A Comparison of Three Orthodontic Treatment Indices with Regard to Angle Classification

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Objectives: *To calculate the agreement between the Dental Aesthetic Index (DAI) and the Index of Complexity, Outcome and Need (ICON) in assessing orthodontic treatment need and to determine correlations between the Peer Assessment Rating (PAR) and DAI and ICON scores according to Angle classification among patients referred for orthodontic evaluation.*

Study Design: *This study included 457 randomly selected patients between 9 to17 years of age. Patients were divided into four groups according to Angle classification [Class I (n=154), Class II division 1(Class II/1) (n=155), Class II division 2(Class II/2) (n=52) and Class III (n=96)]. Relationships between PAR scores and ICON and DAI scores were evaluated with the Spearman correlation test. Unweighted kappa statistics were used to analyse agreement between the ICON and DAI on the need for treatment, according to Angle classification.* ***Results:*** *Class I malocclusions scored significantly lower than other Angle classifications in all indices. Both the ICON and DAI showed significant positive correlations with the PAR in the general study population. For Class II/2 patients, no correlation was found between PAR and DAI scores. There was significant agreement between the ICON and DAI on treatment need among Class I, Class II/1 and Class II/2 patients however, no agreement was found for Class III malocclusions.* ***Conclusions:*** *The ICON, DAI and PAR produce similar results and can be used interchangeably for the general orthodontic patient population. However, based on Angle classification, prominent differences exist in scoring certain occlusal features.*

Key words: *Angle classification, DAI, ICON, Orthodontic indices, PAR*

INTRODUCTION

Several orthodontic indices have been developed both to estimate the prevalence of malocclusions and to objectively quantify the severity of the various features of malocclusion in populations and communities.[1,2] These indices are designed to measure the severity of malocclusion objectively, either as a deviation from normal occlusion or in terms of orthodontic treatment need. This objective evaluation allows the selection of patients for treatment in particular populations when resources are limited.

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The Dental Aesthetic Index (DAI), the Index of Complexity, Outcome and Need (ICON) and the Peer Assessment Rating (PAR) are among the most commonly used orthodontic indices. The DAI is an orthodontic index for treatment need assessment, it has been recognized by the World Health Organization Oral Health Survey as a cross-cultural international index.[3-6] The DAI, which is based on the social acceptability of occlusal conditions, mathematically links the clinical and aesthetic components of malocclusion to determine a single score.[4,7] Despite its advantages, including high reliability and validity,[5-7] the DAI has limitations in epidemiological studies. For example, it excludes missing molars, impacted teeth, buccal crossbite, deepbite and midline discrepancies from the computation of scores.[8]

The PAR was developed to provide a summary score for malocclusion and an estimation of how far an occlusal anomaly deviates from normal alignment.[9] It is a rapid and accurate method of measuring dento-occlusal changes on study models.[10] The validity and reliability of the PAR have been confirmed by several studies in different populations.[9,11,12] Similar to the other indices, PAR index has some limitations; it does not take into account the malocclusions with clinically missing permanent teeth. Additionally, ICON and DAI indices have recommended cut-off points which can be used as a diagnostic test for treatment need. Contrarily, PAR index was developed without recommended cut-off points. So, it could

not be used in orthodontic treatment need assessment. Recently, in their study, Firestone et al.[13] determined cut-off points of PAR index and concluded that the PAR index could be used to predict professionally assessed treatment need by using a PAR score of 17 as the optimal cut-off point in the decision-making process in the United Kingdom and the United States. But, cut-off points could be set to represent national, geographic, or local differences in orthodontic opinion, or to include orthodontic opinion from large multinational areas.[14]

The ICON was developed in eight European countries and the United States and is arguably more valid than the PAR index.[15,16] High validity of the ICON has been reported,[17] and several European studies have shown good reliability.[16,18] The ICON is a single measurement protocol that includes an aesthetic score as an integral part of the evaluation of treatment need.[19] The ICON is a multifunctional index because it assesses both the treatment need and outcome. It also evaluates the malocclusion complexity, thus offering significant advantages over other indices of treatment need.[15] However, similar to other orthodontic indices, there are some limitations with using ICON. The index is heavily weighted for aesthetics. Secondly, the ICON includes only upper arch crowding or spacing. The lower arch was not taken into consideration.

