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An evaluation of the morphogenic and anatomic effects of the functional regulator utilizing the counterpart analysis

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SUMMARY The 'counterpart' procedure is an 'anatomic' means for determining morphologic and morphogenic conditions and relationships within an individual. Conventional cephalometric planes are not utilized, and population standards are irrelevant. Using lateral headfilms, this procedure analyses goodness-of-fit among regional anatomic parts in order to identify the composite of conditions that underlie facial form and pattern in a given person. The objective of the present study is to determine and evaluate the nature of morphogenic responses of some of these regional relationships in conjunction with treatment by the Fränkel appliance. A sample of 96 Class II division 1 patients receiving functional regulator treatment, and a matched control group of untreated Class II individuals, were analysed. The findings revealed the nature of certain anatomic relationships the aggregate of which had mandibular protrusive results in a majority of the treated individuals. The findings also show that prediction of treatment outcome may be possible through consideration of different Class II craniofacial morphologic types. Of the types studied, based on different combinations of the regional morphologic variables comprising the counterpart analysis, correspondingly different growth changes related to treatment were observed.

Introduction

The 'counterpart analysis' provides a means of determining the nature of certain basic anatomic and developmental relationships throughout the growing craniofacial complex. Using this procedure, conventional cephalometric planes and angles, for the most part, are not relevant, and need for comparisons with population norms or standards is not involved. Rather, key morphologic conditions within each individual person are identified by determining the manner of assembly of actual anatomic components. This provides a basis for evaluating the cumulative composite of regional morphologic factors that underlie the craniofacial pattern in an individual. These anatomic conditions, and different combinations of conditions, are evaluated for a given population sample, treatment group, or control sample. The nature and effects of changes through time are similarly determined and evaluated for individuals, as well as for comparisons of frequency distributions and mean magnitudes within and between groups.

Each regional skeletal part in the craniofacial composite has one or more 'counterparts' with which it fits. If a given part is either horizontally or vertically short or long relative to its counterpart(s), that regional condition can be passed on to have a direct or indirect retrusive or protrusive effect on the mandible or maxilla. The boundaries of the anatomic parts considered in this analytic procedure, significantly, represent major sites of remodelling and displacement (Enlow, 1982). The alignment of parts is also taken into account, because the rotational nature of a part's position either increases or decreases the expression of its vertical and horizontal dimensions. The aggregate of all of the various regional morphologic relationships, then, contributes to the establishment of the particular craniofacial form in an individual child or adult at any given age. Changes in regional relationships reveal the morphogenic pattern associated with progressive development or with treatment.

In the present study, a sample of Class II patients treated with the Fränkel 2 appliance was compared with a matched growth sample of untreated Class II children. The purpose was not to determine efficacy of functional regulator treatment. Rather, the objectives were firstly to determine which of the various anatomic relationships were responsive to this type of orthodontic procedure, and which were unaffected, and secondly to determine if differences occurred in treatment response according to different combinations of these relationships present at the beginning of treatment (i.e., differences according to anatomic variations in facial pattern and type).

Subjects and methods

The treatment sample consisted of 54 female and 42 male Class II, division 1 Caucasian patients, mean starting age of 10 years, 2 months (s.d. 1 year, 8 months), treated with the functional regulator of Fränkel by 8 orthodontists judged to be experienced and competent in this method of treatment. All patients had at least an end-to-end molar or canine relationship. Orthognathic surgery, fixed, or other removable appliances were not used before or during the period analysed. Pre-treatment lateral headfilms were taken within 2.5 months prior to the onset of treatment. Radiographic landmarks were readily identifiable. Satisfactory patient cooperation was a criterion for selection, and appliances were worn for at least 18 hours a day for the first 18 months of the approximately two-year study period. Cases in which headfilms showed a 2 mm or greater distance between the anterior border of the atlas and the closest point on the ramus were not used. Seventy-one of the children had one or more maxillary deciduous teeth present at the start of treatment. Appliances were fabricated according to the principles of Fränkel (1984) and McNamara (1982). The mandible was brought forward 3-5 mm, leaving interocclusal clearance for crossover wires to the lower lingual shield.

The control sample consisted of 41 untreated Class II division 1 individuals from the University of Michigan Elementary and Secondary Growth Study. Records were selected to match the criteria utilized for the treatment sample.

