The Correlation of DSD Teeth Outline Ratios to Q-Sort Smile Assessment and Smile Mesh Analysis

Hussein A. Alnajar[1], Ameer A. Altabatabaie [2], Ahmed A. Alquzweeni[3] , Tholfqar majed[4]

[1]Research Scholar, Department of orthodontics, Faculty of Dentistry, university of Kufa, [2]Research Scholar , Department of conservative dentistry, Faculty of Dentistry, university of Kufa, [3]Research Scholar, Department of conservative dentistry, Faculty of Dentistry, university of Kufa, [4]Research Scholar, Dental technology department , Faculty of dentistry, Dijlah university

Abstract

Smile beauty is considered the main goal in many cosmetic or orthodontic dental treatments. However many objective and sujectives methods were developed to evaluate smile attractivesness depending on many variables. The purpose of this study was to develop a new method based on digital smile design teeth outlines ratios for smile esthetic evaluation and to correlate this method with Q-sort assessment method and smile mesh variables. Frontal posed smile photograph of 48 individuals were subjected to smile mesh measurments, digital smile design (DSD) and Q-sort assessment method. The areas of DSD teeth outlines were measured using image J software in addition to the teeth areas lie in the outlines to calculate the ratio of each individual tooth area to its outline area and the total teeth areas to totsl outlinrs area.

The results showed a significant correlation between the new method and Q-sort asseseement method, additionally there was a significant difference in individual and total teeth outlines ratios between the pleasant and unpleasant smile groups.

Conclusions It was found that Digital smile design teeth outline ratios method could be considered as a valuable tool for evaluation of smile esthetics.

Key words: *Digital smile design, Q-sort, Smile mesh, Tooth outline.*

Introduction

One of the main objectives of any cosmetic dental treatment is to obtain a beautiful smile. the pleasant smile necessitate a harmonious and balanced relationship among the lip framework, the gingival scaffold and the teeth[(1)].

Peck and Peck's [(2)] introduced a smile classification based on previous studies about facial expressions and concluded that smile can be either spontaneous or posed, additionally Ackerman et al. [(3)] classified the smile into posed or social smile and the enjoyment or unopposed smile.

Many authors have referred the unstrained social smile as a reliable reference for measurement and characterization of the smile [(4, 5)] .

It is necessary to quantify the smile characteristics which considered a distinctive facial feature to help orthodontists and cosmetic dentists not to judge it wholly subjectively due to the absence of a morphometric quantifying tool. Many experimental and clinical studies were performed to identify the esthetic quality of the pleasant smile achieved by cosmetic or orthodontic treatment based on many potential characteristics such as gingival display, incisor protrusion, smile arc and buccal corridors which can greatly influence the esthetic perception of persons [(6)] .

Corresponding author,
Hussein A. Alnajar
Research Scholar, Department of orthodontics, Faculty of Dentistry, university of Kufa,
E-mail: najarorthodontist@gmail.com

Additionally many diagnostic tool that aids in aesthetic diagnosis and prognosis and used for objective smile evaluation such as Objective Grading System (OGS), Diagram of Facial Aesthetic References (DFAR), smile mesh and Digital smile design (DSD) . The smile mesh was developed by Ackerman and Ackerman to test the reproducibility and reliability of the posed smile, it comprised five horizontal lines and seven vertical lines superimposed on the posed smile image. This analysis showed that the smiles were reproducible, also it showed high correlation coefficient and high intrarater and interrater reliability between repeated measures [3, 5] .

Digital smile design (DSD) planning permit the esthetic evaluation of the intra and extra-oral digital photographs to establish an even gingival contour and proper dental alignment. This final dental outline provides greater predictability to the final result and assisting as a guide to fabricate the diagnostic wax-up and mock-up [7] .

Materials and Method

Approval for the study was obtained from the scientific committee of orthodontic department in Kufa University faculty of dentistry. The recruited subjects were 48 dental students (28 females and 20 males) to satisfy the Q-sort method design. The sample power was 0.80 as determined by G-power software with respect to correlation tests (Type I error = .05) 5. All 48 subjects included in the study had many characteristics such as: age ranging from 18 - 24 years ; no missing or malformed teeth ; Pleasing faces ; normal occlusion ; no history of previous orthodontic treatment. Additionally many exclusion criteria were considered such as : gummy smile ; canting in the maxillary occlusal plane ; craniofacial anomalies ; history of orthognathic surgery/ cosmetic treatment ; Obvious facial asymmetry [8].

