Original Article

Orthodontic Outcomes Assessment Using the Peer Assessment Rating Index

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Abstract: The purpose of the present study was to gain more information on the assessment of orthodontic treatment using the PAR Index. The PAR Index was used to assess the study casts of 54 cases treated by 5 orthodontists who successfully completed Phase III of the American Board of Orthodontics. These peer-reviewed cases were considered to represent a subjective opinion of an excellent treatment standard. The PAR scores for the Board-accepted cases were then compared with the PAR scores of 51 cases consecutively treated by orthodontic graduate students. The pretreatment, posttreatment, and percent changes in PAR scores for the Board cases and the graduate student-treated cases were compared. The PAR Index scores and treatment duration were analyzed for the entire sample using general linear models techniques. Results of the study showed no statistically significant difference between the Board-accepted cases and the graduate student-treated cases for any single component of the PAR Index at either the pretreatment or posttreatment times. However, the percent reduction in the mean PAR score for the Board-accepted cases was significantly more than the reduction for the graduate student-treated cases (87.9% ± 9.5% vs 81.7% ± 15.3%). Analysis of treatment duration showed that a higher pretreatment PAR score and a greater percent reduction in PAR score were significantly associated with longer treatment durations. (*Angle Orthod* 2001;71:164–169.)

Key Words: PAR Index; Treatment outcomes; American Board of Orthodontics

INTRODUCTION

The assessment of orthodontic treatment outcomes has traditionally been accomplished using the subjective opinion and experience of clinicians. Several indices have been devised in an attempt at providing a more objective assessment of malocclusion severity. Otuyemi and Jones[1] recently reviewed different methods of assessing malocclusion and divided the indices into 5 groups, ie, diagnostic, epidemiological, treatment need, treatment success, and treatment complexity.

Indices of treatment need, including Summer's Occlusal Index and Salzmann's Handicapping Malocclusion Assessment Record, have been used to evaluate orthodontic treatment success.[2–5] However, these indices were developed to assess occlusion on large populations and often sacrifice detail in order to be more efficiently applied to a greater number of individuals.

The Peer Assessment Rating (PAR) Index was designed specifically to provide a more objective assessment of treatment success. The PAR Index has been shown to have good intra- and interexaminer reliability, with intraclass correlation coefficients of .95 and .91, respectively.[6] The PAR Index has also demonstrated a high correlation with the opinions of dentists on the severity of malocclusion, having a Pearson correlation coefficient equal to .85.[6]

The PAR Index has been extensively used as a method of audit in Europe.[7–12] The changes resulting from orthodontic treatment were reported on a sample of 1630 patients treated by the Regional Consultant Orthodontic Services in England and Wales.[7] The mean reduction in PAR score for the treated English sample was 68%. The mean reduction in PAR score for 220 patients treated by Norwegian orthodontic specialists was 78%.[8]

The PAR Index has been used in only a limited number of studies using US samples. O'Brien et al[13] evaluated 250 US patients with Class II division 1 malocclusions treated by various treatment modalities. The mean percent PAR

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TABLE 1. PAR Index Component Weightings as Determined Using Opinions of British Dentists[6] and American Orthodontists[20]

PAR Component	British Study	US Study
(1) Upper labial segment alignment	1	1
(2) Lower labial segment alignment	1	0
(3) Overbite	2	3
(4) Overjet	6	5
(5) Midline	4	3
(6) Right buccal segment relationship	1	2
(7) Left buccal segment relationship	1	2

score reduction for the sample was 75.4% ± 17.5%. Further study using the PAR Index on different samples would be useful to report on values that orthodontists can use as a method of self-audit and/or comparison with others.

The American Board of Orthodontics (ABO) currently helps set standards of excellence for orthodontists. The objectives of the ABO are ''the pursuit of excellence . . . to provide the candidate a goal toward which to strive and to establish a standard for orthodontists in America and throughout the world.''[14] Cases presented for the Phase III Candidate Case Report Examination are highly selected and represent some of the candidates' best work.

