

Personal Audit in Orthodontics

STEPHEN RICHMOND, B.D.S., F.D.S., M.Sc.D., D.ORTH., PH.D.

Orthodontic Unit, Department of Oral Health and Development, Higher Cambridge Street, Manchester M15 6FH

Abstract. *The use of different criteria to assess outcome of orthodontic treatment makes it difficult to compare treatment from one individual practitioner to the next. This article describes a method for all dentists to use to record outcome for self-audit purposes.*

A sample of 51 consecutively treated patients was assessed. On average, the mean percentage reduction in PAR score was 74 per cent. Eight per cent of patients were categorized as 'Worse or no different', 39 per cent 'Improved', and 53 per cent 'Greatly improved'. To achieve a good standard of orthodontic treatment it is proposed that the mean percentage reduction in PAR score should be greater than 70 per cent. The proportion of patients falling into the 'Worse or no different' category should ideally be less than 5 per cent.

Index words: Outcome of Treatment, Audit, Occlusal Indices, Quality Assurance.

Introduction/Background

The average standard of orthodontic treatment has been recently reported on a sample of 1010 patients in England and Wales and 200 patients in Norway (Richmond *et al.*, 1992a). The standard of treatment in Norway was approximately 23 per cent higher than in England and Wales (78 and 55 per cent, respectively). To improve the quality of orthodontic care to individual patients, attention should focus on internal or personal audit. This is a procedure where individual health care professionals get a feed back on performance compared with others or with what should be expected.

There have been a paucity of reports related to the outcome of treatment by individual health care workers. There have been only two reports in which consecutively treated cases have been studied. Berg (1979) analysed 248 consecutively treated cases, the majority having undergone fixed appliance treatment. The author looked at both dental cast and radiographic records. He found that the objectives were only achieved in 43 per cent of all cases. Root resorption was present in 14 per cent and overjet was not eliminated in 13 per cent of Class II cases. The objectives were not achieved in a substantial proportion of Class I, Class II, and Class III malocclusions. Although all the objectives had not been achieved, substantial improvement had been attained. In a further study, Berg and Fredlund (1981) used the Treatment Priority Index (TPI), on 60 cases selected randomly from 329 consecutively treated patients in two private practices. At the end of treatment 36 cases (60 per cent) achieved normal or near normal occlusion. They suggested that the

degree of improvement was more important than the 'success' of treatment in that, it is not always possible to achieve an ideal occlusion.

The use of different criteria makes it difficult to compare treatment from one individual practitioner to the next. The aim of this article is to describe a method for all dentists to use to record an important outcome of orthodontic treatment, namely occlusal change.

Methods

A sample of 51 consecutive patients who started treatment at Bolton General Hospital was obtained. The majority of patients were treated with fixed appliances. The type of treatments were divided into one-arch, two-arch and surgical (orthognathic) cases. The treatment duration was determined from the dates on the pre- and post-treatment study casts.

Measures of Outcome

The Index of Orthodontic Treatment Need (Richmond, 1990; Brook and Shaw, 1989) and the PAR Index (Richmond *et al.*, 1992b) were applied to the pre- and post-treated cases.

Index of Orthodontic Treatment Need (IOTN)

The Index of Orthodontic Treatment Need has two components, Aesthetic and Dental Health.

Aesthetic Component (AC). The Aesthetic Component records the dental aesthetic impairment and consists of 10 photographs showing different levels

of dental attractiveness, with Grade 1 being the most attractive and Grade 10 the least attractive arrangement of teeth (Fig. 1). Pre- and post-treatment study models can be identified and ranked according to this scale. Arguably, most treatments should start in the higher ranges and finish in the 1–3 range.

