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Malocclusion and Orthodontics Indices: A Review

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ABSTRACT: *Malocclusion is classified into three groups based on the location of the permanent maxillary first molar relative to the mandibular first molar. Class I malocclusion, or neutroclusion, is distinguished by an optimal mesiodistal connection between the jaws and dental arches. The mesiobuccal cusp of the maxillary first molar occluding mesially to the mesiobuccal groove of the mandibular first molar distinguishes Class II malocclusion, also known as distoclusion in the permanent dentition. Class III malocclusion, or mesiooclusion, is defined as the mesiobuccal cusp of the maxillary first molar occluding more than the width of a premolar distal to the mandibular first molar's mesiobuccal groove. Orthodontic indices are used in clinical and epidemiological research of malocclusion. The Peer Assessment Rating (PAR) index is an essential tool in orthodontics for assessing the severity of malocclusions and measuring the success of treatment measures. It offers a systematic and standardized way to evaluate various elements of malocclusions. Bolton Analysis effectively detects tooth size differences since it examines and determines the standard anterior and overall ratios of mesiodistal widths in maxillary and mandibular teeth. The Index of Orthodontic Treatment Need (IOTN) is a tool for determining whether or not an individual requires orthodontic treatment which divided into two parts: the Dental Health Component (DHC) and the Aesthetic Component (AC), which assesses the health and functionality of teeth and jaws while also taking into account the appearance of teeth and their impact on a smile.*

Keywords: *malocclusion; dentistry; peer assessment rating; Bolton analysis; index of orthodontic need.*

I. INTRODUCTION

Orthodontics is a specialized field that explores the complexities of facial growth, the formation of teeth, and how they align when we bite down, which professionals call occlusion. Among the many responsibilities that fall under this category are the early diagnosis of problems, preventing problems from becoming more severe, and providing treatment for anomalies in occlusion (Mitchell, 2007). Orthodontics, in its most fundamental sense, is crucial in ensuring that our teeth and jaw integrate seamlessly, achieving optimal function and a pleasing appearance (Proffit, 2000).

Orthodontic treatment aims to create a bite where the upper and lower teeth fit together correctly, allowing for efficient chewing and preventing issues that may arise from misalignments. Ultimately, orthodontic care extends beyond mere aesthetics, emphasizing restoring proper function in the masticatory system ensuring a healthy and balanced oral environment (Kansal et al., 2012). The standard biting action, where the upper and lower teeth fit together correctly, is essential for smooth and efficient chewing. Severe malocclusion can disrupt this process, affecting overall oral function and highlighting the importance of addressing alignment issues for improved comfort and oral health (Christensen, 2002).

Normal occlusion, or central occlusion (CO), is the intentional alignment of teeth that allows maximum

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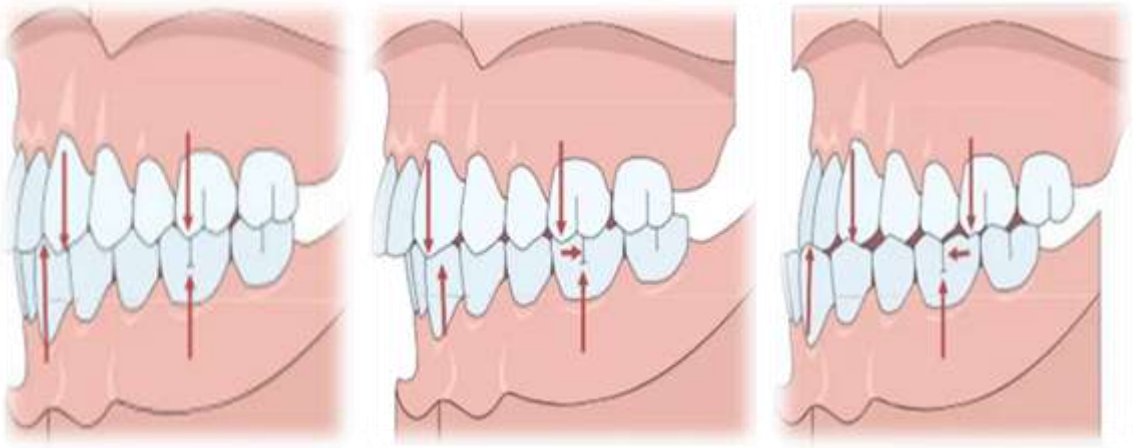
contact when they come together, playing a crucial role in dental function. In this arrangement, each tooth in one arch lines up with a corresponding tooth in the opposite arch, except for the lower front teeth (mandibular central incisors) and the upper back molars (maxillary third molars). Overjet is used when the upper dental arch extends beyond the lower one. The distance measured from the mandibular incisor's labial surface to the maxillary incisor's lingual surface (Balogh, 2006). In centric occlusion, where the teeth bite together in their usual position, the upper incisors overlap the lower incisors. This specific overlap is known as an overbite.

