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Original Article

The 5-year-olds' index, the GOSLON Yardstick index, and the modified Huddart/Bodenham index among children with complete unilateral cleft lip and palate: A methodological study

ABSTRACT

Background: The function of many orthodontic indices is to assess occlusion in patients born with a cleft. The aim of this study was to assess the intra- and interexaminer reliability for the 5-year-olds' (5YO) index, the GOSLON Yardstick index, and the modified Huddart/Bodenham (MHB) index in dental casts of children with complete unilateral cleft lip and palate (UCLP); a further aim is to compare the indices to each other.

Methods: Forty dental casts from 5-year-old nonsyndromic patients with complete UCLP who had undergone primary surgery at Skåne University Hospital in Malmö, Sweden, were examined by two examiners: one orthodontic specialist and one general dentist.

Results: Intraexaminer reliability for 5YO and MHB had a substantial (κ: 0.61–0.80) to almost perfect agreement (κ: 0.81–1.00) and GOSLON Yardstick moderate (κ: 0.41–0.60) to almost perfect agreement. Grouped teeth or single-tooth MHB had an almost perfect agreement for both examiners. Interexaminer reliability for 5YO had a moderate agreement, whereas GOSLON Yardstick and MHB had a fair agreement (κ: 0.21–0.40). Grouped teeth or single-tooth MHB had an almost perfect agreement.

Conclusions: The 5YO index illustrates the occlusion and has a high degree of reliability for an experienced orthodontist. The GOSLON Yardstick also illustrates the occlusion, but reliability between assessments is lower. MHB index can be used with a high degree of reliability when categorized as grouped or single tooth, but the judgment of total occlusion is more uncertain.

Keywords: 5-year-olds' index, complete unilateral cleft lip and palate, GOSLON Yardstick, index, modified Huddart/Bodenham, orthodontic, unilateral cleft lip and palate

INTRODUCTION

To evaluate which orthodontic treatment strategy and surgical approach is the most appropriate for the primary repair of cleft lip and palate (CLP), jaw relations and dentitions can be assessed with different orthodontic growth indices. Such indices with relevance for CLP are as follows: the 5-year-olds' (5YO), the GOSLON Yardstick, the Bauru-Bilateral CLP yardstick, the Huddart/Bodenham, the modified Huddart/Bodenham (MHB), the EUROCRAN Yardstick, and the GOAL Yardstick indices.[1] The 5YO index, the GOSLON Yardstick, and the MHB are the three most frequently used indices.[1,2]

Previously published data have compared the GOSLON Yardstick index and the 5YO index by scoring dental casts

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Access this article online	
Website: www.orthodrehab.org	Quick Response Code
DOI: 10.4103/ijor.ijor_11_18	

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How to cite this article: Chaudhry M, Svensson H, Becker M, Wiedel AP. The 5-year-olds' index, the GOSLON Yardstick index, and the modified Huddart/Bodenham index among children with complete unilateral cleft lip and palate: A methodological study. Int J Orthod Rehabil 2018;9:101-6.

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taken at the age of 5 years and comparing GOSLON Yardstick index ratings at the age of 10 years.[3,4] Another study served as a pilot to establish a calibration model between MHB and the GOSLON Yardstick index or 5YO index.[5] The GOSLON Yardstick index and the MHB were used to score dental casts taken at the ages of 8–10 and 10–12 years.[6]

The aim of this methodological study was to assess intra- and interexaminer reliability between three different orthodontic growth indices, namely, the 5YO index, the GOSLON Yardstick index, and the MHB, and to compare the indices to each other.

METHODS

Study population

All children born between 2004 and 2011 with complete unilateral CLP (UCLP) who had undergone primary plasty of the lip and primary plasty of the palate at the CLP center at Skåne University Hospital in Malmö, Sweden were included. Patients with syndromes were excluded. No patients had orthodontic treatment performed before dental impressions were taken at the age of 5 years. Clinical data and demographic information were collected from the medical records. In total, 50 patients were included. As 10 patients had no dental casts at the age of 5 years due to a lack of cooperation, 40 patients remained. In total, 30 were boys and 10 were girls. Moreover, 26 patients had a left-sided cleft and 14 had a right-sided cleft.

