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Cleft Lip and Palate Indices: A Review

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Abstract

Cleft lip and palate are the most common congenital craniofacial anomaly which require orthodontist as a member of collaborative multidisciplinary team. Successful treatment of these children require thorough description of the disease process, classification system and planning of the treatment protocol. The aim of this study is to review the available literature of the indices used to assess the severity of malocclusion in cleft lip and palate patients. This overview can create better understanding regarding the uses, advantages, and disadvantages of different index systems. The literatures were searched by using electronic databases.

Keywords: Cleft Lip and Palate, Cross-bite, Index, Malocclusion, Yardstick

1. Introduction

Cleft Lip and Palate (CLP) includes a group of different disorders that affect between one and seven out of 1000 newborns[1]. Patients suffering from this condition may show wide range of functional and esthetic problems like mid-face deficiency, constricted maxillary dental arch, congenitally missing and malformed teeth[2]. Anomalies such as crowding, rotation, malposition, impaction and abnormal dental arch relationship are common orthodontic problems[3].

Many studies have proposed various parameters to evaluate cleft lip and palate problems. Classification systems were proposed by various authors based on developmental and embryological aspects (Davis and Ritchie-1922, Veau's classification-1931, Fogh and Anderson-1942, Kernahan and Stark-1958, Schuchardt and Pfeifers Symbolic Classification-1964, Spina-1974, Millard-1977, LAHSHAL Classification-1987)[4]. However, many classification systems do not describe treatment need and treatment outcome and evaluate the severity, thus indices were developed.

Dental arch relationship is an important indicator of facial growth and thus an important parameter for cleft treatment planning. Pruzansky and Aduss (1964)[5] and Matthews (1970)[6] assessed arch relationship, arch length, arch width for the examination of crossbite. Although, these methods were useful to evaluate individual parameters, but an overall evaluation was not obtained. To address this problem, Huddart and Bodenham (1972)[7] developed a numerical scoring system of the crossbite in deciduous dentition and estimated overall degree of malocclusion. Mossey et al. (2003)[8] proposed a modified Huddart and Bodenham (mHB) index to apply to the mixed dentition with improved scoring system.

The dental arch relationship with unilateral cleft lip and palate can be assessed by using GOSLON (1987)[9], GOAL (1991)[10] and Five year old yardstick (1997)[11] whereas mHB index (2003)[8] and Bilateral cleft lip and palate (BCLP-2011)[12] yardstick are used for bilateral cleft lip and palate patient.

2. Methods

Due to the need of different indices of CLP in orthodontics, literature search was carried out. Articles from year 1964 to 2018 were searched by using Medline-PUBMED, Science Direct, and Google scholars, from which 50 articles were chosen in the study initially. References of relevant articles were then searched manually and 25 articles were finally chosen. The pictures were adopted from literatures[7, 13] and redrawn using Adobe Photoshop software.

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3. Criteria for Ideal Index

According to the World Health Organization, the ideal index should have criteria like reliability, validity, sensitivity, simplicity, acceptance by the profession, amenable to statistical analysis and simple to administer[14].

The methods for recording malocclusion can be classified into qualitative and quantitative methods[15]. Qualitative method describes the occlusal features and provides descriptive classification of the dentition, however does not provide any information of the treatment need and treatment outcome[16]. 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[17]. Indices used for cleft lip and palate are listed as follows:

1. Pruzansky and Aduss (1964)[5]
2. Matthews et al. (1970)[6]
3. The Huddart–Bodenham (HB) Index (Huddart and Bodenham, 1972)[7]
4. The GOSLON Yardstick (Mars et al. 1987)[9]
5. The GOAL Yardstick (Friede et al. 1991)[10]
6. The Five-Year-Old Index (Atack et al. 1997)[11]
7. The Modified Huddart–Bodenham (mHB) Index (Mossey et al. 2003)[8]
8. The EUROCRAN Yardstick (Oskouei, 2007)[18]
9. Bilateral Cleft Lip and Palate (BCLP) Yardstick (Ozawa et al. 2011)[12]

The above mentioned indices are described below with their characteristics, advantages and disadvantages in the chronological order.