Since its publication in 1899, the Angle classification has become a mainstay in orthodontics as a widely used, reliable, repeatable and relatively objective method of defining sagittal discrepancies in occlusion.[20,21]

All of the orthodontic indices were developed to assess dental malocclusions objectively and have enabled quantification of the need for treatment. However, because of the multifactorial nature of malocclusion, which includes the patient's expectations and psychological needs as well as the physical characteristics of the occlusion,[22,23] it is difficult to standardize judgements and comparisons.[24] Some epidemiologic studies have compared the indices used to determine orthodontic treatment need without incorporating Angle classification information.[1,6,7,19,25] No study has compared the DAI, PAR and ICON indices according to Angle classification. Therefore, the aims of this study were to calculate the agreement between the DAI and ICON assessments of orthodontic treatment need and as well as to determine correlations between PAR and DAI scores and between PAR and ICON scores according to Angle classification in a representative random sample of patients referred to orthodontic clinic.

MATERIAL AND METHOD

This study included 457 patients (173 males, 284 females) between 9 and 17 years of age who were randomly selected from among those seen in the Department of Orthodontics at our university between May 2011 and April 2012. Patients with cleft lip and palate, previous orthodontic and/or prosthetic treatment, large restorations/crowns or serial extractions were excluded from the study.

Data on demographic characteristics, Angle's classification and DAI, PAR and ICON scores were recorded by one specialist. The specialist was previously calibrated using re-examination of dental students. To ascertain intraexaminer reliability in the use of the indices, 60 students of dental faculty were re-examined after a period of 2–3 weeks by the same examiner. The intrarater correlation coefficient for repeated measurements was very close to 1.0, indicating high reliability.

Patients were considered to have Class I (n=154), Class II/1 (n=155), Class II/2 (n=52) or Class III (n=96) malocclusion, according to Angle's classification.[20,26] Class II/2 is defined as the incisal relationship in which the lower incisor edges lie posterior to the cingulum of the upper central incisors, with retroclination of the upper incisors.[26]

DAI, ICON and PAR scores were determined for each patient. Malocclusions were divided into two groups according to treatment need: Group 1: no treatment need [DAI ≤ 25 (grade 1); ICON≤43] and Group 2: treatment need [DAI> 25 (grades 2–4); ICON ≥ 43].[15,27,28]

Statistical analysis

Statistical analyses were performed with SPSS version 15.0 (SPSS Inc., Chicago, Illinois, USA). Kruskall-Wallis test was used to compare DAI, ICON and PAR index scores in accordance to Angle classifications. Relationships between PAR and ICON scores and between PAR and DAI scores were evaluated with the Spearman correlation test. Unweighted kappa statistics were used to analyse the agreement between the ICON and the DAI on the treatment need according to Angle classification. P values less than 0.05 were considered statistically significant.

RESULTS

According to Angle classification, the total sample (n = 457) included 33.7% (n=154) of patients with Class I malocclusion, 33.9% (n=155) with Class II/1, 11.4% (n=52) with Class II/ 2, and 21.0% (n=96) with Class III (Table 1).

All indices produced significantly lower scores for Class I malocclusions than for the other Angle classifications (p<0.0001; Table1). No significant difference was found between Angle Class II/1 and Class II/2 according to all indices. In accordance to DAI, Class II/1 patients have significantly greater scores than Class III ones (p< 0.0001; Table1).

There was 80% agreement between the ICON and DAI on the need for treatment for the sample population as a whole and the kappa statistics for diagnostic agreement was 0.331, indicating moderate agreement (p<0.0001) (Table 2). The kappa statistics for diagnostic agreement between the two indices on the need for treatment was 0.288 among Class I patients (moderate agreement; p<0.0001), 0.449 among Class II/1 patients (moderate agreement; p<0.0001), and 0.225 among Class II/2 patients (low agreement; p<0.05). Among the Class II/2 patients, only one did not require treatment, according to the ICON. There was no significant diagnostic agreement between the ICON and DAI for Class III patients (Table 2).

Correlations between PAR and DAI scores and between PAR and ICON scores according to Angle classification and the associated Spearman rank order correlation coefficients were shown in Table 3. The plots of PAR scores vs. DAI scores and of PAR scores vs. ICON scores according to Angle classification were shown in Figures 1 and 2, respectively. The ICON and DAI had significant positive correlations with the PAR in the general sample population (p<0.001). However, for Class II/2 malocclusions there was no significant correlation between PAR and DAI scores.

