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REVIEW ARTICLE

An Overview of Orthodontic Indices

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ABSTRACT

Analysis of prevalence of various types of malocclusion is an important aspect of today's evidence-based dentistry. Orthodontic indices are a tool in the hands of an epidemiologist to analyze the prevalence and severity of various kinds of malocclusion. The aim of this article is to look into the various qualitative and quantitative methods of grading and assessing malocclusion and their evolution over the years along with their advantages and limitations have also been analyzed. The article also compares the commonly used indices—DAI and IOTN.

Keywords: Malocclusion indices, Dental esthetic index, Index of orthodontic treatment need.

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INTRODUCTION

Over the years, a variety of indices have been developed to assist professionals in categorizing malocclusion according to the level of treatment need. However, it is the societal forces that define the norms for an acceptable, normal and attractive physical appearance. Identification by children and their parents of abnormal, unacceptable and disfiguring dentofacial characteristics is influenced as much by social context and cultural milieu as by objective criteria.

A good method of recording or measuring malocclusion is important for documentation of the prevalence and severity of malocclusion in population groups. This kind of data is not only important for the epidemiologist, but also for those who plan for the provision of orthodontic treatment in a community or for the training of orthodontic specialists. If the method is universally accepted and applied, data collected from different population groups can be compared. The methods of recording and measuring malocclusion can be broadly divided into two types: Qualitative and quantitative. A method that measures malocclusion quantitatively can also be used to assess treatment effects of orthodontic appliances.

A review of the literature related to the recording and measuring of malocclusion severity found that most of the investigations were published between the 1940s and the 1970s. In the past decade, there have been relatively few publications that discussed this topic. In order to fulfill the research gap, the objective of this article is to review the literature related to the quantitative and qualitative methods of recording and measuring malocclusion and to discuss the two commonly used indices, DAI and IOTN.

QUALITATIVE METHODS OF RECORDING MALOCCLUSION

The earliest methods of recording malocclusion were qualitative ones. A summary of the more important methods is presented in Table 1.

Angle's method of classifying malocclusion with or without modifications has been widely accepted and is still in use since it was first published in 1899.[1] There have been many critiques of Angle's classification of malocclusion.

Case[2] pointed out that Angle's method disregarded the relationship of the teeth to the face; and although malocclusion was a three-dimensional problem, Angle's system had only taken into account anteroposterior deviations in the sagittal plane. When reliability was tested by Gravely and Johnson,[3] they found that the between-examiner errors, as well as the within-examiner errors in categorizing Angle class II, division 2 malocclusions, were both relatively high. Nonetheless, it must be remembered that Angle devised his classification method as a prescription for treatment, not as an index of malocclusion or an epidemiologic tool as it was used later by other researchers.

On the basis of the principles developed for defining and recording individual traits of malocclusion by Björk et al,[4] a simplified method was developed during the years 1969 to 1972 by the working group 2 (WG2) of the FDI commission on classification and statistics for oral conditions. During the period 1973 to 1976, the method was field tested and modified. Final modifications were carried out by the WG2 in collaboration with the World Health Organization. The final version of the 'WHO/FDI basic method for recording of malocclusion' was published in the bulletin of the World Health Organization in 1979.[5] The primary objective of the assessment method was to determine the prevalence of malocclusion and dental irregularities and to estimate the treatment needs of a population, as a basis for the planning of orthodontic services.

Trends can be identified when reviewing the development of the qualitative methods of recording malocclusion. Researchers in the earlier days did not define the malocclusion symptoms to be recorded,[6-8] thus, malocclusion symptoms were recorded in an all-or-none manner. However, in 1964, Björk, Krebs and Solow[4] developed a detailed method to record malocclusion with clearly defined items. The methods developed by the WHO/FDI[5] also followed the trend of recording malocclusion symptoms with very carefully defined criteria.

