The Herbst appliance and the Activator: influence of the vertical facial pattern

Christopher Turnock[*] and Michael G. Woods[†]

Orthodontic Unit, University of Melbourne[*] and Melbourne Health and the Royal Melbourne Hospital,[†] Melbourne, Australia

Aim: To compare the effects of the Herbst appliance and the Activator at the completion of two-phase treatment, with respect to the vertical facial pattern (VFP) and to identify possible predictors of treatment effect.

Materials and methods: Pretreatment, post-treatment and overall cephalometric change data were used to assess the dental and skeletal effects. Results for the change in mandibular length were also compared with changes reported for an untreated external control group.

Results: Clinically significant dental and skeletal changes (including mandibular incisor proclination and overjet reduction) were characteristics of both treatment methods. Any increases in mandibular length and chin prominence were not greater than those expected following natural growth. The pretreatment VFP remained essentially unaltered, while mean changes as a result of treatment were similar for brachyfacial, mesofacial, and dolichofacial subjects. No predictive factors were identified.

Conclusions: Clinicians are advised to expect significant overjet reduction and mandibular incisor proclination with either treatment method. Significant skeletal change may be observed in growing subjects; however, any increase in mandibular length or chin projection is not likely to be beyond the limit set by nature. While there will be some individual variation, no significant long-term alteration in the pretreatment vertical facial pattern should be expected with either treatment. Long faces will remain long and short faces will remain short.

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Christopher Turnock: turnockchris@gmail.com; Michael G. Woods: michaelgwoods55@gmail.com

Introduction

The orthodontic and orthopaedic treatment of the developing Class II occlusion and skeletal base has been an area of much controversy. Class II malocclusions may be separated into maxillary and mandibular dental and skeletal components, with a general lack of homogeneity in the presenting dentofacial morphology observed.[1] It is, however, recognised that the majority of Class II cases involve a component of mandibular retrognathia.[2] It is this realisation that has prompted extensive research into the use of functional appliances and two-phase orthodontic treatment.

Successful individualised treatment planning relies on an analysis of skeletal and dental components in all three dimensions. Diagnosis should not simply focus on the anteroposterior components of the presenting malocclusion. Any Class II case will have a considerable genetic origin[3] which may also be influenced by functional and environmental stimuli.[4] Growth status,[5,6] as well as the underlying vertical facial pattern (VFP)[1,7] and associated growth rotation[8-12] may play significant roles in overall treatment effect and success.

There are few reported assessments of two-phase orthodontic treatment in which the focus has been directed at the presenting vertical pattern. Instead, considerable attention has been paid to two-phase treatment and emphasis placed more firmly on different appliance types. Previous comparisons between the Herbst and Activator appliances have been limited to first-phase analysis.[5,13] With all of this in mind, the present study was undertaken to compare

the effects of the Herbst appliance and Activator at the completion of two-phase treatment, in growing subjects, with respect to VFP.

Materials and methods

Pre- and post-treatment records of 59 orthodontic patients were obtained from clinic archives. All gave permission for their records to be used for research purposes. Thirty were treated with a variation of the Herbst appliance (Cantilever Bite Jumper™ (CBJ)) followed by passive self-ligating fixed appliances (0.022 inch, Damon™) and 29 were treated with an Activator[14] followed by conventional twin-bracket pre-adjusted fixed appliances with elastomeric module ligation (0.018 inch, Victory Series™). For both groups, construction-bites were taken with the minimum increase in vertical dimension to reach an edge-to-edge incisal relationship. The two groups were treated in different private specialist practices by a single experienced orthodontist in each practice.

All subjects initially presented with Class II skeletal and Angle's Class II dental relationships. Consecutive patient records were selected for the two groups, starting with treatments completed during the same calendar year. No additional appliances were permitted, but inter-arch elastics were used as required in the fixed appliance phase. Initial alignment and maxillary expansion were permitted. No treatment, however, involved the extraction of any permanent teeth (except possible later third molar extraction). Subjects with missing permanent teeth, other than third molars, were excluded. High quality pre- and post-treatment lateral cephalograms were available

for all subjects. Poor compliance was not part of the exclusion criteria. Subjects in the Activator group were instructed to wear their appliances for approximately 14 hours per day (including sleeping). Patients were not chosen on the basis of successful completion of treatment, but were, instead, selected on the basis that no premolar extractions had been undertaken.

