Original Article

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Correlation of hard and soft tissue among different sagittal malocclusion

Yadav R,[1] Poudel S,[2] Joshi DR,[3] Yadav N[4]

[1]Rajiv Yadav, [2]Sanju Poudel, Department of Orthodontics and Dentofacial Orthopaedics, Dental Teaching Hospital; [3]Deepak Raj Joshi, Department of Community Medicine and Public Health, Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University; [4]Neelam Yadav Consultant Prosthodontist, Multi-Specialist Dental Hospital Private Limited, Maharajgunj, Kathmandu, Nepal.

ABSTRACT

Introduction: The essential determinant for facial aesthetics is an understanding of the relationship between the facial bones and soft tissue. A proportionate relationship among the different structures of a face is the key to its aesthetic and pleasing appearance. The facial profile is determined by the facial soft tissue thickness (FSTT) and dental and skeletal characteristics. Face contours are traditionally considered to be a result of the position of basic hard dental and skeletal tissues followed by the soft tissue.

Objective: To correlate the hard and soft tissue in different skeletal malocclusion.

Methodology: A descriptive cross-sectional study was conducted from 2023 September to 2024 May after ethical approval. Convenient sampling method was used to collect 105 samples who were divided into three groups I, Class II, Class III. Patients aged 18-30 years were included in this study. Patients undergoing orthodontic treatment and with no craniofacial deformities were included in the study. Statistical analysis was performed using IBM SPSS Statistics for Windows, version 21 (IBM Corp., Armonk, N.Y., USA).

Result: In this study, in hard tissue parameter, mean value of LI to A-pog, UI to PP plane, UI to SN plane, Interincisal angle, IMPA is 4.458 mm, 118.08 ◦,112.16◦, 115.64◦ and95.98◦ respectively. Whereas in soft tissue parameter, mean value of UL-SNpog', LL-SNpog', LLSMe, Sn-ULI, Sline to lower lip, upper lip thickness andLower lip thickness are 2.91mm, 3.34mm, 41.2, 15.36mm, 2.136mm, 13.964 mm and 12.42mm respectively.

Conclusion: There is correlation of hard tissue to soft tissue. Hence clinicians and researchers must give due considerations while working on these parameters.

Keywords: cephalometric analysis; hard tissue; skeletal malocclusion; soft tissue.

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Address for correspondence

Dr. Rajiv Yadav,
Associate Professor and Head,
Department of Orthodontics and Dentofacial Orthopaedics,
Dental Teaching Hospital, Maharajgunj Medical Campus,
Institute of Medicine, Tribhuvan University, Maharajgunj,
Kathmandu, Nepal.
E-mail: drrajivresearch@gmail.com

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INTRODUCTION

Gidon determined facial features that evoke pleasure.[1] 80% of patients seek orthodontic treatment for aesthetic purposes, regardless of their functional condition, evaluation of facial aesthetics became a routine in orthodontic practice, both during and after orthodontic treatment.[2]

Several cephalometric standards have been introduced to assess attractiveness of the face; yet it has been shown that facial harmony can exist within a wide range of cephalometric values.[3,4] The essential determinant for facial aesthetics is understanding of the relationship between facial bones and soft tissue. However, soft tissue acts independently of the basic dento-skeletal base and is considered to be main factor in determining a patient's final facial profile.[5] Placing teeth according to accepted cephalometric criteria does not necessarily ensure that overlying soft tissue will drape in a harmonious

manner.[6-8] There is shift of the paradigm from the conventional analysis of hard tissues, to include soft tissue.[9-11] Muscles, subcutaneous fat, soft tissue and skin, develop proportionately in relation to corresponding skeletal structures.[12] There can be variations in the thickness, length, and tone of soft tissue, which all affect facial aesthetic.[13]

Patients have least interest regarding changes occurring in bone or the angulations of teeth as exhibited in a cephalometric radiograph, rather they have keen interest in visual changes in protrusion of the lips, curl of lower lip and the apparent growth or the forward displacement of the chin.[5,14-16] Since the soft tissues largely determine the limitations of orthodontic treatment, from the perspectives of function and stability and aesthetics the orthodontist must plan treatment within the patient's limits of soft tissue adaptation and soft tissue contours driven by the same concern aiming to organise a diagnostic method supported by protocols and capable of providing specific predictions.The purpose of this study is to correlate the hard and soft tissue in different skeletal malocclusion.

