Original Article

Mandibular First Molar Relation to Variable Lower Face Skeletal Components

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ABSTRACT

Objective: To evaluate the position of the mandibular first permanent molar in the mandible relative to several factors.

Materials and Methods: A total of 185 untreated Class I and Class II patients were randomly selected from a sample of 350 patients from a single office. The palatal and mandibular planes were related to Frankfort horizontal to create the interjaw or ''B'' angle. Age and the mesial contact of the mandibular first molars were used. The landmarks were projected at right angles to the Frankfort horizontal for effective mandibular dimension lengths. Actual-length dimensions were projected at right angles to the mandibular plane. Pearson product moment correlation coefficients were computed to evaluate the effect of age, cranial length, and mandibular contribution to the molar's sagittal position in the mandible. Significance was reported only when $P < .05$ to determine a 95% confidence level.

Results: Statistically significant positive correlations indicated that the mandibular molar is located more forward with increasing age, longer mandibular body length, and increasing posterior facial height. In contrast, significant negative correlations to the interjaw, mandibular plane, ramal inclination angles, and the linear ramal contribution corresponded to a more posterior position of the molar with increasing angles.

Conclusions: The mandibular first permanent molar is located more anteriorly with an older patient, a longer mandibular body, greater posterior facial height, and an acute interjaw angle. In contrast, an increase in the forward tip of the ramus places the molar in a more posterior location.

KEY WORDS: Correlation coefficients; *P* values; Mandibular molar; Effective and actual lengths

INTRODUCTION

Edward H. Angle classified Class II malocclusions as ''when the mesio-buccal cusp of the upper first molar is received in the buccal groove of the lower first molar.'' He stated that the maxillary first molar ''more nearly than any other tooth or point in the anatomy furnishes an exact scientific basis from which to reason on malocclusion.[4]'' He therefore believed that malocclusions are of mandibular origin. Most studies have concerned the skeletal interarch relations while devoting little attention to the dental components as etiological factors.[1–20]

A Class II molar relationship may be of dental as well as skeletal origin. The maxillary molar may be located forward in the maxilla, or the mandibular molar may be located posteriorly in the mandible. Elman[21] used the distal contact of the mandibular first molar and measured the distance perpendicular to lines representing the posterior and inferior borders of the mandible. He determined that the molar occupied the same position for both the normal control and the Class II group. Baldridge[22] reported the angle SNU6 showed no essential difference between Class I and Class II cases. Wylie[23] projected the buccal groove of the maxillary first molar to include its distance from the ptery-

