

Vertical facial pattern and orthodontic stability

Part I: Pretreatment vertical pattern and stability

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The occlusions of sixty patients treated by one experienced orthodontist were assessed using the PAR Index. For each patient, pretreatment, post-treatment and long-term follow-up study casts were examined. Follow-up casts were taken at least 6.5 years following the removal of all retention appliances. Following pretreatment cephalometric analysis, the patient sample was divided into three vertical facial subgroups according to the Jarabak Facial Height Quotient. Mean weighted PAR scores were then calculated at each stage for the total sample and for the three subgroups. Mean absolute and percentage occlusal changes were also calculated for the post-treatment period. The relationship between post-treatment occlusal change and pretreatment vertical facial pattern was then studied.

The mean weighted pretreatment, post-treatment and follow-up PAR scores were 27.3, 3.3 and 8.0, respectively. The mean absolute and percentage post-treatment increases in weighted PAR score were 4.7 and 25.4, respectively. No statistically-significant relationship could be found between the pretreatment vertical facial pattern and changes occurring in the weighted PAR score during the follow-up period. It was concluded, therefore, that pretreatment vertical facial pattern, at least on its own, is not likely to be predictive of the amount of post-treatment occlusal change.

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Introduction

A major aim of orthodontic treatment is to provide a functional occlusion that is both aesthetic and stable.¹ Despite the fact that long-term orthodontic treatment outcomes have been studied and discussed for many years,^{2,3,4} it has been shown that improvements that have been achieved through long and complex treatment may be lost to varying degrees after the removal of active appliances. This relapse is frequently noted, even during periods of formal retention.⁵

The ability to predict when post-treatment occlusal changes are likely to occur would be of great value to the practising orthodontist. For that reason, previous researchers have investigated the possible relationships between many diagnostic and treatment factors and post-treatment stability. These studies have included the effects of the presence of third molars,⁶ pretreatment incisor positions,⁷ post-treatment incisor positions,⁸ incisal changes during treatment,⁹ whether or not teeth were extracted,^{10,11} pretreatment Angle's classification and mechanics used in treatment,⁴ and the standard of occlusal finish at the end of active treatment.¹² The pretreatment vertical facial pattern has also been implicated as one possible factor in determining occlusal stability following orthodontic treatment.¹³ Unfortunately, information in the literature regarding the effects of such vertical patterns on occlusal stability has not been gained from the study of patients necessarily treated with similar aims and methods. For this reason, the present study has been designed to determine the influence of the pretreatment vertical facial pattern on post-treatment occlusal change (as assessed with the PAR Index) occurring after fixed-appliance orthodontic treatment of patients managed by one orthodontist with consistent aims and methods.

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Materials and methods

The sample and orthodontic treatment procedures

The retrospective records of 60 patients treated by one private specialist orthodontist (E.C.C.) were obtained for this study. Criteria for patient selection, pretreatment aims for all patients and the general mechanical regime have been presented in previous papers.^{9,12} All patients had pretreatment (T1), post-treatment (T2), and follow-up (T3) casts and lateral cephalograms available at the time of the study. The follow-up records were taken at least 6.5 years following the removal of all retention appliances. Of the sixty patients, forty-six were females and fourteen were males. The mean age was 15 years, with the distribution heavily weighted around a median age of 13.7 years. Seventeen patients had been treated with premolar extractions, forty-three without. The mean duration of active treatment was 29.0 months, with a standard deviation of 8.9 months. The mean duration of the post-treatment observation period was 11 years, with a standard deviation of 33.6 months.

Calibration, error measurement and data collection

The PAR Index

Pretreatment (T1), post-treatment (T2) and follow-up (T3) casts were assessed by one examiner (N.J.P.), using the PAR Index as described by Richmond *et al.*¹⁴ Richmond, himself, had first assessed that examiner's ability to assess occlusions using the official PAR Index calibration casts. Once the examiner had been calibrated, the casts for all patients were arranged randomly so that casts for any one patient were not scored in sequence (T1, T2, T3). In order to determine intra-examiner reliability, 30 randomly selected sets of models were scored twice, four weeks apart. With a correlation coefficient of 0.96, the scores were considered to be highly consistent, matching the findings of Richmond *et al.*¹⁴ and Woods *et al.*,¹² who reported correlation coefficients for intra-examiner reliability of 0.94 and 0.97, respectively. Further examination of the data using the paired *t*-test indicated that bias within the scored-sample was low.

