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Original Article

The feasibility of Index of Orthodontic Treatment Need (IOTN) in labial segment malocclusion among 8-10 years old

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Abstract The purpose of this study was to assess the feasibility of the use of Index of Orthodontic Treatment Need (IOTN) on labial segment malocclusion in determining the need for orthodontic treatment among 8 to 10-year old children. Convenient sample of one hundred and six (106) children (54 boys and 52 girls) were examined extra and intra-orally. Their skeletal and dental discrepancies were assessed in all three dimension planes. Any presence of mandibular displacement was identified. The IOTN score was determined for each child. Respectively it was found that 39.6%, 49.1% and 11.3% of the children presented with skeletal Class I, Class II and Class III malocclusion(p<0.05). Inter-arch relationship showed a significant difference of the midline condition of the upper arch and the presence of anterior and posterior crossbite (p<0.05). About 17.8% of the children had increased overjet of more than 6 mm. Increased overbite was seen in 55.7% of the children with 7.6% presenting with palatal contact. There was a higher prevalence (57.5%) of crowding in the mandibular arch, while the maxillary arch had a higher prevalence (62.2%) of spacing. More than half (62.2%) of the children were in need of treatment (IOTN Grade 3, 4 and 5).This study showed a high prevalence of labial segment malocclusion among 8 to 10-year-old children which indicate orthodontic intervention. The IOTN is not a suitable index for mixed dentitions to be used for developing occlusion for the population group.

Keywords: labial segment, malocclusion, orthodontic treatment need.

Introduction

The World Health Organization (WHO) recommended the increase in preventive and interceptive health care programs. In response to this, numerous studies were conducted to determine the incidence of dental malocclusion and the need for treatment among various populations (Abdullah and Rock, 2001; Uğur *et al*., 1998; Ngom *et al.*, 2007). Most of these studies had utilised different indices in collecting the quantitative data of malocclusion. This allows adequate provision of orthodontic service in particular the preventive and interceptive types. The widely accepted 'cut-off' points of indices allow for a realistic estimation of the possible amount of treatment that can be undertaken at any one time. Therefore, the standard and quality of the treatment provided will not be compromised and will be maintained despite the shortage in manpower.

A developing malocclusion can be predicted or detected early (Proffit and Fields, 2000; Vig and Fields, 2000). Commonly, referral of children with malocclusion is initiated early when progression of disorder in the development of the dental arches becomes noticeable. Through early detection and a systematic treatment plan, it is possible for early orthodontic treatment to intercept or prevent a dental malocclusion. This may contribute to a significant reduction in treatment need

(Al Nimri and Richardson, 2000). Minimising the extent or severity of a malocclusion may help simplify subsequent treatment and even shorten its duration. Early treatment allows for greater potential of skeletal growth modification, improved self-esteem, better treatment outcome, more stable results and reduced potential for traumatic injuries (Tulloch *et al.,* 1997; Seehra *et al*., 2013; Keski-Nisula *et al*., 2008).

One of the more commonly known indices is the Index of Orthodontic Treatment Need (IOTN). This index is the most frequently used index to date, especially in determining treatment priority and needs of a given population. This is because the IOTN is valid and reproducible, easy to learn and the recording of all the relevant features of malocclusion can be done in a minute amount of time (Cardoso *et al*., 2011). The Dental Health Component of IOTN is divided into five grades, with Grade 1 indicating no treatment is required and Grade 5 showing great need for treatment (Brook and Shaw, 1989). The occlusal trait with the highest score indicates the grade in which the malocclusion belongs to, hence, determining the degree of treatment needs. Nevertheless, the IOTN has been recommended and widely used for patients in the full permanent dentition but not in the mixed dentition stage.

Therefore, the objective of this study was to assess the feasibility of the use of IOTN on labial segment malocclusion in determining the need for orthodontic treatment among 8 to 10-year old children.

