Research Article

Comparative evaluation of smile attractiveness in various orthodontic treatment modalities- A cross-sectional study

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ABSTRACT

Background: Smile plays a significant role in facial attractiveness and social interactions. The present study aimed to evaluate the smile attractiveness in subjects treated with extraction or non-extraction orthodontic treatment modality.

Materials and Methods: Frontal smiling photographs of 100 orthodontically treated subjects with an age range of 16-25 years were taken and divided into two groups each having 50 subjects. Group I (ANB 0° to 4°) was subdivided into cases treated with extraction (group Ia) and without extraction (group Ib). Similarly, Group II (ANB > 4°) was subdivided into cases treated with extraction (group IIa) and without extraction (group IIb). Smile esthetics and esthetic scores were assessed on frontal smile photographs by using different smile variables objectively and with the help of raters (10 laypersons,10 dental graduates, and 10 orthodontists) subjectively.

Results: In extraction cases, the esthetic scores of dental practitioners and orthodontists were higher than in cases of non-extraction. Between extraction and non-extraction cases, laypeople had no esthetic preference. In Skeletal class I, smile variables such as the arch form index, smile arc and maxillary incisor show had a higher value in extraction cases however, the buccal corridor was more in non-extraction cases. In Skeletal Class II, smile variables such as the maxillary incisor show and arch form index were more in extraction cases and exposure of mandibular teeth was more in non-extraction cases. Judgement given by the raters was mainly based on maxillary incisor show, number of teeth displayed, and buccal corridor ratio. In orthodontic patients treated with and without the extraction, statistically non-significant variations in smile esthetics and esthetic scores were found.

Conclusion: Thus, a decision regarding the extraction of teeth in orthodontic patients should not be solely based on smile esthetics but other factors which determine extraction should be considered.

KEYWORDS: Extraction, Non-extraction, Smile, Facial esthetics, Orthodontic treatment

INTRODUCTION

A smile is an important feature of facial appearance since attention is drawn mostly toward the eyes and mouth during social interaction.[1,2] It is an untutored form of human communication that has been learned by humans as part of evolution.[3] Facial beauty is enriched by a smile, which also portrays the qualities and virtues of one's personality.[4] A smile is an important part of social interaction that projects a variety of positive emotions, such as happiness, approval, and humour. Psychological studies have shown that the way a person is treated by others is factored in to a large extent, by the facial attractiveness of the person.[5] The circle of attractiveness extends to every sphere of one's life from home to school. It can affect teacher–student and student–peer relations as well as academic achievement.[6] Individuals who are better looking, tend to succeed more than unattractive individuals with regard to perceived job qualifications, decisions of hiring and future career successes.[7] Thus, a visually pleasing smile can improve a person's self-esteem in social situations.[8]

The interpretation of esthetics varies individually based on gender, age, and ethnicity, influenced by personal experiences and social environment.[9] It has been said that facial attractiveness is defined more by the smile than by soft tissue relationships.[10] A pleasing smile is often considered a major criterion defining the success of any dental intervention, by most of the patients.[11] Due to the subjectivity of evaluation the achievement of a well-balanced smile can be challenging.[12] For better smile esthetics, the goal of orthodontic treatment is to obtain a balanced facial appearance, stable occlusion, healthy oral tissues, and efficient mastication. Smile is assessed in three dimensions. In the transverse dimension, arch form, buccal corridor, transverse cant, and smile asymmetry are assessed. Maxillary incisor exposure, upper lip length and lower lip length are assessed in the vertical dimension whereas in the sagittal dimension, overjet and incisor angulation are measured.[13]