3.1 Pruzansky and Aduss (1964)[5]

Pruzansky and Aduss in 1964 pioneered the index of cleft lip and palate. This is a descriptive index which considers anteroposterior and transverse plane for describing the dental arch crossbite. This index does not provide scoring and does not predict treatment outcome. It is not used commonly nowadays.

Pruzansky divided the dental occlusion into six categories such as: no crossbite present, canine crossbite only, buccal crossbite only, anterior and buccal crossbite, anterior and canine crossbite and anterior crossbite only[5].

3.2 Matthews et al. (1970)[6]

Matthews et al in 1970 described the occlusion on the basis of anteroposterior relationship of the lesser and greater segments of cleft, arch size, and collapse of the maxillary arch (Table 1). This is also a descriptive index, which does not consider scoring, prognosis and treatment need.

Table 1. Occlusion classification by Matthews[6]

Class	Description
A	All segments of the maxilla are in normal occlusion with the mandible
B1	The tooth bordering the cleft on the lesser segment is in the lingual occlusion
B2	Normal occlusion of the greater segment but very slightly lingual to the lesser segment
B3	Maxillary arch is perfect but is too small
C	An overall Class III occlusion of both segments of maxilla; in addition, collapse of some part of the small maxillary arch

3.3 The Huddart-Bodenham (HB) Index (1972)[7]

The original Huddart and Bodenham scoring system was developed in 1972. This index is used for unilateral cleft of lip, alveolus and palate on deciduous dentition at 5 years of age. It considered the 'Pruzansky and Aduss' descriptive classification of occlusion[8], the 'Author's numerical classification of occlusion' (Figure 1)[7] and 'maxillary arch form' to establish whether there is good arch alignment or alignment overlap (Figure 2)[7].

Author's numerical classification divided the occlusion in one labial segment (consisting of two deciduous central incisors), two buccal segments (consisting of canine and first and second deciduous molars). In the labial segment, the deciduous lateral incisors were not assessed as they are absent very often. If a Central Incisor (CI) is missing, the other CI is used for scoring missing incisor. And if any of the tooth is unerupted, that's tooth score is determined by midpoint of maxillary alveolar ridge. Each tooth is awarded a number of points depending on its position relative to its antagonist tooth in the mandibular arch. Incisors are scored using 5 categories and whereas canine and molars are scored using 3 categories. Normal

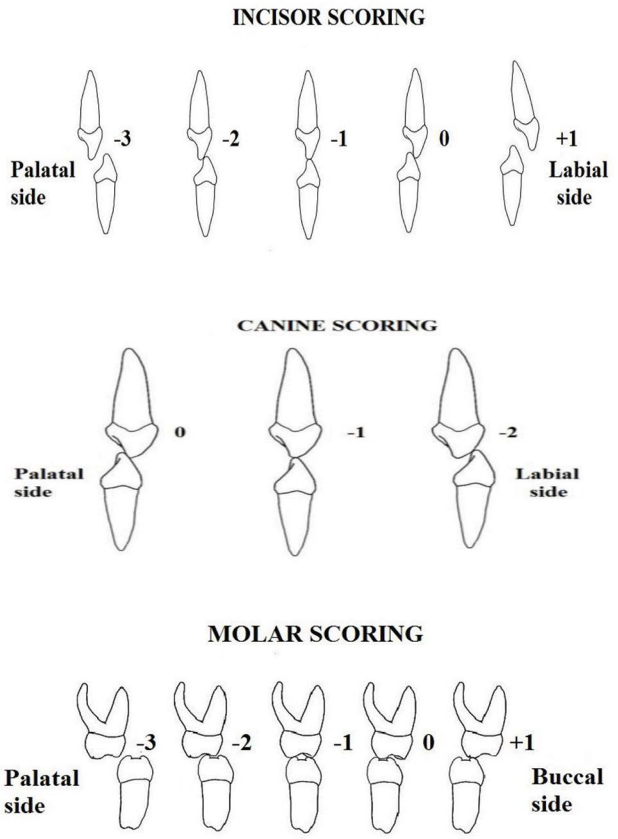


Figure 1. Author's numerical classification[7].

