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Microaesthetics of The Smile: Extraction vs. Non-extraction

Sanam Tauheed
Aga Khan University

Attiya Shaikh
Aga Khan University

Mubassar Fida
Aga Khan University

ORIGINAL ARTICLE

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Sanam Tauheed, Attiya Shaikh and Mubassar Fida

ABSTRACT

Objective: To compare microaesthetics in pre- and post-orthodontic cases, treated with non-extraction and extraction treatment and assessed whether the achieved microaesthetic parameters are comparable to the proposed norms.

Study Design: Quasi-experimental study.

Place and Duration of Study: Orthodontic Clinic, the Aga Khan University Hospital, Karachi, from January 2005 to December 2009.

Methodology: Orthodontic records of 31 cases treated with non-extraction therapy and 26 cases treated with extraction of upper first premolars were selected. Patients were of Pakistani origin, aged between 12 to 30 years. Microaesthetics was assessed by measuring maxillary central incisor crown width-height ratio, connectors between the maxillary anterior sextant, gingival zenith level of the maxillary lateral incisor and golden percentage of the anterior teeth using the patients' plaster models and intraoral frontal photographs. Measurements of the golden percentage were made using the software Adobe Photoshop, whereas all other parameters were measured on the plaster casts using a digital vernier caliper. Paired t-test, independent t-test and one sample t-test were used to make comparisons within the groups, between the groups, and to compare the posttreatment values with the proposed norms, respectively. Statistical significance level was set at $p \leq 0.05$.

Results: A statistically significant improvement in the microaesthetic parameters was observed for both extraction and non-extraction subjects ($p < 0.05$) after orthodontic treatment. Values closer to the proposed norms were achieved more readily in the non-extraction group.

Conclusion: Microaesthetics of the smile is improved with orthodontic treatment. It is recommended that greater consideration be given to the microaesthetic parameters of the smile during the finishing stages particularly when utilizing extraction mechanics during orthodontic treatment.

Key words: *Aesthetics. Extraction. Non-extraction.*

INTRODUCTION

Facial and smile attractiveness play a key role in social interaction.[1] A symmetrical dental arrangement is thought to be a fundamental component of an attractive smile.[2] Therefore, the influence of orthodontic treatment on dental characteristics and smile aesthetics is of paramount importance.

An aesthetically pleasing smile is not solely reliant on gross components such as tooth alignment and inclinations. Intricate details in the smile provide it with harmony and balance. Over the years, the concept of microaesthetics was introduced to add more perfection to the smile. The components of microaesthetics specifically tooth proportions in height and width, gingival shape and contours, connectors and embrasures, black triangular spaces and tooth shade all critically determine the ultimate precise appearance of the orthodontically finished smile and form a harmonic and symmetric entity.[3]

Department of Orthodontics, Department of Surgery, the Aga Khan University Hospital, Karachi.

***Correspondence:** Dr. Sanam Tauheed, the Aga Khan University Hospital, Private Wing, Dental Clinic, Karachi.*

E-mail: sanam.tauheed@aku.edu

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To predict aesthetic treatment needs, Waldrop recommended that the foundation of the smile should be assessed independently as well as a composite picture during treatment planning.[4] Emphasis should be laid on the 'pillars' of the smile, which include observing tooth length, width, contact area length and location as well as on the 'façade' which includes the attached gingiva, interdental papillae and free gingival margins. Certain smile components such as midline position, axial midline angulation, buccal corridor, and smile arc have received greater attention than others.[5-8]

The impact of extraction and non-extraction therapy on smile aesthetics has been critically appraised. Studies have been executed to assert whether extraction treatment can negatively influence facial and smile aesthetics, particularly when compared with non-extraction therapy.[2,9-12] However, very little scientific research is available to ascertain the influence of different orthodontic mechanics on microaesthetics of the smile.

The objective of this study was to compare the elements of microaesthetics in pre-orthodontic and post-orthodontic cases, treated with non-extraction and extraction treatment to determine the impact of orthodontic treatment on microaesthetics of the smile as well as to assess whether the achieved microaesthetic parameters are comparable to the accepted proposed norms.