Table 1: Summary of qualitative methods of recording malocclusion

Angle (1899)	Classification of molar relationship devised as a prescription for treatment.
Stallard (1932)	The general dental status, including some malocclusion symptoms, was recorded. No definition of the various symptoms was specified.
Mc Call (1944)	Malocclusion symptoms recorded include molar relationship, posterior crossbite, anterior crowding, rotated incisors, excessive overbite, open bite, labial or lingual version, tooth displacement, constriction of arches. No definition of these symptoms was specified. Symptoms were recorded in 'all or none manner'.
Sclare (1945)	Specific malocclusion symptoms were recorded, which include Angle's classification of molar relationship, arch constriction with incisor crowding, arch constriction without incisor crowding, superior protrusion with incisor crowding, superior protrusion without incisor crowding, labial prominence of canines, lingually placed incisors, rotated incisors, crossbite, open bite and closed bite. No definition of these symptoms was specified. Symptoms were recorded in 'all or none manner'.
Fisk (1960)	Dental age was used for grouping patients. Three planes of space was considered: 1. Anteropostero relationship: Angle's classification, anterior crossbite, overjet (mm), negative overjet (mm). 2. Transverse relationship: Posterior crossbite (maxillary teeth biting buccally or lingually). 3. Vertical relationship: Open bite (mm), overbite (mm). Additional measurements include labiolingual spread (Draker, 1960), spacing, therapeutic extractions, postnatal defects, congenital defects, mutilation, congenital absence, supernumerary teeth.
Bjork, Krebs and Solow (1964)	Objective registration of malocclusion symptoms based on detailed definitions. Data obtained could be analyzed by computers. Three parts: 1. Anomalies in the dentition: Tooth anomalies, abnormal eruption, malalignment of individual teeth. 2. Occlusal anomalies: Deviation in the positional relationship between the upper and lower dental arches in the sagittal, vertical and transverse plane. 3. Deviations in space conditions: Spacing or crowding.
Proffit and Ackerman (1973)	Five steps procedure of assessing malocclusion (no definite criteria for assessment was given): 1. Alignment: Ideal, crowding, spacing, mutilated. 2. Profile: Mandibular prominence, mandibular recession, lip profile relative to nose and chin (convex, straight, concave). 3. Crossbite: Relationship of dental arches in the transverse plane, as indicated by buccolingual relationship of posterior teeth. 4. Angle's classification: Relationship of the dental arches in the sagittal plane. 5. Bite depth: Relationship of the dental arches in the vertical plane, as indicated by the presence and absence of anterior open bite, anterior deep bite, posterior open bite and posterior collapsed bite.
WHO/FDI (1979)	Five major groups of items were recorded (with well-defined recording criteria) as follows: 1. Gross anomalies. 2. Dentition: Absent teeth, supernumerary teeth, malformed incisors, ectopic eruption. 3. Spaced condition: Diastema, crowding, spacing. 4. Occlusion: A. Incisor segment: Maxillary overjet, mandibular overjet, crossbite, overbite, open bite, midline shift. B. Lateral segment: Anteropostero relations, open bite, posterior crossbite. 5. Orthodontic treatment need judged subjectively: Not necessary, doubtful, necessary.

In the earlier methods, only a few malocclusion symptoms were selected arbitrarily as the items to be recorded.[6-8] In the later methods, there was an increasingly obvious tendency to record items that were logically grouped.[4,5,9,10]

Quantitative Methods of Measuring Malocclusion and its Severity

Quantitative methods of measuring malocclusion were made somewhat later than those for qualitative methods. Most of the indices for measuring malocclusion severity were developed in the 1950s and 1960s (Table 2).

In 1951, Massler and Frankel[11] made the initial attempt to develop a quantitative method of assessing malocclusion. The total number of displaced or rotated teeth was the basis for the evaluation of prevalence and incidence of malocclusion in population groups.

In 1959, VanKirk and Pennell[12] proposed the malignment index, which involved the grading of tooth displacement and rotation. They defined quantitatively tooth

