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Correlation between interlabial gap, lip morphology and lip strain: A cephalometric study

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Abstract
Background: Analysis of the soft tissue profile of the face is a concern for the orthodontist. The study of facial beauty and harmony has been pivoted in orthodontics and has moved beyond the stage of simple tooth alignment to a more holistic approach, considering facial appearance.
Aim & Objectives: This cephalometric study aims to analyze correlation between interlabial gap, lip morphology and lip strain in patients with proclined and normally inclined incisors.
Materials and Methods: The retrospective study groups consisted of pretreatment records of sixty untreated individuals with the age group between 14 to 45 years. The samples were divided into two groups (group 1 and group 2) based on the upper incisor to NA angle. Each group was further divided into two subgroups (1a, 1b and 2a, 2b) based on interlabial gap. After geometric measurements; the data was compiled, analyzed and compared among each sub groups.
Results: The present study showed statistical significance between basic upper lip thickness, upper lip thickness and lip length in subgroup 1a. Subgroup 1b and subgroup 2a showed statistical significance between basic upper lip thickness and lip thickness and no correlation with lip length and lip strain. Subgroup 2b showed statistical significance between basic upper lip thickness, lip thickness and lip length and no correlation with lip strain.
Conclusion: This retrospective study concludes that lip strain, lip morphology and interlabial gap are not correlated with each other. The above soft tissue parameters depend on the maxillary incisors' position.

Keywords: Cephalometric, Interlabial gap, lip morphology

Introduction
Beauty is defined as “a state of harmony – a balance of facial proportions – a balanced relationship among skeletal structures, teeth, and soft tissue” or as the relative measure of balance and harmony. The question of facial balance and harmony in orthodontics has engaged the profession from its earliest beginnings to the present time. Analysis of the soft tissue profile of the face is therefore a concern for the orthodontist. A balanced profile should be one of the key factors in deciding on the methods of treatment for any form of malocclusion, as good occlusion does not necessarily mean good facial balance [1].
As health professionals have increased their ability to change faces, the necessity to understand what is and is not beautiful has intensified [2].
Orthodontics today has moved beyond the stage of simple tooth alignment to a more holistic approach, taking facial appearance in its entirety into consideration. Ideal occlusion by itself is no longer an acceptable end result of treatment, but must be in association with optimal facial aesthetics. Edward H. Angle stated 'The mouth is a most potent factor in making or marring the beauty and character of the face' (Angle, 1907) and 80 years later, this still holds true.
Soft tissue analysis is a part of diagnosis that helps us to establish a treatment plan. Due to greater variability of the soft tissue thickness, it does not always match the hard tissue underlying them making it difficult for the orthodontist to plan an appropriate treatment. Normally, a small vertical space or interlabial gap is found between the upper and lower lips in the relaxed position. In malocclusions and facial disharmonies, the interlabial gap may be large or completely lacking [3] Taking this into account, it could be hypothesized that lip morphology plays an important role in the inter-labial gap.

Considering different incisor positions such as proclined or normally inclined incisors will help to establish variations in the soft tissue morphology.

Aim

To establish a correlation between interlabial gap, lip morphology and lip strain in patients with proclined and normally inclined incisors.

Materials and Methodology

Inclusion criteria

1. Study participants between Age group 14 to 45 years.
2. Patients with Permanent Dentition.
3. Patients having Skeletal Class I malocclusion.
4. Normally inclined and proclined incisors (based on upper incisor to NA angle).

Exclusion criteria

1. History of previous orthodontic treatment cases was excluded.
2. Study participants having congenital craniofacial deformities
3. Altered nasal morphology (Increased/decreased nasal angle)
4. Short lower lip length

Methodology

The study consisted of pretreatment records of 60 untreated individuals in the age group between 14 to 45 years. The lateral cephalograms and profile photographs which were taken with the lips in the relaxed position were obtained from the previous records.

The lateral cephalograms were traced on standard acetate paper with a staedtler pencil using 0.35 mm graphite lead. All the manual procedures were undertaken by a single operator.