Materials and methods

The protocol of this study was approved by Research and Ethics Committee of Faculty of Dentistry Universiti Kebangsaan Malaysia (No: UKM 1.25.11/111/2, dated: 9 Mac 2007). The study was cross-sectional in nature. It was carried out at three different clinics, mainly the Orthodontic Consultation, Paediatric Dental and Students' Polyclinic. The selection of subjects was based on convenient sampling over a period of seven months.

Children between the ages of 8 to 10 years that came for dental treatment or consultation at the Faculty of Dentistry, Universiti Kebangsaan Malaysia were invited to participate in this study. These children were assumed to have full unit permanent incisors on the upper and lower labial segments present. Children with a history of interception or orthodontic appliance treatment and those without informed consent from their parents or guardian were excluded. Children with syndromes, medical problems and congenital diseases that might influence the normal development of the occlusion were also excluded.

The clinical examination consisted of extra-oral and intra-oral examinations. A standardised examination form, specially designed for this study was used for each patient. The extra-oral assessment consisted of the skeletal classification in the antero-posterior, transverse and vertical dimensions. The intra-oral examination consisted of assessment of intra-arch (crowding) and inter-arch relationship (overjet, overbite, crossbite and mandibular displacement with premature contact).

Overjet is the distance between the edge of the upper central incisor and the labial surface of the lower central incisor measured in millimeters. Overjet between 0.1 and 3 mm was considered as normal, greater than 3 mm was considered as increased, and 0 mm was taken as edge to edge. The term reverse overjet was used if both the left and right maxillary central incisors were in palatal occlusion.

Overbite, the perpendicular distance from the edge of the central lower to the upper central incisor edge, was measured in millimeters. Overbite between 0 and 3 mm was considered as normal. Greater than 3 mm was considered as deep bite and less than 0 mm (vertical gap) as open bite. The children were also asked regarding the presence of habits such as thumb or dummy sucking in relation to openbite.

Mandibular displacements were identified when crossbites were presented with premature contacts. They were measured in millimeters. The outcome of the clinical examination was limited to clinical findings without the use of any radiographs.

Crowding was measured as tooth width to arch length discrepancy and was recorded specifically for anterior crowding. Only crowded arches were measured using an electronic digital caliper (AM Germany Series 600) to two decimal points. The width of each lateral and central incisor of the upper and lower arches was measured intraorally. The arch length was calculated by measuring the width of both the central and lateral incisors on the right and left quadrants of the same arch. Following this, the measurements recorded were then summed up. This value was then taken as the arch length of the labial segment.

Measurements of tooth size to arch length discrepancy were not carried out in cases with spacing or well aligned labial segments.

The IOTN scores of the 8 to 10-year old children were mainly based on labial segment of the upper and lower arches. The occlusal traits that were scored upon were the overjet, reversed overjet, crossbite with mandibular displacement, overbite and open bite.

Descriptive results and cross-tabulation of the results with gender were calculated using the SPSS Windows Version 21.0. Clinical examination of each child was performed by one examiner (WFMA). The examiner was calibrated prior to the study. A total of 11 subjects from the study population were re-examined after one month to assess for intra-examiner reproducibility. The correlation coefficient with Kappa analysis between the two readings was calculated and the r value was found to be 0.94 (r = 1), indicating good correlation or intra-examiner reliability. The Pearson Chi-square test was used to determine the significant difference of the results in relation to gender.

Results

A total of 106 children (54 boys and 52 girls) with mean age of 8.9 ($\pm$ 0.8) years participated in this study. The majority of the children were found to be Class II (n=52; 49.1%) skeletal pattern, followed by Class I (n=42; 39.6%) and Class III (n=12; 11.3%). About two-third of the boys (35; 64.8%) presented with Class II antero-posterior relationship while more than half of the girls (n=28; 53.8%) were Class I. A statistically significant gender differences for antero-posterior skeletal relationship was observed in the study population (p<0.05; Table 1). For the transverse dimension evaluation, 103(97.2%) children presented with symmetrical faces, which was equally distributed between genders. Only two (n=2; 1.9%) boys and one (0.9%) girl showed deviation of the chin, resulting in asymmetrical faces. In relation to vertical height dimension, more than half of the children (n=67; 63.2%) was in the average category. However, the vertical skeletal discrepancy showed no significant difference between genders for all categories (p>0.05).