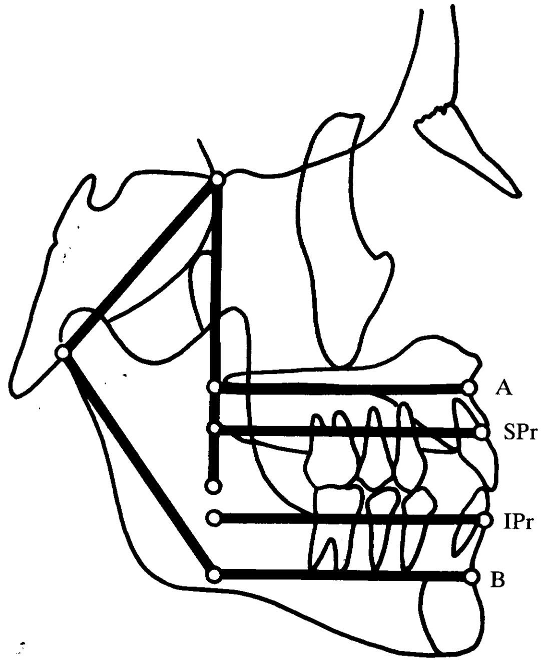


Figure 1 Planes utilized in the counterpart analysis. Bilateral landmarks are averaged. The middle cranial fossa (MCF) is represented by a line from articulare to the intersection of the great wing of the sphenoid with the floor of the basicranium (see also Figure 3). This intersection indicates the anatomic boundary between the middle and anterior basicranial fossae and also the posterosuperior boundary of the nasomaxillary complex. The posterior nasomaxillary vertical plane is a line from the great sphenoidal wing and basicranial intersection inferiorly to the inferior-most point of PTM, thus representing the maxillary tuberosity. This plane is based on the direct anatomic positional and boundary relationship between the anterior cranial fossae and the maxillary complex.

Ramus alignment is determined by a plane extending from articulare inferiorly to constructed gonion. The oblique ramus line shown in Figures 1-4 is intended to illustrate rotational changes of the ramus and mandible as a whole, not the ramus plane just defined for purpose of measurement. Ramus breadth is measured along an extension of the functional occlusal plane from the posterior to anterior borders of the ramus. The horizontal dimension of the middle cranial fossa is measured from articulare to the vertical posterior maxillary line parallel to the functional occlusal plane. Bony maxillary arch length is measured from **A** and SPr points posteriorly to the vertical maxillary plane (posterior maxillary tuberosity) parallel to the functional occlusal plane. Bony mandibular arch length is determined from **B** and IPr (infradentale) points posteriorly to the lingual tuberosity parallel to the functional occlusal plane (Enlow *et al.*, 1971).

The regional anatomic relationships evaluated in this study are briefly reviewed below in conjunction with the findings and also in Figures 1-4.

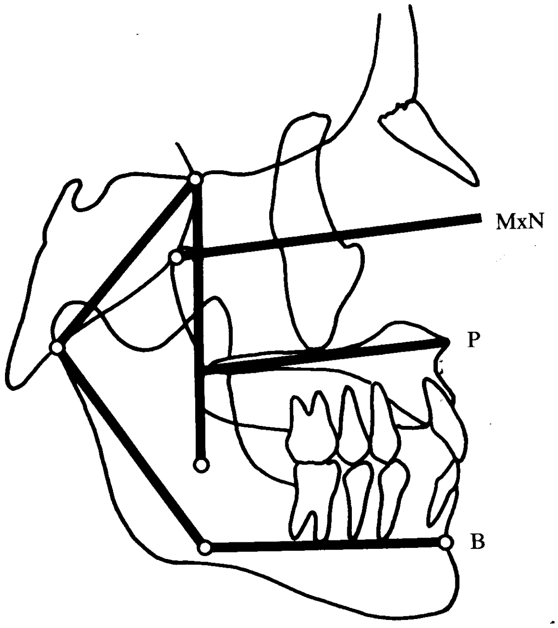


Figure 2 The plane of the maxillary nerve is represented by a line from the foramen rotundum to a point 4 mm above averaged orbitale. The location of this foramen is represented by a point on the posterosuperior aspect (the '10 o'clock' position) of averaged PTM (Ricketts, 1975). Since the maxillary nerve turns downward at the entrance of the infraorbital canal in the posterior part of the orbital floor, the point above orbitale provides an approximation of the nerve's course prior to its entrance into the canal (Enlow, 1983). It is that segment of the nerve which retains an embryonic relationship with palatal position and growth after birth (Moss and Greenberg, 1967). Palatal plane extends from the anterior to posterior nasal spines.