The aim of the present study was to gain a greater understanding of the usefulness of the PAR Index as a method of evaluating orthodontic treatment results. The Index was used to assess cases presented by 5 successful candidates to the American Board of Orthodontics. The amount of malocclusion correction of these Board-accepted cases was compared with consecutively completed cases treated by orthodontic graduate students. The aim of the present study was to determine if the PAR Index could discriminate between the 2 groups.

MATERIALS AND METHODS

The PAR Index

The PAR Index assigns scores to occlusal traits as listed in Table 1. The traits have been weighted to reflect opinions of malocclusion severity in 2 validation exercises. The first validation exercise used the opinions of a panel of 74 dentists in Great Britain.[6] The second validation exercise used the opinions of a panel of 11 orthodontists in private practice in western Pennsylvania.[15] The weightings calculated in each exercise are shown in Table 1. In the US-based weighting system, the lower labial segment alignment was weighted 0. In the present study, the PAR scores are reported using both weighting systems. However, the British-based weighting system was used for statistical analysis so that the lower labial segment alignment could be taken into account.

The scores for each occlusal feature are added to give a total PAR Index score. The higher the PAR scores, the greater the deviation from an ideal occlusion. Richmond[16] distinguished 3 categories of orthodontic treatment outcomes using discriminant analysis functions on 128 patient records based on the subjective assessment of 74 examiners. These categories were worse or no different, improved, and greatly improved. They judged a case improved if greater than a 30% reduction in PAR score was achieved. A case was considered greatly improved if the total PAR Index was reduced by more than 22 points.

TABLE 2. Pretreatment Age and Treatment Duration Descriptive Statistics for the Board-Accepted and Resident-Treated Cases

	Pretreatment Age in Years			Treatment Duration in Months		
	Mean	SD	Range	Mean	SD	Range
Board accepted	16.9	8.6	6.9–37.8	31.7	10.4	16–63.5
Resident treated	16.7	8.2	10.4–46.2	23	5.2	5–31

Method

The pretreatment and posttreatment study casts of 54 Board-accepted cases treated by 5 different orthodontists were scored with the PAR Index using both the British and US weighting systems. A single investigator trained in the use of the PAR Index determined the scores. Five local orthodontists whose treated cases were accepted by the ABO for Board certification contributed the Board-accepted cases.

The PAR scores of 51 consecutively completed cases treated by orthodontic graduates at the Orthodontic Department of the University of Alabama School of Dentistry were also calculated. Cases were not excluded based on the type of appliance used, the presence of missing teeth, or whether orthognathic surgery was part of the treatment.

Table 2 contains the mean pretreatment ages and treatment times of the samples. The average pretreatment age of the Board-accepted cases was 16.9 years (range 6.9 to 37.8 years). The average pretreatment age of the graduate student-treated cases was 16.7 years (range 10.4 to 46.2 years).

The relationship of treatment outcome and treatment duration for the Board-accepted and graduate student-treated cases was analyzed with general linear model regression techniques. The average duration of treatment for the Board-accepted cases was 31.7 months (range 16 to 63.5 months) compared with 23 months (range 5 months to 31 months) for the graduate student-treated cases.

Statistical analysis of the data

All statistical analyses were carried out using SAS Version 6.03 software (SAS Institute Inc, Cary, NC). The British-based weighting system was used for the statistical analysis. To analyze differences between the Board-accepted

TABLE 3. Mean PAR Index Scores and Percent Reduction in PAR Score Using British[6] and US[20] Weightings on the Board-Accepted and Graduate Student-Treated Cases; Percent of Greatly Improved Cases Using the Criteria of Richmond et al[21] are Also Listed

