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ORIGINAL ARTICLE

DYNAMIC SMILE EVALUATION IN ALL THREE SKELETAL PATTERNS

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ABSTRACT

OBJECTIVES: To compare the different smile variables amongst patients with varying vertical skeletal patterns, and to find whether there is a correlation between the dynamic contributing factors and the vertical smile parameters.

METHODS: This cross-sectional study was conducted at department of Orthodontics, Nishtar Institute of Dentistry, Multan, Pakistan from 01-10-2020 to 01-04-2021. The posed smiles of 120 participants, aging 15-25 years, having well-aligned dental arches were videotaped for objective measurements and comparisons with their underlying vertical skeletal growth patterns.

RESULTS: The evaluation of smile parameters showed a significantly decreased inter-labial gap in patients with skeletal low angle in males (8.92±3.6mm) and females (9.44±2.58 mm) [p<0.004]. Upper lip length was significantly decreased in low angle (16.23±1.59 mm) cases for males as compared to vertically high (18.57±1.47 mm) and normal angle (18.24±2.08 mm) cases. Inter commissural width was increased significantly in the low angle cases (63.39±8.14 mm) when compared with the high angle cases (58.24±5.44 mm) in females. Maximal Incisal Display was significantly increased in high angle cases (9.03±1.31 mm) p<0.001 as compared to the low angle cases (7.64±1.98 mm). A 65.8% (n=79) of the sample showed a flat smile arc with 26.7% (n=32) having consonant smiles while 7.5% (n=9) showed a reverse smile arc.

CONCLUSION: Smile dynamics are influenced by underlying skeletal patterns. Individuals with skeletally high angles showed an increased incisal display and an increased upper lip elevation upon smiling. While the low angle patterns displayed a decreased inter-labial gap and majority showed a flat smile arc.

KEYWORDS: Smile dynamics (Non-MeSH); Skeletal (MeSH); Vertical parameters (Non-MeSH); Esthetics (MeSH)

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INTRODUCTION

Facial esthetics is of paramount importance in the field of orthodontics. Initially orthodontists used to put great emphasis on dentate occlusion with least concern over facial esthetics.[1] With the dawn of the twenty-first century the importance and role of soft tissues came to light resulting in a paradigm shift.[2,3] The soft tissue variables became the new focus around which diagnosis and treatment planning began to revolve.

Physical attractiveness influences evaluations of others with attractive individuals receiving more positive appraisals.[4] People have been studied to agree more often with the opinion of attractive vs less attractive individuals.[5-7] The human face is a powerful weapon laced with an arsenal of smiles. Service with a smile is an established mantra and smiling faces are greatly coveted in the advertisement world, drawn to billboards like moths to a flame.[6,7] Human social behavior is an amalgamation of interactions between individuals and their environments. Smiles are potent social forces that positively influence relational judgments, communicate positive intent and are central tools for encouraging social interactions.[8,9]

Patients have become increasingly conscious of the significance of a beautiful smile. An interplay of both dynamic and static relations between the various dento-skeletal and the soft tissue elements of the face determines smile characteristics. The static relationship between these components reveal different vertical skeletal patterns presenting with characteristic smile features, but so far very few studies have been conducted on the dynamic aspect[10] and more research is needed.

Our study intended to compare the different smile variables amongst patients with varying vertical skeletal patterns, and to correlate the dynamic contributing factors with vertical smile parameters. This will help determine the impact of these factors on orthodontic treatment planning and mechanics to enhance the appearance of the smile.