More detailed descriptions of radiographic landmarks, construction of planes, and procedures for evaluating the anatomic parts and alignment of these parts have been presented in a previous report (Enlow *et al.*, 1971). Studies having various other evaluation objectives utilizing this analytic method have been presented (Enlow, 1982; Trouten *et al.*, 1983; Goldberg and Enlow, 1981; Enlow *et al.*, 1982; Bhat and Enlow, 1985).

Anatomic planes that are employed and the morphologic relationships which are analysed are summarized in Figures 1–4. Each of the regional relationships illustrated in Figure 3 has a mandibular retrusive/maxillary protrusive direction of effect (+). Of the regional conditions shown in Figure 4, each has a mandibular protrusive/maxillary retrusive effect (−). The variable nature of the mix among all of these various anatomic conditions with regard to regional directions of change (mandibular protrusive/retrusive) and their magnitudes are determined for each individual. Frequency distributions, mean magnitudes of change, and statistical significance are then determined for the growth-with-treatment group compared to the growth-without-treatment controls.

Awareness of which particular regional morphogenic relationships demontrate a significant response, one way or the other, to a treatment procedure provides essential information helping to understand the biological basis for their modes of action. Knowledge as to which relationships do not respond, further, also contributes to a more complete and meaningful understanding.

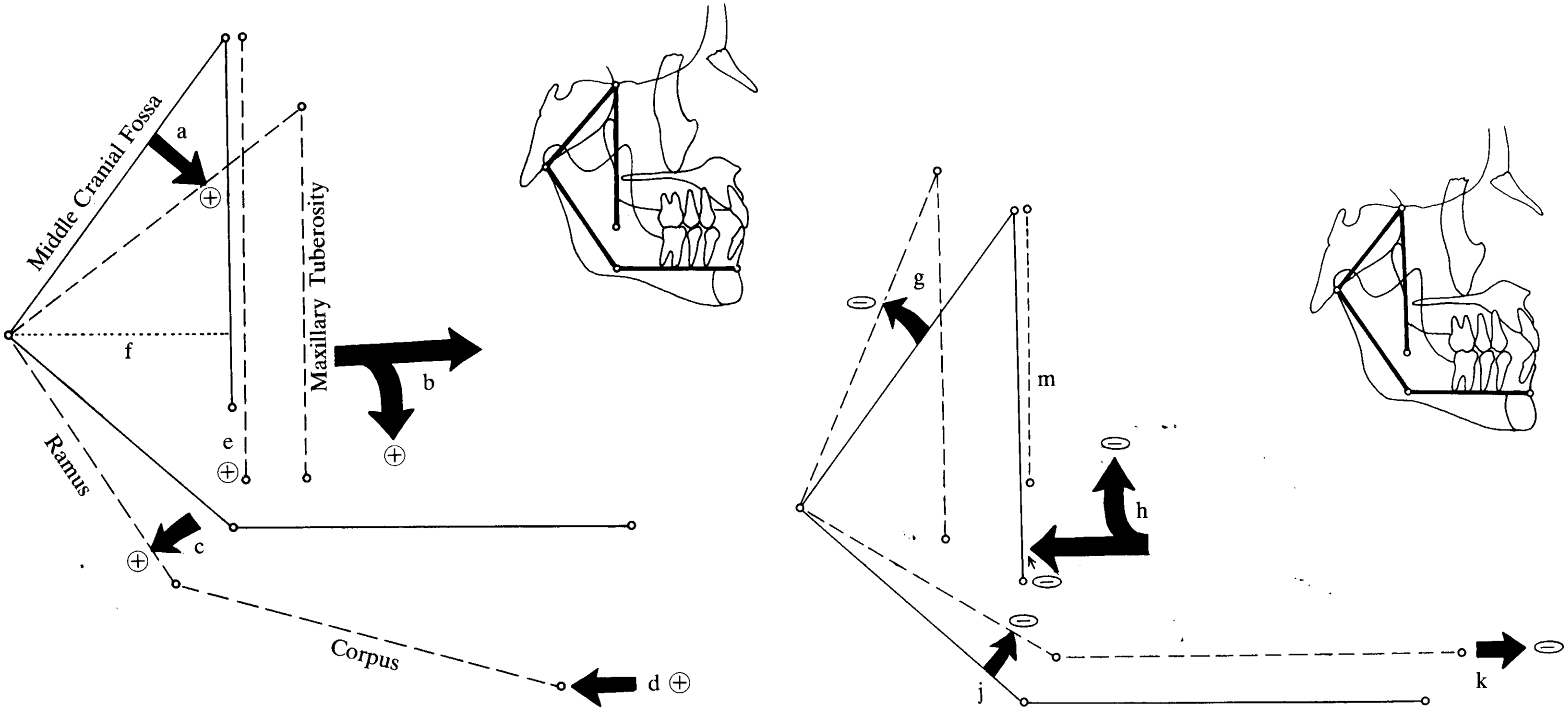
Results

Middle cranial fossae alignment. A forward inclination of the middle endocranial fossae (Fig. 1 and **a** in Fig. 3) establishes two-way movements of the upper and middle versus lower facial components; the maxillary complex becomes more protrusively placed and is also lowered (**b**), and the mandible is rotated in a postero-inferior manner (**c**). The composite result is a mandibular retrusive effect (**d**). This combination frequently occurs in individuals having a dolichocephalic headform (Bhat and Enlow, 1985).