The major groups were divided into three vertical subgroups identified as brachyfacial, mesofacial and dolichofacial, and based on the mandibular plane angle and on the facial axis angle. Pretreatment age, cervical vertebral maturation (CVM: CS1 to CS6)[15] and incisal overjet (OJ) were recorded (Table I). No significant differences were found in mean pretreatment age (Herbst = 140.1 months vs. Activator = 141.8 months) or overjet (Herbst = 7.3 mm vs. Activator = 8.4 mm). The mean CVM was significantly higher in the Herbst group compared with the Activator group (CS Herbst = 3.0 vs. CS Activator = 2.1).

First phase treatment duration for the Herbst subjects was, on average, 9 months, compared with 17.5 months for the Activator subjects. The duration of Activator treatment, however, included a variable holding period before the fixed appliance phase. No significant differences were evident between the two groups for the widely-varying second phase duration (Herbst = 22.0 +/- 13.1 months, Activator = 26.1 +/- 5.7 months), or overall duration of treatment (Herbst = 41.5 +/- 15.0 months, Activator = 43.7 +/- 11.6 months). For the Herbst subjects, the overall duration of treatment included a non-uniform rest period between phases, where no retention appliances were prescribed.

Table I. Pretreatment characteristics.

			Age (months)			CVM (CS 1-CS 6)			OJ (mm)		
			Mean	S.D.		Mean	S.D.		Mean	S.D.	
Herbst	Total	N = 30	140.1	18.4	NS	3.0	1.0**		7.3	3.1	NS
	B	N = 5	143.2	22.9	NS	4	1.0**		8.6	3.0	NS
	M	N = 14	140.5	15.7	NS	2.8	1.1**		5.8	2.7	NS
	D	N = 11	138.2	21.2	NS	2.7	0.6**		8.6	2.9	NS
Activator	Total	N = 29	141.8	22.0	NS	2.1	1.2**		8.4	3.0	NS
	B	N = 10	152.6	22.4	NS	2.5	1.4**		8.1	3.3	NS
	M	N = 12	139.3	21.8	NS	2.3	1.2**		8.4	3.4	NS
	D	N = 7	130.6	16.0	NS	1.4	0.7**		8.7	2.9	NS

B, brachyfacial; M, mesofacial; D, dolichofacial
NS, Not significant, * $p < 0.05$, ** $p < 0.01$

All pre- and post-treatment lateral cephalograms were digitised using methods previously described.[1] Linear measurements were multiplied by 0.926 or 0.917 where appropriate to accommodate for magnification enlargement. To assess landmark location and measurement error, three cases from each group were randomly selected. Each was digitised twice, with a washout period of four weeks to avoid bias. The results of the paired t-test showed no significant differences between the two sets of measurements at the 95% confidence level. Definitions for all measurements used and the various pretreatment cephalometric characteristics are provided in Tables II and III.

SPSS (Version 17.0) was used to calculate descriptive statistics and to analyse all pretreatment and post-treatment characteristics in addition to changes occurring during active treatment. The data obtained displayed a normal distribution. Independent t-tests and ANOVA were therefore used to search for differences ($p < 0.05$) between the two major groups and the six subgroups respectively. Pearson's correlation coefficients (r) were calculated to assess the relationships between the various pretreatment variables and changes observed following active treatment. Non-parametric tests were used for analyses involving CVM.

Table II. Cephalometric measurements.

Facial Axis (FA)	(deg)	Posteroinferior angle between Ba-Na and Pt-Gn
Mandibular plane (MdP)	(deg)	Anteroinferior angle between Po-Or and Go-Me
ANB	(deg)	Difference between SNA and SNB angles
Mx1 to PP	(deg)	Posteroinferior angle between long axis of the maxillary central incisor and ANS-PNS
Md1 to MdP	(deg)	Posterosuperior angle between long axis of the mandibular central incisor and Go-Me
Pog to N-Perp	(mm)	Perpendicular distance from pogonion to the nasion vertical
Pog' to Pog	(mm)	Perpendicular distance from pogonion to the PM reference line
Co to Gn	(mm)	Absolute distance from condylion to gnathion
Overjet	(mm)	Horizontal distance between maxillary and mandibular incisal edges

Table III. Pretreatment cephalometric characteristics.