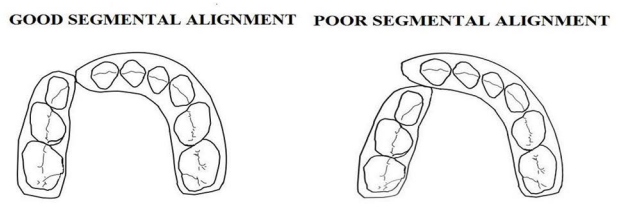


Figure 2. Arch alignment[7].

overjet scores 0, more overjet scores +1, edge to edge -1 and reverse overjet scores -2 and -3. Reverse overjet were considered for incisors only, not for canines and molars. Before 6 years' maximum score ranges from -18 to +2 and after 6 years of age as permanent first molar is also included, so maximum score ranges from -22 to +2.

3.4 GOSLON Yardstick (Mars et.al, 1987)[9]

GOSLON (Great Ormond Street, London and Oslo, Norway) Yardstick is a clinical tool that classify the dental relationship into five discrete categories from excellent to very poor. It is used in unilateral cleft lip and palate patients in the early permanent dentition at 10 years of age. Following clinical features are considered as the most important parameters in categorizing the malocclusion.

1. Anteroposterior arch relationship

   - Class II div 1 relationship (rare): Favorable
   - Class III incisor relationship and pre-existing dentoalveolar compensation in the form of reverse overjet: Least favorable

2. Vertical labial segment relationship

   - Deep overbite: Favorable (as it tends to exaggerate Class III tendency)
   - Open bite: Least favorable

3. Transverse relationship

   - Canine crossbite worse than molar crossbite
   - Degree of transverse arch narrowness is critical than number of teeth in crossbite

GOSLON index considers malocclusion in all three planes of space and ranks the models in difficulty order to achieve a favorable treatment outcome (Table 2). It has good inter- and intra-examiner reliability, is valuable in predicting treatment need (orthodontic treatment or surgical treatment). However, it is less powerful as it is subjective, ordered, categorical and non-versatile. Alam et al. further described the GOSLON yardstick in 2008[19].

Table 2. General features of the GOSLON yardstick by Alam et al. 2008[19]

Grade	Dental arch relationship	Treatment need	Predicted outcome
1	Positive overjet and overbite Exhibit Angle Class II division 1 - Favorable relationship	Straight forward Orthodontic Treatment or none at all	Excellent
2	Class I dental relationship Favorable relationship	Straight forward Orthodontic Treatment or none at all	Good
3	Edge to edge dental relationship (Class III malocclusion) In borderline case between Group 3 and 4: Deep overbite - Group 3	Complex Orthodontic Treatment	Fair

3.5 The GOAL Yardstick (1991)[10]

GOAL (Goteborg, Oslo, Aarhus, Linkoping) index is a modification of GOSLON yardstick, defined the condition of crossbite more strictly and has been used for mixed dentition, rates the dentition on scale of 1 to 5 (best to worst prognosis respectively). It has following characteristics (Table 3).