Three photographs were required for smile analysis as follows: full face with a wide smile, full face at rest, and retracted view of the full maxillary arch with teeth apart [9] .

Photos were taken by digital camera (Nikon D7100, Japan) with Macro lens (105mm, Sigma), camera settings and patient positioning were performed as mentioned by Vachiramon et al, 2007 [10] . While scale measurement and dental photography guidelines were followed as mentioned by Soni et al [11] . The subjects were instructed to smile before photographs taking. Ackerman et al. demonstrated the reproducibility of the posed smile obtained from the static photograph 3.

The Smile Mesh parameters were measured via image J software as described by Schabel et al [5] : Maximum incisor exposure ; Upper lip drape ; Lower lip to incisor ; lnter labial gap ; Inter canine width ; Smile width and Smile index.

Then the standardized photos were subjected to digital smile design as describes by Coachman and Calamita [12] and Choachman et al [13] . After creating the tooth out line for each of the 8 anterior teeth the image j software used again to measure the area of each tooth outline separately and the total teeth outlines area. Additionally the area of each tooth (of the eight anterior teeth) that lies inside the tooth outline was measured separately in addition to the total teeth area. The ratio of each tooth area to its outline area was calculated in addition to the ratio of total teeth area to the total teeth outlines area. The ratio of individual tooth or total teeth represent the degree of fitness to ideal tooth or teeth outlines and to what extent the tooth or teeth form and position close or far from the ideal smile design.

For Q-sort assessment, the attractiveness of the 48 images was ranked by the panelists (25 orthodontists) from 0-8 according to the method developed by Stephenson which is based on various subjective criteria [14] . The average of cut points between attractive and unattractive smiles was calculated to generate the overall demarcation between unattractive and attractive smile images [15] . However it was 3.2 in the present study. The samples that have scores less than 3.2 were considered unattractive while those that have 3.2 or above were considered as an attractive smiles.

Statistical Analysis

Descriptive statistics included mean and standard deviation . The correlations among variables were examined by Pearson correlation Coefficient. Independent sample t test was used to compare means of all variables. The level of significance for all statistical tests was set at 0.05. All statistical tests were performed with a software program (SPSS version 12.0).

Results

Descriptive statistics of smile mesh variables, DSD ratios and Q-sort scores are shown in table 1. Pearson correlation didn't show any significant correlation between DSD teeth outlines total ratio and smile mesh variables, while there were a significant correlation with Q-sort assessment (table 2).

After obtaining the average of cut points for Q-sort assessments of the panelists which was 3.2 the total sample was divided inti two groups unattractive smile group (<3.2) and attractive smile group (≥ 3.2). An independent samples t test between attractive and unattractive smile groups was done (table 3), for smile mesh variables only upper lip drap and smile width showed a significant difference between the two groups. While for DSD outlines ratios all variables showed a significant differences between the two groups except the tooth 14.

Table 1: Descriptive Statistics of all Q-sort assessment, smile mesh variables and DSD teeth outlines ratios

Variables	N	Minimum	Maximum	Mean	Standard Deviation
maximum incisor exposure	48	5.00	13.20	9.3	1.7
upper lip drap	48	-6.00	5.20	-0.021	2.4
lower lip to incisor	48	0.70	10.50	4.4	2.2
interlabial gap	48	7.00	21.30	14.34	3.52
inter canine width	48	32.80	56.90	41.76	4.75
smile width	48	57.30	93.60	72	8.57
smile index	48	3.40	8.30	5.3	1.34
14 ratio 1	48	0.00	0.83	0.48	0.18
13 ratio 2	48	0.36	0.91	0.71	0.15
12 ratio 3	48	0.37	0.96	0.72	0.12
11 ratio 4	48	0.42	0.88	0.72	0.11
21 ratio 5	48	0.39	0.92	0.72	0.11
22 ratio 6	48	0.38	0.90	0.67	0.13
23 ratio 7	48	0.13	0.93	0.64	0.18
24 ratio 8	48	0.00	0.77	0.42	0.21
total ratio	48	0.45	0.80	0.67	0.09
Q-sort assessment	48	1.30	7.10	4.0	1.43

[1] Ratio of tooth area of maxillary right first premolar lies inside tooth outline to tooth outline area in DSD .

