British Journal of Orthodontics

ISSN: 0301-228X (Print) (Online) Journal homepage: http://www.tandfonline.com/loi/yjor19

A Study of the Mandibular Closure Path in Angle Class III Relationship

John F. Gravely M.Ch.D., D.Orth., R.C.S., L.D.S.

To cite this article: John F. Gravely M.Ch.D., D.Orth., R.C.S., L.D.S. (1984) A Study of the Mandibular Closure Path in Angle Class III Relationship, British Journal of Orthodontics, 11:2, 85-91, DOI: 10.1179/bjo.11.2.85

To link to this article: http://dx.doi.org/10.1179/bjo.11.2.85

British Journal of Orthodontics/Vol 11/1984/85–91

A Study of the Mandibular Closure Path in Angle Class III Relationship

John F. Gravely, M.Ch.D., D.Orth., R.C.S., L.D.S.
Department of Child Dental Health, The Dental School, Clarendon Way, Leeds LS2 9LU

Abstract. A cephalometric study has been made of patients with Angle Class III incisor relationships to discover the extent of any forward displacement of the mandible occurring during closure from the point of initial incisor contact to one in which the posterior teeth occlude. The significance of the findings to the assessment of skeletal pattern is discussed.

Introduction

A feature of Angle Class III malocclusions described by several authors is a deviation in the path of closure variously referred to as an anterior or forward displacement (Brenchley, 1966; Houston and Isaacson, 1980), a mesial displacement (McCallin, 1955), a forward disengagement (Ballard, 1955), a functional protrusion (Hopkin, 1963) and a mandibular slide (Sperry *et al.*, 1977). The supposition is that the normal hinge movement which usually occurs in closing from the resting posture to the position of maximum occlusal contact cannot occur because of premature contact between the maxillary and mandibular incisors. This results in forward displacement of the mandible which disengages the incisor teeth and permits further closure into the position in which the posterior teeth occlude and the incisal edges of the maxillary incisors lie lingual to the lower incisors.

Such displacements often appear to be marked and to exaggerate a skeletal discrepancy (Fig. 1). Appearances can be deceptive, however, and there seems to be some disagreement as to the extent and precise mechanism of the disengagement. Hopper (1955) stated that patients in this category overclose to achieve occlusion between the maxillary and mandibular buccal segments, with the effect that the chin point is carried both forwards and upwards, and from visual examination of temporo-mandibular joint radiographs, he claimed that there was no evidence of any forward displacement of the condyles when the posterior teeth were in occlusion. Mills (1966, 1982) has also questioned the extent to which forward displacements occur during closure and suggested that in cases with large overbites the mandibular heads move backwards during closure, following the disengagement of the premature contact between upper and lower incisors. Thus the forward displacement which occurs immediately after the premature contact is counteracted by a backward displacement during further closure into the Class III incisor position. To support this statement Mills has stated that if a tracing is made from a conventional lateral cephalograph of a case with a large overbite and a Class III incisor relationship, the outline of the mandible can be rotated on a pin placed in the region of the condyle into a position in which the upper and lower incisors are edge to edge; this suggests the absence of any significant forward displacement when the posterior teeth are in contact.

The presence and extent of a forward displacement of the mandible is of clinical importance if an evaluation of a skeletal discrepancy is to be made for patients with Class III incisor relationships, for if displacement is marked it will invalidate any of the conventional cephalometric analyses based on tracings of lateral skull X-rays taken with the posterior teeth in occlusion.

Unfortunately this is not a subject very readily investigated. Comparisons of cephalometric analyses before and after treatment show small increases in angle ANB values during the period of treatment (Mills, 1966; Bennett, 1968; Bryant, 1981). Although this might be partly attributed to elimination of the mandibular displacement, there are other possible causes of this increase such as increases in angle SNA associated with proclination of the upper incisors or to changes in Angles SNA and SNB associated with growth. It is,

