DOI: 10.2478/aoj-1996-0003

MESIAL MIGRATION OF LOWER MOLARS IN RELATION TO FACIAL GROWTH AND ERUPTION

Author:
Margaret E. Richardson, M.Dent., Sc.D.Orth.[1]

Mesial migration of teeth in the buccal segments is a well recognised phenomenon in the human dentition. Its aetiology is not fully understood. It has been suggested that it is, to some extent, dependent on growth changes in the lower face.

The purpose of this investigation was to examine mesial movement of first molars in the intact lower arch in relation to the amount and direction of facial growth and eruption of teeth.

Mesial migration of lower first molars between 13 and 18 years was measured on 60 degree cephalograms of 22 males and 29 females with intact lower arches. Correlation analyses were used to examine the relation between mesial migration and tooth eruption, growth changes in mandibular length and anterior face height and direction of growth.

There was, on average, forward movement of first molars of 2.0 - 3.0mm and eruption of 2.0 - 4.0mm. No relation was found between forward movement of first molars and their eruption or the amount and direction of facial growth.

Key words: Mesial migration, facial growth, eruption

Aust Orthod J 1995; 14: 87-91

Received for publication, November 1994.
Accepted, March 1995.

1 Associate Specialist Orthodontist
Department of Orthodontics
The Royal Hospitals
School of Dentistry
Northern Ireland

Introduction

Mesial migration of human teeth has been recognised since the late 18th century when John Hunter[1] described the forward movement which occurred following loss of a first permanent molar.

Friel[2] presented evidence based on Brash's[3] madder feeding experiments on pigs and Broadbent's[4] serial radiographic studies of facial development together with clinical evidence to support the concept that all teeth migrate in a mesial direction.

Continual mesial migration to maintain tooth contact was demonstrated by Begg[5] in the attritional dentition of Australian Aborigines of the Stone Age era. He claimed that it was a normal physiological phenomenon which, in the absence of approximal attrition, could produce malocclusion. Later investigations suggest that mesial migration takes place even in the absence of attrition. Bjork *et al*[6] noted marked forward migration of first molars of 8.0mm between 7 and 18 years in a modern Australian Aboriginal dentition without attrition. They claimed that it was an important factor in providing space for alignment of third molars and that it caused the lower incisors to become crowded.

Picton[7] reviewed methods of studying tooth migration in man and other mammals and concluded that: "drift occurs when a sustained disturbance is produced in the balance of forces acting on a tooth and will continue until a new balance is established".

Moss[8] reviewed the theories relating to the aetiology of tooth migration. He claimed that the evidence was inconclusive in support of the theories of the anterior component of the force of occlusion, the horizontal component of eruption, the mesial vectors of muscular contraction on mesially inclined teeth and the eruptive force of developing molars, and that contraction of the trans-septal fibre system of the periodontal ligament may be of considerable importance.

Bjork and Skieller[9], in an implant study of nine boys, found a mean forward migration of lower first molars of 5.2mm between 7 and 20 years, which was associated to some extent with a forward direction of condylar growth.

Stephens and Houston[10], using spontaneous lower first premolar space closure as a measure of mesial migration of posterior teeth in a small group of 13 subjects, concluded that this movement is, at least, partly dependent on growth changes in the lower face.

The purpose of the present investigation was to examine mesial migration of lower molars in the intact lower arch in relation to the amount and direction of facial growth and eruption of teeth.

Material

Twenty-two males and 29 females were recorded with 90-degree left lateral and 60-degree left and right lateral standardised cephalometric radiographs soon after eruption of second permanent molars, when their average age was 13 years (range 11.8 - 13.5 years), and again five years later.

Both lower third molars were present in all subjects. The sample included mixed facial types with some degree of malocclusion: Class I or slight Class II with mild to moderate crowding.

