

Aesthetic perception and factors associated with dentofacial midline awareness

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Aims: To examine orthodontic patients' aesthetic perception and factors likely to influence the detection of a dentofacial midline discrepancy.

Methods: An electronic questionnaire was designed to invite an orthodontic population to evaluate and select an ideal value, a detectable value and a tolerable value from a series of images exhibiting a dentofacial midline discrepancy. A binary logistic regression analysis was performed to evaluate possible influencing factors.

Results: A barely discernable dentofacial midline discrepancy ranged between -0.020 ± 0.38 mm. The personal characteristics of the evaluators appeared to have no appreciable effect at this level. A detectable value was 1.33 ± 0.63 mm and the education level, orthodontic history and malocclusion severity were influencing factors amongst the assessors. A tolerable value was 2.63 ± 0.94 mm and influencing factors included the education level and the malocclusion severity of the evaluators.

Conclusion: The barely discernable value, detectable value and tolerable value could be used to quantify the aesthetic perception of orthodontic patients regarding a dentofacial midline discrepancy. The aesthetic perception was influenced by observer education level, orthodontic history and personal malocclusion severity, but not by age, gender, and subjective evaluation of dentofacial appearance.

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Introduction

The coincidence between dental midline and facial midline has been stressed as an important feature of an aesthetic smile. An early study¹ showed that a dentofacial midline discrepancy was common and reported an incidence of approximately 30%. A slight dental midline deviation is often difficult to detect and attracts minimal attention. A greater midline deviation is readily identified as it usually occurs in dental or skeletal malocclusions involving facial asymmetry. The noticeable midline discrepancy not only affects facial appearance, but may herald dysfunction of the stomatognathic system. Consequently, a dentofacial

midline discrepancy is considered an important factor in orthodontic diagnosis and treatment planning. However, restoring dental and facial midline coincidence may not always be successful using conventional orthodontic treatment. Orthodontists may spend a great deal of clinical time and effort without improvement noticed or appreciated by the patient. Therefore, significant value would be provided by a determination of the level of dental midline deviation which can be detected and deemed acceptable by orthodontic patients.

While there have been past attempts to establish an evaluation standard, an aesthetic appreciation of

dental midline deviation is subjective and difficult to quantify. Orthodontists have been significantly less tolerant of dental midline deviations compared with laypeople,²⁻⁴ with the acceptance and tolerance by dentists in between. There has been no general agreement in relation to the level of dental midline deviation considered acceptable.⁵⁻⁹ Personal differences exist due to different backgrounds of evaluators related to gender, nationality, profession, and facial type. According to past research into dentofacial midlines, uncertainty and therefore controversy exists regarding the assessment of facial midline.¹⁰ The evaluation of a dental midline may be complicated if other midline facial structures are not well aligned.

The present study focused on the aesthetic perceptions of orthodontic patients regarding the detection of a dentofacial midline discrepancy through a series of full-face photographs exhibiting dental midline deviation. To quantitatively and systematically describe dentofacial variation, the aesthetic evaluation was explored from three levels: from an ideal value, a detectable value and a tolerable or acceptable value. The possible influencing factors governing aesthetic perception were also evaluated.

Materials and methods

A female model, aged 24, was selected for this study. The subject exhibited no discernible dentofacial asymmetry, dental abnormality, frontal deformity, or trauma. A frontal facial photograph was taken while the subject was seated in natural head position with a posed smile. The photographic distance was set at 1.5 metres and the camera placed at the same level as the subject's eyes. The captured digital photograph was edited using Adobe Photoshop CS3 software and Magic Morph 1.95b software to achieve a symmetrical average facial picture¹¹ (Figure 1). The dentition in the original image was removed and replaced by an axial symmetrical image of an individual normal occlusion, which was computer generated to coincide the dental midline with the facial midline. The image magnification was calculated as 0.7. A series of images was subsequently produced (Figure 2) which depicted increasing deviation of the upper dental midline by 0.5 mm, 1.0 mm, 1.5 mm, 2.0 mm, 2.5 mm, 3.0 mm, 3.5 mm, 4.0 mm, 4.5 mm and 5.0 mm, both to the right and to the left.

