Referral patterns of pediatric dentists and general practitioners to orthodontists based on case complexity

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Objective: The objectives of this research were to investigate and compare general and pediatric dentists' subjective judgments of orthodontic case complexity and to determine how their perceptions of case complexity influence their decisions to refer the patient to an orthodontist. **Methods:** Twenty pediatric dentists and 21 general dentists participated in the study. Pretreatment orthodontic records of 20 patients with a variety of malocclusions and a range of American Board of Orthodontics Discrepancy Index (DI) scores were used. Respondents were asked about their background and training in orthodontics. They were also asked to identify the subjective complexity of each case with the use of a 100-point visual analog scale (VAS) and whether they would refer the patient to an orthodontic specialist. A mixed-model multivariate data analysis was used to evaluate the subjective case complexity with the use of fixed factors such as DI score, type of panel member, experience, annual continuing education rate, and gender. Generalized linear mixed models were used to investigate the referral patterns of the general dentists and pediatric dentists. Level of significance was set at $P < 0.05$ for all statistical analyses. **Results:** General dentists appeared to provide more overall orthodontic treatment than pediatric dentists; many general dentists provide limited orthodontic treatment and clear aligner therapy ($P < 0.05$). The perceived complexity score for cases was not significantly different between the 2 groups ($P = 0.82$). The association between DI score and perceived complexity was similar in both groups ($P = 0.183$) and there was a high correlation between DI and VAS score in the sample ($r = 0.71$; 95% CI 0.38-0.87). Pediatric dentists had higher referral rates for cases with DI scores both below and above 20. Significant differences were noted between the pediatric and general dentists in the individual case referral decision as evaluated by the DI ($P < 0.037$) and VAS ($P < 0.042$) scores. **Conclusions:** General dentists provided more orthodontic care than the pediatric dentists. Both groups identified case complexity similarly, with only minor differences, but pediatric dentists had higher referral rates to orthodontic specialists regardless of the initial case complexity. (Am J Orthod Dentofacial Orthop 2019;156:61-6)

Assessment of a patient's orthodontic treatment need depends on the provider's expertise and level of training.[1,2] In the United States, orthodontists attend advanced education programs for 2-3 years after dental school to gain additional training on diagnosis and correction of dental and skeletal abnormalities. Given the time limitations of the undergraduate dental curriculum, exposure to orthodontic diagnosis and treatment may not be sufficient or standard across the dental schools.[3]

It is estimated that 65.1% of all orthodontic cases are treated by orthodontic specialists, 3.7% by pediatric dentists, and 31% are treated by general practitioners.[4] Other studies have shown that general practitioners are providing 20%-50% of all orthodontic treatment.[5-7] Some general dentists pursue additional orthodontic education through continuing education (CE) courses. However, much controversy exists about the general practitioner's ability to offer comprehensive expert care.[8] Another study documented that one-third of pediatric dentists provide orthodontic care, with a higher emphasis on limited treatment.[9] However, both general and pediatric dentists are dissatisfied with the

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orthodontic education they received in undergraduate dental education and during pediatric residency.[3,9-12]

General dentists graduate from dental school with limited training in orthodontic diagnosis, treatment planning, and clinical experiences, with schools providing on average 95 hours of scheduled orthodontic instruction, or <2% of the total undergraduate education.[3,13] Most dental schools do not think that their new graduates could formulate an orthodontic treatment plan and think that orthodontic undergraduate training should focus more on diagnosis and recognition of dental malocclusions than on developing a comprehensive treatment plan so that dentists would be more prepared to make appropriate referrals to a specialist.[14] Similar issues exist in pediatric dental residencies, with significant variation in the amount and nature of didactic orthodontics taught to graduate students in pediatric dentistry and an even greater variation in clinical orthodontic training.[15] Owing to the perceived lack of adequacy in dental education regarding orthodontic diagnosis and treatment, there could be a discrepancy between the ability to determine case complexity among orthodontists, general dentists, and pediatric dentists.