Examiners and procedures

Two examiners – one orthodontic specialist and one general dentist – assessed and scored the dental casts according to the three orthodontic growth indices. The orthodontic specialist had prior experience of patients with CLP and was familiar with the GOSLON Yardstick index, as the examiner was part of the multidisciplinary CLP team. The general dentist, on the other hand, had no prior experience of CLP patients. The dental casts were assessed in randomized order by both examiners twice, using the three orthodontic growth indices, with an interval of 1 month. For interexaminer reliability and the correlation analysis, the second scoring session was used.

A 1-month interval was chosen to ensure that there was no memory bias on the results. Before scoring commenced, each index criteria were discussed between examiners to achieve a basic calibration. For the GOSLON Yardstick index, the examiners also had the opportunity to study the reference dental casts. However, the examiners were not permitted to consult with each other during the assessment of the study casts.

Different indices

The 5YO index assesses three aspects of the primary dentition at the age of 5 years: The presence of a crossbite and/or open bite, the shape of the maxillary arch and the anatomy of the palate, and the presence of an overjet, and whether the incisors are inclined or retroclined. Depending on the assessment, the dental cast will be assigned a category from 1 to 5, where category 1 is equivalent to an excellent occlusion and predicted long-term outcome, whereas category 5 reflects the opposite.[3]

The GOSLON Yardstick index was specifically developed for patients with UCLP. It is used to assess the three relationships of the dentition in relation to the anterior/posterior arch, the vertical segment and transverse width, and assessment of future orthodontic treatment needs. Here also five categories are defined, from 1 (excellent) to 5 (very poor). One dimension of the GOSLON Yardstick index is that because it may predict future treatment need, it is therefore mostly used in the mixed dentition around 10 years of age. For the GOSLON Yardstick index, a set of reference casts were observed before assessments commenced.[7]

The MHB differs from the 5YO index and GOSLON Yardstick index in that each maxillary tooth (central incisors, canines, and two primary molars/permanent premolars) and its opposing tooth is assessed in regards to crossbiting instead of the whole occlusion. MHB can be applied in both deciduous and permanent teeth at any age above 3 years and in any cleft type.[8] The scoring is in relation to the presence or absence of crossbite and the degree of crossbite in the primary dentition. There are five categories for scoring central incisors and three categories for scoring canines and molars. The score depends on the severity of the crossbite. After scoring is performed, the scores are added so that an overall score is yielded for each dental cast set. The most severe cases' score was −18, and the best cases' score was +2. A low score does not necessarily indicate a poor treatment outcome or the need for future treatment.[8]

Statistical analysis

All statistical analyses were performed with SPSS Statistics (version 23.0, IBM Corporation, NY, USA). To assess the intra- and inter-reliability for the measurements by the examiners, unweighted kappa with a 95% confidence interval was used. The interpretation of unweighted kappa was based on the strength of agreement: 0–0.20 = slight, 0.21–0.40 = fair, 0.41–0.60 = moderate, 0.61–0.80 = substantial, and 0.81–1.00 = almost perfect.[9]

The correlation of each index with each of the others in the second session was measured with Spearman's rank correlation coefficient. The interpretation of Spearman's rank correlation

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coefficient was based on the strength of relationship: 0 = no correlation, 0.20–0.39 = weak, 0.40–0.59 = moderate, 0.60–0.79 = strong, and 0.80–1.0 = very strong.[10]

Ethics

Ethical approval was obtained from the Regional Ethical Review Board in Lund, Sweden (no 2016–143) and written consent from the parents or legal guardians of the participating patients.

RESULTS

Intraexaminer reliability

Kappa statistics for the orthodontic specialist showed an almost perfect agreement for all three indices. The general dentist had a moderate/substantial agreement [Table 1].