According to Bishara et al, lip protrusion is an important pretreatment profile characteristic that influences the extraction decision in addition to the presence of a tooth size-arch length discrepancy.[14] In the study conducted by Lim et al, premolar extraction patients showed greater improvement in facial profile compared to non-extraction in borderline Korean patients.[15] Extraction treatment can produce improved facial esthetics for many patients who present with some combination of crowding and protrusion. The faces of extraction patients were, on average, 1.8 mm flatter than those of non-extraction subjects[16] and thus extraction would be potentially beneficial when the lips were more protrusive than 2 to 3 mm beyond Ricketts' E-plane. For certain patients who have a combination of crowding and protrusion, extraction treatment may produce improved facial esthetics. Extraction procedure, probably, results in narrower dental arches, which are associated with a less esthetic smile in turn.[17] Reduction of arch width causes unesthetic triangles with negative spaces lateral to the buccal segments at the corners of the mouth.[18] According to Dierkes', 4 first premolar extraction treatment may lead to unesthetic black triangles at the corners of the mouth while smiling.[19] In the extraction group, Anna H. Meyer observed a substantial increase in posttreatment maxillary intercanine distance.[20] Arch widths between the maxillary first molars and at the level of the posterior rugae were greater in the non-extraction group. There are different modalities of orthodontic treatment which include extraction, distalization and non-extraction protocols that might affect the outcome of the smile in different malocclusions.

The perceptions of orthodontists, dentists, and laypersons are different and are important for orthodontic treatment. So, in this study, we aimed to compare the effect of extraction on smile esthetics in different malocclusions subjectively by rating and objectively by measuring the smile variables by dental professionals and laypersons.

METHOD

This was a cross-sectional study conducted at the Department of Orthodontics where the post-treatment frontal smiling photographs of orthodontically treated skeletal class I and class II subjects with an age range of 16-25 years were retrieved and they were further divided into extraction and non-extraction group. The inclusion criteria included completed orthodontic treatment with fixed appliances, frontal smiling photographs with good resolution, and skeletal Class I / Class II extraction and non-extraction cases. Similarly, the exclusion criteria included orthodontic treatment with orthognathic surgery; class III malocclusion; patients with obvious facial asymmetry; gingival recession; and increased overjet, overbite and midline discrepancy after the treatment.

The minimum required sample size with 80% power of study and 5% level of significance was 21 extraction patients in each group and 24 non-extraction patients in each group. Therefore, Group I (ANB < 4°) was subdivided into cases treated with extraction (group Ia) and without extraction (group Ib) and Group II (ANB > 4°) was also subdivided into extraction (group IIa) and cases treated without extraction (group IIb) of teeth (Fig. 1)

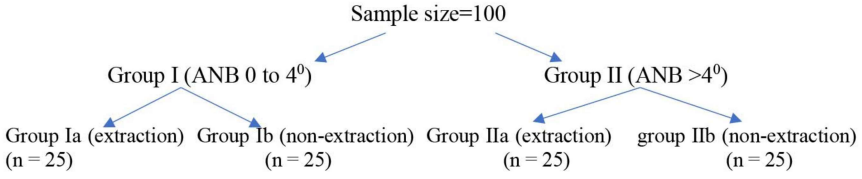

Figure 1. Sample distribution into different groups.

Photoshop software (ADOBE CC 2020) was used to crop only perioral area of frontal smiling photograph of each patient to a size of 5 × 3.5 inches. The smile esthetic score was evaluated by 10 orthodontists, 10 general dentists, and 10 laypersons

Microsoft PowerPoint was used to show the photographs to the raters in a random order. To rate the attractiveness of the smile, a smile rating chart (Visual Analog Scale, VAS) was given to all panel members individually and were asked to rate the attractiveness on a 10-point scale with 10 as the most attractive and 0 as the least attractive. Each panel member made their evaluation separately, without any knowledge of the subject's identity as coding was done. Before the final decision, raters were allowed to revise the slides. The raters' scores obtained for each subject were averaged and a mean was determined. Different smile variables of each subject were measured using linear measurement tool in Adobe Photoshop and the data were entered in an MS Excel spreadsheet (Fig. 2).