Table 2: Summary of various indices of occlusion

Massler and Frankel (1951)	Count the number of teeth displaced or rotated. Assessment of tooth displacement and rotation is qualitative—all or none.
Malalignment index by Vankirk and Pennell (1959)	Tooth displacement and rotations were measured. Tooth displacement defined quantitatively: Less than 1.5 mm or more than 1.5 mm. Tooth rotation defined quantitatively: Less than 45° or more than 45°.
Handicapping labiolingual deviation index by Braker (1960)	Measurements include cleft palate (all or none), traumatic deviations (all or none), overjet (mm), overbite (mm), mandibular protrusion (mm), anterior open bite (mm) and labiolingual spread (a measurement of tooth displacement in mm).
Occlusal feature index by Poulton and Aaronson (1961)	Measurements include lower anterior crowding, cuspal interdigitation, vertical overbite and horizontal overjet. Occlusal features measured and scored according to defined criteria.
Malocclusion severity estimate by Grainger (1960-61)	Seven weighted and defined measurements: (1) Overjet, (2) overbite, (3) anterior open bite, (4) congenitally missing maxillary incisors, (5) first permanent molar relationship, (6) posterior crossbite and (7) tooth displacement (actual and potential). Six malocclusion syndromes were defined as follows: 1. Positive overjet and anterior open bite. 2. Positive overjet, positive overbite, distal molar relationship and posterior. crossbite with maxillary teeth buccal to mandibular teeth. 3. Negative overjet, mesial molar relationship and posterior crossbite with maxillary teeth lingual to mandibular teeth. 4. Congenitally missing maxillary incisors. 5. Tooth displacement. 6. Potential tooth displacement.
Occlusal index by Summers (1966)	Nine weighted and defined measurements: (1) Molar relation, (2) overbite, (3) overjet, (4) posterior crossbite, (5) posterior open bite, (6) tooth displacement, (7) midline relation, (8) maxillary median diastema, (9) congenitally missing maxillary incisors. Seven malocclusion syndromes were defined as follows: 1. Overjet and open bite. 2. Distal molar relation, overjet, overbite, posterior crossbite, midline diastema and midline deviation. 3. Congenitally missing maxillary incisors. 4. Tooth displacement (actual and potential). 5. Posterior open bite. 6. Mesial molar relation, overjet, overbite, posterior crossbite, midline diastema and midline deviation. 7. Mesial molar relation, mixed dentition analysis (potential tooth displacement) and tooth displacement. Different scoring schemes and forms for different stages of dental development: Deciduous dentition, mixed dentition and permanent dentition.
Treatment priority index by Grainger (1967)	Eleven weighted and defined measurements: (1) Upper anterior segment overjet, (2) lower anterior segment overjet, (3) overbite of upper anterior over lower anterior, (4) anterior openbite, (5) congenital absence of incisors, (6) distal molar relation, (7) mesial molar rotation, (8) posterior crossbite (maxillary teeth buccal to normal), (9) posterior crossbite (maxillary teeth lingual to normal), (10) tooth displacement, (11) gross anomalies. Seven malocclusion syndromes defined as follows: 1. Maxillary expansion syndrome 2. Overbite 3. Retrognathism 4. Open bite 5. Prognathism 6. Maxillary collapse syndrome 7. Congenitally missing incisors.
Handicapping malocclusion assessment record by Salzmann (1968)	Weighted measurements consist of three parts as follows: 1. Intraarch deviation: Missing teeth, crowding, rotations, spacing. 2. Interarch deviation: Overjet, overbite, crossbite, open bite, mesiodistal deviation. 3. Six handicapping dentofacial deformities: (1) Facial and oral clefts, (2) lower lip palatal to maxillary incisors, (3) occlusal interferences, (4) functional jaw limitation, (5) facial asymmetry, (6) speech impairment. This part can only be assessed on live patients.
Dental esthetic index (DAI), Cons (1986)	DAI components include: 1. Number of visible missing teeth (incisors, canines and premolars in maxillary and mandibular arch).

