

# Quality assessment in orthodontics using the IOTN and PAR indices

Hans Bäckström and Bengt Mohlin

Denna studie visar att IOTN och PAR index är användbara för rutinmässig klinisk kvalitetskontroll. Den kombinerade användningen av de två indexen täcker flera aspekter av ortodontisk kvalitetskontroll innefattande såväl patientselektion som estetik och övriga morfologiska faktorer. För att minska observatörsvariationer av registreringar i ett längre tidsperspektiv genom kontinuerlig kalibrering skulle bildandet av studiegrupper för kvalitetsutveckling vara av värde. Enligt PAR-indexet uppnår den undersökta kliniken lika goda eller bättre behandlingsresultat som specialistkliniker i England och Norge, undersökta med samma metodik. Långtidseffekten av behandlingarna återstår att undersöka. Majoriteten av de patienter som behandlades 1995 och 1996 hade ett uttalat behandlingsbehov enligt IOTN-DHC. Den estetiska bedömningen, IOTN-AC, visade att 20–25 % av patienterna hade lågt estetisk behandlingsbehov medan cirka 35 % bedömdes ha ett uttalat sådant behov.

For some years, the dental and medical professions in Sweden have been obliged to evaluate regularly the quality of treatment. In public dentistry for children, most countries have developed instruments for continuous follow-up of productivity and the cost of treatment. Epidemiological information has been available mainly in respect of dental caries and gingivitis/periodontitis. Orthodontic care has not had well accepted tools for the audit and evaluation of the success of treatment in the long and short term.

The quality of orthodontic care involves the appropriate selection of patients for treatment with good short and long-term morphological and functional improvement after treatment, the control of side effects of treatment and on acceptable treatment time, among other things [1–3]. The effective use of the resources for orthodontic care in Sweden is of immediate interest due to a recent reduction in manpower and the great increase in the number of children expected during the next decade.

About ten years ago a debate began concerning the quality of dental and especially orthodontic treatment in the United Kingdom. One result was the formation of an "occlusal index committee" with the task of producing indices to describe the need for and the success of treatment. Two indices were produced: the IOTN (Index of Orthodontic Treatment Need) and PAR (Peer Assessment Rating) [4–6]. The IOTN has two parts: the dental health component (DHC) and the aesthetic component (AC). The dental health component was developed from the index for orthodontic treatment need designed by the Swedish Board of Health and Welfare (1967) by addition of clearly measurable cut-off points between the different grades. The inter- and intraexaminer agreement