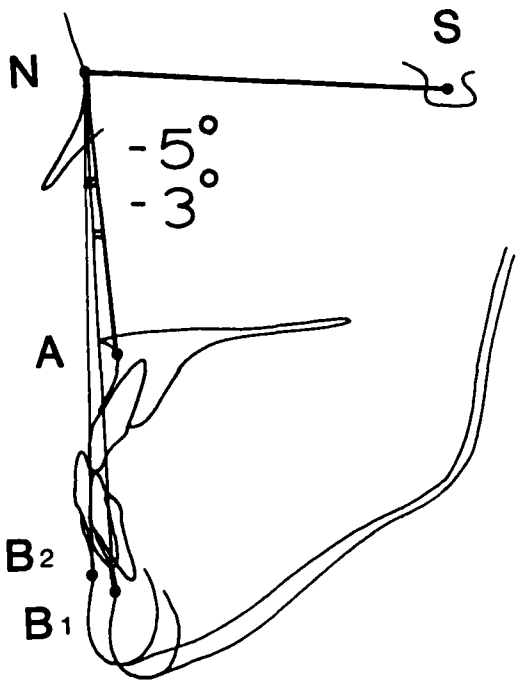

Fig. 1. Tracings of the cephalographs taken of the same patient, the first with the incisors edge to edge and the second with the posterior teeth occluded, superimposed on S–N to show the effect on Angle ANB of closure from position (1) to position (2).

therefore, difficult to draw firm conclusions from such data.

To investigate the path of closure in Angle Class III cases without the problems associated with alveolar changes brought about by appliance therapy or the changes in skeletal pattern which result from growth, an investigation was designed using pre-treatment cephalographs only.

Method and Material

Lateral cephalographs of 50 Angle Class III patients who were able to bring their incisors edge to edge were obtained in two positions: the first in the conventional position with the posterior teeth in occlusion and the second with the maxillary central incisors edge to edge with the mandibular incisors. The radiographs were borrowed from colleagues who had indicated in reply to questionnaires posted to all consultant orthodontists in the UK, that these radiographic views were on occasions used by them. The material is not, therefore, a random sample but is representative of cases referred to consultant orthodontists for advice or treatment and for whom two cephalographs were taken for clinical purposes. None of the radiographs was taken purely for the purpose of the study.

Each radiograph was placed on an illuminated tracing screen and traced on to a high quality tracing paper in the conventional way, after which lines necessary to the investigation were constructed and angular and linear measurements made with a protractor and ruler. Each tracing was repeated on a separate occasion and mean values calculated for the measurements made from each cephalograph, one set from the film with the buccal segments in occlusion, and one for the film taken at the point of initial contact. The differences between estimates of skeletal pattern made from lateral skull radiographs with the posterior teeth in occlusion and those taken at the point of initial contact of the incisors were measured, and the extent to which these differences are due to alterations in vertical relationship or to forward displacement assessed.

To test the hypothesis that the initial forward displacement of the mandible is later counteracted by a backward displacement as closure continues, a further tracing was made for each patient from both tracings of the cephalographs taken with the posterior teeth in occlusion, but the mandibular outline was re-traced after swinging its original outline downwards until the overbite was reduced to zero, using a pin placed at the highest point of the condylar outline as a pivot. Mean values were calculated from the measurements made from these tracings and these were compared with those obtained from re-traced tracings of the cephalographs taken with upper and lower incisors occlusing edge to edge. If the hypothesis is valid, there should be no significant difference between these measurements. Any significant difference is a measure of mandibular displacement.

Results

Table 1 gives the mean values and standard deviations for measurements of the overjet and overbite and for angles SNA, SNB and ANB for the group, measurements having been made of tracings of cephalographs taken both with the posterior teeth in occlusion and with the incisors edge to edge.

With the posterior teeth in occlusion, the mean overjet for the group is about −2·5 mm ranging from approximately −7 mm in one case to approximately −1 mm in four cases; the mean

TABLE 1

Mean linear and angular measurements from cephalographs of 50 patients with Angle Class III malocclusions

	Overjet		Overbite		Angle SNA		Angle SNB		Angle ANB	
	Mean (mm)	S.D.	Mean (mm)	S.D.	Mean (deg)	S.D.	Mean (deg)	S.D.	Mean (deg)	S.D.
Tracings with posterior teeth in occlusion	−2·58	1·229	4·83	2·118	79·19	4·364	83·32	4·036	−4·1	2·921
Tracings with Incisors edge to edge	—	—	—	—	79·15	4·459	80·53	4·137	−1·4	2·464

overbite is about 5 mm ranging from approximately 13 mm in one case to about 1 mm in four cases.