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	2. Incisal segment crowding 3. Incisal segment spacing 4. Midline diastema 5. Maxillary anterior irregularity 6. Mandibular anterior irregularity 7. Maxillary overjet 8. Mandibular overjet 9. Vertical anterior open bite 10. Anteroposterior molar relationship.
IOTN	It has two components as follows: A. Dental health component (DHC): has five grades Grade 1—none: variations in occlusion including displacement less than or equal to 1 mm. Grade 2—little 1. Increased overjet greater than 3.5 mm or less than 6 mm with lips competent at rest. 2. Reverse overjet greater than 0 mm but less than or equal to 1 mm. 3. Increased overbite greater than 3.5 mm with no gingival contact. 4. Anterior or posterior crossbite with less than or equal to 1 mm displacement. 5. Small lateral or anterior open bites greater than 1 mm but less than or equal to 2 mm. 6. Prenormal or postnormal occlusions with no other anomalies. 7. Mild displacement of teeth greater than 1 mm but less than or equal to 2 mm. Grade 3—moderate 1. Increased overjet greater than 3.5 mm but less than or equal to 6 mm with incompetent lips at rest. 2. Reverse overjet greater than 1 mm but less than or equal to 3.5 mm. 3. Increased and complete overbite greater than 3.5 mm with gingival contact but without indentations or signs of trauma. 4. Anterior or posterior crossbite with less than or equal to 2 mm but greater than 1 mm displacement between retruded contact position and intercuspal position. 5. Moderate lateral or anterior open bite greater than 2 mm but less than or equal to 4 mm. 6. Moderate displacement of teeth greater than 2 mm but less than or equal to 4 mm. Grade 4—great 1. Increased overjet greater than 6 mm but less than or equal to 9 mm. 2. Reverse overjet greater than 3.5 mm with no reported masticatory or speech difficulties. 3. Reverse overjet greater than 1 mm but less than or equal to 3.5 mm with reported masticatory or speech difficulties. 4. Anterior or posterior crossbite with greater than 2 mm displacement between retruded contact position and intercuspal position. 5. Posterior lingual crossbites with no occlusal contact in one or both buccal segment. 6. Severe displacement of teeth greater than 4 mm. 7. Extreme lateral or anterior open bite greater than 4 mm. 8. Increased and complete overbite causing notable indentations on the palate or labial gingivae. 9. Patient referred by colleague. 10. Less extensive hypodontia requiring prerestorative orthodontics or orthodontic space closure to obviate the need for a prosthesis (not more than one tooth missing in any quadrant) Grade 5—Very great 1. Defects of cleft lip and/or palate. 2. Increased overjet greater than 9 mm. 3. Reverse overjet greater than 3.5 mm with reported masticatory and speech difficulties. 4. Impeded eruption of teeth (with exception of 3rd molars) due to crowding, displacement, presence of supernumerary teeth, retained deciduous teeth and any other pathological cause. 5. Extensive hypodontia with restorative implications (more than 1 tooth missing in any quadrant) requiring prerestorative orthodontics.
Peer assessment rating index (PAR index) Richmond (1992)	It has 11 components as follows: 1. Upper right segment 2. Upper anterior segment 3. Upper left segment 4. Lower right segment 5. Lower anterior segment 6. Lower left segment 7. Right buccal occlusion 8. Overjet 9. Overbite 10. Centerline 11. Left buccal occlusion.

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Index of complexity, outcome and need (ICON) Richmond (2000)	The occlusal traits scored included: 1. Upper and lower segment alignment. 2. Anterior vertical relationship, centerline, impacted teeth, upper and lower buccal segment alignment (left and right added together), buccal segment anteroposterior 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. Esthetic assessment based on IOTN esthetic component, overjet in mm, reverse overjet in mm, upper and lower incisor inclination relative to the occlusal plane, overall upper arch crowding/spacing, lip competency.

displacement and rotation, which was a step forward. The handicapping labiolingual deviation index (HLDI) was developed by Draker[13] in 1960. Carlos and Ast[14] tested the ability of the HLDI in distinguishing 'handicapping' and 'nonhandicapping' malocclusions. Clinical judgment made by orthodontists was used as the standard. The distribution of HLDI scores in the two groups were found to be largely overlapping, which indicated that the HLDI was unable to distinguish the so-called handicapping malocclusion. The occlusal feature index was proposed by Poulton and Aaronson in 1961.[15] This index was considered incomplete since only four features of occlusion were measured and scored (Table 2).

Malocclusion Severity Estimate (MSE)

Grainger[16] developed the malocclusion severity estimate (MSE), in the Burlington Research Center, which can be used both on models or on patients. Validity was tested by comparing the index scores of a study sample with clinical standards obtained by having five orthodontists and one public health dentist array these occlusions according to esthetics, function and treatment difficulty. However, there were at least three possible shortcomings of the MSE, namely: (1) The index was derived from data of 12-year-old patients and therefore might not be valid for deciduous and mixed dentitions; (2) the MSE score did not reflect all measurements that were accumulated; and (3) the absence of any occlusal disorder was not scored as zero. The MSE was later revised, and the revised version was called the treatment priority index.[17]

Occlusal Index (OI)

The occlusal index (OI) was developed by Summers in 1966,[18] and was based on the malocclusion severity estimate, with attempts to remedy its shortcomings. The first shortcoming of the MSE could be remedied in part by defining normality over time, in particular equating the mixed dentition analysis with actual tooth displacement; and in part by giving different weights to certain items in different dental age groups, if these items would have their 'norms' changing as dental development proceeded. A scoring scheme for each stage of dental development (i.e. deciduous, mixed and permanent dentition stages) was therefore developed and different scoring forms were used for subjects in each stage. The second shortcoming of the MSE was remedied in the OI by considering the scores of all syndromes in arriving at the final OI score. The MSE considered only the score of the syndrome with the highest score, but in the OI, the other scores were also considered by adding half of the sum of the remaining scores to the highest score among the seven syndromes. The third shortcoming of the MSE was remedied by adjusting for normality, so that the absence of any occlusal disorder would be scored as zero.