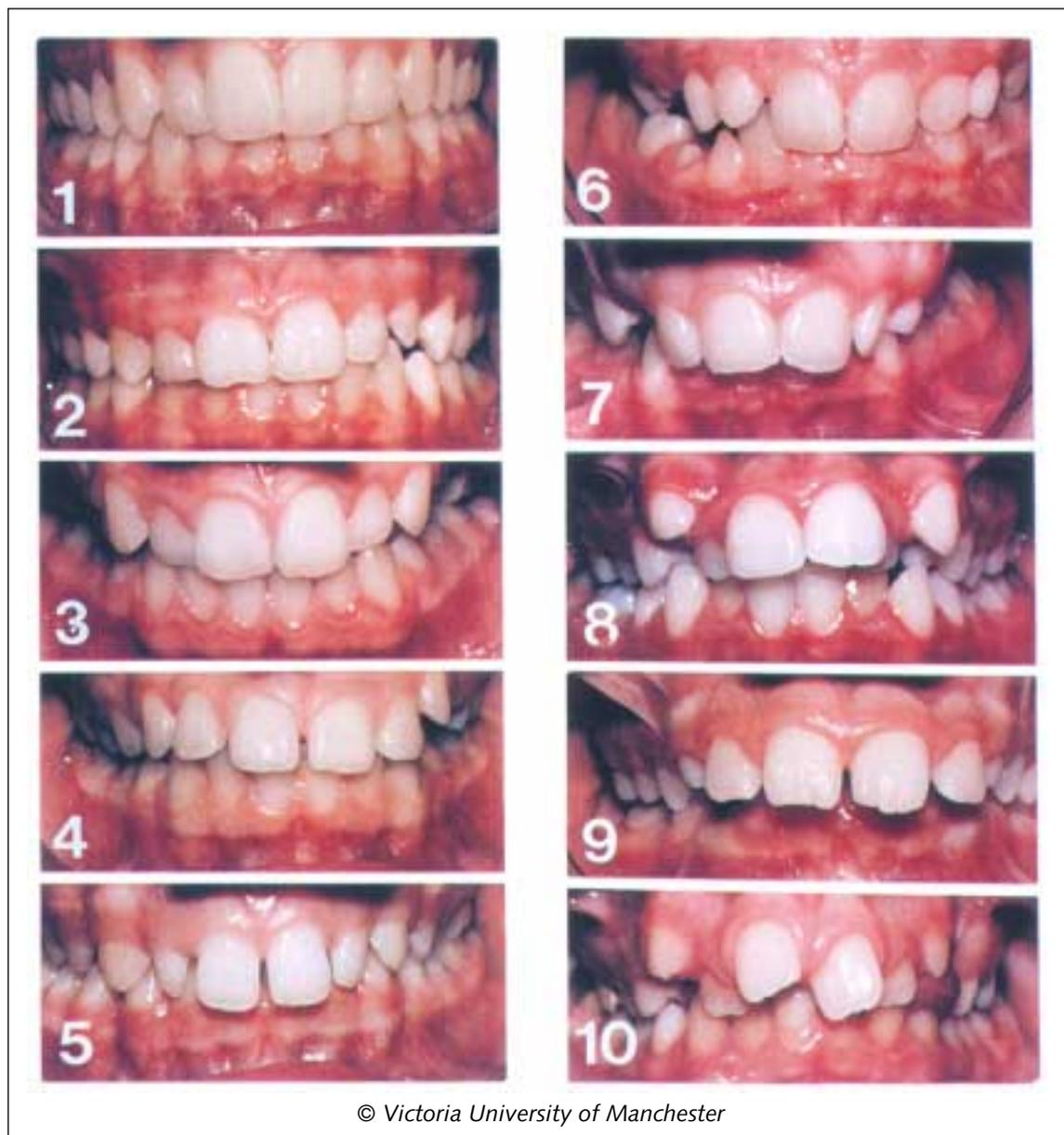
## Authors

Hans Bäckström, Specialist Clinic in Orthodontics, Uddevalla/ Stenungsund, Bohuslän and Bengt Mohlin, Department of Orthodontics, Institute of Odontology, Göteborg University, Sweden.

## Key words

malocclusion; orthodontics; occlusal indices; quality assessment

Accepted for publication 28 February 1998



**Figure 1.** The aesthetic component (AC) of the IOTN. Photo number 1 is the most attractive and number 10 the least attractive arrangements. Grades 1–4 indicate no/ slight need for treatment, grades 5–7 a moderate/ borderline need for treatment and grades 8–10 a definite need for orthodontic treatment.

has been tested on referred patients and 11 to 12- year-old schoolchildren and was found to be acceptable. The aesthetic component was developed after the examination by six non-professional examiners of a large number of standardised dental photographs. The aesthetic component now exists as a series of photographs illustrating increasingly severe malocclusions in stages of 1 (the least severe) to 10 (the most severe).

The PAR index is intended to measure morphological changes during treatment. The index was validated by a group of 74 dentists and a weighting was applied to represent British professional opinion at the time the index was devised. An attempt has been made to adjust the weighting to American orthodontic opinion [7].