II. MALOCCLUSION

Malocclusion cases grouped into three main classes, according to the permanent maxillary first molar position to the mandibular first molar (Angle, 1899). This classification system is based on the relationship of the teeth as showed in Figure 1. Class I malocclusion, known as neutroclusion, is characterized by an ideal mesiodistal relationship between the jaws and dental arches. The mesiobuccal cusp of the maxillary first molar occludes the first molar's mesiobuccal groove. The maxillary canine occludes the distal half of the mandibular canine and the mesial half of the mandibular first premolar at the opposite arch canines (Balogh, 2006). William (2000) states that Class I malocclusion typically represents the regular relationship of molars, but the occlusion line may deviate due to malposed teeth, rotations, and various other factors. A typical example of Class I malocclusion manifests in crowding or spacing within standard jaw dimensions. Crowding occurs when teeth are misaligned within the dental arch, often caused by a disproportion between the size of the teeth and the available space within the arch.

Class II malocclusion, referred to as distoclusion in the permanent dentition, is distinguished by the mesiobuccal cusp of the maxillary first molar occluding mesial to the mesiobuccal groove of the mandibular first molar. Additionally, in this malocclusion class, the mandibular canine's distal surface extends beyond the maxillary canine's mesial surface by at least the width of a premolar (Balogh, 2006). Within Class II malocclusion, two subtypes exist: division I and division II. These subtypes are differentiated based on the anterior position, palate shape, and resulting facial profile. The characteristics of Division II often result in a reduced overbite compared to Division I (Balogh, 2006).

Class III malocclusion, commonly referred to as mesiooclusion, is characterized by the mesiobuccal cusp of the maxillary first molar occluding more than the width of a premolar distal to the mesiobuccal groove of the mandibular first molar (Balogh, 2006). In simpler terms, the upper first molar is positioned further forward than average to the lower first molar. This misalignment leads to the distal surface of the mandibular canine being mesial to the mesial surface of the maxillary canine by at least the width of a premolar. This malocclusion class presents a unique dental arrangement where the lower jaw appears more prominent or protrusive than the upper jaw. The severity of Class III malocclusion can vary, ranging from mild misalignment to more pronounced discrepancies in the positioning of the molars and canines (Balogh, 2006).



(a) (b) (c)

Figure 1: Type of malocclusions a) Type I b) Type II c) Type III

III. ORTHODONTICS INDICES

Orthodontic indices are used in clinical and epidemiological research of malocclusion. These indices comprise numerical values that intricately quantify a population's relative malocclusion status, positioning them on a graded scale defined by upper and lower bounds. This numerical representation facilitates comparisons between populations, especially those classified using identical criteria and methods (Gupta and Shrestha, 2015). However, none of the indices are appropriate for all-purpose, accurate, valid, and reliable malocclusion assessment for treatment priority. The evolution of orthodontic indices traces back to the 1950s when Massler and Frankel introduced a pioneering quantitative method for assessing malocclusion (Järvinen, 2001). Subsequently, Angle (1899) made significant contributions by categorizing malocclusion, laying the foundation for numerous subsequent classification systems. However, early qualitative approaches were deemed insufficient in gauging the severity of malocclusion and determining treatment needs (Gupta & Shrestha, 2015).