- **Subgroup 1a:** Normal interlabial gap.
- **Subgroup 1b:** Increased interlabial gap.
- **Subgroup 2a:** Normal interlabial gap.
- **Subgroup 2b:** Increased interlabial gap.

Results

Table 1 and Graph 1. The Test results showed that the mean Lip thickness for Sub Group 1a was 14.60±3.25, for Sub Group 1b was 12.53±2.20, for Sub Group 2a was 12.13±2.45 and for Sub Group 2b was 11.13±1.96. This difference in the mean Lip thickness between different sub groups was statistically significant at p=0.009.

Table 2 and Graph 2. The Test results showed that the mean basic upper lip thickness for Sub Group 1a was 15.20±2.93, for Sub Group 1b was 13.93±2.22, for Sub Group 2a was 16.00±2.30 and for Sub Group 2b was 14.60±2.06. This difference in the mean basic upper lip thickness between different Sub Groups was not statistically significant at p=0.18.

Table 3 and Graph 3. The Test results showed that the mean Lip strain for Sub Group 1a was 0.60±1.64, for Sub Group 1b was 1.40±1.55, for Sub Group 2a was 3.87±1.77 and for Sub Group 2b was 3.47±1.96. This difference in the mean Lip strain between different Sub Groups was statistically significant at p=<0.001.

Table 4 and Graph 4. The Test results showed that the mean lip length for Sub Group 1a was 20.47±3.42, for Sub Group 1b was 20.27±3.49, for Sub Group 2a was 21.13±3.25 and for Sub Group 2b was 20.87±2.85 respectively.

Table 5 and Graph 5. The test results demonstrated that in Sub Group 1a, the Lip thickness showed a significant strong positive correlation with Basic Upper Lip thickness [rho=0.78] & lip Length [rho=0.68] and the finding was statistically significant at p=0.001 & p=0.006 respectively, indicating that an increase / decrease in the Lip thickness will lead to a corresponding increase / decrease in Basic Upper Lip thickness & Lip length. The Lip thickness showed a significant negative moderate correlation with Lip Strain [rho = - 0.56] and the finding was statistically significant at p=0.03, indicating that an increase in Lip thickness will lead to decrease in Lip strain and Vice Versa. However, no significant relationships were observed between other parameters.

Table 6 and Graph 6. The test results demonstrated that in SubGroup 1b, the Lip thickness showed a significant strong positive correlation with Basic upper Lip thickness [rho=0.77] and the finding was statistically significant at p=0.001, indicating that an increase / decrease in the Lip thickness will lead to a corresponding increase / decrease in Basic upper Lip thickness.

Table 7 and Graph 7. The test results demonstrated that in SubGroup 2a, the Lip thickness showed a significant strong positive correlation with Basic Lip thickness [rho=0.74] and the finding was statistically significant at p=0.002, indicating that an increase / decrease in the Lip thickness will lead to a corresponding increase / decrease in Basic upper Lip thickness.

Table 8 and Graph 8. The test results demonstrated that in SubGroup 2b, the Lip thickness showed a significant moderate positive correlation with Basic Lip thickness [rho=0.58] & strong positive correlation with lip Length [rho=0.78] and the finding was statistically significant at p=0.02 & p=0.001 respectively.

Table 1: Comparison of mean Lip Thickness (in mm) b/w diff. sub groups

Comparison of mean Lip Thickness (in mm) b/w diff. sub groups using Kruskal Wallis Test						
Groups	**N**	**Mean**	**SD**	**Min**	**Max**	**p-value**
Sub Group 1a	15	14.60	3.25	8	20	0.009*
Sub Group 1b	15	12.53	2.20	8	15	
Sub Group 2a	15	12.13	2.45	8	16	
Sub Group 2b	15	11.13	1.96	8	15	

Table 2: Comparison of mean Basic Upper Lip Thickness (in mm) b/w diff. subgroups

Comparison of mean Basic Lip upper Thickness (in mm) b/w diff. sub groups using Kruskal Wallis Test						
Groups	**N**	**Mean**	**SD**	**Min**	**Max**	**p-value**
Sub Group 1a	15	15.20	2.93	10	20	0.18
Sub Group 1b	15	13.93	2.22	10	17	
Sub Group 2a	15	16.00	2.30	12	20	
Sub Group 2b	15	14.60	2.06	9	17	