			FA			MdP			ANB			Mx1 to PP			Mn1 to MdP			Pog to N-Perp			Pog' to Po			Co-Gn			OJ		
			Mean	S.D		Mean	S.D		Mean	S.D		Mean	S.D		Mean	S.D		Mean	S.D		Mean	S.D		Mean	S.D		Mean	S.D
Herbst	Total	N = 30	88.3	4.4	**	26.4	5.3	*	6.0	2.5	NS	112.9	10.5	NS	97.9	6.5	NS	-9.5	6.4	NS	49.4	5.8	NS	103.2	5.7	NS	7.3	3.1	NS
	B	N = 5	92.6	5.6	**	19.4	4.0	**	4.6	2.5	NS	115.5	8.1	NS	97.9	7.5	NS	-2.9	5.1	**	52.4	5.7	*	109.8	5.9	*	8.6	3.0	NS
	M	N = 14	89.0	3.1	**	24.8	1.5	**	6.0	2.7	NS	110.1	12.4	NS	98.9	6.9	NS	-7.8	5.1	**	50.9	5.4	*	103.7	3.4	*	5.8	2.7	NS
	D	N = 11	85.4	3.6	**	31.8	3.5	**	6.7	2.1	NS	115.4	8.6	NS	96.6	5.8	NS	-14.6	4.6	**	46.2	5.3	*	99.6	5.4	*	8.6	2.9	NS
Activator	Total	N = 29	91.2	3.7	**	23.7	5.1	*	6.2	2.2	NS	113.7	13.2	NS	96.8	7.4	NS	-7.5	5.0	NS	49.2	5.7	NS	102.7	6.8	NS	8.4	3.0	NS
	B	N = 10	94.5	2.3	**	18.5	2.2	**	5.3	2.0	NS	112.9	16.5	NS	96.1	5.7	NS	-3.7	4.5	**	50.7	5.8	*	105.8	7.9	*	8.1	3.3	NS
	M	N = 12	90.5	2.9	**	23.9	2.0	**	6.5	2.2	NS	113.4	13.2	NS	97.0	8.0	NS	-7.6	3.2	**	50.4	4.5	*	102.0	6.3	*	8.4	3.4	NS
	D	N = 7	87.6	2.3	**	30.7	2.1	**	6.9	2.3	NS	115.2	8.9	NS	97.4	9.4	NS	-12.8	3.5	**	44.9	6.1	*	99.7	4.8	*	8.7	2.9	NS

B, brachyfacial; M, mesofacial; D, dolichofacial
Difference between Herbst and Activator: NS, Not significant, * $p < 0.05$, ** $p < 0.1$

Results

Post-treatment characteristics for the Herbst and Activator groups are summarised in Table IV. With all measurements, there was considerable individual variation around the means, for all groups and subgroups. When the overall change in mandibular length for the total sample in this study was compared with average measurements taken from the external control subjects from the University of Michigan Growth Study,[17] the mean increase in Co-Gn was 3.17 mm/year, compared with 3.48 mm/year in the Michigan subjects (males from age 12 to 16). The pretreatment differences in facial axis measurements for the two treatment groups were still present in the post-treatment analysis. Significant post-treatment differences were also found for maxillary incisor angulation (Herbst = 109.7° vs. Activator = 115.2°, p = 0.01), and overjet (Herbst = 2.2 mm vs. Activator = 2.9 mm; p = 0.05). Post-treatment overjet was, on average, 0.7 mm less for the Herbst group, while at the same time, maxillary incisors were, on average, 5.5° more upright.