Table 1. Comparison of DAI, ICON and PAR scores in accordance to Angle classification.

Indices	Angle groups	n	Median	Min	Max	p	Angle groups comparisons[†]
DAI Score	Class I	154	28.0	17.0	54.0	*	1-2 1-3 1-4 2-4
	Class II/1	155	34.0	17.0	63.0		
	Class II/2	52	31.0	21.0	81.0		
	Class III	96	30.5	19.0	76.0		
ICON Score	Class I	154	58.0	16.0	103.0	*	1-2 1-3 1-4
	Class II/1	155	69.0	25.0	107.0		
	Class II/2	52	70.0	33.0	108.0		
	Class III	96	74.0	29.0	122.0		
PAR Score	Class I	154	13.0	2.0	38.0	*	1-2 1-3 1-4
	Class II/1	155	17.0	3.0	36.0		
	Class II/2	52	15.0	2.0	32.0		
	Class III	96	18.0	5.0	45.0		

$P<0.0001$*; [†]; Group 1:Class I; Group 2: Class II/1; Group 3:Class II/2; Group 4: Class III

Table 2. Agreement between DAI and ICON indexes in accordance to orthodontic treatment need for Angle classification.

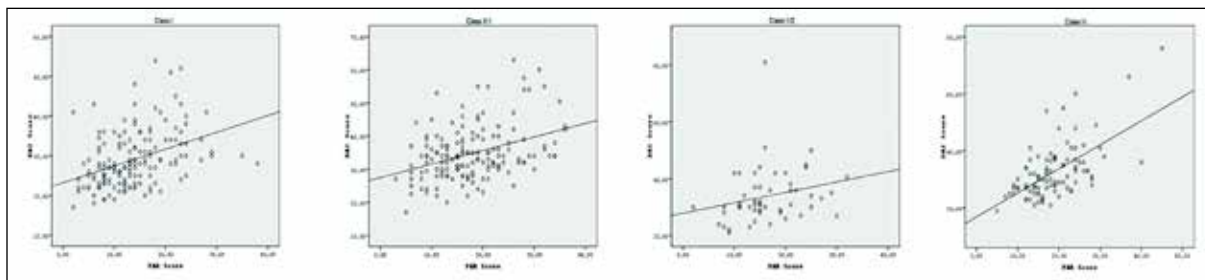|		DAI			Kappa	p
		No need		Need		
ICON	Class I	No need	25	17	0.288	**
		Need	31	81		
	Class II/ 1	No need	10	15	0.449	**
		Need	4	126		
	Class II/ 2	No need	1	0	0.225	*
		Need	6	45		
	Class III	No need	2	3	0.101	NS
		Need	16	75		
	Total	No need	38	35	0.331	**
		Need	57	327		

$P<0.05$; **$p<0.0001$

Figure 1. Scatterplot showing PAR scores vs. DAI scores for all Angle classifications.

Figure 2. Scatterplot showing PAR scores vs. ICON scores for all Angle classifications
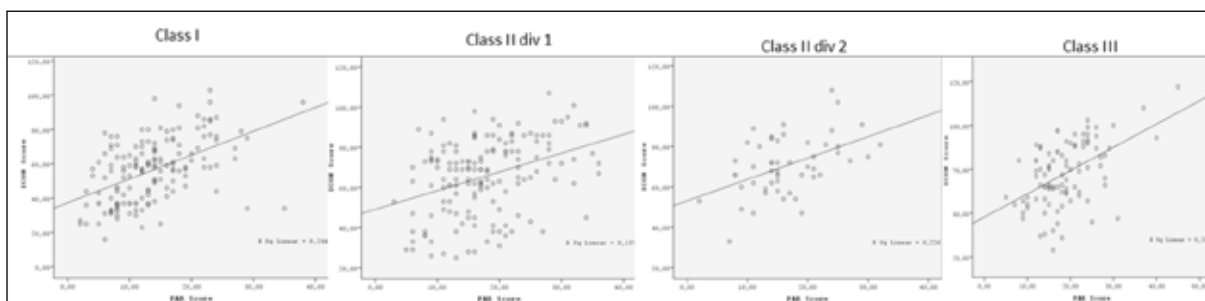
Table 3. Correlations between PAR, DAI and ICON scores with regard to the Angle classification.

