Localization of first permanent molars in lateral cephalometric and panoramic radiographs from early mixed dentition to early permanent dentition

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Changes in position and mesiodistal angulations of maxillary and mandibular first permanent molars from early mixed dentition to early permanent dentition were measured on panoramic radiographs and compared with the values measured on lateral cephalometric radiographs. It was found that the maxillary and mandibular first permanent molars were uprighted gradually, drifted mesially and vertically, and that the changes in mesiodistal angulations were clearly on the panoramic radiographs in comparison with the cephalometric radiographs.

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INTRODUCTION

Edward H. Angle[1] called the first molar the ''key to occlusion". Certainly, this tooth is very important in maintaining the stability of the dentition. On the basis of the work of Friel[2] and Baume,[3] most dentists accept the concept that the physiologic drift of the teeth in a mesial direction is primarily responsible for the change of the first molar occlusion in the transitional dentition. Some of the arch perimeter reduction could be due to the closure of spaces during the change from the deciduous to the permanent dentition ("leeway space"), and some due to the loss of mesiodistal tooth widths with attrition. Apart from the mesial shifting of permanent first molars into the leeway space following the loss of deciduous second molars, mesial shifting of these teeth occurs as a physiologic phenomenon.

Dimensional and angular measurements from radiographs can be used in clinical dentistry to determine the inclination and relative positions of the teeth. However, there is little information regarding the positional and angular changes of first molar on radiographs in the transitional dentition.

The purpose of the present investigation was to examine and quantify the normal positional changes of maxillary and mandibular first molars in children from early mixed dentition to early permanent dentition in two views, with lateral cephalometric and panoramic radiographs to be viewed at the same time.

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MATERIALS AND METHODS

Standard lateral cephalometric and panoramic radiographs of 200 orthodontically untreated Taiwanese children were obtained from the files of our department. The set of records was taken at one office visit. All radiographs had good quality. Only children without premature loss of primary teeth and free from any disorder affecting growth were selected. The stages of dental development were divided into four stages according to the system devised by Hellman: 1) IIIA (early mixed dentition), 2) IIIB (late mixed dentition), 3) IIIC (permanent second molars commence emergence), and 4) IVA (permanent second molars attain eruption). Each stage consisted of 50 sets (25 boys and 25 girls) of radiographs.

The cephalometric and panoramic radiographs were traced on overlying matte acetate papers. The lateral cephalometric radiograph gives a less clear picture, but with the right and left molar teeth superposed on each other. Only right side of the panoramic radiograph was used for measurements. For both types of radiograph, anatomic reference points and reference planes on the tracing (Figures 1 and 2) were determined and inputted to the personal computer with digitizer. The measurements on the radiographs were recorded directly without correction for enlargement. The precision of measurement was 0.1 degree for angles and 0.01 mm. for distances.

Mesiodistal angulations (distal angle between the reference plane and the molar centerline) of maxillary and mandibular first molars and X and Y coordinate

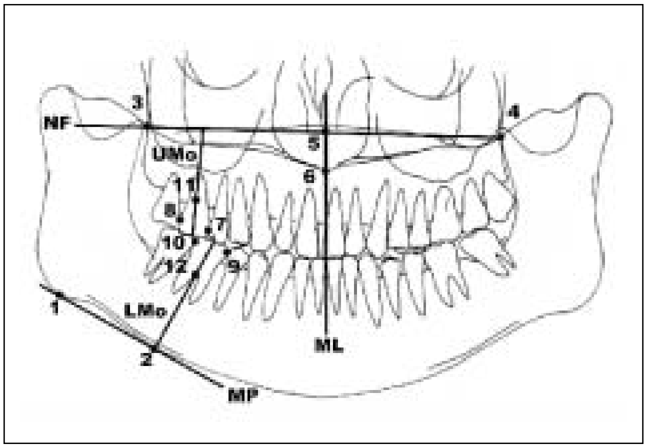

Figure 1. Reference points, planes, and measurements on panoramic radiograph.