Table 3. GOAL yardstick describing Dental Arch Relationship[10]

Scale	Dental arch relationship	Prognosis
1	No crossbite (CB) or minor lateral or minor anterior CB	Best
2	Lateral CB with or without minor anterior CB	Good
3	Anterior and lateral CB	Fair
4	Anterior and lateral CB; Slight malrelation between maxillary and mandibular bases	Poor
5	Anterior and lateral CB; Definite malrelation between maxillary and mandibular base	Worst

3.6 Five Year Old Index (1997)[11]

Five-year-old index was developed by Atack et al. and is based on the GOSLON Yardstick. It assesses the study models of 5-year-old child. This index was developed for the deciduous dentition to allow early assessment of the primary surgery. It is a more precise index. The 5 year old child is 'clean', with respect to surgical procedures, and not 'contaminated' by other treatments such as secondary alveolar bone grafting or orthodontic treatment[20]. It has good inter- and intra-examiner reliability. It is more reliable than GOSLON Yardstick as it does not include secondary alveolar bone grafting and orthodontically treated patients[11]. However true validation of this index is not possible as it relies on face validity[11]. The 5-year-old index is also ordinal and not versatile like the GOSLON yardstick (Table 4).

Table 4. Showing general features of study models in 5-year-olds index[11]

Grade	General features	Predicted outcome
1	Positive overjet with average inclined or retroclined incisors No crossbite/openbite Good maxillary arch shape and palatal vault anatomy	Excellent
2	Positive overjet with average inclined or proclined incisors Unilateral crossbite or crossbite tendency +/- Openbite tendency around cleft segment	Good
3	Edge to edge bite with average inclined or proclined incisors; or reverse overjet with retroclined incisors Unilateral crossbite +/- Openbite tendency at cleft segment	Fair
4	Reverse overjet with average inclined or proclined incisors Unilateral crossbite, +/- Bilateral crossbite tendency +/- Openbite tendency around cleft segment	Poor
5	Reverse overjet with proclined incisors Bilateral crossbite Poor maxillary arch form and palatal vault anatomy	Very poor

3.7 Modified Huddart and Bodenham Index (Mossey 2003)[8]

Modified Huddart and Bodenham (mHB), can be applied to both deciduous and permanent teeth at any age above 3 years. It is used for both unilateral and bilateral cleft lip and palate. It has 5 categories for scoring incisors, canines and molars, making it much easier to use. Normal overjet scores 0, more overjet scores +1, edge to edge -1 and reverse overjet scores -2 and -3. Scoring for the models below 6 years of age, range from –24 to +8 for central incisors, canines and deciduous molars on both sides. After 6 years of age, the maximum scores range from is –30 to +10 for central incisors, canines, deciduous molar/premolars, and first permanent molar (Figure 3, Table 5). It is more reliable, objective and sensitive than GOSLON and 5-year-old Yardstick indices[21]. The measurements used in this scoring system can also be

used for the assessment of digital images. This would help in reducing the time for measurement and analysis of the data and permit easy inter-centre comparisons.[8] However, it does not score for anteroposterior skeletal and vertical discrepancies, and does not take into account of incisor inclinations[21].