An electronic questionnaire was designed in Microsoft

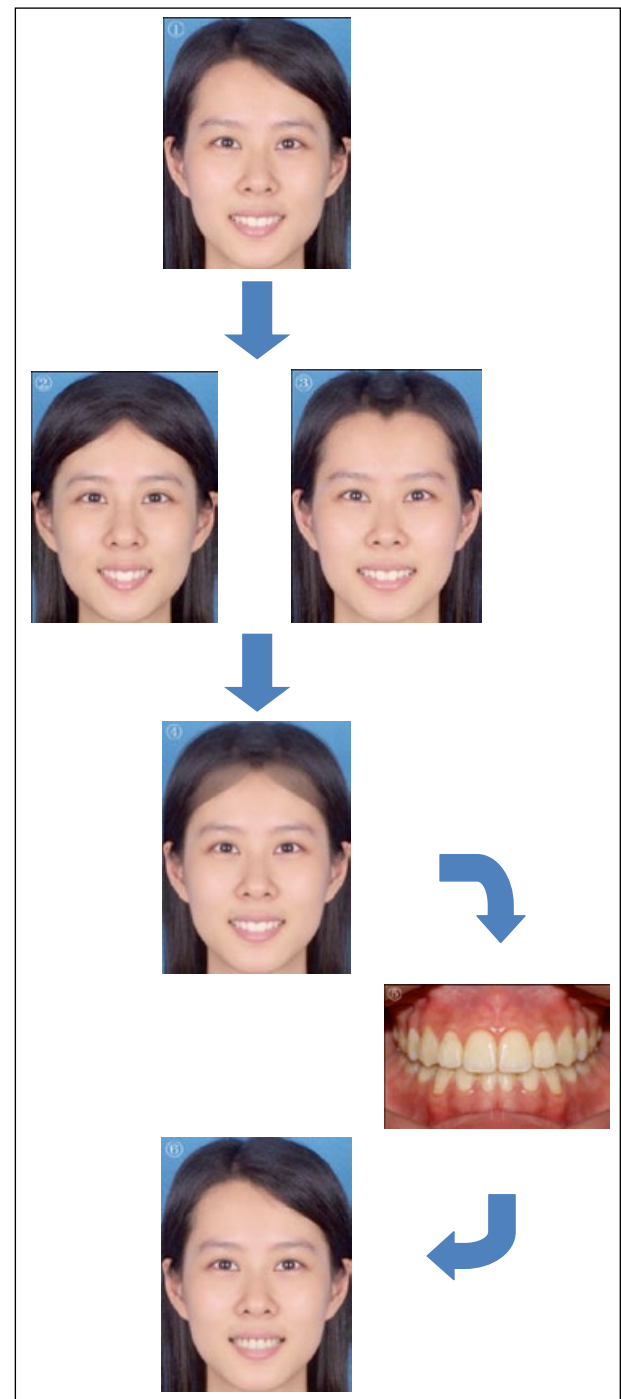


Figure 1. The process of making the symmetrical averaged model. (1) Original image; (2) Left-left face; (3) Right-right face; (4) Symmetrical averaged face; (5) Symmetrical individual normal occlusion and (6) Final image.

Visual Studio 2008 and C # language and composed of two sections: 1) A basic information survey (Figure 3) which included personal information of each evaluator related to age, gender, education level, marital status, orthodontic history and subjective

