Orthodontic indices

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Abstract
Objective: This article will discuss some of the most commonly used indices in orthodontics

Materials and Methods: A comprehensive literature from orthodontic relevant sources and information was searched with the help of Pubmed, Medline, Google scholar, Scopus using keyword like orthodontic indices.

Result: 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.

Conclusion: The use of indices in orthodontics allows more uniform interpretation and application for criteria for treatment need and changes. Still there is a need of a development of index which can be universally accepted in terms of reliability and validity.

Keywords: orthodontic indices, malocclusion indices, dental esthetic index, Index of orthodontic treatment need

Introduction
What is an index and why we use it?
An index is a tool used to provide a numerical value describing the status of a case on a graded scale. In orthodontics, indices are essential component in diagnosis or assessing treatment need, severity, complexity and outcome.

Orthodontic indices are one of the tools that are available for orthodontists to grade and assess malocclusion [1]. Orthodontic indices can be useful for an epidemiologist to analyse prevalence and severity of malocclusion in any population [2].

Evaluation of dental malocclusion is an essential component in establishing the diagnosis and treatment need of the orthodontic patient but problems in studying malocclusion is the availability of a suitable method for recording and objectifying the occurrence and severity of orthodontic problem. Thus, orthodontic indices are used in clinical and epidemiological studies of malocclusion. An index comprises of numerical values describing the relative status of a population on a graduated scale with definite upper and lower limits, which is designed to permit comparison with other populations classified by the same criteria and methods [3]. However, none of the indices can be considered ideal for all purpose, accurate, valid and reliable for assessing the malocclusion for the priority of treatment need, allocating limited resources and assessing treatment outcomes [4].

Requirements of an ideal index (WHO) [5]
1. Classification is expressed by a finite scale with definite upper and lower limits; running by progressive gradation from zero (absence of disease), to the ultimate point (disease in its terminal stage).
2. The index should be equally sensitive throughout the scale.
3. The score should correspond closely with the clinical importance of the disease stage it represents.
4. Index value should be amendable to statistical analysis.
5. The index must be reproducible.
6. The index should also be simple, accurate and yield itself to modification for the collection of data.
7. The examination procedure should require a minimum of judgment.
8. The index should be simple enough to permit the study of a large population without undue cost in time or energy.
9. The examination required should be performed quickly, to evidence to a group variation.
10. The index should be valid during time.

General requirements of an index
- Validity (can the index measure what it was designed to measure?)
- Reliability (Reproducibility) (does the index give the same result when recorded on two different occasions, and by different examiners?)
- Acceptability to profession and public.
- Simplicity and cheapness.

This article will discuss some of the most commonly used indices in orthodontics

Table 1: Most commonly used indices in orthodontics

| Diagnostic indices                          | Treatment complexity indices                                      | Treatment need indices                                      | Treatment outcome indices                                | Multi-purpose orthodontic indices                           |
|---------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|
| Angle Classification System (1899) [6]      | Mal-alignment Index (Van Kirk & Pennel, 1959) [9]                 | Handicapping Labio-lingual Deviation index (HLD) (Draker, 1960, 1967) [16] |
| Incisal Categories of Ballard & Wayman (1964) [7] | Occusal Feature Index (Poulton & Aaronson, 1961) [10]             | Swedish Medical Board Index (SMHB 1966; Linder Aronson, 1974, 1976) [17, 18] |
| Five-point System of Ackerman & Profit (1969) [8] | The Bjork Method (1964) [11]                                      | Dental Aesthetic Index (DAI) (Cons et al. 1986) [19]          | Peer Assessment Rating Index (PAR) (Richmond et al. 1992) [21] |
|                                              | Summers’ Occlusal Index (1971) [12]                               | Index of Orthodontic Treatment Need (IOTN) (Brook & Shaw, 1989) [20] |
|                                              | The FDI Method (Baume et al. 1973) [13]                           | Index of Orthodontic Treatment Complexity (IOTC) (Liewellyn et al. 2007) [22] |
|                                              | Little’s Irregularity Index (1975) [14]                           | Index of Complexity, Outcome & Need (ICON) (2000) [21]       | Index of Complexity, Outcome & Need (ICON) (2000) [21]     |
|                                              | Discrepancy Index (DJ) (2004) [15]                               |                                                             |                                                          |

Diagnostic indices
These indices provide descriptive classification of the dentition or skeletons. As all these indices were covered in other lectures, this lecture will just enumerate them.

1. **Angle’s classification** [6]

   The Angle classification of malocclusion was described by Edward H Angle in 1899 and is based on the relative anteroposterior position of the first permanent molars. (Fig 1)

   ![Fig 1: Angle's classification](image_url)

2. **Canine classification** (Fig 2)

   The canine relationship is based upon anteroposterior position of canines.

   ![Fig 2: Canine classification](image_url)
3. **Incisor classification** (Fig 3) [7]
The British Standards Institute classification is based upon anteroposterior position of incisors.

