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Frequency of Dentoskeletal Factors Affecting Soft Tissue Chin Strain on Lip Closure in Class I And Class II Div I Malocclusion

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Abstract

Introduction: Contemporary orthodontics includes the treatment of dental and skeletal disharmonies, including careful consideration of integumental features of the face. Whenever there is a protuberance of upper or lower incisors, attempts by patients to close their lips result in lip strain, which is supplemented by hyperactive mentalis muscle function and elevation of the integument of the chin. Orthodontic treatment usually corrects this problem and results in smoother soft tissue contours.[1]

Objective: To assess the frequency of dentoskeletal factors (UI-N.Pog distance, overjet, UI-ULip distance) affecting soft-tissue strain of chin on lip closure in class I and class II div I malocclusion.

Material and Methods: Lateral Cephalograms and pretreatment frontal and lateral facial photographs of eighty patients were analyzed to calculate the angular and linear measurements.

The frequency of dentoskeletal factors (UI-N.Pog distance, overjet, UI-ULip distance) affecting soft-tissue strain of chin on lip closure in class I and class II div 1 malocclusion were assessed.

Result: Soft tissue chin strain was seen in Class I and Class II div 1 malocclusion when upper incisor-nasion pogonion (UI-NPog) distances were greater than 14.2 mm, Overjet was greater than 4.7 mm, or Upper incisor-upper lip (UI-ULip) distances were greater than 5.6 mm.

Conclusion: UI-NPog, with a cutoff estimate of 14.2mm, was used to categorize no-strain or strain subjects, followed by overjet, which had a cutoff estimation of 4.7mm, and UI-upper lip distance, which had a cutoff estimation of 5.6mm. Orthodontic treatment should aim to decrease UI-NPog distance, overjet, and UI-Upper lip distance values in order to achieve optimum esthetics and to achieve ideal or near-ideal appearing soft tissue contours in individuals with Class I and Class II div 1 malocclusions.

Keywords: Soft-tissue chin; Mentalis; class I malocclusion; Class II div I malocclusion

Introduction

Orthodontics strives to ensure a harmonious soft tissue profile and good dental and skeletal relationships as part of the treatment process. It is sometimes challenging to achieve such a profile due to the highly variable thickness of the soft tissues that cover the teeth and bones.[2] Whenever there is a procumbence of upper or lower incisors, closing the lips results in hyperactive mentalis muscle function, and a rise of the integument of the chin occurs.[3] This problem can usually be corrected through orthodontic treatment, resulting in a smooth, soft tissue contour.[4]

Structural discrepancies have traditionally been viewed as the primary limitation of

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orthodontic treatment by orthodontists. As a matter of fact, therapeutic modifiability is more closely related to soft tissues than to hard tissues. Eventually, it became obvious that even excellent occlusion would be unsatisfactory if it was achieved at the expense of appropriate facial proportions. Soft tissue analysis has been suggested as a reliable guide for occlusal treatment and subsequent soft tissue changes. [5]

The total mass, position in space, and typical activity of the soft-tissue structures largely influence tooth stability, malocclusion, and facial esthetics. To achieve a desirable and aesthetically pleasing soft tissue profile, dental or skeletal factors that affect soft tissue chin contour must be deliberated in the analysis and treatment planning.[6,7] Vertical height of the face increases with growth, but the lips maintain a stable relationship with incisal edges.[8]

Usually, two lip positions are available: the position of the relaxed lip, where the lips are relaxed, loose, and not constricting, and the position of the closed lip, where the lips are lightly touching to produce an anterior seal.[9,10] In the Class II div I case where there is a noteworthy overjet, the closed lip position is inferred as that position in which light contact exists between the maxillary incisor and the lower lip.[11] An orthodontic patient with an extended anterior face height with protruding incisors and a large interlabial gap will likely experience soft tissue chin strain upon closing the lips. An elongated lower lip and upward movement of the mento-labial sulcus indicate tension.[12]

Aesthetic considerations are integral to orthodontic principles and practice. According to Mary-Eleni[13], most patients seek orthodontic services because they have facial disharmony or misaligned teeth. There must be visible improvements in the protrusion of the lips, the contour of the lower lip, and the development of the chin. Patients are not particularly concerned with bone changes and tooth angulations.