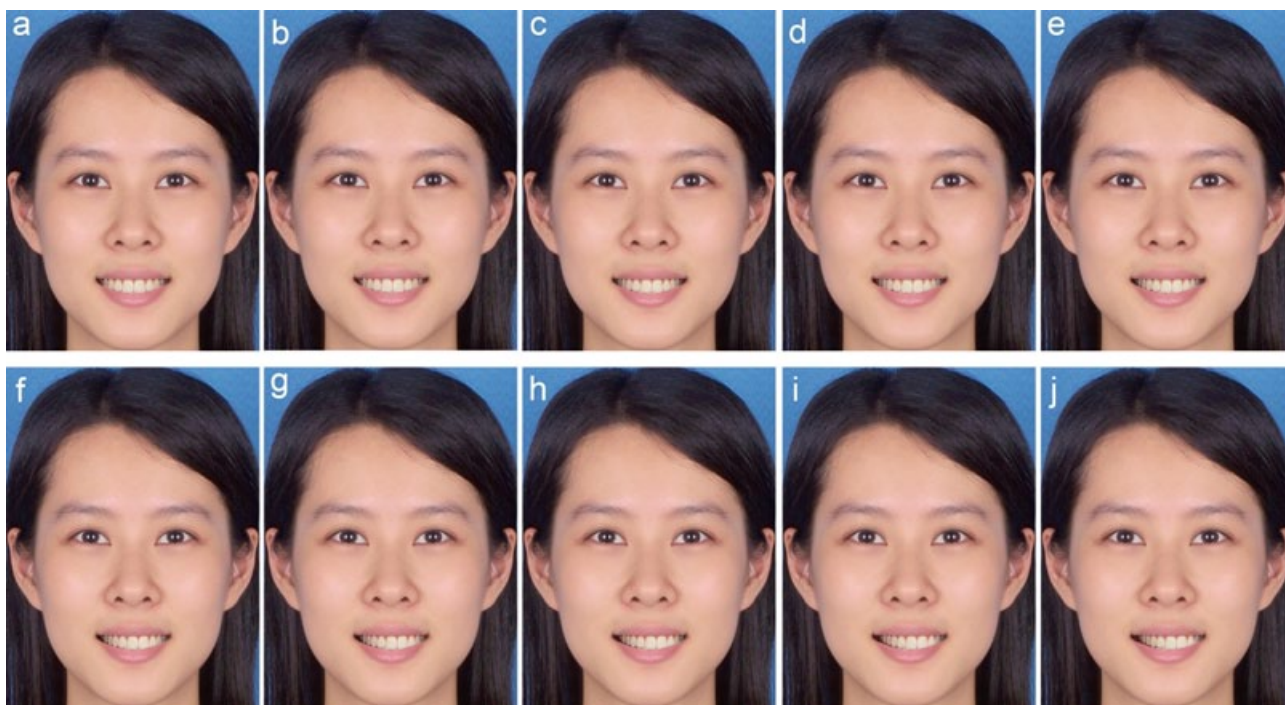


Figure 2. Schematic diagram of the images with quantitative dentofacial midline discrepancy to the left. Deviation distance (a: 0.5 mm; b: 1.0 mm; c: 1.5 mm; d: 2.0 mm; e: 2.5 mm; f: 3.0 mm; g: 3.5 mm; h: 4.0 mm; i: 4.5 mm; j: 5.0 mm)

evaluation of their dentofacial appearance; 2) a survey of aesthetic perception of dentofacial midline discrepancy (Figures 4-6) which involved three questions asked according to the protocol described by Ker et al.⁸ The series of images with quantitative dental midline deviation was shown to the evaluators. The computerised movement of a slide bar or the pressing of an icon under the picture would sequentially alter the image. To answer question 1, the evaluators were required to press the icon continuously until a detectable disharmony was observed between dental and facial midlines. In question 2, participants were further instructed to select the most attractive image by moving the slide bar from left to right. In question 3, the initial images were defined by the answer to question 1, and the evaluators were required to again press the icon continuously until each considered the midline discrepancy in the images was unacceptable. In so doing, the facial images selected in answer to the three questions were considered a detectable value, an ideal value and a tolerable value, respectively.

The investigation recruited orthodontic patients from Guanghua School of Stomatology, Hospital of Stomatology, SunYat-sen University who participated as the evaluators. All were asked to answer the

electronic questionnaire anonymously. The inclusion criteria were: 1) patients who had received orthodontic treatment on their own initiative or those with the desire for orthodontic treatment; 2) over 12 years of age, with a junior high school education level or above; 3) without cognitive disorders; 4) without experience of dental study or work; 5) and patients who took a voluntary and active part in the investigation and who provided informed consent. The procedures were in accordance with the ethical standards of the responsible committee on human experimentation at Sun Yat-sen University. Each of the evaluators underwent a dental clinical examination by three experienced orthodontists who assessed the malocclusion severity according to the Index of Orthodontic Treatment Need (IOTN).¹² A mild malocclusion was included under IOTN Treatment Grade 1 and 2, a moderate malocclusion under Grade 3, while Grades 4 and 5 defined a severe malocclusion. According to an average IOTN score, the evaluators were divided into three groups defined by their malocclusion severity.