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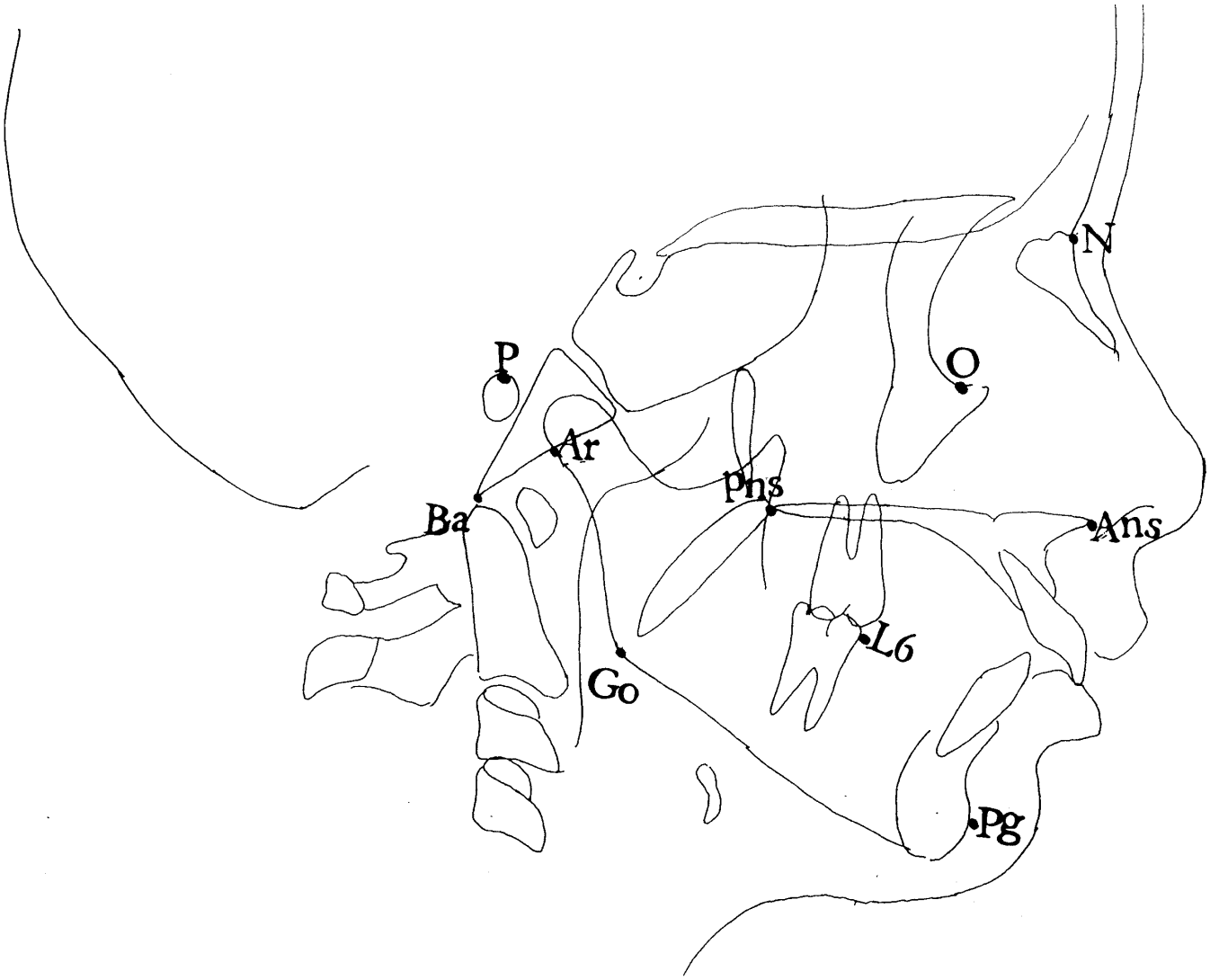

Figure 1. Cephalometric landmarks.

gomaxillary fissure as a variable in his analysis of anteroposterior dysplasia.

What have been neglected are the possible relations of variable skeletal components on the molar's position. Andria et al[24] found a negative correlation of the maxillary first molar's position relative to angular relations of the maxilla and mandible and positive correlations when compared with linear and proportional dimensions.

The purpose of this investigation was to test the following several null hypotheses that may have a relation to the sagittal position of the mandibular first permanent molar in the mandible irrespective of the class of malocclusion and the possible interactions of these same factors:

- The chronological age will have no relation to the sagittal position of the mandibular first molar in the mandible.
- The interjaw or "B" angle[25] will have no relation to the sagittal position of the mandibular first permanent molar in the mandible.
- The palatal plane (PPL) angle will have no relation to the sagittal position of the mandibular first permanent molar in the mandible.
- The mandibular plane (MPL) angle will have no relation to the sagittal position of the mandibular first permanent molar in the mandible.
- The ramal inclination (RIL) angle will have no relation to the sagittal position of the mandibular first permanent molar in the mandible.
- The mandible's location on the posterior cranial base (BaAr) will have no relation to the sagittal position of the mandibular first permanent in the mandible.
- The ramal horizontal dimension (ArGo) will have no relation to the sagittal position of the mandibular first permanent molar in the mandible.