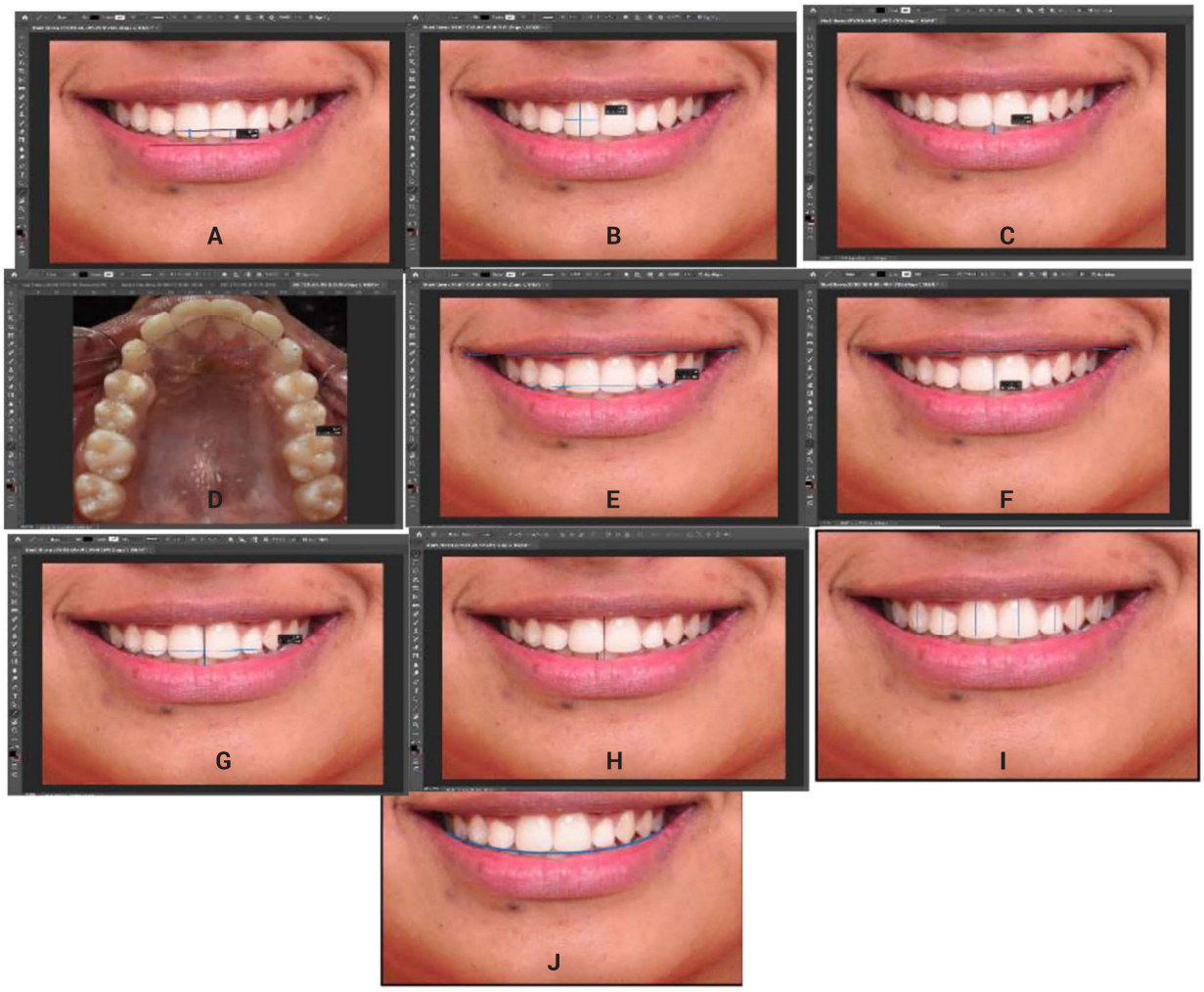

Fig 2: A, smile arc ratio (a, distance of maxillary incisor edge to intercanine connecting line; b, distance of lower lip to the intercanine connecting line) B, maxillary incisor show (c, distance of maxillary incisal edge to upper lip; d, maxillary incisor width), C, mandibular teeth exposure (e, visible mandibular incisor length; f, mandibular incisor width) D, arch form index (g, intercanine width; h, intermolar width) E, buccal corridor ratio (i, intercommissure width; j, intercanine width) F, smile index (i, intercommissure width; k, interlabial gap) G, interlabial gap (k, interlabial gap; j, intercanine width). H ,Upper and lower midline (i) on (ii) off I, Cervical line J, Smile line

Data were entered into a Microsoft Excel spreadsheet and then checked for any missing entries. It was analyzed using Statistical Package for Social Sciences (SPSS) version 21. Study variables were a mix of continuous, ordinal & nominal variables. Graphs were prepared in Microsoft Excel. Independent t-test was used to compare the two means. The chi-square test was used to compare categorical data. Friedman test was used to compare more than two related means of ordinal variables. Post hoc pairwise comparison was done using the Wilcoxon test. Mann Whitney U test was used for inter-group comparison of ordinal variables. The level of statistical significance was set at 0.05.