The questionnaire data were collected and SPSS13.0 software used for statistical description and hypothesis testing (the level of significance was 2-sided $\alpha = 0.05$) of the ideal value, the detectable value and the

Part 1 Basic information

Name:

Age:

Gender: ☐ Male ☐ Female

Education level: ☐ Middle school and below ☐ High school ☐ University and above

Marital status: ☐ Married ☐ Unmarried

Orthodontic history: ☐ With ☐ Without

What do you think about your dentofacial appearance?

☐ Excellent ☐ Good ☐ General ☐ Insufficiency ☐ Poor

What do your friends or relatives think about your dentofacial appearance?

☐ Excellent ☐ Good ☐ General ☐ Insufficiency ☐ Poor

Next

Figure 3. The user interface for basic information survey.

Part 2

Question 1: Please press the button to select the first image that you find inconsistency between dental and facial midline.

Go back Next

Figure 4. The user interface for the investigation of the detectable value.

Part 2

Question 2: Please move the slider to select the image you find to be most attractive.

Go back Next

Figure 5. The user interface for the investigation of the ideal value.

Part 2

Question 3: Please press the button to select the first image that you find unacceptable.

Go back Next

Figure 6. The user interface for the investigation of the tolerable value.

tolerable value. A binary logistic regression analysis was applied to explore possible influencing factors. The independent variables assessed included the evaluators' age, gender, education level, orthodontic history and subjective evaluation of dentofacial appearance, as well as malocclusion severity. The detectable value and the tolerable value of dentofacial midline discrepancy were taken as the dependent variables, respectively.

Results

A total of 222 orthodontic patients who met the inclusion criteria participated in the survey. The evaluators aged from 12 to 39 years (mean age of 19.9 years), including 81 teenagers and 141 young adults (18 years old and above). Ninety-nine participants were males (44.6%) and 123 were females (55.4%).

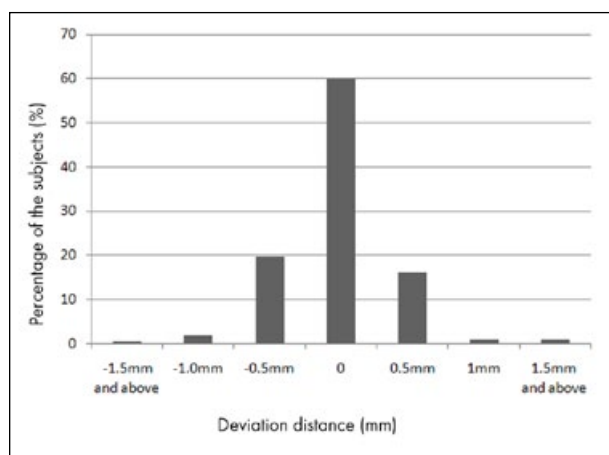
The sample distribution and associated factors are shown in Table I.

Orthodontic patients' aesthetic perceptions of a dentofacial midline discrepancy were evaluated according to the three levels and the means and standard deviations are presented in Table II. There were no significant differences ($p > 0.05$) between right and left deviations in the detectable value and the tolerable value in the two independent samples rank sum test. Therefore, the average value of the right and left deviations was calculated as the final result. The mean thresholds for the detectable value and the tolerable value were 1.33 ± 0.63 mm and 2.63 ± 0.94 mm.

The ideal value of dentofacial midline discrepancy was -0.02 ± 0.38 mm (negative value indicated left deviation, positive value indicated right deviation). Nearly 60% of the evaluators chose the 0 mm picture

Table I. Sample distribution of the potential related factors for dentofacial midline discrepancy and the statistical values of the rank sum test for the ideal value.