METHODOLOGY

It was a quasi-experimental study designed to evaluate microaesthetics in orthodontically treated smiles of patients attending the orthodontic clinic from 2005 to 2009. Pre- and posttreatment orthodontic records were used to evaluate the various variables used in the study.

Patients of Pakistani origin, ranging between the ages of 12 - 30 years, with good quality pre- and posttreatment plaster models and intraoral frontal photographs were incorporated into the sample, whereas patients who had missing anterior teeth, anterior dental anomalies like malformed teeth, transpositions and impactions were excluded.

A careful review of 100 orthodontic records was performed and pre- and posttreatment records of 31 cases treated with non-extraction therapy and 26 cases treated with extraction of upper first premolars were selected based on the selection criteria.

Microaesthetics was assessed for both the groups by evaluating the parameters of crown width-height ratio of the maxillary central incisors, connectors between the maxillary anterior sextant and the level of the gingival zenith of the maxillary lateral incisor on the pre- and posttreatment plaster casts. Golden percentage of each anterior tooth was also calculated to assess apparent individual tooth width when viewed from a frontal aspect. All measurements were made of the left side on the anterior dentition. Measurements of the golden percentage were made using the software Adobe Photoshop (version 7.0), whereas, all other parameters were measured on the plaster casts using a digital vernier caliper (0-150 mm ME00183, Dentaurm, Pforzheim, Germany) with accuracy of 0.02 mm and repeatability of 0.01 mm manufacturer's specification.

Ward developed a set of proportionate values that today are accepted as ideal.[13] The preferred anatomic crown width-to-height ratio of the maxillary central incisor is 78% with an acceptable range of 66 - 80% (Figure 1). These values hold true regardless of race or gender.[14] The width-to-height ratio of the maxillary central incisor was calculated from both the pre-orthodontic and post-orthodontic models. Measurements for the height of the clinical crown were made from the gingival margin to the incisal edge whereas, the width was measured from the most mesiodistally bulbous part of the tooth between the interproximal contacts as seen from the frontal view, using a digital vernier caliper. Calculations for the ratio were made using this data.

The gingival relationship of the six maxillary anterior teeth plays an important role in the artistic appearance of the smile. To attain harmony, the gingival zeniths of the lateral incisor should be positioned 1 - 2 mm coronal to the gingival zeniths of the adjacent central incisor and canine.[15] The Gingival Aesthetic Line (GAL) was constructed by joining the tangents of the gingival zeniths of the maxillary central incisors and canines (Figure 2).[4] The gingival zenith level of the maxillary lateral incisor was recorded, relative to the GAL, in an apical-coronal direction by using a digital vernier caliper.

The connector heights between the maxillary anterior teeth in an aesthetic smile exhibit a proportional relationship, which Morley and Eubank quantified as the 50:40:30 rule (Figure 3).[16] This rule defined the ideal connector heights between the central incisors as 50%, between the central and lateral incisors as 40% and between the lateral incisors and canines as 30% of the height of the central incisors. The connector zone was measured on the plaster casts using a digital vernier caliper from the incisal convergence of the gingival embrasure to the gingival convergence of the incisal embrasure.[16] This measuring technique was used to measure all interdental connector zones between the central incisors, central and lateral incisors and lateral incisors and canines. The connector height was determined as a percentage of the height of the ipsilateral central incisor for each measured connector zone.

Snow recommended the proportional width of each central incisor to be 25%, lateral incisor 15%, and canine 10% of the total distance across the anterior segment in order to achieve an aesthetically pleasing smile (Figure 4).[17] Measurements for this golden percentage were made using Adobe Photoshop and were calculated by dividing the width of the central incisor, lateral incisor and canine each, by the total width of all six anterior teeth. The value thus obtained was then converted to percentage to achieve the golden percentage of each tooth.

Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) for Windows (version 19.0, SPSS Inc. Chicago). The values obtained

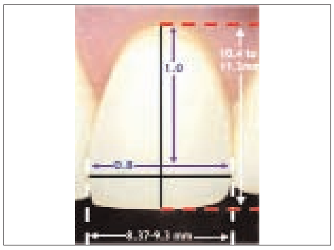

Figure 1: Crown width-height ratio.

Figure 2: Gingival zenith levels.

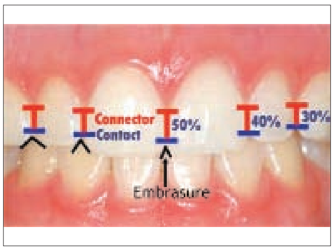

Figure 3: Connector heights.

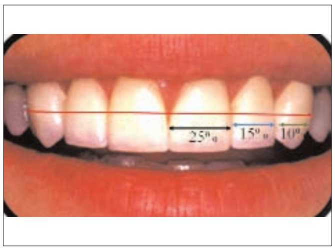

Figure 4: Golden percentage.

for the parameters of width-to-height ratio of the maxillary central incisors, gingival zenith level of the maxillary lateral incisors, connector heights and golden percentage of the anterior teeth for the extraction and non-extraction groups were compared to one another as well as to the proposed norms. Descriptive statistics, including means and standard deviations were calculated for pre- and post-orthodontic values for all the parameters. Comparisons within the sample group were assessed by paired t-tests. Differences between sample groups were tested with the independent sample t-test, whereas, one sample t-test was used to compare the posttreatment values with the proposed norms. Statistical significance level was established at $p \leq 0.05$.

RESULTS

The total sample consisted of 57 subjects comprising of 12 males and 45 females. Table I summarizes the comparative analysis of pre- and post-orthodontic values for the non-extraction and extraction groups. For the non-extraction group, statistically significant differences for the connector heights between the central incisors (p = 0.002), central and lateral incisors (p < 0.001) and lateral incisors and canines (p < 0.001) and golden percentage of the lateral incisors (p = 0.026) and canine (p = 0.015) were observed. For the extraction group, statistically significant differences were observed for the crown width-height ratio of the central incisors (p = 0.001), connectors between the central and lateral incisors (p = 0.007), lateral incisors and canines (p < 0.001), golden percentage of the central incisors (p = 0.004) and canines (p = 0.007).

Table II shows a comparison between the posttreatment values for the non-extraction and extraction groups. Statistically significant differences in the posttreatment values of the gingival zenith level of the maxillary lateral incisors (p = 0.004) and the golden percentages of the canines (p = 0.034) were found.

Table III shows comparison between the posttreatment values of non-extraction and extraction groups with

Table II: Comparative analysis between posttreatment means of non-extraction and extraction groups.

Variable	Non-extraction (n=31)		Extraction (n=26)		p-value
	Mean (mm)	±SD	Mean (mm)	±SD	
WHR	0.883	0.128	0.942	0.105	0.064
GZL	0.882	0.520	0.495	0.437	0.004
CCI	43.142	10.596	43.108	9.074	0.990
CCIL	31.423	8.671	33.446	7.762	0.362
CLC	23.368	5.911	24.219	8.154	0.659
GPCI	23.258	1.183	23.834	1.985	0.183
GPL	14.316	1.618	14.265	1.094	0.893
GPC	10.561	1.832	9.638	1.179	0.034

N = 57; Independent samples t-test; p-value ≤ 0.05
WHR = Crown width-height ratio
GZL = Gingival zenith level of lateral incisor
CCI = Connector between central incisors
CCIL = Connector between central and lateral incisors
CLC = Connector between lateral incisors and canine
GPCI = Golden percentage of central incisor
GPL = Golden percentage of lateral incisor
GPC = Golden percentage of canine

Table I: Comparative analysis of pre- and posttreatment values for non-extraction and extraction groups.