Table 3: Comparison of mean Lip Strain (in mm) between different subgroups

Comparison of mean Lip Strain (in mm) b/w diff. sub groups using Kruskal Wallis Test						
Groups	**N**	**Mean**	**SD**	**Min**	**Max**	**p-value**
Sub Group 1a	15	0.60	1.64	-3	3	<0.001*
Sub Group 1b	15	1.40	1.55	-1	4	
Sub Group 2a	15	3.87	1.77	1	7	
Sub Group 2b	15	3.47	1.96	0	6	

* - Statistically Significant

Table 4: Comparison of mean Lip Length (in mm) b/w diff. sub groups

Comparison of mean Lip Length (in mm) b/w diff. sub groups using Kruskal Wallis Test						
Groups	**N**	**Mean**	**SD**	**Min**	**Max**	**p-value**
Sub Group 1a	15	20.47	3.42	15	27	0.93
Group 1b	15	20.27	3.49	14	25	
Group 2a	15	21.13	3.25	15	28	
Group 2b	15	20.87	2.85	16	26	

Table 5: Spearman's Rank correlation test to assess the relationship b/w study parameters in SubGroup 1a

Spearman's Rank correlation test to assess the relationship b/w study parameters in Sub Group 1a					
Variable	**Values**	**Lip thickness**	**Basic upper Lip thickness**	**Lip strain**	**Lip length**
Lip thickness	Rho	1	0.78	-0.56	0.68
	p-value	.	0.001*	0.03*	0.006*
Basic Lip thickness	Rho	0.78	1	0.02	0.39
	p-value	0.001*	.	0.95	0.15
Lip strain	Rho	-0.56	0.02	1	-0.47
	p-value	0.03*	0.95	.	0.08
Lip length	Rho	0.68	0.39	-0.47	1
	p-value	0.006*	0.15	0.08	.

* - Statistically Significant

Table 6: Spearman's Rank correlation test to assess the relationship b/w study parameters in SubGroup 1b

Spearman's Rank correlation test to assess the relationship b/w study parameters in SubGroup 1b					
Variable	**Values**	**Lip thickness**	**Basic Lip thickness**	**Lip strain**	**Lip length**
Lip thickness	Rho	1	0.77	-0.33	0.44
	p-value	.	0.001*	0.23	0.10
Basic Lip thickness	Rho	0.77	1	0.30	0.44
	p-value	0.001*	.	0.27	0.10
Lip strain	Rho	-0.33	0.30	1	-0.15
	p-value	0.23	0.27	.	0.60
Lip length	Rho	0.44	0.44	-0.15	1
	p-value	0.10	0.10	0.60	.

- Statistically Significant

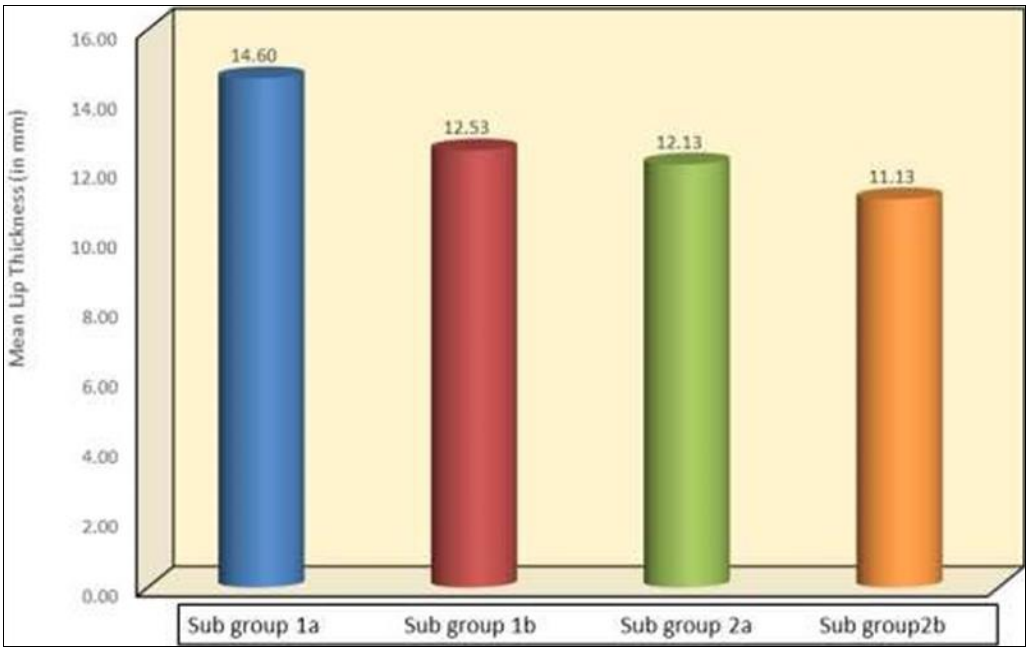
Table 7: Spearman's Rank correlation test to assess the relationship b/w study parameters in SubGroup 2a

