Original Article

Comparative evaluation of esthetic perception of black spaces in patients with mandibular incisor extraction

Matheus Melo Pithon[a]; Adrielle Mangabeira Santos[b]; Felipe Santos Couto[c]; Lívia Maria Andrade de Freitas[a]; Raildo da Silva Coqueiro[d]

ABSTRACT

Objective: To evaluate the degree of perception of laypersons, dental professionals, and students with regard to the esthetics of the smile in cases of mandibular incisor extractions with the presence of black spaces between them.

Materials and Methods: Changes were made to a front-view intraoral photograph of occlusion treated by means of a mandibular incisor extraction, simulating various configurations of black spaces between mandibular incisors. For this purpose, a specific image manipulation program was used (Photoshop CS3). After digital manipulation the photographs were printed on photographic paper and attached to a questionnaire and distributed to laypersons, dental professionals, and students (n = 90). To evaluate the degree of esthetics, an attractiveness scale was used, in which a score of 0 would represent ''hardly attractive,'' 5 ''attractive,'' and 10 ''very attractive.'' The differences between examiners were checked using the Mann-Whitney test. All of the statistics were performed with a confidence level of 95%.

Results: The results demonstrated that dentistry professionals, students, and laypersons were capable of identifying cases with and without black spaces. In all groups evaluated, with the increase in black spaces the scores assigned were statistically lower ($P < .05$).

Conclusions: It could be concluded that black spaces occurring after mandibular incisor extraction had a negative repercussion on dental esthetics for the dentist, the dental student, and the layperson. (*Angle Orthod.* 2012;82:806–811.)

KEY WORDS: Incisors; Gingiva; Extraction

INTRODUCTION

The architecture of a pleasant smile plays a fundamental role in facial attractiveness and esthetics and performs an important function in terms of the individual's nonverbal communication and self esteem.[1] The capacity to analyze and recognize the morphological requisites that interfere with and influence dental and facial esthetics is governed by various esthetic peculiarities, among them the relationship between bone and soft tissues as well as harmony between the teeth.[2,3]

The demands made by society with regard to appearance, such as the perception of facial esthetics and particularly self-perception, have direct consequences on the field of dentistry. Orthodontics follows specific guidelines that make diagnosis and planning feasible in planning treatment, although the concepts that qualify and quantify beauty are based on subjective questions.

Precise diagnosis and, consequently, correct formulation of the treatment plan presents a high degree of difficulty and complexity.[4,5] When defining the treatment plan, a significant percentage of cases involving malocclusion (for example, discrepancies between the sizes of teeth and maxilla and discrepancies between the bony bases) rely on therapy that involves extractions.[6]

[a] Professor, Southwest Bahia University UESB, Bahia, Brazil.
[b] Student of Dentistry, Southwest Bahia University UESB, Bahia, Brazil.
[c] Graduate in Information Systems, State University of Southwest Bahia UESB, Bahia, Brazil.
[d] Professor of Epidemiology Center for Studies in Aging, State University of Southwest Bahia UESB, Bahia, Brazil.
Corresponding author: Matheus Melo Pithon, PhD, Professor, Department of Orthodontics, University Federal of Rio de Janeiro (UFRJ), Avenida Otavio Santos 395 sala 705, Vitória da Conquista, Bahia 45020750, Brazil
(e-mail: matheuspithon@gmail.com)

Accepted: January 2012. Submitted: October 2011.
Published Online: February 21, 2012

The routinely extracted teeth are the first premolars, second premolars, and molars, in this order. Mandibular incisor extraction is a less common treatment option.[7,8] Mandibular incisor extraction, however, involves a region of easy visual access and offers results that may have negative repercussions when the extractions are performed in an undue manner. The appearance of black spaces is the most common esthetic complication in cases involving mandibular incisor extraction; these black spaces compromise interdental gingival esthetics. Thus, the aim of this study was to evaluate the degree of perception of laypersons, dental professionals, and dental students with regard to the esthetics of the smile in cases involving mandibular incisor extractions with the presence of black spaces between them.