It has already been shown that orthodontists and orthodontic residents estimate the case complexity more accurately than general dentists and dental students.[1] However, to our knowledge, no study has investigated the differences between general and pediatric dentists in complexity assessment of orthodontic cases. Given the fact that many general practitioners and pediatric dentists are providing orthodontic care, the aim of the present study was to investigate how well general and pediatric dentists could estimate the complexity of an orthodontic case in association with the American Board of Orthodontics (ABO) Discrepancy Index (DI) score and if their perception of case complexity influences their decision to refer the patient to an orthodontist for treatment. We also evaluated a variety of other factors, such as practice history, satisfaction rate with orthodontic training received during pediatric residency or undergraduate dental education, annual orthodontic CE hours, orthodontic records taken, and types of orthodontic services provided.

MATERIAL AND METHODS

Approval for the study was granted by the Institutional Review Board of the University of Texas Health Science Center at Houston (HSC-DB-15-0486). Pretreatment orthodontic records of individuals 11-17 years of age with various malocclusions who were treated in the years 2012-2017 at the University of Texas Health Science Center at Houston School of Dentistry were screened. Pretreatment records, including extraoral and intraoral photos, panoramic radiographs, traced cephalometric radiographs with values, and digital models were used in the assessment. Patients with craniofacial anomalies, severe facial asymmetries, or who had previous orthodontic treatment were excluded. A total of 20 cases were included in the study. Case complexity was evaluated according to the ABO DI. The cases had DI scores ranging from 9 to 40; 3 had DI scores <10, 6 had DI scores of 10-20, and 11 had DI scores >20. These records were included in a web-based survey with the use of eSurvey software (eNuvo Co, Zürich, Switzerland). Two of the 20 cases were repeated in the survey to assess the repeatability of the panel members.

Forty-one panel members (56.1% male, 43.9% female) evaluated the survey. Panel members were grouped as general dentists (n = 21; 51.2%) and pediatric dentists (n = 20; 48.9%). As part of the study, the following information was collected from the panel members: practice history, satisfaction with orthodontic training received during pediatric residency or undergraduate dental education, annual orthodontic CE hours, orthodontic records taken, and types of orthodontic services provided in their practices. In addition, the participants were shown a complete set of pretreatment orthodontic records (Fig) of the 20 patients and were asked to evaluate the case complexity with the use of a computer generated 100-mm visual analog scale (VAS) ranging from 0 mm (simple) to 100 mm (difficult). They were then asked whether they would refer the case in question to an orthodontist or provide the treatment themselves.

Results were analyzed with the use of IBM SPSS Statistics for Windows (version 24; IBM Corp, Armonk, NY). Repeatability of the panel participants was evaluated by means of Cohen kappa with the use of a nominal conversion of the case-complexity scores. Characteristic differences between the 2 groups related to the practice of orthodontics were evaluated by means of Fisher exact test. Pearson correlation coefficient was used to assess the overall correlation of the average complexity score and the DI score in each panel group. Perceived complexity score change by 1 point in the DI score was estimated according to a linear regression model. A mixed-model multivariate data analysis was used to evaluate the subjective case complexity with the use of fixed factors such as DI score, type of panel member, experience, annual CE rate, and gender. The last 3 of these factors did not create any significant effects and were not included in the final model. Finally, generalized linear mixed models were used to investigate the referral patterns of the general dentists and pediatric dentists.