Spearman's Rank correlation test to assess the relationship b/w study parameters in SubGroup 2a					
Variable	**values**	**Lip thickness**	**Basic upper Lip thickness**	**Lip strain**	**Lip length**
Lip thickness	rho	1	0.74	-0.37	0.35
	p-value	.	0.002*	0.18	0.20
Basic upper Lip thickness	rho	0.74	1	0.33	0.47
	p-value	0.002*	.	0.23	0.07
Lip strain	rho	-0.37	0.33	1	0.14
	p-value	0.18	0.23	.	0.63
Lip length	rho	0.35	0.47	0.14	1
	p-value	0.20	0.07	0.63	.

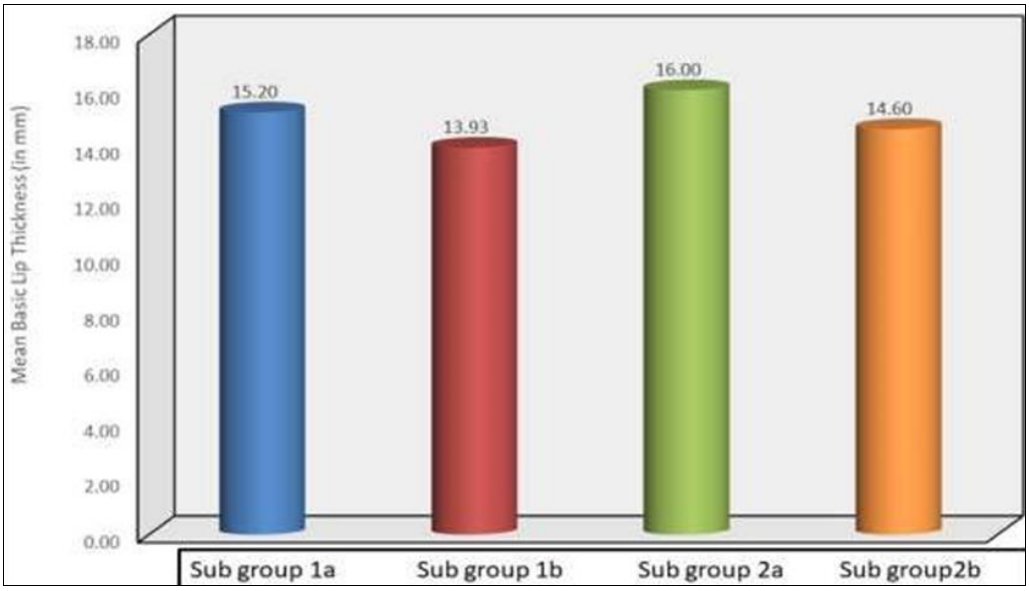
Table 8: Spearman's Rank correlation test to assess the relationship b/w study parameters in SubGroup 2b

Spearman's Rank correlation test to assess the relationship b/w study parameters in Sub Group 2b					
Variable	**values**	**Lip thickness**	**Basic upper Lip thickness**	**Lip strain**	**Lip length**
Lip thickness	rho	™	0.58	-0.41	0.78
	p-value	.	0.02*	0.13	0.001*
Basic upper Lip thickness	rho	0.58	1	0.45	0.40
	p-value	0.02*	.	0.09	0.14
Lip strain	rho	-0.41	0.45	1	-0.37
	p-value	0.13	0.09	.	0.17
Lip length	rho	0.78	0.40	-0.37	1
	p-value	0.001*	0.14	0.17	.