MATERIALS AND METHODS

To conduct this study a frontal intraoral photograph of a patient—a girl aged 16 years and 10 months with normal occlusion—was used. The photograph used was taken with a digital camera (10 Megapixels; Canon Rebel XTI, Japan), resulting in some images in which only the gingival tissue and the teeth could be visualized. The real photograph was manipulated with the aid of a computer program, Adobe Photoshop CS3 software (Adobe Systems Inc, San Francisco, CA); however, we maintained the maxillary arch without any modification.

The changes in the photograph were made in the region of the antero-inferior arch of the image with various compositions of differently sized black spaces. With the intention of simulating the extraction of the mandibular right central incisor, the crown and the gingival curvature was removed as a result of the presence of its respective root. Six images were obtained with and without the presence of black spaces in increased proportions: one image without the presence of black spaces and the others with the presence of black spaces measuring 0.5 mm, 1.0 mm, 1.5 mm, 2.0 mm, and 2.5 mm in size (Figure 1). All of the images presented the teeth with mandibular alignment.

Prior sample size calculation was performed, which resulted in the distribution of a questionnaire to 87 individuals in each group. The images were numbered, randomly printed on photographic paper, and attached to a questionnaire and distributed to laypersons, dental professionals, and students ($n = 90$). On a second sheet, the distribution of the same images was altered; they were renumbered and attached to the same questionnaire to evaluate the degree of reliability of the answers given by the evaluators in the first round of evaluation. The images were individually printed on additional sheets (in order to be evaluated individually), and we provided a scale of attractiveness, in which 0 would represent ''hardly attractive,'' 5 ''attractive,'' and 10 ''very attractive.'' All of the evaluators were advised not to compare the images on different sheets. The evaluation time interval for each image was limited to 60 seconds.

Statistical Procedures

The frequencies of the answers given by the dentistry professionals, students, and laypersons were compared by means of the chi-square test. In cases in which the expected frequency was less than five (5), the Fisher's exact test was used. The scores of grades awarded to each photograph were compared by means of the Kruskal-Wallis test, and comparisons between pairs were performed using the Mann-Whitney test. The means of grades awarded to each photograph were calculated in each group in order to determine the Spearman correlation coefficients to evaluate the similarity between the perceptions of the dental professionals, students, and laypersons. The level of significance adopted was 5% ($\alpha = .05$). The data were tabulated and analyzed in the statistical program BioEstat (version 5.0, Belém-PA, Brazil).

RESULTS

Table 1 shows the demographic data of the study participants. Of the 90 individuals, 58.9% were men, and the majority of participants (75.6%) fell into the 16 to 30–year age range.

All of the dentistry professionals, students, and laypersons who participated in the study were able to note the differences between the photographs presented in image 1 and image 2. Table 2 presents the perception of the research participants with respect to the preferences with regard to the images presented. The data related to image 1 showed that there was no statistical difference in the proportions among the groups regarding the most and least preferred photograph. In general, photographs F and A were identified by the great majority as being the best and worst, respectively. For image 2, no significant difference in the frequencies among groups was found either, photograph A being elected as the best and photograph F as the worst.

The means of scores attributed to each image are shown in Table 3. Image A was scored as the most attractive by the three groups, whereas image F was ranked as the least attractive. None of the images presented a significant difference in the scores between the groups.

Table 4 shows the correlations between the mean scores given to images by the components of the three groups. Perfect correlations were found for the scores