METHODOLOGY

A descriptive cross-sectional study was designed after rigorous literature search.[16-22] The ethical clearance for the study was obtained from the Institutional Review Committee of Maharajgunj Medical Campus, Institute of Medicine, Maharajgunj, Kathmandu, Nepal (Reference Number: 130(6-11) E2 080/081. Convenient sampling method was used to enroll 105 patients undergoing orthodontic treatment with Skeletal Class I, Skeletal Class II and Skeletal Class III with 35 samples in each group. Routine cephalometric x-rays of the samples were collected after taking consent from the samples. The Skeletal Class I, II, III relation, adult patients, completely erupted teeth from second molar to second molar in both arches, no severe crowding and spacing in posterior segments, mo inter radicular pathology, acceptable radiographic quality, no history of previous orthodontic or prosthodontic treatment were the inclusion criteria. Dental arches with severe crowding or rotation causing interradicular space deficiency, missing teeth, periodontal disease-causing defect within interradicular space, poor quality radiographic images were excluded from the study. The study was conducted at Department of Orthodontics and Dentofacial Orthopaedics, Tribhuvan University Teaching Hospital, Maharajgunj Medical Campus, Institute of Medicine, Kathmandu. The data were collected from 2023 September to 2024 May after ethical approval. Following cephalometric measurements will be done to classify different skeletal malocclusion samples: SNA angle: angle formed by the SN line and the NA line, SNB angle: angle formed by the SN line and the NB line, ANB angle: angle formed by the NA line and the NB line, Wits Appraisal: distance between points AO and BO (perpendicular line from pt. A and pt. B to functional occlusal plane), Beta Angle: angle formed between the A-B line and the perpendicular through point A from the apparent axis of the condyle (C). CI (0≤ ANB ≤4), CII div 1 (ANB > 4 with normal or proclined upper incisors), CII div 2 (ANB > 4 with retroclined upper incisors) and CIII (ANB < 0). Hard tissue variables – U1-L1, U1-SN, U1-PP, U1-NA, U1-NA (mm), U1-APog, U1-APog (mm), L1-NB, L1-NB (mm), L1-APog, L1-APog (mm), L1-MP. Soft tissue variables – UL-SnPog', LL-SnPog', UL-E, LL-E, UL-S, LL-S, NLA, NB-H, Sn-ULI, LLSMe, UL thickness, LL thickness, A'-TVL, ULA-TVL, LLA-TVL, B'-TVL, ULC.[14] Inter-observer reliability will be calculated using Intraclass Correlation Coefficient (ICC) test. Analyses will be performed using the SPSS program (SPSS Inc, Chicago, Ill). Mean and standard deviation of safe zone was determined. One-factor analysis of variance (ANOVA) will be used to compare means of measurements between different skeletal patterns. Post hoc multiple comparison will also be performed with Tukey test when ANOVA yielded significant difference. P-values <0.05 will be considered to be significant. The sample size was determined on the statistical evaluation of the previous study.[23] A minimum sample size of 102 patients (n = 34 per group) was required. An additional sample of three patients (n = 35 /group) was included to compensate for any patients who were lost due to follow-up. Descriptive statistics was used to calculate mean, minimum, and maximum values standard deviations. Pearson correlation test and Sperman test is used for correlation of different variable.

RESULT

The means and standard deviations of the skeletal, dental, and soft tissue variables are listed among skeletal class I, Skeletal class II and Skeletal Class III Table 1. The correlation between hard and soft tissues is tried to identify by using Spearman's rank correlation coefficient. In class I, the modest positive correlation of LI to A-Pog with s line to upper lip (r=0.31, p-value = 0.019) and S-line to lower lip (r=0.40 and p-value = 0.002). Similarly, UI to SN plane is found significantly correlated with LL-SnPog (r=0.27, p-value=0.038) and S-line to lower lip (r= 0.39, p-value=0.003). Also, a weak positive correlation is found in Interincisal angle with Nasolabial angle (r=0.31, p-value=0.017) and S line to lower lip (r= 0.260, p-value= 0.049). Correlation between other variables was found

in class I Table 2. In class II, there is the weak correlation of LI to A-Pog with Nasolabial angle (r=0.58, p-value = 0.00) and Similarly, IMPA is found Weakly correlated with Nasolabial angle (r=0.625, p-value=0.00). Also, a modest positive correlation is found in UI-PP plane with SN-ULI (r=0.35, p-value=0.045) Table 3. In class III, there is weak correlation of LI to A-Pog with LLS-Me (r=0.639, p-value = 0.01) and Similarly, Interincisal angle is found Weakly correlated with Sn-ULI (r=0.637, p-value=0.011) Table 4.