Reference points
1: lower gonion
2: inferior border of mandible at permanent first molar region
3: the point that maxillary tuberosity intersects with NF (right side)
4: the point that maxillary tuberosity intersects with NF (left side)
5: the point that NF intersects with ML
6: anterior nasal spine
7: the most convex point at mesial surface of maxillary permanent first molar crown
8: the most convex point at distal surface of maxillary permanent first molar crown
9: the most convex point at mesial surface of mandibular permanent first molar crown
10: the most convex point at distal surface of mandibular permanent first molar crown
11: furcation between mesiobuccal and distobuccal roots
12: furcation between mesial and distal roots

Reference planes
NF: nasal floor (the straight line along nasal floor)
MP: mandibular plane (the straight line that passes reference points **1** and **2**)
ML: midline (perpendicular to the **NF** and passes the anterior nasal spine)

Measurements
UMo: angulation of upper right permanent first molar (angle formed by molar axis and nasal floor)
LMo: angulation of lower right permanent first molar (angle formed by molar axis and mandibular plane)

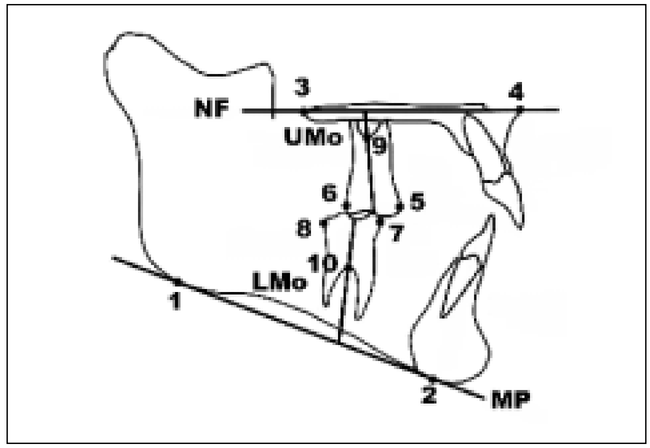

Figure 2. Reference points, planes, and measurements on cephalometric radiograph.

Reference points
1: lower gonion
2: menton
3: posterior nasal spine
4: anterior nasal spine
5: the most convex point at mesial surface of maxillary permanent first molar crown
6: the most convex point at distal surface of maxillary permanent first molar crown
7: the most convex point at mesial surface of mandibular permanent first molar crown
8: the most convex point at distal surface of mandibular permanent first molar crown
9: furcation between mesiobuccal and distobuccal roots
10: furcation between mesial and distal roots

Reference planes
NF: nasal floor (the straight line that passes reference points **3** and **4**)
MP: mandibular plane (the straight line that passes reference points **1** and **2**)

Measurements
UMo: angulation of maxillary permanent first molar (angle formed by molar axis and nasal floor)
LMo: angulation of mandibular permanent first molar (angle formed by molar axis and mandibular plane)

values of each reference point were calculated by using the reference points and planes (Figures 1 and 2). Statistical analysis was done using SigmaStat software. Mean values and standard deviations for the radiographic measurements in each stage were calculated. Independent sample t-tests showed no significant sex differences for any of these measurements. Data from boy and girl subjects were pooled. One-way analysis of variance (ANOVA) was used for comparison of mean values for the mesiodistal angulations among four stages and the results are shown in Figure 3. The mean positions of the maxillary and mandibular first permanent molars for each stage were evaluated and the superimposition and positions relative to the nasal floor are shown in Figures 4 and 5.

RESULTS

Significant differences were found among the four stages for mesiodistal angulations of maxillary and mandibular permanent first molars on both cephalometric and panoramic radiographs. At stage 1, the maxillary first permanent molar was oriented in a distal direction and the mandibular permanent first molar was oriented in a mesial direction.

They were upright gradually from stage 1 to 4. The amounts of angular change from stage 1 to 4 were about 10 degrees on panoramic radiographs and 8 degrees on cephalometric radiograph in maxillary permanent first molar. The amounts of angular change from stage 1 to 4 were about 7 degrees on panoramic radiographs and 2 degrees on cephalometric radi-

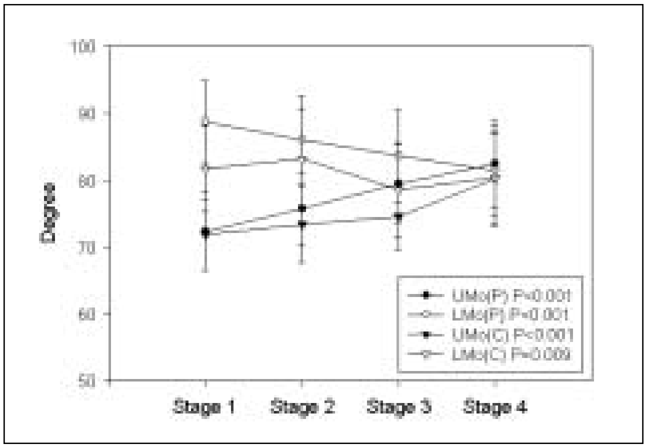

Figure 3. Comparison of mesiodistal angulation of permanent first molars from stage 1 to 4.