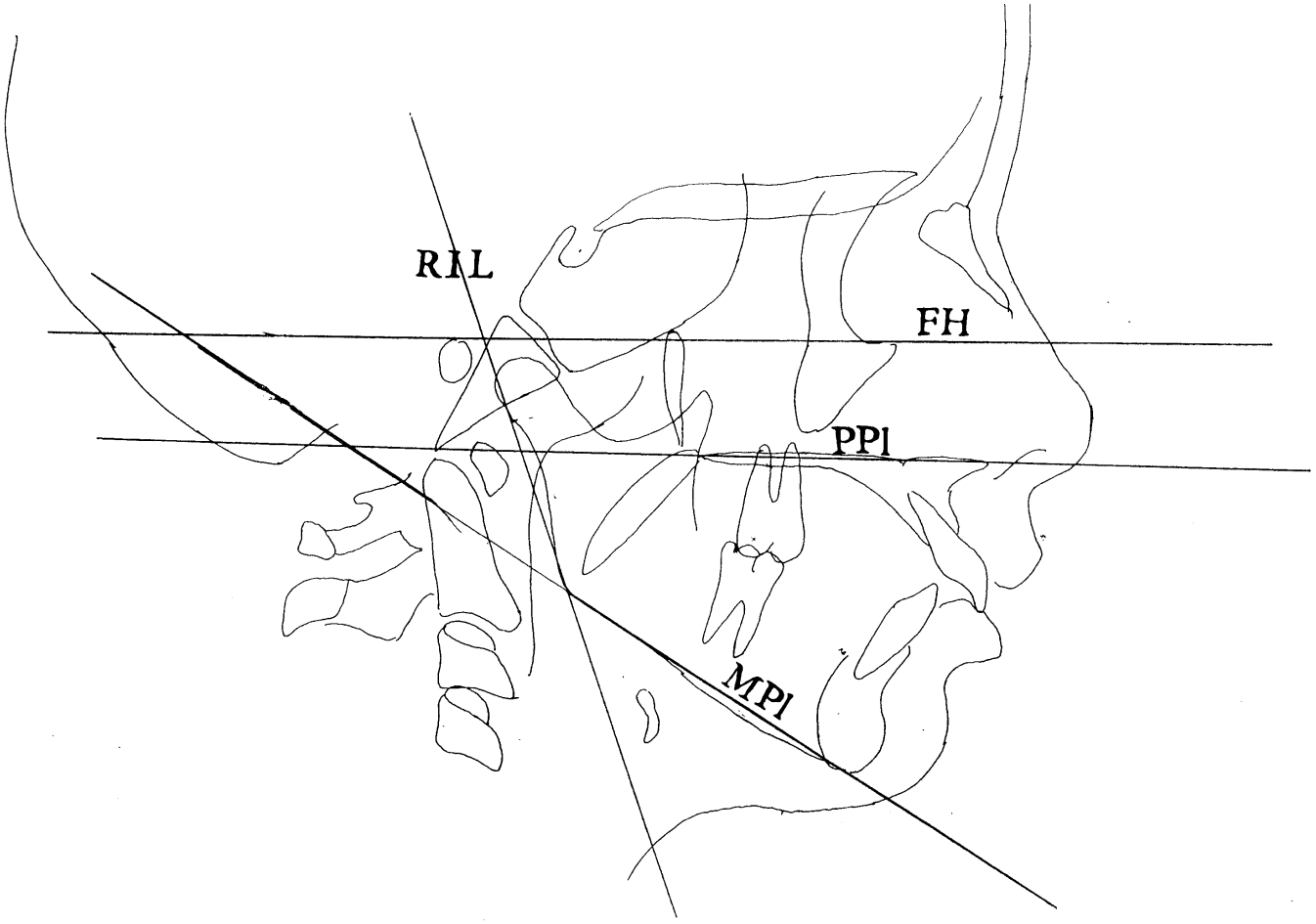

Figure 2. Cephalometric planes.

- The effective length (EL) of the mandibular body (GoPg) will have no relation to the sagittal position of the mandibular first permanent molar in the mandible.
- The actual length (AL) of the mandibular body (GoPgAL) will have no relation to the sagittal position of the mandibular first permanent molar in the mandible.
- Posterior facial height (PnsGo), linear or proportional, will have no relation to the sagittal position of the mandibular first permanent molar.