”Improvement” requires a reduction in the PAR score of at least 30%. If the reduction is 22 points or more, the case is considered greatly improved [6]. The evaluation of the success of treatment is made either from the percentage reduction in the PAR score or by the use of a nomogram. The selection of patients for treatment and the result of treatment are associated in many ways. Cases which are greatly improved according to the PAR score are required to have a fairly severe malocclusion before treatment begins. In an evaluation of orthodontic treatment in general dental practice in England and Wales, it was found that 21% of the treated cases were unimproved or worse. If the less severe cases were considered (IOTN less than 3), this proportion rises to 34% [2]. Another reason not

to treat less severe cases is to avoid patients with a tendency to project other than dental problems onto a perceived malocclusion which does not seem realistically associated with the problems described by the patient.

A further reason to include easily comparable measurements of malocclusion at the beginning and end of orthodontic treatment in the records of all patients is to provide data for the long-term follow-up of the results of treatment. Several recent studies indicate that occlusal changes may take place several years after retention and include changes in the alignment of teeth and the development of lower front crowding [8–13]. Our knowledge of the influence the various factors have on the long-term stability of treatment remains incomplete. Hence, there is a reason for continuous evaluation of the various treatment factors and the long-term effects of different types of treatment.

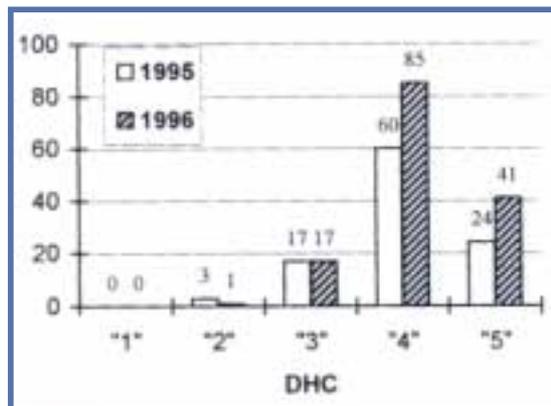
The aim of the present study is to evaluate patient selection and the success of orthodontic treatment in a specialist clinic using the IOTN and PAR. These data will serve as a baseline for long-term follow-up and will also serve as a quality indicator which will enable regular follow-up of treatment results to be done in an individual clinic as well as allowing comparisons to be made between clinics. The usefulness of these two indices in continuous quality control will be discussed.

### Material and methods

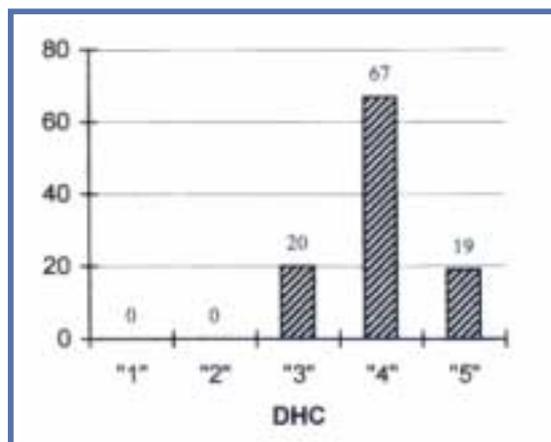
All patients registered at the specialist Orthodontic clinic in Stenungsund, Bohuslän, from the first of July 1994 until the end of 1996 have been evaluated using the IOTN and PAR. 106 of these patients were examined before and after completion of treatment. All the measurements for both indices were made by the same examiner (HB). The examiner was calibrated with regard to accuracy at the Department of Orthodontics, University of Manchester, where the indices were developed.

The IOTN-DHC uses a five-point scale where the cut-off points have been defined precisely. The patient is assigned to a particular group on the basis of the trait of malocclusion which is considered to be the most severe (Table 1). The assessment is made from study casts and from clinical measurements. A special ruler was developed to make measurements fast and easy.

