

## Research Article

# Angle's Classification Versus Dental Aesthetic Index in Evaluation of Malocclusion among Turkish Orthodontic Patients

F Deniz Uzuner<sup>1\*</sup>, E Kaygısız<sup>1</sup>, L Taner<sup>1</sup>, K Güngör<sup>2</sup> and Z Gençtürk<sup>3</sup>

<sup>1</sup>Department of Orthodontics, Gazi University Faculty of Dentistry, Ankara, Turkey

<sup>2</sup>Department of Dento Maxillofacial Radiology, Gazi University Faculty of Dentistry, Ankara, Turkey

<sup>3</sup>Department of Biostatistics, Ankara University Faculty of Medicine, Ankara, Turkey

\*Corresponding author: F Deniz Uzuner, Department of Orthodontics, Gazi University Faculty of Dentistry, Biskek Cd, (8.Cd) 82, Sk. No: 406510; Emek, Ankara, Turkey. Tel: +90 3122034000; Fax: +90 3122239226; E-mail: fduzuner@yahoo.com.tr

Received: October 10, 2014; Accepted: February 02, 2015; Published: February 04, 2015

## Abstract

**Objective:** To evaluate Angle's classification and dental aesthetic index (DAI) in interpretation of malocclusion among orthodontic patients.

**Methods:** A total of 457 orthodontic patients (284 female, 173 male) between 9 to 17 years old who referred to the orthodontic clinic were included in this study. Malocclusion prevalence, the severity of malocclusion and treatment requisite were evaluated as was the association between DAI and Angle's classification. Pearson Chi-square test was used for the comparison of categorical data.  $p < 0.05$  was considered as significant.

**Results:** The percentage of patients with DAI  $\leq 25$  indicating little or no need for treatment was 20.8% and 52.7% (DAI  $\geq 31$ ) had highly desirable or mandatory need for treatment. Among patients with DAI  $\leq 25$ , a significantly high percentage of patients were in Class I (37.0%) ( $p < 0.001$ ). Significantly higher percentage of patients were having DAI score of  $\geq 35$  in Class II/1 (42.6%) and Class II/2 (36.5%) than Class I (18.8%) and Class III (31.3%) groups ( $p < 0.001$ ). Only 50.1% of patients with Class III malocclusion were associated with appropriate DAI scores ( $\geq 31$ ) of severity and treatment need category.

**Conclusion:** Only 52.7% of patients referring to orthodontic clinic revealed DAI score of  $\geq 31$  suggesting severe, very severe or disabling malocclusion with highly desirable or mandatory orthodontic treatment requisite. Although DAI seems sensitive to detect the presence of Angle's classification based malocclusion, it may be improved in terms of severity and treatment requisite criteria. While the complementary use of the two methods seems to be feasible and is suggested in all-inclusive evaluation and care for patients with malocclusion in clinical practice.

**Keywords:** Malocclusion; Prevalence; Angle's classification; Dental aesthetic index; Treatment requisite

## Introduction

Malocclusion, defined as an irregularity of the teeth or a mal relationship of the dental arches beyond the ideal range, is one of the most common dental problems ranking third among worldwide dental public health priorities [1-3], while associated also with oral dysfunction, increased susceptibility to trauma and periodontal disease as well as psychosocial problems related to impaired dento facial aesthetics and disturbed quality-of-life [1,4-8]. In this regard, gathering epidemiological data on the prevalence and distribution of malocclusions as well as orthodontic treatment need become of special interest for screening treatment priority and resource planning for orthodontic treatments within a public health system [2,9-12].

Since its publication in 1899, the Angle's classification become a milestone in orthodontics as the most widely used instrument for evaluation of malocclusions [13,14].