MATERIALS AND METHODS

Before orthodontic treatment, complete orthodontic records of 185 Class II and Class I Angle malocclusion patients were randomly selected from the complete records of a sample of 350 patients all treated by one of the authors. The patients were of western European ancestry with a mean age of 9.7 years (SD 2.9 years). Gender differences were not taken into consideration. Records consisted of cephalometric headfilms, plaster models, intraoral or Panorex dental radiographs, and facial photographs.

Each lateral cephalometric radiograph was traced, as were both midline and bilateral images. All bilateral images were bisected and thereafter treated as midline structures to correspond to cranial midline structures. Linear measurements were read to the nearest 0.5 mm, and angular measurements were obtained with a standard protractor and read to the nearest 0.5°. A right-angle coordinate system, as described by Coben,[3] was used to determine proportions.

Cephalometric Landmarks and Measurements

The cephalometric landmarks basion (Ba), nasion (N), porion (P), orbital (O), articulare (Ar), gonion (Go), pogonion (Pg), mesial contact of the mandibular first permanent, posterior nasal spine (Pns), and anterior nasal spine (Ans) were recorded (Figure 1). Cephalometric planes recorded were Frankfort horizontal (FH), MPL, RIL, and PPL (Figure 2).

Cephalometric landmarks Ba, N, Ar, Go, Pg, and L6

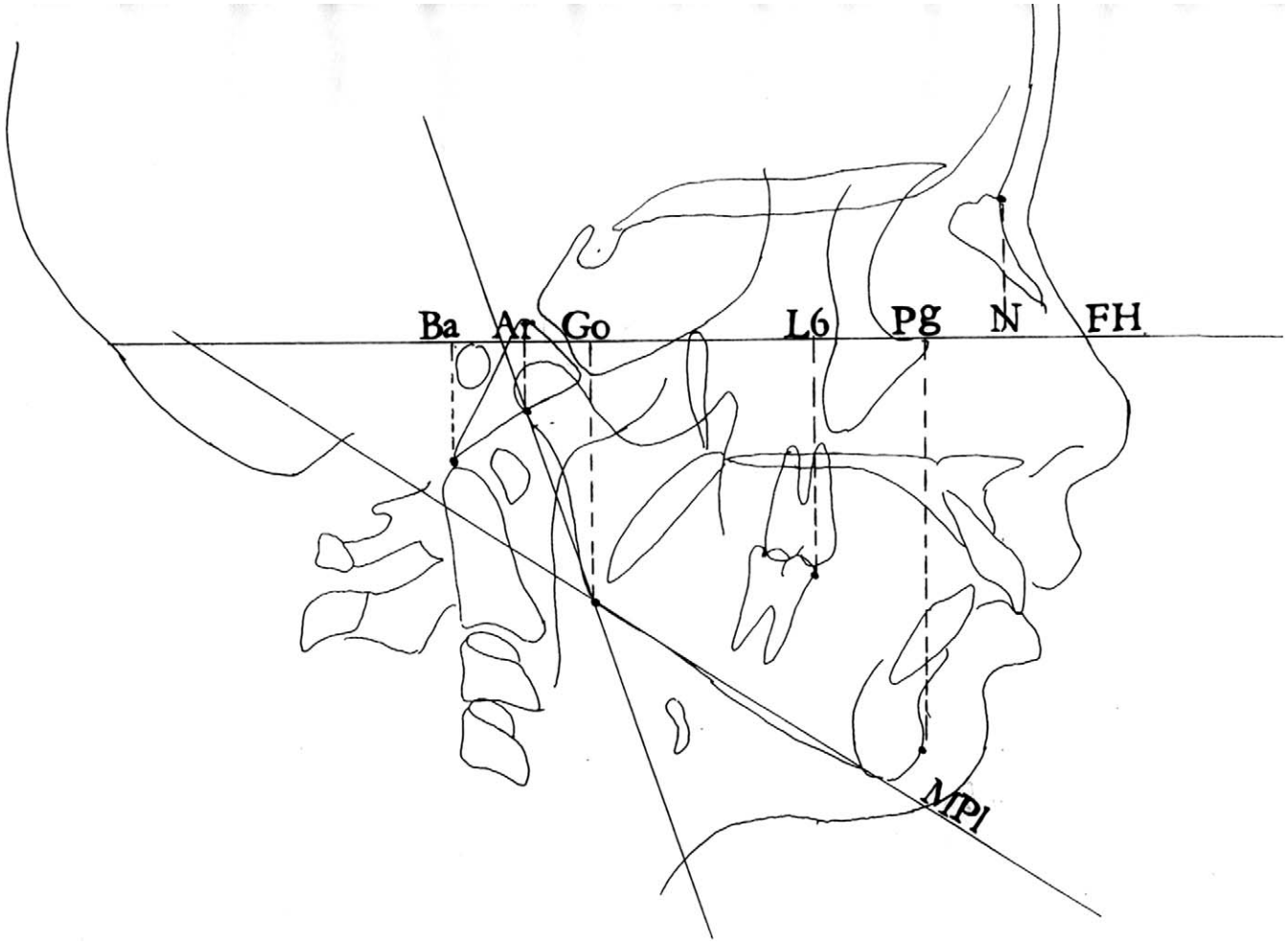

Figure 3. Effective lengths.