In Gupta and Shrestha's comprehensive classification of occlusal indices, the first group, diagnostic indices, plays a pivotal role in accurately diagnosing malocclusions. This group encompasses significant systems such as the Incisal Categories of Ballard and Wayman and the Five Point System of Ackerman and Proffit. These diagnostic tools serve as foundational elements in orthodontics, aiding practitioners in identifying and categorizing various malocclusions, thus laying the groundwork for effective treatment planning.

Transitioning to the second group, epidemiologic indices, a set of seven key metrics contribute to the broader understanding of malocclusion patterns within populations. These indices, including the Index of Tooth Position, Malalignment Index, Occlusal Feature Index, The Bjork Method, Summers' Occlusal Index, The FDI method, and Little's Irregularity Index, serve as valuable tools in research settings, facilitating the analysis of malocclusion prevalence, distribution, and characteristics across diverse demographic groups.

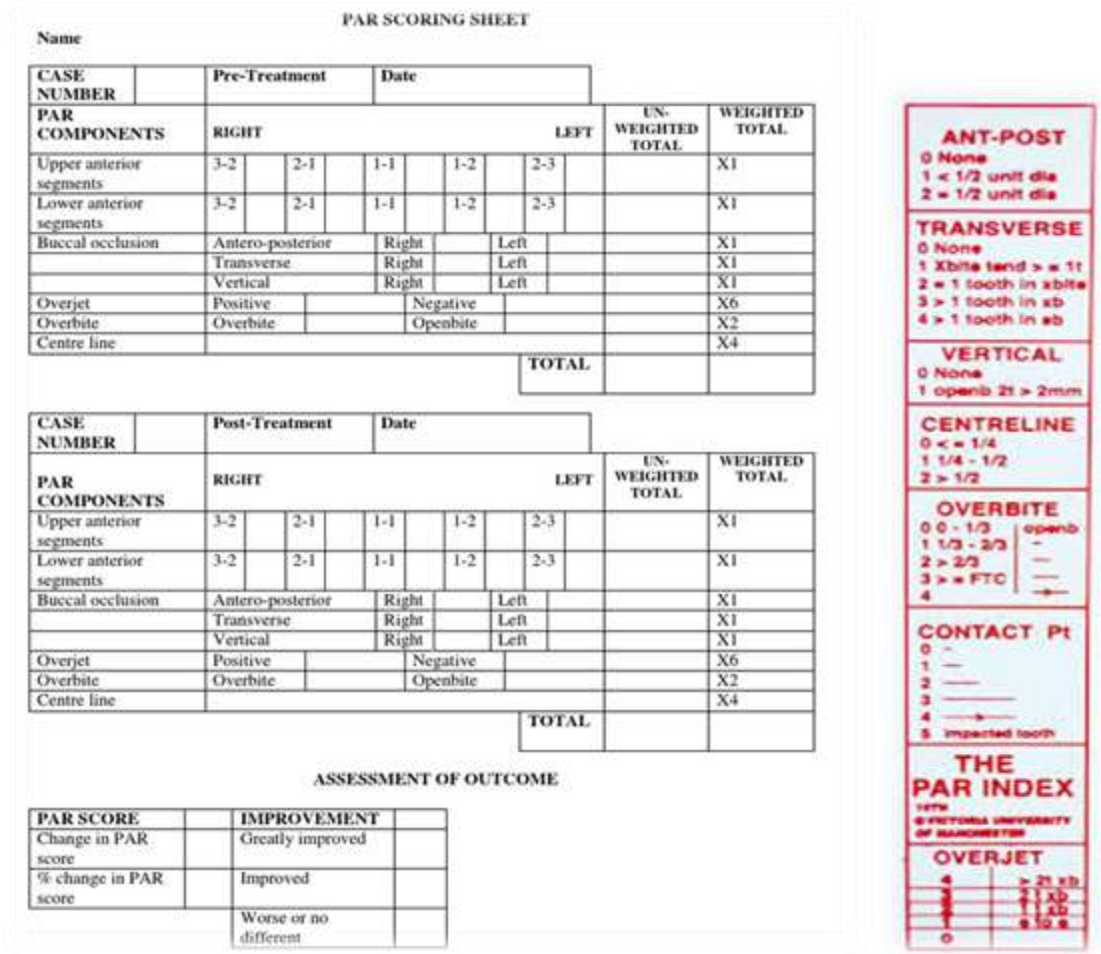
The third group focuses on orthodontic treatment needs indices, which are crucial for guiding treatment decisions based on the severity and urgency of cases. This group includes indices such as the Handicapping Labio-lingual Deviation index (HLD), Swedish Medical Board Index, Dental Aesthetic Index (DAI), Index of Orthodontic Treatment Need (IOTN), and Index of Complexity, Outcome & Need (ICON). These indices aid practitioners in prioritizing cases, ensuring a systematic and evidence-based approach to addressing orthodontic needs.