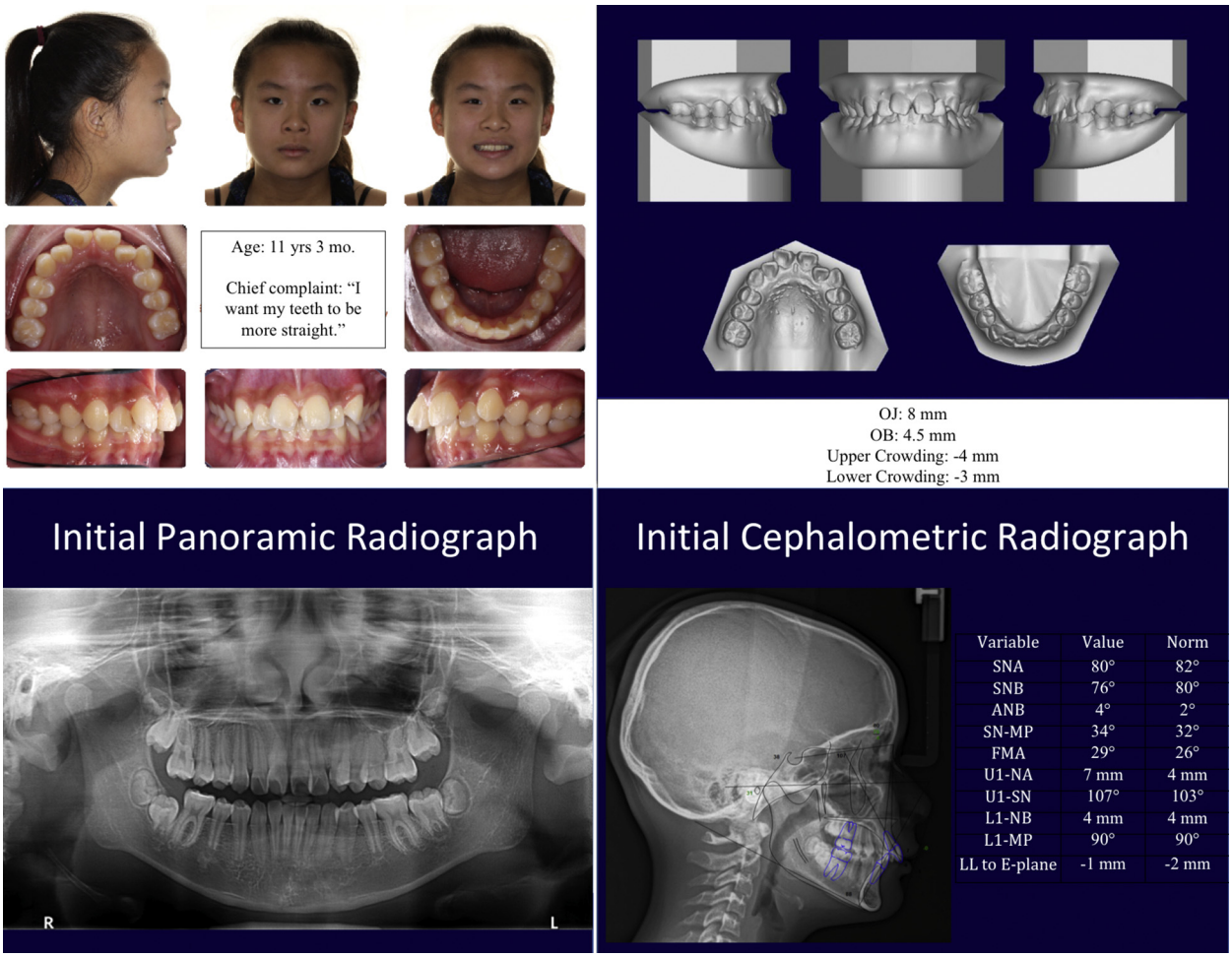

Fig. Sample of the patient records shown to panel members.

The level of significance was set at $P < 0.05$ for all statistical analyses.