were projected at right angles to FH for EL (Figure 3). AL dimensions were acquired by projecting landmarks Go, L6, and Pg at right angles to the MPL, thereby eliminating the influence of the angular variability of the MPL on the molar position (Figure 4). The PPL was determined by connecting Ans to Pns, and the MPL was established by a line tangent to the bisecting image of the lower border of the mandible. Both were recorded relative to FH. The RIL angle was created by erecting a line connecting Ar to the posterior border of the ramus and recoding the angle with a line perpendicular to FH passing through Ar. The interjaw B angle[25] was read as the resultant MPL and PPL angles.

Statistical analysis included calculating linear correlation coefficients and performing Student's *t*-tests. Significance was reported only when $P < 0.5$. Analyses were performed with Microsoft Excel (Redmond, Washington) and SAS Version 8.02 (Lead Tech, Chicago, IL).

Sixteen angular, linear, and proportional measurements were determined for each patient. The angular measurements were PPL/FH, MPL/FH, and PL/MP. The linear dimensions included BaN, BaAr, ArGo, GoPg, GoL6, GoL6AL, GoPg (AL), and PnsGo. The proportional measurements (Figures 3 and 4) were GoL6 % BaN, GoL6 % GoPg, and GoL6 (AL) % GoPg (AL).

RESULTS

A statistically significant positive correlation exists with chronological age and both the effective and actual linear sagittal position of the mandibular first molar relative to Go (Table 1). The same positive correlation is proportionally present when the molar's actual location is related to the AL of the mandibular body (GoPg AL) but not to the molar's respective effective length (Go/6 % GoPg). However, there is the same positive correlation when the effective molar's position is related to cranial base length (Go/6 % BaN).

A statistically significant negative correlation is seen in Table 2 to both the actual linear location of the man-

