

The Development of the Index of Complexity, Outcome and Need (ICON)

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Abstract. This paper is based on the winning submission for the 1998 Chapman prize awarded by the British Orthodontic Society for an essay on a subject promoting the interests of orthodontics. The aim of the investigation is to develop a single index for assessing treatment inputs and outcomes. An international panel of 97 orthodontists gave subjective judgements on the need for treatment, treatment complexity, treatment improvement, and acceptability on a diverse sample of 240 initial and 98 treated study models. The occlusal traits in the study models were scored according to a defined numerical protocol. Five highly predictive occlusal traits were identified (IOTN Aesthetic Component, crossbite, upper arch crowding/spacing, buccal segment antero-posterior relationships, and anterior vertical relationship) and then used to 'predict' the panellist's decisions using regression analysis. Cut-off values were determined for the dichotomous judgements by plotting specificity sensitivity and overall accuracy. Twenty percentile ranges were used to determine 5 grades of complexity and improvement. The index prediction of decisions for treatment need, had specificity 84.4 per cent, sensitivity 85.2 per cent, and overall accuracy 85 per cent. When used to predict treatment outcomes, the new index had specificity 64.8 per cent, sensitivity 70.1 per cent, and overall accuracy 68.1 per cent. The index could explain 75.6 per cent of the variance in the mean casewise complexity score and 63.5 per cent of the mean casewise improvement score. A new orthodontic index is proposed to assess treatment need, complexity, and outcome. It is based on international orthodontic opinion.

Index words: Icon, Occlusal Index, Orthodontics.

Introduction

The provision of orthodontic treatment has been justified on the grounds of potentially improving dental aesthetics, dental health, occlusal functioning, and psychosocial adjustment. However, the efficacy of orthodontic treatment at improving dental health, functioning, and psyche is somewhat weak. Occlusal aims include the creation of the six keys of ideal occlusion as presented by Andrews (1972), but very few treatments achieve the six keys (Kattner and Scheider, 1993).

The spectrum of malocclusion ranges from near ideal to markedly anomalous and so the justification for treatment for an individual will vary. The actual receipt of treatment may also be modified by patient demands.

The point at which the potential risks of treatment outweigh the potential benefits is a matter of contention and must be judged for patients on an individual basis, but it is clear that practitioners may be biased by non-clinical factors when assessing borderline cases (Richmond and Daniels, 1998a).

Aesthetic Justification for Treatment

Most research suggests that patients seek treatment principally for aesthetic improvements (Gochman, 1975; Shaw, 1981; Tulloch *et al.*, 1984; McKiernan *et al.*, 1992) and that the principle benefits perceived by patients post-treatment are related to aesthetics (Schroeder, 1972; Albino *et al.*, 1994).

Psycho-social Enhancement

Psychological aspects have also been cited as justification for treatment, but patient perceptions of their malocclusion are frequently disproportionate to the objective signs of the malocclusion (Howitt *et al.*, 1967; Lewit and Virolainen, 1968; Shaw *et al.*, 1975, 1991a; Graber and Lucker, 1980; Lindsey and Hodgkins, 1983; Evans and Shaw, 1987; Holmes, 1992a,b). Many younger patients are brought for treatment by parents who may be seeking the treatment for reasons other than the child's malocclusion (Baldwin and Barnes, 1965, 1967; Baldwin, 1980; Pratelli *et al.*, 1998) though the children may well reflect their parents perceived concerns (Lewit and Virolainen, 1968).

Functional Improvement and Promotion of Better Oral Health

Correction of defects in speech or mastication and enhancement of dental and oral health could also justify orthodontic treatment, but the evidence supporting such intervention is somewhat weak. Specific occlusal traits that are indications for treatment and the grounds that have been advanced to justify treatment are summarized briefly below.

Cleft Lip and Palate

The immediate impact of an oro-facial cleft is the dento-facial deformity with later affects on speech, hearing

(through middle ear infection), mastication, and dentofacial appearance. Psychosocial affects are profound with affected individuals experiencing significant childhood behaviour problems (Spetz *et al.*, 1993), lower marriage rates (Ramstadt *et al.*, 1995), and higher suicide rates.

Posterior Crossbite

In conjunction with erosion, a crossbite with an associated slide to intercuspal position can cause considerable tooth surface loss (Silness *et al.*, 1993). There is a demonstrable increase in TMD where the slide on closure to intercuspal position is 4 mm or greater, or in the presence of unilateral lingual crossbite (McNamara, 1995).

Increased Overjet (Greater Than 6 mm)

Increased overjet is associated with increased trauma to the upper incisors (Jarvinen, 1978, 1979; Forsberg and Tedestam, 1993) and especially in the presence of incompetent lips (O'Mullane, 1973; Ghose *et al.*, 1980; Burden, 1995). There has been some reports of accentuated periodontal destruction associated with overjets greater than 8 mm (Horup *et al.*, 1987; Bjornas *et al.*, 1994). It has also been observed that oral hygiene may be poorer with increased overjet (Geiger and Wasserman, 1976), and that periodontal pocketing and gingivitis is increased (Helm and Petersen, 1989). Numerous studies have noted negative social stereotyping attributed to individuals with large overjets (Helm *et al.*, 1985; Cons *et al.*, 1986; Evans and Shaw, 1987; Kilpelaineen *et al.*, 1993).

Reverse Overjet

Certain speech articulation defects have been noted more commonly in Finnish dental students with Class III incisor or molar relationship than with normal occlusion (Laine, 1987, 1992). Mandibular prognathism may be perceived unfavourably and result in social stigmatization (Sergl *et al.*, 1992, Cons *et al.*, 1986). Mohlin and Thilander (1984) found that Class III malocclusion was correlated with symptoms of temporo-mandibular joint dysfunction (TMD) in males, and Wisth (1984) found in a retrospective sample that a treated group of class III patients had fewer TMD symptoms than an untreated control group.

Impeded Eruption or Impaction of Teeth

Impeded teeth may cause follicular cyst formation and resorption of adjacent teeth (Ericsson and Kurol, 1987).

Anterior Open Bite

This trait has been associated with TMD (McNamara, 1995), but has a more obvious effect on the reduced efficiency of biting in the incisor region. Certain speech sounds are poorly formed in the presence of anterior open bite (Kletchak *et al.*, 1976).

