All of the cases studied were regrouped according to the amount of increase in occlusal arch length into increments of one-fourth of a millimeter from 0.25 mm to 1.25 mm. For each increment a mean angle of deviation from the assumed ideal of 60° was calculated (Table III). It was found that for approximately each three degrees of mesiolingual molar rotation there was an added increase in occlusal arch length of one quarter of a millimeter.

When subjecting an individual case of the Class I sample to examination and analysis, it was found that very frequently the amount of anterior displacement of the premolars was noticeably greater than the rotation of the molars could account for. In these cases the mesiolingual cusp of the molar was found to be well forward in the central fossa of the lower molar.

Failure to correct the mesiolingual

TABLE I

	Cases at time of retention			Postretention		
Sample	Mean Angle of Rotation	S.D.	Range	Mean Angle	S.D.	Range
Meek Cases*	60.05°	4.93°	49-71.5°	60.6°	4.47°	47-69°
Foresman Cases*	60.91°	3.23°	56-69.5°	60.1°	2.98°	54.5-65.5°

* N=15

TABLE II

	Angle of rotation			Mesiodistal width increase	
Sample	Mean	S.D.	Range	Mean	Range
Class I*	49.6°	4.46°	33.5-56°	.844mm	.25-2.0mm
Class II*	49.9°	4.44°	40-58°	.734mm	0-1.25mm

* N=45

TABLE III

	Mesiodistal width increase					
	.25mm	.50mm	.75mm	1.00mm	1.25mm	1.50mm
Mean deviation from 60°	4.01°	6.96°	9.87°	12.75°	16.21°	19.09°

rotation of upper molars has been cited by many experienced orthodontists as a prominent cause for relapse of otherwise well-treated orthodontic cases. I dare say most of us, at one time or another, have taken an impression for the purpose of making a retainer and have seen irregularities in that cast which we would not have intentionally allowed to remain.

A certain amount of overtreatment with Class II elastics is a fairly common practice among many of us. And in oral preretention evaluation of a case, only the buccal cusp relationship of a molar can be seen. Thus an overtreated but still mesiolingually rotated molar will not be noticed for the potential trouble maker it really is. Downs[10] has wisely advocated the taking of a simple occlusal impression just prior to retention for the purpose of preretention evaluation; it is a procedure which can save much time and worry later.

Summary

The literature has been reviewed on the subject of rotation of the maxillary first permanent molar. Mesiolingual rotation of the upper molar is common to a large majority of malocclusions and contributes to the problem of inadequate arch length. The purpose of this investigation has been to determine how much loss of arch length (increase in occlusal arch length) can occur from molar rotation.

From the results of this study it has been found that:

1. The ideal molar rotational relationship to the midpalatal suture by the method used in this and earlier studies is sixty degrees.
2. The amount of mesiolingual rotation of the upper molar can be just as great in Class I malocclusions as in Class II and rotations of as much as 20° are not uncommon.
3. The mesiodistal arch space of the upper first molar may be increased as much as 2 mm due to mesiolingual rotation.
4. For approximately each 3° of rotation there will be an increase in width of 0.25 mm.

207 West Pearl St.

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