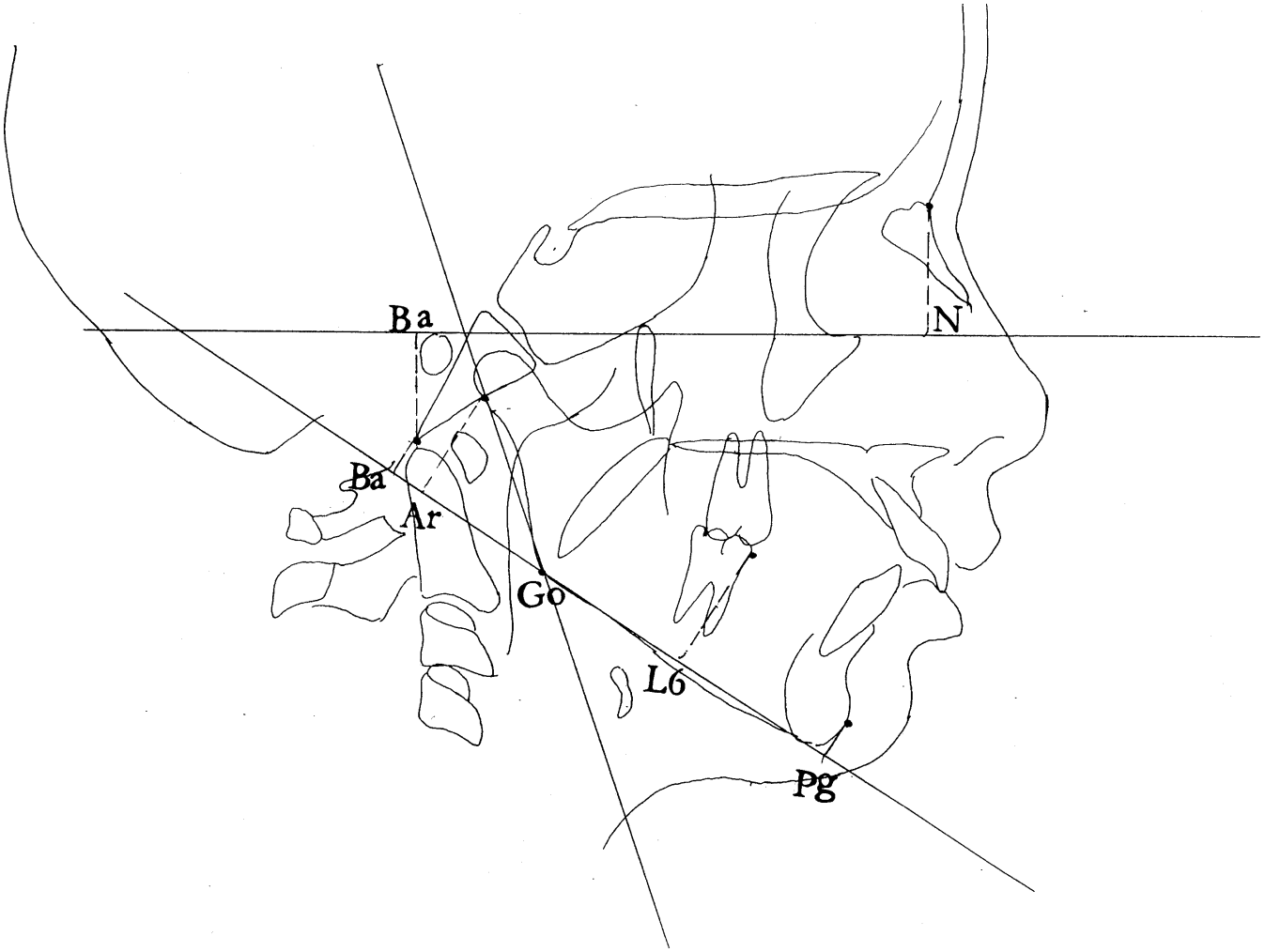

Figure 4. Actual lengths.

Table 1. Mandibular Molar Sagittal Position Relative to Age*

	Correlation	*P* Value
Age and B angle	−0.1163688	>.05
Age and PPL angle	−0.047549	>.05
Age and MPL angle	−0.09682	>.05
Age and RIL angle	−0.14212	>.05
Age and Go/6 mm	0.44703	<.0001
Age and Go/6 % BaN	0.38307	<.0001
Age and Go/6 % GoPg	0.1378	>.05
Age and Go/6 Al mm	0.415	<.0001
Age and Go/6 % GoPg AL	0.3972	<.0001

* PPL indicates palatal plane; MPL, mandibular plane; RIL, ramal melination; and AL, actual length.