Treatment Priority Index (TPI)

Grainger[19] in 1967 modified the MSE to develop the treatment priority index (TPI). Grainger described the index as a method of assessing the severity of the most common types of malocclusion and hence, provided a means of ranking patients according to the severity of malocclusion, the degree of handicap or their priority of treatment.

The prerequisites for determining a handicap were defined by Grainger[19] as follows: (1) Unacceptable esthetics, (2) significant reduction in masticatory function, (3) traumatic condition predisposing to tissue destruction, (4) speech impairment, (5) unstable occlusion and (6) gross or traumatic defects. On the basis of these six prerequisites for determining a handicap, items to be observed in the TPI were selected. A few manifestations of malocclusion, such as midline diastema and slight asymmetry, were rejected as being of little public health significance. Measurements could be made either clinically or indirectly from dental study casts.

In an attempt to revise the MSE, the TPI had corrected for scoring normalities as zero. However, it had deleted the 'mixed dentition analysis', which measures potential tooth displacement. It is also inadequate for assessing the occlusion of the deciduous or mixed dentition. Ghafari et al[20] did a longitudinal evaluation of the TPI. They found that TPI was a valid epidemiologic indicator of malocclusion, but TPI values recorded in the transitional dentition do not predict the future severity of malocclusion in the permanent dentition.

Handicapping Malocclusion Assessment Record (HMAR)

In 1968, Salzmann[17] developed the handicapping malocclusion assessment record (HMAR). The assessment record forms and the definition of handicapping malocclusion presented were officially approved by the Council on Dental Health of the American Dental Association, and the Board of Directors of the American Association of Orthodontists.[21]

Salzmann's purpose of developing the HMAR was to provide a means for establishing priority for treatment of handicapping malocclusion. Handicapping malocclusion and handicapping dentofacial deformity were defined as conditions that constitute a hazard to the maintenance of oral health and interfere with the well-being of the patient by adversely affecting dentofacial esthetics, mandibular function or speech. A cut-off point was set at a score so that those patients whose scores were above the cut-off point would be treated by the professional personnel available in the community, at the same time keeping with the funds budgeted for orthodontics.

The measurements were made according to the criteria, and point values were assigned to them. The relative point values, which were based on clinical orthodontic experience, had been tested by orthodontists from various parts of the United States. One important aspect of the HMAR is that it records and weighs functional problems, which no other index does.

Dental Esthetic Index

The dental esthetic index (DAI) was introduced by Cons in 1987, is based on socially defined esthetic norms. It takes into consideration, the importance of psychosocial factors in the assessment of malocclusion and it also assists professionals in categorizing malocclusion according to treatment needs.[22] The relationship between dental esthetics and psychological and social well-being has been noted by many investigators. In response to the demand for an orthodontic index that includes psychosocial criteria in assessing need for orthodontic care and for use in epidemiological surveys, led to the development of this index.

The DAI is one such tool which the orthodontist can make use of in identifying the orthodontic treatment need of the child based on severity, and also provides a single score linking the public's perceptions for dental esthetics with objective measurements associated with malocclusion. The DAI is particularly sensitive to occlusal conditions that have the potential for causing psychological or social dysfunction.

The DAI has been integrated into the international collaboration study of health outcomes by the World Health Organization (WHO, 1989) as an international index, identifies occlusal traits and mathematically derives a single score.

The DAI links clinical and esthetic components mathematically to produce a single score that combines physical and esthetic aspects of occlusion, including patient perceptions.

The score falls between 0 (the most socially acceptable) and 100 (the least socially acceptable). The DAI score of 36 serves as the cut-off point to differentiate handicapping from nonhandicapping malocclusion.

Group Severity Level and Treatment Need[23]

- Less than 25: Normal or minor malocclusion—No treatment need or slight need
- 26 to 30: Definite malocclusion—treatment elective
- 31 to 35: Severe malocclusion—treatment highly desirable
- More than 36: Very severe (handicapping) malocclusion —treatment mandatory.