The Dental Aesthetic Index (DAI) was developed in the USA and integrated into the International Collaboration Study of Oral Health Outcomes by the World Health Organization (WHO) [15] as an

objective, simple and easy to use universally accepted cross-cultural index that links clinical and aesthetic components mathematically to produce a single score [14,16,17]. Being recommended to be used in epidemiologic research to establish the orthodontic treatment need and the priority of orthodontic care in public programs, DAI has been a widely used index of assessing malocclusion with high reliability and validity that was shown to compare favorably with other indices in the population-based studies of malocclusion [11,12,18-20].

Verification of Angle's classification and DAI in comparative and complementary terms as two widely used indexes in the assessment of malocclusions is important in the dental clinical practice. Most of the published data on treatment requisite has been based on screening of general population, while limited data are available on actual treatment need in patients diagnosed with orthodontic disorders and thereby referred to orthodontics clinics for treatment [14,21]. The present study was designed to evaluate Angle's classification and dental aesthetic index in assessment of malocclusion and treatment need among orthodontic patients who referred to the orthodontic clinic after the initial diagnosis made in oral diagnostic clinics.

**Table 1:** Evaluation of malocclusion according to Angle's classification and Dental Aesthetic Index.

		Malocclusion	
Angle's classification	Prevalence, n (%)		
Class I	154 (33.7)		
Class II/1	155 (33.9)		
Class II/2	52 (11.4)		
Class III	96 (21.0)		
Dental Aesthetic Index	Prevalence	Severity	Treatment requisite
	n (%)		
≤25	95 (20.8)	Normal or mild occlusion	Little or no need
26-30	121 (26.5)	Defined malocclusion	Elective
31-35	114 (24.9)	Severe malocclusion	Highly desirable
≥35	127 (27.8)	Very severe or disabling malocclusion	Mandatory

## Methods

### Study population

A total of 523 randomly selected orthodontic patients who consecutively admitted to the orthodontics clinic at Gazi University Faculty of Dentistry between May 2011 and April 2012 were included in this study. Patients with cleft lip and palate, having previous orthodontic and/or prosthetic treatment, having great restorations/crown were excluded from the study. Remaining 457 (284 female, 173 male) patients between 9 to 17 years old were clinically examined in reference to the DAI and Angle malocclusion.

### Study parameters

Data on demographic characteristics, Angle's classification and DAI scores were recorded. Malocclusion prevalence was identified according to both methods, while the severity and treatment requisite were evaluated according to DAI. The association between DAI and Angle classification was also evaluated.

### Angle's classification

Patients were considered to have Class I (neutral occlusion), Class II (distocclusion; Class II/1: increased overjet > 4 mm, Class II/2: retroclined upper central incisors with increased overbite) and Class III (mesioocclusion) malocclusion according to Angle's classification [13].

### DAI

DAI was based on evaluation of criteria including dentition (absence of incisor, canine and premolar), space (crowding in the incisor region, spacing in the region of incisors, diastema), anterior jaw misalignment, anterior mandibular misalignment) and occlusion (anterior maxillary overjet, anterior mandibular overjet, vertical anterior open bite) and anteroposterior molar relationship. DAI score was calculated using the regression equation of 10 occlusal traits: "(visible missing teeth x 6) + (crowding) + (space) + (diastema x 3) + (anterior maxillary misalignment) + (anterior mandibular misalignment) + (anterior maxillary overjet x 4) + (anterior mandibular overjet x 4) + (anterior vertical open bite x 4) + (anteroposterior molar relationship x 3) + 13" [14-16].

To determine the treatment need based on the DAI score, patients were categorized into four groups including those with score of ≤25

(normal or mild occlusion with little or no need for treatment), scores of 26-30 (defined malocclusion with elective need for treatment), 31-35 (severe malocclusion with highly desirable need for treatment) and ≥36 (very severe or disabling malocclusion with mandatory treatment) [22,23].

### Calibration

One specialist was previously calibrated using re-examination of dental students. To ascertain intraexaminer reliability in the use of the DAI, 60 students were re-examined after a period of 2-3 weeks by the same examiner. The intrarater correlation coefficient for repeated measurements was 0.98 ( *P* < 0.001), indicating high reliability.