IV. PEER ASSESSMENT RATING (PAR) INDEX

Various quantitative indices have been developed to evaluate orthodontic treatment needs and outcomes, and among them, the Peer Assessment Rating (PAR) index holds particular prominence (Deguchi et al., 2005). Widely utilized in orthodontics, the PAR index is a valuable tool for assessing the severity of malocclusions and measuring the efficacy of treatment interventions in addressing them. Its creation in 1987 resulted from a collaborative effort involving ten seasoned orthodontists constituting the British Orthodontic Standards Working Party (Green, 2016). The PAR index provides a systematic and standardized approach to evaluating diverse malocclusion aspects. It allows orthodontic professionals to quantify treatment needs objectively and measure treatment outcomes in a standardized manner. Using multiple expert perspectives in its development ensures a comprehensive evaluation, enhancing its reliability and applicability across various clinical scenarios. The Peer Assessment Rating (PAR) Index, designed to evaluate the effectiveness of malocclusion treatment, has emerged as a crucial tool in orthodontics. Initially developed and validated as an occlusal index, the PAR Index serves to quantify the degree to which a patient deviates from normal alignment and occlusion (Firestone et al., 2002). This comprehensive index provides a summary score for occlusal anomalies and a quantitative measure of the extent to which a malocclusion deviates from the established norms in alignment and occlusion (Onyeaso & Begole, 2007).

The Peer Assessment Rating (PAR) index, a comprehensive tool in orthodontics, encompasses 11 crucial components that contribute to its nuanced evaluation as showed in Figure 2. These components include segments for the upper right, upper anterior, upper left, lower right, lower anterior, and lower left, along with assessments for right and left buccal occlusions, overjet, overbite, and centerline (Gupta & Shrestha, 2018). The PAR score calculation involves meticulously considering these parameters, offering a holistic perspective on the

patient's occlusal characteristics. Specific tools are employed to facilitate the measuring procedure, ensuring accuracy and consistency. The PAR Ruler is a precise instrument for gauging relevant dimensions, the PAR scoring sheet aids in systematic documentation, and standard stationery complements the process. Integrating these tools and components in the PAR index enhances the objectivity of orthodontic assessments and streamlines the communication of treatment needs and outcomes among professionals in the field.



PAR SCORING SHEET

Name

CASE NUMBER		Pre-Treatment		Date								
PAR COMPONENTS	RIGHT									LEFT	UN-WEIGHTED TOTAL	WEIGHTED TOTAL
Upper anterior segments	3-2		2-1		1-1		1-2		2-3			X1
Lower anterior segments	3-2		2-1		1-1		1-2		2-3			X1
Buccal occlusion	Antero-posterior			Right		Left						X1
	Transverse			Right		Left						X1
	Vertical			Right		Left						X1
Overjet	Positive			Negative								X6
Overbite	Overbite			Openbite								X2
Centre line												X4
										TOTAL		

CASE NUMBER		Post-Treatment		Date								
PAR COMPONENTS	RIGHT									LEFT	UN-WEIGHTED TOTAL	WEIGHTED TOTAL
Upper anterior segments	3-2		2-1		1-1		1-2		2-3			X1
Lower anterior segments	3-2		2-1		1-1		1-2		2-3			X1
Buccal occlusion	Antero-posterior			Right		Left						X1
	Transverse			Right		Left						X1
	Vertical			Right		Left						X1
Overjet	Positive			Negative								X6
Overbite	Overbite			Openbite								X2
Centre line												X4
										TOTAL		