Factor	Category	N	Ideal value	
			Mean rank	<i>p</i>
Age	Adolescence	81	105.16	0.21
	Adult	141	115.07	
Gender	Male	99	113.96	0.56
	Female	123	109.52	
Education level	Middle school and below	59	105.48	0.33
	High school	47	105.65	
	University and above	116	116.93	
Orthodontic history	Without orthodontic history	40	116.98	0.50
	With orthodontic history	182	110.30	
Self-evaluation of dentofacial aesthetics	Excellent/Good	49	114.12	0.62
	General	77	115.12	
	Insufficiency/Poor	96	107.26	
Dentofacial aesthetic evaluation by others	Excellent/Good	49	109.13	0.86
	General	91	113.97	
	Insufficiency/Poor	82	110.18	
Malocclusion severity	Mild	50	120.35	0.42
	Moderate	106	107.54	
	Severe	66	111.15	

**Figure 7.** Distribution of the ideal value to dentofacial midline discrepancy.

(no deviation) as their preferred option. Ninety-six per cent of evaluators selected an ideal value in the range of $-0.5 \sim +0.5$ mm (Figure 7). The results of the Wilcoxon rank sum test and Kruskal-Wallis test determined that non-significant factors were found in the evaluation of the ideal value (Table I).

Detailed information regarding the independent and dependent variables in the binary logistic regression analysis is shown in Table III. Variables with $p < 0.05$ were included in the logistic regression model (forward stepwise procedure). After controlling for the impact of confounding factors, the logistic regression analysis (Tables IV and V) showed that the education level ($p = 0.001$, odds ratio [OR] = 0.56), orthodontic history ($p = 0.048$, OR = 0.46) and the malocclusion severity of the participants ($p = 0.007$, OR = 1.72) were the influencing factors related to midline discrepancy detection. The tolerable value was influenced by factors associated with the level of participant education ($p < 0.001$, OR = 0.47) and their malocclusion severity ($p = 0.042$, OR = 1.50). (The odds ratio [OR] is a measure of effect size which describes the strength of an association or non-independence between two binary data values. It is used as a descriptive statistic and plays an important role in logistic regression).

The logistic regression equations were therefore:

$$Y_1 = 1.83 - 0.57X_3 - 0.77X_4 + 0.54X_7$$

$$Y_2 = 1.14 - 0.77X_3 + 0.41X_7$$

Table II. The ideal value, detectable value and tolerable value of orthodontic patients' aesthetic perception of dentofacial midline discrepancy (mm).

	Left		Right		Average		Median	<i>p</i>
	Mean	SD	Mean	SD	Mean	SD		
Ideal value	-	-	-	-	-0.020	0.38	0	-
Detectable value	1.40	0.77	1.26	0.66	1.33	0.63	1.25	0.086
Tolerable value	2.70	1.08	2.55	0.93	2.63	0.94	2.50	0.203

Negative value means left deviation, and positive value means right deviation. The average of the detectable value and tolerable value has been taken as the absolute value before amalgamation.

Statistically significant at $p < 0.05$

Table III. Category and valuation of the possible related factors for dentofacial midline discrepancy.

Variable	Related factor	Category and valuation
X_1	Age	Adolescence (1); Adult (2)
X_2	Gender	Male (1); Female (2)
X_3	Education level	Middle school and below (1); High school (2); University and above (3)
X_4	Orthodontic history	Without orthodontic history (1); With orthodontic history (2)
X_5	Self-evaluation of dentofacial aesthetics	Excellent/Good (1); General (2); Inadequate/Poor (3)
X_6	Dentofacial aesthetic evaluation by others	Excellent/Good (1); General (2); Inadequate/Poor (3)
X_7	Malocclusion severity	Mild (1); Moderate (2); Severe (3)
Y_1	Detectable value	< Median (0); > Median (1)
Y_2	Tolerable value	< Median (0); > Median (1)

Scores for categorical parameters in the parenthesis

Table IV. Binary logistic regression analysis for the detectable value of dental midline deviation.

