A Comparison of Two Mandibular Reference Planes

W. H. Feasby, D.D.S., F.R.C.D.

Radiographic studies of eruption of mandibular teeth are facilitated by stable planes of reference. This study is a comparison of two such planes, one suggested by Brodie[1] and the other employing landmarks described by Björk.[2]

The lower border of the mandible and its tangent, the mandibular plane, were considered to be stable by Brodie.[1] He stated that there was "very little addition—made at the lower border. Thus it seems legitimate to superpose on the lower and posterior borders—." Enlow[4] has cast some doubt on the stability of the lower border of the mandible when he demonstrated resorption in the area of the angle.

Björk,[2] using metallic implants in a serial study of forty-five boys, showed that the lower border of the mandible is unsuitable as a reference line. He suggested that lateral radiographs should be superimposed so that the tip of the chin and the following three internal structures are made to coincide as far as possible:

(1) The inner cortical structure of the inferior border of the symphysis.

(2) Detailed structures of the mandibular canal.

(3) The lower contour of the molar germ from the time mineralization of the crown is visible until the roots begin to form.

Björk explained that there was a definite thickening of the cortical layers of the lower border of the symphysis with growth but that the process occurs through periosteal deposition on the inferior surface. The orientation of the radiographs in relation to the tooth germs is based on the observation—"that from the onset of mineralization of the crown to the time the roots start to develop the lower border of the germ is apparently stationary."[2]

The vertical stability of the molar crypt is of particular significance because it provides a reference point that can be compared to the mandibular plane. Orban,[7] in an extensive histologic study of human material, found that "the deepest point of a tooth germ remains at its original place" and that the tooth crypt does not move apically. Thomas,[8] in a histologic study of humans and rats and in a radiographic study of humans, confirmed that the follicle does not migrate during intraosseous development. Gwinnett[5] reviewed human and feline material and could find no evidence of resorption of the lower contour of the molar crypt. In fact, his evidence suggested apposition occurring from cap stage onward. O'Brien et al.[6] in a histologic study of rats found that from twenty-one days insemination age to five days postnatal (prior to root formation) there was no resorption of the inferior border of the crypt but varying degrees of apposition. Dienstein,[3] in a histologic study of rat mandibles, confirmed the finding that the base of the crypt does not move downward. All of the cited authors confirm that the crypt does not move apically or toward the mandibular plane. While some (Gwinnett, O'Brien, and Dienstein) suggest slight occlusal movement of the base of the crypt.

Method

The serial cephalometric records of the Burlington Orthodontic Research Centre were used as the data source.

Of 119 boys with annual records from age three to fourteen years, thirty were selected at random. Bilateral structures were corrected to the midplane by constructing a new tracing midway between. Only two of Björk's landmarks could be found routinely, namely, the inner cortical structure of the inferior border of the symphysis and the lower contour of the molar crypt. The lower contour of the second permanent mandibular molar crypt was available from age three or four years to age seven or eight years while the third molar crypt was usually available from nine to fourteen years. The inner cortical structure at the symphysis was traced along with the cusp tip of the canine, the buccal cusp tips of the first and second premolars, and the mesiobuccal cusp tip of the first permanent molar.

Tracings were completed from the first and last annual record available for each molar crypt landmark. It is important to note that the useful time range for the second and third molar did not overlap.

A tangent was constructed touching the lower contour of the molar crypt (posterior landmark) and the inner cortical structure at the symphysis (anterior landmark). The tracings were then grouped in two pairs for each papient, one pair composed of the tracings using the second permanent molar crypt (n=30) and one pair of tracings that employed the third molar crypt (n=27). Each pair of tracings was then superimposed on the above tangent with registration on the internal cortical structure at the symphysis (Fig. 1).