A more vertical alignment of the middle cranial fossae (**g** in Fig. 4) has an opposite, mandibular protrusive effect. The maxilla is placed retrusively (**h**), and the mandible is rotated more anteriorly (**j**). The composite result is mandibular protrusion (**k**). This is a common anatomic combination among individuals having a brachycephalic or a dinaric headform (Bhat and Enlow, 1985).

No significant difference in frequency distribution was found between the control and treatment groups (Table 1). Only a small percentage of individuals in both groups demonstrated any measurable change at all in basicranial alignment during continued growth. Mean magnitudes of change (when such occurred) are very small, measuring one millimetre or less (Table 2).

Ramus compared to middle cranial fossa horizontal dimensions. The postero-anterior skeletal breadth of the pharynx (**f** in Fig. 3) is



Figures 3 (left) and 4 (right) The posterior vertical length of the nasomaxillary complex relative to the vertical length of the ramus/middle cranial fossa is determined by evaluating the latter's rotational positions. If the ramus becomes rotated downward-backward to a greater extent than MCF is rotated forward and downward, the vertical length of the maxilla is 'long', thereby producing the greater extent of mandibular rotation. The magnitude of the horizontal effect on mandibular protrusion/retrusion is determined by measuring the difference between these two rotational changes as expressed along the functional occlusal plane. If the ramus rotates to a lesser extent than MCF, the maxilla is 'short' and is similarly measured. Various other combinations of MCF and ramus rotations demonstrate corresponding nasomaxillary conditions. For example, if the MCF rotates downward but the ramus becomes aligned more upward, the maxilla is relatively short in vertical length. Or, if the MCF rotates upward and the ramus also rotates upward but to a greater extent, the maxilla is likewise vertically short in a relative sense. If both are aligned downward or upward to the same extent, the posterior part of the nasomaxillary complex is thereby 'neutral' in vertical relationship and has no mandibular protrusive or retrusive effects.

The effects of direction and magnitude of ramus rotation on changes in mandibular retrusion or protrusion are determined by direct measurement along the occlusal plane. Alignment effects of middle cranial fossa rotational changes on mandibular position are similarly determined.

Table 1 Percentage changes.

Morphologic relationship	Distribution of mandibular protrusive direction of change		Distribution of mandibular retrusive direction of change		No change distribution		Statistical significance (Chi square)
	Treated sample %	Untreated controls %	Treated sample %	Untreated controls %	Treated sample %	Untreated controls %	
Middle cranial fossa alignment	11	5	9	7	79	88	NS
Ramus/middle cranial fossa relative dimensions	15	15	60	63	25	22	NS
Ramus/corpus alignment (Gonial angle)	57	49	25	34	18	17	NS
Maxillary nerve and palatal alignment	22	24	18	15	60	61	NS
Whole mandible alignment	27	17	24	42	49	42	$p = 0.1$
Curve of Spee	Decreased curve 48	Decreased curve 22	Increased curve 23	Increased curve 59	29	20	$p < 0.01$
Max/Mand bony arches (A and B points)	72	49	10	34	18	17	$p < 0.01$
Max/Mand bony arches (prosthions)	76	34	16	54	8	12	$p < 0.01$
Nasomaxillary vertical length	43	22	19	51	39	27	$p < 0.01$
Aggregate effects (A and B points)	73	37	14	37	14	27	$p < 0.01$
Aggregate effects (prosthions)	80	29	9	37	10	34	$p < 0.01$