ASSESSMENT OF OUTCOME

PAR SCORE		IMPROVEMENT	
Change in PAR score		Greatly improved	
% change in PAR score		Improved	
		Worse or no different	

(a) (b)

Figure 2: Peer Assessment Rating (PAR) a) Scoring Sheet b) Ruler

V. BOLTON ANALYSIS

Bolton Analysis, introduced by William R. Proffit in 1958, serves as a valuable tooth size analysis tool to identify tooth size discrepancies (Proffit, 2000). This analytical approach evaluates and defines the standard anterior and overall ratios of the mesiodistal widths of both the maxillary and mandibular teeth (Taibah, 2016). Bolton's foundational concept was rooted in establishing a mathematical relationship between the overall length of an ideal occlusion's maxillary and mandibular dental arches as showed in Figure 3. The underlying idea was that such a relationship could furnish orthodontists with a precise diagnostic tool, aiding in detecting discrepancies in teeth of various sizes.

Lopatiene (2009) emphasized that Bolton ratio evaluation is of the most clinical importance and affects the planning and execution of orthodontic interventions. In order to achieve the best possible overbite, overjet, and seamless interdigitation of maxillary and mandibular teeth after orthodontic treatment, it is essential to establish a harmonious mesiodistal relationship between the two sets of teeth (Taibah, 2016). In agreement with Proffit (2000), it is emphasized that maintaining tooth sizes in proportion is a prerequisite to attaining a healthy occlusion. As a result, a careful analysis of the Bolton ratio becomes essential, helping orthodontists to develop

specialized treatment plans that successfully correct tooth size disparities. This thorough analysis highlights the pivotal role of the Bolton ratio in successful orthodontic care, ensuring functional occlusion and achieving aesthetically pleasing outcomes and long-term stability in orthodontic results.

Díaz et al. (2016) investigate differences in Bolton index values between manual and digital measurement methods. In this study, two different measurement methods were used to analyze 70 pairs of study models. A compass and a millimeter ruler were among the traditional instruments used in the first method; an electronic vernier caliper was used in the second, more modern technique. There were no statistically significant differences between the measurements made using these two methodologies, an essential finding of the study. The results demonstrate the potential for interchangeability and validate the effectiveness of digital tools in orthodontic research by indicating a degree of consistency and reliability in applying both manual and digital techniques for assessing Bolton index values.

Watanabe-Kanno et al. (2010) conducted a study to evaluate and compare digital models with the established gold standard plaster models concerning the discrepancy in tooth size and Bolton analysis. The researchers gathered 15 pairs of plaster models from patients who had permanent dentition and were undergoing orthodontic treatment. In order to conduct evaluations, two examiners used a digital vernier caliper to measure the plaster models. They also measured the teeth' mesiodistal width and arch length three times. When conducting the statistical analysis, the following methods were utilized: interclass correlation (ICC), mean differences, and paired t-tests for comparisons. The study's findings indicate that the utilization of digital models and software for evaluating tooth-size discrepancy and Bolton analysis is an approach that is suitable for clinical use. However, in addition to shedding light on the dependability of digital methods in orthodontic evaluations, this research also contributes to the ongoing incorporation of digital technologies into contemporary clinical practices.