RESULTS

Sample characteristics and information regarding the provider groups' orthodontic involvement is listed in Table I. According to our findings, general dentists are less satisfied with the orthodontic education received during their dental training than pediatric dentists are with the orthodontic education received during their residency program ($P < 0.05$). A higher number of general dentists attend >5 hours of orthodontic CE courses a year ($P < 0.05$). General dentists, on average, provide more orthodontic treatment than pediatric dentists, with large numbers of them providing limited orthodontic treatment and clear aligner therapy ($P < 0.05$). Pediatric dentists, however, provide significantly more limited orthodontic treatment than general dentists ($P < 0.05$). Although the number of orthodontic records obtained by the panel groups is similar, general dentists are taking more bite registrations and full-mouth series of radiographs ($P < 0.05$) for diagnostic purposes.

Repeated evaluations of the panel participants were found in the range of good repeatability ($\kappa = 0.8$; $P < 0.05$). DI score was significantly associated with perceived complexity score ($P < 0.001$). The associations between DI score and perceived complexity in the general dentist group ($r = 0.68$; 95% CI 0.32-0.86) and the pediatric dentist group ($r = 0.73$; 95% CI 0.40-0.88) were not different ($P = 0.183$). Pearson correlation coefficients indicated a high correlation between DI and VAS scores in the general sample ($r = 0.71$; 95% CI 0.38-0.87). In addition, the perceived complexity scores for cases were not different between the 2 panel groups ($P = 0.82$). According to the linear regression model, 1-point change in the DI caused 0.83 and 0.99 change

Table I. Characteristic differences between the 2 groups

Characteristic	Pediatric dentists	General dentists	P
n	20	21	
Years in practice			0.08
<20	11 (55%)	6 (28%)	
>20	9 (45%)	15 (72%)	
Satisfaction with orthodontic training	49.50%	10%	0.02*
Annual orthodontic CE hours			0.03*
0-5	12 (60%)	9 (43%)	
>10	8 (40%)	12 (57%)	
Pretreatment records taken			
Cephalometric radiograph	10 (50%)	6 (29%)	0.2
Panoramic radiograph	19 (95%)	17 (81%)	0.3
Extraoral and intraoral photos	15 (75%)	20 (95%)	0.09
Full mouth series of radiographs	6 (30%)	18 (86%)	<0.001*
Impressions	16 (80%)	21 (100%)	0.04*
Bite registration	9 (45%)	19 (90%)	0.003*
None of the above	1 (5%)	0 (0%)	0.4
Types of orthodontic services			
Full braces	6 (30%)	8 (38%)	0.7
Limited orthodontic treatment	19 (95%)	14 (67%)	0.04*
Clear aligner therapy	2 (10%)	15 (71%)	<0.001*

*$P < 0.05$.

Table II. Referral decisions of the panel group according to DI

Cases	Pediatric dentists	General dentists	Total
DI < 20 (n = 9)	81.1%	62.4%	71.5%
DI ≥ 20 (n = 11)	88.6%	72.7%	80.5%

in the general and pediatric dentist groups' perceived complexity scores, respectively.

Table II presents the percentage of referrals to an orthodontist when the DI score was below and above 20. It appears that pediatric dentists made more referrals than general dentists in both categories. The last part of our analysis was based on a generalized linear mixed model for the evaluation of DI and VAS scores' effects on the referral decision. With each 1-point increment in DI ($P < 0.001$) and VAS ($P < 0.001$), the odds ratio for the referral decisions increased significantly in the entire panel group. However, significant differences were noted between pediatric and general dentists in the individual case referral decision as evaluated by the DI ($P < 0.037$) and VAS ($P < 0.042$) scores. This could be explained by the higher referral rate of pediatric dentists compared with general dentists as mentioned above.

DISCUSSION

The rationale of the current study was the thought that initial evaluation of an orthodontic case comprising standard patient records might be an important step to consider referring the case to an orthodontist. Because the ABO DI has been shown to be a reliable and objective tool to measure pretreatment case complexity,[16] subjective assessments of general and pediatric dentists were evaluated in accordance with DI. Thus the relationship between perceived case complexity and associated referral patterns of general practitioners and pediatric dentists were investigated.