Variable	Pre- treatment		Posttreatment		p-value
Non-extraction (n= 31)					
	Mean (mm)	±SD	Mean (mm)	±SD	
WHR	0.889	0.118	0.883	0.128	0.584
GZL	0.746	0.768	0.882	0.520	0.312
CCI	32.858	18.995	43.142	10.596	0.002
CCIL	18.345	15.152	31.423	8.671	0.001***
CLC	14.654	11.736	23.368	5.911	0.001***
GPCI	22.765	1.741	23.258	1.183	0.071
GPL	12.726	3.866	14.316	1.618	0.026
GPC	11.797	2.636	10.561	1.832	0.015
Extraction (n=26)					
WHR	0.897	0.085	0.942	0.104	0.001
GZL	0.687	0.653	0.495	0.437	0.133
CCI	38.535	14.462	43.108	9.074	0.085
CCIL	25.758	12.627	33.446	7.768	0.007
CLC	16.450	9.520	24.219	8.154	0.001***
GPCI	22.548	2.546	23.834	1.985	0.004
GPL	13.771	3.007	14.265	1.094	0.362
GPC	11.166	2.678	9.638	1.179	0.007

*N= 57; Paired sample t-test; p ≤ 0.05; ***p ≤ 0.001*
WHR = Crown width-height ratio
GPCI = Golden percentage of central incisor
GZL = Gingival zenith level of lateral incisor
GPL = Golden percentage of lateral incisor
CCI = Connector between central incisors
GPC = Golden percentage of canine
CCIL = Connector between central and lateral incisors
CLC = Connector between lateral incisors and canine

Table III: Comparative analysis between posttreatment means of non-extraction and extraction groups and proposed norms.

Variable	Posttreatment		Theoretical value	p-value
Non-extraction (n=31)				
	Mean (mm)	±SD		
WHR	0.883	0.128	0.8	0.001
GZL	0.882	0.520	1	0.218
CCI	43.142	10.596	50	0.001
CCIL	31.423	8.671	40	0.001***
CLC	23.368	5.911	30	0.001***
GPCI	23.258	1.183	25	0.001***
GPL	14.316	1.618	15	0.025
GPC	10.561	1.832	10	0.098
Extraction (n=26)				
WHR	0.942	0.105	0.8	0.001***
GZL	0.495	0.437	1	0.001***
CCI	43.108	9.074	50	0.001
CCIL	33.446	7.762	40	0.001***
CLC	24.219	8.154	30	0.001
GPCI	23.834	1.985	25	0.007
GPL	14.265	1.094	15	0.003
GPC	9.638	1.179	10	0.137

*N= 57; One sample t-test; p ≤ 0.05; ***p ≤ 0.001*
WHR = Crown width-height ratio
GPCI = Golden percentage of central incisor
GZL = Gingival zenith level of lateral incisor
GPL = Golden percentage of lateral incisor
CCI = Connector between central incisors
GPC = Golden percentage of canine
CCIL = Connector between central and lateral incisors
CLC = Connector between lateral incisors and canine

proposed norms. For the non-extraction group, statistically significant differences were found for the parameters of width to height ratio of the central incisors ($p = 0.001$), connector heights between the central incisors ($p = 0.001$), central and lateral incisors ($p < 0.001$), lateral incisors and canines and golden percentage of the central incisors ($p < 0.001$) and golden percentage of the lateral incisors ($p = 0.025$). For the extraction group, statistically significant differences were found for the parameters of width to height ratio of the central incisors ($p < 0.001$), gingival zenith level of the lateral incisors ($p < 0.001$), connector heights between the central incisors ($p = 0.001$), central and lateral incisors ($p < 0.001$), lateral incisors and canines ($p = 0.001$), golden percentage of the central incisors ($p = 0.007$) and lateral incisors ($p = 0.003$).

DISCUSSION

In an orthodontic patient, maximal aesthetics for an ideal smile cannot be achieved lest all the components of the smile are analyzed before and after tooth movement and realistic goals are anticipated. Past research has suggested that aesthetics is not entirely a subjective field. There are values that stay within some accepted ranges and may be considered as ideal.[4] Moreover, these values could be used in conjunction with other subjective and objective aesthetic parameters during diagnosis, treatment planning and in reconstructing a natural smile with orthodontic treatment.