METHODS

The study was carried out at the dept. of Orthodontics, Nishtar Institute of Dentistry Multan from October of 2020 to April of 2021. A hundred and twenty (n=120) southern Punjab participants aged between 15-25 years took part in the study. The study was given approval by the Institutional Ethics Board and an informed consent was collected from all the individuals participating in the study. The criteria for selection of the participants partaking in the study is as under:[10]

INCLUSION CRITERIA

- Southern Punjab participants aged 15-25years
- Participants with well aligned arches
- Overjet of 1-5mm

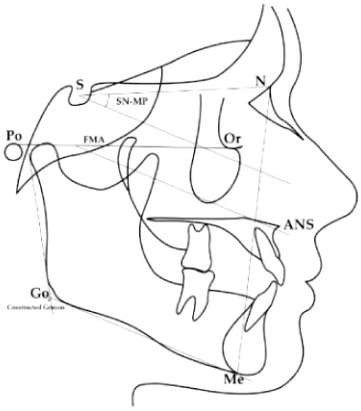

Figure 1: Factors for classifying vertical skeletal patterns: (i) Sella Nasion-Mandibular Plane, (ii) Frankfort-Mandibular plane angle, (iii) Jaraback ratio

- No history of prior orthodontic treatment

EXCLUSION CRITERIA

- Presence of any apparent facial asymmetry
- Any apparent periodontal disease, dental attrition or caries
- Trauma to the dentofacial area
- Absent or surplus teeth visible upon smiling, presence of prosthesis or restoration done on any teeth observable upon smiling
- Lip surgery

The patients were categorized into groups according to gender and skeletal patterns, for the latter; standardized lateral head roentgenograms were taken, ceph parameters: FMA, SN-MP and Jaraback ratio were recorded and the patients were classified as high, normal and low angles accordingly (Figure 1).[10]

For the video graphic recording of dynamic smiles, a Nikon D5300 DSLR camera with 18-105 mm lens was placed on a tripod stand and in order to ensure equal magnification the fixed distance of 3 feet was ensured for every participant. The lens of the camera was attuned at the level of the occlusal plane for each participant. The postural rest position was attained by the command method in which the patient was asked to swallow following which the mandible spontaneously returned to the rest position. A short clip was recorded for each participant in which the participant began with the lips at rest to the lips in maximal posed smile. The video clips were imported into Adobe Premiere Pro version 14 Adobe Inc. The program was used to slice the video into frames whereby each frame was studied and for each participant two frames were selected. One frame documented the lips at rest and the other portrayed the lips at maximal posed smile. The frames were saved as TIFF images, imported to Adobe Photoshop CC 19.1 Adobe Inc. and cropped to identical dimensions. Care was taken to keep the dimensions strictly same for each participant in order to get accurate measurements. The measuring tool employed was predetermined.

(Click image>Analysis>set measurement scale>custom) with the ruler view activated (Click View>Ruler) straight lines were drawn with the aid of the Ruler tool from the sidebar and measurements were documented from the measurement log section.

Five linear measurements were recorded. The measurement for upper/maxillary lip length (ULL) was recorded from the resting position photograph (Figure IIA), while measurements of: change in upper lip length (ULL), interlabial gap (ILG), intercomissural width and maxillary incisal display (MID) were taken on each smiling photograph.[11] The cut-off vales for Maximal Incisal Display on smile were kept different for both genders, and were documented as Adequate and Inadequate accordingly (Table I). Smile arc12 was noted in all three skeletal patterns and frequencies for each type calculated (Table II).

II-A: MEASUREMENTS ON REST POSITION PHOTOGRAPH:

1. Upper/Maxillary lip length at rest (ULL): distance measured between the stomion superius and the sub-nasale.

II-B: SMILE PHOTOGRAPH MEASUREMENTS:

1. Maxillary incisal display (MID): distance recorded from maxillary incisal edge to stomion-superius
2. Interlabial gap (ILG): is the measured distance from stomion superius to stomion-inferius
3. Inter-commissural width (ICW): distance observed between the two outer commisures

Figure 2 (A & B): Measurements on rest and smiling photographs

4. Change in maxillary lip length from rest to smile (ULL): difference in the upper lip length during resting and smiling taken as a percentage ratio of upper lip length at rest. It shows the lip elevation on smile.