[2] Ratio of tooth area of maxillary right canine lies inside tooth outline to tooth outline area in DSD.

[3] Ratio of tooth area of maxillary right lateral incisor lies inside tooth outline to tooth outline area in DSD .

[4] Ratio of tooth area of maxillary right central incisor lies inside tooth outline to tooth outline area in DSD .

[5] Ratio of tooth area of maxillary left central incisor lies inside tooth outline to tooth outline area in DSD .

[6] Ratio of tooth area of maxillary left lateral incisor lies inside tooth outline to tooth outline area in DSD .

[7] Ratio of tooth area of maxillary left canine lies inside tooth outline to tooth outline area in DSD .

[8] Ratio of tooth area of maxillary left first premolar lies inside tooth outline to tooth outline area in DSD .

Table 2: The significant correlation of total teeth outlines ratio with other variables.

Variables	N	Minimum	P value
maximum incisor exposure	48	5.00	0.017
upper lip drap	48	-6.00	0.000
lower lip to incisor	48	0.70	0.000
interlabial gap	48	7.00	0.000
inter canine width	48	32.80	0.000
smile width	48	57.30	0.000
smile index	48	3.40	0.000
14 ratio	48	0.00	0.000
13 ratio	48	0.36	0.000

Table 3: Independent samples t test between attractive and unattractive smile groups

variables	Unpleasant	Pleasant	P value
upper lip drap	-1.60	0.36	0.018
smile width	75.90	70.38	0.019
13 ratio	0.62	0.75	0.009
12 ratio	0.63	0.76	0.000
11 ratio	0.65	0.75	0.001
21 ratio	0.68	0.74	0.013
22 ratio	0.62	0.68	0.035
23 ratio	0.56	0.67	0.011
24 ratio	0.34	0.45	0.025
total ratio	0.60	0.70	0.000
Q-sort assessment	2.34	4.69	0.000

Discussion

This study was conducted to evaluate the correlation among a new method for smile evaluation using DSD teeth outlines ratios, Q-sort assessment and smile mesh variables. Additionally to compare the variables of these three methods between pleasant and unpleasant smiles.

For DSD analysis there was a significant positive correlation between Q-sort assessment and with most individual teeth outlines ratios and total ratio. However this indicates that high individual teeth outline ratios results in high total ratio which reflect the degree of fitness of the patients teeth to the planned ideal teeth outline according to the guidelines and this ratio can reflect how close or far the patients smile from ideal, unfortunately no previous studies were conducted on DSD to identify a discrepancy index for smile evaluation and analysis; however the reason for significant correlation of individual and total teeth outlines ratios could be explained by that dental, skeletal or soft tissue discrepancies in vertical and/or horizontal dimensions such as asymmetries in the dental arch might play a role in smile attractiveness from visual inspection as mentioned by Schabel et al [16] . While for smile mesh variables there was no significant correlation with the total outlines ratio. However this may be due to that these variables are mostly vertical linear measurements and even for horizontal measurements it is difficult to detect asymmetry with this method.

Additionally despite McNamara et al [17] focusing on the role of the lips in the evaluation of the smile, aligned teeth could attract the attention of raters more than the lips, features [16], however this finding could be supported by another one who reported that a greater number of teeth displayed during smiling can give more attractive smile in comparison to fewer teeth [18]. Additionally deviation in incisor angulation, incisal plane asymmetry and canting and which were considered as the most noticeable criteria in smile attractiveness evaluation [19, 20] that could affect teeth outlines ratios more than smile mesh variables.

The direct comparison between attractive and unattractive smile groups failed to find any significant differences between the 2 groups of subjects in smile mesh variables except for upper lip drape and smile width this was in disagreement with Schabel et al and McNamara et al [16, 17], but when Schabel et al compared the 11 most attractive smiles with the 11 most unattractive smiles they found that the maxillary incisors to lower lip and the smile index were significantly different, this could be attributed to many factors like the age of individuals which were ranging from 18-25 in the present study compared to 12-20 years in Schabel et al study, also the patients in this study were not treated orthodontically while in Schabel et al study they were finished their orthodontic treatment and finally the comparison in the present study done between all the two groups scores not between the 11 most attractive and 11 most unattractive photos. On the other hand there was a significant difference for all DSD ratios between attractive and unattractive smile groups

Conclusions

Teeth outlines ratios were significantly correlated Q-sort assessment of smile esthetics. Teeth outlines ratios were significantly increased in pleasant smile group. Teeth outline ratios could be considered as a valuable tool for evaluation of smile esthetics.