According to the results, general dentists expressed only a 10% satisfaction rate with their undergraduate orthodontic training, and pediatric dentists expressed a 49.5% satisfaction rate with their orthodontic education during their pediatric residency. This finding was in agreement with previously published studies.[3,9-12] Owing to the perceived dissatisfaction with orthodontic education in dental school and pediatric residency, many general dentists and pediatric dentists seek CE to help increase their knowledge and skill in orthodontics.[17] The present study reflected this trend, with both pediatric and general dentists taking some hours of CE in orthodontics per year; 57% of the general dentists, however, took >10 hours of CE per year in orthodontics, whereas only 40% of the pediatric dentists took >10 hours of CE per year in orthodontics. Interestingly, previous studies have shown that orthodontic graduate students only begin to make appropriate treatment planning decisions after 10-16 months of full-time study and begin to be able to control mechanics after 18-24 months based on one-on-one instruction.[8] Orthodontic residency programs include a minimum of 3700 hours of training, whereas fellowship in the Academy of General Dentistry requires a total of 500 hours of CE over 10 years, and mastership requires only 600 hours beyond that. Most think that it is not realistic to claim that the specialty of orthodontics can be learned entirely through continuing education.[8]

Large numbers of both pediatric and general dentists provide comprehensive orthodontic treatment, including banded or bonded orthodontic appliances, to treat Class I, II, or III malocclusions.[4,18-20] Other studies have shown that pediatric dentists most commonly treat the primary and early-mixed dentitions, followed by the late-mixed and permanent dentitions.[21] One study estimated that 55% of pediatric dentists

provided at least limited orthodontic treatment, 35% provided comprehensive treatment, and 11% provided no treatment.[9] The literature lacks updated reports, especially from the past decade, about the percentage of general and pediatric dentists providing orthodontics. In this study we found that 95% of the pediatric dentists provide limited orthodontic treatment. However, it appeared that general dentists are providing less limited treatment but more comprehensive-type treatment. In 2013, Align Technologies reported an approximate number of 40,000 Invisalign providers. More than 20,000 of these were general dentists practicing in the United States.[22] In the present study, 71% of the general dentists reported facilitating clear aligner use in their practices. Therefore, it is possible that the reported percentage of general dentists providing comprehensive orthodontic treatment in our study would increase even more when general dentists providing clear aligner therapy were added in the same category.

Perception assessment could be an arduous and difficult task. We chose to use VAS for this purpose because the feasibility of the tool in health-related and social studies[23-26] is already established. In orthodontic diagnosis and treatment planning, the use of DI[1,16,27-30] is commonly regarded as a reliable and objective tool in measuring pretreatment complexity. There is a generalized consensus among clinicians that the greater the DI, the greater the case complexity due to the larger numbers of target disorders present, such as crowding, increased overjet, etc.[27] Our results were in agreement with these findings as subjective VAS evaluation of a case by 2 different groups of dental professionals reflected the objective DI measurement from the same case harmoniously. However, this finding should be interpreted carefully. Even though there was no significant difference between the general and pediatric dentists, for each point increase in DI score, pediatric dentists showed a slightly better estimate of the case complexity. Furthermore, this finding only means that general and pediatric dentists had a similar assessment of orthodontic case complexity but not necessarily a thorough one.