## Statistical Analysis

Statistical analysis was made using computer software (SPSS version 15.0, SPSS Inc. Chicago, IL, USA). Pearson Chi-square ( $\chi^2$ ) test for the comparison of categorical data. Data were expressed as "mean (standard deviation; SD)", minimum-maximum and percent (%) where appropriate. *p*<0.05 was considered statistically significant.

## Results

### Malocclusion according to Angle's classification and DAI scores

Angle's classification revealed Class I, Class II/1, Class II/2 and Class III malocclusion in 33.7%, 33.9%, 11.4% and 21.0% of patients respectively. According to DAI scores 20.8% of patients (DAI ≤ 25), 26.5% (DAI 26-30), and 52.7% (DAI ≥31) (Table 1).

### Distribution of DAI components

Anterior upper jaw misalignment (89.9%), crowding (88.2%) and deviation from the normal molar relationship (73.3%) were the three most commonly observed components of DAI (Table 2).

### Association between Angle's classification and DAI scores

Among patients with DAI scores of ≤25, significantly higher percentage of patients were Class I (37.0%) than Class II (22.5%; 9.0% for Class II/1 and 13.5% for Class II/2) and Class III (18.8%) as Angle's classification (*p*<0.001). Among patients determined to have DAI score of ≥35; significantly higher percentage of patients were Class II/1(42.6%) and Class II/2 (36.5%) than Class I (18.8%)

**Table 2:** Distribution of Dental Aesthetic Index components.

Dental Aesthetic Index components	Present n(%)	Absent
<b>DENTITION</b>		
<b>Tooth loss</b>	93 (20.4)	364 (79.6)
One tooth	57	
Two teeth	27	
Three teeth	9	
<b>SPACE</b>		
<b>Crowding</b>	403 (88.2)	54 (11.8)
Single jaw	135	
Both jaws	268	
<b>Incisor region diastema</b>	115 (25.2)	342 (74.8)
Single jaw	89	
Both jaws	26	
<b>Upper central inter-incisor diastema</b>	86 (18.9)	371 (81.2)
<b>Anterior upper jaw misalignment</b>	411 (89.9)	46 (10.1)
1-3 mm	264	
4-6 mm	138	
≥7mm	9	
<b>OCCLUSION</b>		
<b>Overjet (&gt; 4mm)</b>	270 (59.1)	187 (40.9)
<b>Negative overjet</b>	129 (28.2)	328 (71.8)
<b>Anterior open bite</b>	70 (15.3)	387 (84.7)
<b>MOLAR RELATIONSHIP</b>		
<b>Deviation from the normal molar relationship</b>	335 (73.3)	122 (26.7)
Half cusp	225	
One cusp	110	

**Table 3:** Association between Angle's classification and Dental Aesthetic Index.

	Angle's classification				Total (n=457)
	Class I (n=154)	Class II/1 (n=155)	Class II/2 (n=52)	Class III (n=96)	
<b>Dental Aesthetic Index</b>	<b>n (%)</b>				
≤25	57 (37.0)	14 (9.0)	7 (13.5)	18 (18.8)	95 (20.8)
26-30	44 (28.6)	32 (20.6)	16 (30.8)	30 (31.3)	121 (26.5)
31-35	24 (15.6)	43 (27.7)	10 (19.2)	18 (18.8)	114 (24.9)
≥35	29 (18.8)	66 (42.6)	19 (36.5)	30 (31.3)	127 (27.8)
$\chi^2 = 54.87$ $p < 0.001$					

and Class III (31.3%) ( $p < 0.001$  for each). Only 50.1% of patients with Class III malocclusion were associated with appropriate DAI scores ( $\geq 31$ ) of severity and treatment need category (Table 3).

## Discussion

Our findings in cohort of orthodontic patients revealed the presence of malocclusion in all examined patients based on Angle's classification as Class I (33.7%), Class II (45.3%) and Class III (21.0%).