Hypodontia

Visible missing anterior teeth are considered to be among the most unattractive occlusal traits (Cons *et al.*, 1986).

Deep Overbite (Greater Than 6 mm)

Direct tissue trauma is the main dental risk in the presence of increased overbite and, in a sample of Norwegian army recruits, it was found that overbite in excess of 6 mm was associated with a higher rate of periodontal breakdown than a control group (Bjornas *et al.*, 1994). The degree of attrition has been shown to increase with the depth of overbite (Ritchard *et al.*, 1992, Silness *et al.*, 1993).

Contact Point Displacement

Typically, contact point displacement is taken as an analogue for dental crowding and has been formulated into various indices of dental crowding, e.g. Little (1975). It is the commonest malocclusal trait and some researchers have found evidence to associate dental crowding with increased periodontal breakdown (Helm and Petersen, 1989), whereas others have not found it to be of importance (Addy *et al.*, 1988, 1990). Dental crowding is regarded as unattractive (Evans and Shaw, 1987; Prah-Andersen *et al.*, 1979).

Spacing

Dental spacing has no dental health significance, other than it is associated with a lower incidence of caries (Helm and Petersen, 1989).

The Quantification of Malocclusion: occlusal indices

In order to quantify malocclusion, occlusal traits are often given a numerical weighting system and combined into mathematical expressions called occlusal indices. The use of the Index of Orthodontic Treatment Need (IOTN; Shaw *et al.*, 1991a) and the Peer Assessment Record (PAR Index; Richmond *et al.*, 1992), is now familiar in the UK for the purposes of research, audit and practice management. The most important advantage of using occlusal indices is to maximize consistency between and within examiners.

Although IOTN and PAR are both reliable and valid they have some important limitations:

1. The two indices have been developed and validated to assess treatment entry and exits as separate phenomena, when they are clearly part of the same clinical process. This requires additional training and duplicates the effort of measuring what are often similar occlusal traits.
2. Treatment categorizations using the Dental Health Component and the Aesthetic Component can be contradictory, with one component suggesting treatment and the other suggesting no treatment.
3. The hierarchical structure of Dental Health Component requires a separate protocol when only study models are available.
4. The IOTN or PAR indices have been validated against UK dental opinion (Richmond *et al.*, 1992, 1995) and thus may not be representative of professional opinions in other countries.
5. The PAR index, has been criticized for undue leniency of residual extraction spacing, unfavourable incisor inclinations, and rotations (Hinman, 1996). Other authors have found it unduly harsh on treatments with limited aims (Kerr and Buchanan, 1993).

6. Otuyemi and Jones (1995a) point out that PAR takes no account of periodontal destruction, decalcification, root resorption, dynamic occlusion, and facial aesthetics. Although these points are undoubtedly true, there is immense difficulty assessing these parameters reliably and their importance is debatable when assessing aggregate caseloads.

The Need for a Unified Index

It would be desirable to use the same measurement tool to assess treatment need as to assess treatment outcome. Although treatment need indices have been used to assess outcomes (Elderton and Clark, 1983, 1984; Lobb *et al.*, 1994; Richmond *et al.*, 1994a; Richmond and O'Brien, 1996) none of the indices used (Occlusal Index, Summers, 1972; Dental Aesthetic Index, Cons *et al.*, 1986; IOTN, Shaw *et al.*, 1991a) have been designed or validated for this purpose. At best these indices are measuring the degree of residual treatment need, but this may not be sufficiently quantitative to assess significant differences in treatment efficacy. The PAR index has been very useful in the latter respect, but is not validated for determining treatment need. Tentative attempts have been undertaken to adapt PAR for use as a complexity scale (DeGuzman *et al.*, 1996; Richmond, *et al.*, 1997).

Objectives

The objectives of this study were to propose orthodontic indices to assess treatment need, complexity, treatment improvement, and outcome based on international professional opinion, intended for use in the context of specialist practice. Such indices could provide the means to compare treatment thresholds in different countries and serve as a basis for quality assurance standards in orthodontics.

Methods

Professional perceptions of treatment need and treatment outcome were solicited by asking an international panel of 97 orthodontists from nine countries to judge a diverse sample of study casts. The study cast material has been previously described (Richmond and Daniels, 1998a,b), and consisted of 240 dental casts for assessment of treatment need and 98 paired pretreatment and post-treatment cases for assessment of treatment outcome. The practitioners each gave a dichotomous decision on the need for treatment and the acceptability of the treatment outcome. Furthermore, the practitioners gave a judgement (using 5-point rating scales), for the pretreatment complexity and the post-treatment degree of improvement. The mean complexity and improvement rating was then worked out for each case.

The dental casts were examined by the author and occlusal traits in the sample were comprehensively scored according to an objective scoring protocol (Richmond and Daniels, 1998a). The occlusal traits scored included:

- (1) upper and lower labial segment alignment;
- (2) anterior vertical relationship, centreline, impacted teeth, upper and lower buccal segment alignment (left and

right added together), buccal segment antero-posterior relationship (left and right added together), buccal segment vertical relationship (left and right added together), crossbite, missing teeth for any reason (excluding 3rd molar);

- (3) aesthetic assessment based on IOTN aesthetic component, overjet in mm (centred at 3 mm), reverse overjet in mm, upper and lower incisor inclination relative to the occlusal plane, overall upper arch crowding/spacing, overall lower arch crowding/spacing, lip competency.

The practitioners' subjective judgements of the casts, were then related to the occlusal trait scores for each case using regression analyses. Stepwise Multiple Logistic Regression was used to identify occlusal traits which were useful to predict the practitioners dichotomous decisions (treatment versus no treatment and accept outcome versus reject outcome).

Initially, separate predictive equations were calculated for treatment need and outcome decisions. Fortuitously, the equations for the two dichotomous decisions identified similar (though not identical) occlusal traits. This finding led to the use of a set of five occlusal traits (identified in the initial analyses) to predict both dichotomous decisions. Initially, weightings for the five occlusal traits were calculated for the treatment need and outcome decisions separately, then a single set of weightings was tested which was based on the average of the two weightings for each occlusal trait. These are all shown in Table 1. The set of 'average' weightings formed a new single index of treatment need and outcome assessment.

The potential use of the new index to assess treatment complexity and degree of improvement was then explored by regressing the five weighted traits, on to the casewise mean complexity and improvement scores.