Table 2 shows the inter-arch relationship of the study population. A total of 70 children (66.0 %) presented with upper centreline that coincided with the facial midline. This feature was mostly observed among the boys (n=42, 60 %); p<0.05). Meanwhile, 59(55.7%) children presented with lower centreline that coincided with the facial midline but the difference between the genders was not statistically significant. Out of these, 34(32.1%) had both upper and lower centrelines coincided. With regards to overjet, 54(50.9%) children presented with normal overjet and among these, 31 (57.4%) were boys. Among 45 (42.5%) children who had increased overjet, 5(11.1%) boys and 3(6.7%) girls were observed with overjet of more than 6mm but the difference between the genders was not statistically significant. A total of 59 (55.7%) children had increased overbite and the distribution was almost equal between boys and girls. Among those children, 5(4.7%) boys and 2(1.9%) girls presented with complete overbite and palatal contact. Only one (0.9%) girl experienced complete overbite with gingival or palatal trauma. Although nine (8.4%) children admitted to sucking on their thumb or on some form of object, anterior open bite was only detected in one (0.9%) boy. Crossbite was observed in 20(18.9%) children in which the majority were girls (n=13; 65%; p<0.05). Upon clinical examination between retruded contact position and intercuspal position

among children with crossbite, premature contacts were identified in 8(61.5%) of the girls. Anterior mandibular displacement was the most common condition detected.

As shown in Table 3, intra-arch relationship was evaluated for spacing and crowding. Compared to the upper arch, the lower labial segment was more crowded (n=61; 57.5%). It was found that girls (n=32; 52.4%) had a higher incidence of crowding in the lower labial segment compared to boys (n=29; 47.6%). In contrast, spacing was more prominent in the upper labial segment (n=66; 62.2%) with a higher percentage in boys (n=37; 56.1%) than girls (p<0.05).

Based on the IOTN score, 66(62.2%) of 106 children examined were found to be in need of treatment (Table 4). From this, 58(54.6%), 6(5.7%) and 2(1.9%) were in Grade 3, Grade 4 and Grade 5 scores respectively. More girls (n= 35; 53.0%) were in need of treatment as compared to boys (n=31; 47.0%) but difference was not statistically significant. In children with Grade 1 and 2 scores, 27(25.5%) were observed with centreline shifts.

Table 1 Distribution of the skeletal relationship

Skeletal	Classification	Boys (%)	Girls (%)	Total (%)	*p*
Antero-posterior	Class I	14 (25.9)	28 (53.8)	42 (39.6)	0.004*
	Class II	35 (64.8)	17 (16.0)	52 (49.1)	
	Class III	5 (9.3)	7 (6.6)	12 (11.3)	
	Total	**54 (100)**	**52 (100)**	**106 (100)**	
Transverse	Symmetrical	52 (96.3)	51 (98.1)	103 (97.2)	0.581
	Asymmetrical	2 (3.7)	1 (1.9)	3 (2.8)	
	Total	**54 (100)**	**52 (100)**	**106 (100)**	
Vertical	High	14 (25.9)	13 (25.0)	27 (25.5)	0.792
	Average	35 (64.8)	32 (61.5)	67 (63.2)	
	Low	5 (9.3)	7 (13.5)	12 (11.3)	
	Total	**54 (100)**	**52 (100)**	**106 (100)**	