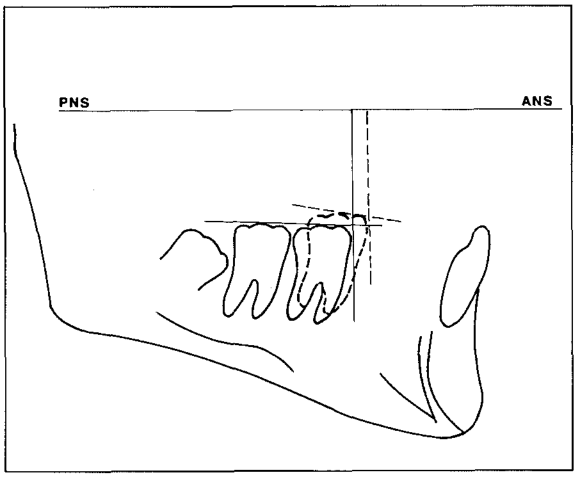

Figure 1. Measurement of mesial drift of the lower first permanent molars on a 60 degree cephalogram with a tracing of the first radiograph superimposed on the second, registering on internal mandibular structures (inner outline of mandibular symphysis and inferior dental canal.) Solid line - first film. Broken line - second film. ANS = anterior nasal spine. PNS = posterior nasal spine.

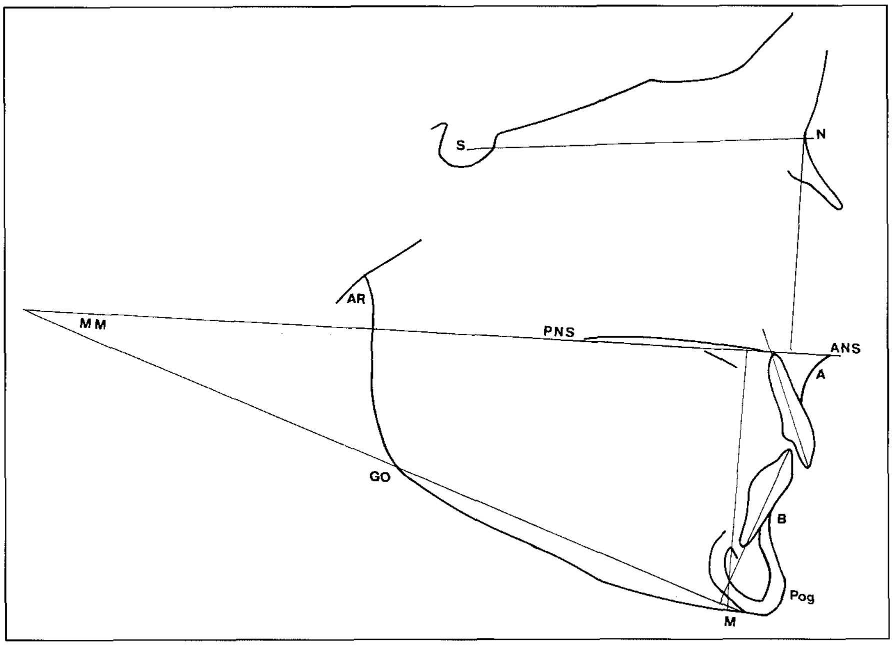

Figure 2. Landmarks used in the measurement of anterior face height (NM), mandibular length (AR-Pog) and Maxillary-Mandibular planes angle (MM) on 90-degree lateral cephalogram. N = nasion, M = menton, A = articulare, Pog = pogonion, Go = gonion, ANS = anterior nasal spine, PNS = posterior nasal spine. Maxillary plane = ANS-PNS, Mandibular plane = Go-M.

None had extractions or mechanical orthodontic treatment in the lower arch. Most had some simple treatment in the upper arch to align canines or incisors, or to correct an overjet.