Early orthodontists used dental occlusion as a model for correcting teeth and jaw irregularities in young, growing patients. As facial aesthetics have evolved over time, the use of quantitative soft tissue diagnostics has replaced cultural and ethnic-based norms.[14]

Broadbent's introduction of cephalometric radiography in 1931 inevitably shifted the skeletal structures in priority compared to the facial soft tissues.[15] However, clinicians understand that soft tissue changes are related to complex tissue changes. Research has shown that adhering to hard tissue norms does not result in facial balance or harmony, nor does it ensure long-term stability.[4] The harmonized facial structures are a primary goal of orthodontic treatment.[13]

A profound analysis of soft tissues is required for effective treatment planning and adequate diagnosis. Orthodontic procedures can provide acceptable facial contours but may not always achieve the best results. At this point, surgical intervention is justified to enhance the treatment's outcome.[16]

It is well known that the soft tissue facial profiles of Caucasian subjects have been extensively studied, but little is known about the soft tissue facial profiles of black subjects.[17,18] In today's multicultural society, racial and ethnic differences have become increasingly important. Today's metropolitan areas have a more diverse population, presenting the challenge of making diagnostic and treatment decisions based on a single measure of facial aesthetics.[19]

Usually, changes in appearance after correction of malocclusion should satisfy all concerned. However, many orthodontists had the dreadful experience of discovering that some subjects' faces looked better before they had orthodontic corrections made.[20]

There is a close association between the study of orthodontics and facial art. "The mouth is the most potent factor in creating or distorting the beauty and character of the face." These words of Edward H Angle preceded a methodical debate on facial art correlated to orthodontics.[21] So, a single facial aesthetics and profile standard may not be applied to disparate facial and ethnic groups.

In 2013, Yun-Hee Yu et al.[9] studied the lateral cephalograms with pretreatment facial photographs (frontal and lateral) of 209 women (aged 18–30 years) with Class I or II malocclusions. Upper Incisor-Nasion Pogonion (UI- N.Pog: cut off value < 4.8mm with 86.3% fall in no strain group), and Upper incisor-upper lip (cut off value < 5.75% with 90.1% fall in no strain group), were found to be discriminants for group classification, and the prediction rate was 81.8%. The male Korean population was not included in this study.

This study aims to assess the frequency of dentoskeletal factors (UI-N.Pog distance, overjet, UI-ULip distance) affecting soft-tissue strain of chin on lip closure in class I and class II div I malocclusion, coming to the orthodontic department of Sharif medical and dental college, Lahore & University College of Dentistry, Lahore. In Pakistan, this will be the first research of its kind. These dentoskeletal factors were not emphasized much in the past, and no regional statistics were available. As a result, we can diagnose and plan orthodontic interventions for achieving aesthetic soft tissue profiles for both males and females and determine their local magnitude. This study will also provide these critical factors' local magnitude and norms.

Material and Methods

A descriptive cross-sectional study was conducted in the Department of Orthodontics, Sharif medical and dental college, Lahore for six months after synopsis approval. The inclusion criteria include Lateral Cephalograms and pretreatment frontal and lateral facial photographs of patients of both genders, aged 15-30 years with complete permanent dentition, and both parents of Pakistani origin were collected. Patients with any craniofacial deformity or syndrome, previous orthodontic or orthognathic treatment, multiple missing teeth, and ANB less than 0° were excluded.

The sample size was calculated using WHO sample size calculator at 95% confidence level and 9% margin of error. It came out to be Eighty cases in total (31 Class I and 49 Class II div 1), taking the likely percentage of Upper lip-Nasion Pogonion (UI- N.Pog), i.e., 80% (least among all) factors affecting soft tissue strain on the chin on lip closure in Class I and Class II div 1 malocclusion. Non-probability consecutive sampling was used.[22]

After ethical board committee approval, form no #320-AD/PG/R/SMDC, and written informed consent by patients, Lateral Cephalograms were taken with the "SoreDex Carnex-D Ceph" machine in a natural head position with lips parted. The subject-to-source distance was kept constant, i.e., 5 feet for all patients.

Pretreatment lateral and frontal photographs, with Camera settings for extra Oral photographs with a shutter speed set at 1/200sec, ISO 800, six feet distance between patient and camera, and F 1/8, of patients were taken to assess dimpling or puckering of mentalis muscle on lip closure, i.e., soft tissue chin strain.