Table 2. Mandibular Molar Sagittal Position Relative to B Angle*

	Correlation	*P* Value
B and PPL angle	0.2753	<.0001
B and MPL angle	0.8393	<.0001
B and RIL angle	−0.0531	>.05
B and Go/6 mm	−0.1533	>.05
B and Go/6 % BaN	−0.0612	>.05
B and Go/6 % GoPg	0.1508	>.05
B and Go/6 AL mm	−0.306	<.0001
B and Go/6 % GoPg AL	−0.3385	<.0001

* See Table 1 for definitions of abbreviations.

dibular molar and its proportional relation to the actual mandibular body length to the B angle but not its effective linear and proportional position. In addition, a significant positive correlation exists between the B angle and PPL and MPL, with a much stronger correlation between the B and MPL.

Table 3 indicates no relation between PPL and the molar's location. Table 4 demonstrates the same negative correlations seen with the B angle corresponding to the strong correlation of B and MPL.

There are statistically significant negative correlations (Table 5) when the molar's actual, effective, and proportional lengths are related to the RIL angle.

There does not appear to be any relation to the location of the mandible on the posterior cranial base and

Table 3. Mandibular Molar Sagittal Position Relative to PPL Angle*

	Correlation	*P* Value
PPL and MPL angle	−0.2809	.0003
PPL and RIL angle	0.09	>.05
PPL and Go/6 mm	0.0578	>.05
PPL and Go/6 % BaN	0.112	>.05
PPL and Go/6 % GoPg	−0.0923	>.05
PPL & Go/6 mm AL	0.1394	>.05
PPL and Go/6 % GoPg AL	−0.024	>.05

* See Table 1 for definitions of abbreviations.

Table 4. Mandibular Molar Sagittal Position Relative to MPL Angle*

	Correlation	*P* Value
MPL and RIL angle	−0.099998	>.05
MPL and Go/6 mm	−0.19526	>.05
MPL and Go/6 % BaN	−0.12951	>.05
MPL and Go/6 % GoPg	0.200875	<.05
MPL and Go/6 mm AL	−0.39225	<.0001
MPL and Go/6 % GoPg AL	−0.32789	<.0001

* See Table 1 for definitions of abbreviations.

Table 5. Mandibular Molar Sagittal Position Relative to RIL Angle*

	Correlation	*P* Value
RIL and Go/6 mm	−0.39554	<.0001
RIL and Go/6 % BaN	−0.38917	<.0001
RIL and Go/6 % GoPg	−0.05781	>.05
RIL and Go/6 mm AL	−0.32449	<.0001
RIL and Go/6 % GoPg AL	−0.32292	<.0001
RIL and BaAr mm	0.0573006	>.05

* See Table 1 for definitions of abbreviations.

Table 6. Mandibular Molar Sagittal Position Relative to Mandible Position on Posterior Cranial Base*

	Correlation	*P* Value
BaAr mm and Go/6 mm	0.028108	>.05
BaAr mm and Go/6 % BaN	0.012123	>.05
BaAr mm and Go/6 % GoPg	0.013997	>.05
BaAr mm and Go/6 AL mm	0.051271	>.05
BaAr mm and Go/6 % GoPg AL	0.013574	>.05

* AL indicates actual length.

Table 7. Mandibular Molar Sagittal Position Relative to Ramal Length Contribution*

	Correlation	*P* Value
ArGo mm and Go/6 mm	−0.2603492	.003
ArGo mm and Go/6 % BaN	0.0299889	>.05
ArGo mm and Go/6 % GoPg	0.0320001	>.5
ArGo mm and Go/6 AL mm	−0.1852122	>.05
ArGo mm and Go/6 % GoPg AL	0.0329651	>.05

* AL indicates actual length.

Table 8. Mandibular Molar Sagittal Position Relative to Mandibular Body Effective Length*

	Correlation	*P* Value
GoPg mm and Go/6 mm	0.5455103	<.0001
GoPg mm and Go/6 % BaN	−0.10466	>.05
GoPg mm and Go/6 % GoPg	−0.111204	>.05
GoPg mm and Go/6 AL mm	0.5987844	<.0001
GoPg M and Go/6 % GoPg AL	−0.105227	>.05

* AL indicates actual length.