	Class I		Class II/1		Class II/2		Class III		Total sample	
Indices	r	p	r	p	r	p	r	p	r	p
PAR vs DAI	0.395	*	0.376	*	0.240	NS	0.608	*	0.454	*
PAR vs ICON	0.504	*	0.370	*	0.475	*	0.503	*	0.495	*

p<0.001*, r=Spearman rank order correlation coefficient

DISCUSSION

Several researchers have discussed the application and validity of orthodontic indices in assessing the severity of malocclusion as it relates to orthodontic treatment difficulty and need. However, no absolute consensus exists on the individual characteristics and occlusal features that should be assessed to objectively establish the need for treatment.[12] Index scores differ in certain cases, because there are prominent differences in how certain occlusal features are scored.[1,28,29] The present study aimed to compare the PAR, ICON and DAI in scoring the specific occlusal anomalies with regard to Angle classifications.

Total sample

Among the total sample of this study, the ICON identified a greater proportion of patients in need of treatment (84%), compared with the DAI (79.2%). In another word, it was found that 20% of patients who referred to an orthodontic clinic did not need orthodontic treatment. This finding may be due to the inappropriate evaluation of treatment need during their initial examination at oral diagnostic or pediatric dentistry clinics. It seems that using the indices in those clinics' practice as well, may provide proper patient selection.

The small difference in the percentage of patients identified as needing orthodontic treatment might have resulted from the number of patients who were ranked differently according to each index. There was statistically significant agreement of 80% between the DAI and ICON in determining treatment need, suggesting that the ICON can generally be substituted for the DAI and will produce similar results. These results are consistent with those of Onyeaso and Begole.[28] Among the 20% of patients with different treatment need determinations, the same patient may or may not be selected for treatment depending on which index was used. Because the DAI and ICON are designed and implemented using different methods, their results differ in some cases. Inherent differences between the DAI and other orthodontic indices have been reported in the literature.[1,2,25,29] In most cases, if the ICON selected an individual for treatment while the DAI did not it may due to the presence of a deepbite, posterior/anterior crossbite with functional malocclusion, and impacted teeth.

There were significant positive correlations between PAR and DAI scores and between PAR and ICON scores for the total sample. The degree of correlation between the PAR and ICON scores reported in the UK (r=0.51) is similar to our results (r=0.495).[8]

Angle Classifications

This study evaluated the lack of assessment of some occlusal anomalies in detail by classifying patients according to Angle malocclusion.

Angle Class I

In all indices, patients with Class I malocclusion had significantly lower scores than those with other classifications, a finding similar to that of Soh et al.[14] There was significant agreement between the DAI and ICON in determining treatment need among Class I patients. Significant correlations were found between PAR and DAI scores and between PAR and ICON scores of these patients. The correlations between PAR and ICON scores were higher than between PAR and DAI scores.

The higher percentage of subjects determined to need treatment according to the DAI might result from the sensitivity of the indices in assessing specific occlusal features, such as mandibular crowding, which is a primary reason for referral to orthodontic clinics.

Angle Class II

In assessing treatment need, the ICON generally agreed with the DAI for Class I, Class II/1 and Class II/2 malocclusions. There was significant agreement between the DAI and ICON in treatment need among Class II/1 patients. Significant correlations were also found between PAR and DAI scores and between PAR and ICON scores. The DAI evaluates ten occlusal situations, weights them according to their relative contribution to the aesthetic impairment caused by the malocclusion. Because each situation contributes only a small amount to the final score, it is impossible to establish exactly which specific occlusal situation causes the inconsistency between the ICON and the DAI. For this reason, when the DAI selected patients for treatment that the ICON did not, no ordered classification of the reasons of the diverging criteria was made. To clarify these differences, we assessed the occlusal parameters that are evaluated and that score higher in the DAI than in the ICON, such as midline diastema, mandibular spacing and crowding and the amount of overjet. In Class II/1 patients, the basic anomaly is the increased overjet, which is evaluated in the DAI, but not in the ICON.

For Class II/ 2 patients, although there was no significant correlation between PAR and DAI scores, a significant correlation was found between PAR and ICON scores. The DAI does not record certain traits of Class II/2 malocclusions that can strongly influence the determination of treatment need, such as traumatic deep overbite.[28,30] The ICON does not have similar deficiencies and in both PAR and ICON, overbite is considered.