The Data were summarized as mean (standard deviation). Intra and Inter group mean difference significance was computed via Tukey's post hoc test. A p value less than 0.05 was deemed to be statistically significant. Analyses were computed on SPSS software (Armonk, NY: IBM Corp. Released in 2012. IBM SPSS Statistics, Version 21.0).

RESULTS

Various measurements like ULL, UL, MID, ILG and ICW were compared in both genders from low to high angle (Table III).

Inter Labial Gap (ILG) was significantly decreased in patients with skeletal low angle (8.91±3.61 mm in males, 9.44±2.58 mm in females) in both the genders (p value of 0.004 in females and a p value of 0.007 in males). [Table IV). Upper Lip Length (ULL) was significantly decreased in low angle (16.23±1.59 mm) cases for males (p=0.002) as compared to vertically high (18.57±1.47 mm) and normal angle (18.23±2.08 mm) cases. The change in maxillary lip length ULL was significant in males (p 0.039). Comparisons between males and females showed significant gender dimorphism for change in ULL from rest to smile, with greater amount of

TABLE I: CRITERIA FOR ADEQUACY VS INADEQUACY FOR MAXIMAL INCISAL DISPLAY ON SMILE IN GENDER

Co-morbidities	Adequate	Inadequate
Male	≥80%	<80%
Female	100%	≤99%

TABLE II: MEASUREMENTS USED IN THE STUDY

SMILE ARC	Flat	When the maxillary incisal edges, canine and premolar cuspal tips fail to follow the curve of the lower lip line a flat smile results.
	Consonant	When the incisal edges, canines and premolar cusp tips of the maxillary teeth follow the curve of the lower lip line.
	Reverse	A reverse curve is observed between the upper incisal edges, the canines and premolars in relation to the lower lip line.
CEPHALOMETRIC PARAMETERS	FMA	The Frankfort-mandibular plane angle (FMA) is formed by the intersection of the Frankfort horizontal plane and the mandibular plane.
	Jarabak ratio	Jarabak ratio is the percentage of the anterior and posterior facial proportions. Anterior facial height is measured from nasion to menton and the posterior facial height is measured from sella to gonion.
	SN-MP	Angle between the cranial base (SN Sella-Nasion) and the mandibular plane (Go-Gn Gonion to Gnathion)

shortening observed in females than males. The horizontal smile measurement, the ICW, was markedly increased in the low angle cases when put in comparison with the high angle cases in females (p 0.036).

The sample showed that a 65.83% (n=79) of the sample had a flat smile arc, with 26.66% (n=32) having consonant smiles while 7.5% (n=9) showed a reverse smile arc (Table V). With regards to gender dimorphism reverse smile was more prevalent in females (n=7; 11.66%) as compared to their male counterparts (n=2; 3.33%), while consonant and flat smile arcs showed nearly equal distribution. When evaluating the smile arc distribution amongst the three vertical skeletal patterns, the sample showed that a 30% (n=12) of normal angle patients had consonant smiles, 65% (n=26) showed flat smile arcs and 5% (n=2) presented with reverse smiles, for vertically high angle cases 40% (n=16) had consonant smiles, 55% (n=22) showed flat smile arcs and a 5% (n=2) showed Reverse smile arcs (Table VI).

DISCUSSION

Smile is a dynamic interplay of perioral soft tissues with underlying dental and skeletal elements.[11-13] The beauty of a smile is in the harmonized relationship between teeth, gingiva, and lips. All three of which when present in their optimal states bring together a pleasing smile.

There are numerous studies on smile that used still photography or direct measurements for their analysis.[14,15] A key shortcoming of still photography is the failure to know whether the observer was able to capture the intended frame in that one picture. In order to battle this disadvantage, in our study, digital video was used.