When categorizing MHB as central incisors, canines, and molars, the orthodontic specialist had an almost perfect agreement in all three tooth groups. The general dentist also had an almost perfect agreement in two tooth groups, while for the molars, there was a substantial agreement [Table 1].

When MHB was categorized as a single tooth, both examiners had an almost perfect agreement [Table 2].

Interexaminer reliability for the second scoring

For the 5YO index, the orthodontic specialist and the general dentist reached consensus in 23 of 40 scorings on the 40 dental casts [Table 3].

For the GOSLON Yardstick index, the orthodontic specialist and the general dentist reached consensus in 20 of 40 scorings on the 40 dental casts [Table 4].

For the MHB, eight scorings for each dental cast were obtained. For 288 of 320 assessed maxillary teeth, the orthodontic specialist and general dentist had the exact same score. Instances of agreement among examiners for each tooth 55, 54, 53, 51, 61, 63, 64, and 65 in the MHB index were in the range of 34–38 (n = 40). Highest instances of agreement were 38 of 40 for tooth 53 and lowest instances of agreement were 34 of 40 for tooth 61. Where there was a disagreement, the discrepancy was only ±1 unit between the orthodontic specialist and the general dentist.

Kappa statistics for the 5YO index showed that the two examiners had a moderate agreement. The GOSLON Yardstick and MHB index showed a fair agreement [Table 5]. For the interexaminer reliability of MHB for central incisors and molars, the interexaminer agreement was substantial and almost perfect for canines [Table 5]. When each tooth was assessed in the MHB, all teeth, except tooth 61, were in almost perfect agreement [Table 6].

Relationship between 5-year-olds', GOSLON Yardstick, and modified Huddart/Bodenham indices

Spearman's rank correlation coefficient showed that the relationship between the 5YO index, the GOSLON Yardstick index, and MHB index when compared with one another was very strong for both the orthodontic specialist and the general dentist [Table 7].

DISCUSSION

Different examiners

The different backgrounds of the two examiners seem to have affected the intraexaminer reliability, as the orthodontic specialist had an almost perfect kappa score for all three indices. The orthodontist's achievement is compatible with previously reported outcomes regarding experienced orthodontists.[11] Outcomes otherwise reported in the literature vary, depending on different backgrounds of the examiners.[11] This is in line with our observations, where our general dentist had an overall lower intraexaminer agreement. Previous experience with cleft treatment seems to have a favorable effect when scoring dental casts.[6] Moreover, there appears to be a learning curve when scoring dental casts, as seen for the general dentist. The significance of continuous learning is a crucial factor for achieving durable results, which, for instance, has been clearly shown in connection with surgery of the palate.[12]

Considerations regarding the 5-year-olds' index

For the 5YO index, each category has specific orthodontic criteria and also a predicted long-term outcome.[3] Our intraexaminer reliability had κ scores of 0.87 and 0.76, and a plausible reason for this good agreement is actually the fully detailed orthodontic description for each category. The interexaminer reliability showed a slightly lower kappa

Table 1: The intraexaminer reliability for each index and modified Huddart/Bodenham total, modified Huddart/Bodenham incisors, modified Huddart/Bodenham canines, and modified Huddart/Bodenham molars

Examiner	Unweighted kappa (95% CI) for different indices					
	GOSLON Yardstick	5-year-olds' index	MHB total	MHB incisors	MHB canines	MHB molars
Orthodontist	0.84 (0.71-0.97)	0.87 (0.75-0.99)	0.89 (0.79-0.99)	0.91 (0.81-1.01)	0.92 (0.82-1.03)	0.94 (0.86-1.02)
General dentist	0.58 (0.38-0.78)	0.76 (0.60-0.92)	0.65 (0.50-0.80)	0.88 (0.77-0.99)	0.89 (0.76-1.01)	0.757 (0.61-0.90)

MHB: Modified Huddart/Bodenham, CI: Confidence interval

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Table 2: The intraexaminer reliability for each tooth in modified Huddart/Bodenham