Measurements

On 60-degree left and right cephalograms

The change in antero-posterior position of the lower first molars (CMol) was measured as the difference between projections of the mesial contact points of the first molars on to the maxillary plane (ANS-PNS) of the first film; with a tracing of the first film superimposed on the second registering on internal mandibular structures (the inner outline of the mandibular symphysis and inferior dental canal) (Fig. 1) (Richardson[11]). Positive values indicated forward movement.

Eruption of the lower first molars (EMol) was measured as the distance between the occlusal surfaces of the first molars on the same tracing superimposed as above (Fig. 1). If the two occlusal surfaces were not exactly parallel, an average between the mesial and distal separation was used.

On 90-degree left lateral cephalograms

Anterior face height, from Nasion to Menton (NM) perpendicular to the maxillary plane, mandibular length, from Articulare to Pogonion (ArP) and the angle between the Maxillary and Mandibular planes (MM) (Fig. 2) were measured on tracings of both radiographs and the changes (CNM, CArP and CMM) calculated. Positive changes indicated increased dimensions.

The change in direction of mandibular growth was measured as the change in the angle Nasion Sella Gnathion (CNSGn) with a tracing of the first radiograph superimposed on the second, registering on the anterior cranial base (de Coster's line) (Figure 3). Positive values (that is, increase in the angle) indicated more downward, as opposed to forward, direction of growth.

Mandibular growth rotation was measured as the change in angulation of SN, with a tracing of the first film superimposed on the second, registering on internal mandibular structures[12] (Fig. 4). Positive values indicated forward rotation.

All measurements were repeated after an interval of at least one month. If the discrepancy exceeded 0.5mm or 0.5 degrees, a third reading was made and the aberrant measurement discarded. The mean of the two closest measurements was used in calculations.

Statistical Analysis

Means and standard deviations for the change in each measurement and for males and females were calculated. Differences between males and females were tested with the independent samples t-test. The significance of the changes was tested with the paired samples t-test.

Correlation analyses were used to examine the relation between the change in first molar position (CMol) and the changes in all the other variables. Separate analyses were performed for left and right sides for males and females. Significance was set at the five per cent level.

Results

There was, on average, significant forward movement of lower first molars (CMol) of 2.5 - 3.0mm in males and 1.6mm in females; and eruption (EMol) of 4.0mm in males and 2.0mm in females. Anterior face height (CNM) increased 12.5mm in males and 6.5mm in females; and mandibular length

Table 1. Means and standard deviations for the changes in variables between 13 and 18 years.

		Males Mean	(n=22) SD	Females Mean	(n=29) SD	Diff M-F
CMol (mm)	L	2.94[3]	1.80	1.63[3]	0.86	1.30[2]
	R	2.52[3]	1.35	1.59[3]	1.35	0.93[1]
EMol (mm)	L	3.86[3]	1.48	2.36[3]	1.25	1.50[2]
	R	4.00[3]	1.60	2.22[3]	1.35	1.78[3]
CNM (mm)		12.49[3]	4.40	6.53[3]	3.56	5.95[3]
CArP (mm)		11.96[3]	3.83	7.23[3]	3.76	4.22[3]
CMM (degrees)		-0.61	2.29	-1.44[2]	2.66	0.83
CNSGn (degrees)		0.11	2.18	0.32	2.12	-0.21
Rot (degrees)		3.24[3]	2.76	2.44[3]	3.04	0.80

1 = P<0.05   2 = P<0.01   3 = P<0.001

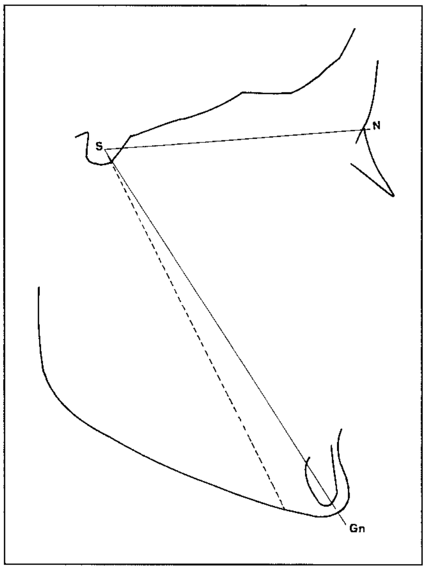

Figure 3. Measurement of the change in Nasion-Sella-Gnathion angle (NSGn) on 90 degree lateral cephalogram with a tracing of the first radiograph superimposed on the second registering on the anterior skull base (de Coster's line).
S = sella, N = nasion, Gn = gnathion.