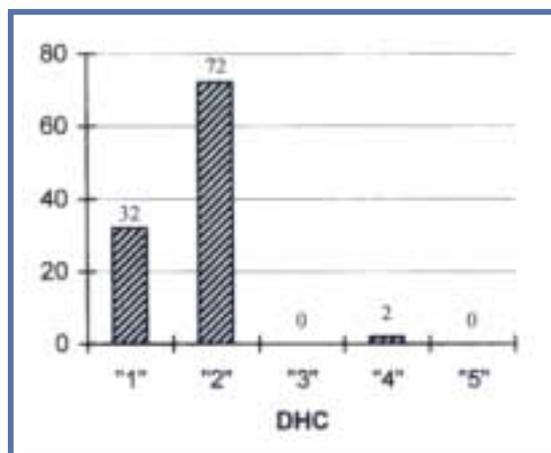
The second part of the index, the aesthetic component (AC), evaluates dental attractiveness on a 10-point scale and each step is illustrated by a clinical photograph (Fig. 1). Grades 1–4 indicate no/slight aesthetic need for treatment, grades 5–7



**Figure 2.** Distribution of the 1995 and 1996 patients by the different grades of the IOTN-DHC.



**Figure 3.** Distribution before treatment by the grades of the IOTN-DHC for patients who had completed treatment.



**Figure 4.** Distribution after treatment by the grades of the IOTN-DHC for patients who had completed treatment.

a moderate/borderline need and grades 8–10 indicate a definite need for treatment.

The PAR index includes five components: 1) Upper and lower anterior segments, 2) left and right buccal occlusion, 3) overjet, 4) overbite and 5) centreline. The contact point displacement in the upper and lower anterior segments is recorded as the shortest distance between contact points of adjacent teeth measured parallel to the occlusal plane. Deviations are given particular scores (Table 2). Weightings have been derived for the five components after a validation study carried out by 74 British dentists [5, 6].

**Table 1. The dental health component of the index of orthodontic treatment need (IOTN)****Grade 5 (Need treatment):**

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

**Grade 4 (Need treatment):**

- 4.h Less extensive hypodontia requiring preresorative orthodontics or orthodontic space closure to obviate the need for a prosthesis.
- 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.m Reverse overjet greater than 1 mm but less than 3.5 mm with recorded masticatory and speech difficulties.
- 4.c Anterior or posterior crossbites with greater than 2 mm discrepancy between retruded contact position and intercuspal position.
- 4.l Posterior lingual crossbite with no functional occlusal contact in one or both buccal segments.
- 4.d Severe contact point displacements 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.t Partially erupted teeth, tipped and impacted against adjacent teeth.
- 4.x Presence of supernumerary teeth.

**Grade 3 (Borderline need):**

- 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 crossbites with greater than 1 mm but less than or equal to 2 mm discrepancy between retruded contact position and intercuspal position.
- 3.d Contact point displacements 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 Deep overbite complete on gingival or palatal tissues but no trauma.

**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 crossbite with less than or equal to 1 mm discrepancy between retruded contact position and intercuspal position.
- 2.d Contact point displacements greater than 1 mm but less than or equal to 2 mm.
- 2.e Anterior or posterior open bite 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 Prenormal or postnormal occlusions with no other anomalies (includes up to half a unit discrepancy).

**Grade 1 (None):**

- 1.a Extremely minor malocclusions including contact point displacements less than 1 mm.

## Results

### Subjects

The sex distribution of the patients registered in 1995 and 1996 shows a slight female dominance. In 1995, 55% were girls and 45% boys. The corresponding figures for 1996 were 59 and 41% respectively. Half of the 375 patients registered during the entire observation period belonged to the age group 11–15 years. The separate figures for 1995 and 1996 were 47 and 49% respectively. The second most prevalent age group was 16–19 years, with 28% for both years. This age group represented 27% of the subjects in 1995 as well as 1996. The proportion of adult patients (20 years and above) was 17% in 1995 and 19% in 1996.

### Index values

The distribution of the different DHC levels shows that the majority of patients were assigned to grades 4 and 5 (treatment need), 12–16% to grade 3 (borderline need) and only a few subjects to grade 2 (little need) (Fig. 2). Among different malocclusion traits crucial for the DHC score, increased overjet was most common, especially in 1996, followed by cross-/scissors bites and crowding with an almost equal prevalence and thereafter eruption problems and hypodontia. The distribution of the different AC grades was more even, also including 27% in 1995 and 22% in 1996 with no or slight need for aesthetic correction. 38% in 1995 and 45% in 1996 were considered to have a moderate or borderline need for aesthetic reasons. The mean weighted PAR score was almost 25 in 1995 and close to 29 in 1996.

