A Review of Orthodontic Indices

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ABSTRACT
Orthodontic indices are essential component in assessing severity, complexity and treatment outcome of malocclusion. Moreover, they are useful in evaluating treatment need, funding for treatment cost and public health aspects of orthodontic treatment. The present article reviews orthodontic indices used for clinical and epidemiologic purposes. The article attempts to classify the indices in qualitative and quantitative methods based on the description given by the respective authors. The indices are presented in chronological order in tabular form.

INTRODUCTION
British Society of Orthodontics in 1922 defined orthodontic specialty as, ‘Orthodontics includes the study of the growth and development of the jaws and face particularly, and the body generally as influencing the position of the teeth; the study of action and reaction of internal and external influences on the development and the prevention and correction of arrested and perverted development’. 1

The evaluation of malocclusion is the essential component in establishing the diagnosis and treatment need of the orthodontic patient. One of the major problems in studying malocclusion is the availability of a suitable objective method for recording the occurrence and severity of orthodontic problem. Thus, orthodontic indices are used in clinical and epidemiological studies of malocclusion. The index comprise 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.2 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.3

The objective of this article is to review the historical aspects of various orthodontic indices, provide their brief description and to classify them.

Requirements of an ideal index (WHO)4

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.

Angle in 1899 classified malocclusion, after which numerous classification methods evolved. However, qualitative methods of classifications were found to be not suitable for measuring the severity and treatment needs. The WHO/FDI basic method recorded symptoms of malocclusion with carefully defined criteria. This method was essentially derived from the principle developed for recording individual traits of malocclusion by Bjork et al.

Initially, occlusal indices were used as an epidemiological tool to rank or classify the occlusion. During 1950s and 1960s, many occlusal indices were introduced. William Shaw and co-workers in 1995 classified occlusal indices into five following groups.

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1. Diagnostic indices
- Angle Classification System (1899)8
- Incisal categories of Ballard & Wayman (1964)9
- Five-point system of Ackerman & Proffit (1969)10

2. Epidemiologic indices
- Index of Tooth Position (Massler & Frankel, 1951)11
- Malalignment Index (Van Kirk & Pennel, 1959)12
- Occlusal Feature Index (Poulton & Aaronson, 1961)13
- The Bjork Method (1964)4
- Summers’ Occlusal Index (1971)14
- The FDI method (Baume et al, 1973)15
- Little’s Irregularity Index (1975)16

3. Orthodontic treatment need indices
- Handicapping Labio-lingual Deviation index (HLD) (Draker, 1960, 1967)17
- Swedish Medical Board Index (SMHB 1966; Linder Aronson, 1974, 1976)18,19
- Dental Aesthetic index (DAI) (Cons et al, 1986)20
- Index of Orthodontic treatment Need (IOTN) (Brook & Shaw, 1989)21
- Index of Complexity, Outcome & Need (ICON) (Daniel & Richmond, 2000)22
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4. Orthodontic Treatment Outcome indices
- Peer Assessment Rating Index (PAR) (Richmond et al, 1992)23
- Index of Complexity, Outcome & Need (ICON) (2000)22

5. Orthodontic Treatment Complexity indices
- Index of Orthodontic Treatment Complexity (IOTC) (Llewellyn et al, 2007)24
- Index of Complexity, Outcome & Need (ICON) (2000)22

The method for recording malocclusion can be classified into qualitative and quantitative methods.26 Qualitative method describes the occlusal features and provides descriptive classification of the dentition, however does not provide any information of the treatment need and outcome. Malocclusion symptoms are recorded in all or none manner as the studies on epidemiology of malocclusion do not define the method of measuring the variables.26

Quantitative methods quantify the complexity and severity of the problem rated in a scale or proportion. They are used to prioritize the need for treatment. Their use minimizes the subjectivity related to the diagnosis, outcome and complexity assessment of orthodontic treatment.