The mean values for angles SNA, SNB and ANB from the cephalographs taken with the posterior teeth in occlusion were approximately 79°, 83° and −4° respectively. The mean value for Angle SNA was also measured from tracings of the cephalographs taken with the incisors edge to edge, and was again found to be approximately 79°, but the mean value for angle SNB was reduced by just under 3° to 80·5°, and angle ANB increased by just under 3° to a little over −1°. These differences in angles SNB and ANB might be due to a forward displacement of the mandible, to a change in position of Point B which is carried upwards and forwards during closure, or to a combination of both. If the difference is entirely due to differences in vertical height, and not to bodily displacement of the mandible, a close correlation must exist between overbite and the differences in both the SNB and ANB values; the greater the overbite the greater the hinge movement between the two positions of the mandible, and the greater the differences between the mean measurements taken from the two cephalographs. To test the association between overbite and the change in the value of angle SNB and in angle ANB when measured on the two types of cephalograph, the coefficient of linear correlation was calculated and found to be 0·65 and 0·67 respectively. These values are both significant at a level of probability of 1 per cent (with values for *t* of 5·987 and 6·272 respectively). These findings confirm that changes in vertical relationship are closely associated with changes in the position of point B as the mandible closes from the position of initial incisor contact to one in which there is a reverse overjet. The correlation between overbite and changes in angle SNB are demonstrated graphically in Figure 2. The fact that this relationship exists does not, of course, preclude the possibility of some forward movement of the mandible occurring as well.

It has been argued that if there is no bodily displacement of the mandible and the differences between angle ANB and in SNB on the two types of cephalograph are due entirely to the hinge movement occurring at the condyle, it should be possible to reproduce the data obtained from the cephalograph taken with the incisors edge to edge from a film taken when the posterior teeth are in occlusion by placing a pin in the region of the condyle, after tracing the cranial base and maxillary complex, and swinging the mandibular

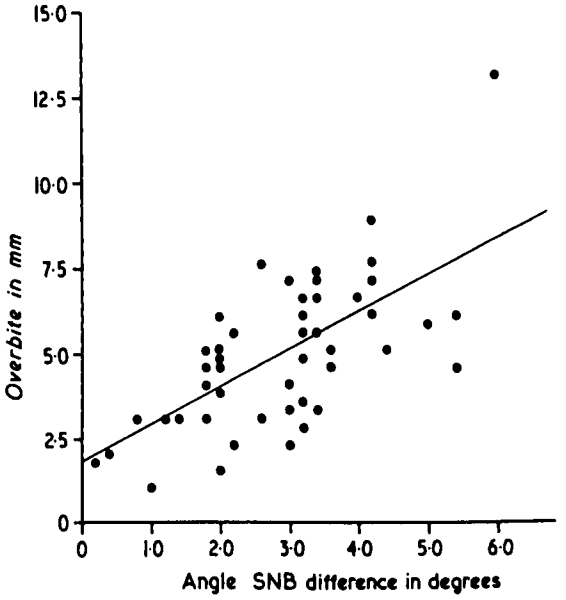

Fig. 2. The relationship between overbite and the difference in Angle SNB measured from tracings in which:
1, the incisors were edge to edge and
2. the posterior teeth were in occlusion and the incisors in a class III relationship.

TABLE 2

Comparison of angles SNA, SNB and ANB from tracings of cephalographs taken with the incisors edge to edge and similar tracings artificially constructed from cephalographs taken with the posterior teeth in occlusion

	Angle SNA		Angle SNB		Angle ANB	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
(1) Cephalometric tracings of patients with incisors edge to edge constructed from tracings of cephalographs taken with posterior teeth in occlusion	79·46	4·357	80·97	3·942	−1·5	2·564
(2) Retraced tracings of cephalographs taken with incisors edge to edge	79·34	4·447	80·57	4·026	−1·2	2·432
(3) The coefficient of correlation when tracings (1) and (2) are compared	0·983*		0·974*		0·933*	

* Significant at the 1% level of probability.

outline downwards until the overbite is reduced to zero before re-tracing the mandible. Tracings have been made in this way from both tracings of each of the 50 cephalographs taken with the posterior teeth in occlusion and mean values obtained for Angles SNA, SNB and ANB. These have been compared with the mean values obtained for each patient from re-traced tracings of cephalographs taken with incisors edge to edge. The findings are given in Table 2.

One would expect the mean value of SNA for the group to be the same whether measured on tracings of cephalographs taken with the posterior teeth occluded or on those in which the upper incisors occlude edge to edge with the lower incisors. Table 2 shows this to be the case, the minor variation being attributable to errors inherent in the method. As expected there is also a high coefficient of linear correlation when a comparison is made of the measurement for each individual. Moreover, if these data are plotted graphically, the slope of the line with the 'best fit' does not differ significantly from 1 (at 0·96 with a value of $t=1·427$) and crosses the y-axis (i.e. when $x=0$) at the point where $y=3·05°$ which again does not vary significantly from zero (with a value for t of 1·483).