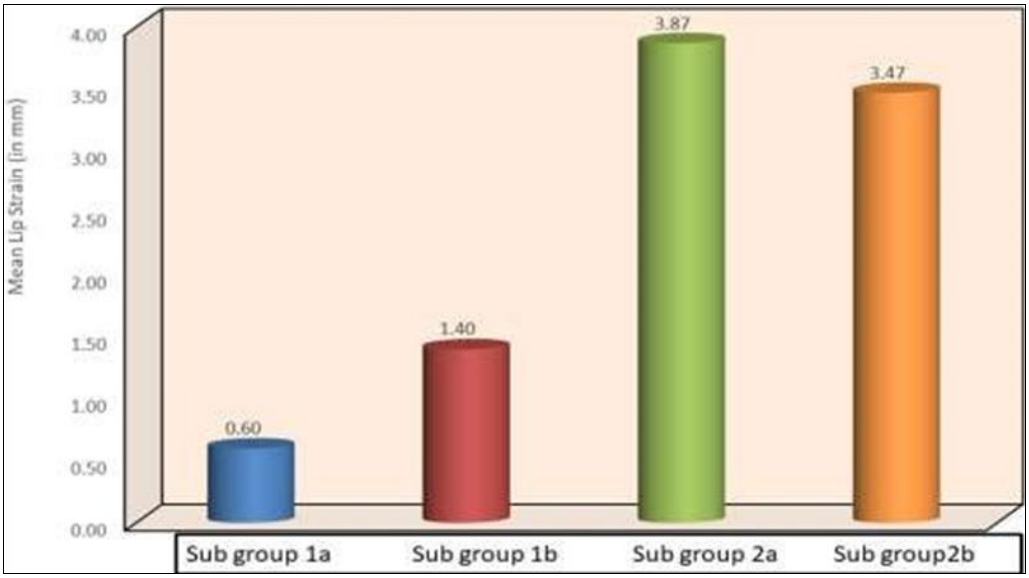
- Statistically Significant



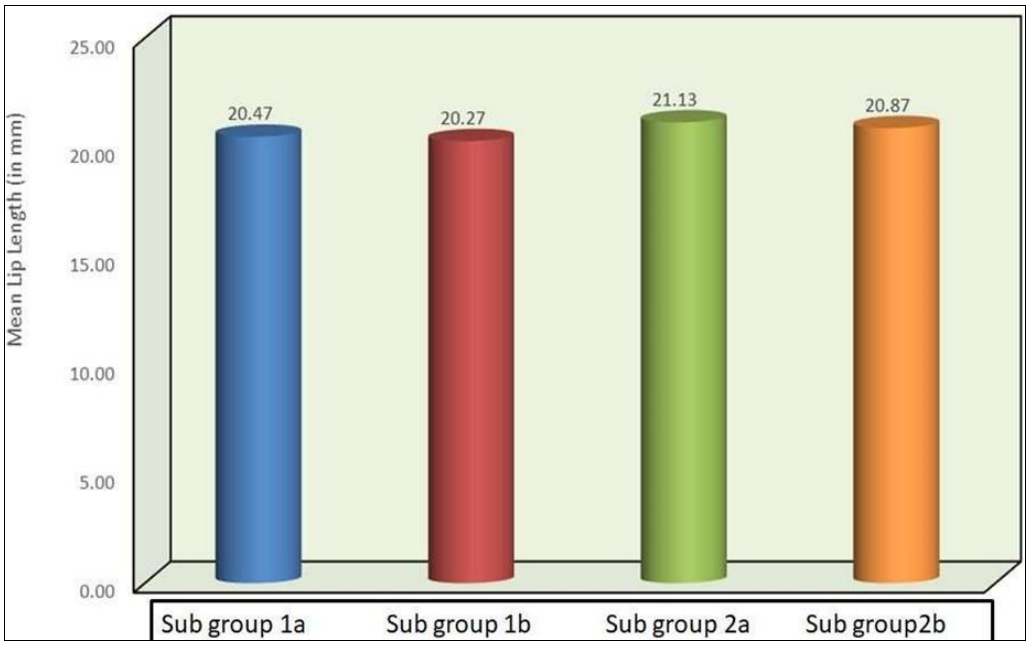
Graph 1: Mean lip thickness (In mm) b/w diff. sub groups