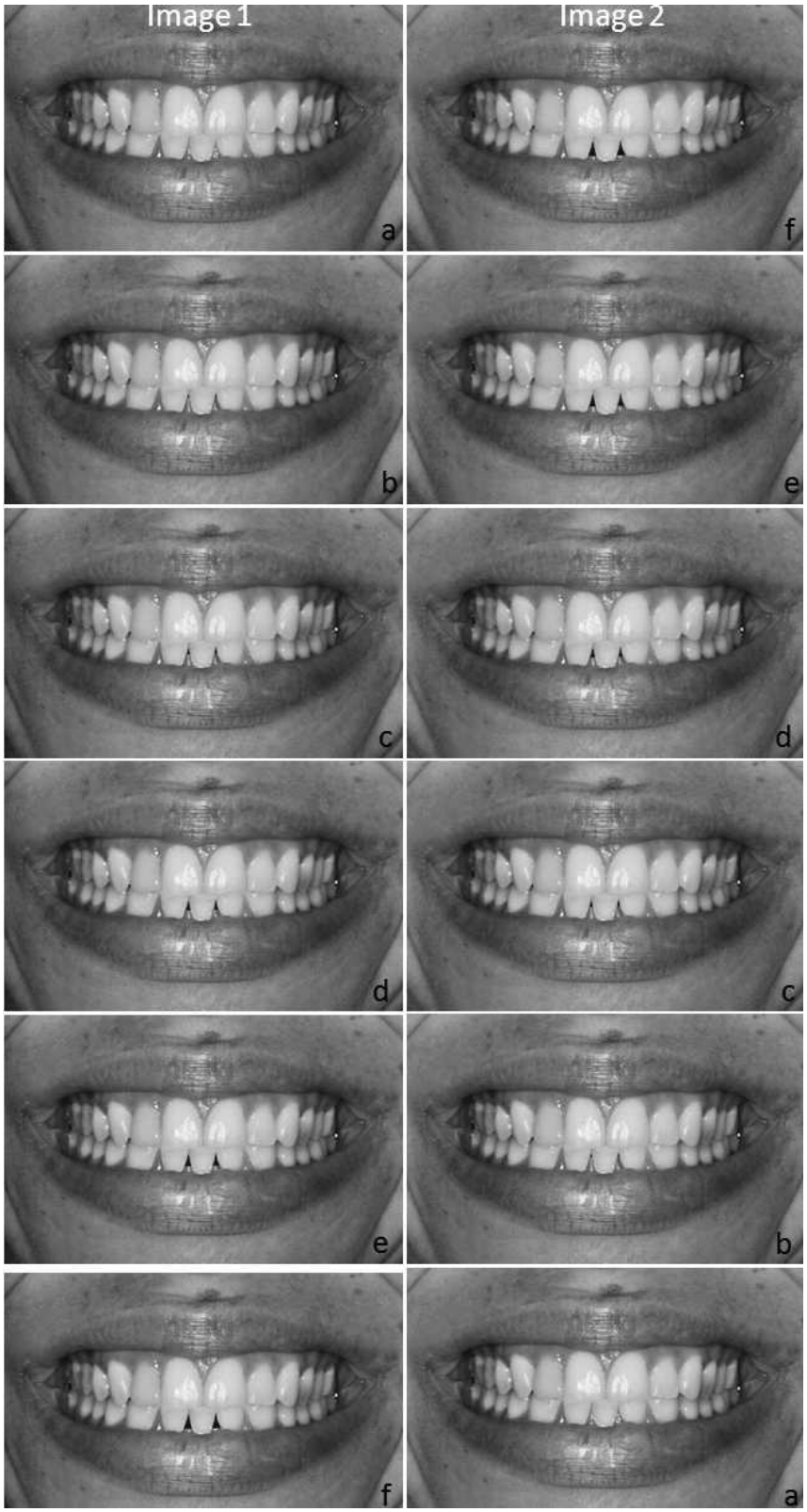

Figure 1. Modified images evaluated. (a) Without black spaces and with (b) black space of 0.5 mm; (c) black space of 1 mm; (d) black space of 1.5 mm; (e) black space of 2.0 mm; and (f) black space of 2.5 mm.

Table 1. Demographic Data of Study Participants in Groups

Characteristics	Dentistry Professionals (%) (n = 90)	Dentistry Students (%) (n = 90)	Laypersons (%) (n = 90)
Sex			
Male	51 (56.7)	54 (60.0)	54 (60.0)
Female	39 (43.3)	36 (40.0)	36 (40.0)
Age group			
16–30 y	48 (53.3)	87 (96.7)	69 (76.7)
31–45 y	27 (30.0)	3 (3.3)	21 (23.3)
>45 y	15 (16.7)	0 (0.0)	0 (0.0)

among the dentistry professionals, students, and laypersons.