Table 1: The means and standard deviations of the skeletal, dental, and soft tissue variables are listed among skeletal class I, Skeletal class II and Skeletal Class III (n=105)

Descriptive Statistics	Class 1			Class 2			Class 3		
	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD
Age	7	36	18.72±5.163	12	31	19±4.99	12	26	19.13±4.24
SNA (82 ± 2°)	75	90	80.9±3.1859	77	86	81.516±3.1737	77	83	80.733±2.1536
SNB (80 ± 2°)	72	87	78.241±3.4733	70	81	75.672±3.5777	77	83	80.067±2.4044
ANB (2.8 ± 1.5°)	0	4	2.698±1.1545	4	9	5.688±1.0607	-1	3	0.667±0.9759
Wits AO/BO (0 to -1 mm)	-7	6	0.448±2.7605	-7	6	1.328±2.2987	-7	4	-1.567±2.9633
Beta angle (27- 35°)	21	47	31.33±4.864	21	36	29.94±4.032	23	41	31.47±5.041
HARD TISSUE									
LI to A-Pog (0.4 ± 1.8 mm)	-2.5	9	4.234±3.0347	-2.5	13	4.466±3.168	2	13	5.307±3.6031
UI to PP plane (112 ± 5)	89	135	117.17±8.676	89	133	118.5±9.066	90	135	120.67±13.254
UI to SN plane (102°)	91	142	112.21±11.026	91	127	112.12±9.435	91	142	112.07±14.911
Interincisal angle (135.4°)	98	160	117.59±14.873	90	140	111.22±12.21	100	160	118.2±16.072
IMPA	27	112	96.12±12.655	27	112	95.94±15.31	27	115	95.53±20.375
SOFT TISSUE									
UL-SnPog'upper lip to subnasale to pogonion	-1.5	6	2.897±1.5066	-1.5	5	2.969±1.385	-1.5	4	2.833±1.3584
LL-SnPog'lower lip to subnasale pogonion	-1	6	3.397±1.7715	-1	5	3.281±1.6061	-1	4.5	3.267±1.387
LLSMe	36	46	41.302±2.426	34	45	41.031±2.7029	37	46	41.2±2.6979
Sn-ULI	13	18	15.336±1.5655	12	18	15.406±1.6086	13	18	15.367±1.5637
Nasolabial angle (102 8°)	79	127	101.93±12.976	75	130	100.78±13.958	75	117	98.13±12.878
Sline to ULSline to LL	-1.5	5	1.947±1.617	-1.5	5	2.366±1.7046	-1.5	4.5	1.493±2.1282
S line to lower lip	-2	7.5	2.0586±2.12198	-2	7.5	2.5509±2.03826	-2	5.5	1.55±2.15928
E line (-2 mm)	-9	9	1.383±4.6158	-9	5.6	0.831±2.9336	-4.5	9	1.333±3.5338
Upper lip thickness	12	18	14.021±1.5464	12	18	13.609±1.8954	12	18	14.5±1.9453
LL thickness	6	16	12.521±2.3827	6	15	12.163±2.1205	7	22	12.613±3.9161

Table 2: Spearman Correlation of hard and soft tissue in Class I (n=35)

Spearman's rho of Correlations Class I											
		UL-SnPog	LL-SnPog	LLSMe	Sn-ULI	Nasolabial (102 8°)	Sline- UL Sline-LL	S line to LL	E line (-2 mm)	UL thickness	LL thickness
LI to A-Pog (0.4 ± 1.8 mm)	Correlation Coefficient	0.11	0.227	-0.097	-0.193	0.116	.306*	.397**	0.171	0.143	0.046
UI to PP plane (112 ± 5)	Correlation Coefficient	0.103	0.137	0.036	-0.108	0.034	0.038	0.205	0.194	0.03	-0.165
UI to SN plane (102°)	Correlation Coefficient	0.216	.273*	0.074	-0.169	0.074	0.144	.387**	0.03	-0.194	-0.033
Interincisal angle (135.4°)	Correlation Coefficient	0.02	-0.194	0.04	0.117	-.313*	-0.224	-.260*	-0.025	-0.012	0.083
IMPA	Correlation Coefficient	-0.014	-0.006	-0.031	-0.178	0.127	0.101	0.093	0.067	0.243	-0.126

* Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).