Results

The new index is comprised of an assessment of dental aesthetics, the presence of crossbite, analysis of upper arch crowding (or the presence of impacted teeth in either arch), buccal segment antero-posterior inter-digitation, and the anterior vertical relationship. The scoring protocols are described in the appendix.

TABLE 1 *Logistic regression weightings for treatment need, treatment outcome, and the combined index using occlusal trait scores as explanatory variables*

Term	Weighting for treatment need	Weighting for treatment outcome	'Average' index weighting
IOTN Aesthetic Component	0.8420	0.5914	0.7
Left + right buccal antero-posterior	0.3032	0.3030	0.3
Upper arch crowding	0.6036	0.2519	0.5
Overbite/open bite	0.4927	0.3876	0.4
Crossbite	0.6460	0.5091	0.5

Determining Treatment Need and Outcome Acceptability Threshold Values

All pretreatment score values greater than 43, would be considered in need of treatment. Post-treatment scores of less than 31 signify acceptable end occlusion. These cut-off values were chosen to optimize the specificity and sensitivity of the index (using aggregate practitioner opinion as the gold standard). The specificity and sensitivity of the index varies depending on the cut-off values chosen, as shown in Figures 1 and 2. The performance of the index at the optimum cut-off values for assessments of treatment need and outcome acceptability is shown in Table 2.

TABLE 2 Decision cut-off values, for logistic regressions of treatment need, outcome, and the combined index at the optimum specificity, sensitivity and overall accuracy

Index parameter	Treatment need	Treatment outcome	Combined need	Combined outcome
Specificity (%)	86.4	64.1	85.6	64.8
Sensitivity (%)	85.2	71.8	83.6	70.1
Overall accuracy (%)	85.5	69.0	84.1	68.1
Cut-off score	43	31	43	31

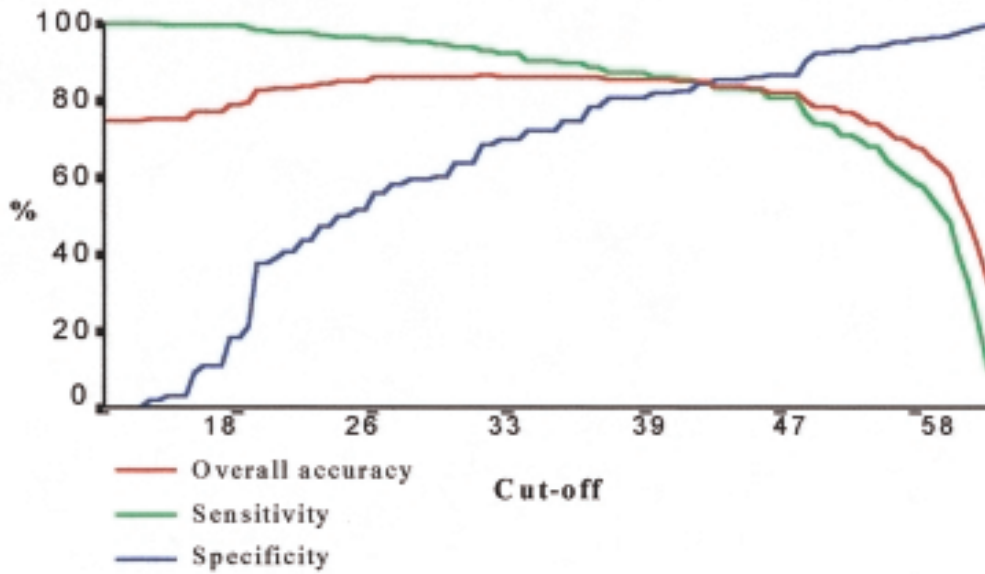


FIG. 1 The sensitivity, specificity, and overall accuracy of the index to assess treatment need is shown for all possible cut-off values. A suitable cut-off value makes the best compromise between specificity and sensitivity. For assessments of treatment need the cut-off value is 43.

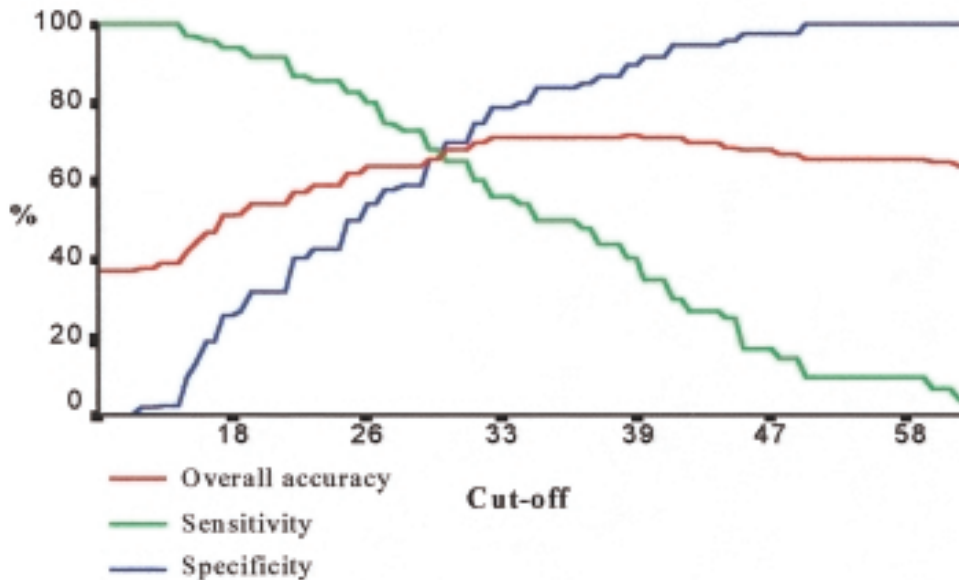


FIG. 2 The sensitivity, specificity and overall accuracy of the index to assess treatment outcomes is shown for all possible cut-off values. For assessments of treatment outcome acceptance the cut-off value is 31.

Practical Use of the Index to Assess Treatment Need

To use the index to assess treatment need the pretreatment study models are examined and occlusal traits are scored according to the protocol in the appendix. The five occlusal trait scores are then multiplied by their respective weightings and summed (Table 3). If the summary score is greater than 43, treatment is indicated.

Practical Use of the Index to Assess Treatment Outcome Acceptability

To assess treatment outcome, apply the index scoring method to the post-treatment models only. If the summary score is less than 31 the outcome is acceptable.