Examiner	Unweighted kappa (95% CI) for each analyzed tooth in MHB							
	55	54	53	51	61	63	64	65
Orthodontist	0.93 (0.81-1.06)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	0.93 (0.84-1.02)	0.93 (0.84-1.02)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	0.96 (0.87-1.04)
General dentist	0.94 (0.82-1.06)	0.89 (0.76-1.03)	0.91 (0.78-1.03)	0.93 (0.84-1.02)	0.87 (0.74-0.99)	0.95 (0.87-1.04)	0.88 (0.75-1.01)	0.91 (0.79-1.03)

MHB: Modified Huddart/Bodenham, CI: Confidence interval

Table 3: Categories assigned by orthodontic specialist and general dentist in the 5-year-olds' index and instances of agreement among examiners

		GD				
	C	1	2	3	4	5
OS	1	3	3	0	0	0
	2	0	6	3	0	0
	3	0	0	9	3	0
	4	0	0	4	4	1
	5	0	0	0	3	1

OS: Orthodontic specialist, GD: General dentist, C: Categories

Table 4: Categories assigned by orthodontic specialist and general dentist in the GOSLON Yardstick index and instances of agreement among examiners

		GD				
	C	1	2	3	4	5
OS	1	3	7	1	0	0
	2	0	2	3	1	0
	3	0	0	9	2	0
	4	0	0	2	5	1
	5	0	0	0	3	1

OS: Orthodontic specialist, GD: General dentist, C: Categories

value, namely 0.44. The divergencies occurred in the mildest cases, where the orthodontist had assigned lower scores, whereas in the severest cases, the orthodontist assigned higher scores [Table 3]. Agreement occurred frequently in the intermediate cases. These findings are compatible with a previous report on the same topic.[3] Although the two examiners of this study had no previous experience of the 5YO index, they were able to achieve reliable and useful estimations of the occlusal characteristics.

Considerations regarding GOSLON Yardstick

For the GOSLON Yardstick index, each category has specific orthodontic criteria, predicted orthodontic/orthognathic treatment need and also predicted long-term outcome.[7] For the intraexaminer reliability, the orthodontist had almost perfect agreement (κ score: 0.84), whereas the general dentist had a moderate agreement (κ score: 0.58). These values are consistent with previously published data with κ scores of 0.52–0.75.[11]

Despite using reference dental casts for the GOSLON Yardstick index, the aspect of subjectivity is clearly apparent in the results, and this has also been reported previously.[5,8] The GOSLON Yardstick index requires an orthodontic background to foresee the upcoming orthodontic and orthognathic treatment needs for a patient, and this influences the judgment.[8] Not surprisingly, the weakest interexaminer reliability was noted regarding the GOSLON Yardstick index, with a κ score of 0.36.

Also for the GOSLON Yardstick index, divergencies occurred in the mildest cases where the orthodontist had assigned lower scores, whereas in the severest cases, the orthodontist assigned higher scores [Table 4]. Agreement occurred frequently in the intermediate ones. When used in the 5YO dentition, it has been suggested that a score of 3 would be considered a score of 2 and a score of 4 would be considered a score of 3.[4] Consequently, the GOSLON Yardstick index is more difficult to use in the 5YO dentition and supports the view that it is more useful in 10-year-olds.[3]

Considerations regarding the modified Huddart/Bodenham

The MHB is an ordinal scale. It assigns a score to each tooth and is less subjective than the 5YO index and the GOSLON Yardstick index.[7,8] The orthodontist had an almost perfect intraexaminer reliability regardless of whether the teeth were added up as a total score, categorized as groups or considered individually. However, the general dentist had a one-step lower degree of agreement (substantial agreement) when the teeth were added up for the total score [Table 1]. A contributing reason might be that in 8-teeth added total score a single ±1 unit mismatch in any tooth reduces the intraexaminer reliability as an unweighted kappa requires exact matches.

