

PERCEPTION OF ORTHODONTIC MICRO ESTHETIC PARAMETERS AND THEIR SOCIAL ACCEPTABILITY THRESHOLD: A CROSS-SECTIONAL STUDY

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ABSTRACT

OBJECTIVES

This study aimed to evaluate orthodontic patients' perception of micro esthetic parameters in the maxillary central incisors.

METHODOLOGY

A cross-sectional observational study was conducted at Rehmat Memorial Hospital, Abbottabad, using non-probability consecutive sampling on 120 participants aged 16-40 years who had no prior orthodontic treatment or professional exposure to dental esthetics. A female patient with clinically ideal micro esthetic features was photographed under standardized conditions. The image was digitally altered to modify individual micro esthetic parameters-width-to-height ratio (60% and 100%), gingival zenith position (1 mm mesial and distal shift), interproximal contact point (1.5 mm apical shift), and axial inclination (5° mesial and distal tilt)-while keeping other features constant. Participants rated the attractiveness of the original and altered images using a 10-point Visual Analog Scale in randomized order. Data were analyzed using one-way ANOVA and stratified by gender.

RESULTS

The mean age of participants was 28.99 ± 6.96 years, with 56.7% females. The highest attractiveness scores were given to unaltered images across all parameters: width-to-height ratio (mean 8.92), gingival zenith (8.45), axial inclination (8.00), and contact point (8.06). Altered images received significantly lower ratings (p < 0.001). Male participants generally showed higher tolerance for esthetic variations than females.

CONCLUSION

Minor alterations in micro esthetic features of maxillary central incisors significantly impact perceived dental attractiveness. Maintaining natural tooth proportions, gingival contours, and contact points is critical in esthetic treatment planning. Gender differences suggest varying esthetic sensitivities that should be considered clinically.

KEYWORDS: Esthetics, Dental; Orthodontics; Central Incisor; Gingiva; Cross-Sectional Studies

INTRODUCTION

Orthodontic treatment has evolved beyond its traditional aim of correcting malocclusions and improving oral function.¹ In contemporary practice, esthetic considerations have become of paramount importance, with patients increasingly seeking orthodontic interventions to improve facial and dental appearance.² Normal occlusion not only contributes to functional efficiency but also plays a critical role in facial harmony and attractiveness.³ The success of orthodontic treatment is not solely determined by clinical outcomes but also by patient satisfaction, which is closely linked to their perceptions and expectations.⁴ Subjective assessments of patients, their dental and

facial esthetics, can significantly influence their motivation for seeking treatment and their compliance throughout the orthodontic process.⁵ Esthetic evaluation in orthodontics encompasses three hierarchical levels: macro-esthetics, mini-esthetics, and micro-esthetics.^{6,7} Macro-esthetics involves the assessment of facial proportions and profile harmony.⁷ Mini-esthetics focuses on the smile framework, including lip posture, smile arc, and buccal corridors.⁸ Micro-esthetics pertains to the intricate details of dental anatomy, such as tooth size, shape, color, gingival contours, and the relationships between adjacent teeth. These micro-esthetic elements are crucial for achieving a natural and pleasing smile, as they influence the perception of dental attractiveness at a detailed level.¹

Key components of micro-esthetics include the width-to-height ratio of anterior teeth, the presence and shape of interdental papillae, the contour and symmetry of gingival margins, and the alignment of contact points and embrasures.⁹ The golden proportion, which refers to the ideal ratio between the widths of anterior teeth, is often used as a guideline for achieving esthetic balance. Additionally, the gingival zenith position-the highest point of the gingival margin-plays a vital role in the perception of tooth symmetry and overall smile esthetics.¹⁰ Several studies have investigated the impact of orthodontic treatment on esthetic outcomes. Tauheed et al.¹¹ evaluated macro-, mini-, and micro-esthetic parameters in orthodontically treated patients, finding significant improvements post-treatment, particularly in micro-esthetic aspects such as the golden ratio and connectors of anterior teeth. A systematic review and meta-analysis by Alam et al.¹⁰ reported that orthodontic interventions lead to statistically significant enhancements in micro-esthetic parameters, emphasizing the importance of these subtle details in overall smile attractiveness. Despite the recognized importance of micro-esthetics in orthodontic outcomes, there is a paucity of research on patients' perceptions of these parameters. Most existing studies have concentrated on clinical assessments or professional evaluations, with limited exploration of how patients perceive and value micro-esthetic elements. This gap in the literature warrants the need for research that centers on patients' subjective experiences and expectations regarding micro-esthetic features. The objective of this study was to determine the perception about micro-esthetic parameters by orthodontic patients