RESULTS

The mean and the standard deviation of all the smile variables of Group I and Group II are shown in Table 1. When we compared the various ratios for smile esthetics; the smile arc ratio, maxillary incisor show, and arch form index ratio were found to be significantly higher among Group Ia. Mandibular teeth exposure, buccal corridor ratio, smile index ratio, and interlabial gap were higher in Group Ib. Whereas maxillary incisor show, arch form index ratio were found to be significantly higher among Group IIa and mandibular teeth exposure was found to be significantly higher among Group IIb. When the median number of teeth display was taken it did not differ among extraction and non-extraction subgroups (Table 2).

In Group I and Group II among subgroups a and b, the esthetic score ratings given by orthodontists did not differ significantly from dentists. While the esthetic score ratings given by laymen were found to be significantly lower than that of both orthodontists & dentists. Among the subgroups, no significant difference could be found in (Table 3). Buccal corridor ratio & smile index ratio were found to be significantly higher among Group II as compared to Group I among the extraction subgroup. On the other hand, smile arc ratio, maxillary incisor show, arch form index ratio, buccal corridor ratio and smile index ratio were found to be significantly higher among Group II as compared to Group I among non-extraction subgroup and mandibular teeth exposure was found to be significantly higher among Group I and interlabial gap did not show any significant difference between Group I & Group II in extraction subgroup (Table 4).

Table 1. Comparison of smile parameters across the two groups

Parameters	Subgroup	N	Group I			Group II		
			Mean	Std. Deviation	P value	Mean	Std. Deviation	P value
Smile arc ratio	Extraction	25	.5520	.02598	<0.001	.5172	.15975	0.810
	Non-extraction	25	.3864	.08361		.5296	.19993	
Max incisor show	Extraction	25	1.0400	.02415	<0.001	1.0212	.16440	0.005
	Non-extraction	25	.7264	.02515		.8888	.15377	
Mand teeth exposure	Extraction	25	.3764	.40052	<0.001	.4556	.15303	0.033
	Non-extraction	25	.6772	.02170		.5516	.15612	
Arch form index ratio	Extraction	25	.8100	.01414	<0.001	.8060	.02517	<0.0001
	Non-extraction	25	.7548	.01782		.7784	.02055	
Buccal corridor ratio	Extraction	25	1.5444	.01083	<0.001	1.6884	.08975	0.557
	Non-extraction	25	1.6128	.03458		1.6748	.07165	
Smile index ratio	Extraction	25	5.3804	.33114	0.001	6.4196	.77417	0.301
	Non-extraction	25	5.7968	.47389		6.7488	1.37180	
Inter labial gap	Extraction	25	.2592	.02019	0.001	.2780	.02739	0.089
	Non-extraction	25	.2904	.03758		.2968	.04679	

Table 2: Number of teeth display during smile.

	Class I group		Class II group	
	Median	IQR	Median	IQR
Extraction (Group a)	8	2	8	1
Non-extraction (Group b)	8	2	9	2
p-value	0.350	0.086	0	14

Table 3: Esthetic Scores by orthodontists, dentists and layperson

Esthetic score for Class I group						Esthetic score for Class II group				
	Extraction gr		Non extraction gr			Extraction gr		Non extraction gr		
Esthetic score	Mean	Std. Deviation	Mean	Std. Deviation	Pvalue	Mean	Std. Deviation	Mean	Std. Deviation	Pvalue
Orthodontist	6.9600	.65447	7.0560	.56279	0.460, NS	6.9600	.58452	6.8680	.53285	0.669, NS
Dentists	6.8960	.52716	6.7960	.56751	0.552, NS	6.9480	.58247	6.8640	.66888	0.662, NS
Lay men	6.1040	.37247	6.1000	.62517	0.946, NS	6.0400	.57591	6.0480	.64104	0.831, NS
P[b] value	<0.0001, S		0.001, S			<0.0001		0.002		
Post hoc pairwise comparison	a*b – 0.966 a*c – <0.0001 b*c - <0.0001		a*b – 0.188 a*c – <0.0001 b*c – 0.001			a*b – 0.872 a*c – <0.0001 b*c - <0.0001		a*b – 0.882 a*c – <0.0001 b*c – 0.001		