Angle Class III

In our study, five of the 96 Class III patients were determined to have no orthodontic treatment need according to the ICON (total score≤43), compared with 18 of the Class III patients according the DAI (total score ≤25). There was no significant agreement between the two indices for the Class III patients. This finding suggests that the ICON cannot be substituted for the DAI in these patients. This result is in conflict with that of a previous study.[28] Class III

malocclusions in this sample may have been more difficult to treat based on severity according to the PAR and ICON. The DAI may not be sensitive to the specific occlusal problems and treatment requirements of patients with Class III malocclusion and therefore may lead to neglect or delay of treatment in such cases. DAI scores neglect the edge to edge incisor relationship in Class III patients, so the severity of malocclusion is underestimated by the DAI in most of these patients.[2,31] It should be noted that approximately 80 % of our Class III patients were determined to require orthodontic treatment according to the DAI (DAI score≥31). A similar disagreement in ranking was reported in a previous study.[31]

Significant correlations were found between PAR and ICON scores and between PAR and DAI scores for Class III patients. However, there was no significant agreement between DAI and ICON scores. These results conflict with those of Onyeaso and Begole,[28] who found higher correlation between the ICON and PAR than between the ICON and DAI.

In our sample, PAR and ICON scores were highest among Class III subjects, while DAI scores were highest among Class II/1 patients. These results are in conflict with those of Soh et al.[14], who reported that Class II/2 malocclusions had higher PAR scores than other types of malocclusion among Asian men.

PAR index was not used in evaluation of treatment need in this study because of the absence of cut-off point of PAR index for Turkish population. Therefore, only the correlations between the PAR vs. DAI and PAR vs. ICON were determined. Further studies are needed to define the cut off-point.

Although the proportion of individuals determined to need treatment according to the DAI and ICON are very similar, the 20% overall disagreement between the indices has to be considered when measuring, recording and quantifying orthodontic treatment need.

In assessment of the indices in relation with Angle classifications, prominent differences exist in scoring certain occlusal features, therefore fundamental determination of orthodontic treatment need should be performed in conjunction with Angle classifications.

We recommend the usage of alternative indices instead of only one index for borderline cases in evaluation of the treatment need.

CONCLUSIONS

- There was no significant agreement between the DAI and ICON for Class III patients.

- There were significant positive correlations between the PAR and ICON for all Angle classifications.

- There were significant positive correlations between the PAR and DAI for all Angle classifications, with the exception of Class II/2 patients.

REFERENCES

1. Borzabadi-Farahani A. An insight into four orthodontic treatment indices. Prog Orthod 12:132-42, 2011.

2. Borzabadi-Farahani A. A review of the evidence supporting the aesthetic orthodontic treatment need indices. Prog Orthod 13:304-13, 2012.

3. Cons NC, Mruthyunjaya YC, Pollard ST. Distribution of occlusal traits in a sample of 1,337 children aged 15-18 residing in upstate New York. Int Dent J 28:154-64, 1978.

4. Jenny J, Cons NC, Kohout FJ, Frazier PJ. Test of a method to determine socially acceptable occlusal conditions. Community Dent Oral Epidemiol 8:424-33,1980.

5. World Health Organization International Collaborative Study of Oral Health Outcomes (ICS II), document 2. Oral data collection instrument and evaluative criteria, WHO, Geneva. 1989.

6. Beglin FM, Firestone AR, Vig KW, Beck FM, Kuthy RA, Wade D. A comparison of the reliability and validity of 3 occlusal indexes of orthodontic treatment need. Am J Orthod Dentofacial Orthop 120:240-6, 2001.

7. Jenny J, Cons NC. Comparing and contrasting two orthodontic indices, the Index of Orthodontic Treatment need and the Dental Aesthetic Index. Am J Orthod Dentofacial Orthop 110:410-6, 1996.

8. Danyluk K, Lavelle C, Hassard T. Potential application of the dental aesthetic index to prioritize the orthodontic service needs in a publicly funded dental program. Am J Orthod Dentofacial Orthop 116:279-86, 1999.

9. Richmond S, Shaw WC, O'Brien KD, Buchanan IB, Jones R, Stephens CD, et al. The development of the PAR index (peer assessment rating): reliability and validity. Eur J Orthod 14:125-39, 1992.