Consistent with inclusion of orthodontic patients in the present study, when compared to published data on the prevalence of malocclusion determined via Angle's classification in relation to the general population of children in Turkey [24] as well as from the

other countries [14,25-28], our findings revealed lower rates for Class I (33.7%), while higher rates for Class III (21.0%) malocclusions. Differences between our results and those of other studies are most likely due to differences in the selection of subjects. Our subjects were randomly chosen from patients referred to the orthodontic clinic, whereas in the other studies the general population was evaluated. Additionally, the variations in the prevalence of malocclusions from the other studies including the patients referred to an orthodontic clinic may be due to different sample sizes or to different ethnic origins, ages, and dentition stages of the patients [29-32].

Class II malocclusion was the most prevalent malocclusion in our patients which is in agreement with data from a past study on

occlusal pattern among the general population of Central Anatolian adolescents, which revealed Class II malocclusion as the most prevalent (44.7%) malocclusion [24].

Data on DAI-based evaluation of malocclusion in the general population of children revealed inconsistent data with indication of almost two thirds of general population of children to have no abnormality or mild malocclusion with no need of treatment in some studies [28,31,32], while much higher rates for defined, severe or very severe malocclusion along with treatment requisite that ranged from 50% to 77% in others [28,33,34]. DAI based evaluation revealed normal or mild occlusion with little or no need for treatment only in 20.8% of the patients, which is considerably high, while defined malocclusion of varying severity and treatment need was evident in 79.2% of our study population. In this regard, our findings emphasize the inappropriate evaluation of treatment need in one fifth of treatment naïve patients during their initial evaluation at oral diagnostic clinics.

Anterior upper jaw misalignment (89.9%), crowding (88.2%) and increased overjet (59.1%) were the leading space and occlusion anomalies, while tooth loss (20.4%) was the least prevalent DAI component in our study population. Although these findings are in line with the available data on the general population of children aged 10-15 years [7,14,32,33,35,36], it should be noted that much higher rates for each anomaly was observed in our study population despite the similar age range (9-17 years), consistent with the fact that our study population was composed entirely of patients referred to an orthodontics clinic. Similarly in a past study [29] on the patterns of malocclusion in a sample of orthodontic patients aged 12 to 25 years, crowding in the upper and lower dental arches were reported to be the most frequent of all anomalies (70.0% and 47.3% respectively)

Additionally, when compared to the published data [1,7,14,24,29,33,37], in this study differing rates for both anterior open bite (15.3%) and increased overjet (59.1%) and negative overjet (28.2%) were noted.

In contrast to identification of normal anteroposterior molar relationship in most of the children with deviation from normal molar relationship was reported in less than one third of different populations in past studies [7,14,35,38], which was 73.3% of our patients, mostly affecting the half cusp. Notably, ancestral background of the various populations as well as premature loss or massive caries of deciduous teeth have been suggested to be associated with identification of greater frequencies of children with deviated anteroposterior molar relation [7,18,31].

The greater need for orthodontic treatment was found in our study (52.7%; DAI  $\geq 31$ ) when compared with the published data in the general population in which treatment need was reported in almost one third of subjects [7,14,22,35,36]. Likewise, in a past study concerning the need for orthodontic treatment in a school population and a group of population referring for orthodontic treatment, 38.8% of a school population whereas 83.2% of the referred population was reported to show a great need for treatment, based on the Index of Orthodontic Treatment Need (IOTN) [39]. In this regard, given the overall need for elective, highly desirable and mandatory treatment in 79.2% of our study population, our findings are in agreement with the

treatment requisite that ranged from 74% to 83.2% in various studies [39-42].