Table 4: Comparison of parameters according to ANB among Extraction and Non Extraction subgroup

Parameters		N	Mean	Std. Deviation	P value	Mean	Std. Deviation	P value
Smile arc ratio	ANB<4	25	.5520	.02598	0.288	.3864	.08361	0.002
	ANB>4	25	.5172	.15975		.5296	.19993	
Max incisor show	ANB<4	25	1.0400	.02415	0.574	.7264	.02515	<0.0001
	ANB>4	25	1.0212	.16440		.8888	.15377	
Mand teeth exposure	ANB<4	25	.3764	.40052	0.360	.6772	.02170	<0.0001
	ANB>4	25	.4556	.15303		.5516	.15612	
Arch form index ratio	ANB<4	25	.8100	.01414	0.492	.7548	.01782	<0.0001
	ANB>4	25	.8060	.02517		.7784	.02055	
Buccal corridor ratio	ANB<4	25	1.5444	.01083	<0.0001	1.6128	.03458	<0.0001
	ANB>4	25	1.6884	.08975		1.6748	.07165	
Smile index ratio	ANB<4	25	5.3804	.33114	<0.0001	5.7968	.47389	0.002
	ANB>4	25	6.4196	.77417		6.7488	1.37180	
Inter labial gap	ANB<4	25	.2592	.02019	0.008	.2904	.03758	0.596
	ANB>4	25	.2780	.02739		.2968	.04679	

DISCUSSION

Smile esthetics has become more important for orthodontists because orthodontic patients evaluate the treatment outcome by their smiles and overall improvement in their facial appearance. Although the primary treatment goal in orthodontics is to achieve good occlusal relationships, now more attention is paid to enhancing dentofacial characteristics to produce the best facial esthetics. In orthodontics, the major challenge is to develop esthetic excellence and to create harmony between the components of the orofacial zone. Literature includes far more studies of skeletal structure in orthodontics than of the structure of soft tissue, more studies of the profile of patients than of their frontal view, and more studies of structure in static functional positions than during dynamic functional movements. One consequence of these assumptions and practices is that the impact of orthodontic treatment on the esthetics of the smile has been least investigated.[21]

It has been suggested that extraction of premolars leads to constriction of the dental arch which increases buccal corridor space that is unesthetic. Dong JK suggested that the arch width is not necessarily constricted in patients with tooth extraction.[22] Therefore, this study was done to assess smile esthetics after orthodontic treatment in subjects with and without extraction. In the present study, groups were divided according to ANB angle and subdivided into extraction and non-extraction groups so that the smile esthetics can be evaluated separately. In the study, the frontal view smiling images were used because frontal smile view helps the orthodontist to visualize transversely and vertically some dental or skeletal asymmetry. Sarver and Ackerman claimed that frontal smile photography is much better than any other view of transverse dental asymmetry, either full-face or close-up.[23] According to Dustin et al, the frontal facial shape dates back to the Egyptians, who portrayed the “golden proportion” of ideal facial esthetics. In his study, only the young adult subjects were selected because this age group best describes the features of an esthetic smile.[24]

In this study, the smile attractiveness was rated subjectively by dentists, orthodontists, and laypersons on a VAS scale. The orthodontist and dentist routinely assist the patients in clinical treatment decisions and esthetic judgment plays an important role. Laypersons were selected because they are the ones with more social interactions. In this study visual analog scale (VAS) was used as a measurement tool that can be applied to evaluate the perception and it is a convenient, reliable, and valid tool to assess perception for rapidly obtaining value judgements as suggested by Hollard and Shaw.[25]

The frontal smile photograph was used in this study to evaluate esthetic parameters in both groups because during social interaction frontal esthetics is most visible. When the comparison of variables was done in group I and in between subgroups (Ia, Ib) smile arc, maxillary incisor show, arch form ratio and buccal corridor were statistically significant. Smile arc, maxillary incisor show and arch form index were greater in Group Ia cases than in Group Ib. In Group Ia the arch form index was significantly higher, this could be because closing the extraction space also results in the molars’ mesial movement into a narrower arch and the canines’ distal movement into a wider arch, causing the ratio to be higher; similar results were found in the study done by Cheng et al.[26]