When post-treatment values were analysed with respect to vertical pattern, significant mean differences between the vertical subgroups were found for facial axis, mandibular plane angle and both measures of chin projection, as well as for maxillary incisor angulation and overjet. All mean differences were present in the pretreatment analysis, except for those of maxillary incisor angulation and overjet. Mean changes during active treatment are summarised in Table V and displayed in Figure 1. The only statistically significant difference between the two treatment groups was the change in the ANB angle (p = 0.01). On average, the Activator group showed a reduction of 2.9° compared with a 1.5° reduction in the Herbst group. No other significant mean differences were observed between the major groups. Clinically significant overjet reduction and mandibular incisor proclination were found consistently in both treatment groups.

The overall analysis of the vertical subgroups found no significant difference in mean changes with active treatment for any variable. However, there was considerable individual variation. Therefore, on average, treatment effects were similar, regardless of the presenting facial type. Significant pretreatment differences in facial axis and mandibular plane angle were still present in the post-treatment analysis of the subgroups, while the associated mean changes with active treatment were small and not significant. Therefore, in these samples, it was found that neither
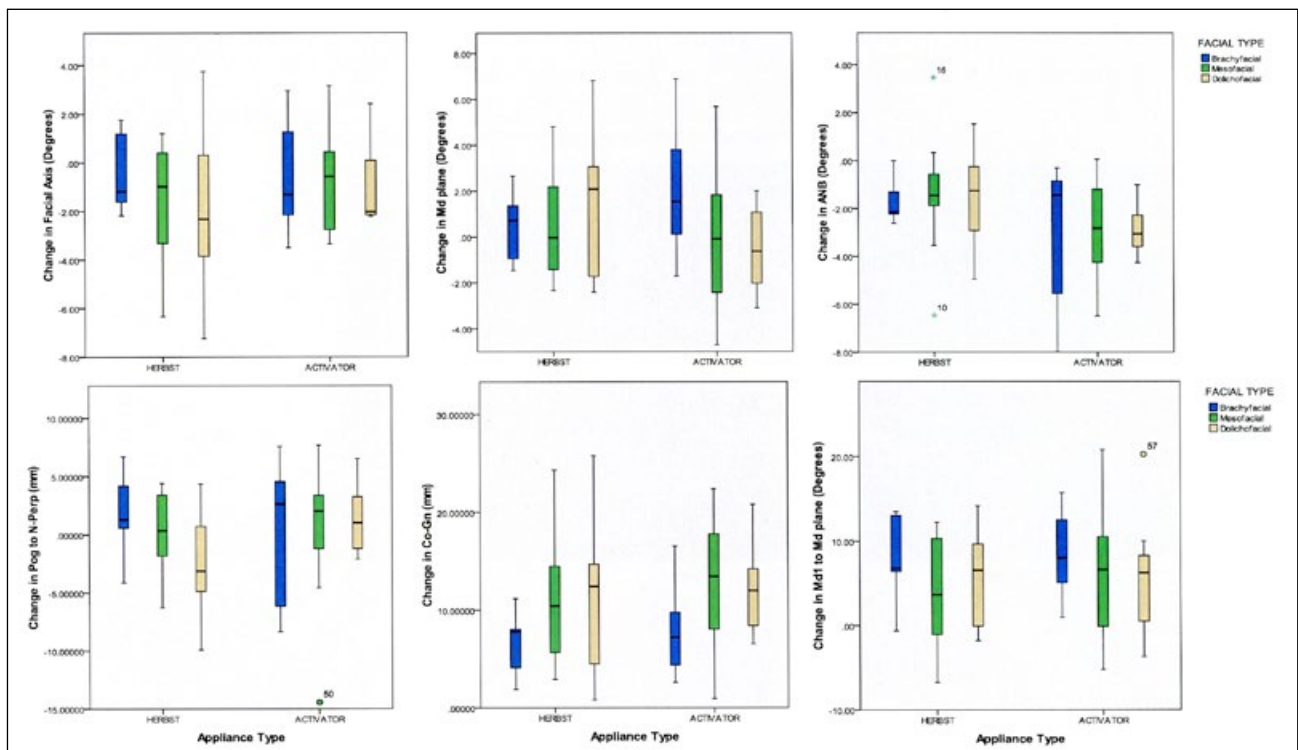

Figure 1. Cephalometric changes with two-phase treatment.

Table IV. Posttreatment cephalometric characteristics.