Table 2 Mean magnitudes of change.*

	Mandibular protrusion			Mandibular retrusion		
Morphologic alignment	Treated sample	Untreated control	Statistical significance	Treated sample	Untreated control	Statistical significance
Middle cranial fossa Alignment	0.76 (0.33)	1.0 (0.79)	NS	0.98 (0.82)	0.67 (0.29)	NS
Ramus/middle cranial Fossa relative dimensions	2.8 (2.2)	2.3 (2.2)	NS	3.3 (2.2)	3.5 (2.7)	NS
Ramus/corpus alignment (Gonial angle)	2.9 (2.4)	2.9 (2.1)	NS	1.9 (1.9)	1.7 (1.1)	NS
Maxillary nerve and palatal alignment	**	**	—	**	**	—
Whole mandible alignment	1.4 (1.2)	1.1 (0.6)	p = 0.077	1.2 (0.5)	1.4 (0.9)	NS
Curve of Spee	Decreased curve 3.1	Decreased curve 3.8	NS	Increased curve 2.6	Increased curve 2.1	NS
Max/mand bony arches (A and B points)	4.7 (2.9)	3.0 (2.4)	p < 0.01	2.3 (2.4)	2.6 (1.5)	NS
Max/mand bony arches (prosthions)	5.1 (3.1)	3.0 (2.0)	p < 0.001	3.7 (2.7)	2.4 (1.7)	NS
Nasomaxillary vertical length	6.0 (2.8)	1.2 (0.8)	p < 0.0001	1.3 (0.9)	2.0 (0.9)	p < 0.01
Aggregate effects (A and B points)	3.6 (1.9)	1.8 (1.5)	p < 0.0001	1.6 (1.1)	1.8 (1.7)	NS
Aggregate effects (prosthions)	3.5 (1.8)	2.5 (2.3)	p = 0.056	2.2 (1.5)	1.9 (1.3)	NS

* Gonial angles measured for degrees of angular change; all other relationships measured in millimetres. Standard deviations in parenthesis. Statistical significance determined by *t*-test with comparison of z means.

** Protrusive versus retrusive directions of change only are considered (see Table 1).

established by the middle endocranial fossae (and temporal lobes of the cerebrum) and is bridged by the ramus. The ramus is thus an architectural counterpart of the middle endocranial fossa. A ramus that is horizontally broad or narrow relative to the fossa has a corresponding mandibular protrusive or retrusive effect, respectively.

No significant changes were found in ramus breadth relative to the middle cranial fossa in the treatment group compared to the controls (Tables 1 and 2). It is noted, however, that a marked extent of horizontal ramus growth movement ('relocation'; Enlow, 1982) was nonetheless involved, even though the relative breadth of the ramus itself did not increase. This is important, and it relates to a morphogenic process required for the lengthening of the mandibular corpus which necessitates active ramus remodelling. To increase the horizontal corpus dimension, the whole ramus must relocate posteriorly by a remodelling movement of all of its parts. The former anterior part becomes converted by remodelling into an addition for the corpus. Because the corpus was found to lengthen to a greater relative extent and in more treated individuals than among the controls (see below), the entire ramus and its condyle, thus, appear in this way to have been responsive to treatment, or at least unconstrained compared to maxillary growth. The same process of ramus remodelling also contributes directly to vertical adjustments of the ramus which accommodate the changing ramus/vertical maxillary relationship: this is also a significant point.

Ramus-to-corpus alignment. A more obtuse alignment relationship (opening of the gonial angle) increases the overall length of the mandible and thus has a protrusive effect (**j** in Fig. 4). A more closed relationship shortens the mandible and has a retrusive effect. Effects on the opening or deepening of the bite may also occur. The gonial angle was determined at the intersection of a plane from articulare to gonion with a plane from gonion to menton.

Changes in this alignment condition were not significantly different in the treatment group compared to the controls (Tables 1 and 2).

Maxillary nerve/palatal alignment. Alignment of the palate normally closely parallels that segment of the maxillary nerve extending from the foramen rotundum to the entrance of the infraorbital canal in the posterior part of the orbital floor (**MxN** and **P** in Fig. 2; Enlow, 1982). The purpose of this determination is to establish if any marked degree of palatal divergence relative to the nerve existed prior to treatment, or if any significant degree of rotational alignment change occurred after treatment as compared to the controls.

A counterclockwise rotational position of the palate (facing right) relative to the nerve has a mandibular retrusive effect if accompanied by a closing of ramus-to-corpus alignment. A clockwise rotation has a mandibular protrusive effect if accompanied by an opening of the ramus-corpus relationship.

No significant differences in this relationship were found in the treatment group compared to the control group (Table 1).

Whole-mandible alignment. Two principal anatomic factors that contribute to the rotational position of the mandible (independent of ramus-to-corpus gonial angle alignment) are considered in this study. One is middle cranial fossa alignment (described above), and the other is nasomaxillary vertical length relative to the combined height of the ramus and middle cranial fossa (described below). These two factors combine to result in either backward/downward (**c** in Fig. 3) or forward/upward (**j** in Fig. 4) ramus (and whole mandible) rotations and have mandibular retrusive and protrusive effects, respectively.