### Qualitative methods of measuring malocclusion

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<td>Stallard (1932)29</td>
<td>General dental status, including some malocclusion symptoms are recorded</td>
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<td>McCall (1944)30</td>
<td>Include molar relationship, posterior crossbite, anterior crowding, rotated incisors, excessive overbite, open bite, labio/linguo version, tooth displacement, constriction of arches.</td>
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<td>Sclare (1945)31</td>
<td>Include Angle classification of molar relationship, arch constriction with/without incisor crowding, superior protrusion with/without incisor crowding, labial prominence of canines, lingually placed incisors, rotated incisors, crossbite, open bite and closed bite.</td>
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<td>Involve grading of the tooth displacement and rotation Quantitatively defines tooth displacement (&lt;1.5 mm or &gt;1.5mm) and tooth rotation (&lt;45° or &gt;45°)</td>
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<td>Bjork, Krebs &amp; Solow (1964)</td>
<td>Objective registration of malocclusion symptoms based on detailed definitions. Data obtained could be analyzed by computers. Primarily developed for epidemiological purpose with little emphasis on treatment need. Following three parts are considered: 1. Anomalies of dentition: Tooth anomalies, abnormal eruption, malalignment 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.</td>
</tr>
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<td>Ballard &amp; Wayman (1965)</td>
<td>Also known as British Standards Institute Classification. Considered more reliable to Angle classification as posterior teeth relation did not influence the incisor occlusion. Based on the relationship of incisal edges of upper and lower incisors.</td>
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<td>Memorandum of Orthodontic Screening &amp; Indications for Orthodontic Treatment (1990)</td>
<td>Proposed by Danish National Board of Health to assess orthodontic treatment need</td>
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<td>Grade Index Scale for Assessment of Treatment Need (GISATN) -Salonen, Mohlin et al (1992)</td>
<td>Developed in Sweden as a malocclusion index for treatment need</td>
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<tr>
<td>5-Year-Olds’ Index - Atack et al (1997)</td>
<td>Frequently used index for cleft lip and palate cases in deciduous dentition. Applied reliably to photographs of models and to clinical photographs. Predicted long term outcome is divided into five following groups: 1. Excellent: Positive overjet with average inclined/retroclined incisors, no crossbite/openbite, good maxillary shape and palatal anatomy 2. Good: Positive overjet with average inclined/proclined incisors, unilateral crossbite or crossbite tendency, open bite tendency around cleft site 3. Fair: Edge-to-edge bite with average inclined or proclined incisors; or reverse overjet with retroclined incisors, unilateral crossbite, +/- open bite tendency at cleft site 4. Poor: Reverse overjet with average inclined or proclined incisors, unilateral crossbite, bilateral crossbite, open bite around cleft site 5. Very poor: Reverse overjet with proclined incisors, bilateral crossbite, poor maxillary arch form and palatal vault anatomy</td>
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### Quantitative methods of measuring malocclusion