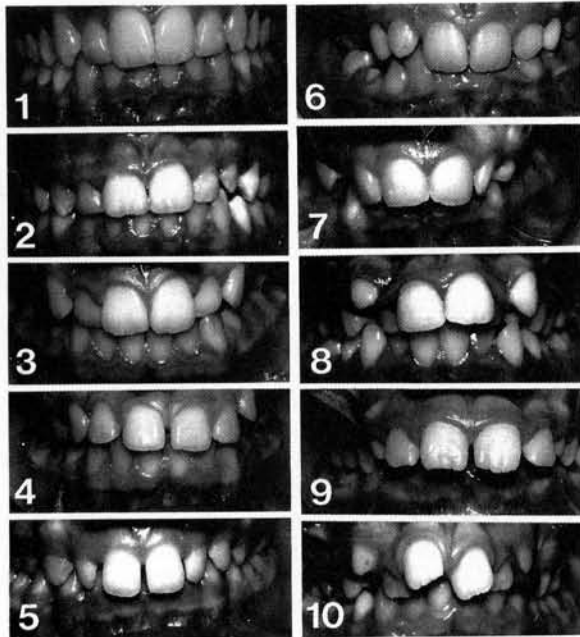


FIG. 1 The Aesthetic Component of the Index of Orthodontic Treatment Need.

Dental Health Component (DHC). The Dental Health Component records the individual occlusal traits which are most likely to increase the morbidity of the dentition and surrounding structures. There are five grades, grade 5 the greatest and grade 1 the least need for treatment on dental health grounds (Table 1). It would be expected that most treatment should start in grades 4 and 5, and finish in grades 1 and 2. Grade 3 is regarded as borderline need for treatment on dental health grounds.

The PAR Index

The PAR Index measures the standard of treatment and improvement. The concept is to assign a score to each deviant occlusal trait, and these are then summed to provide a single summary score for the individual patient. The Index has been described in more detail elsewhere (Richmond *et al.*, 1992a,b,c). Scores less than 5 would be regarded as an almost ideal occlusion and increasing scores representing increasing levels of malocclusion.

The PAR Index has been statistically weighted to reflect British dental opinion. The difference in the

pre- and post-treatment PAR scores indicates the degree of improvement. The percentage reduction in PAR score represents the success of treatment. The degree of improvement has been organized into three categories 'Worse or No different', 'Improved', and 'Greatly Improved' (Fig. 2). The degree of improvement can be assessed by mapping the pre- and post-treatment PAR scores on the horizontal and vertical axes. Where the intercept coincides the category is determined. For instance Patient 3 starting at 50 and finishing at 5 would be regarded as 'Greatly Improved'.

It has been stated (Richmond *et al.*, 1992a) that a high standard of treatment is achieved when the proportion of cases falling into the 'Worse or No different' category of an individual practitioner's case load is less than 5 per cent and the mean percentage reduction in weighted PAR score is greater than 70 per cent. If there is also a high proportion of cases falling into the 'Greatly Improved' category (greater than 40 per cent) this suggests that the practitioner is treating a substantial proportion of patients with a clear need for treatment.

Results

Treatment time

The average treatment time was 2.1 years. In one arch patients this was slightly less at 1.6 years (Fig. 3).

Index of Orthodontic Treatment Need

Aesthetic Component. The pre- and post-treatment scores are shown in Fig. 4 and Table 2. The pre-treatment scores for the surgical cases started at 10 and finished at 1. The two-arch treatments started at 8 and finished at 2. The one-arch treatment had a lower pre-treatment total, 7 and finished at 2. All cases on average started at 8 and finished at 2.

Dental Health Component. The mean pre- and post-treatment scores are illustrated in Fig. 5 and Table 2. On average all treatments started in the grade 4 category and finished in grade 2.

The PAR Index

The pre- and post-treatment scores are shown in Fig. 6 and Table 2. The surgical cases started treatment with a high pre-treatment score, 37, and the one-arch cases with a low initial score, 21.

Success of treatment (mean percentage reduction)

The success of treatment is shown in Fig. 7 and Table 2. The highest mean percentage reduction was

TABLE 1 The Dental Health Component of the Index of Orthodontic Treatment Need (IOTN)

Grade 1 (None)

1 Extremely minor malocclusions including displacements less than 1 mm.

Grade 2 (Little)

- 2.a Increased overjet greater than 3.5 mm, but less than or equal to 6 mm with competent lips.
 2.b Reverse overjet greater than 0 mm, but less than or equal to 1 mm.
 2.c Anterior or posterior cross-bite with less than or equal to 1 mm discrepancy between retruded contact position and intercuspal position.
 2.d Displacement of teeth greater than 1 mm, but less than or equal to 2 mm.
 2.e Anterior or posterior openbite greater than 1 mm, but less than or equal to 2 mm.
 2.f Increased overbite greater than or equal to 3.5 mm without gingival contact.
 2.g Pre- or post-normal occlusions with no other anomalies. Includes up to half a unit discrepancy.