However, DAI has some limitations:

1. The index does not identify cases with deepbite, buccal crossbite, open bite, midline discrepancy.
2. The DAI had been developed as a screening tool for permanent dentitions; it might be unsuitable during the mixed dentition stage accompanied with changes in future dental appearance.[22]
3. Since, DAI was developed to determine severity of malocclusion and relative need for publicly subsidized orthodontic treatment based on perceptions of dental esthetics by US students; hence the cut-off score for different ethnic groups may have to be established.
4. DAI measurements are made using a millimeter gauge, and small errors in accuracy can have an exaggerated effect because of the index weightings.[22]

Advantages

1. The DAI considers patients' perceptions regarding orthodontic treatment, as it is the patients who receive treatment and need to gain satisfaction from improved esthetics and function.
2. DAI can be effectively used on a prospective basis to identify the need for orthodontic treatment quantitatively.
3. It can be used directly in the patients' mouth.
4. Dental auxiliaries can be trained to use it to reduce cost and burden on dentists.
5. Can be used to assess the treatment standards although it was not developed for such use.

Index of Orthodontic Treatment Need (IOTN)

After reviewing the available literature, Peter Brook and William Shaw[24] (1989) felt that malocclusion could be best quantitatively measured by using two separate components to record firstly the dental health and functional indications for treatment and secondly the esthetic impairment caused by the malocclusion.

Dental Health Component

The index of treatment priority used by the Swedish Dental Board[25] (Linder-Aronson, 1974) was used as the basis for grading the functional and dental health indications for treatment. There are 5 grades, grade 1 representing little or no need for treatment and grade 5 representing great need for treatment (Table 3). Values for cut-off points between grades for each occlusal trait that represents a quantifiable threat to the dentition were established.

Esthetic Component

The second part of the overall assessment is to record the esthetic impairment contributed by malocclusion. This scale was constructed using dental photographs of 1000, 12-year-old collected during a large multidisciplinary survey. Six nondental judges rated these photographs on a visual analog scale, and gave a 10-point scale (Fig. 1) from 0.5 (attractive dental appearance) to 5.0 (unattractive dental appearance).

Peer Assessment Rating Index (PAR Index)

The peer assessment rating index (PAR) was introduced by Richmond in 1992. The PAR index is a quantitative, objective method for measuring malocclusion and the efficacy of orthodontic treatment. The PAR index provides a single score, based on a series of measurements, that represents the degree to which a case deviates from normal

Table 3: Dental health component of IOTN

Grade 1	None • Variations in occlusion including displacement less than or equal to 1 mm.
Grade 2	Little 1. Increased overjet greater than 3.5 mm or less than 6 mm with lips competent at rest 2. Reverse overjet greater than 0 mm but less than or equal to 1 mm. 3. Increased overbite greater than 3.5 mm with no gingival contact. 4. Anterior or posterior crossbite with less than or equal to 1 mm displacement. 5. Small lateral or anterior open bites greater than 1 mm but less than or equal to 2 mm 6. Prenormal or postnormal occlusions with no other anomalies. 7. Mild displacement of teeth greater than 1 mm but less than or equal to 2 mm.
Grade 3	Moderate 1. Increased overjet greater than 3.5 mm but less than or equal to 6 mm with incompetent lips at rest. 2. Reverse overjet greater than 1 mm but less than or equal to 3.5 mm. 3. Increased and complete overbite greater than 3.5 mm with gingival contact but without indentations or signs of trauma. 4. Anterior or posterior crossbite with less than or equal to 2 mm but greater than 1 mm displacement between retruded contact position and intercuspal position. 5. Moderate lateral or anterior open bite greater than 2 mm but less than or equal to 4 mm. 6. Moderate displacement of teeth greater than 2 mm but less than or equal to 4 mm.
Grade 4	Great 1. Increased overjet greater than 6 mm but less than or equal to 9 mm. 2. Reverse overjet greater than 3.5 mm with no reported masticatory or speech difficulties. 3. Reverse overjet greater than 1 mm but less than or equal to 3.5 mm with reported masticatory or speech difficulties. 4. Anterior or posterior crossbite with greater than 2 mm displacement between retruded contact position and intercuspal position. 5. Posterior lingual crossbites with no occlusal contact in one or both buccal segment. 6. Severe displacement of teeth greater than 4 mm. 7. Extreme lateral or anterior open bite greater than 4 mm. 8. Increased and complete overbite causing notable indentations on the palate or labial gingivae. 9. Patient referred by colleague. 10. Less extensive hypodontia requiring prerestorative orthodontics or orthodontic space closure to obviate the need for a prosthesis (Not more than 1 tooth missing in any quadrant).
Grade 5	Very great 1. Defects of cleft lip and/or palate. 2. Increased overjet greater than 9 mm 3. Reverse overjet greater than 3.5 mm with reported masticatory and speech difficulties. 4. Impeded eruption of teeth (with exception of 3rd molars) due to crowding, displacement, presence of supernumerary teeth, retained deciduous teeth and any other pathological cause. 5. Extensive hypodontia with restorative implications (more than 1 tooth missing in any quadrant) requiring prerestorative orthodontics.