	Board-Accepted PAR Scores			Graduate Student PAR Scores		
	Mean	SD	Range	Mean	SD	Range
Pretreatment (British)	27.9	9.7	12–49	25.6	11.2	6–49
Posttreatment (British)	3.1	2.0	0–9	4.0	2.8	0–14
Percent reduction (British)	87.9	9.3	64.3–100	81.7	15.3	33.3–100
Pretreatment (US)	28.0	8.7	13–49	25.1	10	9–50
Posttreatment (US)	5.4	3.1	0–12	6.8	4.0	0–19
Percent reduction (US)	79.5	13.3	47.6–100	68.6	22.0	13.7–100
Percent of cases considered 'greatly improved'		58.3%			43.1%	

and graduate student-treated cases, a general linear models procedure was performed using each component of the PAR Index as well as total pretreatment, posttreatment, and percent change in PAR scores as dependent variables. The relationship of treatment outcome and treatment duration for the entire sample of Board-accepted and graduate student-treated cases was analyzed with a general linear models procedure using the duration of treatment in days as the dependent variable.

Reliability

Reliability was determined by a duplicate scoring of 142 study casts at a 2-month interval. Intraexaminer agreement was checked using the Pearson correlation coefficient. Analyses were run separately for the 71 pretreatment study casts and 71 posttreatment study casts as well as for a combination of the two. For the total sample, the Pearson correlation coefficient was .99. The pretreatment and posttreatment Pearson correlation coefficients were .98 and .95, respectively. The intraexaminer error can thus be considered negligible.

RESULTS

The mean PAR scores for the 2 groups are shown in Table 3. The frequency distributions for the Board-accepted and graduate student-treated cases are shown in Figures 1 and 2. No Board-accepted cases and only 1 graduate student-treated case showed a posttreatment PAR Index score greater than 10. This finding suggests that highly acceptable occlusal results were obtained for both the Board-accepted and graduate student-treated cases. Using the criteria of O'Brien,[13] 58.3% of the Board-accepted cases and 43.1% graduate student-treated cases were considered greatly improved.

The unweighted mean PAR Index component scores for the Board-accepted and graduate student-treated cases are shown in Table 4 along with the results of the general linear models procedure. When the individual components of the PAR Index were analyzed, no statistically significant difference was found for any component either at the pretreatment or posttreatment times. There was also no statistically

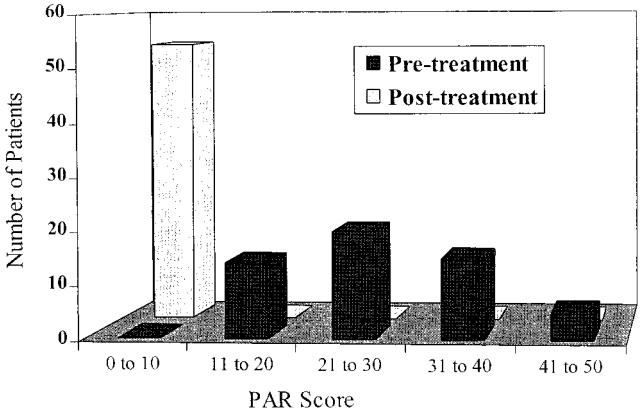

FIGURE 1. Frequency distribution of Board-quality cases.

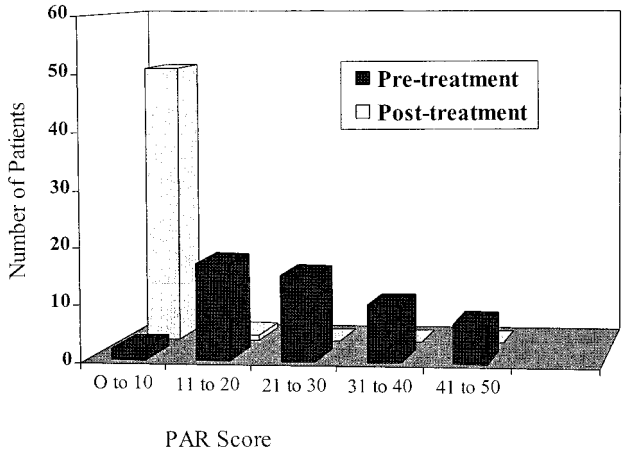

FIGURE 2. Frequency distribution of graduate student--treated cases.

significant difference between the mean PAR scores for the 2 groups at either the pretreatment or posttreatment times. However, there was a tendency for the Board-accepted cases to have higher pretreatment and lower posttreatment PAR scores. This tendency was reflected by a statistically significant difference in the mean percent change in PAR score (81.7% ± 15.3% for graduate student-treated cases vs 87.9% ± 9.5% for Board-accepted cases).