*p<0.05

Table 2 Distribution of the inter-arch relationship

Inter-arch relationship		Classification	Boys (%)	Girls (%)	Total (%)	*p*
Midline shift	Upper arch	Shifted	12 (22.2)	24 (46.2)	36 (34.0)	0.009*
		Coincide	42 (77.8)	28 (53.8)	70 (66.0)	
		Total	**54 (100)**	**52 (100)**	**106 (100)**	
	Lower arch	Shifted	25 (46.3)	22 (42.3)	47 (44.3)	0.679
		Coincide	29 (53.7)	30 (57.7)	59 (55.7)	
		Total	**54 (100)**	**52 (100)**	**106 (100)**	
Overjet		Normal	31 (57.4)	23 (44.2)	54 (50.9)	0.268
		Increased	21 (38.9)	24 (46.2)	45 (42.5)	
		Edge to edge	2 (3.7)	0 (0)	2 (1.9)	
		Reversed	0 (0)	5 (9.6)	5 (4.7)	
		Total	**54 (100)**	**52 (100)**	**106 (100)**	
Overbite		Normal	10 (18.5)	15 (28.8)	25(23.6)	0.229
		Increased	30 (55.6)	29 (55.8)	59(55.7)	
		Reduced	14 (25.9)	7 (13.5)	21(19.8)	
		Openbite	0 (0)	1 (1.9)	1(0.9)	
		Total	**54 (100)**	**52 (100)**	**106 (100)**	
Crossbite		Present	7 (13.0)	13 (25.0)	20 (18.9)	0.05*
		None	47 (87.0)	39 (75.0)	86 (81.1)	
		Total	**54 (100)**	**52 (100)**	**106 (100)**	
Premature contact		Present	6 (11.1)	9 (17.3)	15 (14.2)	0.36
		None	48 (88.9)	43 (82.7)	91 (85.8)	
		Total	**54 (100)**	**52 (100)**	**106 (100)**	

*p<0.05

Table 3 Distribution of the intra-arch relationship

Labial segment	Intra-arch relationship	Boys (%)	Girls (%)	Total (%)	*p*
Lower arch	Spacing	14 (25.9)	11 (21.2)	25 (23.6)	0.715
	Align	11 (20.4)	9 (17.3)	20 (18.9)	
	Crowding	29 (53.7)	32 (61.5)	61 (57.5)	
	Total	**54 (100)**	**52 (100)**	**106 (100)**	
Upper arch	Spacing	37 (68.5)	29 (55.8)	66 (62.2)	0.05*
	Align	9 (16.7)	5 (9.6)	14 (13.2)	
	Crowding	8 (14.8)	18 (34.6)	26 (24.5)	
	Total	**54 (100)**	**52 (100)**	**106 (100)**	

*p<0.05

Table 4 Distribution of IOTN in relation to labial segment malocclusion

Grade IOTN		Boys (%)	Girls (%)	Total (%)	*p*
1	No need for treatment	20 (37.0)	14 (26.9)	34 (32.1)	0.679
2	Little need for treatment	3 (5.6)	3 (5.8)	6 (5.7)	
3	Moderate need for treatment	26 (48.2)	32 (61.5)	58 (54.6)	
4	Great need for treatment	4 (7.4)	2 (3.8)	6 (5.7)	
5	Very great need for treatment	1 (1.8)	1 (2.0)	2 (1.9)	
	Total	54 (100)	52 (100)	106 (100)	

Discussion

This study was conducted with the aim to determine the prevalence of labial malocclusion, hence the need for interceptive orthodontic treatment among 8 to 10-year old children. The results in this study must be interpreted with caution. Firstly, various scoring systems had been used to quantify the malocclusion (Abdullah and Rock, 2001; Uğur *et al*., 1998; Ngom *et al*., 2007; Al Nimri and Richardson, 2000). Besides that, the influence of racial features as one of the predisposing factors to the prevalence of malocclusion cannot be denied. Any comparisons between different studies involving various communities in different parts of the world should be done with caution.