Orthodontic mechanics can alter the crown width-height ratio by extrusion or intrusion of the teeth. Several other non-orthodontic causes of inadequate crown width-to-height ratios are inadequate eruption, attrition, gingival recession and tooth form. Disproportionality in tooth size requires consideration before the initiation of comprehensive treatment to allow for appropriate treatment mechanics for its correction.

Wolfart *et al*. in their study on the assessment of smile attractiveness of standardized changes in incisor proportions concluded that width-to-height ratios of the maxillary central incisors within the range of 75-85% were considered most attractive.[18] Konikoff *et al*. in their evaluation of posttreatment plaster models observed the crown width-to-height ratio of the maxillary central incisors to range from 90 - 94%. Eighty to 90% of central incisors from their sample exceeded the allowed 80% tooth width-to-height ratio.[19]

In the present study, the mean crown width-to-height ratio of the maxillary central incisors, post-orthodontically, was found to be 90% which was similar to Konikoff *et al*. outcome.[19] Fifty one percent of the central incisors from the sample exceeded the ideal tooth width-to-height ratio. In contrast to the non-extraction group, where the width-to-height ratio was maintained at the pre-treatment value, an increase in the ratio was observed in the extraction group (p-value = 0.003).

The position of the ginigival zeniths of the anterior dentition can be modified by orthodontic treatment. Konikoff *et al*. in their study on the evaluation of post-orthodontic casts, observed that 45% of orthodontically treated lateral incisors from their sample were within 1mm from the GAL. The remaining 55% were positioned more than 1 mm from it.[19]

In this study, at the end of orthodontic treatment, in the total treated cases, 33% of the lateral incisors were positioned 0.5 - 1 mm from the GAL, whereas 35% were at a distance of less than 0.5 mm.

Raj *et al*. validated the existence of Morley and Eubank's 50:40:30 rule for connector heights in the anterior dentition, using casts of orthodontically treated subjects.[20] They reported the average connector heights between the anterior teeth to be 49%, 38% and 27% between the central incisors, central and lateral incisors, and the lateral incisors and canines, respectively.

In the present study, a significant improvement in the connector heights was observed after orthodontic treatment. The mean values were found to be comparable to those of Raj *et al*. results, being 43%, 32% and 23% between the central incisors, central and lateral incisors, and the lateral incisor and canines, respectively.[20] The improvement in the mean values was more marked for the non-extraction group compared to the extraction group.

The relative width percentage of teeth, as viewed from a frontal aspect, is determined by individual tooth alignment within an arch form. Several factors, including rotation, spacing, overlapping, and other forms of malalignment of teeth, all negatively influence the relative proportion of each anterior tooth seen in the frontal view. If these malalignment factors are eliminated, then the apparent width percentages of teeth is determined by curvature of the arch form itself.

Murthy and Ramani in their study on golden percentage in natural smiles reported the golden percentage of the central incisors, lateral incisors and canines to be 22%, 15.5% and 12.5%, respectively in their sample of aesthetic smiles.[21] In the current study, the mean golden percentages of the maxillary anterior teeth after orthodontic treatment were observed to be 24%, 13% and 10% for the maxillary central incisors, lateral incisors and canines, respectively. At the end of treatment, improvement was observed for both groups.

Finally, smile aesthetics consists of attributes that must be considered in orthodontic treatment planning with the insight that every characteristic is essential in achieving the ultimate artistic appearance of the smile.

CONCLUSION

The significant difference between the posttreatment means of both the groups and the proposed norms suggested that ideal values are challenging to achieve, whether orthodontic treatment utilizes non-extraction or extraction mechanics. However, the means for microaesthetic parameters achieved by non-extraction mechanics came much closer to the proposed norms compared to the extraction group. Hence, it is of paramount importance to focus on enhancing the microaesthetics of the smile during the finishing stages particularly when utilizing extraction mechanics during orthodontic treatment.

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