Table 3: Spearman Correlation of hard and soft tissue in Class II (n=35).

Correlations of Spearman's rho Class II											
		UL-SnPog	LL-SnPog	LLSMe	Sn-ULI	Nasolabial (102 8°)	Sline-UL Sline-LL	S line to LL	E line (-2 mm)	UL thickness	LL thickness
LI to A-Pog (0.4 ± 1.8 mm)	Correlation Coefficient	-0.12	0.111	-0.144	0.092	-.582**	-0.002	0.099	0.017	-0.104	-0.03
	Sig. (2-tailed)	0.512	0.545	0.431	0.618	0	0.993	0.589	0.928	0.573	0.872
UI to PP plane (112 ± 5)	Correlation Coefficient	-0.227	0.17	0.273	.357*	-0.069	0.041	0.028	0.138	-0.049	-0.076
UI to SN plane (102°)	Correlation Coefficient	-0.146	0.106	0.1	0.074	0.104	-0.033	0.035	0.136	0.077	-0.019
Interincisal angle (135.4°)	Correlation Coefficient	0.231	-0.145	0.111	0.048	0.225	0.018	-0.099	0.057	0.104	-0.11
IMPA	Correlation Coefficient	0.047	0.067	0.074	0.321	-.625**	-0.093	-0.033	0.119	-0.3	-0.257

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Table 4: Spearman Correlation of hard and soft tissue in Class III (n=35)

Correlations of Spearman's rho Class III											
		UL-SnPog	LL-SnPog	LLSMe	Sn-ULI	Nasolabial (102 8°)	Sline-UL Sline-LL	S line to LL	E line (-2 mm)	UL thickness	LL thickness
LI to A-Pog (0.4 ± 1.8 mm)	Correlation Coefficient	-0.055	0.039	-.639*	0.051	-0.274	0.032	-0.052	-0.104	-0.076	0.343
UI to PP plane (112 ± 5)	Correlation Coefficient	-0.037	-0.13	-0.109	0.203	-0.196	-0.272	-0.096	-0.217	0.013	0.322
UI to SN plane (102°)	Correlation Coefficient	0.049	-0.149	0.057	0.203	-0.333	-0.301	-0.084	-0.147	-0.341	0.077
Interincisal angle (135.4°)	Correlation Coefficient	0.198	0.007	-0.298	-.637*	-0.015	-0.382	-0.293	-0.405	-0.07	-0.003
IMPA	Correlation Coefficient	-0.176	-0.071	-0.132	0.236	-0.427	-0.277	-0.265	-0.215	-0.334	0.088

* Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).