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<td><strong>Handicapping Labirolingual Deviation Index (HLDI)</strong>&lt;br&gt;- Draker (1960)&lt;sup&gt;17&lt;/sup&gt;</td>
<td>- Measurement include cleft palate, traumatic deviations (all or none), overjet, overbite, mandibular protrusion, anterior openbite and labio-lingual spread&lt;br&gt;- The Maryland version of HLD; the HLD (Md) index&lt;sup&gt;18&lt;/sup&gt; modified the HLD’s original scoring formula for overjet and overbite.&lt;br&gt;- The modified HLD (CalMod) index included deep impinging bites and crossbites of individual anterior tooth with tissue destruction (Parker 1998)&lt;sup&gt;19&lt;/sup&gt;</td>
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<tr>
<td><strong>Malocclusion Severity Estimate</strong>&lt;br&gt;- Grainger (1960-61)&lt;sup&gt;20&lt;/sup&gt;</td>
<td>- Seven weighted and defined measurements are: Overjet, overbite, anterior openbite, congenitally missing maxillary incisors, molar relationship, posterior crossbite, tooth displacement (actual and potential).&lt;br&gt;• Six malocclusion syndromes are defined as follows:&lt;br&gt;1. Positive overjet and anterior openbide&lt;br&gt;2. Positive overjet, positive overbite, distal molar relationship and posterior crossbite with maxillary teeth buccal to mandibular teeth&lt;br&gt;3. Negative overjet, mesial molar relationship and posterior crossbite with maxillary teeth lingual to mandibular teeth&lt;br&gt;4. Congenitally missing maxillary incisors&lt;br&gt;5. Tooth displacement&lt;br&gt;6. Potential tooth displacement</td>
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<td><strong>Occlusal Feature Index (OFI)</strong>&lt;br&gt;- Poulton &amp; Aaronson (1961)&lt;sup&gt;13&lt;/sup&gt;</td>
<td>- Measures four occlusal features: lower anterior crowding, cuspal interdigititation, vertical overbite and horizontal overjet.&lt;br&gt;- Scoring done according following criteria:&lt;br&gt;  Slight: No need for orthodontic treatment&lt;br&gt;  Mild: Some variation from ideal occlusion but not sufficient to need treatment&lt;br&gt;  Moderate: Orthodontic treatment indicated and would be beneficial&lt;br&gt;  Severe: Treatment essential</td>
</tr>
<tr>
<td><strong>Occlusal Index (OI)</strong>&lt;br&gt;- Summers, Arbor (1966, 1971)&lt;sup&gt;14&lt;/sup&gt;</td>
<td>- Valid tool for measuring occlusion and malocclusion for epidemiological purpose.&lt;br&gt;• Different scoring scheme for deciduous, mixed and permanent dentition&lt;br&gt;• Nine weighted and defined measurements are: Molar relation, overbite, overjet, posterior crossbite, posterior openbite, tooth, displacement, midline relation, maxillary median diastema, congenitally missing maxillary incisors&lt;br&gt;• Seven malocclusion syndromes are:&lt;br&gt;1. Overjet and openbite&lt;br&gt;2. Distal molar relation, overbite, overbite, posterior crossbite, midline diastema and midline deviation&lt;br&gt;3. Congenitally missing maxillary incisors&lt;br&gt;4. Tooth displacement&lt;br&gt;5. Posterior open bite&lt;br&gt;6. Mesial molar relation, overjet, overbite, posterior crossbite, midline diastema and midline deviation&lt;br&gt;7. Mesial molar relation, mixed dentition analysis &amp; tooth displacement</td>
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<td><strong>Swedish Medical Board Index (SMBI)</strong>&lt;br&gt;- SMHB (1966); -Linder-Aronson (1974, 1976)&lt;sup&gt;18,19&lt;/sup&gt;</td>
<td>- Developed by Swedish Medical Health Board&lt;br&gt;• Treatment need is represented by 4 categories (Grade 1 to 4):&lt;br&gt;  Later Linder-Aronson revised the index by adding fifth category of Grade zero.&lt;br&gt;• Categorized as Grade 4-0; very urgent need, urgent need, moderate need, little need and no need.&lt;br&gt;• Features like esthetically and/or functionally handicapping anomalies such as cleft lip and palate, aplasia, occlusion, deep bite, open bite, crossbite, scissors bite, overjet, crowding, spacing, rotation, retained teeth are considered.</td>
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<td><strong>Treatment Priority Index (TPI)</strong>&lt;br&gt;- Grainger (1967)&lt;sup&gt;41&lt;/sup&gt;</td>
<td>- Eleven weighted and defined measurements are: upper anterior segment overjet, lower anterior segment overjet, overbite of upper anterior over lower anterior, anterior openbite, congenital absence of incisors, distal molar relation, mesial molar relation, posterior crossbite (buccal), posterior crossbite (lingual), tooth displacement, gross anomalies&lt;br&gt;• Seven malocclusion syndromes are: Maxillary expansion syndrome, overbite, retrognathism, openbite, prognathism, maxillary collapse syndrome, congenitally missing incisors</td>
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| **Handicapping Malocclusion Assessment Index (HMAR)**                                                   | - Salzmann (1968)⁴²  
  • Weighted measurements consist of following three parts:  
    1. Intra-arch deviation: Missing, crowding, rotations, spacing  
    2. Inter-arch deviation: Overjet, overbite, crossbite, open bite mesiodistal deviation  
    3. Six handicapping dentofacial deformities: Facial and oral clefts, lower lip palatal to maxillary incisors, occlusal interferences, functional jaw limitation, facial asymmetry, speech impairment |
| **Eismann Index (EI)**                                                                                 | - Eismann (1974)⁴⁵  
  • Based on Bjork’s method  
  • Objective method of measuring malocclusion and assessing the efficacy of orthodontic treatment  
  • Based on numerical evaluation of 15 morphological traits of malocclusion  
  • Modified by Farcnik et al in Slovenia.⁴⁴,⁴⁵                                                                                                                                 |
| **Irregularity Index**                                                                                 | - Little (1975)¹⁴  
  • Simple, reliable and valid method of measuring linear displacement of the anatomic contact point  
  • Used by public health and insurance program to establish the severity of malocclusion and priority of treatment.  
  • Five linear displacement of adjacent contact point starting from mesial of right lower canine to mesial of left lower canine are recorded.  
  • Model cast is ranked on a scale ranging from 0-10.                                                                                                                                                                                                                         |
| **Dental Aesthetic Index (DAI)**                                                                        | - Cons et al (1986)²⁰  
  • Developed in USA  
  • Integrated into International Collaboration Study of Oral Health Outcomes by WHO as an international index  
  • Links clinical and aesthetic components mathematically to produce a single score that combines physical and aesthetic aspects of occlusion, including patient perceptions.                                                                                                                                                       |
| **Goslon Yardstick Index**                                                                             | - Mars et al (1987)⁴⁶  
  • Used in Great Ormond Street, London and Oslo.  
  • Clinical tool that allows the categorization of dental relationships in late mixed dentition and early permanent dentition into five discrete categories  
    - Group 1: Excellent- No treatment  
    - Group 2: Good- Simple orthodontic treatment/ no treatment  
    - Group 3: Fair- Complex orthodontic treatment, good result anticipated  
    - Group 4: Poor- Limited orthodontic treatment without orthognathic surgery if growth is favorable  
    - Group 5: Very poor- Orthognathic surgery, categorizes malocclusion in cleft lip & palate.                                                                                                           |
| **Standardized Continuum of Aesthetic Need (SCAN Index)**                                               | - Evans & Shaw (1987)⁴⁷  
  • Developed in UK  
  • Dental occlusion is matched with overall dental attractiveness against ten-scaled photographs of Aesthetic Component of IOTN.  
  • Useful in state-funded hospital services.                                                                                                                                                                                                                                   |
| **Index of Orthodontic Treatment Need (IOTN)**                                                         | - Brook & Shaw (1989)²¹  
  • IOTN has two components: Dental health component (DHC) and Aesthetic component (AC).  
  • DHC comprise of five grades of treatment need ranging from Grade 1-5; none, little, moderate, great & very great.  
  • Features like displacement, overjet, crossbite, openbite, occlusion, hypodontia, defects of cleft lip and palate, overjet, impeded eruption, supernumerary teeth, retained deciduous teeth, other pathologic cause  
  • Aesthetic Component consists of 10-grade standard reference photographs representing different grades of dental attractiveness.                                                                                                                                                         |
| **Peer Assessment Rating (PAR) Index**                                                                 | - Richmond (1992)²³  
  • Comprise of 11 following components; upper right segment, upper anterior segment, upper left segment, lower right segment, lower anterior segment, lower left segment, right buccal occlusion, overjet, overbite, centre line & left buccal occlusion.                                                                                                                                 |
| **Norwegian Orthodontic Treatment Index (NOTI)**                                                        | - Espeland, Ivarsso, Stenvik (1992)⁴⁸  
  • A new approach to the combination of public and private funding of treatment to determine the level of public health copayment to the patient.  
  • On morphologic and functional basis, four groups defined are: very great, great, obvious, little/no need  
  • Used in total reimbursement for severe malocclusion with cleft lip and palate, and partial or nil reimbursement for other malocclusions.                                                                                                                                 |