If the same analyses are carried out for angle SNB using measurements from the cephalographs in which the incisors occlude edge to edge and those taken from the more conventional view but after swinging the mandible downwards on a pin placed in the region of the condyle, one would expect similar findings if there is no mandibular displacement. If, on the other hand, displacement occurs one would expect to find that the line with the 'best fit' does not pass through the origin of the graph or the gradient of the slope would vary significantly from 1. In fact the mean and standard deviation values for both groups are very similar and the coefficient of linear correlation almost as high as it is for angle SNA.

The vertical displacement of the line with the 'best fit' is greater ($y=4·08°$ when $x=0$) but this is still not significant at either the 1 per cent or 5 per cent levels of probability (with a value for t of 1·599). The slope of this line is 0·95 which deviates rather more from 1 than that for angle SNA (with a value for t of 1·447). Because the mean values of SNB for each group are almost identical, it seems unlikely that these findings indicate the presence of a displacement of the mandible.

Further support for the view that no mandibular displacement persists after the initial disengagement of the incisors is given if the data for angle ANB are analysed. The mean values for Angle ANB and their standard deviations are almost identical in the two groups. The coefficient of linear correlation is again high and the line with the 'best fit' passes almost exactly through the origin of the graph ($y=-0·29°$ when $x=0$) with a slope which does not differ significantly from 1 (i.e. 0·98 giving a value for t of 0·292). These data are shown graphically in Figure 3.

A more sensitive method of analysis is to examine the individual differences between measurements derived from the two sources, one source being the re-traced tracings of cephalo-

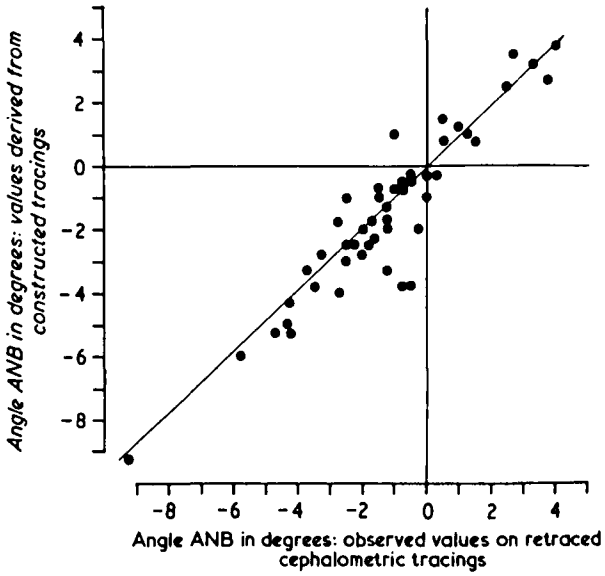

Fig. 3. The relationship between the values of angle ANB from retraced tracings of cephalographs taken with the incisor teeth edge to edge ('observed values') and those constructed from cephalographs taken with the posterior teeth in occlusion but with the mandibular outline pivoted around a point in the region of the condyle until the overbite was reduced to zero ('constructed tracings').

graphs taken with the incisors edge to edge, the other being tracings with the posterior teeth in occlusion re-traced after repositioning the mandible as described. These data are given in the first section of Table 3. As one would expect there is no significant difference in the values of SNA, but a difference is detected in angle SNB (at the 1 per cent level of probability) and in angle ANB (at the 5 per cent level), the mean values of angle SNB, being very slightly larger, and that of angle ANB being very slightly smaller in the artificially constructed tracings than in the cephalographs taken with the incisors edge to edge. This suggests that some residual displacement of the mandible may remain when the posterior teeth are in occlusion although either the amount is very small or the number of individuals affected small, absolute values of the mean difference being only 0·4° for angle SNB and 0·28° for angle ANB.

If mandibular displacement persists in some but

TABLE 3

Comparison of differences in angle SNA, SNB and ANB from tracings of cephalographs taken with the incisors edge to edge and of similar tracings constructed from cephalographs taken with the posterior teeth in occlusion

	n	Angle	Mean difference	t*	Level of significance
Total sample examined	50	SNA	−0·12	1·028	N.S.
		SNB	−0·40	3·062	1%
		ANB	+0·28	2·087	5%
Group with overbite 4 mm or less	18	SNA	−0·31	1·400	N.S.
		SNB	−0·50	2·525	5%
		ANB	+0·19	0·995	N.S.
Group with overbite greater than 4 mm	32	SNA	−0·02	0·116	N.S.
		SNB	−0·34	1·983	N.S.
		ANB	+0·32	1·822	N.S.

* Calculated using the method of differences between pairs.
N.S.—Not significant at the 5% level.

not all patients with a Class III incisor relationship one would expect a relationship to exist between depth of overbite and the extent of displacement. To test this hypothesis the data were examined after various regroupings were made according to the size of overbite, but because the total sample consists of only 50 cases its subdivision results in groups which are too small for satisfactory analysis. However, the data examined in this way does suggest a relationship between size of overbite and displacement.