Related factor	β	S.E.	Wald χ^2	df	<i>p</i>	OR	95% C.I.	
							Lower	Upper
Education level	-0.57	0.18	10.75	1	0.001	0.56	0.40	0.79
Orthodontic history	-0.77	0.39	3.92	1	0.048	0.46	0.22	0.99
Malocclusion severity	0.54	0.20	7.30	1	0.007	1.72	1.16	2.55
Constant	1.83	0.92	3.93	1	0.047	6.23		

Table V. Binary logistic regression analysis for the tolerable value of dental midline deviation.

Related factor	β	S.E.	Wald χ^2	df	<i>p</i>	OR	95% C.I.	
							Lower	Upper
Education level	-0.77	0.18	18.61	1	0.000	0.47	0.33	0.66
Malocclusion severity	0.41	0.20	4.15	1	0.042	1.50	1.02	2.22
Constant	1.14	0.58	3.90	1	0.048	3.12		

Discussion

Facial midline and symmetrical averageness

Absolute symmetry of the craniofacial region does not exist but is considered an essential requirement of facial beauty. Research has determined that facial asymmetry is common even in normally-featured people.^{10,13} Bidra et al.¹⁰ revealed that anatomic landmarks used to determine the facial midline were not co-linear. It was suggested that an assessment of facial midline was affected by different landmarks which introduced different perspectives and added to the debate regarding the definition of the facial midline. Accordingly, there have been no unified criteria for facial midline assessment in past research and so comparison has been uncertain. Facial asymmetry can also affect the evaluation of appearance and becomes a confounding and misleading influence in the aesthetic evaluation of dental midline deviation.

In order to obtain an absolutely symmetrical face, the present study adopted the method of symmetrical averaging to create the model subject picture. The original image was bisected along its perpendicular axis to obtain two halves by the use of computer image processing software. Each half face was horizontally flipped and joined with its original to produce two pictures comprising 'left-left' and 'right-right' faces. Two completely different symmetrical faces were therefore obtained. This computer-generated face is usually less attractive and less accepted by lay people compared with natural faces.¹⁴ Hence the step of computer 'averaging' was performed after the 'symmetry' generation process. The 'averaging' did not affect the symmetry of the image, and the final facial result has been widely accepted as more attractive by the public.^{15,16} The effect of facial asymmetry and the uncertainty in determining the facial midline was eliminated in the absolutely symmetrical averaged face.

The evaluation levels of a dentofacial midline discrepancy and their correlation

The value considered ideal indicated the level of symmetry of a highly attractive face. Symmetry was considered to be an important factor in determining facial aesthetics.¹⁵ A three-dimensional measurement of cranio-maxillofacial structures of attractive people found that the facial symmetry in this group was significantly higher than in the general population.¹⁷

In the present study, nearly 60% of the evaluators chose 0 mm as the ideal value which represented no dentofacial midline discrepancy and up to 95.95% chose the value ranging from -0.5 to 0.5 mm (Figure 3). The evaluators' choice of the ideal value was not affected by their personal characteristics (Table I). Consistency of dentofacial midline unsurprisingly proved to be appreciated by laypeople, perhaps because symmetry of dental midline is a requirement of facial aesthetics, but also in the function and health of stomatognathic system.

A detectable value was defined as the degree to which a dentofacial midline discrepancy was definitely noticed by the evaluators. Previous research^{2,5} has indicated that 2 mm was a threshold value of detection and acceptability. In the present study, the acceptable level of deviation was 1.33 mm. A possible explanation for the difference might be the different population and characteristics of the evaluators. Published research usually involved the general public as evaluators, while the evaluators in the present study were orthodontic patients who may have been biased because their own dental aesthetic perceptions were higher. The greater awareness could result in a lower detectable value.¹⁸

The tolerable value was the maximum dental midline discrepancy which an evaluator considered acceptable. Studies have focused on a tolerable value, but results have been conflicting. Ker et al.⁸ reported that the publicly acceptable range of maxillary midline to face midline deviation was 2.9 mm. After studying 120 individuals, including orthodontists, general dentists, orthodontic patients, and parents of patients, Beyer et al.³ described the mean threshold for acceptable dental midline deviation as 2.2 ± 1.5 mm. Pinho et al.⁴ discovered that although a tolerable value of dental midline deviation among orthodontists was 1.0 mm, laypeople were often not aware of a 4 mm deviation. In the present study, a tolerable level of dental midline deviation was 2.6 mm. This result was close to the average value of Chinese people reported as 2.4 mm by Zhang et al.⁷ Other results varied according to the respective model, calculating methods, statistic methods and cultural background of the evaluators.