The Index Assessment of Complexity

The pretreatment index score has a (squared) multiple correlation of, $R^2 = 0.756$, to the mean casewise examiner complexity score. The scatter plot for casewise mean complexity versus the index score is shown in Figure 3, which demonstrates a reasonably strong linear relationship, passing through the origin (1 was the lowest point on the

complexity rating scale). This relationship is used as the basis for a five-grade complexity scale based on the cut points for the 20, 40, 60, and 80 percentiles on the mean complexity scale of 2.1, 2.768, 3.156, and 3.586. These cut-points correspond to index score values of 28, 50, 63, and 77, respectively. The 5-point grading of treatment complexity (simple, mild, moderate, difficult, very difficult) is summarized in Table 4.

Practical Use of the Index to Assess Treatment Complexity

To assess treatment complexity as a 5-point scale it is probably justifiable to use the cut points for the 20 percentile intervals, using the ranges given in Table 4 from the pretreatment models.

Index Assessment of Improvement

The use of the index to assess end of treatment acceptability has been described above. This method is sufficient for making qualitative comparisons, but is not sufficiently sensitive to grade the degree of occlusal change. Occlusal improvement is usually assessed by comparing the pretreatment assessment with the post-treatment and calculating either the overall score reduction or a percentage improvement.

TABLE 3 *ICON variables, weightings, and cut-off values for treatment need and outcome decisions*

Occlusal trait	ICON weighting
IOTN Aesthetic Component	7
Left + right buccal antero-posterior	3
Upper arch Crowding	5
Overbite	4
Crossbite	5
Treatment need cut-off	43
Treatment outcome cut-off	31

TABLE 4 *ICON complexity cut-off values*

Complexity grade	Score range
Easy	< 29
Mild	29-50
Moderate	51-63
Difficult	64-77
Very difficult	> 77

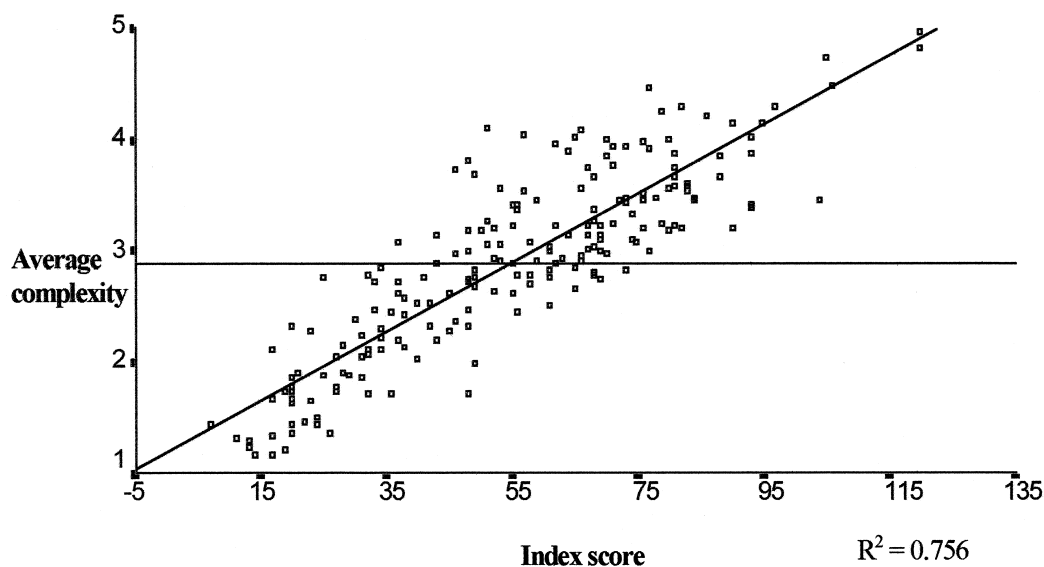


FIG. 3 The casewise index score is plotted against the casewise average complexity and shows a good correlation. The mean complexity score for the sample is indicated by the horizontal line.

The pre- and post-treatment score, score reduction, and percentage reduction was calculated for each treated case. The mean (practitioners) improvement rating for each case was calculated and a number of possible expressions were tried to model the mean improvement ratings. A close approximation to the most accurate expression involves the subtraction of four times the post-treatment score from the pretreatment score, which yields a (squared) multiple correlation of $R^2 = 0.626$ to the casewise mean improvement rating. The scatterplot of pretreatment $-4 \times$ the post-treatment index score versus mean improvement rating is shown in Figure 4.

In Figure 4, the spread of points is reasonably close to the regression line. There appears to be good separation of (red) cases deemed unacceptable (which have a post-treatment score ≥ 31) from the (green) cases deemed acceptable (which have a post-treatment score < 31). An improvement rating of three indicates the case was accorded the description of neither worse nor better. It is obvious that most of the cases had an average rating which suggested some improvement (i.e. above 3) and the distribution of the acceptable and unacceptably scored cases (according to the index dichotomy) suggests that cases need to be somewhat improved to be acceptable. Nevertheless, there are some cases whose average improvement score (determined by the panel judgements) seems to conflict with the classification for improvement and acceptability as determined by the ICON index. All indexing methods suffer this problem, which is why the use of indices is most valid when used to assess series of cases, rather than individuals.

Once again 20 percentile intervals have been used as the basis for the 5-point scale. The vertical bars in Figure 4 correspond to these intervals having cut-off values (for pretreatment $4 \times$ post-treatment) score of -85 , -53 , -25 , and -1 . An improvement nomenclature is given in Table 5.

TABLE 5 Pretreatment -4 (post-treatment) ICON index score ranges, for ratings of treatment improvement

Improvement grade	Score range
Greatly improved	> -1
Substantially improved	-25 to -1
Moderately improved	-53 to -26
Minimally improved	-85 to -54
Not improved or worse	< -85

Practical Use of the Index to Assess the Degree of Improvement

To assess the degree of improvement, the post-treatment score is multiplied by 4 and the result subtracted from the pretreatment score. The ranges in Table 5 are then used to assign a grade.

Discussion

The literature review concerned the professional indications for recommending orthodontic treatment. Important occlusal traits, such as cleft palate, overjet, reverse overjet, and hypodontia, are not measured directly by the index, and it is easy for the unwary to think that a serious omission in the index structure has occurred. The multiple regression techniques used to formulate the index, identify traits which have major and distinct contributions to the prediction of the practitioner judgements. Disparate occlusal traits such as cleft lip, overjet, hypodontia, etc., have a large impact on the anterior aesthetics of the malocclusion, all of which can be efficiently reflected by the aesthetic component score. This component is the most important predictor in the index by a large margin and this is reflected by its relatively heavy weighting.