10. Holman JK, Hans MG, Nelson S, Powers MP. An assessment of extraction versus nonextraction orthodontic treatment using the peer assessment rating (PAR) index. Angle Orthod 68:527–34, 1998.

11. DeGuzman L, Bahiraei D, Vig KW, Vig PS, Weyant RJ, O'Brien K. The validation of the Peer Assessment Rating index for malocclusion severity and treatment difficulty. Am J Orthod Dentofacial Orthop 107:172-6, 1995.

12. Richmond S, Daniels CP, Fox NA, Wright J. The professional perception of orthodontic treatment complexity. Br Dent J 183:365-70, 1997.

13. Firestone AR, Beck FM, Beglin FM, Vig KW. Evaluation of the peer assessment rating (PAR) index as an index of orthodontic treatment need. Am J Orthod Dentofacial Orthop 122:463-469, 2002.

14. Soh J, Sandham A, Chan YH. Malocclusion severity in Asian men in relation to malocclusion type and orthodontic treatment need. Am J Orthod Dentofacial Orthop 128:648-52, 2005.

15. Daniels CP, Richmond S. The development of the index of complexity, outcome and need(ICON). J Orthod 27:149-62, 2000.

16. Richmond S, Ikonomou C, Williams B, Ramel S, Rolfe B, Kurol J. Orthodontic treatment standards in a public group practice in Sweden. Swed Dent J 25:137-44, 2001.

17. Firestone AR, Beck M, Beglin FM, Vig KWL. Validity of the index of complexity, outcome, and need. Angle Orthod 72:15-20, 2002.

18. Liepa A, Urtane I, Richmond S, Dunstan F. Orthodontic treatment need in Latvia. Eur J Orthod 25:279-84, 2000.

19. Borzabadi-Farahani A, Borzabadi-Farahani A. Agreement between the index of complexity, outcome, and need and the dental and aesthetic components of the index of orthodontic treatment need. Am J Orthod Dentofacial Orthop 140:233-8, 2011.

20. Silva RG, Kang DS. Prevalence of malocclusion among Latino adolescents. Am J Orthod Dentofacial Orthop 119:313-5, 2001.

21. Angle H. Classification of malocclusion. Dental Cosmos 41:248-64, 1899.

22. Baume LJ, Marechaux S. Uniform methods for the epidemiologic assessment of malocclusion. Am J Orthod 66:121-9, 1974.

23. McLain JB, Proffit WR. Oral health status in the United States: prevalence of malocclusion. J Dent Educ 49:386-96, 1985.

24. Koochek AR, Yeh MS, Rolfe B, Richmond S. The relationship between index of complexity, outcome and need, and patients' perceptions of malocclusion: a study in general dental practice. Br Dent J 191:325-9, 2001.

25. Johnson M, Harkness M, Crowther P, Herbison P. A comparison of two methods of assessing orthodontic treatment need in the mixed dentition: DAI and IOTN. Aust Orthod J 16:82–7, 2000.

26. British Standard Institute. British Standard Incisor Classification. Glossary of Dental Terms BS 4492, BSI, London 1983.

27. Estioko LJ, Wright FA, Morgan MV. Orthodontic treatment need of secondary schoolchildren in Heidelberg, Victoria: an epidemiologic study using the Dental Aesthetic Index. Community Dent Health 11:147-51, 1994.

28. Onyeaso CO, Begole EA. Relationship between index of complexity, outcome and need, dental aesthetic index, peer assessment rating index, and American Board of Orthodontics objective grading system. Am J Orthod Dentofacial Orthop 131:248-52, 2007.

29. Manzanera D, Montiel-Company JM, Almerich-Silla JM, Gandia JL. Diagnostic agreement in the assessment of orthodontic treatment need using the dental aesthetic index and the index of orthodontic treatment need. Eur J Orthod 32:193-8, 2010.

30. Otuyemi OD, Noar JH. Variability in recording and grading the need for orthodontic treatment using the handicapping malocclusion assessment record, occlusal index and dental aesthetic index. Community Dent Oral Epidemiol 24:222-4, 1996.

31. Garbin JI, Perin PCP, Garbin CAS, Lolli LF. Malocclusion prevalence and comparison between the Angle classification and the Dental Aesthetic Index in scholars in the interior of São Paulo state – Brazil Dental Press J Orthod 15:94-102, 2010.