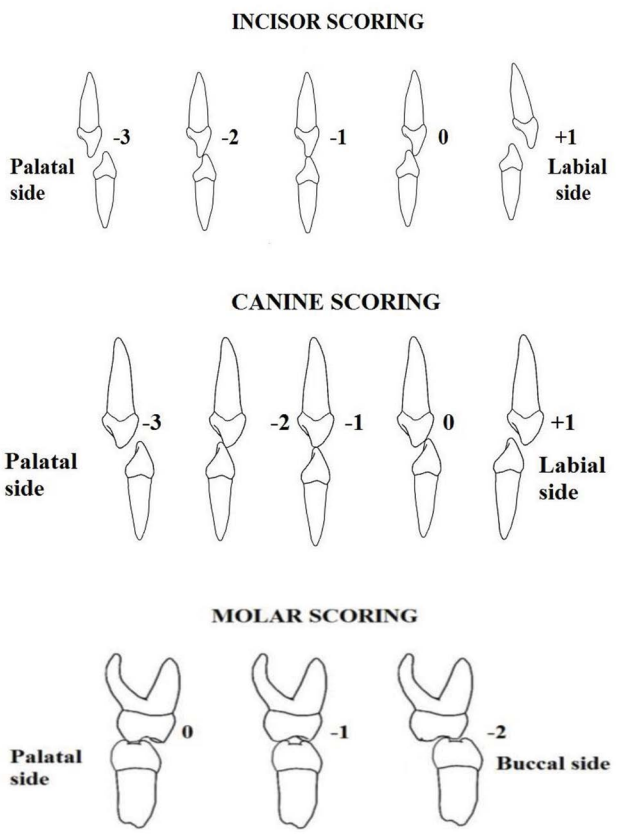


Figure 3. Huddart-Bodenham scoring of buccolingual dental relationship (modified by Heidbuchel and kujipers-jagtman,1997)[13].

Table 5. Scoring chart for Modified Huddart and Bodenham Index

Score	Overjet	Incisor scoring	Canine scoring	Deciduous molar/ Premolar scoring	Molar scoring
0	Normal				
+1	Increased				
-1	Edge-to-edge				
-2	Reverse				
-3	Increased reversed				

3.8 EUROCRAN Yardstick[18]

This index was developed by the participants of EUROCRAN project (2000-2004). It was an extension of the EUROCLEFT project with the aim to improve research capabilities. It is a modification of GOSLON yardstick and 5-year old yardstick[22]. It assess dental arch relationship in all three plane of space, ranging from Grade 1 to 4 (best to worst), instead of the 5-grading scale (Table 6). It also assesses palatal morphology. It is assumed that the scar tissue that develops over the denuded palatal bone after palatal surgery may affects its growth. Therefore, examination of palatal morphology should be a part of the evaluation of treatment outcomes (Table 7). This index can also be used to assess 2D photographs of study model and 3D digital model.

Table 6. Grades for dental arch relationship according to EUROCRAN index[23]

Grade	Dental arch relation	Treatment need	Prognosis
1	Skeletal Class I or Class II	No orthodontic treatment need	Best
2	Skeletal Class I Teeth on cleft side are malposed and rotated	Orthodontic treatment on cleft side	Good
3	Apical base edge to edge or mild skeletal Class III or skeletal Class I with moderate open bite	Complex orthodontic treatment	Fair
4	Skeletal Class III with marked openbite	Orthodontic treatment + Orthognathic surgery	Worst

3.9 Bilateral Cleft Lip and Palate (BCLP) Yardstick[12]

This index is also called as Bauru-Bilateral Cleft Lip and Palate Index (BCLP). BCLP index is based on the principle of the GOSLON Yardstick and used at 6, 9, and 12-year-old, rates the dentition on scale of 1 to 5 (best to worst prognosis respectively). The sagittal dental base

relationship is considered the most important feature as it is an indicator of the treatment outcome (Table 8). In BCLP yardstick for permanent dentition, cross-bite is ignored as there are very high chances of orthodontic treatment received by patient. Score 1 and 2 are combined. Moderate to severe openbite would increase the score by one grade. The BCLP yardstick and the mHB system are reliable scoring systems for evaluation of dental arch relationships of complete BCLP patients[13].

Table 7. Grades for Palatal morphology according to EUROCRAN index[23]

Grade	Palatal morphology	Arch form	Prognosis
1	Good anterior and posterior height; minor surface irregularities (bumps, crevices)	Nil or minor deviation of arch form	Good
2	Moderate anterior and posterior height; moderate surface irregularities (bumps, crevices)	Moderate deviation of arch form (eg. segmental displacement)	Fair
3	Severe reduction in palate height; severe surface irregularities (bumps, crevices)	Severe deviation in arch form (eg. hourglass constriction)	Poor/ Worst

4. Discussion

The GOSLON Yardstick is the most commonly used index for cleft lip and palate, possibly due to its use for a longer period of time. According to WHO criteria, Modified Huddart and Bodenham (mHB) index is best in its performance. Recent evidence suggests that the mHB Index equalled or beaten the rest of the indices on all the WHO criteria, hence it could be a standard index to measure the treatment outcomes of CLP patients[24].