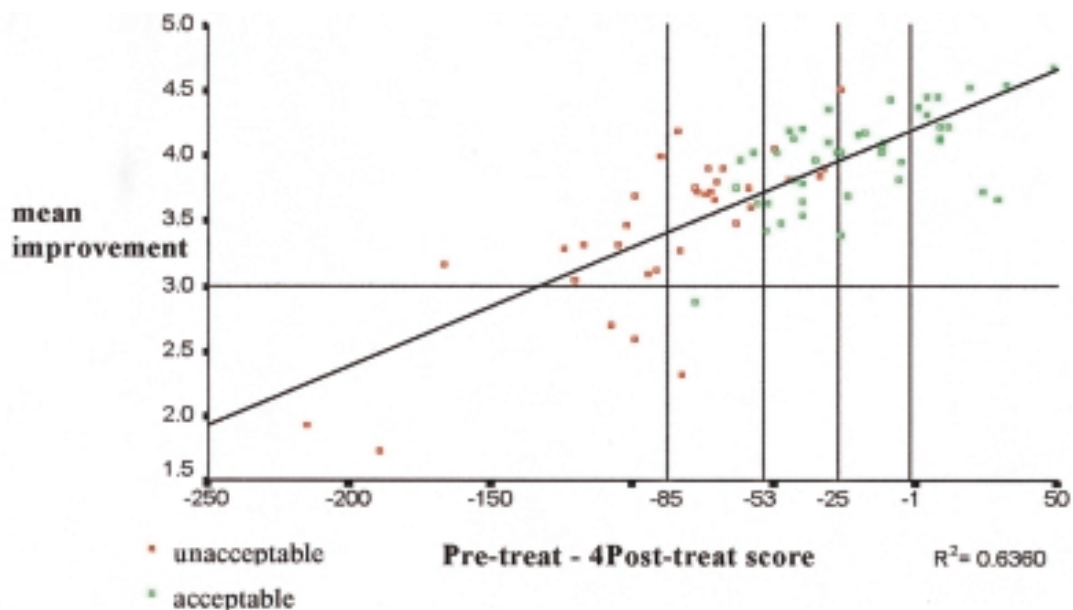


FIG. 4 The casewise [pretreatment $-4 \times$ post-treatment] index scores is plotted against the casewise mean improvement score, and demonstrates a moderate correlation. The red markers indicate cases in which the post-treatment cases would receive an unacceptable rating, i.e. post-treatment score > 31 .

The ICON has relatively lower predictive accuracy for the treatment outcome than for treatment need judgements. This is due to the much lower level of inter-examiner agreement in decisions of treatment acceptability (Richmond and Daniels, 1998a,b).

It has been purported that orthodontic treatment complexity may be affected by such factors as patient compliance, social, medical, logistic, and resource factors (Kirshen, 1997). Although there is no scientific evidence for this belief, practitioners were invited to consider complexity in the frame of a predetermined standard of treatment, namely to obtain ideal occlusion, with a full range of appliances and with a co-operative growing patient (Daniels, 1998). Standardizing these factors does not allow us to examine how they may impact on the perception of complexity if they are allowed to vary, but it would be safe to say that any factor which interferes with the efficiency of the treatment process is likely to lead to materially worse outcomes. The mean practitioner judgement of treatment complexity (as expressed using a 5-point scale) has been mathematically modelled, but what does the model mean? Can the difference between a 'difficult' and a 'very difficult' grading be interpreted in terms of the likely impact on treatment success? Previous work suggests that treatment complexity may be an entity that degrades post-treatment success (Richmond *et al.*, 1997; Richmond and Daniels, 1998b). Further validation in this area is needed before the complexity assessment can be used to predict treatment success.

The use of the pre- and post-treatment scores to derive an estimate of treatment improvement is familiar. It was surprising to find that the most useful formula to express the degree of improvement involved the subtraction of a multiple of the post-treatment score from the pretreatment score. The overall fit for the mean improvement score was only of the order of 63 per cent. It is noteworthy that once a treatment is initiated, some degree of improvement must be obtained for the treatment to be deemed acceptable, and this is particularly pertinent for mild malocclusions, which cannot be improved by much.

The PAR index (Richmond *et al.*, 1992) and the IOTN (Shaw *et al.*, 1991b), are now widely used in Britain and over 70 papers and abstracts have been published from Ireland, Britain, Norway, Israel, Finland, USA, Germany, Netherlands, Italy, Singapore, Hong Kong, and Australia, which gives them almost celebrity status. Can the new index overcome the few short-comings which affect the current indices and offer significant advantages to off-set the future incompatibility of data with previous publications?

The new index is relatively simple to use requiring no hierarchy (cf. IOTN) and having relatively few traits to measure. Most of the measurement protocols are common to components of PAR or IOTN, so there is already experience in the use and teaching of most of the occlusal traits. The new index resolves the possible conflict between treatment need and outcome classifications. Application of the index takes approximately 1 minute for each case and, therefore, it is relatively quick. It requires no measurement tools other than an ordinary millimetre rule and an Aesthetic Component scale (Shaw *et al.*, 1991a). The index is valid for both treatment need, complexity, and outcome assessments in as much as it represents a broadly based international body of expert opinion in orthodontics.

The index is intended for use in the late mixed dentition

onwards, because transitional stages during the early and middle mixed dentition are difficult to assess for aesthetics.

How Does the New Index Compare with the Current British Standard?

The index is not comparable to the Dental Health Component of IOTN; however, the Aesthetic Component is incorporated. All patients with an aesthetic score in excess of 5 will enter the treatment category and many lesser aesthetic conditions by virtue of the remaining four traits. The new index therefore yields a lower treatment threshold than is currently used in the UK. The arch crowding/spacing assessment, includes residual extraction space and posterior impactions, and this should address the limitations of the PAR index in this respect. The dichotomous outcome assessment has no comparison to PAR score reduction, but high improvement ratings require quite high levels of arch alignment and co-ordination, which may be more stringent than the current standard of 80 per cent PAR reduction.