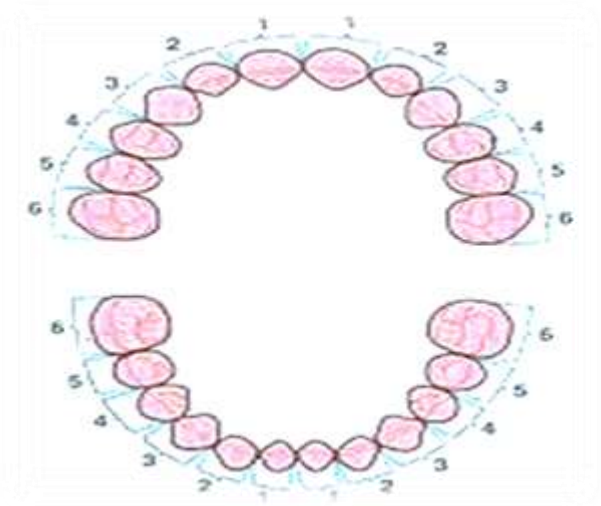


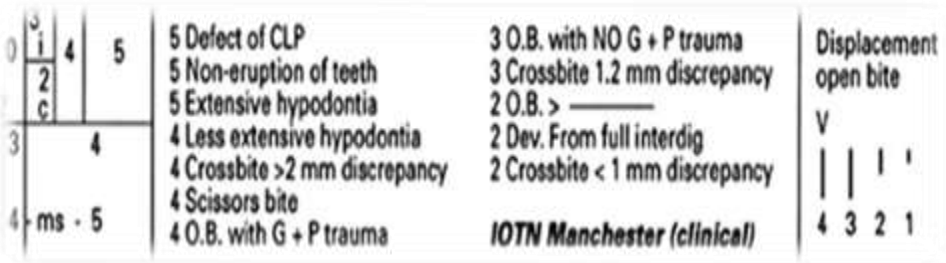
Figure 3. Measurement of Mesiodistal Width for Bolton Analysis

VI. INDEX OF TREATMENT NEED (IOTN)

British orthodontists Peter Brook and William Shaw developed the Index of Orthodontic Treatment Need (IOTN) in 1989. At first, it was known as the Index of Orthodontic Treatment Priority; however, it was renamed the Index of Orthodontic Treatment Need (Borzabadi-Farahani, 2011). It is a tool that has been examined and utilized extensively in various countries to determine whether or not an individual requires orthodontic treatment. The Dental Health Component (DHC) and the Aesthetic Component (AC) are the two aspects that they take into consideration (Jawad et al., 2015). Both the Dental Health Component (DHC) and the Aesthetic Component (AC) are essential components that are included in the Index of Orthodontic Treatment Need (IOTN). These components contribute to the evaluation of the severity of malocclusion cases. Biological and anatomical aspects of oral health and function are the primary areas of dental health care (DHC) concentration. Imagine it as a comprehensive examination of the teeth and jaws, focusing on how well they function in conjunction.

DHC is utilized by dentists in analyzing models of the teeth, regardless of whether the models are clinical casts or dental casts. A five-point scale is used for the grading system for DHC assignments. If a patient receives a score of zero, it indicates that they do not require orthodontic treatment, whereas a score of five indicates a significant or high need for treatment. When dentists use DHC, they are essentially investigating the health and functionality of the teeth, looking at how they bite and align with one another. Using this evaluation, they can determine whether or not orthodontic treatment is required and, if so, to what extent. Determining the level of assistance the teeth might require to achieve optimal health and appearance is comparable to assigning a grade. To grade DHC, a specially designed ruler is used as showed in Figure 4.

The Aesthetic Component (AC) is essential in orthodontic evaluation, particularly when considering treatment's behavioral and social effects. Imagine it as a personalized aesthetic journey for teeth, where the objective is to serve a functional purpose and create a beautiful smile that contributes to overall well-being. A collection of photographs that illustrate varying degrees of dental attractiveness is utilized by AC, which employs a scale with ten points. The dentist will not strictly adhere to these images; instead, they will assign a grade based on the overall appearance of the teeth. An exact match to the photographs is not required for this grading process; instead, the emphasis is placed on the overall appearance. In addition to considering the aesthetic concerns that necessitate treatment, the grade that is produced takes into account the broader social and psychological aspects associated with orthodontic care. Customizing the treatment plan to encompass functional necessities, individual sentiments, and social engagements about one's smile is fundamentally involved.



(a)

(b)

Figure 4: Index of Treatment Need (IOTN) a) Ruler b) Assessment on Dental Cast

VII. CONCLUSION

Malocclusion cases are categorized into three main classes based on the position of the maxillary first molar to the mandibular first molar—class I known as neutroclusion; Class II known as distoclusion; and Class III known as mesiooclusion. The Peer Assessment Rating (PAR) index is a crucial tool in orthodontics used to assess the severity of malocclusions and measure the efficacy of treatment interventions. It provides a systematic and standardized approach to evaluate diverse aspects of malocclusions, allowing orthodontic professionals to quantify treatment needs objectively and measure outcomes in a standardized manner. Bolton Analysis is a valuable tool for identifying tooth size discrepancies. It evaluates and defines the standard anterior and overall ratios of mesiodistal widths of maxillary and mandibular teeth, helping orthodontists develop specialized treatment plans to correct tooth size disparities and achieve optimal occlusion and a harmonious dental

appearance. The Index of Orthodontic Treatment Need (IOTN) is a tool to determine if an individual requires orthodontic treatment. It consists of two components: the Dental Health Component (DHC) and the Aesthetic Component (AC), which evaluate the health and functionality of teeth and jaws while considering the appearance of teeth and their impact on the smile.