Bongaarts et al. did a randomized controlled clinical trial in three different Cleft Palate Centers in Nijmegen, Amsterdam, and Rotterdam, The Netherlands. Five year old index and Huddart scoring system were used to assess the treatment outcome[25].

Bartzela et al. did study at Neijmegen, The Netherlands in the year 2013 on Complete Bilateral Cleft Lip and Palate (CBCLP) and concluded that Bilateral Cleft Lip and Palate Yardstick and modified Huddart and Bodenham (mHB) index are reliable scoring systems for CBCLP. Both the scoring system should be used if more sensitive measure of treatment outcome is needed[13].

According to Haque et al.[22] in cleft lip and palate, combination of different types of indices appears to be

Table 8. BCLP Yardstick for deciduous, mixed and early permanent dentition[12]

Score	Apical base relationship	Incisor relationship	Crossbite	Arch form	Prognosis
1	Class I or Class II	Positive overjet and overbite (no openbite)	None	Good	Best
2	Class I or Class II	Corrected incisors would be positive overjet and overbite (or minimal openbite)	Possible	Minor deviation. (If severe deviation or severe open bite, Score 3)	Good
3	Edge-to-edge	Corrected incisors would be edge-to-edge	Possible	Major deviation	Fair
4	Class III	Corrected incisors would not be edge to edge	Possible	Major deviation	Poor
5	Class III (Extreme)	Corrected incisors would not touch lower incisors	Possible	Poor	Worst

Table 9. Comparative characteristics of CLP indices

	Index	Year	Type	Dentition	Cleft type	Plane	Advantage	Disadvantage
1	Pruzansky & Aduss	1964	Qualitative	Deciduous	UCLP	AP and transverse	Descriptive	Does not explain tx need and tx outcome
2	Matthews *et al.*	1970	Qualitative	Mixed	UCLP/ BCLP	AP and transverse	Descriptive	Does not provide scores for assessment of arch relationship
3	Huddart–Bodenham (HB) Index	1972	Quantitative (Continuous)	Deciduous	UCLP	AP and transverse	Based on scoring system	Reverse overjet not considered for deciduous canine and molars
4	GOSLON Yardstick	1987	Quantitative (Ordinal)	Late mixed dentition	UCLP	AP, transverse, vertical	First index to consider all three planes	Need trained judges
5	GOAL Yardstick	1991	Quantitative (Ordinal)	Mixed	UCLP	AP, transverse, vertical	Simple	Does not score arch relationship
6	Five-Year-Old Index	1997	Quantitative (Ordinal)	Deciduous	UCLP	AP, transverse, vertical	Primarily developed for 5 year	Not useful for tx prediction
7	Modified Huddart–Bodenham (mHB) Index	2003	Quantitative (Continuous)	Deciduous, Mixed, Permanent	UCLP/ BCLP	AP and transverse	Provides reliable assessment of maxillary arch constriction	Does not consider vertical plane
8	EUROCRAN Yardstick	2007	Quantitative (Ordinal)	Mixed dentition	UCLP	AP, transverse, vertical	Considers palatal morphology, Quick in scoring model	Scoring palatal vault is subjective
9	Bilateral Cleft Lip and Palate (BCLP) Yardstick	2011	Quantitative (Ordinal)	Deciduous, mixed, Permanent	BCLP	AP, transverse, vertical	Simple scoring	Need professional judgement

AP- Anteroposterior; tx- Treatment; UCLP- Unilateral cleft lip and palate; BCLP- Bilateral cleft lip and palate

more beneficial and promising. Use of indices of cleft lip and palate shall be need-based. The comparative characteristics of various cleft lip and palate indices are summarized in (Table 9).

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