Treatment group comparison with the controls shows that treatment-related changes in ramus and whole mandibular alignment had a trend toward reduced frequency distribution of a mandibular retrusive effect and an increased distribution for a mandibular protrusive direction of change (Table 1). Although this is less than the statistically highly significant changes seen for some of the other relationships analysed, there does exist an increased spread between the retrusive versus protrusive directions of change. This tendency for an altered anatomic relationship occurred primarily in conjunction with reduced relative midfacial height (or increased ramus/MCF height), since alterations in basicranial alignment were unchanged in the great majority of treated individuals. Mean magnitudes of change were similar to those in control individuals having the same directions of change but with a tendency toward a slightly greater amount of mandibular protrusion in the treated sample (Table 2).

Curve of Spee. Changes in the height of the incisal edge of the lower central incisor above or below the functional occlusal plane were determined.

The dentoalveolar curve represents a compensatory dental adjustment to variations in a composite of different vertical and horizontal nasomaxillary, mandibular, and basicranial skeletal relationships. Vertical drifting of the anterior mandibular teeth contributes to offsetting an anterior open bite that could otherwise result from such regional conditions (Enlow, 1982; Trouten *et al.*, 1983).

A flatter occlusal curve is an anatomic sequela that was found to accompany a mandibular corpus that had become, following treatment, horizontally longer relative to the horizontal size and placement of the maxilla. Also, a midface that had become vertically 'shorter' relative to the ramus/middle cranial fossa (or a ramus that had become relatively 'longer'), together with a forward/upward rotation of the mandible, further contributes to the developmental basis for responsive occlusal flattening when in conjunction with relative mandibular arch lengthening and resultant alteration in the incisor relation.

A significantly greater percentage of individuals showing flattening of the occlusal curve was seen in the treatment group, and a deepening of the curve in the control group (Table 1), although corresponding magnitudes of change were similar (Table 2).

Maxillary compared to mandibular bony arches (A and B points). Determination of the horizontal length of the mandibular corpus from the lingual tuberosity to **B** point compared to the maxillary corpus from the maxillary tuberosity to **A** point reveals whether skeletal arch lengths contribute to the composite basis for either mandibular retrusion or protrusion (Fig. 1).

A significantly increased percentage of

individuals showing a mandibular protrusive direction of change (mandibular arch becoming 'longer' relative to the maxillary bony arch) occurred in the treatment group (Table 1). The controls had a greater frequency of a retrusive direction of change. In the treated group, the mean magnitude of protrusive change was also significantly greater than those individuals in the untreated sample showing mandibular protrusion (Table 2).

Maxillary compared to mandibular bony arches (Superior and Inferior Prosthion). Changes in relative arch lengths as determined from SPr and IPr (infradentale) to the maxillary and lingual tuberosities, respectively, resulted in a significantly increased percentage of treated individuals compared to controls having a mandibular arch that had become longer than before treatment relative to the maxillary arch (Table 1). The mandibular protrusive magnitude of change was also significantly greater in the treatment individuals (Table 2).

Nasomaxillary vertical length. A midface that is vertically long relative to the combined height of the middle cranial fossa and ramus (or a MCF/ramus that is 'short') has a mandibular retrusive effect and thus can contribute to the aggregate of the multiple anatomic conditions underlying a Class II malocclusion (**e** in Fig. 3). Conversely, a nasomaxillary complex that is short relative to the MCF/ramus has a mandibular protrusive effect (**m** in Fig. 4).

A significantly increased per cent of individuals showing a changing direction toward a relative vertically 'shorter' midface (or a relatively 'longer' middle cranial fossa/ramus) occurred in the treatment group (Table 1). The controls, conversely, had a greater frequency distribution with a direction toward mandibular retrusion. In mean magnitude of change, also, the mandibular protrusive changes were significantly greater than in the control group, and the mandibular retrusive magnitude was greater among the controls (Table 2).

It is noted that the ramus remodelling process participates directly in establishing the nature of the vertical maxillary/ramus relationship. This was briefly described in an earlier section, 'Ramus compared to middle cranial fossa horizontal dimensions' in which it was shown that horizontal ramus remodelling simultaneously contributes to vertical relationships as well.