In our study the vertical smile parameters (Maximal Incisal Display, Inter Labial Gap, Upper Lip Length) were observed to be greater in the skeletally high angle cases as compared to the low angle cases. The horizontal smile measurement, (ie, Inter Commissure Width) displayed a reverse tendency. It was decreased in the skeletal high angle cases as compared to the skeletally low angle cases in females. These results were consistent with observations made by Grover et al.[16]

Our study found statistically significant results for upper lip length (ULL), it was significantly increased in skeletally high angle cases when put in comparison to the low angle cases (p 0.002). The results of this study were consistent with the outcomes of Blanchette,[17] Lai et al.,[18] and Feres et al.,[19] who deduced based on their lateral roentgenogram studies that dolichofacials had long lips, while brachyfacial individuals had shorter lips.

In our study Maximal Incisal Display (MID) was significantly increased in males in high angle cases (p 0.007) as compared to the low angle cases, which was similar to the outcomes of Miron et al.[20] in their study exploring the maxillary lip changes and the different amounts of gum exposure upon smiling. The increased incisal display in skeletally high angle cases during smile can be implied to the underlying increased maxillary height and to the greater elevation of the maxillary lip seen in subjects with vertical growth patterns.[21] George et al., found a higher prevalence (2.5%) for high smile line in females as compared to males which impelled increased incisal show at smile for female vs male.[22] A study involving young females with different skeletal forms evaluated for their lip positions on smile revealed that in the high angle group, the upper/maxillary lip was elevated increasingly more in the vertical direction compared with the normal and low angle groups.[23] Our study showed gender dimorphism for upper lip length (ULL), with greater amount of shortening and increased incisal display observed for skeletally high angle females. These outcomes support the conjecture that individuals having a gummy smile have hypermobile upper lip.[24] In skeletally high angle pattern, muscle responsible for elevating the lip has an increased angle to the horizontal plane. As the muscle contracts and comes into play, it brings about an increased distance in the vertical plane, and this helps explain as to why individuals in the skeletally vertical/high angle group display more lip elevation.[23]

Inter Labial Gap (ILG) is significantly mediated by the vertical alterations of the lips. Individuals with high skeletal profiles have increased upper lip elevation than low angle cases.[23] This conclusion is identical to the study of Siddiqui et al[10] using 2-dimensional videography. Our study was consistent with these findings.

TABLE III: MEAN VALUES OF SMILE VARIABLES IN THE THREE SKELETAL GROUPS WITHIN MALES AND FEMALES

Measurements (mm)	Group	Gender	Mean (mm)	Std. Deviation
Upper Lip Length (ULL)	Normal angle	Male	18.239	2.087
		Female	17.740	1.309
	High angle	Male	18.574	1.476
		Female	17.933	1.983
	Low angle	Male	16.234	1.595
		Female	16.990	1.838
Change in Upper Lip Length (ULL)	Normal angle	Male	13.844	2.819
		Female	12.755	2.129
	High angle	Male	13.677	1.580
		Female	13.247	1.779
	Low angle	Male	12.130	1.886
		Female	12.819	2.209
Maximum Incisal Display (MID)	Normal angle	Male	8.260	1.516
		Female	8.607	1.542
	High angle	Male	8.900	1.127
		Female	9.160	1.500
	Low angle	Male	7.363	1.905
		Female	7.925	2.076
Inter Labial Gap (ILG)	Normal angle	Male	10.177	2.982
		Female	12.190	3.258
	High angle	Male	11.901	2.143
		Female	12.675	3.203
	Low angle	Male	8.912	3.609
		Female	9.438	2.588
Inter Commissure Width (ICW)	Normal angle	Male	56.466	6.112
		Female	59.415	5.256
	High angle	Male	55.841	3.789
		Female	58.241	5.447
	Low angle	Male	56.336	4.713
		Female	63.394	8.140