Fig. 1: Esthetic component of IOTN

alignment and occlusion. This index is a valid and reliable tool for measuring malocclusion on plaster models and patients. The average time to record the PAR index score is approximately 5 minutes.

In orthodontics, it is important to objectively assess whether a worthwhile improvement has been achieved in terms of overall alignment and occlusion for an individual patient. This can be evaluated by a reduction in the PAR index score.

Index of Complexity, Outcome and Need (ICON)

The index of complexity, outcome and need (ICON), was developed by Richmond and Daniels in 2000,[26] with an objective to assess treatment need, complexity, treatment improvement and outcome based on international orthodontic professional opinion, intended for use in the context of specialist practice. Such an index would serve as a means to compare treatment thresholds in different countries and serve as a basis for quality assurance standards in orthodontics. It was intended to be a single index for assessing treatment inputs and outcomes. An international panel of 97 orthodontists gave subjective judgments on the need for treatment, treatment complexity, treatment improvement and acceptability on a diverse sample of 240 initial and 98 treated study models. The index is intended for use in late mixed dentition onwards, because transitional stages during the early and middle mixed dentitions are difficult to assess for esthetics.

This index has been designed specifically 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 is relatively simple and having relatively few traits to measure which is reliable and easy to apply, to study models or clinically. Application of the index takes approximately 1 minute for each case and therefore is relatively quick. It requires no measurement tools other than an ordinary millimeter rule and an esthetic component scale (Shaw et al, 1991). 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.[26]

DISCUSSION

Over the years various studies[21,27-29] have compared IOTN and the DAI, both include two components, anatomic and esthetic measuring many of the same traits. These include overjet, reverse overjet, open bite, displacements and missing teeth. However, the importance of missing teeth trait is rated differently by each index. One missing tooth in the dental health component of the IOTN, if judged the worst trait, is given a grade of 3 on the revised IOTN scale, indicating 'definite need' for treatment. In contrast, in the DAI one missing tooth is given a weight of six. If a missing tooth was the only trait recorded on a person, the weight of six would be multiplied by one and added to the constant number 13 to give a DAI score of only 19. This score would be judged by the DAI as not requiring orthodontic treatment or as having only a slight need.

In the IOTN, the esthetic component is a separate instrument from the dental health component. The IOTN in both its dental health and esthetic components uses only three grades, 'no need', 'borderline need', and 'definite need'. A scale with only three grades lacks the ability to rank order cases with greater or lesser need for treatment within grades.

The advantage of the DAI is that perceptions of esthetics are linked with anatomic trait measurements to produce a single score, obviating the need for two separate instruments that cannot be combined as in the IOTN and scores can be rank ordered on a continuous scale and can differentiate cases within severity levels.[28]

Brook and Shaw[4] state that the true validation of the IOTN must await the emergence of further research data. Several studies show the validity of the DAI.[22,28-32] The DAI scores are significantly associated with perception of need for treatment by students and parents,[28] and they are good predictors of the receipt of future fixed orthodontic treatment.[12]

Another study compared DAI with handicapping labiolingual deviations index with the California modification [HLD (CalMod)] and IOTN, and found all the three indexes to be valid measures of treatment need as perceived by orthodontists and did not find any significant difference between them.[30]

CONCLUSION

Each index and method of the assessment described earlier was based on the opinion of an individual or a group of individuals. There are bound to be disagreement among other professionals as to the validity of a particular method. It had been widely agreed that no particular index or method available that are truly inclusive of all recommended criteria. Therefore, different indices or method had been developed according to different requirements. Given the above, it may be necessary to use more than one index in order to gather information to suit the objective of the particular study.

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