Our study shows that pediatric dentists had a higher referral rate to orthodontists for cases that present with DI scores both below and above 20, with 81.1% referring cases with DI scores <20, and 88.6% referring cases with DI scores ≥ 20. Only 62.4% of the general dentists referred cases with DI scores <20, and 72.7% referred cases with DI scores ≥ 20. Nearly 30% of general dentists chose not to refer the case to an orthodontist even if the DI score was >20. These referral decisions were also evident in a generalized linear mixed model for the evaluation of DI and VAS scores' effects on the referral decision. With 1-point increments in DI ($P < 0.001$) and VAS ($P < 0.001$), odds ratios for the referral decisions increased significantly in the whole panel group, but there were significant differences between the pediatric and general dentists in the individual case referral decision as evaluated by the DI ($P < 0.037$) and VAS ($P < 0.042$) scores. These results indicate that both the pediatric dentists and general dentists were more likely to refer a case to an orthodontist for treatment if there was an increase in DI or VAS, or perceived case complexity. However, the referral rate by pediatric dentists was higher than that of general dentists, because the general dentists were more likely to treat the cases themselves. These results were in agreement with a previous study that showed that pediatric dentists had lower cutoff points for indicated treatment need than general dentists and were more likely to refer patients to an orthodontist sooner.[2] Even though almost 30% of the general dentists chose not to refer cases with DI scores >20, 72.7% chose to refer them. Similarly, Aldawood et al reported that general dentists refer the majority of more complex cases to orthodontic specialists.[31] Another study, by Jackson et al,[32] found that half of general dentists appropriately recognized malocclusions requiring referral to an orthodontic specialist, but only 20% were able to correctly identify the timing of the referral.

Within the limitations of the current study, we were able to identify some discontent related to the orthodontic training experience of general practitioners and pediatric dentists. Despite the observed trends, both provider groups provide some form of orthodontic treatment. It might be helpful to implement some changes in undergraduate and pediatric residency dentistry programs with particular emphasis on case complexity and importance of case referral in challenging circumstances. Further research could be done to analyze how general or pediatric dentists would choose to treat a case if they chose not to refer it, to gain a better picture of the orthodontic treatment provided in our country by nonorthodontists.

CONCLUSIONS

- General dentists provide more overall orthodontic treatment in the forms of full-fixed and clear aligner therapy, whereas pediatric dentists provide more limited treatment.
- General and pediatric dentists are able to assess case complexity similarly.
- Although point-based increments in both subjective and objective assessments of case complexity increased the odds of referring the case to an

orthodontist in both groups, pediatric dentists had a generally higher referral rate than general dentists.