Conclusions

A new occlusal index is proposed, which is based on the average opinion of a large panel of international orthodontic opinions. For the first time the design of the index has been specifically developed to enable assessments of treatment need and outcome using one set of occlusal traits, and for this reason may offer clear advances on the currently used methods. The practical application of the index has been kept as simple as possible and it is expected that the index will prove reliable and easy to apply, to study models or clinically. The accuracy of the index to reflect professional opinion for a diverse sample of cases was estimated at 84 per cent for decisions of treatment need and 68 per cent for treatment outcomes. The method is heavily weighted by aesthetics.

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Appendix

General Assumptions of the Index

1. When the index is used to assess treatment outcomes, it is assumed that an appropriate level of co-operation was obtained from the patient.

2. The index may require confirmation of the presence of teeth using radiography.
3. Except for the aesthetic assessment, occlusal traits are not scored to deciduous teeth unless they are to be retained in the permanent dentition to obviate the need for a prosthetic replacement, for example, when the permanent tooth is absent.

The index contains five components, all of which must be scored.

Dental Aesthetics

1. The dental aesthetic component of the IOTN (Shaw *et al.*, 1991a) is used.
2. The dentition is compared to the illustrated scale and a global attractiveness match is obtained without attempting to closely match the malocclusion to a particular picture on the scale. The scale works best in the permanent dentition.
3. The scale is graded from 1 for the most attractive to 10 the least attractive dental arrangement. Once this score is obtained it is multiplied by the weighting of 7.

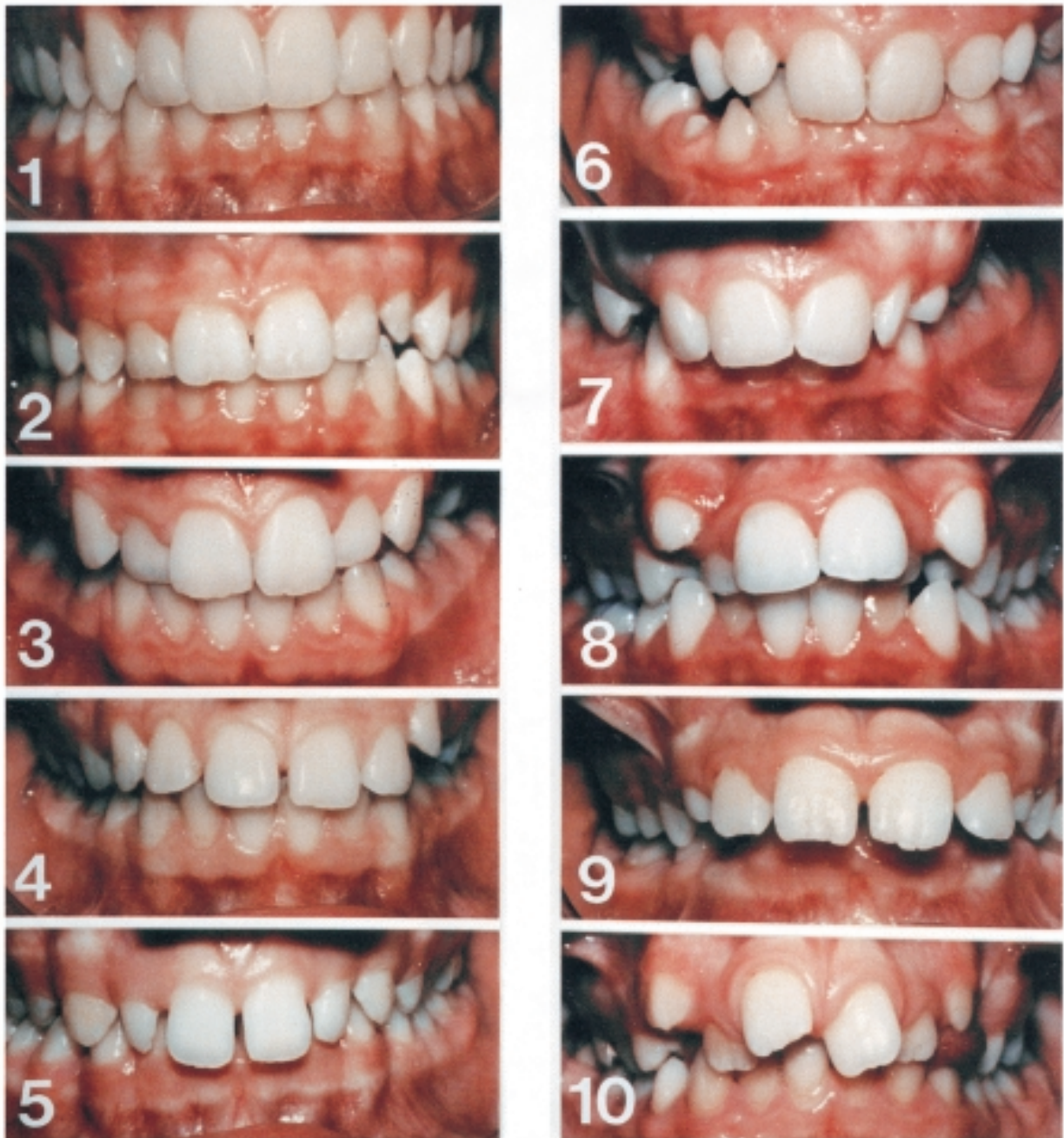


FIG. 5 The aesthetic component scale of IOTN.

Crossbite

A normal transverse relationship in the buccal segments is observed when the palatal cusps of the upper molar and premolar teeth occlude, preferably into the occlusal fossa of the opposing tooth, or at least between the lingual and buccal cusp tips of the opposing tooth. Crossbite is deemed to be present if a transverse relation of cusp to cusp or worse exists in the buccal segment. This includes buccal and lingual crossbites consisting of one or more teeth, with or without mandibular displacement.

1. In the anterior segment, a tooth in crossbite is defined as an upper incisor or canine in edge-to-edge or lingual occlusion.
2. Where a crossbite is present in the posterior or anterior segments or both, the raw score of 1 is given which is multiplied by the weighting of 5.
3. When there is no crossbite the score for this trait is 0.

Anterior Vertical Relationship

This trait includes both open bite (excluding developmental conditions) and deep bite. If both traits are present only the highest scoring raw score is counted. Positive overbite is measured at the deepest part of the overbite on incisor teeth. Scoring protocol is given in Table 6.