Ethical Clearance : Taken from University of Kufa ethical committee

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Conflict of Interest : Nil

References

[1] Janzen, EK. A balanced smile—a most important treatment objective. American journal of orthodontics 1977;72(4):359-72.

[2] Peck, S. Peck, L. Selected aspects of the art and science of facial esthetics. Paper presented at: Seminars in orthodontics, USA, 1995.

[3] Ackerman, J. Ackerman, M. Brensinger, C. Landis, J. A morphometric analysis of the posed smile. Clinical orthodontics and research. 1998;1(1):2-11.

[4] Ackerman, J. Digital video as a clinical tool in orthodontics: dynamic smile analysis and design in diagnosis and treatment planning. Orthodontics in the 21st century, 2002.

[5] Schabel. BJ. Baccetti, T. Franchi, L. McNamara, Jr. JA. Clinical photography vs digital video clips for the assessment of smile esthetics. The Angle Orthodontist .2010;80(4):678-84.

[6] Akyalcin, S. Frels, LK. English, JD. Laman, S. Analysis of smile esthetics in American Board of Orthodontic patients. The Angle Orthodontist. 2014;84(3):486-91.

[7] Meereis, C. De Souza, G. Albino, L. et al. Digital smile design for computer-assisted esthetic rehabilitation: two-year follow-up. Operative dentistry 2016;41(1):E13-E22.

[8] Singh, N. Abdulla, R. Sable, R. Bhosale, V. Halli, R. Smile analysis: A comparison between photographic and videographic methods. Journal of Indian Orthodontic Society . 2016;50(1):8-13.

[9] Câmara, CA. Aesthetics in Orthodontics: Six horizontal smile lines. Dental Press Journal of Orthodontics . 2010;15(1).

[10] Vachiramon, A. Wang, W. Tovee, M. A lighting approach for clinical photographs of the face. J Contemp Dent Pract, 2006;7:153-59.

[11] Soni. U N DS, Dr. Kausal S,etal. Orthodontic Photography –A Clinical Aspect. Sch. J. Dent. Sci. 2016;3(8):231-36.

[12] Coachman, C. Calamita, M. Digital smile design: a tool for treatment planning and communication in esthetic dentistry. Quintessence Dent Technol 2012;35:103-11.

[13] Coachman, C. Calamita, MA. Sesma, N. Dynamic documentation of the smile and the 2D/3D digital smile design process. Int J Periodontics Restorative Dent . 2017;37(2):183-93.

[14] Stephenson, W. The study of behavior; Q-technique and its methodology. 1953.

[15] Schabel, BJ. Franchi, L. Baccetti, T. McNamara, Jr. JA. Subjective vs objective evaluations of smile esthetics. American journal of orthodontics and dentofacial orthopedics . 2009;135(4):S72-S79.

[16] Schabel. BJ. McNamara, Jr. JA. Franchi, L. Baccetti, T. Q-sort assessment vs visual analog scale in the evaluation of smile esthetics. American journal of orthodontics and dentofacial orthopedics 2009;135(4):S61-S71.

[17] McNamara, L. McNamara, Jr. JA. Ackerman, MB. Baccetti, T. Hard-and soft-tissue contributions to the esthetics of the posed smile in growing patients seeking orthodontic treatment. American Journal of Orthodontics and Dentofacial Orthopedics. 2008;133(4):491-99.

[18] Dunn, WJ. Murchison DF, Broome JC. Esthetics: patients' perceptions of dental attractiveness. Journal of Prosthodontics. 1996;5(3):166-71.

[19] Kokich, Jr .VO. Asuman, K. H. Shapiro, PA. Comparing the perception of dentists and lay people to altered dental esthetics. Journal of Esthetic and Restorative Dentistry 1999;11(6):311-24.

[20] Padwa, BL. Kaiser, MO. Kaban, LB. Occlusal. cant in the frontal plane as a reflection of facial asymmetry. Journal of oral and maxillofacial surgery. 1997;55(8):811-16 .