Grade 3 (Moderate)

- 3.a Increased overjet greater than 3.5 mm, but less than or equal to 6 mm with incompetent lips.
 3.b Reverse overjet greater than 1 mm, but less than or equal to 3.5 mm.
 3.c Anterior or posterior cross-bite with greater than 1 mm, but less than or equal to 2 mm discrepancy between retruded contact position and intercuspal position.
 3.d Displacement of teeth greater than 2 mm, but less than or equal to 4 mm.
 3.e Lateral or anterior open bite greater than 2 mm, but less than or equal to 4 mm.
 3.f Increased and complete overbite without gingival or palatal trauma.

Grade 4 (Great)

- 4.a Increased overjet greater than 6 mm, but less than or equal to 9 mm.
 4.b Reverse overjet greater than 3.5 mm with no masticatory or speech difficulties.
 4.c Anterior or posterior cross-bites with greater than 2 mm discrepancy between retruded contact position and intercuspal position.
 4.d Severe displacement of teeth greater than 4 mm.
 4.e Extreme lateral or anterior open bites greater than 4 mm.
 4.f Increased and complete overbite with gingival or palatal trauma.
 4.h Less extensive hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis.
 4.l Posterior lingual cross-bite with no functional occlusal contact in one or both buccal segments.
 4.m Reverse overjet greater than 1 mm, but less than 3.5 mm with recorded masticatory and speech difficulties.
 4.t Partially erupted teeth, tipped and impacted against adjacent teeth.
 4.x Supplemental teeth.

Grade 5 (Very Great)

- 5.a Increased overjet greater than 9 mm.
 5.h Extensive hypodontia with restorative implications (more than 1 tooth missing in any quadrant) requiring pre-restorative orthodontics.
 5.i Impeded eruption of teeth (with the exception of third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any pathological cause.
 5.m Reverse overjet greater than 3.5 mm with reported masticatory and speech difficulties.
 5.p Defects of cleft lip and palate.
 5.s Submerged deciduous teeth.

Nomogram to determine improvement

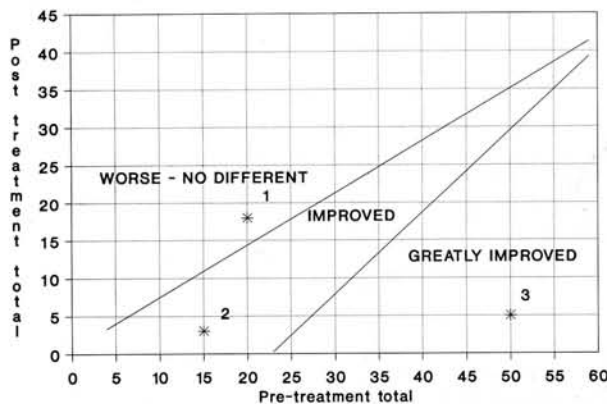


FIG. 2 The nomogram to assess improvement.

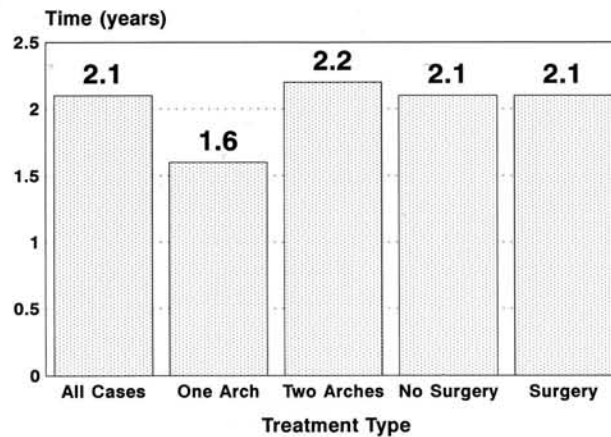


FIG. 3 Length of treatment time.

