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Review Article

Malocclusion indices- A review

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ABSTRACT

Malocclusion is one of the common problems seen in all parts of the world which varies according to genetics, environment and race. It causes the disability of oral health, functions, esthetics and also the psychology of an individual in terms of their appearance.Malocclusion is a misalignment or incorrect relation between the teeth of the dental arches. Indices have an important role in classifying the malocclusion.

1. Introduction

Malocclusion can be defined as abnormal alignment of teeth.[1,2] The need for orthodontic treatment is influenced by the desire of looking good. Complexity and severity are two terms which are often related with malocclusion but there is a difference between them. Severity means the deviation of any malocclusion from normal and complexity is the measurement of efforts and skills required by an orthodontist for the treatment of malocclusion.[3] Aim of the orthodontic treatment is to improve the functioning and esthetics and to create a harmonious environment. Orthodontic indices have an important role in the classification of malocclusion, orthodontic treatment needs, level of complexity and prediction of duration of treatment.[4] An index comprises of numerical values which describes the relative status of a population on a graded scale with definite upper and lower limits. An index is helpful in assessing degree of initial malrelationship.[5]

2. Classification of Malocclusion Indices

The malocclusion indices can be broadly classified as:

1. Qualitative methods
2. Quantitative methods

2.1. *Qualitative methods of measuring malocclusion*[6]

It describes the occlusal features and provides descriptive classification of the dentition, however does not provide any information about the treatment need and outcome.

1. Angle (1899)
2. Stallard (1932)
3. McCall (1944)
4. Sclare (1945)
5. Index of Tooth Position - Massler & Frankel (1951)
6. Malalignment Index - Van Kirk & Pennel (1959)
7. Fisk (1960)
8. Bjork, Krebs & Solow (1964)
9. Incisal categories Ballard & Wayman (1965)Five point system – Ackerman & Proffit (1969)
10. WHO/FDI method - Baume et al (1979).
11. Memorandum of Orthodontic Screening & Indications for Orthodontic Treatment (1990)
12. Five point system – Ackerman & Proffit (1969)
13. Grade Index Scale for Assessment of Treatment Need (GISATN) -Salonen, Mohlin et al(1992)

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14. 5-Year-Olds“ Index - Atack et al (1997)

2.2. *Quantitative methods of measuring malocclusion*[6]

It quantifies the complexity and severity of the problem which is rated in a scale or proportion.

1. Handicapping Labiolingual Deviation Index (HLDI) - Draker (1960)
2. Malocclusion Severity Estimate – Grainger (1960-61)
3. Occlusal Feature Index (OFI) - Poulton & Aaronson (1961)
4. Occlusal Index (OI) – Summers, Arbor (1966, 1971)
5. Swedish Medical Board Index (SMBI) - SMHB (1966); -Linder Aronson (1974, 1976)
6. Treatment Priority Index (TPI) - Grainger (1967)
7. Handicapping Malocclusion Assessment Index (HMAR) - Salzmann (1968)
8. Eismann Index (EI) - Eismann (1974)
9. Irregularity Index - Little (1975)
10. Dental Aesthetic Index (DAI) - Cons et al (1986)
11. Goslon Yardstick Index - Mars et al (1987)
12. Standardized Continuum of Aesthetic Need (SCAN Index) - Evans & Shaw (1987)
13. Index of Orthodontic Treatment Need (IOTN) - Brook & Shaw (1989)
14. Peer Assessment Rating (PAR) Index - Richmond (1992)
15. Norwegian Orthodontic Treatment Index (NOTI) - Espeland, Ivarsso, Stenvik (1992)
16. Risk of Malocclusion Assessment Index (ROMA Index) - Russo, Grippaudo (1998) for other malocclusions.
17. Index of Complexity, Outcome & Need (ICON) Daniels & Richmond (2000)
18. American Board of Orthodontics (ABO)/Discrepancy Index - Cangialosi et al (2004, 2011-12)
19. Index of Orthodontic Treatment Complexity (IOTC) - Liewellyn et al (2007)

2.3. *Angle's classification*[7]

Edward H Angle introduced the system of classifying malocclusion in the year 1899. Based on relation of lower first molar with respect to upper first molar. He categorized malocclusion into class I,II,III malocclusion. He used upper first molar as the key to normal occlusion.

a) Angle's Class I malocclusion - The mesiobuccal cusp of the maxillary first permanent molar occludes in the buccal groove of mandibular first permanent molar.