REFERENCES

1. Heath E, English JD, Johnson CD, Swearingen EB, Akyalcin S. Perceptions of orthodontic case complexity among orthodontists, general practitioners, orthodontic residents, and dental students. Am J Orthod Dentofacial Orthop 2017;151:335-41.
2. Berk NW, Bush HD, Cavalier J, Kapur R, Studen-Pavlovich D, Sciote J. Perception of orthodontic treatment needs: opinion comparisons of orthodontists, pediatric dentists, and general practitioners. J Orthod 2002;29:287-91.
3. Christensen GJ. Orthodontics and the general practitioner. J Am Dent Assoc 2002;133:369-71.
4. Wolsky SL, McNamara JA. Orthodontic services provided by general dentists. Am J Orthod Dentofacial Orthop 1996;110:211-7.
5. Marques L, de Freitas N, Pereira L, Ramos-Jorge M. Quality of orthodontic treatment performed by orthodontists and general dentists. Angle Orthod 2012;82:102-6.
6. Jacobs RM, Bishara SE, Jakobsen JR. Profiling providers of orthodontic services in general dental practice. Am J Orthod Dentofacial Orthop 1991;99:269-75.
7. Vicéns J, Russo A. Comparative use of Invisalign by orthodontists and general practitioners. Angle Orthod 2010;3:425-34.
8. Smith RJ. General practitioners and orthodontics. Am J Orthod Dentofac Ortho 1987;92:169-72.
9. Hilgers K, Redford-Badwal D, Reisine S. Orthodontic treatment provided by pediatric dentists. Am J Orthod Dentofacial Orthop 2003;124:551-60.
10. Roberts WE. Reflecting on the orthodontic educational development symposium. Am J Orthod Dentofacial Orthop 1997;111:110-5.
11. Kwo F, Orellana M. The current state of predoctoral orthodontic education in the United States. J Dent Educ 2011;75:518.
12. Purmal K, Alam M, Nor N, Zakaria N. Orthodontic treatment by the general dental practitioners and their opinion about orthodontics. Int Med J 2013;20:243-6.
13. Brightman BB, Hans MG, Wolf GR, Bernard H. Recognition of malocclusion: an education outcomes assessment. Am J Orthod Dentofacial Orthop 1999;116:444-51.
14. Rock WP, O'Brien KD, Stephens CD. Orthodontic teaching practice and undergraduate knowledge in British dental schools. Br Dent J 2002;192:347-51.
15. Moyers R. Quality assurance in orthodontics. Am J Orthod Dentofacial Orthop 1990;97:3-9.
16. Vu CQ, Roberts WE, Hartsfield JK Jr, Ofner S. Treatment complexity index for assessing the relationship of treatment duration and outcomes in a graduate orthodontics clinic. Am J Orthod Dentofacial Orthop 2008;133:9.e1-13.
17. Togoo RA. Assessment of general dental practitioners' proficiency in diagnosing various simple to moderate malocclusions. Int J Contemp Dent 2013;4:15-8.
18. Koroluk DD, Jones JE, Avery DR. Analysis of orthodontic treatment by pediatric dentists and general practitioners in Indiana. J Dent Child 1988;55:97-101.
19. Foley P. Survey of orthodontic treatment performed by dental practitioners who are not specialists in orthodontics. Thesis, Department of Orthodontics, Saint Louis University; 1988.
20. Galbreath RN, Hilgers KK, Silveira AM, Scheetz JP. Orthodontic treatment provided by general dentists who have master's level in the academy of general dentistry. Am J Orthod Dentofacial Orthop 2006;129:678-86.
21. Aldrees A, Tashkandi NE, AlWanis AA, AlSanouni MS, Al-Hamlan NH. Orthodontic treatment and referral patterns: a survey of pediatric dentists, general practitioners, and orthodontists. Saudi Dent J 2015;27:30-9.
22. Dimatteo A. The straight story on orthodontics in the general practice. Inside Dentistry; 2007.
23. Reips UD, Funke F. Interval-level measurement with visual analogue scales in internet-based research: VAS generator. Behav Res Methods 2008;40:699-704.
24. Miller MD, Ferris DG. Measurement of subjective phenomena in primary care research: the visual analogue scale. Family Pract Res J 1993;13:15-24.
25. Clarke PRF, Spear FG. Reliability and sensitivity in the self-assessment of well-being. Bull Br Psych Soc 1964;17:55.
26. Maxwell C. Sensitivity and accuracy of the visual analogue scale: a psycho-physical classroom experiment. Br J Clin Pharm 1978;6:15-24.
27. Cangialosi T, Riolo M, Owens S, et al. The ABO Discrepancy Index: a measure of case complexity. Am J Orthod Dentofacial Orthop 2004;125:270-8.
28. Campbell CL, Roberts WE, Hartsfield JK Jr, Qi R. Treatment outcomes in a graduate orthodontic clinic for cases defined by the American Board of Orthodontics malocclusion categories. Am J Orthod Dentofacial Orthop 2007;132:822-9.
29. Deguchi T, Honjo T, Fukunaga T, Miyawaki S, Roberts WE, Takano-Yamamoto T. Clinical assessment of orthodontic outcomes with the peer assessment rating, discrepancy index, objective grading system, and comprehensive clinical assessment. Am J Orthod Dentofacial Orthop 2005;127:434-43.
30. Pulfer RM, Drake CT, Maupome G, Eckert GJ, Roberts WE. The association of malocclusion complexity and orthodontic treatment outcomes. Angle Orthod 2009;79:468-72.
31. Aldawood S, Ampuan SN, Medara N, Thomson WM. Orthodontic treatment provision and referral preferences among New Zealand general dental practitioners. Aust Orthod J 2011;27:145-54.
32. Jackson OA, Cunningham SJ, Moles DR, Clark JR. Orthodontic referral behaviour of West Sussex dentists. Br Dent J 2009;207(9):E18.