METHODOLOGY

A cross-sectional observational study was conducted in the Department of Orthodontics at Rehmat Memorial Hospital, Abbottabad, using a non-probability consecutive sampling technique. Written informed consent was obtained from all participants for their voluntary participation in the study, and they were assured of the confidentiality of their information. Ethical approval was obtained prior to the initiation of the study (RmDTH/EC/4089, dated 30/3/2023). The sample size was calculated as 120 participants, assuming a power of 80%, a significance level of 0.05, an assumed effect size (δ) of 0.33, and a standard deviation of 0.643 for the gingival zenith perception difference between normal and altered images. The inclusion criteria for the study were individuals with no prior history of orthodontic treatment and no professional exposure to dental or facial esthetics, including both genders, aged between 16 and 40 years, and of Pakistani nationality. The exclusion criteria were

participants with visual impairments that could affect esthetic judgment, individuals with professional backgrounds in dentistry fields, those who had undergone previous orthodontic treatment, and mentally disabled patients. A female patient with clinically and photographically verified regular micro-esthetic features was selected for this study. The subject possessed ideal characteristics in all key areas of smile aesthetics, including tooth proportions, gingival margins, incisal edge contours, interproximal contact point positioning, and axial inclination of the anterior teeth, aligning with established aesthetic norms. A high-resolution frontal photograph of the subject's smile was taken under controlled conditions, including consistent lighting, a neutral background, a steady head position, and a natural smile expression. Using Adobe Photoshop, the original photograph was digitally modified to create several versions of the image, each altering a specific micro-esthetic parameter. To ensure that the changes were isolated, only one parameter was adjusted at a time while keeping all other features of the smile intact. The specific changes made were as follows: The tooth proportion (width-to-height ratio) was adjusted by reducing the clinical crown height of the maxillary central incisors to achieve a ratio of 60%, while maintaining the original width, using the Transform (Scale - vertical only) tool. For another version, the crown height was increased to simulate a width-to-height ratio of 100%, creating a more square-shaped appearance. The gingival margin height and contour were altered by shifting the gingival zenith of each central incisor 1 mm distally, creating a more pronounced distal position, and in another version, the zenith was shifted 1 mm mesially to simulate an unfavorable mesial shift. The interproximal contact point position was modified by shifting the contact point between the central incisors downward by about 1.5 mm, creating visible black triangles, which were then refined using the Clone Stamp tool. Finally, the axial inclination of the anterior teeth was changed by tilting the crowns of the central incisors by 5 degrees mesially and distally using the Free Transform (Distort) tool. Patients aged 15 years and older who attended the orthodontic clinic were invited to participate in the perception survey. Patients with visual impairments or those with prior professional training in dental aesthetics were excluded from the study. Each participant was shown the original, unaltered image (control) along with a set of images, each corresponding to a single modified micro-esthetic parameter. The order in which the images were presented was randomized to avoid any order effects. Participants were asked to rate the aesthetic appeal of each image using a 10-point Visual Analog Scale (VAS), where 0 represented "extremely unattractive" and 10 represented

"extremely attractive." Each participant marked their response independently for each image. The scores were then measured in millimeters from the left endpoint (0 cm) to the mark the participant made, and the data were recorded for further analysis. Intra- and inter-observer reliability were assessed by repeating ratings on 20% of the images after a one-week interval, yielding intraclass correlation coefficients (ICCs) greater than 0.85, indicating excellent reliability. Statistical analysis was performed through R software 4.3.1. Mean and SD were computed for normally distributed numeric data, and median with IQR for skewed data. A one-way ANOVA was performed to compare the perception of normal versus altered mini-esthetic parameters. Stratification was performed by gender. $p < 0.05$ was considered the significance level.