Based on clinical experience, it is known that a desire for treatment is usually strong if a dentofacial midline discrepancy exceeds a tolerable value. Such patients can be easily satisfied by orthodontic treatment. A case with a dentofacial midline discrepancy higher than a detectable value and lower than a tolerable

value is considered a borderline case, because the dentofacial midline discrepancy can be noticed but is still acceptable. If a dentofacial midline discrepancy is lower than a detectable level, its influence on facial appearance may not be obvious. In these circumstances, orthodontic treatment is not required. However, it has been reported that a tolerable value and a detectable value between dentists and patients were not consistent.^{2,3,18} Therefore, this factor should be taken into consideration in treatment planning.

The factors which influence aesthetic perception of a dentofacial midline discrepancy

The characteristics of individual evaluators require consideration when aesthetic determinations are being made. According to the result of the Binary Logistic regression analysis, the education level ($OR < 1$) of a participant was one of three factors which influenced detection and tolerance of a dentofacial midline discrepancy. Participants with a higher level of education tended to have reduced detectable and tolerable levels. Previous research¹⁹ has shown that patients or their parents with a higher level of education had a stronger desire for orthodontic treatment. Since this group of patients may have higher expectations and may request extensive treatment, orthodontists should be aware and obtain treatment planning consent.

An orthodontic history ($OR < 1$) was a second factor which affected the detectable level of discrepancy. The detectable value of patients with past orthodontic experience was significantly less than of those without previous orthodontic exposure. One explanation might be found in the dental awareness of patients undergoing orthodontic treatment. With resolution of the chief complaint, the patient's dental aesthetic concern could be transferred to other areas, such as a dental midline deviation. Alternatively, according to Pinho et al.⁴ and Janson et al.²⁰ orthodontists were more sensitive than patients regarding a dental midline discrepancy. The aesthetic perception of patients to dentomaxillofacial disharmony could be changed by orthodontists during orthodontic treatment. Therefore, attention should be given to the difference in aesthetic expectations when communicating. It is recommended that orthodontists avoid instilling their ideal treatment goal into patients and pursue an impractical outcome.

An objective assessment of the malocclusion severity ($OR > 1$) also had an impact on the aesthetic perception of dentofacial midline discrepancy. The more serious the malocclusion, the higher the detectable value and the tolerable value of the dentofacial midline discrepancy. Patients with a malocclusion, likely and unconsciously, compared themselves with the displayed images during testing. A patients' self-image possibly played an important role in decision-making. Studies^{21,22} have shown that a malocclusion influenced an individual's aesthetic perception and social consciousness, particularly in teenagers, who were not sufficiently mature to overcome the influential effect caused by negative comments from others. Those with a mild degree of malocclusion in the present study, had higher demands on dental aesthetics and were more sensitive to changes in the dentofacial midline. Orthodontics is often categorised under Aesthetic Medicine which has a higher incidence of body dysmorphic disorder (BDD).^{23,24} Therefore, orthodontists should be able to recognise patients with a predisposition of BDD in clinical practice, as the problems encountered may not be solved by orthodontic treatment alone.

Orthodontics is a combination of science and art, which requires clinicians to have aesthetic cognitive abilities and a sound knowledge of psychology in addition to high professional skills.

Conclusion

The results of the present study may be useful in the early prediction of a patient's cognitive ability and aesthetic expectations through a clinical examination and a midline symmetry assessment. These will assist the orthodontist to set reasonable goals and adopt a treatment plan in response to a patient's need.