VIII. REFERENCES

1. Angle. E. H. (1899) Classification of Malocclusion. The Dental Cosmos. 41(3): 248-264.
2. Balogh, M. J. F. (2006). Illustrated Dental Embryology, Histology, and Anatomy (Second Edi). Elsevier Inc.
3. Borzabadi-Farahani, A. (2011). An insight into four orthodontic treatment need indices. Progress in Orthodontics, 12(2): 132–142.
4. Christensen, G. J. (2002). A Consumer's Guide to Dentistry. In A Consumer's Guide to Dentistry (second edi). Mosby.
5. Deguchi, T., Honjo, T., Fukunaga, T., Miyawaki, S., Roberts, W. E., & Takano-Yamamoto, T. (2005). Clinical assessment of orthodontic outcomes with the peer assessment rating, discrepancy index, objective grading system, and comprehensive clinical assessment. American Journal of Orthodontics and Dentofacial Orthopedics, 127(4), 434–443.
6. Diaz et al. (2016). Bolton's index efficacy with manual vs digital measurement. Revista Mexicana de Ortodoncia. 4(1): e30-e34.
7. Firestone, A. R., Michael Beck, F., Beglin, F. M., & Vig, K. W. L. (2002). Evaluation of the peer assessment rating (PAR) index as an index of orthodontic treatment need. American Journal of Orthodontics and Dentofacial Orthopedics, 122(5): 463–469.
8. Gupta, A., & Shrestha, R. M. (2014). A Review of Orthodontic Indices. Orthodontic Journal of Nepal. 4(2): 44-50.
9. Green, J. I. J. (2016). Index for Primary Dental Care Practitioners. 5(4): 28–37
10. Järvinen, S. (2001). Indexes for orthodontic treatment need. American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, Its Constituent Societies, and the American Board of Orthodontics, 120(3): 237–239.
11. Jawad, Z., Bates, C., Hodges, T. (2015). Who needs orthodontic treatment? Who gets it?And who wants it? British Dental Journal. 218 (3): 99-103.
12. Kansal, A., Kittur, N., & Mahabaleshwar, K. (2012). Analysis of Bolton's ratio among different malocclusion groups: A hospital based study. 3(3), 139–144.
13. Lopatiene, K., & Dumbravaite, A. (2009). Relationship between tooth size discrepancies and malocclusion. Stomatologija. 11(4): 119–124
14. Mitchell, L. (2007). An Introduction to Orthodontics (Third Edit). Oxford University Press.
15. Onyeaso, C. O., & Begole, E. A. (2007). Relationship between index of complexity, outcome and need, dental aesthetic index, peer assessment rating index, and American Board of Orthodontics objective grading system. American Journal of Orthodontics and Dentofacial Orthopedics, 131(2): 248–252.
16. Proffit, W. R., Bailey, L. J., Phillips C., & Turvey T. A. (2000) Long-term stability of surgical open-bite correction by Le Fort I osteotomy. Angle Orthod. 70(2): 112-117.
17. Taibah, S. (2016). Journal of the World Federation of Orthodontists Bolton discrepancy among patients with anterior open bite malocclusion. 5: 13–16.
18. Watanabe-Kanno, G. A., Abrão, J., Miasiro, H., Sánchez-Ayala, A., & Lagravère, M. O. (2010). Determination of tooth-size discrepancy and Bolton ratios using bibliocast Cécile3 digital models. International Orthodontics, 8(3): 215–226.
19. William R. Proffit, H. W. F. J. (2000). Contemporary Orthodontics (Third Edit). MOSBY an Imprint of Elsevier.