Vertical facial pattern

All cephalograms had been taken with the same radiographic unit at a magnification of eight per cent. The pretreatment (T1) cephalograms were

assigned numbers and arranged in random order by an independent observer, before tracing and digitisation by one examiner (N.J.P.). In a pilot study using 20 randomly selected radiographs, three methods of data collection had been compared. These three methods were: (i) hand-traced then hand-measured; (ii) hand-traced then digitized using Dentofacial Planner, version 7.01; and (iii) directly digitised using Dentofacial Planner. The hand-traced and digitized method was found to be the most reproducible and was therefore used for further cephalometric analysis in this study. The pretreatment vertical facial pattern for each subject was established using the Jarabak Facial Height Quotient.¹⁵ This quotient reflects the posterior facial height (S-Go) as a percentage of the anterior facial height (N-Gn). According to the Jarabak Quotient, 30 subjects had hypodivergent facial patterns (> 63%), 16 had neutral patterns (59–63%) and 14 had hyperdivergent patterns (< 59%).

Statistical analysis

Following tabulation of all individual weighted PAR scores, mean weighted PAR scores and standard deviations were calculated for the total sample and for each of the vertical facial subgroups at T1, T2 and T3. Mean absolute and percentage changes were also calculated for the post-treatment follow-up period (T2 to T3). The data were then subjected to analysis of variance (ANOVA) and the Kruskal–Wallis test, to search for any relationship that might exist between the pretreatment vertical facial pattern and post-treatment PAR score changes.

Results

Mean weighted PAR scores

The mean weighted PAR scores at T1, T2 and T3 for the total sample and its vertical subgroups are presented in Table I.

The mean weighted PAR score for the total sample at the commencement of treatment (T1) was 27.3. While the mean weighted scores at T1 were consistent for all vertical subgroups, there was wide variation amongst individual patients. By the end of active treatment (T2), the mean weighted PAR score for the total sample had been reduced to 3.3, with similar reductions in the means for all subgroups and less individual variation than was evident at T1. When assessed after the follow-up period (T3), the mean weighted scores for all subgroups had increased, with a mean weighted PAR

Table I. Mean weighted PAR scores at T1, T2 and T3

	N	Mean	T1 SD	Range	Mean	T2 SD	Range	Mean	T3 SD	Range
Total	60	27.3	9.1	7–42	3.3	2.6	0–13	8.0	6.0	0–28
Hypodivergent	30	28.0	9.0	11–41	3.6	2.9	0–13	7.7	5.7	1–21
Neutral	16	26.9	10.8	7–42	3.7	2.7	1–11	8.4	5.9	0–18
Hyperdivergent	14	27.3	7.4	15–42	2.2	1.6	0–6	7.7	7.0	2–28

Table II. Mean absolute changes in weighted PAR scores (T2 to T3)

Sample Group	Number	Mean	SD	Range
Total Sample	60	+4.7	5.6	-3–26
Hypodivergent	30	+4.3	4.6	-2–16
Neutral	16	+4.7	5.6	-3–17
Hyperdivergent	14	+5.5	7.5	-2–26

Table III. Mean percentage changes in weighted PAR scores (T2 to T3)

Sample Group	Number	Mean	SD	Range
Total	60	+25.4	44.5	-28.6–300
Hypodivergent	30	+19.2	24.5	-28.6–83.3
Neutral	16	+42.4	75.0	-13.0–300
Hyperdivergent	14	+19.1	25.9	-18.2–76.5

Table IV. Variance in weighted PAR score changes (T2 to T3)

Absolute PAR score changes		
Sample group comparison	Test	<i>p</i> Value
Hypo vs neutral vs hyper	ANOVA	0.817
Hypodivergent vs rest of sample	ANOVA	0.615
Percentage PAR score changes		
Sample group comparison	Test	<i>p</i> Value
Hypo vs neutral vs hyper	ANOVA	0.204
Hypo vs neutral vs hyper	Kruskall	0.749
Hypodivergent vs rest of sample	ANOVA	0.285
Hypodivergent vs rest of sample	Kruskall	0.652

score for the total sample of 8.0. Once again, there was considerable individual variation in the weighted scores within all groups in the sample, although less than at T1.

Mean absolute changes in weighted PAR scores during the follow-up period (T2 to T3) are presented in Table II. From the table, it can be seen that there was a mean increase in weighted PAR Score of 4.7 for the total sample, with similar mean increases occurring in each of the subgroups. There was, however, considerable individual variation within all groups.

Mean percentage changes in weighted PAR scores during the follow-up period (T2 to T3) are presented in Table III. From the table, it can be seen that there was a mean percentage increase in weighted PAR score of 25.4 for the total sample. The mean percentage increases varied considerably amongst the vertical subgroups. The mean percentage increase observed in the neutral vertical group, for example, was 42.4 per cent. This considerably higher figure was due largely to changes seen in one individual patient, in whom the weighted PAR score underwent a 300 per cent post-treatment increase. This patient commenced treatment with a low PAR score, which was reduced only one weighted PAR point with treatment. The post-treatment increase of three PAR points, while still small in absolute terms, was very large in percentage terms relative to the one point improvement gained with active treatment. This 300 per cent change, in turn, had the effect of raising the means for both the total sample and the neutral subgroups.