Buccal corridor are statistically significant in Group Ib. In non-extraction cases, the method of gaining space is by the expansion of arches which reduces the buccal corridor space. In contrast to our study, Johnson and Smith found that buccal corridor ratio did not change in extraction and non-extraction subjects.[27] This could be due to inclusion of cases treated with distalization and fixed functional appliances. For group Ib, the maxillary incisor display and smile arc were smaller. Non-extraction orthodontic treatment with increased maxillary incisor torque by dental arch expansion may flatten the smile arc and decrease the display of the incisor. Whereas, there is some degree of torque lost in extraction cases which is why maxillary incisor show is increased in extraction cases. While Group Ia and Group I b participants revealed an equal number of teeth when smiling in both groups. This finding is close to that of Kim and Gianelly, who showed no difference between the extraction and non-extraction groups in the visible number of teeth in smile.[28]

For group II, maxillary incisor show and arch form index ratio were found to be significantly higher among Group IIa. Mandibular teeth exposure was found to be significantly higher among Group IIb. Rest all variables did not show any significant difference between the two subgroups. Arch form index was higher in the extraction

group, this may be because in extraction treatment with little to no molar mesial movement, maximum anchorage is generally required as concluded by cheng et al.[26] The distribution of on & off midline, smile line and cervical line, interlabial gap did not differ significantly among extraction & non-extraction subgroups of both groups.

In our study, we divided the respondents into 3 categories. The results show that general dentists and orthodontists valued Group IIa considerably higher than group IIb. Among both subgroups, the esthetic score ratings given by orthodontists did not differ significantly from dentists. Whereas laypersons had no esthetic preferences between the two subgroups. Similar results were found in a study conducted by Peck et al, they suggested that facial esthetics is judged differently by dental practitioners and laypeople because dentists are qualified to observe attributes that are not apparent to the general public. This outcome is in line with that of Ghaffar and Fida.[29]

Judgement given by raters was mainly based on maxillary incisor show, the number of tooth display and buccal corridor ratio. Both raters have esthetic scores, meaning that a greater maxillary incisor reveals a more esthetic smile. This result is comparable to studies done by Dong Jk and Husley who suggested that a smile with a full incisor display is considered more youthful and esthetic.[30] While the extraction and non-extraction participants revealed an equal number of teeth visible during smiling in both groups. This finding is close to that of Kim and Gianelly, who showed no difference between the extraction and non-extraction groups in the tooth number show parameter.[28] Smiles that reveal more teeth, however, are considered to be more esthetic.

Orthodontists along with maxillary incisor show, tooth number display also considered buccal corridor ratio which was not considered by general dentist and layperson as for them full smile is unnatural and less appealing. No esthetic preference was identified by orthodontists in the buccal corridor ratios between the 2 groups; this is consistent with the findings of McNamara and Johnson.[31,32] Yang et al concluded that the ratio of the buccal corridor region between the extraction and non-extraction groups was not significantly different[33] . In a meta-analysis performed by Cheng et al., it was concluded that extraction did not have a major effect on frontal smile esthetics, both in terms of esthetic score and buccal corridor, which was in resemblence to the Dai et al. study.[33] In extraction and non-extraction subjects, Prasad et al did not notice statistically significant variations in the buccal corridor ratio.[34] No significant difference was found when comparisons between group Ia with Group IIa and Group Ib with Group IIb were done.

CONCLUSION

1. In extraction cases, the esthetic scores of dental practitioners and orthodontists were higher than in cases of non-extraction.
2. Between extraction and non-extraction cases, laypeople had no esthetic preference.
3. In Skeletal class I, smile variables such as the arch form index, smile arc and maxillary incisor show were more in extraction cases and the buccal corridor was more in non-extraction cases.
4. In Skeletal Class II, smile variables such as the maxillary incisor show and arch form index were more in extraction cases and exposure of mandibular teeth was more in non-extraction cases.
5. Judgement given by raters was mainly based on maxillary incisor show, the number of teeth displayed and buccal corridor ratio.

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