		FA		MdP		ANB		Mx1 to PP		Mn1 to MdP		Pog to N-Perp		Pog' to Pog		Co-Gn		OJ	
		Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Herbst	Total N = 30	86.85	5.28 **	27.22	6.31 NS	4.56	2.55 NS	109.71	5.89 **	102.94	6.87 NS	-9.99	8.84 NS	53.31	7.22 NS	114.16	7.25 NS	2.2	0.9 **
	B N = 5	92.24	7.28 **	19.84	4.74 **	2.92	2.38 NS	113.03	4.16 **	105.72	6.81 NS	-1.15	7.89 *	54.65	6.84 *	116.40	5.69 NS	2.20	0.84 *
	M N = 14	87.40	3.01 **	25.17	2.46 **	4.59	1.92 NS	109.98	4.52 *	102.70	5.49 NS	-7.65	5.77 **	56.11	5.25 *	114.17	7.09 NS	2.07	0.92 *
	D N = 11	83.68	4.67 **	33.20	5.13 **	5.27	3.14 NS	107.85	7.60 *	101.97	8.60 NS	-16.97	7.62 **	49.13	8.10 *	113.13	8.39 NS	2.27	0.90 *
Activator	Total N = 29	90.47	3.79 **	24.25	5.16 NS	3.32	2.39 NS	115.19	7.72 **	103.48	6.05 NS	-6.81	5.17 NS	53.96	6.06 NS	113.69	7.20 NS	2.9	0.8 **
	B N = 10	93.94	2.84 **	20.42	3.40 **	2.54	2.12 NS	113.89	7.87 *	104.43	6.48 NS	-3.16	3.11 **	55.18	4.98 *	113.41	7.17 NS	2.70	0.67 *
	M N = 12	89.75	2.88 **	23.98	4.29 **	3.53	2.66 NS	117.04	7.46 *	102.89	4.81 NS	-7.16	5.51 **	55.48	6.59 *	115.03	6.21 NS	3.17	0.72 *
	D N = 7	86.77	1.67 **	30.18	2.69 **	4.07	2.30 NS	113.86	8.46 NS	103.12	7.95 NS	-11.44	2.69 **	49.61	5.02 *	111.81	9.30 NS	2.71	0.92 *

B, brachyfacial; M, mesofacial; D, dolichofacial
Difference between Herbst and Activator: NS, Not significant, * p < 0.05, ** p < 0.01

Table V. Cephalometric changes with two-phase treatment.

		FA		MdP		ANB		Mx1 to PP		Mn1 to MdP		Pog to N-Perp		Pog' to Pog		Co-Gn		OJ	
		Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Herbst	Total N = 30	-1.44	2.65 NS	0.80	2.55 NS	-1.44	1.89 **	-3.24	10.13 NS	5.05	6.20 NS	-0.53	3.98 NS	3.91	4.83 NS	10.98	7.50 NS	-5.13	3.28 NS
	B N = 5	-0.40	1.76 NS	0.47	1.68 NS	-1.66	1.04 NS	-2.49	7.10 NS	7.82	5.77 NS	1.73	4.08 NS	2.24	4.51 NS	6.62	3.63 NS	-6.40	3.36 NS
	M N = 14	-1.55	2.34 NS	0.41	2.29 NS	-1.36	2.16 NS	-0.16	11.50 NS	3.84	6.55 NS	0.12	3.29 NS	5.25	5.47 NS	10.52	5.98 NS	-3.71	2.97 NS
	D N = 11	-1.75	3.37 NS	1.43	3.20 NS	-1.44	1.95 NS	-7.50	8.50 NS	5.33	6.04 NS	-2.38	4.30 NS	2.95	3.97 NS	13.56	9.71 NS	-6.36	3.14 NS
Activator	Total N = 29	-0.73	1.95 NS	0.57	2.76 NS	-2.85	2.12 **	1.53	15.10 NS	6.70	6.86 NS	0.71	4.99 NS	4.77	5.70 NS	10.96	5.89 NS	-5.48	3.05 NS
	B N = 10	-0.58	2.22 NS	1.94	2.61 NS	-2.73	2.69 NS	1.03	13.84 NS	8.36	5.04 NS	0.58	5.54 NS	4.48	7.02 NS	7.64	4.19 NS	-5.40	3.24 NS
	M N = 12	-0.78	1.95 NS	0.07	2.98 NS	-2.95	2.19 NS	3.60	17.28 NS	5.87	7.67 NS	0.45	5.65 NS	5.07	6.11 NS	13.06	6.73 NS	-5.25	3.36 NS
	D N = 7	-0.85	1.82 NS	-0.52	1.99 NS	-2.87	1.13 NS	-1.32	14.52 NS	5.76	8.15 NS	1.35	3.33 NS	4.68	2.95 NS	12.08	4.88 NS	-6.00	3.44 NS