DISCUSSION

Tooth extraction therapy is commonly used in cases of malocclusions in which discrepancies are presented between tooth sizes and the maxilla and the mandible, as well as between discrepant bony bases.[9] However, some authors[10–12] suggest that the removal of a mandibular incisor could solve tooth crowding problems, in addition to providing superior post-treatment stability, when compared with that offered in cases involving premolar extractions.

Treatment with mandibular incisor extraction is not a popular technique in orthodontics because of its apparent disadvantages (eg, increase in overbite, overlap, reopening of the extraction space, unsatisfactory posterior occlusion, recurrence of mandibular crowding, and loss of esthetics of the interdental papilla).[13,14] The risk of gingival retraction in the extraction region occurs mainly in regions that present thin gingiva and bone loss in interproximal contact, triangular-shaped incisors, roots with divergent orientations, and presence of periodontal diseases.[15] On the other hand, some authors[10,16,17] have indicated that this treatment option provides advantages, such as maintenance of intercanine distance, considerable reduction in treatment time, and a stronger possibility of achieving long-term stability.

As a result of innumerable controversies related to this treatment procedure in the area of orthodontics, the purpose of the present study was to evaluate the perception with regard to the esthetics obtained in cases involving the presence of black spaces after therapies involving the extraction of mandibular incisors for the correction of malocclusion (when comparing it with the perception involved in a case without the presence of black space). No study with this same proposal was found in the literature, so that the results found here are unprecedented.

The method consisted of using an image manipulation program to modify a front-view photograph of a smile, in which the patient presented normal occlusion with the presence of all the teeth. Once in possession of the manipulated photographs, an album was mounted and attached to a questionnaire that was passed on to dentists, dentistry students, and laypersons.

Table 2. Perception of the Participants With Regard to Differences and their Preferences With Regard to the Images Presented

	Image 1			
Answers	Dentistry Professionals (%)	Dentistry Students (%)	Laypersons (%)	*P*-Value
Image I, like most				
A	0 (0.0)	3 (3.3)	3 (3.3)	.372
B	0 (0.0)	0 (0.0)	0 (0.0)	
C	0 (0.0)	3 (3.3)	3 (3.3)	
D	0 (0.0)	0 (0.0)	0 (0.0)	
E	3 (3.3)	9 (10.0)	15 (16.7)	
F	87 (96.7)	75 (83.3)	69 (76.7)	
Image I, like least				
A	84 (93.3)	87 (96.7)	81 (90.0)	.912
B	3 (3.3)	0 (0.0)	3 (3.3)	
C	3 (3.3)	3 (3.3)	0 (0.0)	
D	0 (0.0)	0 (0.0)	0 (0.0)	
E	0 (0.0)	0 (0.0)	3 (3.3)	
F	0 (0.0)	0 (0.0)	3 (3.3)	
		Image 2		
Image I, like most				
A	87 (96.7)	75 (83.3)	78 (86.7)	.715
B	3 (3.3)	6 (6.7)	6 (6.7)	
C	0 (0.0)	6 (6.7)	3 (3.3)	
D	0 (0.0)	3 (3.3)	3 (3.3)	
E	0 (0.0)	0 (0.0)	0 (0.0)	
F	0 (0.0)	0 (0.0)	0 (0.0)	
Image I, like least				
A	0 (0.0)	0 (0.0)	0 (0.0)	.326
B	0 (0.0)	0 (0.0)	0 (0.0)	
C	0 (0.0)	0 (0.0)	0 (0.0)	
D	0 (0.0)	3 (3.3)	0 (0.0)	
E	6 (6.7)	0 (0.0)	0 (0.0)	
F	84 (93.3)	87 (96.7)	90 (100.0)	

The methodology of the research conducted in this study was based on previous studies found in the literature,[18–24] in which the results of possible treatments with orthodontic intervention were evaluated by means of modifications in photographs with the use of image-editing programs.