Correlation coefficients (Table IV)

Analysis of variance showed no significant differences ($p \leq 0.05$) amongst the three vertical subgroups for either the absolute or the percentage changes in weighted PAR scores from T2 to T3. In an attempt to equalise the subgroup sizes, the hypodivergent sample ($n = 30$) was then com-

pared with the rest of the total sample ($n = 30$). Once again, no significant differences ($p \leq 0.05$) could be found between these two vertical groups for either absolute or percentage changes in weighted PAR scores from T2 to T3.

Discussion

Limitations of the study

While the sample used in this study might appear to be small, it is substantial when one considers that the patients have been re-examined many years after the completion of active treatment. It is not a totally homogeneous sample because it includes patients with different underlying vertical and anteroposterior facial patterns and malocclusions, and different durations of active treatment. These patients were, however, all treated by the same clinician with generally the same treatment philosophy. While it may be possible to make indirect comparisons between these long-term occlusal changes and those found in alignment-stability studies reported by previous authors such as Little *et al.*,¹⁰ the results can really only be directly compared with those of studies in which the PAR Index has been used as described by Richmond *et al.*¹⁴ Having said that, the problem of post-treatment instability appears to have already been somewhat addressed at the initial treatment planning stage in the cases used in this study. For instance, decisions whether or not to extract teeth, or to use vertical-control headgear had both been made with reference to the underlying vertical facial pattern. A stronger insight into the effect of pretreatment vertical facial pattern upon post-treatment occlusal change might, therefore, have been gained if all patients had been treated with exactly the same mechanical regime, regardless of pretreatment facial type. Given what is already known about selective vertical control for patients with different malocclusions and underlying facial patterns, such non-selective treatment would present significant ethical difficulties, and is unlikely to be purposely attempted.

In the course of this study, several difficulties were encountered when attempting to apply the PAR Index as intended by Richmond *et al.*¹⁴ These difficulties included ambiguities when scoring buccal "scissor-bites" and impacted teeth. Despite these limitations, the PAR Index has been found in this study to be useful for its originally intended purpose of assessing alignment and occlusion during or at the end of orthodontic treatment. Future modifications may make it a more valuable clinical and research tool.

PAR score changes

While the mean weighted PAR scores increased within all experimental groups during the post-treatment follow-up period, none of the means increased to beyond their pretreatment levels. On an individual basis, however, measurements in isolated patients did. Nevertheless, the overall post-treatment occlusal changes observed in this study are consistent with those reported previously in the literature for both treated and untreated samples.^{3,12,16–18}

The fact that no significant differences could be found in the post-treatment PAR score changes for the vertical subgroups is surprising when one considers all that has been written previously regarding the likely influence of vertical facial types on planning and treatment.^{19–27} It is widely-accepted, for instance, that longer-faced, more dolichofacial patterns exhibit generally weaker mandibular muscle forces²⁸ and tolerate less expansion of the dental arches during treatment.^{29–31} On the other hand, shorter-faced, more brachyfacial patterns are acknowledged to exhibit generally stronger mandibular muscle forces²⁸ and to tolerate greater expansion of the dental arches during treatment.^{29–31} While these morphological differences may already have been taken into account during the treatment planning stages for the patients included in this experimental sample, it might still have been expected that greater post-treatment occlusal change would have taken place in those patients with underlying vertical patterns toward the extremes of dolicho- or brachyfacial. In the brachyfacial group, for example, it may have been expected that strong mandibular muscles would eventually re-exert their influence, leading to a considerable return, on average, of deep incisal overbites^{29,32} and, hence, a significant post-treatment increase in weighted PAR score. The fact that such an obvious differential effect was not found may be due to many other factors. The sample size used in this study may simply have been too small to detect small real differences, the PAR score involving the assessment of many occlusal factors may not be sensitive enough to make the assessment, or the Jarabak Quotient itself may not be sensitive enough to identify occlusions that might behave differently because of the different underlying vertical patterns. In the future, a prospective study of a significant number of patients, all with similar malocclusions and separated into distinct vertical facial groups, may be undertaken using the Jarabak Quotient or some other method of vertical facial assessment. On the basis of the results found in this study, however,

the pretreatment vertical facial pattern, at least on its own, does not appear to be an indicator of the likely amount of post-treatment change in a weighted PAR score. That does not exclude pretreatment vertical pattern as one factor involved in post-treatment occlusal change, but it does appear that it is unlikely to be the main factor. It may, in fact, be involved to some extent when combined with other variables such as rotational changes occurring during and after treatment, the positions of the teeth within the facial environment at the end of active treatment, or even possible post-treatment discrepancies between the positions of the teeth in maximum intercuspation and natural muscle-related condylar positions.

Conclusion

The results of this study would suggest that the pretreatment vertical facial pattern, at least on its own, is not likely to be predictive of the amount of post-treatment occlusal change.

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