![Incisor classification](image)

**Fig 3: Incisor classification**

4. **Skeletal classification** (Fig 4)
Usually assessed by lateral cephalometric radiographs:

![Skeletal classification](image)

**Fig 4: Skeletal classification**

Treatment complexity indices

1. **Little’s irregularity index (LII)** [14] Fig 5
This index assesses irregularity of lower labial segment to establish the severity of malocclusion and priority of treatment by measuring linear displacement of five anatomic contact point (from mesial of right lower canine to mesial of left lower canine). Then, these displacements are summed and the model cast is ranked on a scale ranging from 0-10.

![Little’s irregularity index](image)

**Fig 5: Little’s irregularity index**

Example: The irregularity index assesses the total of the millimeter distances from the contact point on each incisor tooth to the contact point that it should touch, as shown by the lines. For this patient, the irregularity index is 10 mm.

2. **Discrepancy index (DI)** [15] Fig 6
This index used to evaluate the difficulty of the cases presented for the American Board of Orthodontics examination. It evaluates criteria from dental models and cephalometric radiographs. These are overjet, overbite, openbite, crowding, occlusion, lingual/buccal posterior crossbite, cephalometric variables.

![Discrepancy index (DI)](image)

**Fig 6: Discrepancy index (DI)**

Discussion

**Treatment need indices**

1. **Index of orthodontic treatment need (IOTN)** [20]
This index is used to rank malocclusions in terms of various occlusal features and perceived aesthetic impairment. The intention is to identify those individuals who would receive the greatest benefit from orthodontic treatment. IOTN has two components:
   - Dental Health Component (DHC)
   - Aesthetic Component (AC)

Dental health component (DHC): The DHC records the worst occlusal feature of the malocclusion that impacts on dental health on a dental cast with a specially designed ruler. A hierarchal scale is used to identify the worst feature. In order of reducing dental health impact these are: Missing teeth > Overjet > Crossbite > Displacement of contact points > Overbite. The acronym MOCDO can be used to remember this hierarchal scale. Once the worst occlusal feature has been recorded, the malocclusion can be characterized into one of five...
grades:
- Grade 1 No need for treatment
- Grade 2 Little need for treatment
- Grade 3 Moderate need for treatment
- Grade 4 Great need for treatment
- Grade 5 Very great need for treatment

Aesthetic component (AC): It consists of 10 color photographs showing different levels of dental attractiveness. The patient is asked to close the front teeth together and the examiner compares the appearance of the patient’s teeth with the visual 1-10 scale. Sometimes, the patients (or parents) are also asked to choose a photograph which most closely represents their own dental appearance to give a score according to this scale (1: the most attractive and 10: the least attractive). Treatment needed can be categorized according to the score given as follows:
Score 1 or 2: No need for treatment
Score 3 or 4: Slight need for treatment
Score 5, 6, or 7: Moderate/borderline need for treatment
Score 8, 9, or 10: Definite need for treatment

A total score combining the DHC and AC can be given to define treatment need. IOTN has its limitations when it is applied to the mixed dentition patients and the AC component can be considered as subjective assessment. Nonetheless, the DHC component of the IOTN provides a structured method for the assessment of a malocclusion.
Treatment outcome indices

1. Peer assessment rating index (PAR Index) [20]
This index has been developed to:
- Provide a single score assessing the degree of malocclusion (Pre-treatment PAR score).
- Assess the quality and standard of orthodontic treatment results, and the degree of improvement by comparing pre- and post-treatment PAR scores on a dental cast using a specially designed ruler. It measures the following features of the malocclusion:
  - Anterior crowding (×1): Upper and lower labial segment contact point displacements.
  - Buccal occlusion (×1): Left and right molar relationship, crossbites and lateral open bites
  - Overjet (×6)
  - Overbite (×2)
  - Centrelines (×4)

The score for each feature is multiplied by weighting factors (given in brackets above), so that some occlusal features bear more importance than others.

The difference between pre- and post-treatment PAR scores can be calculated and from this the percentage change in PAR score is derived.

- PAR reduction < 30%: Worse or no better
- PAR reduction > 30%: Improved
- PAR reduction > 70%: A high standard of treatment
- PAR reduction of 22 points or greater: Greatly improved

Since the pre-treatment PAR score gives an indication of the severity of a malocclusion. Obviously it is difficult to achieve a significant reduction in PAR in cases with a low pre-treatment score.

PAR index is totally dependent on the patient's study models and does not account for improvement in the facial profile, tooth inclinations, arch width and spacing between posterior teeth. It also is not appropriate for assessment of mixed dentition treatment results. However, it is a valid and reliable tool in assessing performance of practitioners or services.

2. Cast-radiograph evaluation (CR-EVAL)
The American Board of Orthodontics Cast-Radiograph Evaluation (ABO CR-EVAL) was developed to evaluate orthodontic treatment outcomes of the cases presented for the American Board of Orthodontics examination. It has been subsequently considered as a precise and objective index when compared to other indices.