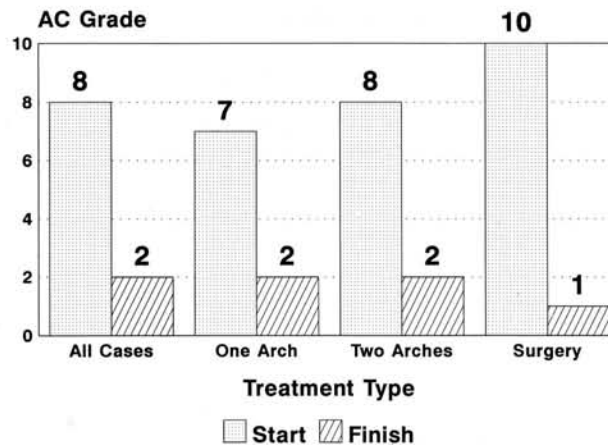


FIG. 4 Pre- and post-treatment scores for the Aesthetic Component.

TABLE 2 IOTN and PAR scores pre- and post-treatment

	Aesthetic Component		Dental Health Component		PAR Scores		% reduction (pre- to post-treatment)
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	
<i>n</i>	51	51	51	51	51	51	51
Mean	8	2	4	2	29	7	74
Standard deviation	2	1	—	—	11	6	21
Minimum	3	1	2	2	4	1	25
Maximum	10	9	5	4	50	30	96

achieved with the surgical cases (83 per cent) and the lowest with the single arch cases (60 per cent). On average for all 51 patients the mean percentage reduction in PAR score was 74 per cent (a good standard of treatment).

Assessment of improvement

Eight per cent of patients were categorized as 'Worse or No different', 39 per cent improved and 53 per cent 'Greatly Improved' (Fig. 8).

'Worse or no different patients'

Patient 1 (Fig. 9). The patient presented with a Class II division 2 type malocclusion. Upper and lower fixed appliances were employed to align the arches prior to surgical correction.

Two weeks prior to the operation the patient decided she was happy with her appearance and declined any further treatment. The aesthetics worsened slightly (AC 8 to 9). The Dental Health Component stayed the same (DHC 4.a), with an

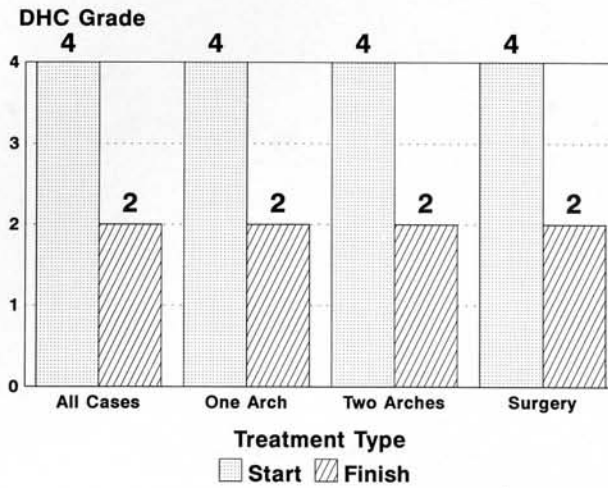


FIG. 5 Pre- and post-treatment scores for the Dental Health Component.

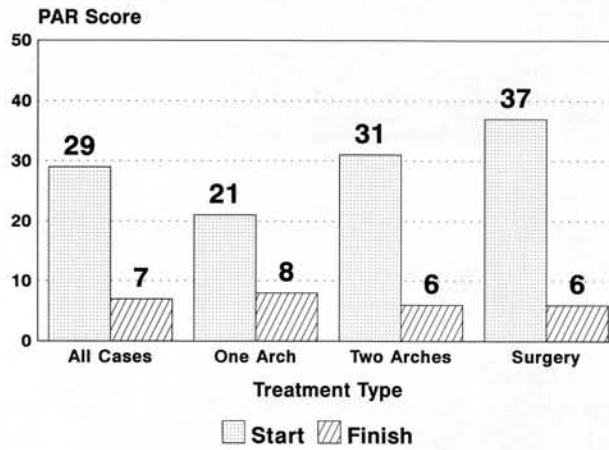


FIG. 6 Pre- and post-treatment PAR scores.