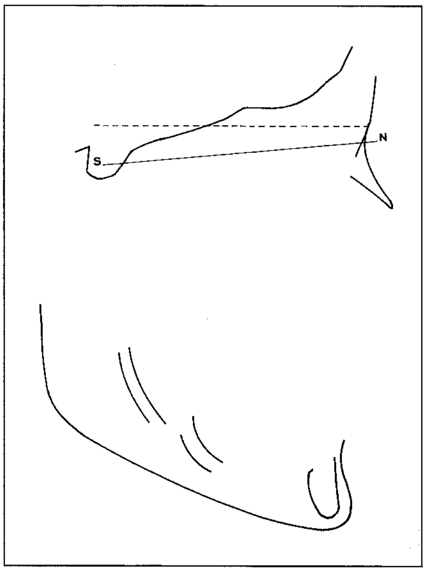

Figure 4. Measurement of mandibular growth rotation on 90 degree lateral cephalogram as the change in angulation of S-N with a tracing of the first radiograph superimposed on the second registering on internal mandibular structures (inner outline of mandibular symphysis and inferior dental canal12).
Solid line - first film
Broken line - second film.

(CArP) 12.0mm in males and 7.0mm in females. There was a non-significant average decrease in the angle of maxillary/mandibular planes (CMM): -0.6 degrees in males and a significant decrease -1.0 degrees in females. There was no significant change in the Nasion-Sella-Gnathion angle (CNSGn). Significant forward rotation of the mandible (3.0 degrees in males and 2.0 degrees in females) was found. With the exception of CMM, CNSGn and rotation (Table 1), the changes in all dimensions were significantly greater in males.

With the exception of the change in the angle of the maxillary/mandibular planes (CMM) on the left side in females (r=0.45 P<0.05), no significant correlations between the change in lower first molar position (CMol) and the other variables were found. Molar eruption (EMol) was significantly correlated with the change in anterior face height (CNM, left r=0.5 P<0.5 males, 0.6 P<0.001 females; right r=0.6 P<0.001 females). The change in anterior face height (CNM) was significantly correlated with the change in mandibular length (CArP r=0.5 P<0.01) and the change in the Maxillary/Mandibular planes angle (CMM r=0.4 P<0.5 females) (Tables 2 and 3).

Discussion

The average forward movement of lower molars of 2.0 - 3.00mm on each side indicates that mesial drift of buccal teeth commonly occurs in the intact lower arch during the teen-age years. It is not inconsistent with the 5.4mm found by Bjork and Skieller[9], whose sample of boys spanned a longer observation period and included the change-over from the mixed to the permanent dentition; or with the 1.58mm by Stephens and Houston[10] over a two-year observation period in premolar extraction cases.

The absence of significant correlation co-efficients between the change in first molar position (CMol) and the changes in the other variables, suggests that mesial drift is independent of eruption and the amount and direction of facial growth. The correlation between the change in first molar position (CMol) and the change in the Maxillary/Mandibular planes angle (CMM r=0.45 P<0.5) occurring only on the left side in females (Table 2) is of little clinical significance. In a correlation analysis of a number of variables, some will be significant merely by chance. Bjork and Skieller[9] found a significant negative correlation between molar migration and condylar growth direction. Stephens and Houston[10] found significant positive correlations between mesial migration, measured as premolar space closure, and anterior and posterior vertical growth; and a significant negative correlation between mesial migration is greater in the presence of forward rotation of the mandible. The numbers in both these studies were small and, as pointed out by Stephens and Houston,[10] correlation and multiple regression analyses in small samples with related variables may produce spurious results.