Open bite may be measured with an ordinary mm rule to the mid incisal edge of the most deviant upper tooth.

The raw score obtained is multiplied by 4.

Upper Arch Crowding/Spacing

1. This variable attempts to quantify the tooth to tissue discrepancy present in the upper arch or the presence of impacted teeth in both arches.
2. The sum of the mesio-distal crown diameters is compared to the available arch circumference, mesial to the last standing tooth on either side. This may require the use of a mm rule for accuracy, but with practice can be estimated by eye.

3. No estimation is made to account for the curve of Spee or the degree of incisor inclination. Once the crowding/spacing discrepancy has been worked out in mm, it is reduced on to the ordinal scale (0–5) using the categories shown in Table 6.
4. Note that an impacted tooth in either the upper or lower arch, immediately scores the maximum for crowding. A tooth must be unerupted to be defined as impacted.
5. An unerupted tooth is defined as impacted under the following conditions:
 - (i) if it is ectopically placed or impacted against an adjacent tooth (excluding third molars but including supernumerary teeth);
 - (ii) when less than 4 mm of space is available between the contact points of the adjacent permanent teeth.

Retained deciduous teeth (i.e. without a permanent successor) and erupted supernumerary teeth should be scored as space unless they are to be retained to obviate the need for prosthesis. In transitional stages average canine and premolar widths can be used to estimate the potential crowding. Suggested averages are 7 mm for premolar and lower canine and 8 mm for upper canine. The presence of erupted antimeric teeth allows more accurate estimation for this purpose. Spacing due to teeth lost to trauma and exodontia is also counted.

Post-treatment spaces created to allow prosthetic replacements should match the antimeric tooth width. Discrepancy between such spaces and the antimeric tooth can be counted as excess spacing or crowding, whichever is appropriate. The use of the index to assess spacing in relation to retained deciduous teeth demands that the fate of the deciduous teeth is known before the index can be applied.

Once the raw score has been obtained it is multiplied by the weighting 5.

Buccal Segment Antero-posterior Relationship

The scoring zone includes the canine premolar and molar teeth. The antero-posterior cuspal relationship is scored

TABLE 6 Protocol for occlusal trait scoring

Score	0	1	2	3	4	5
Aesthetic	1–10 As judged using IOTN AC					
Upper arch crowding	Less than 2 mm	2.1 to 5 mm	5.1 to 9 mm	9.1 to 13 mm	13.1 to 17 mm	> 17 mm or impacted teeth
Upper spacing	Up to 2 mm	2.1–5 mm	5.1–9 mm	>9 mm		
Crossbite	No crossbite	Crossbite present				
Incisor open bite	Complete bite	Less than 1 mm	1.1–2 mm	2.1–4 mm	>4 mm	
Incisor overbite	Lower incisor coverage	Up to 1/3 tooth	1/3–2/3 coverage	2/3 up to full covered	Fully covered	
Buccal segment anteroposterior	Left and right added together	Cusp to embrasure relationship only, Class I, II or III	Any cusp relation up to but not including cusp to cusp	Cusp to cusp relationship		

according to the protocol given in Table 7 for each side in turn. The raw scores for both sides are added together and then multiplied by the weighting 3.

Derivation of the Final Score

Once all of the raw scores have been obtained and multiplied by their respective weights, they are added together to

yield a single weighted summary score for a particular cast. The interpretation of the summary scores is described below.

A Worked Examples of the Combined Index

The case shown in Figure 6 is a pretreatment Class 1 malocclusion, with missing upper lateral incisors and an