Cephalograms of each subject were traced with a 0.3mm mechanical pencil on standard 0.003-inch acetate tracing paper. Cephalometric landmarks and references for the skeletal and dental measurements are displayed in Figure 1. The number of Cephalograms traced daily will be kept to a maximum of 5, eliminating the error due to fatigue.

Data were evaluated utilizing SPSS version 18. Quantitative data, i.e., age, was assessed as mean with standard deviation. Qualitative data, i.e., gender and dentoskeletal factors, i.e.: (UI-N.Pog distance, overjet, and UI-upper lip distance) were given in the form of percentages and frequency. Data were stratified in relation to age and gender, and the post-stratification chi-square test was employed with a p-value ≤0.05 as significant.

Results

The total data of 80 patients were entered and analyzed in SPSS version 18. The distribution of gender was calculated in terms of frequency and percentages. The frequency and percentage of male patients were 33 (41.3%), while the frequency and percentage of female patients were 47 (58.7%). Female patients were more frequent as compared to male patients.

Descriptive statistics of the age of patients were calculated for patients 15-30 years of age in different angle malocclusions in both males and females and age groups were categorized, i.e., adolescents (15-19 years) and adults (20-30 years). The result showed that the 41(51.2%) subjects of the adolescent age group were more frequently visited than the adult age group 39 (48.8%). There were 33 male subjects and 47 female subjects in total.

In Table 1, Descriptive statistics of dentoskeletal factors of patients were calculated for patients in different angle classes in both males and females.

Table 2 calculated the frequency of angle class I and class II div 1 malocclusion. Class II div 1 with strain & class I without strain were more frequent.

In Table 3, Data was stratified of angle classes for UI-NPog distance. The post-stratification chi-square test presented a p-value of 0.000 < 0.05, showing a strong positive correlation between the two variables. The increased values of this factor resulted in chin strain in class II div 1 and class I malocclusions.

In Table 4, Different angle classes were calculated and stratified for overjet. The cut-off value of overjet was ≤ 4.7 mm. Post-stratification chi-square test presented a p-value of 0.000, which is < 0.05. It showed a strong positive correlation between the two variables, and the increased values of this factor resulted in chin strain in class II div 1 and class I malocclusions.

In Table 5, the Frequencies of the Upper incisor to upper lip distance showed a strong positive correlation, with a p-value is 0.00, which is < 0.05, and the increased values of this factor resulted in chin strain in class II div 1 and class I malocclusions.

<u>Co-relation of soft tissue chin strain with dentoskeletal factors:</u>

The strain was seen by dimpling of the mentalis muscle at the muscle insertion point and puckering of the soft tissue chin on lip seal in frontal and lateral photographs when the values of UI-NPog >14.2mm, Overjet > 4.7mm, UI-ULip distance >5.6mm.

Table 1: Frequency distribution of categories of dentoskeletal factors

Upper incisor- nasion pogonion	Frequency	Percent
Up to 14.2 mm	48	60.0
Above 14.2mm	32	40.0
Total	80	100.0
Overjet categories	47	58.8
Up to 4.7 mm		
Above 4.7mm	33	41.3
Total	80	100.0
Upper incisor – upper lip distance		
Up to 5.6 mm	48	60.0
Above 5.6 mm	32	40.0
Total	80	100.0

The cut-off values of UI-NPog=14.2mm, overjet= 4.7mm, and UI-ULip= 5.6mm are more frequent in the sample than the values more extraordinary than the cut-off values of respective variables.

Table 2: Frequency distribution of angle classes

		Frequency	Percent
Class I		31	38.8
Class II div 1		49	61.3
Class I	with strain	4	5.0
Class I	without strain	27	33.8
Class II div 1	with strain	28	35.0
Class II div 1	without strain	21	26.3
Total		80	100.0

Class II div 1 malocclusion is more frequent than class I in the overall sample. Class I malocclusion without strain and class II div 1 with strain are more frequent.

Association of upper incisor- nasion pogonion (UI-NPog) distance categories with both angle classes and chin strain is statistically significant. Values greater than 14.2 mm have presented with chin strain in class I and class II div 1 malocclusion.