Measurements of the amount and direction of growth in the present study are not strictly comparable with those made by Bjork and Skieller[9] or Stephens and Houston[10] and, although the sample

Table 2. Correlation analysis of all the variables – left side.

		CMol	EMol	CNM	CArP	CMM	CNSGn
	M	-0.07					
EMol	F	0.23					
	M	0.21	0.49[1]				
CNM	F	0.26	0.60[3]				
	M	-0.04	0.41	0.50[2]			
CArP	F	-0.10	0.36	0.50[2]			
	M	0.10	0.03	-0.05	-0.01		
CMM	F	0.45[1]	0.15	0.42[1]	-0.10		
	M	0.13	0.11	0.22	-0.23	-0.08	
CNSGn	F	0.15	0.21	0.29	-0.32	-0.28	
	M	0.10	-0.13	-0.30	0.23	0.08	0.31
Rot	F	-0.12	-0.18	-0.12	0.15	0.03	0.14

1 = P<0.05 2 = P<0.01 3 = P<0.001

Table 3. Correlation analysis of all the variables – right side.

		CMol	EMol	CNM	CArP	CMM	CNSGn
	M	0.08					
EMol	F	-0.01					
	M	0.16	0.36				
CNM	F	0.20	0.59[3]				
	M	0.14	0.39	0.50[2]			
CArP	F	-0.02	0.33	0.50[2]			
	M	0.12	0.12	-0.05	-0.01		
CMM	F	0.01	0.52[1]	0.42[1]	-0.10		
	M	0.34	0.11	0.22	-0.23	-0.08	
CNSGn	F	0.33	0.42[1]	0.29	-0.32	-0.28	
	M	0.23	-0.04	-0.30	0.23	0.08	0.31
Rot	F	-0.22	0.06	-0.12	0.15	0.03	0.14

1 = P<0.05 2 = P<0.01 3 = P<0.001

was larger, virtually no significant correlation co-efficients between mesial migration (CMol) and the other variables were found. It must be concluded that the relation between mesial migration and the amount and direction of growth is, at best, tenuous.

Molar eruption (EMol) was significantly correlated with an increase in anterior face height (CNM left, $r=0.5$ $P<0.5$ males, 0.6 $P<0.001$ females; right, 0.6 $P<0.001$ females), an increase in the maxillary/mandibular planes angle (CMM right, $r=0.5$ $P<0.5$ females) and with an increase in the Nasion-Sella-Gnathion angle (NSGn right, $r=0.42$ $P<0.05$ females) (Tables 2 and 3). These findings are consistent with the concept of continued eruption to maintain occlusal contact in response to vertical growth.

Correlations between mesial migration (CMol) and eruption (EMol) were non-significant. Bjork and Skieller[9] claimed that the amount of eruption of first molars was moderately positively correlated with mesial migration; although their correlation co-efficients were not in fact statistically significant. Stephens and Houston[10] reported significant correlations between these two variables. Although the amount rather than the direction, of eruption was measured, some association between eruption and mesial migration might be expected. Non-significant correlations in the present study suggest that mesial migration is not simply due to the mesial component of eruption.

Factors other than those examined in the present investigation may also contribute to mesial migration.

Schwarze[13] measured mesial migration of lower first molars on models of 56 subjects whose third molar tooth germs had been removed and 49 subjects whose third molars were allowed to develop, and found significantly greater mesial drift in the non-extraction group. A similar reduction in mesial drift occurred in 37 subjects treated by extraction of second permanent molars.[14]

Studies on second molar extraction cases[15,16] compared with non-extraction subjects from the same source as the sample used in the present investigation and using the same method, found that mesial migration did not occur. In fact, there was a slight average distal movement of first molars of about 0.5mm in the second molar extraction subjects. This, together with Schwarze's[11,12] findings, suggests that the eruptive force from a third molar, which is removed by early extraction of that molar or by extraction of a second molar, is a more important cause of mesial migration than the amount or direction of facial growth or eruption.