In order to quantitate the changes in the position of the inferior border of the mandible in both an angular and linear manner, two additional steps were taken. First, a second reference plane (mandibular plane) was constructed tangential to the lower border of the mandible. The angle between

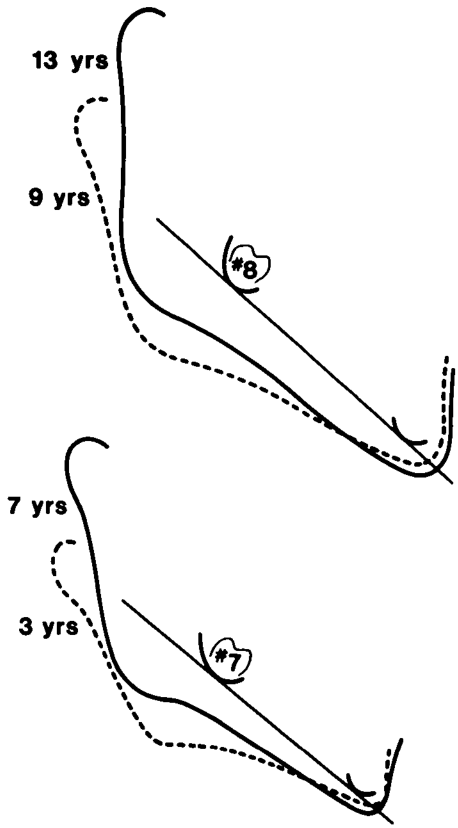

Fig. 1

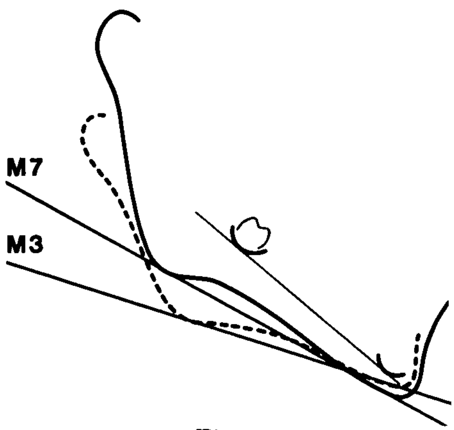

Fig. 2

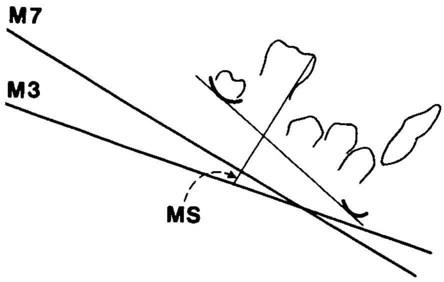

Fig. 3

these two tangents (M3-M7, Fig. 2) was measured to the nearest degree. The mean annual rotation of the mandibular plane for each patient, using both crypts, was determined. Secondly, a perpendicular was constructed from the tip of each cusp in the second tracing to the appropriate mandibular plane and extended to the other mandibular plane of the superimposed pair. The distance between the two planes on this line was measured to the nearest 0.1 mm (MS Fig. 3). The mean annual shift subjacent to each tooth was determined for each patient using both posterior landmarks.

Findings

1. In each superimposition with registration on the internal cortical structure at the symphysis, the lower border of the molar crypts coincided.
2. In every pair of tracings and with both reference points there was an upward transposition of the lower border of the mandible posterior to the first premolar.

The average annual rotation of the mandibular plane relative to the second molar tangent was 2.17° and 1.87° when the third permanent molar was used as a reference (Table I). The mean linear change per year, below each of the four mandibular permanent teeth, is shown in Table II. It should be noted that the linear measurements may be interpreted as an upward movement of the mandibular plane in seven of the eight measures presented. The single exception (0.03 mm) cannot be interpreted as different than zero.

Discussion

The validity of the observations reported here depends on the behavior of

TABLE I
Mandibular Plane Rotation
Mean Annual Rotation

Landmark	Mean	S.D.	n
Second Molar Crypt	—2.17°	0.67°	30
Third Molar Crypt	—1.78°	0.70°	27

A negative sign indicates upward rotation of the distal portion of the mandibular plane such as M3-M7 in Fig. 2.