The change in IOTN-DHC in the 106 patients followed until the completion of active treatment is shown in Figures 3 and 4. These figures show that only 2 individuals still had a residual need for treatment. Prior to treatment, 81% needed treatment and 19% had a borderline need. In one of these two remaining subjects, treatment was interrupted while the second desired only partial treatment. The aesthetic improvement is evident from Figures 5 and 6. All but two individuals were assigned to the groups indicating no or slight treatment need for aesthetic reasons after active treatment.

The percentage improvement of the weighted PAR score was about 87% and of the un-weighted PAR 85%. The average reduction of PAR score was above 23 points, indicating a considerable improvement (Fig. 7). The improvement by treatment is illustrated by the two treated patients in Figures 8 and 9.

## Discussion

Recent studies evaluating orthodontic treatment results in Sweden have focused on the effectiveness of different types of treatment such as interceptive treatment, extractions or the treatment of class II malocclusion [10, 12–14]. No generally accepted methods for continuous and comparable quality evaluation seem to have been available. The introduction of the PAR index was an attempt to create a method of estimating morphological changes in a standardised way. The reproducibility of this index has been tested and found acceptable in comparison with other indices [5, 15, 16]. Reproducibility may vary to some extent depending on the experience of the observers and a certain inter-observer variability is also to be expected [16]. The constancy of recordings over time may also show some variation. One way to reduce the variability of recording may be the continuous calibration of examiners. Nationally, this could be achieved by the creation of study groups for quality evaluation.

Validation, and especially the weighting of the index, reflects British professional opinion and may not necessarily agree with opinion amongst Swedish orthodontists. American validation of the

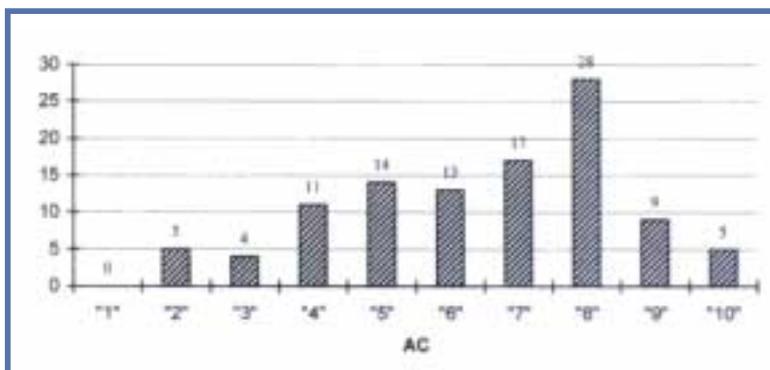


Figure 5. Distribution before treatment by the grades of the IOTN-AC for patients who had completed treatment.

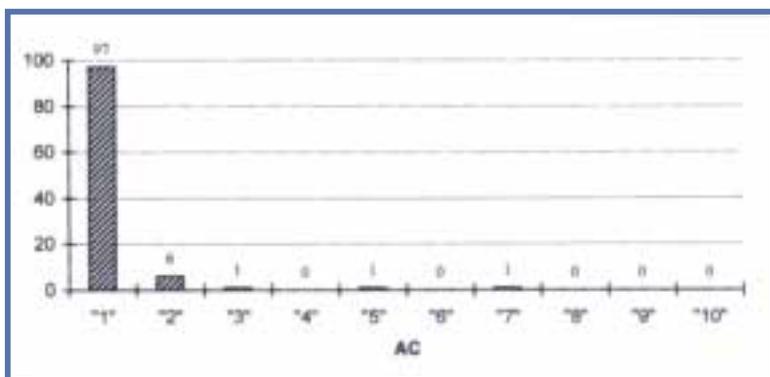


Figure 6. Distribution after treatment by the grades of the IOTN-AC for patients who had completed treatment.