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Risk of Malocclusion Assessment Index (ROMA Index)
- Russo, Grippaudo (1998)

- Tool to assess treatment need and validated instrument to evaluate the malocclusion risk in children with mixed dentition
- Used to individuate not only orthodontic treatment need for children in growing age but also intervention time and treatment costs in the strength of severity of score.
- Identifies 5 grades considering negative effects of malocclusion on both dento-skeletal apparatus and on psycho-social wellbeing.

Index of Complexity, Outcome & Need (ICON)
- Daniels & Richmond (2000)

- Considered highly valid and reliable method
- Developed by a joint effort of 97 orthodontists across 9 countries
- Occlusal traits scores includes:
  1. Upper and lower segment alignment
  2. Anterior vertical relationship, centerline, impacted teeth, upper and lower buccal segment alignment, buccal segment AP relationship, buccal segment vertical relationship, crossebite, missing teeth
  3. Esthetic assessment based on IOTN esthetic component, overjet, reverse overjet, upper and lower incisor inclination relative to occlusal plane, upper arch crowding/spacing, lip competency

American Board of Orthodontics (ABO) Discrepancy Index

- Developed as an index to represent the objective evaluation of difficulty of the case presented for phase III ABO examination.
- Called as discrepancy index (DI)
- Evaluates case complexity based on criteria of case difficulty by evaluating dental models and cephalometric parameters.
- Determinants are overjet, overbite, openbite, crowding, occlusion, lingual/buccal posterior crossebite, cephalometrics.

Index of Orthodontic Treatment Complexity (IOTC)

- A simple method measuring relatively few traits
- Can be used on patients and study casts
- Valid for the assessments of treatment need, complexity and outcome
- Avoids the need to use different indices for different forms of assessment
- Identification of the level of expertise needed to treat a specific case, allocation of health care resources, appropriate recognition of professionals undertaking complex care, and provision for better patient information regarding the likely complexity of the treatment.

DISCUSSION

The present article reviewed various orthodontic indices available in the literature. Classification of orthodontic indices proposed by Shaw et al. is the most comprehensive system found. Descriptions on indices and methods of the assessment of malocclusion mentioned in the present article are based on the opinion of respective authors.

Initially malocclusions used to be described as per the clinical features on qualitative basis, later there have been attempts to quantify them in scale and scores. The present article also attempts to categorize various orthodontic indices into qualitative and quantitative methods.

Most of the orthodontic indices use study model for analysis, however direct examination on patients and photographs have also been used in other systems. Study model serves as a patient awareness tool for the patients and allows three-dimensional analyses. Traditionally, the opinion and experience of the orthodontist are used to explain the discrepancy of the dental arches. In fact, no single classification is found to be ideal, accurate, valid and reliable for assessing the malocclusion and yet that is simple. There have been many disagreements among the authors and researchers about various indices, therefore many newer systems are developed to fulfill the shortcomings of the antecedents. Angles classification is still the most widely used system in clinical and epidemiological purposes and IOTN is perhaps the most accepted index for assessing treatment need. ABO Discrepancy Index serves as the contemporary tool for complexity scores and academic evaluations.

REFERENCES