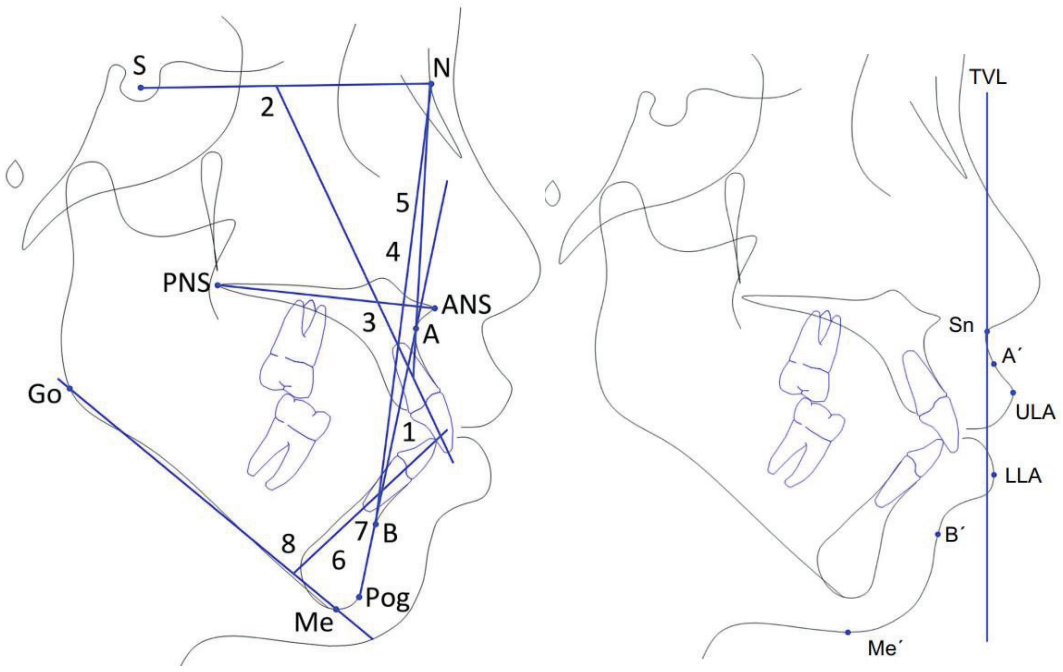

Figure 1: A, subspinale, A′, soft tissue A-point, ANS, anterior nasal spine,B, supramentale; B′, soft tissue B-point; Go, gonion;LL, lower lip; LLA, lower lip anterior; Me, menton; Me′, soft tissue menton, MP, mandibular plane (Go-Me); N, nasion; PNS, posterior nasal spine; Pog, pogonion; PP, palatal plane (ANS-PNS); S, sella, SD, standard deviation; Sn, subnasale; TVL, true vertical line; UL, upper lip; ULA, upper lip anterior; LFH, lower facial height; ULL, upper lip stomion superius; LLS, lower lip stomion inferius; UI, upper incisors; LI, lower incisors

DISCUSSION

This study was designed to assess the correlation between hard and soft tissues in Nepali adults. The age of the subjects selected was over 18 years, as recommended by Subtelny and Sakuda to exclude the effect of growth.[17] The cephalogram of the Nepali males and females were selected from the dental files of Resident doctors; these are usually taken as part of their training in the clinical orthodontic course for diagnosis and treatment planning.

Analysis of this group of Nepali adults with normal occlusion showed that the variation in upper lip length and lower lip position could be explained by variation in the position of the upper incisors position and inclination of the lower incisors. Saxby and freer detected a correlation between the upper and lower incisors horizontal position and the upper incisors angulation to lip position.[18] This study shows that there is correlation between upper and lower incisor angulation to lip position in all three skeletal patterns.

The study conducted by Yogosawa found that the lower lip and upper lip affected by maxillary incisors retraction.[19] In the same study, the influence of the maxillary incisors on lower lip position was detected. Kasai detected an association between the position of the lower incisors and upper lip thickness.[20] And a significant association with Sn-ULI. Another variable for hard tissue (UI-SN) is related to U1-NA. In soft tissue, the variable (LL-SnPog′), is related to LLS-Me′ found also to be correlated with the position of the lower incisors by some researchers.[21-23] This study also shows that lower lip and upper lip affected by maxillary incisors retraction in Skeletal class I . Lower lip position was affected by Position of lower incisor in class II and upper lip was affected by Interincisal angle in Class III. This study also found that nasolabial angle was affected by lower incisor retraction and position of lower incisor in skeletal class II.

Based on the previously described correlations, we can conclude that there is correlation between hard tissue and soft tissue topography in normal Nepali individuals. Many studies have focused on the importance of the teeth support on the upper lip, the present study also shows that the upper and lower teeth can influence the upper and lower lip position in skeletal class I.

Clinically, these results emphasise the possible effects of extraction and non-extraction orthodontic treatment on the upper and lower lips. While retraction of the lips has been observed following retraction of the incisors to a variable degree, changes in upper and lower lip length are another outcome that warrants consideration by clinicians. In addition, this study specified dentoalveolar and soft tissue measurements that can demonstrate the correlation between hard and soft tissues. Among the hard and soft tissue variables studied, the current study identifies the most influential cephalometric measurements that can aid the clinician in diagnosis and assessment of posttreatment changes.

CONCLUSION

Correlation between hard and soft tissue was seen in different sagittal malocclusion. In skeletal class I, there was correlation between LI – A pog to S-line to UL and S-line to lower. Correlation was also seen between UI to SN plane to S-Line to lower lip. In skeletal class II, there is correlation between LI to Apog to nasolabial angle, UI to PP plane to Sn-ULI and IMPA to Upper lip thickness. In skeletal Class III, there is correlation between LI -Apog to LLSme and interincisal angle to Sn-ULI.

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