Present study demonstrated that more than half of the study population (64; 60.4%) presented with skeletal discrepancies (Class II and III) and majority were boys. One study had reported a significant difference between genders with only 24% of the 9-15 year old schoolchildren presented with skeletal discrepancies (Saleh, 1999). Clinical signs of Class II skeletal pattern have been evident in the deciduous dentition and remain unmodified in the transition to the mixed dentition (McNamara, 1981; Bishara, 1998; Baccetti *et al*., 1997). Typically it was characterized by significant mandibular skeletal retrusion and mandibular size deficiency with maxillary protrusions a main component of Class II malocclusion in the mixed and permanent dentitions (Baccetti *et al*., 1997; Antonini *et al*., 2005). Furthermore sagittal and transverse discrepancies have also been reported to be coexisted in skeletal Class II malocclusions (Tollaro *et al*., 1996; Guyer *et al*., 1986). As well as skeletal Class II, Class III also has strong tendencies for early appearance of distinctive characteristics. Studies reported an excessive mandibular growth, which produces a substantially increase mandibular length, hyperdivergent mandible and excessive vertical growth (Wolfe *et al*., 2011; Reyes *et al*., 2006). However, there was no difference of the maxilla growth compared to Class I skeletal (Reyes *et al.*, 2006).

An accurate diagnosis has to be evaluated for the involvement of the maxilla and mandible in the sagittal, vertical and transverse dimensions from the early developmental phases to establish an

appropriate treatment plan. However, other factors such as special indications for each child, patient cooperation and management must also be taken into consideration before early treatment is started. However, the extent of skeletal orthopaedic change in individual, the most effective appliances and timing of such treatment growth modifications remains controversial (Tulloch *et al*., 2004; Kim *et al*., 1999). Generally, transverse discrepancies need to be corrected first to establish a proper base for the anterior-posterior correction. Although most anterior-posterior and vertical jaw discrepancies can be corrected during the primary dentition years, relapse occurs because of continuing growth (Hägg and Pancherz, 1988). They usually need further treatment to maintain the correction.

This study demonstrated a higher prevalence and significant difference in crowding (p<0.05) in the lower arch between genders. Previous studies also showed a higher prevalence of crowding in the mandible compared to maxilla (Thilander *et al.*, 2001; Lew *et al.,* 1993). It is very important to recognize labial segment crowding at an early stage of development. Children with crowding of the deciduous incisors are more likely to be followed by crowding of the permanent incisors (Sanin and Savara, 1973). It is believed that the high frequency of spacing especially in the maxillary labial segment (p<0.05) found in this present study is closely related to the developing occlusion of the children examined. It can be attributed by flaring of the maxillary incisors which is commonly known as the ugly duckling stage. As canines find their final position in occlusion they exert increasing mesial pressure on the distal surfaces of the lateral incisors, forcing the lateral and the central incisors to change their axial inclination and close the diastema. This study also found that most of the children with spacing of their maxillary labial segment had a Class II skeletal pattern. Class II skeletal features usually presents with protrusive maxilla with a longer maxillary arch length in relation to tooth size, creating a space discrepancy (Otuyemi and Abidoye, 1993; Gábris *et al*., 2006).

Nearly half of the children in this study had an increase in their overjet. This has been reported in other studies (Al-Emran *et al*., 1990; Tausche *et al*., 2004). An incisors injury can frequently lead to tooth lesions, affecting both supporting dental structures and hard tissues. Directly or indirectly this may affect their appearance, functional, psychological and social problems (Glendor, 2009). Therefore, it is justifiable to impose an early orthodontic treatment plan on such cases with the intention of preventing unwanted injury to the anterior teeth. This is not only for the benefit of the child involved but also for the orthodontist because it prevents from having to deal with non-vital or traumatised teeth prior to orthodontic treatment