Dewey's modification – Angle's Class I malocclusion modifications It was given by Martin Dewey in 1915.

1. Type 1- Class I malocclusion with bunched or crowded anterior teeth.
2. Type 2- Class I malocclusion with protrusive maxillary incisors.
3. Type 3- Class I malocclusion with anterior cross bite.
4. Type 4- Class I malocclusion with posterior cross bite.
5. Type 5 -The permanent molar has drifted mesially due to early extraction of second deciduous molar or second premolar.

b) Angle's Class II malocclusion - The distobuccal cusp of the maxillary first permanent molar occludes in the buccal groove of mandibular first molar.

1. Angle's Class II div 1 malocclusion - Characterized by proclined upper incisors with a resultant increase in overjet.
2. Angle's Class II div 2 malocclusion - Characterized by retroclined upper incisors and labially tipped lateral incisors overlapping the central incisors.

c) Angle's Class III malocclusion - Mesiobuccal cusp of maxillary first molar occludes in the interdental space between the mandibular first and second molars.

Class III Dewey's modifications

1. Type 1 – The upper and lower dental arches when viewed separately are in normal alignment. But when the arches are made to occlude the patient shows an edge to edge incisor alignment, suggestive of a forwardly moved mandibular dental arch.
2. Type 2 -The mandibular incisors are crowded and are in lingual relation to the maxillary incisors.
3. Type 3- The maxillary incisors are crowded and are in crossbite relation to the mandibular anteriors.

McCall (1944)[17] *and Sclare (1945)*[18]

This index includes dental irregularities in both inter and intramaxillary arches under the following parameters: Molar relationship ,posterior crossbite, anterior crowding ,rotated incisors ,excessive overbite ,open bite, labio/linguo version ,tooth displacement ,constriction of arches but sclare considered few more parameters like superior protrusion with or without incisor crowding, labial prominence of canines.

Massler & Frankel (1951)[19] measured tooth displacement in form of displacement and rotation. This index evaluates the incidence and prevalence of malocclusion in given group of population.

Malalignment Index was given by *Van Kirk & Pennel (1959).*[10] The clear plastic ruler like instrument was used, measuring 1 inch x 4 inches, has a 45^0 angle cut at one end and lines etched 1.5 mm from edges to other end. The segments were assessed in six segment in the following order: Maxillary anterior, maxillary right posterior, maxillary left posterior, Mandibular anterior, mandibular right posterior, and mandibular left posterior. Each tooth present in a segment is scored. 0, 1 or 2.

Table 1:

Various indices used in measuring of a malocclusion	
Angle's classification(1899)[7]	Based on relation of lower first molar with respect to upper first molar. Malocclusion is categorized into class I,II,III malocclusion.
Proffit and Ackerman (1969,1973)[8]	Five steps procedure of assessing malocclusion: 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.
Malalignment index by Vankirk and Pennell (1959)[9]	Designed to measure tooth rotations and displacement
Irregularity Index - Little (1975)[10]	Linear displacement of the anatomic contact point are measured
Dental esthetic index (DAI), Cons (1986)[11,12]	DAI components include: 1. Number of visible missing teeth (incisors, canines and premolars in maxillary and mandibular arch). 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.
Index of Orthodontic Treatment Need (IOTN) - Brook & Shaw (1989)[13]	Dental health component (DHC) and Aesthetic component (AC) DHC comprise of five grades of treatment need ranging from Grade 1-5: Grade 1: None. Grade 2: Little. Grade 3: Moderate. Grade 4: Great. Grade 5: Very great.
Peer Assessment Rating (PAR) Index - Richmond (1992)[14]	It comprises of 11 following components: 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. Centre line 11. Left buccal occlusion.
Index of Complexity, Outcome & Need (ICON) Daniels & Richmond (2000)[16]	Occlusal trait scores include: 1. Upper and lower segment alignment 2. Anterior vertical relationship 3. Centerline 4. Impacted teeth 5. Upper and lower buccal segment 6. alignment 7. Buccal segment AP relationship 8. Buccal segment vertical relationship 9. Crossbite 10. Teeth 11. Esthetic assessment based on IOTN esthetic component 12. Overjet
American Board of Orthodontics (ABO)/Discrepancy Index - Cangialosi et al (2004, 2011-12)[15]	Evaluates the case difficulty by evaluating dental models and cephalometric parameters.