Table 9. Mandibular Molar Sagittal Position Relative to Mandibular Body Actual Length (AL)

	Correlation	*P* Value
GoPg AL and Go/6 mm	0.81333839	<.0001
GoPg AL and Go/6 % BaN	−0.0750542	>.05
GoPg AL % GoPg % GoPg	−0.0816388	>.05
GoPg AL and Go/6 AL	0.86342286	<.0001
GoPg AL and Go/6 % GoPg AL	−0.0787697	>.05

Table 10. Mandibular Molar Sagittal Position Relative to Posterior Facial Height*

	Correlation	*P* Value
PnsGo mm and Go/6 mm	0.252324	<.0005
PnsGo mm and Go/6 AL mm	0.273219	<.0002
PnsGo % BaN and Go/6 mm	0.041291	>.05
PnsGo % BaN and Go/6 AL mm	0.086586	>.05
PnsGo % BaN and Go/6 % BaN	−0.04122	>.05
PnsGo % BaN and Go/6 % GoPg	−0.04564	>.05
PnsGo % BaN and Go/6 % GoPg AL	−0.04125	>.05

* AL indicates actual length.

the molar's position in the mandible either in effective length or AL or its proportional position (Table 6).

Table 7 illustrates a slightly significant negative correlation between the molar's linear location and the ramal linear contribution to lower facial depth (ArGo) but no correlation to AL or proportional values.

A statistically significant positive correlation exists between both linear effective and actual molar location to both the effective and mandibular body length, but no proportional correlations were found (Tables 8 and 9).

Only a significant positive correlation exists between both effective and actual molar position and the linear posterior facial height dimension (Table 10). No proportional correlations were found.

DISCUSSION

Despite the small variation in ages (SD 2.9 years), the positive correlation is indicative of a more anterior position of the mandibular first molar with increasing age both linearly and proportionally. The proportional increase would indicate that the molar's more forward location was greater than the increase in body length. A possible explanation would be an increase in arch

width permitting a more forward molar location. The absence of a proportional correlation with effective dimensions and positive correlation with AL is due to the variable MPL angles.

The similarly found negative correlations seen with the B and MPL angles (Tables 2 and 4) can be explained by the stronger influence of the MPL in the production of the interjaw angle seen in Table 2. As both increase, the lower first molar would be located more posteriorly. The interesting significant negative correlation between PPL and MPL would indicate that a larger MPL is accompanied by a lower ANS anteriorly or a higher Pns location posteriorly. Junkin and Andria[26] found that Pns did not drop in the production of a flatter PPL through the utilization of cervical traction for anterior-posterior correction.

The statistically significant negative correlations relative to actual and effective linear location of the molar to RIL might be indicative of a biological compromise. As the ramus tips increasingly forward, the molar would occupy a more posterior position to compensate for the mandibular body being tipped more forward in the face. The angular effect is seen to be stronger than the linear (ArGo mm) (Table 7) and could be due to a shorter ramal length that is frequently seen with obtuse RIL angles.

The mandible location on the posterior cranial base, BaAr mm (Table 6), does not appear to be a factor in molar location. In contrast, the length of the mandibular body, relative to both the effective length and AL, and molar position positive correlation (Table 8) equates to a more forward location of the molar in a longer body. The absence of a proportional correlation balances location and body size, and the molar remains in a proportionally identical position.

The negative correlations found when relating the molar's position to the interjaw angle prompted a study of posterior facial height with the molar's location. An acute B angle would place the molar more forward. A contrasting finding is seen when the molar is related to posterior facial height. The statistically significant positive correlation, though not as significant as the B data, would dictate that the molar would be located more posteriorly with a short posterior facial height. We may conclude that the difference might be because of the anterior facial height's greater contribution to a steeper MPL and obtuse interjaw angle rather than a lack of posterior facial height.

CONCLUSIONS

- The mandibular first permanent molar is located more anteriorly with an older patient, a longer mandibular body, greater posterior facial height, and an acute interjaw angle.
- In contrast, an increase in the forward tip of the ramus places the molar in a more posterior location.
- The mandible location on the posterior cranial base and the inclination of the PPL do not appear to be factors in determining the molar's location in the mandible either linearly or proportionally to either the length of the mandibular body or cranial base.

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