The anterior component of occlusal force, and the mesial vectors of muscular contraction on teeth which are mesially inclined, may also contribute to mesial drift. Contraction of the trans-septal fibre system of the periodontal ligament (to which Moss[8] attributed considerable importance) may be largely responsible for tooth migration when teeth have been extracted or for the maintenance of inter-proximal contact, particularly in the attritional dentition; however, it is unlikely to be a primary cause of mesial drift in the intact arch of modern man.

Other significant correlations in the present study between the changes in anterior face height (CNM) and mandibular length (CArP $r=0.5$ $P<0.01$) and Maxillary/Mandibular planes angle (CMM $r=0.42$ $P<0.05$ females) (Tables 2 and 3) are consistent with mandibular growth and the increase in the angle of the maxillary/mandibular plane, contributing to an increase in anterior face height.

Conclusions

1. Mesial migration of lower molars commonly occurs in the intact arch between 13 and 18 years.
2. Mesial migration occurs independently of tooth eruption and the amount and direction of facial growth.

Acknowledgments

I am very grateful to Dr Chris Patterson for assistance with statistical procedures.

References

1. Hunter J. The natural history of the human teeth. 2nd ed. Johnson: London, 1778:81.
2. Friel ES. Migrations of teeth following extractions. Proc Roy Soc Med 1945; 38: 456-462.
3. Brash JC. The growth of the alveolar bone and its relation to the movements of the teeth, including eruption. Dent Rec 1926; 46: 641-664; 47: 1-26, 175-186.
4. Broadbent BH. Ontogenic development of the occlusion. Angle Orthod 1941; 11: 223-241.
5. Begg PR. Stone age man's dentition with reference to anatomically correct occlusion, the etiology of malocclusion, and a technique for its treatment. Am J Orthod 1954; 40: 298-312.
6. Bjork A, Brown T, Skieller V. Comparison of craniofacial growth in an Australian Aboriginal and Danes, illustrated by longitudinal cephalometric analyses. Eur J Orthod 1984; 6: 1-14.
7. Picton DCA. Tooth movement as mesial drift and lateral drift. Colston Papers 1976; 27: 108-119.
8. Moss JP. A review of the theories of approximal migration of teeth. Colston Papers 1976; 27: 205-212.
9. Bjork A, Skieller V. Normal and abnormal growth of the mandible. A synthesis of longitudinal cephalometric implant studies over a period of 25 years. Eur J Orthod 1983; 5: 1-46.
10. Stephens CD, Houston WJB. Facial growth and lower premolar extraction space closure. Eur J Orthod 1985; 7: 157-162.
11. Richardson ME. late lower arch crowding: Facial growth or forward drift? Eur Orthod J 1979; 1: 219-225.
12. Bjork A. Prediction of mandibular growth rotation. Am J Orthod 1969; 55: 585-599.
13. Schwarze CW. The influence of third molar germectomy - A comparative long term study. Trans Third Int Orthod Cong London 1975: 551-562.
14. Schwarze CW. Nachuntersuchungsbefunde bei patienten mit extraktion zweiter molaren. Fortschr der Kieferorthop 1980; 41: 105-128.
15. Richardson ME. The effect of lower second molar extraction on late lower arch crowding. Angle Orthod 1983; 53: 25-28.
16. Richardson ME, Mills K. Late lower arch crowding: the effect of second molar extraction. Am J Orthod Dentofac Orthop 1990; 98: 242-246.

Address for correspondence and reprints:

Department of Orthodontics
The Royal Hospitals
School of Dentistry
Grosvenor Road
Belfast BT12 6BA
N. Ireland