**Table 2. The PAR (Peer Assessment Rating) index**

**Components**

- 1. Upper and lower anterior segments
- 2. Left and right buccal occlusion
- 3. Overjet
- 4. Overbite
- 5. Centreline

**1) Contact point displacement score**

- 0 0–1 mm
- 1 1.1–2 mm
- 2 2.1–4 mm
- 3 4.1–8 mm
- 4 >8 mm
- 5 impacted teeth

**2) Buccal occlusal assessment**

*a) Antero-posterior*

- 0 Good interdigitation
- 1 <1/2 unit from full interdigitation
- 2 Half a unit

*b) Vertical*

- 0 No open bite
- 1 Lateral open bite on at least 2 teeth >2 mm

*c) Transverse*

- 0 No crossbite
- 1 Crossbite tendency
- 2 Single tooth in crossbite
- 3 >1 tooth in crossbite
- 4 >1 tooth in scissors bite

**3) Overjet assessment**

*a) Overjet*

- 0 0–3 mm
- 1 3.1–5 mm
- 2 5.1–7 mm
- 3 7.1–9 mm
- 4 >9 mm

*b) Anterior crossbite*

- 0 No crossbite
- 1 ≥1 teeth edge to edge
- 2 one single tooth in crossbite
- 3 2 teeth in crossbite
- 4 >2 teeth in crossbite

**4) Overbite assessment**

*a) Open bite*

- 0 No open bite
- 1 Open bite ≤1 mm
- 2 Open bite 1.1–2 mm
- 3 Open bite 2.1–3 mm
- 4 Open bite ≥4 mm

*b) Overbite*

- 0 ≤1/3 coverage of the lower incisor
- 1 >1/3 but <2/3 coverage of the lower incisor
- 2 ≥2/3 coverage of the lower incisor
- 3 Greater or equal to full tooth coverage

**5) Centreline assessment**

- 0 Coincident and up to 1/4 lower incisor width
- 1 1/4–1/2 lower incisor width
- 2 >1/2 lower incisor width

**Weightings**

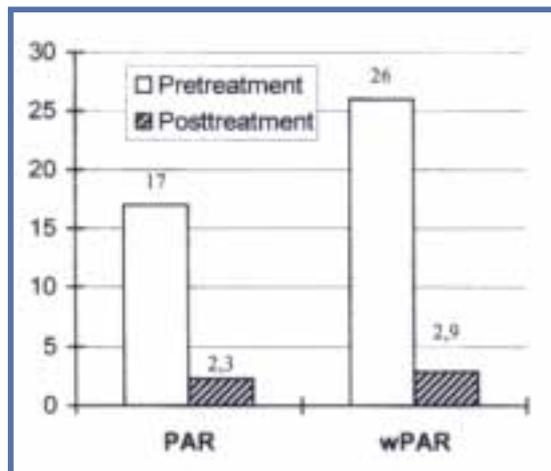
- 1. Upper and lower incisor segments x1
- 2. Left and right buccal occlusion x1
- 3. Overjet x6
- 4. Overbite x2
- 5. Centreline x4

index has, for instance, reduced the high weighting of overjet (4.5 instead of 6) to reflect more exactly the national opinion [7]. Similar adjustment according to Swedish opinion ought to be made. The index can then be used with both national and international weightings for comparison of treatment results. As PAR

is an index for the measurement of occlusal morphology, several aspects of orthodontic treatment quality are not taken into consideration, such as the patient's own assessment of his treatment need and the treatment result, the duration of treatment and various side effects, for instance. The index does

not reflect all details of morphological change. For example, the reduction in overjet may have been accomplished by simple retroclination of the incisors, resulting in an incorrect axial inclination of the teeth. Improper treatment may be demonstrated as a result of long-term follow-up. On the other hand, PAR allows rapid recordings and is therefore suitable for routine quality evaluation in a clinic. It may also serve as a basis for long-term follow-up and further analysis of the causes of relapse. The index has gained widespread use and is thus suitable for both national and international comparison of treatment results.