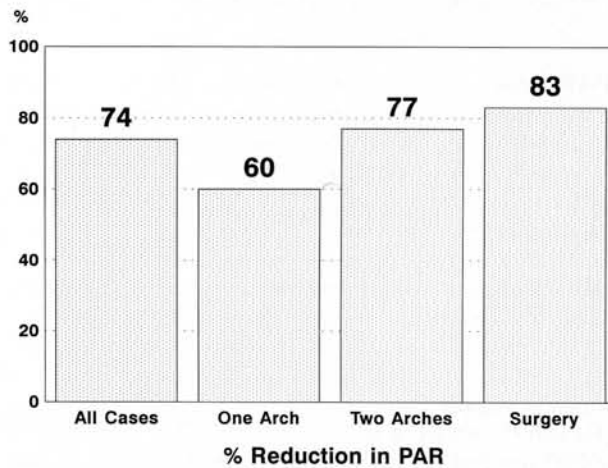


FIG. 7 Success of treatment (mean percentage reduction in weighted PAR scores).

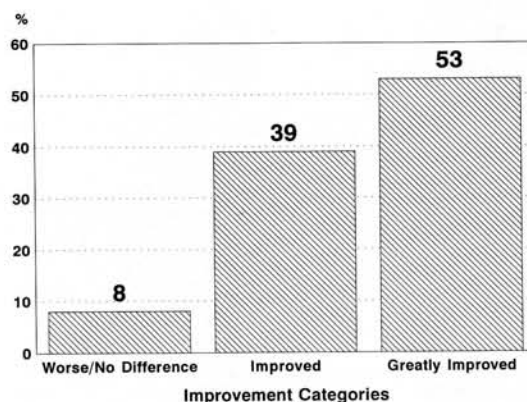


FIG. 8 Assessment of improvement.



FIG. 9 Patient 1: the aesthetics worsened slightly (AC 8 to 9). The Dental Health Component remained the same 4.a. The PAR Index was reduced from 42 to 30, a 29 per cent reduction. This patient would be categorized as 'Worse or No different'.

increased overjet. The PAR Index was reduced from 42 to 30, a 29 per cent reduction in PAR score. It is to be expected that a certain percentage of patients will opt out of treatment. However, it is important that the proportion of patients discontinuing treatment should be kept as low as possible.

Patient 2 (Fig. 10). The patient present with a bimaxillary protrusion; all four first premolars were extracted followed by upper and lower fixed appliances.

The aesthetics have not substantially improved (AC 3 to 1). The Dental Health Component is unchanged (DHC 2.g). The initial score of 4 is difficult to improve upon. In fact, the score was reduced by 1

point, a 25 per cent reduction. Very little improvement has been achieved and it is arguable whether four extractions and 2 years of treatment is worth a 25 per cent reduction in PAR score and a 2-point change in Aesthetic Component. Whilst it is appreciated that the correction of a bimaxillary protrusion may lead to an improvement in a patient's facial appearance, it is doubtful whether this patient benefited either facially or dentally from orthodontic treatment.

'Greatly improved' patients

Patient 3 (Fig. 11). This patient presented with a Class II division 1 malocclusion. The upper first and