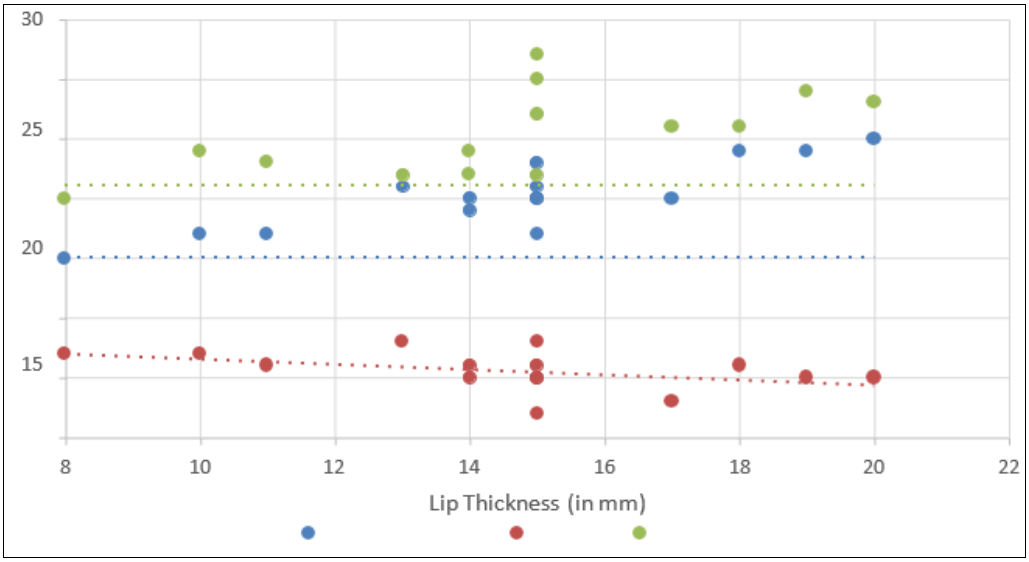
Graph 2: Mean basic upper lip thickness (In mm) b/w diff. sub groups



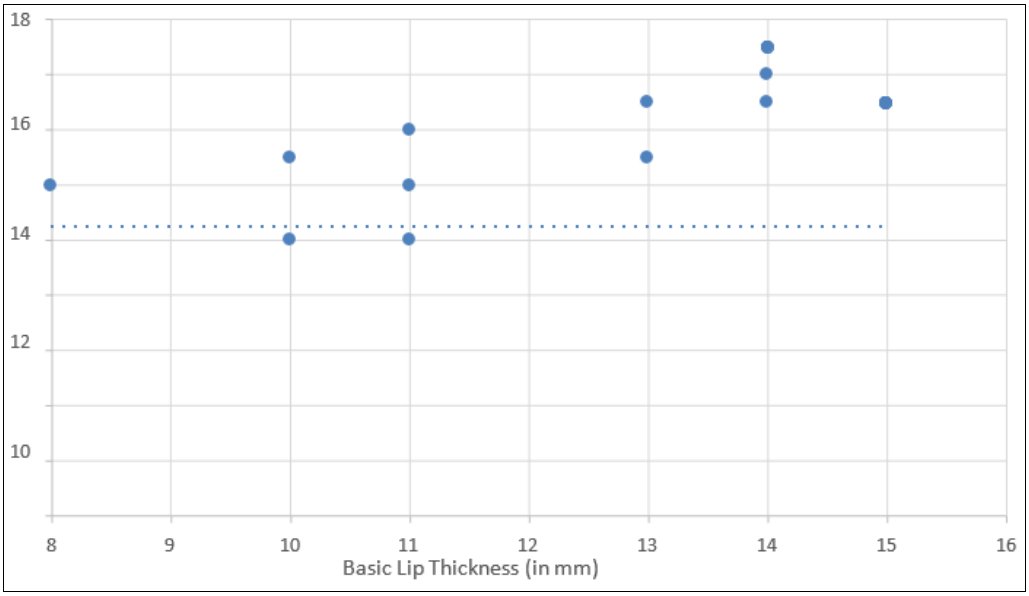
Graph 3: Mean lip strain (In mm)b/w diff. sub groups