In this study, the IOTN index has been used together with the PAR index to include both patient selection and morphological improvement in a routine evaluation in an orthodontic clinic. The reliability has been shown to be good for the dental health component and fairly good for the aesthetic component [4, 16]. The use of indices for patient selection is open to question, especially because they do not consider all aspects of treatment demand and are fairly blunt instruments in the evaluation of dental health and the functional consequences of certain malocclusions. Few indices consider the influence of age upon treatment need. Indices such as the IOTN may, however, be of value in continuous clinical quality evaluation in order to provide an overview of the severity of the cases, including an aesthetic assessment, treated in different clinics. Both PAR and the IOTN have the advantage of being fast and easy to use and this is to some extent a tribute to the assessment rulers which are



**Figure 7.** Change in unweighted and weighted PAR score from start to completion of treatment.

available. Several of the cut-off points in the IOTN are questionable, for instance the assumed influence of different measurements of functional displacement as well as the assumed relationship between different degrees of overjet and the risk of traumatic tooth injuries. Thus, the IOTN needs to be further developed.

The treatment results for patients evaluated in this study according to the PAR index showed an average improvement in the weighted PAR score of almost 90% and an average reduction of PAR score to somewhat above 22. Comparable figures for treatment in the general dental service in England and Wales show a percentage reduction of 52%. Treatment with fixed appliances produced a reduction of 71%. Figures from Norway present an average reduction of slightly below 80% in patients treated by specialists or dentists with postgraduate training



**Figure 8.** One patient before and after orthodontic treatment. Before treatment: IOTN-DHC=4d, IOTN-AC=7, w PAR=49. After treatment: IOTN-DHC=1, IOTN-AC=1, w PAR=0.



**Figure 9.** One patient before and after orthodontic treatment. Before treatment: IOTN-DHC=4d, IOTN-AC=7, w PAR=40. After treatment: IOTN-DHC=2g, IOTN-AC=1, w PAR=1.

[2, 17, 18]. An average reduction of weighted PAR score of 70% is considered to indicate a high standard of treatment and a reduction in the PAR score of 22 or more is considered to demonstrate a great improvement [6].

It appears from the distribution of the aesthetic component that 20–25% of the subjects showed a minor need for treatment while about 35% were judged to have an obvious aesthetic need. This indicates that, apart from the aesthetic reasons for treatment, there seems to be a comparatively large group of patients treated as a result of concern for function or oral health. It would be an advantage in future follow-up if the initial treatment needs were stated in terms of aesthetic, functional or dental health reasons instead of a simple morphological description. In ideal circumstances, this should be combined with a questionnaire or structured interview which attempts to identify the nature and strength of a patient's desire for treatment. Although their desire for treatment has usually been found to be related to the morphological severity, there may be exceptions, not least related to age [19, 20].

The majority of patients in this study belonged to the "treatment need" group; less than 20% showed a borderline need for treatment and none was found to be without the need for treatment according to the IOTN. Thus, it seems that patients with less severe malocclusions have been excluded from treatment. This is of importance, in order to avoid cases where there is not likely to be a substantial improvement as well as avoiding patients who project other than dental problems upon their malocclusion.

## Summary

This study shows that the IOTN and PAR index could be used in routine clinical practice for continuous quality evaluation in orthodontics. The combined use of two indices allows several aspects of orthodontic treatment quality to be assessed including patient selection, aesthetics and morphological change.

In order to reduce variability between observers at the same time and variability of the same observer over time, the formation of study groups for continuous calibration and quality evaluation would be beneficial. According to the methods used, the quality of treatment in the clinic investigated seems to be as good as, or better than, that in specialist practices in England and Norway. The long-term treatment quality remains to be evaluated. The majority of patients treated in 1995 and 1996 showed a high treatment need according to the IOTN-DHC. When the IOTN-AC was applied, 35% of the patients had a clear need for treatment and 20–25% of the patients had a low aesthetic need for treatment.