Given that some amount of the cost of orthodontic treatment has been covered by the public dental services for children up to the age of 18 years in Turkey, regardless of the normative orthodontic treatment need and consequent crowdedness in orthodontics clinics leading delay of treatment for cases with very severe malocclusion [10], identification of highly desirable or mandatory treatment need in 52.7% of our patients seems notable. Accordingly, our findings emphasize the importance of developing treatment priority indices that considers overall factors in addition to appearance in order to achieve a high standard for orthodontic treatment and reduce the waiting times and to enable allocation of limited resources with respect to treatment priority [10,39,43].

On the basis of significantly higher percentage (37%) of patients in Class I malocclusion in the category lower DAI score ( $\leq 25$ ), our findings seem to indicate similar diagnostic sensitivity of the two methods in identification of malocclusion among patients who referred to orthodontic clinics, unlike the previously suggested diagnostic sensitivity difference between the methods in the general population with identification of 50.9% of children with DAI  $\leq 25$  to have normal occlusion in Angle's classification [14].

Notably, higher percentage of Class II patients composed within the category of DAI score of  $\geq 31$  in the present study seems quite consistent with the published data in the general population [14] and indicates a good correlation between the indexes in terms of detection of severe cases.

However, it should be noted that only half of our patients (n=48) in the Class III group were associated with orthodontic treatment need in reference to DAI (DAI score  $\geq 31$ ). A similar disagreement in ranking was also reported in a past study on the comparison of two methods in the diagnosis of malocclusion which revealed that the majority of cases in Angle's Class III malocclusion were not associated with the real severity of the malocclusion in DAI scores [14].

Accordingly, on the basis of our finding that substantial portion of Angle's Class III malocclusion cases was associated with DAI-based treatment needs which were not consistent with the severity of the present problem, it can be assumed that besides lack of providing data on all occlusal traits [32,34], DAI may not be sensitive to specific occlusion problems and treatment requisite of cases in the category of Angle's Class III malocclusion and therefore may lead to neglect or delay of treatment in such cases. DAI scores neglect the tet a tet incisor relationship in Class III patients, so the majority of cases found in Angle's Class III malocclusion do not fit in the DAI distribution in the real severity of malocclusion [11,12,14].

In fact, DAI has also been reported to unable to identify malocclusion cases in its early stages due to inadequacy of the method for the deciduous and mixed dentition which hampers the prevention and early treatment. In addition, DAI fails to record certain traits that could strongly influence the treatment need such as dental midline discrepancy, impacted teeth, traumatic deep overbite, buccal cross-bite and posterior open bite [7,43,44,45]. Further modifications should be implemented in order to overcome limitations associated with severity and treatment requisite criteria of this index to be able

to propose it as an ideal instrument in the assessment of malocclusion [11,12,14].

Nonetheless, given that Angle's classification has also been associated with certain limitations based on evaluation of the positioning of teeth rather than elucidating bone and muscular aspects, and the sagittal changes disregarding the vertical or transversal alterations along with rather questionable feasibility and reliability to be used in epidemiological studies being a qualitative method and not a malocclusion quantitative index [13,14]. Our findings support the distinct characteristics of the two indexes offering an alternative method of using them in a mutually complementary manner [13,14].

## Conclusion

Our findings in a cohort of orthodontic patients revealed the presence of malocclusion in all patients based on Angle's classification and DAI score of  $\geq 31$  in 52.7% of patients suggesting severe, very severe or disabling malocclusion with highly desirable or mandatory orthodontic treatment requisite. Although DAI seems sensitive to detect the presence of Angle's classification based malocclusion, it should be improved in terms of severity and treatment requisite criteria, while the complementary use of two methods seems to be feasible in all-inclusive evaluation and care for patients with malocclusion in the clinical practice.