For example, if the sample is divided into two groups, one consisting of 18 individuals with overbites of 4 mm or less and a larger group of 32 patients with overbites greater than 4 mm, a significant difference in Angle SNB is found (at the 5 per cent level) in the first group but not in the second. These data are shown in Table 3. No significant difference in Angle ANB was found in either group, presumably due to the reduction in the sample size. It should also be noted that in each group the direction of the difference is consistent with mandibular displacement, Angle SNB having a negative value and Angle ANB a positive value.

It would be dangerous to attempt to quantify the effect on Angle SNB or Angle ANB of any residual mandibular displacement from these data alone because the total number of individuals in the survey is small and tracing error in a cephalometric study such as this is high. It would seem, however, that in most cases there can be very little if any displacement present when the posterior teeth are fully occluded. The variation in Angle ANB illustrated in Figure 3 is less than 1° in all but seven cases and the greatest difference is approximately 3°. This may be largely attributable to tracing error but some uncertainty remains because, of the seven cases showing variation greater than 1°, six have a positive value (consistent with displacement) and only one has a negative value.

Conclusions

From the results of the present study it is concluded that:

1. There is little or no residual mandibular displacement in most patients with a Class III incisor relationship when the posterior teeth are in occlusion, forward displacement to disengage the incisors being counteracted by a backward movement of the condyles as further closure takes place.
2. Residual displacement may persist in a few patients, particularly in those with small overbites, but the extent to which this occurs is uncertain.
3. The apparent difference in skeletal pattern between assessments made from cephalographs taken with incisors in the Class III position and those with the incisors edge to edge are closely related to depth of overbite and are a reflection of changes in vertical height rather than to forward displacement of the mandible during closure.
4. In most cases the skeletal pattern is reasonably well reflected in the conventional cephalograph taken with posterior teeth in occlusion and it is questionable whether a second cephalograph taken with the incisors held edge to edge provides sufficient additional information to justify submitting a patient to additional exposure to radiation.

Acknowledgements

I wish to thank several colleagues who took the trouble to meet my request for suitable radiographs to trace, namely Messrs T. G. Bennett, D. E. J. Bowden, J. T. Cook, D. Di Biase, D. B. Johnson, L. J. McBride, J. Metcalf, D. J. Ramsay, Prof. N. R. E. Robertson, Prof. W. C. Shaw and Mr J. K. Williams. To Mr D. Heathcote, Statistical Technician in the Department of Child Dental Health at Leeds, I am grateful for help with tracings and statistical analyses; to Mr C. G. Fairpo, Senior Lecturer in Children's Dentistry for advice; to the Medical Illustrators and Dental Photographic Department, University of Leeds, for the illustrations; and to Miss T. Laycock for typing the manuscript and for clerical assistance.

References

Ballard, C. F. (1955)
A consideration of the physiological background of mandibular posture and movement,
Dental Practitioner, **6**, 80–90.

Bennett, T. D. (1968)
Reinforced occipitomental traction and its effect on the incisor teeth in class III malocclusions,
Dental Practitioner, **18**, 405–412.

Brenchley, M. L. (1966)
Borderline class III cases,
Dental Practitioner, **16**, 233–240.

Bryant, P. M. F. (1981)
Mandibular rotation and class III malocclusion,
British Journal of Orthodontics, **8**, 61–75.

Hopkin, G. B. (1963)
A roentgenographic cephalometric analysis of treatment and growth changes in a series of cases of mesioclusion,
Dental Practitioner, **13**, 394–411.

Hopper, J. (1955)
Preliminary investigation of mandibular guidance in postural class III cases,
Dental Practitioner, **6**, 18–23.

Houston, W. J. B. and Isaacson, K. G. (1980)
Orthodontic treatment with removable applicances (2nd edn),
Bristol: John Wright & Sons.

McCallin, S. G. (1955)
Angle's class III malocclusion,
Dental Practitioner, **6**, 151–164.

Mills, J. R. E. (1966)
As assessment of class III malocclusion,
Dental Practitioner, **16**, 452–465.

Mills, J. R. E. (1982)
Principles and practice of orthodontics,
Edinburgh: Churchill Livingstone.

Sperry, T. P., Speidel, T. M., Isaacson, R. J. and Worms, F. W. (1977)
The role of dental compensations in the orthodontic treatment of mandibular prognathism,
Angle Orthodontist, **47**, 293–299.