TABLE IV: COMPARISONS AMONGST THE THREE GROUPS WITHIN MALES AND FEMALES (P VALUE) BY TUKEY'S POST HOC TEST

MEASUREMENTS (Millimeter)		Normal angle Mean±SD	High angle Mean± SD	Low angle Mean± SD	Low angle vs normal angle (p value)	Low angle vs high angle (p value)	Normal angle vs high angle (p value)
Upper Lip Length	Female	17.740±1.309	17.933±1.983	16.990±1.838	0.365	0.207	0.934
	Male	18.23±2.087	18.574±1.476	16.234±1.595	0.002	0.000	0.816
Change in Upper Lip Length	Female	12.755±2.129	13.247±1.779	12.819±2.209	0.995	0.787	0.729
	Male	13.844±2.819	13.677±1.580	12.130±1.886	0.039	0.069	0.968
Maximum Incisal Display	Female	8.607±1.542	9.160±1.500	7.925±2,076	0.429	0.070	0.572
	Male	8.260±1.516	8.900±1.127	7.363±1.905	0.169	0.007	0.397
Inter Labial Gap	Female	12.190±3.258	12.675±3.203	9.438±2.588	0.016	0.004	0.869
	Male	10.177±2.982	11.901±2.143	8.912±3.609	0.376	0.007	0.168
Inter Commissure Width	Female	59.415±5.256	58.241±5.447	63.394±8.140	0.131	0.036	0.832
	Male	56.466±6.112	55.841±3.789	56.336±4.713	0.996	0.947	0.916

It showed significantly ($p<0.01$) decreased values in patients with skeletal low angle pattern while increased values were recorded for vertically high angle cases in both the genders.

An increased number of subjects depicted a flat smile arc (66.5%) on smile, with consonant and reverse smiles being 26% and 7.5% of the sample. A study in 2007 compared the smile arcs of treated and untreated orthodontic patients and found similar prevalence with an increased number of patients showing flat smile arc.[12] A correlation was found between horizontal growers that showed more non-consonant smiles as compared to the other groups.[25,26] In the individuals who are skeletally low angle cases, the posterior maxillary occlusal plane shows an increased vertical growth than the anterior. This unfavorable posterior vertical growth produces a non-consonant smile arc which is considered less aesthetic.[27,28] Theoretically individuals with the horizontal growth patterns usually have an anterior maxillary occlusal plane that fails to show the necessary clockwise rotation needed to form an ideal smile arc.[29-31]

CONCLUSION

Varying skeletal patterns displayed distinctive smile dynamics. Individuals with skeletally high angle showed increased incisal display and an increased upper lip elevation upon smiling. Individuals with skeletally low angles depicted a decreased inter-labial gap and showed a prevalence for flat smile arcs.

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TABLE V: SMILE ARC FREQUENCIES

		Smile Arcs						Total
		Consonant		Flat		Reverse		
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
Vertical Skeletal Patterns	Normal	12	30%	26	65%	2	5%	40
	High	16	40%	22	55%	2	5%	40
	Low	4	10%	31	77.5%	5	12.5%	40
Total		32	26.66%	79	65.83%	9	7.5%	120
Gender Dimorphism	Males	18	30%	40	66.7%	2	3.3%	60
	Females	14	23.3%	39	65%	7	11.7%	60

TABLE VI: MAXIMAL INCISAL DISPLAY

Vertical Skeletal Patterns		Maximal Incisal Display				Total
		Inadequate		Adequate		
		Frequency	Percentage	Frequency	Percentage	
Males	Normal angle	8	40%	12	60%	20
	High angle	3	15%	17	85%	20
	Low angle	11	55%	9	45%	20
Total		22	36.7%	38	63.3%	60
Females	Normal angle	8	40%	12	60%	20
	High angle	5	25%	15	75%	20
	Low angle	10	50%	10	50%	20
Total		23	38.3%	37	61.7%	60

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

ZaA: Concept and study design, analysis and interpretation of data, drafting the manuscript, critical review, approval of the final version to be published.

ZHA: Analysis and interpretation of data, drafting the manuscript, approval of the final version to be published.

ZuA: Acquisition of data, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request