B, brachyfacial; M, mesofacial; D, dolichofacial
Difference between Herbst and Activator: NS, Not significant, * p < 0.05, ** p < 0.01

treatment method was able to significantly alter the overall pretreatment vertical pattern (Figures 2(a) and (b)).

Pearson's correlation coefficients showed few significant associations between pretreatment characteristics and any changes observed with active treatment. Pretreatment age and mandibular plane angle were not significantly correlated with any changes seen during active treatment. Pretreatment facial axis was weakly correlated with changes in Pog to N-Perp for the Herbst group (r = 0.43; p = 0.05). Pretreatment maxillary incisor angulation was significantly correlated with changes in overjet for the Herbst group (r = -0.60; p = 0.05) and the Activator group (r = -0.47; p = 0.05). A weak but significant negative correlation existed between pretreatment CVM and change in Co-Gn for the Herbst group (r = 0.37; p = 0.05).

Discussion

With any retrospective study, significant bias can be introduced. The assessment of patients treated by clinicians with significant experience in their chosen treatment methods aimed to minimise any proficiency bias and allow for consistent implementation of a two-phase treatment program. In an effort to minimise detection bias, neither clinician was involved in the selection of either sample. Every available case fulfilling the inclusion criteria was assessed. The subjects analysed were selected to provide a realistic comparison of the dental and skeletal outcomes of both forms of treatment. The quality of the final occlusion was not the basis for selection. Transfer bias was kept to a minimum, as all tracings and measurements were performed by one investigator (C.T.), who had no vested interest in either treatment method.
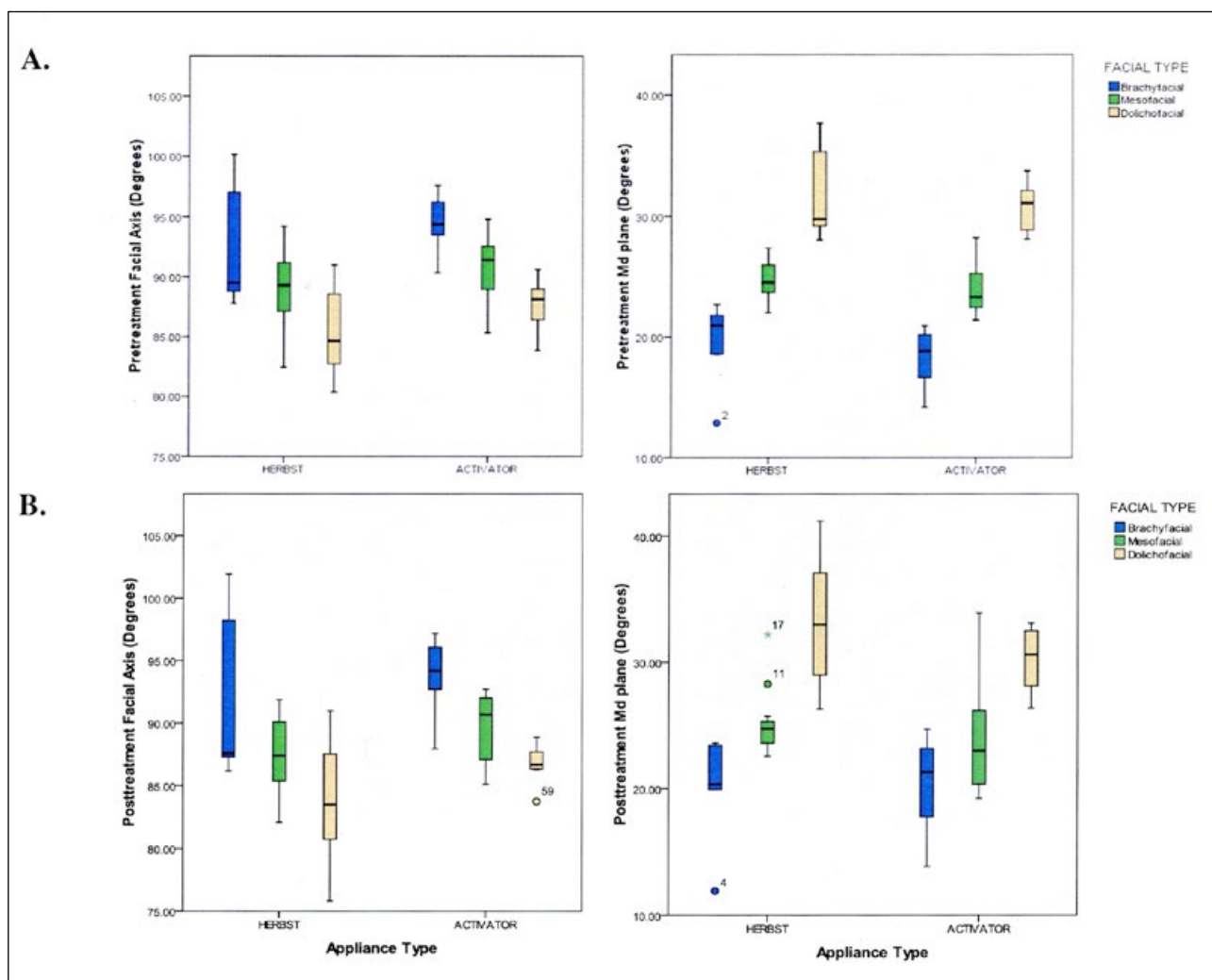