Aggregate effects of anatomic relationships. The cumulative anatomic results of the composite of all the above treatment-affected, regional morphogenic relationships on the position of **B** point relative to **A** point, and IPr relative to SPr, demonstrate a significantly increased frequency of change in a direction toward a more mandibular protrusive relationship in the Fränkel treated group compared to the controls. A much lesser incidence experienced a composite mandibular retrusive direction of change (Table 1). The controls, conversely, showed a greater frequency having a mandibular retrusive direction of developmental change. In the treated group, the magnitudes of mandibular protrusive change were also greater than in the controls (Table 2).

Discussion

Of the morphologic relationships analysed, four were found to be essentially unaffected or the results at least unmeasurable with regard to treatment-affected facial morphogenesis utilizing a functional regulator. However, several other anatomic relationships apparently responded during treatment in a manner that reduced the severity of pre-treatment mandibular retrusion. These relationships included mandibular/maxillary bony arch lengths at both A/B and SPr/IPr, and, significantly, nasomaxillary vertical length relative to ramus/MCF height. A greater incidence of occlusal curve flattening occurred among the treated individuals, and a tendency toward a less backward/downward and more forward/upward mandibular rotational alignment was noted.

With regard to the mandibular/maxillary arch relationship, the extent to which the mandibular corpus was actually lengthened versus the possible extent to which horizontal remodelling and anterior displacement of the maxilla had become constrained, could not be determined by the present analytic method. The relative effects on comparative arch lengths, nonetheless, were significant in the treatment sample examined. Similarly, the extent to which the inferior direction of vertical maxillary displacement and remodelling was constrained versus the extent to which vertical lengthening of the ramus was augmented, could not be determined. The relative anatomic effects, however, were significant.

Within the treatment group, a large majority of patients had a mandibular protrusive result

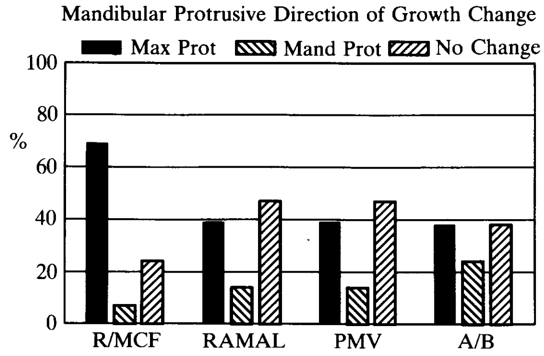


Figure 5 For those treated individuals having a composite, protrusive direction of change resulting from the aggregate of all regional morphogenic relationships, frequency distributions are shown for the relevant relationships. These include the horizontal breadth of the ramus relative to the horizontal dimension of the middle cranial fossa (R/MCF); ramus alignment (Ramal); the relative vertical length of the posterior maxillary complex (PMV); and the horizontal bony arch length of the mandible relative to the maxilla measured at **A** versus **B** points.

due to the cumulative effects of the aggregate of the changed regional anatomic conditions during altered growth and development. Among the individuals that comprise this sub-group, the comparative mandibular retrusive/protrusive influence of each of the relevant anatomic relationships is shown in Figure 5. Note that dominant mandibular protrusive directional effects characterize three of the regional relationships, compared to maxillary protrusion, with a maxillary protrusive (or mandibular retrusive) effect seen for only one regional relationship.

Within the treatment group, a smaller percentage of patients responded with a composite mandibular retrusive and/or maxillary protrusive composite result, which exacerbated the original, pre-treatment Class II condition. The comparative influence of each of the regional anatomic relationships that underlie this aggregate result is summarized in Figure 6. Note that a mandibular retrusive (or maxillary protrusive) direction of effect occurred for all of these regional relationships.

Within the treatment group, a small percentage experienced essentially no change in these relationships during subsequent facial growth and development. In Figure 7, note that two maxillary protrusive (or mandibular retrusive) anatomic relationships are approximately balanced by two mandibular protrusive relationships.

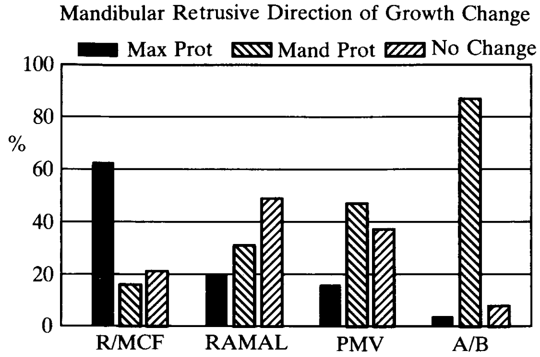


Figure 6 Frequency distribution percentages of regional anatomic relationships for those treated individuals showing a composite mandibular retrusive direction of change. See Figure 5 for abbreviation code.