The use of computer programs that enable manipulation of the structures that compose the face allows for analysis of the degree of influence of certain morphological structures on facial and dental esthetic composition. However, identifying the problem and the form of treatment to choose so that the disposition of teeth can be corrected presents some complex particularities.

Table 3. Mean Grades (Standard Deviation) of the Photographs Awarded by the Dentistry Professionals, Dentistry Students, and Laypersons[a]

Photograph	Dentistry Professionals	Dentistry Students	Laypersons	*P*-Value
Image A	7.61 (1.69)	7.70 (1.64)	8.00 (1.56)	.516
Image B	6.65 (1.93)	6.61 (2.03)	7.12 (1.72)	.590
Image C	5.81 (1.84)	5.75 (1.79)	5.97 (1.88)	.860
Image D	5.40 (1.90)	5.11 (1.72)	4.93 (2.29)	.548
Image E	4.85 (1.95)	4.32 (1.63)	4.24 (2.24)	.398
Image F	3.49 (1.92)	3.04 (1.98)	2.96 (2.30)	.479

[a] The scores of grades were compared by means of the Kruskal-Wallis test.

Recently a great deal attention has been paid to the perception of laypersons and dentistry professionals with regard to esthetic evaluations,[3,18,22,25] which are of fundamental importance in both the treatment to be performed.

The results of our study indicated that all of the individuals who evaluated the photographs were able to note the differences between them, demonstrating the risk to soft tissue arising from incisor extraction treatment, with consequent results that directly harm esthetics to a perceptibly high degree.

The participants' results were shown to be unanimous when they elected the image on the basis of attractiveness, as represented in Table 2. Thus, the image that presented the largest-sized black space was considered the worst result. This demonstrates the extent of the extreme relevance the gingival papilla has in the composition of structures that govern the esthetics of the smile. The results of the means of evaluation among the participants in the study shown in Table 3 indicate that image A was ranked as the most attractive, with means of 7.61 and 7.70 among the dentistry professionals and students, respectively, and with a mean of 8.00 among the laypersons. Image F, however, was ranked as the least attractive, with means of 3.49 and 3.04 among the dentistry professionals and students, respectively, and a mean of 2.96 among the laypersons. These results represent a perfect correlation between the evaluated individuals, as demonstrated in Table 4.

These results reaffirm that when establishing a treatment plan, the risks and benefits must be evaluated, since the professional in the area of orthodontics plays the role of providing both function and esthetics in the periodontal health of the smile, as studies[26] have demonstrated that the presence of black space after this therapy may be reported in up to 40% of cases in adolescent patients.

Table 4. Spearman's Coefficient of Correlation of the Mean Grades for the Photographs

	$r_{Spearman}$	$r_{Spearman}$
Group of Participants	Dentistry Students	Laypersons
Dentistry professionals	1.00*	1.00*
Dentistry students	1.00	1.00*

*$P < .001$ (two-tailed).

Based on this study, it could be proved that black space was perceptible to the three groups evaluated. This reflects on the choice of procedure to be performed, leading the professional to opt for a treatment that does not alter the esthetics and harmony of the smile, considering that periodontal health also fits in among the goals of the orthodontist.

CONCLUSION

- Black spaces after mandibular incisor extraction had negative repercussions with regard to dental esthetics for the dentist, the dental student, and the layperson alike. In addition, the option for central incisor extraction should always be discarded when there are other treatment options available.