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References

1. Miller EL, Bodden WR Jr, Jamison HC. A study of the relationship of the dental midline to the facial median line. *J Prosthet Dent* 1979; 41:657-60.
2. Johnston CD, Burden DJ, Stevenson MR. The influence of dental to facial midline discrepancies on dental attractiveness ratings. *Eur J Orthod* 1999;21:517-22.
3. Beyer JW, Lindauer SJ. Evaluation of dental midline position. *Semin Orthod* 1998;4:146-52.
4. Pinho S, Ciriaco C, Faber J, Lenza MA. Impact of dental asymmetries on the perception of smile esthetics. *Am J Orthod Dentofacial Orthop* 2007;132:748-53.
5. Cardash HS, Ormanier Z, Laufer BZ. Observable deviation of the facial and anterior tooth midlines. *J Prosthet Dent* 2003; 89:282-5.
6. Thomas JL, Hayes C, Zawaideh S. The effect of axial midline angulation on dental esthetics. *Angle Orthod* 2003;73:359-64.
7. Zhang YF, Xiao L, Li J, Peng YR, Zhao ZH. Young people's esthetic perception of dental midline deviation. *Angle Orthod* 2010;80:515-20.
8. Ker AJ, Chan R, Fields HW, Beck M, Rosenstiel S. Esthetics and smile characteristics from the layperson's perspective: a computer-based survey study. *J Am Dent Assoc* 2008;139:1318-27.
9. McLeod C, Fields HW, Hechter F, Wiltshire W, Rody W Jr, Christensen J. Esthetics and smile characteristics evaluated by laypersons: a comparison of Canadian and US data. *Angle Orthod* 2011;81:198-205.
10. Bidra AS, Uribe F, Taylor TD, Agar JR, Rungruangnunt P, Neace WP. The relationship of facial anatomic landmarks with midlines of the face and mouth. *J Prosthet Dent* 2009;102:94-103.
11. Rhodes G. The evolutionary psychology of facial beauty. *Annu Rev Psychol* 2006;57:199-226.
12. Proffit WM, Fields HW. *Contemporary Orthodontics*, 4th ed. Mosby, 2006:17-21.
13. Farkas LG, Cheung C. Facial asymmetry in healthy North American Caucasians. An anthropometrical study. *Angle Orthod* 1981; 1:70-7.
14. Zaidel DW, Deblieck C. Attractiveness of natural faces compared to computer constructed perfectly symmetrical faces. *Int J Neurosci* 2007;117:423-31.
15. Baudouin JY, Tiberghien G. Symmetry, averageness, and feature size in the facial attractiveness of women. *Acta Psychol (Amst)* 2004;117:313-32.
16. Rhodes G, Yoshikawa S, Clark A, Lee K, McKay R, Akamatsu S. Attractiveness of facial averageness and symmetry in non-western cultures: in search of biologically based standards of beauty. *Perception* 2001;30:611-25.
17. Yang B, Huang HZ, Zhang DS. Aesthetic evaluation of craniofacial architecture in 20 adults. *Chin J Med Aesth & Cosmet* 2002;8:178-81.
18. Witt M, Flores-Mir C. Laypeople's preferences regarding frontal dentofacial esthetics: periodontal factors. *J Am Dent Assoc* 2011;142:925-37.
19. Yin L, Chen WJ, Lu SL, Yu J, Zheng L, Yu XZ. A survey of the difference of orthodontic demand and its related factors between dentists and 16 to 22-year-old people. *J Pract Stomatol* 2011;27:58-62.
20. Janson G, Branco NC, Fernandes TM, Sathler R, Garib D, Lauris JR. Influence of orthodontic treatment, midline position, buccal corridor and smile arc on smile attractiveness. *Angle Orthod* 2011;81:153-61.
21. Agou S, Locker D, Streiner DL, Tompson B. Impact of self-esteem on the oral-health-related quality of life of children with malocclusion. *Am J Orthod Dentofacial Orthop* 2008; 134:484-9.
22. Hassan AH, Amin Hel-S. Association of orthodontic treatment needs and oral health-related quality of life in young adults. *Am J Orthod Dentofacial Orthop* 2010;137:42-7.
23. Hepburn S, Cunningham S. Body dysmorphic disorder in adult orthodontic patients. *Am J Orthod Dentofacial Orthop* 2006;130:569-74.
24. Polo M. Body dysmorphic disorder: a screening guide for orthodontists. *Am J Orthod Dentofacial Orthop* 2011;139:170-3.