## References

- Mtaya M, Brudvik P, Aström AN. Prevalence of malocclusion and its relationship with socio-demographic factors, dental caries, and oral hygiene in 12- to 14-year-old Tanzanian school children. *Eur J Orthod* 2009; 31: 467-476.
- Brito DI, Dias PF, Gleiser R. Prevalence of malocclusion in children aged 9-12 years old in the city of Nova Friburgo, Rio de Janeiro state, Brazil. *Rev Dent Press OrtodOrtop Facial* 2009; 14: 118-124.
- Dhar V, Jain A, Van Dyke TE, Kohli A. Prevalence of gingival diseases, malocclusion and fluorosis in school-going children of rural areas in Udaipur district. *J Indian SocPedodPrev Dent* 2007; 25: 103-105.
- Kenealy P, Frude N, Shaw W. An evaluation of the psychological and social effects of malocclusion: some implications for dental policy making. *SocSci Med* 1989; 28: 583-591.
- Marques LS, Ramos-Jorge ML, Paiva SM, Pordeus IA. Malocclusion: Esthetic impact and quality of life among Brazilian school children. *Am J OrthodDentofacialOrthop* 2006; 129: 424-427.
- Bernabé E, Flores-Mir C, Sheiham A. Prevalence, intensity and extent of oral impacts on daily performances associated with self-perceived malocclusion in 11-12-year-old children. *BMC Oral Health* 2007; 7:6.
- Tak M, Nagarajappa R, Sharda AJ, Asawa K, Tak A, et al. Prevalence of malocclusion and orthodontic treatment needs among 12-15 years old school children of Udaipur, India. *Eur J Dent* 2013;S45-53.
- Perillo L, Masucci C, Ferro F, Apicella D, Baccetti T. Prevalence of orthodontic treatment need in southern Italian schoolchildren. *Eur J Orthod* 2010; 32: 49-53.
- Foster TD, Menezes DM. The assessment of occlusal features for public health planning purposes. *Am J Orthod* 1976; 69: 83-90.
- Nalcaci R, Demirel S, Ozturk F, Altan BA, Sokucu O, et al. The relationship of orthodontic treatment need with periodontal status, dental caries, and sociodemographic factors. *ScientificWorldJournal* 2012; 2012: 498012.
- Borzabadi-Farahani A. An insight into four orthodontic treatment need indices. *ProgOrthod* 2011; 12: 132-142.
- Borzabadi-Farahani A. A review of the evidence supporting the aesthetic orthodontic treatment need indices. *ProgOrthod* 2012; 13: 304-313.
- Angle H. Classification of malocclusion. *Dent Cosmos* 1899; 41:248-264.
- Garbin JI, Perin PCP, GarbinCaS, 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* 2010; 15: 94-102.
- World Health Organization 1989 International collaboration study of oral health outcomes (ICS II), document 2: oral data collection and examination criteria WHO, Geneva.
- World Health Organization 1997 Oral health surveys: basic methods , 4<sup>th</sup>ed ., WHO , Geneva , 47- 52.
- Wheeler TT, McGorray SP, Yurkiewicz L, Keeling SD, King GJ. Orthodontic treatment demand and need in third and fourth grade schoolchildren. *Am J OrthodDentofacialOrthop* 1994; 106: 22-33.
- Baca-Garcia A, Bravo M, Baca P, Baca A, Junco P. Malocclusions and orthodontic treatment needs in a group of Spanish adolescents using the dental aesthetic index. *Int Dent J* 2004; 54: 138-142.
- Marques CR, Couto GB, Orestes Cardoso S. Assessment of orthodontic treatment needs in Brazilian school children according to the dental aesthetic index (DAI). *Community Dent Health* 2007; 24: 145-148.
- Camilleri S, Mulligan K. The prevalence of malocclusion in Maltese school children as measured by the index of orthodontic treatment need. *Malta Med J* 2007; 19: 19-23.
- Rudan I, Campbell H, Rudan P. Genetic epidemiological studies of eastern Adriatic Island isolates, Croatia: objective and strategies. *CollAntropol* 1999; 23: 531-546.
- 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* 1994; 11: 147-151.
- Jenny J, Cons NC, Kohout FJ, Jakobsen J. Predicting handicapping malocclusion using the Dental Aesthetic Index (DAI). *Int Dent J* 1993; 43: 128-132.
- Gelgör IE, Karaman AI, Ercan E. Prevalence of malocclusion among adolescents in central anatolia. *Eur J Dent* 2007; 1: 125-131.
- Sidlauskas A, Lopatiene K. The prevalence of malocclusion among 7-15-year-old Lithuanian schoolchildren. *Medicina (Kaunas)* 2009; 45: 147-152.
- Onyeaso CO. Prevalence of malocclusion among adolescents in Ibadan, Nigeria. *Am J OrthodDentofacialOrthop* 2004; 126: 604-607.
- Silva RG, Kang DS. Prevalence of malocclusion among Latino adolescents. *Am J OrthodDentofacialOrthop* 2001; 119: 313-315.
- Abdullah MS, Rock WP. Assessment of orthodontic treatment need in 5,112 Malaysian children using the IOTN and DAI indices. *Community Dent Health* 2001; 18: 242-248.
- Celikoglu M, Akpınar S, Yavuz I. The pattern of malocclusion in a sample of orthodontic patients from Turkey. *Med Oral Patol Oral Cir Bucal* 2010; 15: e791-796.
- Sayin MO, Türkahraman H. Malocclusion and crowding in an orthodontically referred Turkish population. *Angle Orthod* 2004; 74: 635-639.
- Esa R, Razak IA, Allister JH. Epidemiology of malocclusion and orthodontic treatment need of 12-13-year-old Malaysian schoolchildren. *Community Dent Health* 2001; 18: 31-36.
- Al-Zubair NM. Orthodontic treatment need of Yemeni children assessed with dental aesthetic index. *J OrthodSci* 2014; 3: 41-45.
- Johnson M, Harkness M. Prevalence of malocclusion and orthodontic treatment need in 10-year-old New Zealand children. *AustOrthod J* 2000; 16: 1-8.
- Borzabadi-Farahani A, Eslamipour F, Asgari I. A comparison of two orthodontic aesthetic indices. *AustOrthod J* 2012; 28: 30-36.
- Shivakumar K, Chandu G, Shafiulla M. Severity of malocclusion and orthodontic treatment needs among 12-15-year-old school children of