TABLE 4. Mean PAR Index Unweighted Component Scores and Total British Weighted PAR Scores for the Board-Accepted and Graduate Student-Treated Cases; a General Linear Models Procedure Was Performed With Each Component of the PAR Index and Total PAR Scores as the Dependent Variables[a]

	Board Accepted (mean ± SD)		Graduate Student (mean ± SD)		*P* Value	
Component	T1	T2	T1	T2	T1	T2
UA	3.9 ± 3.2	0.1 ± 0.4	4.3 ± 3.6	0.2 ± 0.6	.54	.38
LA	3.4 ± 2.8	0.1 ± 0.6	3.9 ± 3.4	1.0 ± 0.1	.37	.30
RB	2.5 ± 1.1	1.2 ± 0.8	2.2 ± 1.2	1.3 ± 1.0	.27	.46
OJ	1.9 ± 1.4	0.0 ± 0.1	1.5 ± 1.4	0.1 ± 0.2	.15	.29
OB	1.2 ± 1.0	0.2 ± 0.4	1.2 ± 0.9	0.3 ± 0.4	.65	.40
ML	0.5 ± 0.6	0.0 ± 0.1	0.5 ± 0.6	0.0 ± 0.2	.70	.53
LB	2.1 ± 1.1	1.0 ± 0.9	2.0 ± 1.2	1.4 ± 1.0	.33	.10
PAR score	27.9 ± 9.7	3.1 ± 2.0	25.6 ± 11.2	4.0 ± 2.8	.27	.07
%PAR reduction	87.9 ± 9.3		81.7 ± 15.3		.01[b]	

[a] UA, upper labial segment alignment; LA, lower labial segment alignment; RB, right buccal segment relationship; OJ, overjet; OB, overbite; ML, midline; LB, left buccal segment relationship.

[b] Significant at the .05 level.

TABLE 5. General Linear Models Procedure With Treatment Duration as the Dependent Variable

Independent Variable	*P* Value
Pretreatment PAR score	.04[a]
Posttreatment PAR score	.61
% Change in PAR score	.04[a]

[a] Significant at the .05 level.

The general linear models procedure using the duration of treatment as the dependent variable revealed that the pretreatment PAR score and the percent change in PAR score had a significant effect on treatment duration. Posttreatment PAR scores were not significantly related to treatment duration (Table 5).

DISCUSSION

The mean percent reduction of the PAR score for the Board-accepted cases using the British weighting system was 87.9%. This value is higher than the values calculated in the previously discussed studies. Using the British weighting system, the mean reduction in PAR score for the 1630 patients treated by the Regional Consultant Orthodontic Service in England and Wales was 68%,[7] and the mean reduction in PAR score for 220 patients treated by Norwegian orthodontic specialists was 78%.[8]

The mean percent reduction in PAR scores for the graduate student-treated sample in the present study (81.7%) was also higher than the British and Norwegian samples but was statistically significantly lower than the Board-accepted sample. Studies have suggested that the sensitivity of the PAR Index is sufficient to detect differences in treatment outcome when using different treatment methods.[6,7,10,11] A higher percent reduction in PAR score has been demonstrated for patients treated with fixed appliances when compared with patients treated with removable appliances.[7,10,11] Richmond and coinvestigators[6] observed that a higher reduction was achieved with orthognathic surgical cases vs cases treated by orthodontics alone. All of the Board-accepted and graduate student-treated patients in the present study were treated with upper and lower fixed appliances, and the sample included patients treated with orthognathic surgery. The differences in percent reduction among the British, Norwegian, and present samples may be attributed to the use of different treatment modalities. In the British sample, only 57.3% of the patients were treated with upper and lower fixed appliances. Twenty-eight percent were treated by single arch fixed appliances. The remainder of the patients were treated by removable appliances or functional appliances used alone.