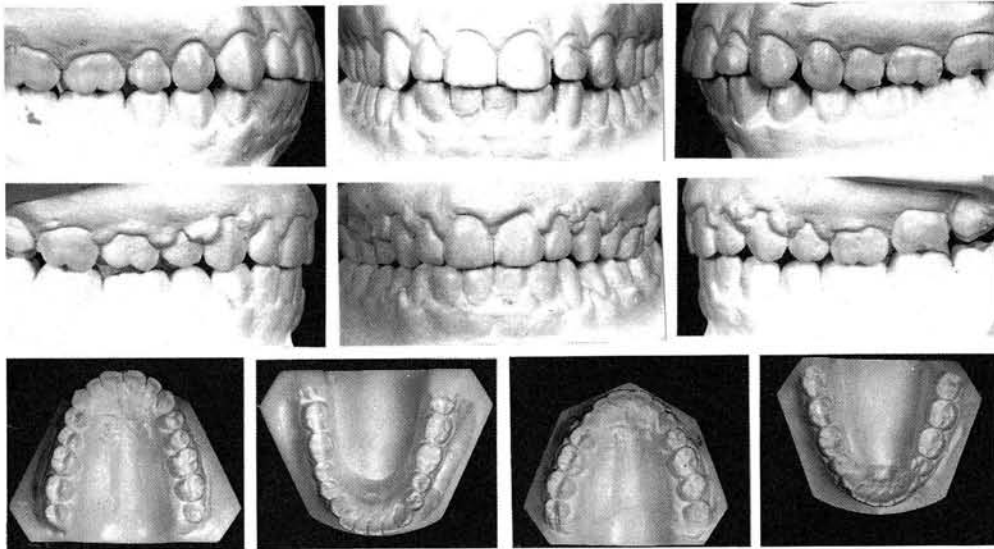


FIG. 10 Patient 2: the aesthetics improved slightly (AC 3 to 1). The Dental Health Component remained the same 2.g. The PAR Index was reduced from 4 to 3, a 25 per cent reduction. This patient would be categorized as 'Worse or No different'.

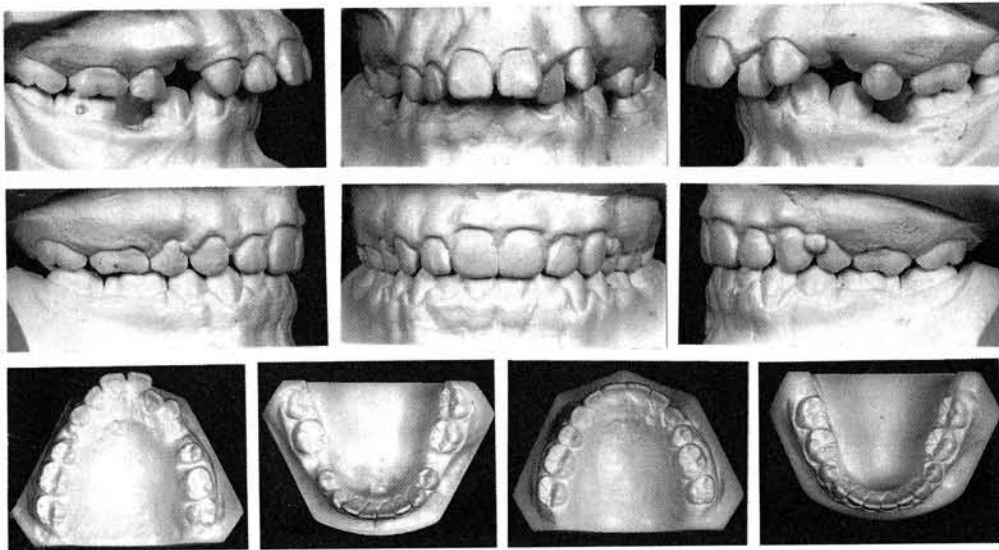


FIG. 11 Patient 3: the aesthetics have substantially improved (AC 9 to 1). The Dental Health Component improved 5.a to 2.g. The PAR Index was reduced from 36 to 2, a 94 per cent reduction. This patient would be categorized as 'Greatly improved'.

lower second premolars were extracted followed by upper and lower fixed appliances.

The Aesthetic and the Dental Health Components have substantially improved (AC 9 to 1; DHC 5.a to 2.g). The weighted PAR score shows a change of 34, a 94 per cent reduction, a good standard of treatment.

Patient 4 (Fig. 12). This patient presented with a

marked Class III relationship. Upper and lower fixed appliances were used prior to surgical intervention.

The Aesthetics and Dental Health Components have substantially improved (AC 10 to 1; DHC 5.b to 2.g). The weighted PAR score has been reduced by 48, a 96 per cent reduction in PAR score. These patients also highlight a common problem resulting from orthodontic treatment, namely areas of gingival