Table 3: Stratification of angle classes with respect to upper incisor- nasion pogonion (UI-NPog) distance categories

Class	UI-NPog categories		Total	P-value
	Up to 14.2mm	Above 14.2mm		
Class I with strain	0 0.0%	4 100.0%	4 100.0%	0.000
Class I without strain	27 100.0%	0 0.0%	27 100.0%	
Class II div 1 with strain	0 0.0%	28 100.0%	28 100.0%	
Class II div 1 without strain	21 100.0%	0 0.0%	21 100.0%	
Total	48 60.0%	32 40.0%	80 100.0%	

Table 4: Stratification of sagittal classes with respect to overjet categories

Class	Overjet categories		Total	P-value
	Up to 4.7mm	Above 4.7mm		
Class I with strain	0 0.0%	4 100.0%	4 100.0%	0.000
Class I without strain	26 96.3%	1 3.7%	27 100.0%	
Class II div 1 with strain	0 0.0%	28 100.0%	28 100.0%	
Class II div 1 without strain	21 100.0%	0 0.0%	21 100.0%	
Total	48 58.8%	32 41.3%	80 100.0%	

Table 5: Stratification of sagittal classes with respect to upper incisor- upper lip (UI-ULip) distance categories

Class	UI-ULip categories		Total	P-value
	Up to 5.6mm	Above 5.6mm		
Class I with strain	0 0.0%	4 100.0%	4 100.0%	0.000
Class I without strain	27 100.0%	0 0.0%	27 100.0%	
Class II div 1 with strain	0 0.0%	28 100.0%	28 100.0%	
Class II div 1 without strain	21 100.0%	0 0.0%	21 100.0%	
Total	48 60.0%	32 40.0%	80 100.0%	

Discussion

Patients' principal priority is facial attractiveness when seeking orthodontic treatment or combined surgical orthodontic therapy. A successful treatment planning process necessitates accurately predicting the post-treatment facial profile. [2]

During the assessment of orthodontic problems, the determining role of the dentoskeletal factors (UI-NPog distance, overjet, UI-Upper lip distance) must be recognized. Including these factors as significant ones in the diagnostic assessment brings in an area of the craniofacial complex not generally considered when diagnosing malocclusion.[3]

Mentalis muscle has aesthetic and functional significance in deciding a patient's profile.[2] It has a focal part in moving the lower lip and decides the jaw's position. In an unaesthetic-looking face with lip incompetency and maxillary incisor proclinations, this mentalis muscle tends to be hyperactive to pick up lip seals which build the pressure at the inclusion site of the mentalis and cause puckering and dimpling of soft tissue chin button.[4]

The present study selected 80 patients divided into two age groups, i.e., adolescents (15-19 years) and adults (20 to 30 years). Patients of both genders aged 15 to 30 years (mean age of 19.4 + 3.6) having normal skeletal vertical relationships were selected. Patients with any craniofacial deformity or syndrome, cleft lip and palate, previous orthognathic or orthodontic treatment, several missing teeth, prostheses, ANB <0°, anterior crossbite, or edge-to-edge bite were not included in the study.

The prevalence of angle class I malocclusion was 38.8%, with soft tissue chin strain at 5% and without soft tissue chin strain at 33.8%. While the incidence of angle class II div 1 malocclusion was 61.3%, with soft tissue chin strain at 35% and without tissue chin strain at 26.3 %. Class II div 1 malocclusion patients are prevalent in the Pakistani population. The results were corroboration by the results from Wenxin[9] and his group. As compared to the no-strain group, the strain group had a lower number of subjects in Class I malocclusion (48 [38.7%] vs.76 [61.3%]) while a marginally higher number with Class II malocclusion (47 [55.3%] vs. 38 [44.7%]).[9.]

The principal factor to be inspected is UI-N.Pog had the most elevated distinguishability at a break-off estimation of 14.2mm. UI- N.Pog distance ranges from 2-19mm with a mean value is 12.35 +3.9 mm. In a past report directed by Ruba[23], patients with Class II div 1 malocclusion and lip inadequacy had advanced perioral muscle exercises compared to those with Class I malocclusion with typical maxillary incisor proclinations.[24] Further, in a past report by Rian[25], in bimaxillary incisor proclinations, the action of the lower lip was evaluated because of extensive pressure on the chin button when lips are closed. These investigations are practically identical to the current study as they assessed Asian populations (both genders). Moreover, the prominence of the chin button should not be overlooked in addition to the maxillary incisors. Due to a feeble and retrognathic lower jaw, strain in the mentalis area occurs as the lower lip must distend more to cover the maxillary incisors.[26] Ideal treatment must include maxillary incisors retraction or orthognathic surgery, such as basal subapical split osteotomy progression for a more favorable chin button.