The mean duration of treatment for the Board-accepted cases was significantly longer than that for the graduate student cases (31.7 months vs 23 months). Fink and Smith[5] investigated factors influencing treatment duration using the Salzmann Index[17] as a measure of occlusal change. He found treatment duration to be significantly correlated to the pretreatment Salzmann Index score. O'Brien et al[13] used the PAR Index to investigate factors influencing treatment duration on a sample of patients with Class II division 1 malocclusions and found a correlation between pretreatment occlusal index score and treatment duration. The present study is in agreement with the findings of the investigations of both O'Brien et al and Fink and Smith in that pretreatment PAR score and treatment duration were found to be associated. It is not unexpected that all 3 studies would find that the treatment of a more severe malocclusion would require a longer duration of treatment.

The present study found that the absolute posttreatment occlusal index scores were not associated with treatment duration. Fink and Smith[5] observed that the time spent in detailed finishing was an important source of variation in treatment duration and concluded that the Salzmann Index

that was used in his study was not ''sensitive to the highly specific and fine details of an ideally finished case.''

O'Brien et al[13] attributed the lack of correlation between treatment duration and posttreatment PAR scores to the Class II division 1 sample used in the study. The treatment may have been terminated before the fine detailing of the occlusion was accomplished due to the severity of the initial Class II division 1 malocclusion and the longer duration of treatment. Although the present study used a sample of Board-accepted cases that were preselected based on the quality of the orthodontic result, no association was found between posttreatment PAR score and duration of treatment. The present study also did not determine a statistical difference between the finely detailed Board-accepted cases and graduate student-treated cases in terms of the absolute posttreatment PAR scores. It appears that a complete evaluation of the quality of the final orthodontic result requires an inspection of other factors in addition to those measured by the PAR Index.

Limitations of the study

The Candidate Case Report Examination instructions of the American Board of Orthodontics states that the orthodontic treatment objectives evaluated include the following:

- treatment complementing facial growth,
- facial harmony—balance and harmony of the soft tissue and proper proportion of facial structures,
- maximum esthetics of the teeth and face,
- dental health—maximum health of the teeth, the supporting tissues, and the adjacent structures,
- optimal function,
- excellent occlusion,
- favorable intercuspation of teeth free of interferences and trauma,
- alignment of permanent second molars,
- favorable overjet and overbite relationship,
- favorable correction of rotations of all teeth,
- favorable axial inclination of all teeth,
- complete space closure,
- coordinated ideal archform with all the teeth aligned within their supporting structures,
- good vertical control,
- good stability.

The PAR Index directly measures only objectives number 6, 8, 9, 10, and 12. Changes in facial profile, psychosocial attitudes, and cephalometric measures that reflect skeletal aspects are not considered in the PAR Index. The PAR Index also does not evaluate functional occlusion, periodontal health, root resorption, tooth angulations, patient satisfaction, or patient compliance.

CONCLUSIONS

The present study suggests that the PAR Index may be a useful adjunctive tool to audit orthodontic treatment outcomes more objectively. The PAR Index was capable of distinguishing successful Board-accepted cases from those treated by orthodontic graduate students in terms of the amount of pretreatment to posttreatment change. This finding suggests that the Board-accepted cases had a more severe malocclusion at the onset of treatment and were treated to a more ideal final occlusion.

However, the PAR Index could not discriminate between the resident-treated and Board-accepted cases in terms of final PAR score. Two conclusions may account for this finding:

1. The Board-accepted cases and the resident-treated cases might have both been treated to the same ideal final occlusion.
2. The PAR Index may not be precise enough to discriminate between excellent final occlusion and good final occlusion.

Further investigation is needed to determine which conclusion is the accurate one.

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