Incisal categories Index given by Ballard & Wayman (1965)[20] is also known as British Standards Institute Classification. It is based on the relationship of incisal edges of upper and lower incisors as they believed posterior teeth relation did not influence incisor occlusion.

The index of Five-point system was given by Ackerman & Proffit (1969)[8]

A venn diagram represented 5 characteristics of malocclusion (Figure 1). It involves evaluation of intra arch alignment symmetry i.e crowding and spacing. The inner circle represent profile assessment. The innermost circle represent dental and skeletal malocclusion in 3 planes of space i.e transverse, sagittal and vertical. Transverse plane malocclusion indicates buccolingual relationshsip of posterior teeth i.e crossbites. Malocclusion in sagittal plane indicates anterior / posterior positioning of maxilla and mandible to each other. Malocclusion in vertical plane indicates bite depth.

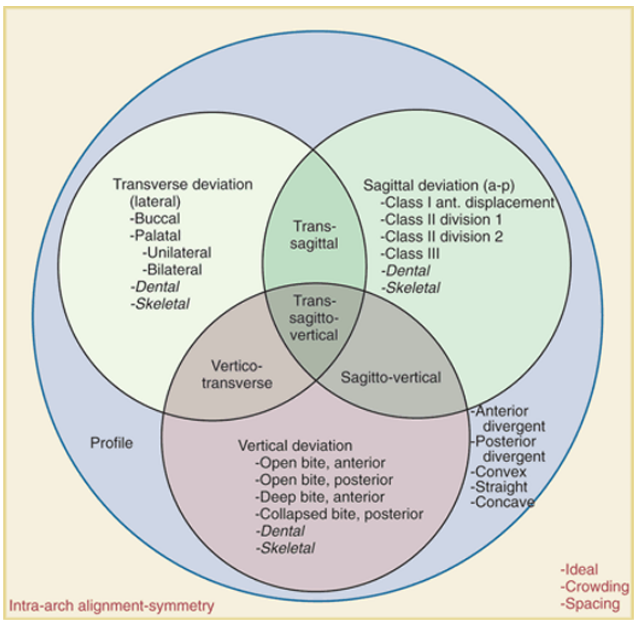

Figure 1: Ackerman & Proffit classification diagram (1969)(Venn diagram)[8]

It was modified in 2007 according to position/ orientation so that transverse plane represents roll of the plane, sagittal plane represents pitch and vertical plane represents pitch.(Figures 2 and 3)

Handicapping Labiolingual Deviation Index (HLDI) was given by Draker (1960)[22] which included the following measurements :cleft palate, traumatic deviations (all or none), overjet, overbite, mandibular protrusion, anterior openbite and labio-lingual spread. The Maryland version of HLD; modified the HLD's original scoring formula for overjet and overbite. The modified HLD (CalMod) index included deep impinging bites and crossbites of individual anterior tooth with tissue destruction (Parker 1998).

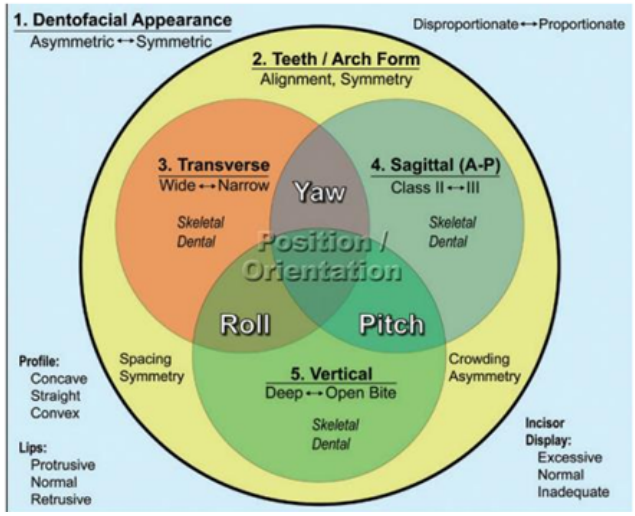

Figure 2: Modified ackerman & proffit classification diagram 2007 (Venn diagram)[21]