Figure 2. Facial axis and mandibular plane angle measurements.

In contrast with previous non-homogeneous Class II samples,[1] a strength of this study is the minimal number of significant pretreatment mean differences between the Herbst and Activator groups. Subgroup characteristics have provided distinct divisions with respect to the vertical pattern, while the other characteristics remained reasonably homogeneous. Efforts have previously been made to predict treatment success based on pretreatment characteristics.[16] Treatment success has, however, simply been defined in terms of overjet reduction, molar relationship correction or a change in total mandibular length.[16] Success is difficult to measure and has no universal unit. The aims and objectives of treatment vary between individual subjects and according to the particular clinician. Being able to simply predict the dental and skeletal effects of two-phase treatment from pretreatment characteristics, without reference to arbitrary definitions of success, would therefore be of great value to the clinician.

The changes in incisal overjet and lower incisor proclination determined by the present study were considerable and clinically significant for both total treatment groups and the vertical subgroups, although the differences between the groups were not found to be statistically significant. As expected, larger pretreatment maxillary incisor angulations were associated with greater overjet reduction, emphasising the importance of dental changes in the overall Class II correction. It was interesting that statistically significant differences were found in post-treatment incisor angulation for the two groups. While overall treatment with the Herbst appliance and passive self-ligating appliances resulted in a smaller mean post-treatment overjet, it occurred at the expense of maxillary incisor torque control. Nevertheless, both treatment methods provided clinically acceptable results. A greater reduction in the ANB angle was recorded for subjects treated with the Activator and conventional fixed appliances, possibly suggesting a greater skeletal response to treatment. Points A and B are, however, dentoalveolar points and may well be influenced by post-treatment incisor angulation, which in this case was greater in the Activator group.

Clinically significant and similar average increases in mandibular length were recorded for both groups. Brachyfacial subjects showed the smallest increase on average. However, this difference may be related to the geometric nature of the condylion to gnathion

measurement. The mean increase in Co-Gn found in this study was 3.17 mm/year, compared with 3.48 mm/year in the University of Michigan subjects.[17] Based on this comparison, it seems that the results of the present study support previous claims that neither treatment method is likely to permanently enhance mandibular growth. For cases in which significant mandibular retrognathia exists and significant facial change is a desired aim of treatment, later orthognathic surgery may still require consideration.