An interesting condition exists with regard to two basic craniofacial types in their nature of morphogenic response to functional regulator treatment. An 'A' type has an underlying composite of anatomic relationships in which the number and magnitude of regional mandibular retrusive effects are dominant and exceed whatever mandibular protrusive effects might also exist, if any. Maxillary **A** point is more protrusive relative to mandibular **B** point by a corresponding extent, as determined perpendicular to the functional occlusal plane. Conversely, a 'B' type has an underlying anatomic combination in which there is a greater mix of regional mandibular protrusive-causing conditions resulting in a lesser extent of mandibular retrusion. **B** point is usually protrusive or at least much less retrusive relative to **A** point, depending on alignment of

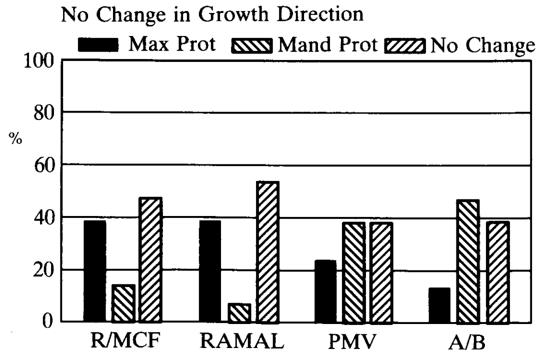
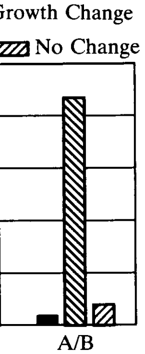


Figure 7 Frequency distributions of anatomic relationships among treated individuals showing no change. See Figure 5 for abbreviation code.



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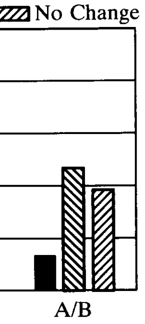

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the occlusal plane. The craniofacial **A** type is the more pure skeletal Class II characterized by a relatively more narrow and vertically and anteroposteriorly more elongated nasomaxillary region, as seen in many dolichocephalic (not dinaric) individuals (Enlow *et al.*, 1971; Enlow, 1982; Bhat and Enlow, 1985). The **A** versus **B** craniofacial types were seen in the present study to have different morphogenic potentials in response to Class II treatment using the Fränkel appliance. This parallels the findings in a study by DiPalma (1982) in which different anatomic combinations of these same regional counterpart relationships demonstrated different responses to Fränkel treatment for open bite.

It was found that 81 per cent of the **A** type individuals in the treatment group responded with a positive, more mandibular protrusive directional result, which is substantially higher than the 37 per cent seen in the untreated control group having an **A** type facial pattern. For the **B** group, however, a lesser 48 per cent had a mandibular protrusive direction of response to Fränkel treatment, which was only 13 per cent higher than the 35 per cent seen in the **B** type untreated control group.

In the **A** groups, 9 per cent of the treated compared to 31 per cent of the controls experienced a mandibular retrusive direction of composite growth. In the **B** groups, 26 per cent of the treated and a similar 29 per cent of the controls demonstrated a mandibular retrusive growth direction.

Treated **A** types showed only 10 per cent 'no change', compared to 32 per cent for the **A** controls. The treated **B** type demonstrated 26 per cent 'no change' as compared to 36 per cent **B** controls.

Thus, it appears that the probability for a composite, more mandibular protrusive treatment outcome using a functional regulator in Class II individuals is much more likely to occur for the beginning **A** type than for the beginning **B** type. Together with this, the treated **A** type shows a lesser tendency either for no change at all or an actual mandibular retrusive composite result, as compared with the treated **B** type.

Certain morphogenic factors are likely to be involved in accounting for these findings. First, if it is indeed true that the functional regulator 'unlocks growth' and allows development more nearly to 'full potential', it is apparent that the **B** type has less, and the **A** type more, morphogenic latitude for an increased mandibular protrusive reaction to the biologic influence of the treatment procedure. Related to this, the **B** type has existent, intrinsic mandibular protrusive features within the craniofacial complex that have already served to offset and partially compensate for what otherwise could be an **A** type of malocclusion. The extent of a mandibular protrusive response by some of the various regional anatomic features in the **B** type would, at the start of treatment, be nearer to whatever maximum adjustive or compensatory limit exists; less of a protrusive reaction could thereby be achieved or expected. Further, it is likely that any significant degree of increased mandibular protrusion would not be a desirable treatment objective in the **B** type of patient, since an exaggerated mandibular or bimaxillary protrusive result could follow.

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