Deep overbites which is vertical overlap of the maxillary and mandibular incisors often varies excessively and is one of the most common and early manifestations of a malocclusion (Goldstein and Stanton, 1936). A reduction in excessive overbite with the development of teeth is due to the stabilization of the occlusion with the eruption of posterior teeth and a greater mandibular growth. It should be a concern with a deep overbite which is accompanied by trauma to the gingiva. Deep traumatic overbite can lead to enhanced levels of inflammation and periodontal deterioration in the presence of plaque. This study reported only 1 child presented with an anterior open bite although 9 of the children reported a thumb sucking habit. At the age of 8 to 10 year old, the feeling of embarrassment to their friends could have a positive influence for them to reduce or stop the habits. Therefore, the malocclusion that might have developed as a consequence of the sucking would have spontaneously self-corrected. Digit and dummy sucking have been described as important etiological factors, particularly for Class II due to maxillary protrusion (Gábris *et al*., 2006; Tausche *et al*., 2004).

This study demonstrated a very high incidence of midline shift. It has been shown that early loss of a primary canine on one side of the arch, most frequently cause a midline shift of the anterior segment of that arch towards the side of the missing canine (Richardson, 1999). This condition

requires early interception so as to alleviate the developing malocclusion. Failure to intercept will surely lead to prolonged orthodontic treatment time in the future as midline corrections can be quite time consuming.

Anterior cross bite, has a reported incidence of four to five percent, usually becomes evident during the early mixed dentition phase (Heikinheimo *et al*., 1987). Anterior crossbites accompanied by anterior displacement of the mandible if left untreated may lead to restriction of maxillary growth, traumatic occlusion, and may lengthen the treatment time. The evidence for the management and stability of anterior crossbites in children has been highlighted (Borrie and Bearn, 2011; Greenlee *et al*., 2011).

The application of the IOTN scoring system was implemented with the exception of the determination of missing and displaced teeth. The types of distinguishable malocclusion in the mixed dentition that believed to benefit from interceptive and preventive treatment within this group include the increased overjet, increased overbite with palatal contact and crossbites with mandibular displacements. Although the index managed to identify 62.2 % (n=66) of the children in need of treatment with majority presented with overjets more than 3.5 mm. These discrepancies will be compensated in part during mandibular growth and development of the dental arch. Even though the degree of crowding and centerline shift was determined, the figures could not be used to score for the orthodontic treatment need. It was discovered that 27(25.5%) of the children with IOTN scores of 1 and 2 presented with centreline shifts. The use of IOTN to determine the orthodontic treatment need for the purpose of interception, those children who require immediate attention would have been overlooked. These features should raise a concern of developing malocclusion in the future. The mixed dentition stage offers the greatest opportunity for occlusal guidance and interception of malocclusion which if delayed to a later stage the treatment may become more complicated.

Nevertheless, the findings indicate the early development of progressive malocclusion symptoms which are evidenced in the IOTN and concur with the acronym 'MOCDO' hierarchy (missing, overjet, crossbite, displacement and overbite). This early formation of progressive symptoms inhibiting or disturbing mandibular or maxillary growth or the development of the normal dental arch, i.e. crossbite, reverse overjet and increased overjet with myofunctional disorders, should be treated at an early stage.

The findings of this study shows that 62.2% (n = 66) of the children examined are in Grade 3 and above. In comparison with Tausche *et al*. (2004), the orthodontic treatment of the children in the early mixed dentition stage of that study was slightly lower with 51.7%. The higher figure found in the present study could be due to the fact that the children for this study were among who came to request for treatment and the demand for dental treatment.

Conclusion

The present study demonstrates that majority of 8 to 10-year old children are in need of interceptive orthodontic treatment. The IOTN is effective in identifying malocclusions related to overjet, overbite and crossbite. However, accurate determination of teeth displacement is less straight forward in mixed dentitions. Furthermore, diagnosing centreline shift is not incorporated in the IOTN. This poses a major disadvantage in identifying children with this problem that may require early orthodontic intervention.

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