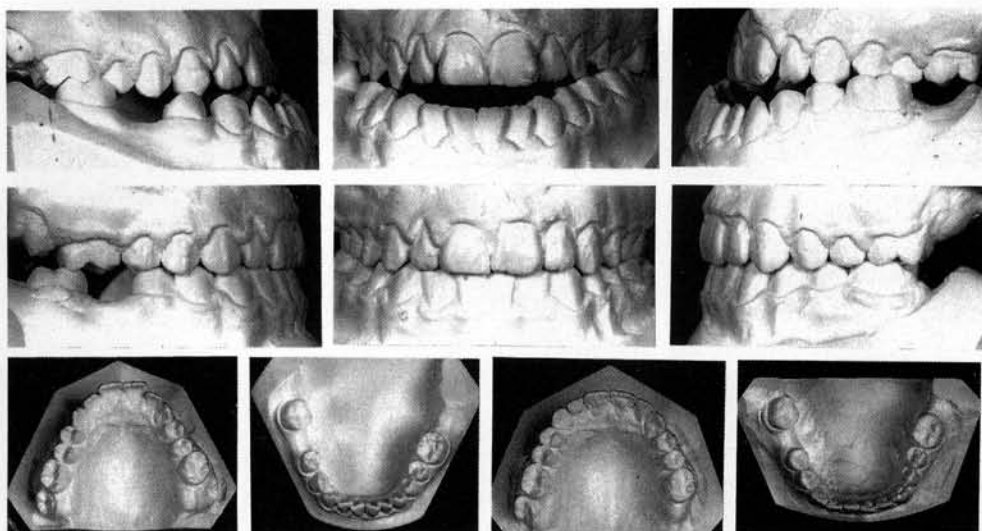


FIG. 12 Patient 4: the aesthetics have substantially improved (AC 10 to 1). The Dental Health Component improved 5.b to 2.g. The PAR Index was reduced from 50 to 2, a 96 per cent reduction. This patient would be categorized as 'Greatly improved'.

hyperplasia, due to a combination of poor oral hygiene, and/or residual composite around brackets.

Discussion

The results suggest that a good standard of treatment has been achieved (mean percentage reduction in weighted PAR score greater than 70 per cent). It was disappointing that the finishing scores for the various types of treatment were not all below 5 PAR points. The number of cases falling into the 'Worse or No different' category was slightly higher than the suggested level of below 5 per cent. The results compared favourably with the general standards in England and Wales (Richmond 1990; Richmond *et al.*, 1992a, 1992c) where the average mean percentage reduction in PAR score was 55 per cent and the number of patients falling into the 'Worse or No different' category was 22 per cent. However, the results were less successful when compared with treatments achieved by some practitioners in Norway (Richmond *et al.*, 1992a) where the mean percentage reduction in weighted PAR score was 78 per cent and the number of cases falling into the 'Worse or No different' category was 4 per cent. In fact, four of the orthodontic practitioners visited in Norway by the author achieved mean percentage reductions of greater than 80 per cent. Of the 51 patients treated, 16 were reviewed 1 year after debond, and showed a slight improvement in overall alignment and occlusion. There was a 2 per cent improvement to the mean percentage reduction in weighted PAR score to 76 per cent.

The difference in the standard of treatment achieved in Norway compared to the General Dental Services of England and Wales can be explained by orthodontic treatment being almost entirely provided by specialist orthodontists using upper and lower fixed appliances in over 90 per cent of Norwegian patients. This compares to 29 per cent of treatments provided by specialist orthodontists, and less than 25 per cent of upper and lower fixed appliances employed in England and Wales. The case load is much lower in Norway compared to England and Wales and this may result from the Norwegians using an index of treatment need, prioritizing their patients, and using upper and lower fixed appliances in the majority of cases. The Norwegians also have a favourable orthodontist: 12-year-old population ratio.

Whilst the PAR index is an initial and valid approach to auditing outcome of orthodontic treatment, there are other factors that should not be ignored, such as the risks of developing root resorption, decalcification, gingival and periodontal disease.

For further development of the audit process, consideration should be given to objectively assessing facial attractiveness, although this area is fraught with difficulty as changes in facial attractiveness will have to be substantiated against a matched population in which no orthodontic treatment has been undertaken. The changes in the face are often small (resulting from orthodontic treatment) compared to the dramatic changes due to normal development (80 per cent of orthodontic treatment is undertaken

between the ages of 11 to 16 (Richmond *et al.*, 1992d). Although the association between occlusal anomalies and mandibular dysfunction is weak (Mohlin and Thilander, 1984), some objective assessment of functional occlusion may be beneficial. Patient satisfaction with their appearance should be sought before and after treatment, and caution is needed when interpreting patient satisfaction on completion of treatment alone.

To check for stability the patients' occlusion should be assessed at least 1 year after completion of appliance therapy, and a random sample of cases perhaps at 5 years and beyond.

A practitioner will never be able to evaluate the long-term effects of treatment if the patients are discharged 1 year after appliance therapy.