No significant improvements in chin position were found with either treatment method, regardless of the pretreatment vertical pattern. A general, but not significant, tendency towards minor backward rotation of the mandible suggests that any observed increase in mandibular length was being expressed vertically, without any improvement in chin prominence. Changes in chin position with first-phase treatment have been directly compared by others for the Herbst and Activator appliances.[5,13,18] Previous claims of increased anterior movement of pogonion with Herbst treatment would appear to be unsubstantiated. The reported 0.9 mm average increase would be of arguable clinical significance.[13] In any case, follow-up results were not available,[13] and would likely be influenced by retention after the Herbst phase with removable functional appliances.[5]

The results of the present study appear to reinforce the temporary nature of any improvement in horizontal chin projection achieved with functional appliances. Even if chin projection improved with first-phase treatment, this improvement was not likely to be present after the completion of the fixed-appliance phase. With all measurements of chin projection, dolichofacial subjects in both treatment groups displayed significantly more retrognathia, when compared with mesofacial and brachyfacial subjects. This was apparent in the pretreatment and post-treatment analyses. Nature still appears to have the final control of chin position, regardless of any temporary alteration in the neuromuscular environment.[1] Therefore, especially in dolichofacial patients, three-dimensional orthognathic surgery may still provide the most appropriate long term management.

It has previously been suggested that treatment using the Herbst appliance may provide a viable alternative to orthognathic surgery in so-called 'borderline' Class II cases.[19,20] Importantly, a major point was overlooked

in that orthognathic surgery is not prescribed simply to correct sagittal discrepancies. Surgery also has the ability to significantly alter the vertical proportions of the face, an ability that did not appear to be a characteristic of either functional appliance used in the present study. Orthognathic surgery may therefore still be considered for significant changes required in the vertical dimension. Further to previous findings from functional appliance research involving first phase analysis alone,[7,21-25] it was found in the present study that the pretreatment vertical pattern was not a significant factor in the ultimate dental and skeletal response to treatment, nor was it of predictive value.[16]

Two-phase orthodontic treatment is a valuable part of the contemporary orthodontic armamentarium, as long as realistic aims and objectives are set. It is reasonable to suggest that these devices should neither be universally dismissed nor used non-selectively. Individual clinical assessment, diagnosis and treatment planning should be the focus and reassessment of the effects of growth and treatment, after the first phase of treatment, is essential. While, in many cases, fine overall results may be achieved without the need for either premolar extractions or jaw surgery, in some cases, extractions and/or orthognathic surgery may still be required. This should not be viewed as evidence of treatment failure. Nature has simply been given her best chance. The reassessment before the second phase should perhaps be seen simply as another opportunity to discuss the situation with all treatment options available.

Brodie recorded in 1946, 'one cannot alter the basic pattern that presents itself for treatment … the only hope for progress lies along the road which starts with the realisation that, in the future, it may be possible to find means of precisely determining the course of development of any given face and to then predict its ultimate potential.'[26]

Conclusions

While accepting the limitations of any retrospective lateral cephalometric study, the following conclusions may be drawn:

1. A significant reduction in incisal overjet and proclination of the mandibular incisors should be expected in Class II cases, treated with either the Herbst appliance or the Activator, as part of two-phase treatment. Significant individual variation in response should be expected.

2. Any increase in mandibular length or chin projection with either treatment method is not likely to be beyond the limit set by nature.

3. No significant long-term alteration in the pretreatment vertical facial pattern should be expected with either treatment method. Long faces will remain long and short faces will remain short. Individual variation should be anticipated.

4. Similar mean dental and skeletal changes with treatment are likely to be found in brachyfacial, mesofacial, and dolichofacial subjects. Successful treatment will depend on the individual aims of treatment set by the clinician.

5. Where extremes of vertical facial pattern are found, or where ultimate natural chin projection is inadequate, orthognathic surgery may still require consideration, if significant facial change, especially in the vertical dimension, is an aim of treatment. This is more likely to be the case for dolichofacial patients.

Acknowledgments

Corresponding author

Michael G. Woods
549 Dandenong Road
Malvern Victoria 3144
Australia

Email: michaelgwoods55@gmail.com

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