REFERENCES

1. Eli I, Bar-Tal Y, Kostovetzki I. At first glance: social meanings of dental appearance. *J Public Health Dent*. 2001;61:150–154.
2. Kepic TJ, O'Leary TJ, Kafrawy AH. Total calculus removal: an attainable objective? *J Periodontol*. 1990;61:16–20.
3. Jornung J, Fardal O. Perceptions of patients' smiles: a comparison of patients' and dentists' opinions. *J Am Dent Assoc*. 2007;138:1544–1553.
4. Shaw WC. Factors influencing the desire for orthodontic treatment. *Eur J Orthod*. 1981;3:151–162.
5. Espeland LV, Stenvik A. Perception of personal dental appearance in young adults: relationship between occlusion, awareness, and satisfaction. *Am J Orthod Dentofacial Orthop*. 1991;100:234–241.
6. Proffit WR. Forty-year review of extraction frequencies at a university orthodontic clinic. *Angle Orthod*. 1994;64:407–414.
7. Gottlieb EL, Nelson AH, Vogels DS III. 1996 JCO Study of orthodontic diagnosis and treatment procedures. Part 2. Breakdowns of selected variables. *J Clin Orthod*. 1996;30:689–698.
8. Dacre JT. The long term effects of one lower incisor extraction. *Eur J Orthod*. 1985;7:136–144.
9. Bernstein L, Edward H. Angle versus Calvin S. Case: extraction versus nonextraction. Historical revisionism. Part II. *Am J Orthod Dentofacial Orthop*. 1992;102:546–551.
10. Canut JA. Mandibular incisor extraction: indications and long-term evaluation. *Eur J Orthod*. 1996;18:485–489.
11. Daher W, Caron J, Wechsler MH. Nonsurgical treatment of an adult with a Class III malocclusion. *Am J Orthod Dentofacial Orthop*. 2007;132:243–251.
12. Riedel RA, Little RM, Bui TD. Mandibular incisor extraction—postretention evaluation of stability and relapse. *Angle Orthod*. 1992;62:103–116.

13. Faerovig E, Zachrisson BU. Effects of mandibular incisor extraction on anterior occlusion in adults with Class III malocclusion and reduced overbite. *Am J Orthod Dentofacial Orthop*. 1999;115:113–124.
14. Riedel RA. A review of the retention problem. *Angle Orthod*. 1960;30:179–199.
15. Kurth JR, Kokich VG. Open gingival embrasures after orthodontic treatment in adults: prevalence and etiology. *Am J Orthod Dentofacial Orthop*. 2001;120:116–123.
16. Valinoti JR. Mandibular incisor extraction therapy. *Am J Orthod Dentofacial Orthop*. 1994;105:107–116.
17. Kokich VG, Shapiro PA. Lower incisor extraction in orthodontic treatment. Four clinical reports. *Angle Orthod*. 1984;54:139–153.
18. Kokich VO, Kokich VG, Kiyak HA. Perceptions of dental professionals and laypersons to altered dental esthetics: asymmetric and symmetric situations. *Am J Orthod Dentofacial Orthop*. 2006;130:141–151.
19. Thomas JL, Hayes C, Zawaideh S. The effect of axial midline angulation on dental esthetics. *Angle Orthod*. 2003; 73:359–364.
20. Parekh S, Fields HW, Beck FM, Rosenstiel SF. The acceptability of variations in smile arc and buccal corridor space. *Orthod Craniofac Res*. 2007;10:15–21.
21. Wolfart S, Brunzel S, Freitag S, Kern M. Assessment of dental appearance following changes in incisor angulation. *Int J Prosthodont*. 2004;17:150–154.
22. Moore T, Southard KA, Casko JS, Qian F, Southard TE. Buccal corridors and smile esthetics. *Am J Orthod Dentofacial Orthop*. 2005;127:208–213; quiz 261.
23. Parekh SM, Fields HW, Beck M, Rosenstiel S. Attractiveness of variations in the smile arc and buccal corridor space as judged by orthodontists and laymen. *Angle Orthod*. 2006;76:557–563.
24. Beyer JW, Lindauer SJ. Evaluation of dental midline position. *Semin Orthod*. 1998;4:146–152.
25. Abu Alhaija ES, Al-Shamsi NO, Al-Khateeb S. Perceptions of Jordanian laypersons and dental professionals to altered smile aesthetics. *Eur J Orthod*. 2010;32:1–7.
26. Burke S, Burch JG, Tetz JA. Incidence and size of pretreatment overlap and posttreatment gingival embrasure space between maxillary central incisors. *Am J Orthod Dentofacial Orthop*. 1994;105:506–511.