- Davangere district, Karnataka, India. *Eur J Dent* 2010; 4: 298-307.
36. Danaei SM, Amirrad F, Salehi P. Orthodontic treatment needs of 12-15-year-old students in Shiraz, Islamic republic of Iran. *East Mediterr Health J* 2007; 13: 326-334.
37. Borzabadi-Farahani A, Borzabadi-Farahani A, Eslamipour F. Malocclusion and occlusal traits in an urban Iranian population. An epidemiological study of 11-to 14-year-old children. *Eur J Orthod* 2009; 31: 477-484.
38. Thilander B, Pena L, Infante C, Parada SS, de Mayorga C. Prevalence of malocclusion and orthodontic treatment need in children and adolescents in Bogota, Colombia. An epidemiological study related to different stages of dental development. *Eur J Orthod* 2001; 23: 153-167.
39. Uçüncü N, Ertugay E. The use of the Index of Orthodontic Treatment need (IOTN) in a school population and referred population. *J Orthod* 2001; 28: 45-52.
40. Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. *Eur J Orthod* 1989; 11: 309-320.
41. Richmond S, Roberts CT, Andrews M. Use of the Index of Orthodontic Treatment Need (IOTN) in assessing the need for orthodontic treatment pre- and post-appliance therapy. *Br J Orthod* 1994; 21: 175-184.
42. Firestone AR, Häsler RU, Ingervall B. Treatment results in dental school orthodontic patients in 1983 and 1993. *Angle Orthod* 1999; 69: 19-26.
43. 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* 1996; 24: 222-224.
44. Borzabadi-Farahani A. A review of the oral health-related evidence that supports the orthodontic treatment need indices. *ProgOrthod* 2012; 13: 314-325.
45. Manzanera D, Montiel-Company JM, Almerich-Silla JM, Gandía 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* 2010; 32:193-198.