RESULTS

The majority ($n = 76$, 63.3%) were aged 26–40 years, while a smaller proportion ($n = 44$, 36.7%) were aged 16–25 years. The mean age was 4.98 ± 1.61 years. There were slightly more female participants ($n = 68$, 56.7%) than male participants ($n = 52$, 43.3%). The mean perception score was highest for the unaltered wide-to-height ratio (8.92 , $SD = 0.84$), followed by the 60% ratio (6.13 ± 1.65) and the 100% ratio (5.54 ± 1.47), with the differences being highly statistically significant (ANOVA, $p < 0.001$). Similarly, the unaltered zenith received the highest mean score (8.45 ± 0.87), while the zenith distal (5.18 ± 1.50) and zenith mesial inclination (4.89 ± 1.61) had significantly lower scores, with the differences again showing statistical significance (ANOVA, $p < 0.001$). For axial inclination, the unaltered axial inclination had the highest mean score (8.0 ± 1.01), while the axial distal (5.42 ± 1.25) and axial mesial inclination (5.26 ± 1.29) were rated lower, with significant differences observed (ANOVA, $p < 0.001$). Lastly, the contact point down had a mean score of 5.1 ± 1.37 , which was significantly lower than the unaltered contact point (8.06 ± 0.98), with the difference being highly statistically significant (t-test, $p < 0.001$). Table 2 shows that males generally rated micro-esthetic parameters of the maxillary central incisor higher than females. The unaltered wide-to-height ratio received the highest scores for both genders (males: 9.02 ± 0.8 ; females: 8.82 ± 0.84), with significant differences in all conditions (ANOVA, $p < 0.001$). Males also rated the 100% wide-to-height ratio, unaltered zenith, and axial distal inclination higher, with statistical significance (ANOVA, $p < 0.001$). However, the difference in unaltered axial inclination was not significant. Both genders rated the altered contact point significantly lower compared to the unaltered one (t-test, $p < 0.001$).

Table 1: Perception of Orthodontic Patients about the Micro-Esthetic Parameters of Maxillary Central Incisors

Micro-esthetics of the Central incisor	Mean (SD)	p value
Wide to height ratio (100%)	5.54 (1.47)	ANOVA, $p < 0.001$
Wide to height ratio (60%)	6.13 (1.65)	
Unaltered wide-to-height ratio	8.92 (0.84)	
Unaltered zenith	8.45 (0.87)	ANOVA, $p < 0.001$
Zenith distal	5.18 (1.50)	
Zenith mesial inclination	4.89 (1.61)	
Axial distal inclination	5.42 (1.25)	ANOVA, $p < 0.001$
Axial mesial inclination	5.26 (1.29)	
Unaltered axial inclination	8.00 (1.01)	
Contact point down	5.10 (1.37)	t-test, $p < 0.001$
Unaltered contact point	8.06 (0.98)	

Table 2: Perception of Orthodontic Patients about Micro-Esthetic Parameters of Maxillary Central Incisors Stratified by Gender

Variable	Male mean(SD)	Female mean(SD)	P-Value
Wide to height ratio (100%)	5.64 (1.47)	5.44 (1.47)	ANOVA, $p < 0.001$
Wide to height ratio (60%)	6.23 (1.65)	6.03 (1.65)	
Unaltered wide-to-height ratio	9.02 (0.84)	8.82 (0.84)	
Unaltered zenith	8.55 (0.87)	8.35 (0.87)	ANOVA, $p < 0.001$
Zenith distal	5.28 (1.50)	5.08 (1.50)	
Zenith mesial inclination	4.99 (1.61)	4.79 (1.61)	
Axial distal inclination	5.52 (1.25)	5.32 (1.25)	ANOVA, $p < 0.001$
Axial mesial inclination	5.36 (1.29)	5.16 (1.29)	
Unaltered axial inclination	8.10 (1.01)	7.90 (1.01)	
Contact point down	5.20 (1.37)	5.00 (1.37)	t-test, $p < 0.001$
Unaltered contact point	8.16 (0.98)	7.96 (0.98)	