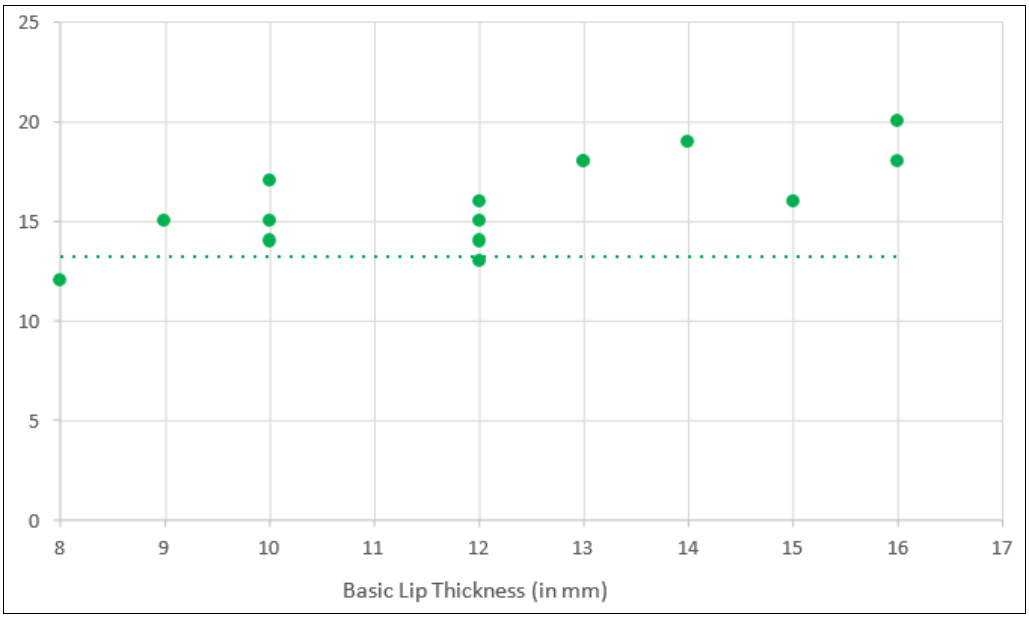
Graph 4: Mean lip length (In mm) b/w diff. sub groups



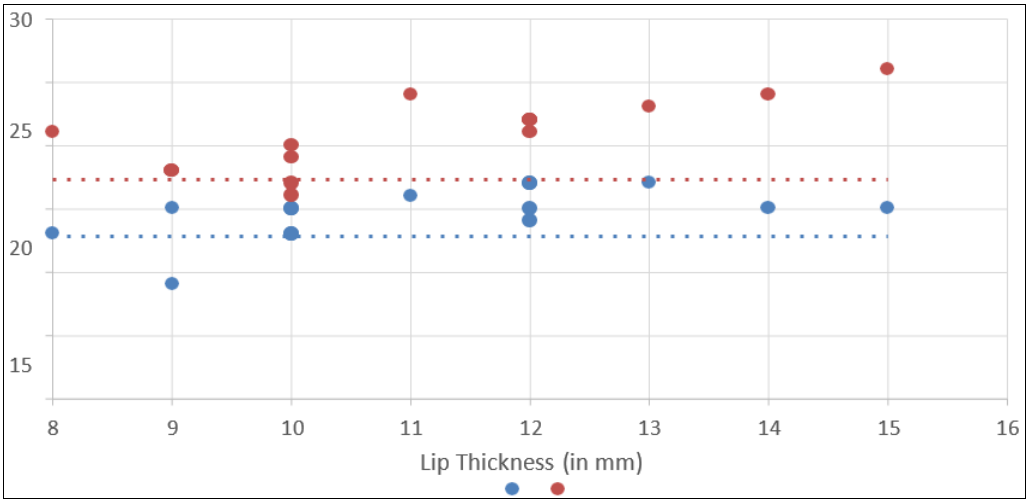
Graph 5: Scatterplot depicting the relationship b/w Lip Thickness, Basic upper Lip Thickness, Strain & Lip Length in Group 1a