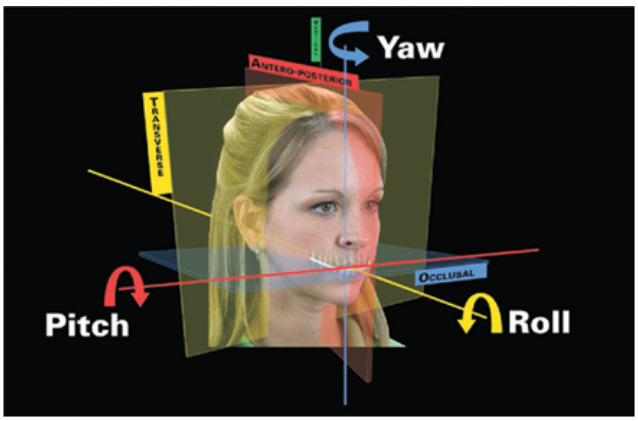

Figure 3: 3 planes represented by pitch, roll and yaw[21]

Occlusal Index (OI) which was given by *Summers, Arbor (1966, 1971)*[23] is a valid tool for measuring occlusion and malocclusion in deciduous, mixed and permanent dentition. Parameters included are: Overjet and openbite, distal molar relation, overbite, overbite, posterior crossbite, midline diastema and midline deviation, congenitally missing maxillary incisors ,tooth displacement, posterior open bite, mesial molar relation, overjet, overbite, posterior crossbite, midline diastema and midline deviation, mesial molar relation, mixed dentition analysis & tooth displacement .

Treatment Priority Index (TPI) was given by Grainger (1967)[24] including the following parameters : 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.

Few syndromes were also considered- Maxillary expansion syndrome, Overbite, Retrognathism, Openbite, Prognathism, Maxillary collapse syndrome, Congenitally missing incisors.

Irregularity Index given by Little (1975)[10] is a simple, reliable and valid method that measures linear displacement of the anatomic contact point. Severity of malocclusion and priority of treatment is established using this index. Five linear displacement of adjacent contact point starting from mesial of right lower canine to mesial of left lower canine are recorded. Ranking is done for study models on a scale ranging from 0-10.

Dental Aesthetic Index (DAI) was developed in USA by *Cons et al (1986)*[11,25] It provides a link between clinical and aesthetic components mathematically to produce a single score that combines physical and aesthetic aspects of occlusion also including how the patient perceives his/her occlusion.

Index of Orthodontic Treatment Need (IOTN) was given by Brook & Shaw (1989)[13] which included the 2 components i.e Dental health component (DHC) and Aesthetic component (AC). DHC comprise of five grades of treatment need for the following measures like displacement, overjet, crossbite, openbite, occlusion, hypodontia, defects of cleft lip and palate, overjet, impeded eruption, supernumerary teeth, retained deciduous teeth, other pathologic cause which ranges from Grade 1-5 Features Aesthetic Component analyses different grades of dental attractiveness using standard reference photographs.

Peer Assessment Rating (PAR) Index was given by *Richmond (1992)*[14] that comprises of 11 dental components. Following measures are included 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 and left buccal occlusion.

Index of Complexity, Outcome & Need (ICON) given by Daniels & Richmond (2000)[16] considers various dental and soft tissue components which include Occlusal trait scores include upper and lower segment alignment ,anterior vertical relationship, centerline ,impacted teeth, upper and lower buccal segment alignment, buccal segment ap relationship ,buccal segment vertical relationship ,crossbite ,teeth 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 given by Cangialosi et al (2004, 2011-12)[15] represents the objective evaluation of difficulty of the case. It is called as discrepancy index (DI) as it evaluates case complexity based on criteria of case difficulty. Evaluation of dental models and cephalometric parameters is done under the following determinants: overjet, overbite, openbite, crowding, occlusion, lingual/buccal posterior crossbite, cephalometrics.

Index of Orthodontic Treatment Complexity (IOTC) was given by *Liewellyn et al (2007)*[26] and is a valid measure for assessment of treatment need, complexity and outcome. Because of this index there is no need to use different indices for various forms of assessment of malocclusion.

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None.

4. Conflict of Interest

None.

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