UMo: maxillary permanent first molar
LMo: mandibular permanent first molar
(P): measurement on panoramic radiograph
(C): measurement on cephalometric radiograph

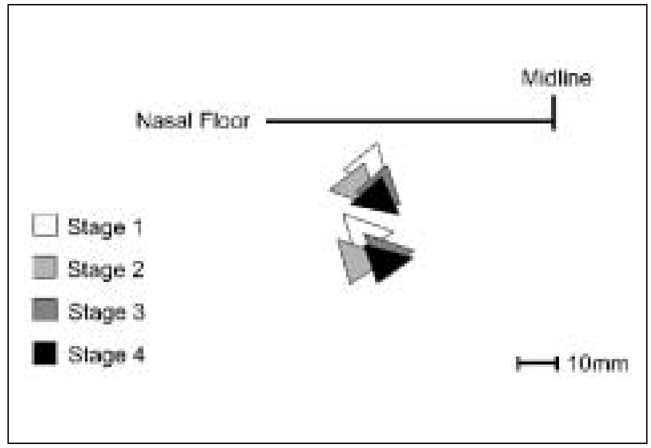

Figure 4. The superimposition of mean positions of the maxillary and mandibular permanent first molars relative to nasal floor and midline on panoramic radiographs.

The shape of the permanent first molars was shown with the triangle that three points of the most convex points at mesial surface, the most convex point at distal surface, and furcation point wear connected with.

ographs in mandibular permanent first molars. The amounts of angular change in both maxillary and mandibular permanent first molars between each stage on panoramic radiographs were almost fixed.

On cephalometric radiographs, however, the amount of angular change was remarkable between stage 3 and 4 in maxillary permanent first molars and between stage 2 and 3 in mandibular permanent first molars. The angles were about 80 degrees at stage 4 for both maxillary and mandibular permanent first molars.

There were vertical positional changes and mesial shift of the permanent first molars from stage 1 to 4 (Figures 4 and 5). In vertical direction, the positional changes of the permanent first molars were remarkable from stage 1 to 2 and from stage 3 to 4 on both panoramic and cephalometric radiographs. In horizontal direction, the superimposition on midline and nasal floor (Figure 4) showed that the permanent first molars closed to midline from stage 2 to 3 and the superimposition on posterior nasal spine (PNS) and nasal floor (Figure 5) showed that the permanent first molar was far away from maxillary tuberosity from stage 3 to 4.

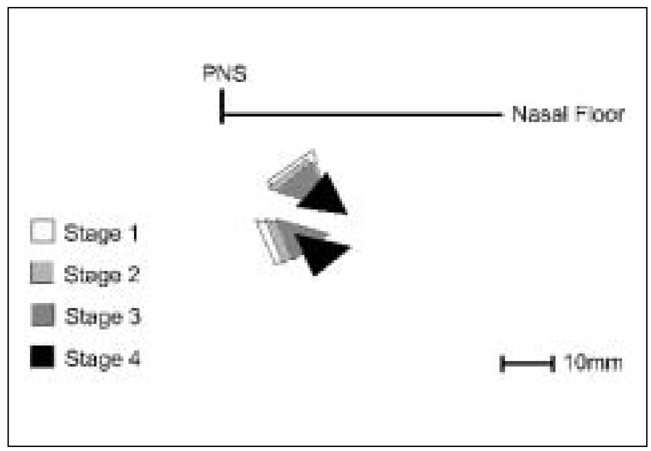

Figure 5. The superimposition of mean positions of the maxillary and mandibular permanent first molars relative to nasal floor and PNS on cephalometric radiographs.

The shape of the permanent first molars was shown with the triangle that three points of the most convex points at mesial surface, the most convex points at distal surface, and furcation point were connected with.