Graph 6: Scatterplot depicting the relationship b/w Lip Thickness & Basic upper Lip Thickness in Group 1b



Graph 7: Scatterplot depicting the relationship b/w Lip Thickness & Basic Lip Thickness in Group 2a



Graph 8: Scatterplot depicting the relationship b/w Lip Thickness, Basic upper Lip Thickness & Lip Length in Group

Discussion

A person's ability to recognize a beautiful face is innate, but translating this into defined treatment goals is problematic. Recognizing beauty is not practiced nor is it difficult.

The perception of beauty is an individual's preference with cultural bias. The rules governing why a face is beautiful are not understood nor are required for anyone to say that a face is beautiful. Artists and health professionals have attempted to define and recreate an ideal.

They recognize beauty, yet objective standards are difficult, despite unending attempts to clarify this concept. As health professionals have increased their ability to change faces, the necessity to understand what is and what is not beautiful has intensified [2].

Comprehensive orthodontic diagnosis and treatment planning includes facial harmony as a primary goal. Angle suggested that if the dentition was intact and arranged in an optimum occlusion, the soft tissue would then assume a harmonious position. However, Hellman pointed out that variations from normal occur in the soft tissue even in the presence of a normal occlusion.

Tweed proposed the use of a hard tissue diagnostic triangle in diagnosis and treatment planning with the assumption that an upright mandibular incisor over the basal bone was stable and esthetic. Reidel stated that the ultimate goal of orthodontics is perfection, and this includes ideal function, ideal esthetics, and maintenance of these ideals.

But evaluation of the soft tissue profile is also vital in the diagnosis and the treatment planning of the orthodontic patient. Soft tissue changes have been shown to accompany growth, as well as orthodontic treatment [4].

The soft-tissue profile plays an important part in our orthodontic considerations. Harmonious soft tissue profile, an important treatment goal in orthodontics, is sometimes difficult to achieve, partly because the soft tissue overlying the teeth and bones is highly variable in its thickness.

These variations result not only from an imbalance of the dental and skeletal structures but also from individual variations in the thickness and tension of the soft tissues [5].

Previous studies done by Rudee *et al.* [6], Garner *et al.* [7], Hodgkinson *et al.* [8], Ramos A.L *et al.* [9] also showed similar results and found that variation in incisor position will alter the lip morphology. Jacobs J D10 evaluated the vertical lip changes from maxillary incisor retraction.

Previous study done by Hayashida *et al.* [11] also showed similar results. These results are similar with the present study signifying that the interlabial gap depends upon the position of the upper incisors.

The study done by Qadeer TA *et al*. [12] found that for every 1 mm movement of maxillary incisors, lip movement of 0.6 mm occurred for those with competent lips and 0.8 mm occurred in the incompetent group.

The study also suggests that if the upper lip strain and interlabial gap occurs due to the proclination of maxillary incisor, retraction of maxillary incisors in such cases helps in reliving the lip strain. Thus resulting in an increase of the post-treatment lip thickness.

Conclusion

The present study concludes that interlabial gap, lip morphology and lip strain are not correlated with each other. The above soft tissue parameters are dependent only on the position of the maxillary incisors. The present study also indicates that the lip strain and interlabial gap are the most important factors in assessing the lip response when compared with lip thickness.

Conflict of Interest

Not available.

Financial Support

Not available.

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