The CR-EVAL included eight criteria:
- Alignment/rotation: Study model
- Marginal ridges: Study model
- Buccolingual inclination: Study model
- Overjet: Study model
- Occlusal contacts: Study model
- Occlusal relationship: Study model
- Interproximal contacts: Study model
- Root angulation: Panoramic radiograph

Post-treatment study models and panoramic radiographs are measured according to the above eight criteria and scored 0, 1, or 2 depending on the amount of deviation from the standards established by the ABO. The sum of points of these criteria for each treated case represents the overall score of the ABO CR-EVAL.

- Total score > 30 points: Unacceptable or incomplete treatment results
- Total score of 20-30 points: Needs re-evaluation and then will be passed or considered incomplete
- Total score < 20 points: Satisfactory treatment results

CR-EVAL offers an objective and stringent assessment of treatment outcomes, especially for detailed tooth position. When compared to the PAR index, it adds angulation, spacing and crowding of buccal segments, and root parallelism. Additionally, it uses the final models only to assess treatment outcomes, unlike the PAR index where both pre- and post-treatment models.
Multi-purpose orthodontic indices

1. Index of complexity, outcome, and need (ICON) [21]
This index was developed to evaluate the complexity of a case, as well as treatment need and outcome. It incorporates features of both IOTN and PAR indices:

| Feature | Description |
|---------|-------------|
| IOTN AC | (x7) Upper arch crowding and spacing (x5) |
| Crossbite | (x5) Buccal segment anteroposterior relationships (x3) |
| Anterior vertical relationship | (x4) |

Table 2: Evaluation of different analysis qualitative and quantitative

| Index | Description |
|-------|-------------|
| Angle (1899) [1] | Formulated to aid in proper treatment planning. Base on the molar relationship present, the malocclusion was classified in 3 different types. In 1992, Houston et al. considered Angle classification as the only internationally recognized classification mostly used in epidemiological studies. The index has been criticized by Graber (1972), Rinchuse (1988) [24]. |
| Stallard (1932) [22] | Malocclusion symptoms present along with general dental status are recorded. |
| McCall (1944) [26] | Include superior protrusion with/without incisor crowding, labially placed canines, lingually placed incisors, rotation of incisors, crossbite, open bite and deep bite, Angle classification of molar relationship, arch constriction, anterior vertical relationship, anterior crowding. |
| Sclare (1945) [27] | In 1992, Houston et al. considered Angle classification of molar relationship, arch constriction, anterior vertical relationship, anterior crowding. |
| Massler & Frankel (1951) [8] | Involving grading of the tooth displacement and rotation. Incidence and prevalence of malocclusion in a population group is evaluated using the data. |
| Van Kirk & Pennel (1959) [9] | Patients are grouped according to the dental age. Malocclusion is divided according to 3 planes of space: 1. Sagittal relationship: Angle’s molar classification, canine classification, anterior crossbite, overjet. 2. Transverse relationship: Posterior crossbite, scissor bite 3. Vertical relationship: Openbite, deepbite. |
| Bjork, Krebs & Solow (1964) [29] | Primarily developed for epidemiological purpose with little emphasis on treatment need. Registration of malocclusion symptoms based on detailed definitions. Data obtained could be analyzed by computers. Following three parts are considered: 1. Anomalies of dentition: Tooth anomalies, abnormal eruption, mal-alignment of individual teeth. 2. Occlusal anomalies: Deviation in the positional relationship between upper and lower dental arches in sagittal, vertical and transverse plane. 3. Deviations in space conditions: Spacing or crowding. |
| Ballard & Wayman (1965) [71] | Also known as British Standards Institute Classification. As posterior teeth relation did not influence the incisor occlusion, this classification is considered more reliable to Angle classification. Based on the relationship of incisal edges of upper and lower incisors. |
| Ackerman & Profitt (1969) [30] | Venn diagram is used to represent major characteristics of malocclusion. Includes information about skeletal jaw proportions. Includes all 3 planes of space. Includes evaluation of crowding and asymmetry intra-arch. Five-step procedure of assessing malocclusion: 1. Alignment: crowding, spacing. 2. Profile: convex, straight, concave. 3. Crossbite: Relationship of dental arches in the transverse plane, as indicated by bucco-lingual relationship of posterior teeth. 4. Angle classification: Relationship of the dental arches in the sagittal plane 5. Bite depth: Relationship of the dental arches in vertical plane, as indicated by the presence/absence of anterior/posterior open bite and posterior collapsed bite. |
| Baume et al. (1979) [13] | Method of measuring occlusal traits developed by Federation Dentaire Internationale (FDI) Commission on Classification & Statistics for Oral Conditions (COCSTOC). Five major groups are recorded 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/mandibular overjet, overbite, openbite, crossbite b. Lateral segment: antero-posterior relations, open bite, posterior crossbite 5. Orthodontic treatment need judged subjectively: Not necessary, doubtful, necessary. |
| Memorandum of orthodontic screening & indications for orthodontic treatment (1990) [131] | Proposed by Danish National Board of Health to assess orthodontic treatment need. |
| Grade index scale for assessment of treatment need (GISATN) Salonen, Mohlin et al. (1992) [122] | Developed in Sweden as a malocclusion index for treatment need. |
| 5-year-olds’ index | Most used index in deciduous dentition for cleft lip and palate cases. |
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