The following prescient variable studied in the present study was overjet, with break-off estimations of 4.7mm. Overjet ranges from 0.50 -14mm with a mean value are 6.11±3.2mm. The overjet has been shown to affect lip action in a previous study, where diminished upper lip movement and expanded action of the lower lip were related to the increased overjet, affecting lip seal, discourse, and mastication.[27]

In a preadolescent group, Guan[28] studied the Han populace and concluded that overjet > 6mm was unequivocally related to a confined lower lip and that >7mm encouraged unsatisfactory coverage of the lower lip over the maxillary incisors. In contrast, there is no direct association between the overjet and the various distinctive positions of the upper lip.[29]

UI-upper lip (mm) estimates the respective length of the upper lip. UI-Upper lip distance ranged from 1 - 8mm with a mean value of 4.85±1.8mm. The cut-off value of 5.6mm demonstrates the association of increased strain in the mentalis with maxillary incisor extrusion. Class II div 1 malocclusion subjects had an extraordinary relationship, suggesting that the maxillary incisors are likely to supra-erupt in this malocclusion.

Stephan et al.[30] revealed that the maxillary incisor tip, when shifted, had the most potent effect on the lower lip vertical position. Lower lip eversion occurs because of padding of the lower lip on the lingual side of extruded maxillary incisors. Maxillary incisors' vertical position should also be deliberated during orthodontic treatment, along with other factors.[3]

The present study's findings corroborate a previous report by Wenxin et al.[9], who also found approximately 14.2 mm of a cut-off value of UI-N.Pog distance, 4.8mm of a cut-off value of overjet, 5.75 mm cut-off value of UI-Upper lip distance in the Korean female population.

In the present study, the post-stratification chi-square test for gender and soft tissue chin strain on lip closure was used; the p-value was 0.4, which was > 0.05, so there is no positive correlation between the two variables. Post-stratification chi-square tests for age groups and soft tissue chin strain on lip closure were calculated; the p-value was 0.9, which was > 0.05, so there is no positive correlation between the two variables, and chin strain was independent of age. However, the percentage of adult subjects presented with chin strain in the sample was relatively high (53.1%).

Post-stratification chi-square test for association between dentoskeletal factors (UI-N.Pog, overjet, UI- Upper lip distance) and soft tissue strain of chin on lip closure to check the significance level. The p-value was 0.00, which was <0.05, so there was a positive correlation between the two variables chin strain is dependent on the dentoskeletal factors, and the correlation coefficient shows that the dentoskeletal factors have a significant effect size on chin strain.

In patients with soft tissue chin button strain, extraction of premolar teeth is one method for establishing a cordial maxillary and mandibular incisor relationship. Lip action changes result in a more attractive profile.[31] By recognizing the factors that impact the soft tissue strain, a rule can be developed for considering the vital dentoskeletal elements of orthodontic treatment. UI-N.Pog, overjet, and UI-upper lip distance values should be arranged to lessen the strain on the delicate soft tissue.

The dentoskeletal structure and the soft tissue's thickness, length, and tone can strain this delicate tissue. Additional studies should incorporate soft tissue factors for a favorable profile after orthodontic treatment. The present study was confined to a small sample of the Pakistani population. Further studies about racial gatherings are justified to examine the errors emerging from these prescient variables.

Conclusion

1. UI-NPog, with a cutoff estimate of 14.2mm, was used to categorize no-strain or strain subjects, followed by overjet, which had a cutoff estimation of 4.7mm, and UI-upper lip distance, which had a cutoff estimation of 5.6mm.
2. Comparing the strain group to those in the no-strain group, the strain group displayed retruded mandibles and dentoalveolar proclinations.
3. Pakistani population samples showed a higher prevalence of class II div 1 malocclusion than class I. In Class II div 1, the strain was more prominent due to the small mandible and proclined upper incisors, followed by class I without strain.
4. A higher proportion of females than males developed skeletal patterns of class II.

Ethical Approval

The study was approved by the ethical board committee of Sharif Medical and Dental College (Ref #320-AD/PG/R/SMDC).

Conflict of Interest

No conflict of interest

Authors' Contribution

GH: Conceptualization, data collection, discussion writing

MN: Data Collection, editing

AY: Statistical analysis

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