## References

1. Shaw WC, O'Brien KD, Richmond S, Brook P. Quality control in Orthodontics: Risk/benefit considerations. *Br Dent J* 1991; 170: 33–7.
2. Shaw WC, Richmond S, O'Brien KD. The use of occlusal indices: A European perspective. *Am J Orthod Dentofacial Orthop* 1995; 107: 1–10.
3. Mohlin B. Kap 10 in "Ortodonti-Varför-När". Avd för Ortodonti, Odontologiska fakulteten, Göteborg, 1995.
4. Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. *Eur J Orthod* 1989; 11: 309–20.

5. Richmond S, Shaw WC, O'Brien KD, Buchanan IB, Jones R, Stephens CD, Roberts CT, Andrews M. The development of the PAR Index (Peer Assessment Rating): reliability and validity. *Eur J Orthod* 1992; 14: 125-39.
6. Richmond S, Shaw WC, Roberts T, Andrews M. The PAR Index (Peer Assessment Rating): methods to determine outcome of orthodontic treatment in terms of improvement and standards. *Eur J Orthod* 1992; 14: 180-7.
7. DeGuzman L, Bahiraei D, Vig KWI, Vig PS, Weyant RJ, O'Brien K. The validation of the Peer Assessment Rating Index for malocclusion severity and treatment difficulty. *Am J Orthod Dentofacial Orthop* 1995; 107: 172-6.
8. Bishara SE, Cummins DM, Zaher AR. Treatment and posttreatment changes in patients with Class II, division 1 malocclusion after extraction and non-extraction treatment. *Am J Orthod Dentofacial Orthop* 1997; 111: 18-27.
9. Dugoni SA, Lee JS, Varela J, Dugoni AA. Early mixed dentition treatment: postretention evaluation of stability and relapse. *Angle Orthod* 1995; 65: 311-20.
10. Hellekant M, Lagerström L, Glerup A. Overbite and overjet correction in a Class II, division 1 sample treated with Edgewise therapy. *Eur J Orthod* 1989; 11: 91-106.
11. Little RM. Stability and relapse of dental arch alignment. *Br J Orthod* 1990; 17: 235-41.
12. Owman G, Bjerklin K, Kuroi J. Mandibular incisor stability after orthodontic treatment in the upper arch. *Eur J Orthod* 1989; 11: 341-50.
13. Persson M, Persson E-C, Skagius S. Long-term spontaneous changes following removal of all first premolars in Class I cases with crowding. *Eur J Orthod* 1989; 11: 271-82.
14. Ahlgren J. Tioårig utvärdering av ortodontiska behandlingsresultat. *Tandläkartidningen* 1980; 5: 208-16.
15. Buchanan IB, Shaw WC, Richmond S, O'Brien KD, Andrews M. A comparison of the reliability and validity of the PAR Index and Summers' Occlusal Index. *Eur J Orthod* 1993; 15: 27-31.
16. Roberts CT, Richmond S. The design and analysis of reliability studies for the use of epidemiological and audit indices in orthodontics. *Br J Orthod* 1997; 24: 139-47.
17. Richmond S, Andrews M. Orthodontic treatment standards in Norway. *Eur J Orthod* 1993; 15: 7-15.
18. Birkeland K, Furevik J, Bøe OE, Wisth PJ. Evaluation of treatment and posttreatment changes by the PAR Index. *Eur J Orthod* 1997; 19: 279-88.
19. Espeland LV, Stenvik A. Perception of personal dental appearance in young adults: Relationship between occlusion, awareness, and satisfaction. *Am J Orthod Dentofacial Orthop* 1991; 100: 234-41.
20. Espeland LV, Ivarsson K, Stenvik A, Alstad T. Perception of malocclusion in 11-year-old children: a comparison between personal and parental awareness. *Eur J Orthod* 1992; 14: 350-8.

### Address

Hans Bäckström, Specialist Clinic in Orthodontics,  
Box 5003, SE-541 05 Uddevalla, Sweden.