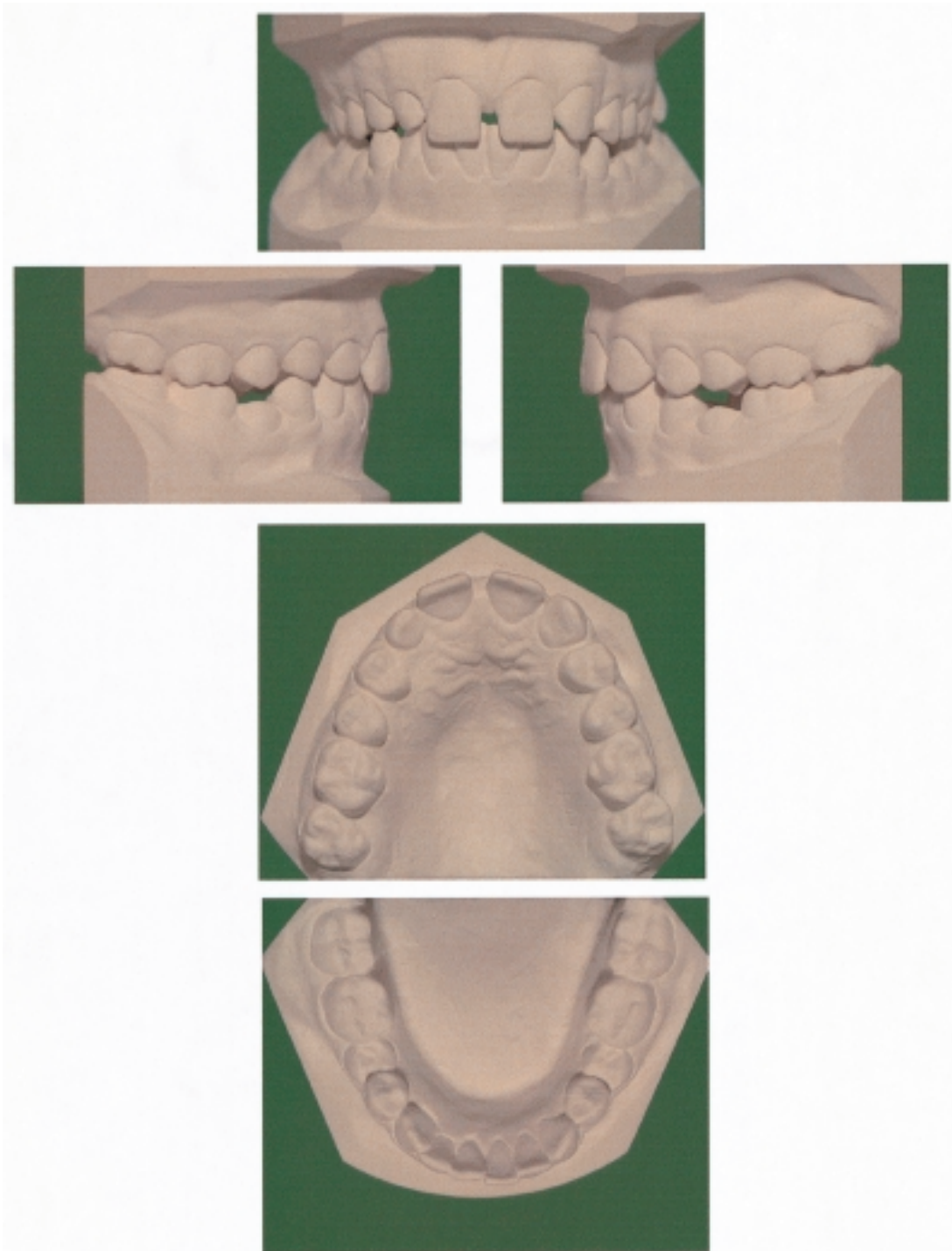


FIG. 6 This case shows missing upper lateral incisors and an impacted upper right canine. See Table 7 for index scoring.

impacted upper right canine, with very mild lower arch crowding. The upper labial segment has a 2-mm diastema. The case which has an aesthetic score of 5, an impacted tooth scoring 5, no crossbite, a normal overbite, and cusp-to-cusp relationship in both buccal segments. The index score is shown in Table 7, and summates to a value of 61. As the value is greater than 43 a categorization of treatment need can be given and has a difficult complexity grading.

The post-treatment cast is shown in Figure 7. The aesthetics obtained are probably close to optimal for this case, but nevertheless has an aesthetic score of 2. There is no space, or residual crowding, or crossbites yielding raw scores of 0 for these traits. A slight increase in the overbite and an imperfect left buccal inter-digitation both obtain scores of 1, yielding an overall weighted score of 21. The result is classified as acceptable and substantially improved

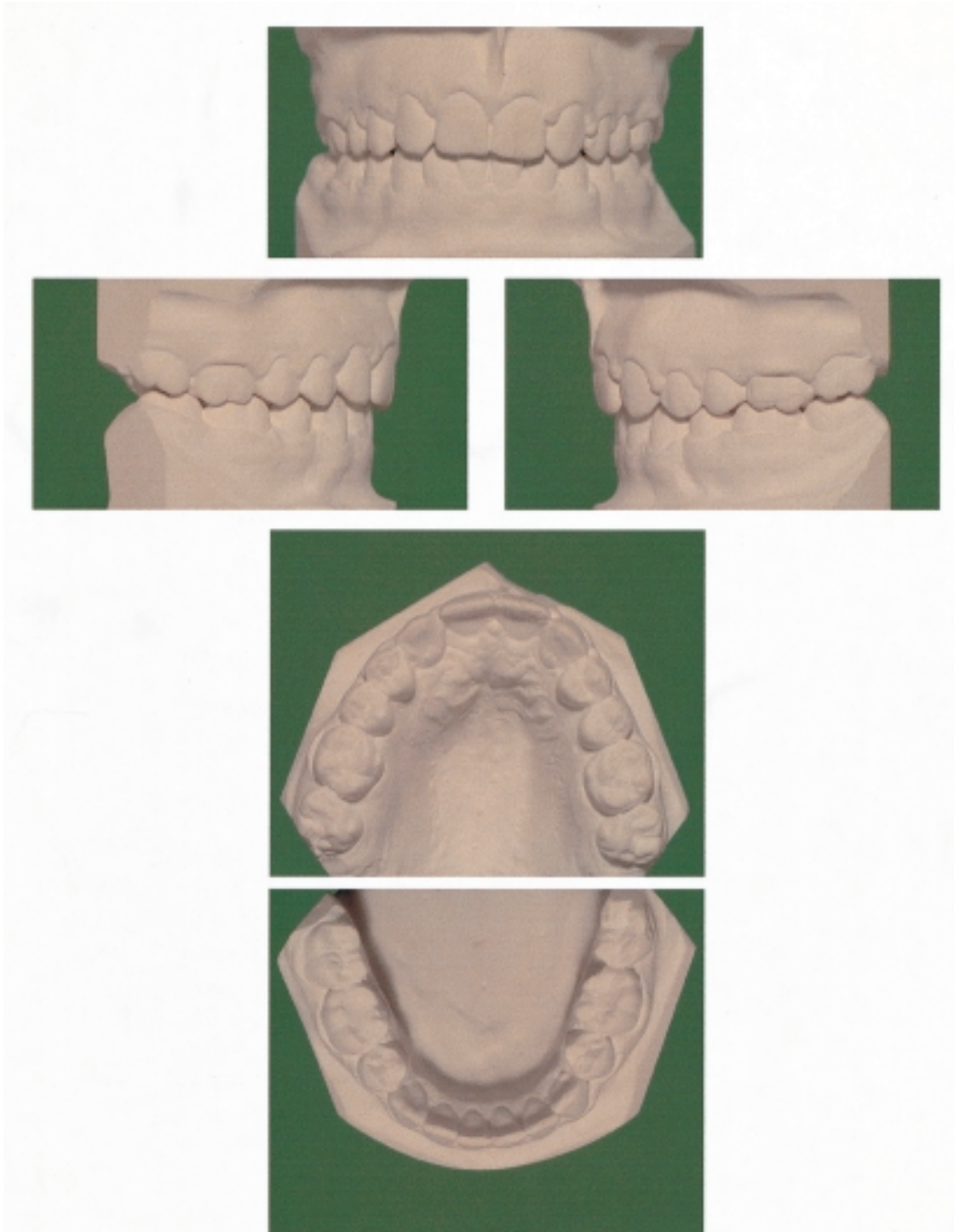


FIG. 7 The treatment has delivered a well aligned occlusion with satisfactory buccal segments. See text for index scoring.

TABLE 7 Example of a combined index calculation for a treatment need assessment

Case 1	Pretreatment score	Post-treatment score	Weighting
Aesthetic Component	5	2	7
Upper arch crowding	5	0	5
Crossbite	0	0	5
Overbite	0	1	4
Buccal antero-posterior relationship	4	1	3
Weighted score	72	21	
Treatment?	Yes	N/A	
Complexity	Difficult	N/A	
Improvement	N/A	Substantially improved	
Outcome	N/A	Acceptable	

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