TABLE II
Mandibular Plane Rotation
Mean Annual Change Related to Mandibular Teeth

Landmark	Second Molar Crypt n=30		Third Molar Crypt n=27	
Shift Subjacent to:—	Mean (mm)	S.D.	Mean (mm)	S.D.
Canine	+0.03	0.05	—0.06	0.15
First Premolar	—0.13	0.17	—0.19	0.15
Second Premolar	—0.36	0.17	—0.36	0.15
First Molar	—0.60	0.22	—0.42	0.21

A negative sign indicates upward movement of the mandibular plane such as a decrease in MS in Fig. 3.

the molar tooth crypt used as a posterior landmark. Since the mesiodistal stability has been demonstrated, the movement of concern is in the vertical vector. An upward movement of the crypt would indicate a rotation of the mandibular plane even more rapidly than observed. On the other hand, a downward movement of the crypt could account for the observation shown in Figure 1. However, Björk, who used four metallic implants in the mandible, reported the relative stability of the inferior border of the molar crypt. His statement that "the germ is apparently stationary—from the onset of mineralization of the crown to the time when the root starts to develop. . . ." has not been challenged by histologic or radiographic evidence. In fact, studies by Dienstein, Gwinnett, O'Brien, Orban, and Thomas supported Björk's view. The observed change in the mandibular plane could be attributed to resorption of the lower border of the mandible. This concept was supported by the histologic studies of Enlow[4] which demonstrated resorption of the inferior border of the mandible in the area where this study indicates a shift occurred.

The available evidence therefore indicates a resorption of the inferior border of the mandible from approximately the first premolar area to the angle. All growth data measured from the mandibular plane are in error by the amount by which the mandibular plane shifts. More accurate growth data in the vertical vector such as the eruption of mandibular teeth could be obtained by adding the mean annual shift value shown in Table II when the lateral exposure is employed.

Summary

Changes at the inferior border of the mandible from three to fourteen years relative to molar crypts were studied on lateral cephalograms obtained from thirty boys in the Burlington Orthodontic Research Centre serial sample. Pairs of tracings of the mandible obtained at four to five yearly intervals were superimposed on a tangent to the inferior border of the last molar crypt until root formation began (second and third permanent mandibular molars) and the inner cortical surface of the symphysis.

It was found in each superimposition with registration on the inner cortical structure at the symphysis that the lower borders of the molar crypts coincided. In every pair of tracings and with both crypts, there was an upward transposition of the lower border of the mandible posterior to the first premolar. The average annual rotation of the mandibular plane was 2.17° when the second permanent molar crypt was used as a reference and 1.87° when the third permanent molar crypt was employed. The mean annual upward shift of the mandibular plane subjacent to the canine first and second premolars and first permanent molar ranged up to 0.6 mm.

Conclusion

A cephalometric study of the mandibles of thirty boys showed that the mandibular plane rotates upwards between age 3 and 14 years at the rate of approximately 2° annually when compared to internal landmarks that have been validated by histologic and implant studies. Evidence was presented to show that the rotation is due to resorption of the inferior border of the mandible in the region posterior to the first premolar.

Faculty of Dentistry
University of Western Ontario
London, Canada

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BIBLIOGRAPHY

1. Brodie, A. G. The growth pattern of the human head from the third month to the eighth year of life. *Am. J. Anat.*, 68:209-262, 1941.
2. Björk, A. Variations in the growth pattern of the human mandible: Longitudinal radiographic studies by the implant method. *J. Dent. Res.*, 42:200-411, 1963.
3. Dienstein, B. Tooth development and eruption II biometric analysis of the histologic relationship of the root of the mandibular first molar of the rat in growth and eruption to the lower border of the mandible. *J. Dent. Res.*, 35:479, June 1956.
4. Enlow, D. H. and Harris, D. B. A study of the postnatal growth of the human mandible. *Am. J. Orthodont.*, 50:25-50, Jan. 1964.
5. Gwinnett, A. J. Personal communication.
6. O'Brien, C., Bhaskar, S. N., and Brodie, A. G. Eruptive mechanism and movement in the first molar of the rat. *J. Dent. Res.*, 37:467-484, June 1958.
7. Orban, B. Growth and movement of tooth germs and teeth. *J.A.D.A.* 15: 1004, June 1928.
8. Thomas, N. R. The process and mechanism of tooth eruption. Ph.D. Thesis, Dept. of Dental Medicine, Univ. of Bristol, Sept. 1965.