For the interexaminer reliability, fair agreement was seen when teeth were added up as a total score. Once again, the same reasoning applies: In an 8-teeth added total score, a single ±1 unit mismatch in any tooth reduces the interexaminer reliability as an unweighted kappa requires exact matches [Table 5]. For categories incisors and molars, the agreement increased to substantial; for categories canines, the agreement was almost perfect. The single-tooth agreement had an interexaminer reliability of almost perfect, with one exception, namely 61. As such, MHB does not require prior experience of the method in patients with

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Table 5: The interexaminer reliability for each index and modified Huddart/Bodenham total, modified Huddart/Bodenham incisors, modified Huddart/Bodenham canines, and modified Huddart/Bodenham molars

Examiner	Unweighted kappa (95% CI) for different indices					
	GOSLON Yardstick	5-year-olds' index	MHB total	MHB incisors	MHB canines	MHB molars
Orthodontist with general dentist	0.36 (0.18-0.54)	0.44 (0.24-0.64)	0.39 (0.23-0.55)	0.67 (0.51-0.83)	0.81 (0.66-0.96)	0.61 (0.44-0.78)

MHB: Modified Huddart/Bodenham, CI: Confidence interval

Table 6: The interexaminer reliability for each tooth in modified Huddart/Bodenham

Examiner	Unweighted kappa (95% CI) for each analyzed tooth in MHB							
	55	54	53	51	61	63	64	65
Orthodontist with general dentist	0.82 (0.63-1.01)	0.84 (0.66-1.01)	0.91 (0.79-1.03)	0.83 (0.69-0.97)	0.80 (0.65-0.95)	0.85 (0.70-1.00)	0.84 (0.69-0.99)	0.82 (0.67-0.97)

MHB: Modified Huddart/Bodenham, CI: Confidence interval

Table 7: The Spearman's correlation coefficient, where each index is compared against each other

Examiner	Spearman's correlation coefficient ($P<0.001$)		
	MHB compared with GOSLON Yardstick	MHB compared with 5-year-olds' index	GOSLON Yardstick compared with 5-year-olds' index
Orthodontist	−0.87	−0.90	0.96
General dentist	−0.84	−0.86	0.98

MHB: Modified Huddart/Bodenham

clefts [Tables 1 and 2]. The lower agreement seen in 61 might be due to difficulty assessing near cleft area, as rotation and tipping of teeth might be present in the cleft area.[6]

One drawback of the MHB is that when measurements are added, the total score is a summation of eight evaluations. A confined anomaly might thereby be disguised, as positive and negative scorings are added up, thus misinforming the extent of malocclusion. A mild general variability may yield a poorer score than a more severe but confined anomaly.[7] In addition, it does not take into account the whole orthodontic panorama, but only the degree of crossbiting in the individual tooth.

Comparisons between the three indices

This inconsistency is probably the cause of the poorer correlation between the 5YO index and MHB, as well as between the GOSLON Yardstick index and MHB. When the 5YO index and the GOSLON Yardstick index were compared, the correlation was better [Table 7]. This was true for both the orthodontist and the general dentist. An explanation for the better correlation between the 5YO index and the GOSLON Yardstick index might be that both had five categories each and only one scoring for each dental cast, as opposed to MHB.

When categorized in groups of teeth or if single tooth was assessed, the MHB index had the best intra- and interexaminer reliability for both examiners. It seems that MHB, when categorized in groups or as a single tooth, can be used by dentists, regardless of CLP experience, when analyzing transversal relationships in dental casts. The second-best results in this study were for the 5YO index, suggesting that this index might be used when assessing all three dimensions orthodontically.

CONCLUSIONS

- The 5YO index illustrates the occlusion and has a high degree of reliability for an experienced orthodontist
- The GOSLON Yardstick also illustrates the occlusion, but reliability between assessments is lower
- MHB index can be used with a high degree of reliability when categorized as groups or single tooth, but the judgment of total occlusion is more uncertain.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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