Considerations to improve personal orthodontic standards

(i) *Period of training.* Quality, type and length of orthodontic training is important during which experience should be gained in both longitudinal and cross-sectional treatments, and more importantly, assessing outcome and relapse. Also the practitioners should continue to keep abreast of new techniques and should be aware of new developments to assess treatment need and success of treatment.

(ii) *Measures of compliance.* There should be a more objective assessment of compliance to reduce the number of patients wishing to terminate treatment early. Patients should be made more aware of the benefits and risks of orthodontic treatment (Shaw *et al.*, 1991).

(iii) *Borderline or lack of need for treatment.* Those patients who have initial low PAR, aesthetic or dental health scores should perhaps not be treated. Patients and parents should be made aware that little benefit will be achieved if they underwent appliance therapy and that risks are involved, in that, the treatment may not be successful, and root resorption and/or decalcification may occur. In a study of borderline cases (Richmond *et al.*, 1992c), as many as 50 per cent of patients did not appear to benefit from treatment.

(iv) *One or two arch treatments, and appliance type.* Due consideration should be given to the relative benefit of one-arch treatments. The overall benefit will depend on the alignment, the interdigitation, and the development of crowding in the opposing arch. The use of upper and lower fixed appliances produces the best standard of treatment (Richmond *et al.*, 1992c).

(v) *Continuous audit.* This type of assessment will be undertaken by the author whose results will be re-assessed on a consecutive sample of 50 patients every 2–3 years to check that the standard of care is at least maintained and, hopefully, improved. It is hoped that all orthodontists will audit their treatment results periodically and discuss their treatments with their peers in organized meetings in order that standards are maintained or improved.

Conclusions

A method to undertake self-audit has been described. To achieve a good standard of orthodontic treatment it is proposed that the mean percentage reduction in PAR score should be greater than 70 per cent, the proportion of patients falling into the 'Worse or no different' category should be less than 5 per cent. If more than 50 per cent of patients fall into the 'Greatly Improved' category then this indicates the practitioner is treating a high proportion of his/her patients with a clear need for treatment to a high standard.

Acknowledgements

I would like to thank David Lewis for his advice and expertise in clinical matters, and to Alan Jack and Clive Atack for the illustrations and photographs.

References

- Berg, R. and Fredlund, A. (1981)**
Evaluation of orthodontic treatment results, *European Journal of Orthodontics*, **3**, 181–185.
- Berg, R. (1979)**
Post-retention analysis of treatment problems and failures in 264 consecutively treated cases, *European Journal of Orthodontics*, **1**, 55–68.
- Brook, P. H. and Shaw, W. C. (1989)**
The development of an index for orthodontic treatment priority, *European Journal of Orthodontics*, **11**, 309–332.
- Mohlin, B. and Thilander, B. (1984)**
The importance of the relationship between malocclusion and mandibular dysfunction and some clinical applications in adults, *European Journal of Orthodontics*, **6**, 192–204.
- Richmond, S. (1990)**
A critical evaluation of orthodontic treatment in the General Dental Services of England and Wales, Ph.D. Thesis, University of Manchester.
- Richmond, S., Shaw, W. C., Roberts, C. T. and Andrews, W. (1992a)**
The PAR Index (Peer Assessment rating): Methods to determine outcome of orthodontic treatments in terms of improvement and standards, *European Journal of Orthodontics*, **14**, 180–187.

- Richmond, S., Shaw, W. C., O'Brien, K. D., Buchanan, I., Jones, R., Stephens, C. D., Roberts, C. T. and Andrews, M. (1992b)**
The development of the PAR Index (Peer Assessment Rating): Reliability and validity,
European Journal of Orthodontics, **14**, 125-139.
- Richmond, S., Shaw, W. C., Stephens, C. D., Roberts, C. T. and Andrews, M. (1992c)**
Orthodontics in the General Dental Service in England and Wales: A critical assessment of standards,
British Dental Journal, (in press).
- Richmond, S., Andrews, M. and Roberts, C. T. (1992)**
The provision of orthodontic care in the General Dental Services of England and Wales: Extraction patterns, treatment duration and standards,
British Journal of Orthodontics, (in press).
- Shaw, W. C., O'Brien, K. D., Richmond, S. & Brook, P. H. (1991)**
Risk benefit appraisal in orthodontics,
British Dental Journal, **170**, 33-37.