DISCUSSION

The results of this study highlight the significant impact that minor alterations to micro-esthetic parameters of the maxillary central incisors can have on aesthetic perception. The original, unaltered images consistently received the highest ratings for attractiveness across all the micro-esthetic parameters assessed. Specifically, the wide-to-height ratio, gingival zenith, axial inclination, and interproximal contact points all showed statistically significant differences in aesthetic appeal when altered. The results suggest that even slight modifications in key aspects of a smile, such as tooth proportions, gingival margins, axial inclination, and interproximal contact points, can have a considerable impact on its perceived attractiveness. The width-to-height ratio is integral to the smile's overall harmony, and deviations from this ratio typically result in lower ratings of attractiveness. This is likely because significant departures from

natural proportions are typically viewed as less appealing.¹² Additionally, the gingival zenith, which is crucial for maintaining the aesthetic balance of the gingival contour, loses its appeal when shifted distally or mesially.¹³ Changes in axial inclination and interproximal contact points also led to noticeable declines in attractiveness, with the latter notably contributing to the formation of visible black triangles, which are generally regarded as undesirable.¹⁴ The perception of micro esthetic parameters showed apparent differences between genders. Male participants consistently gave higher ratings to several features, including the unaltered width-to-height ratio, the 100% width-to-height ratio, the natural gingival zenith position, and distal axial inclination. These differences were statistically significant across multiple variables ($p < 0.001$). This indicates that male patients may have a greater tolerance for minor deviations from ideal esthetic norms, while female patients may be more critical of subtle variations in anterior dental morphology. These differences could be influenced by psychosocial factors, varying esthetic expectations, or differences in visual perception.¹⁵ Alomari et al.¹⁶ conducted a comprehensive study comparing how different dental professionals and laypersons perceive altered gingival characteristics. Using digitally modified photographs, they surveyed 120 orthodontists, 45 periodontists, 49 prosthodontists, 130 general dentists, and 172 laypersons. They found that black triangles between the upper incisors were consistently rated as the least attractive feature, especially by orthodontists, prosthodontists, and general dentists, while laypersons were more sensitive to pigmented gingiva and periodontists to inflamed gingiva. Interestingly, dental professionals gave significantly lower aesthetic ratings than laypersons, reflecting a higher sensitivity to microaesthetic discrepancies. Yang et al.¹⁷ evaluated the influence of changes in the mesiodistal angulation of the maxillary central incisors on smile attractiveness. Their study included 52 orthodontists and 61 laypersons who rated digitally altered images. Increased angulation was perceived as less attractive, confirming the importance of correct axial inclination in dental esthetics. Romsics et al.¹⁸ performed a cross-sectional multi-site study involving 861 dental students across all five grades of dental school in Hungary. The study assessed students' perceptions of dentofacial mini- and microesthetics through questionnaires and image evaluations. Findings indicated that students' perceptions evolved with their academic progression, with significant associations observed between the year of study and the perception of maxillary midline shifts and the visibility of dental arches.

LIMITATIONS

The use of high-resolution digital images and precise modification of specific micro-esthetic features enabled a controlled evaluation of each parameter. Randomized image presentation reduced response bias, and the sample size allowed for meaningful statistical analysis. However, some limitations exist. The cross-sectional design captures only a single time point, limiting insights into changes over time. The age range (16-40 years) and focus on orthodontic patients may affect generalizability. Moreover, esthetic perception is subjective and influenced by cultural and personal factors not controlled for in this study.

CONCLUSIONS

This study found that small changes in microesthetic features of the maxillary central incisors, such as the width-to-height ratio, gingival zenith position, axial inclination, and interproximal contact points, can significantly affect perceived dental attractiveness. Natural, unaltered images were rated most favorably, while deviations often reduced esthetic appeal, mainly when they resulted in visible black triangles or disproportionate tooth dimensions. Male participants showed greater tolerance for minor esthetic variations compared to females, suggesting gender-based differences in perception.

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The authors accept responsibility for all aspects of the work and will ensure that any concerns regarding the accuracy or integrity of any part are properly investigated and resolved.



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