DISCUSSION

This study questions the use of the lateral cephalometric radiograph only, where the first molars are superimposed on each other. The lateral cephalometric radiograph may be an aid in this procedure, but one needs other types of radiographic films that will show the individual tooth and its relationship to the contiguous parts. Therefore, a comparison was made between measurements made directly from cephalometric radiographs and measurements made from panoramic radiographs of the same child. For measurements on panoramic radiographs, the position of the points seemed easier to determine but distortion may occur, depending on the orientation of the head in the apparatus. In clinically acceptable panoramic radiographs, the variation in head tilting affecting the molar mesiodistal angulation was estimated not to exceed 5 degrees.[4,5]

Previous investigations found that there is a strong tendency for mandibular third molars to become more upright during the course of development,[6-10] and if space is available this should lead to eruption of the third molars. A theory of differential root growth, the mesial root dominating when the third molar uprights, and distal root dominance causing increased mesial inclination has been advanced.[10] The gradual upright of the first permanent molars in this study may be due to movement of the first molar itself or/and due to development of the teeth distal to the first molar. The changes in mesiodistal angulations of the first permanent molars were clearly on the panoramic radiographs in comparison with the cephalometric radiographs in this study.

Sinclair and Little[11] examined 65 untreated normal occlusions and revealed a consistent trend toward a decrease in arch length in the mixed dentition to early adulthood. This study also found the gradual mesial shift of the first permanent molars from early mixed dentition to early permanent dentition. During growth of the maxilla, space to accommodate the erupting first, second, and third molars must be created by growth in the posterior region of the tuberosity. The maxillary growth in this area must normally be downward and forward to create room for the eruption of each succeeding molar. An early growth disturbance in the posterior part of the maxilla may lead to local crowding in this segment, thereby forcing the permanent molar to erupt in a more mesial direction.

The mesial shift of the permanent first molars in this study was remarkable from stage 2 to 3 on panoramic radiographs and from stage 3 to 4 on cephalometric radiographs. At stage 2, the stage that permanent canines and premolars are emerging, the first permanent molars drift mesially when the leeway space exists. At stage 3, the stage that permanent second molars are emerging, the first permanent molars drift mesially by eruption force of the permanent second molars.

The growth of the alveolar process usually depends on eruption of the teeth. Schudy[12] related dental distoclusion or mesioclusion to mandibular rotation. He suggested that the “vertical drift” of the maxillary and mandibular molars is responsible for the vertical growth of the jaws. This concept of “vertical drift’’ was further modified by Enlow,[13] who differentiated it from dental eruption.

He stated that the amount of ‘’vertical drift’’ could vary considerably among different individuals having different facial types as well as between the anterior and posterior parts of the dental arch. The remarkable vertical positional changes of the permanent first molars from stage 1 to 2 in this study may be due to the vertical drift because the permanent first molars attained eruption in early mixed dentition. And the remarkable vertical positional changes of the permanent first molars from stage 3 to 4 in this study may be due to eruption of the permanent second molars.

REFERENCES

1. Angle EH. New system of regulation and retention. Dent Register 41: 497-603, 1887.
2. Friel S. Occlusion, observations on its development from infancy to old age. Transactions of the First International Orthodontic Congress 138-157, 1926.
3. Baume LJ. Phylogenetic tooth migration and its significance for the development of occlusion. I. The biogenetic course of the deciduous dentition. II. Biogenesis of accesional dentition. J Dent Res 29: 123-132, 331-337, 1950.
4. Tronje G, Welander U, McDavid WD, Morris CR. Image distortion in rotational panoramic radiography. III. Inclined objects. Acta Radiologica: Diagnosis 22: 585-592, 1981.
5. Bjerklin K, Kurol J. Ectopic eruption of the maxillary first permanent molar: etiologic factors. Am J Orthodont 84: 147-55, 1983.
6. Bjork A Skieller V. Facial development and tooth eruption. An implant study at the age of puberty. Am J Orthodont 62: 339-83, 1972.
7. Richardson ME. Development of the lower third molar from 10 to 15 years. Angle Orthodont 43: 191-3, 1973.
8. Richardson ME, Dent M. Some aspects of lower third molar eruption. Angle Orthodont 44: 141-5, 1974.
9. Svendsen H, Malmskov O, Bjork A. Prediction of lower third molar impaction from the frontal cephalometric projection. Euro J Orthodont 7: 1-16, 1985.
10. Richardson M. The development of third molar impaction and its prevention. Internat J Oral Surg 10(Suppl 1): 122-30, 1981.
11. Sinclair PM, Little RM. Maturation of untreated normal occlusions. Am J Orthodont 83: 114-23, 1983.
12. Schudy JJ. The rotation of the mandible resulting from growth: Its implications in orthodontic treatment. Angle Orthodont 35: 36-50, 1965.
13. Enlow D. Handbook of facial growth, Philadelphia, WB Saunders Company, 1975.