



## INFLUENCE OF LIP SEAL COMPETENCY ON CRANIOFACIAL SKELETAL PATTERNS: A CEPHALOMETRIC ANALYSIS OF VERTICAL AND SAGITTAL DISCREPANCIES

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### ABSTRACT

**Objective:** To evaluate differences in craniofacial skeletal pattern among subjects with competent and incompetent lip seal (ILS).

**Methodology:** Sample of 261 subjects (177 females and 84 males) was constituted by random selection from patients who visited Orthodontic OPD. Lip seal was assessed by clinical examination on the basis of visual inspection of muscular tension in the mental region at mandibular rest position and subjects were divided into competent lip seal and incompetent lip seal group. Skeletal measurements were performed on lateral cephalograms to assess differences in vertical and sagittal skeletal pattern among subjects in both groups.

**Results:** Competent lip seal was found in 64.4 % of the subjects and 35.6% of subjects had incompetent lips. ILS group had greater values of SNA and ANB whereas SNB value was reduced. The inclination of maxilla (SNPP) was larger in competent lip group and inclination of mandible (SNMP) was larger in incompetent lip group. Statistically significant differences were found between the two groups in the interbasal relationship (PPMP), Y-axis angle and anterior lower facial height ratio, with increased values of these measurements in incompetent lip group. Posterior facial height ratio was comparatively reduced in subjects with ILS.

**Conclusion:** Patients with ILS have higher tendency to develop class II skeletal pattern with mandibular retrognathia, increased inclination of mandibular plane and tendency for clockwise rotation of mandible. Lip incompetence also leads to vertical growth pattern resulting in increased anterior lower face height and decreased posterior facial height

## **INTRODUCTION:**

Development of craniofacial bones and soft tissues is a complex process which can be affected by the disturbance in oral cavity physiologic functions that include not only mastication, swallowing and speech but also suckling and respiration (1). Studies have shown positive correlation between growth of craniofacial development and various orofacial dysfunctions such as thumb sucking, mouth breathing, abnormal speech and swallowing (2-4). Other than mouth breathing, thumb sucking and abnormal swallowing, incompetent lip seal (ILS) is also considered as an oral dysfunction that can cause significant developmental and growth anomaly (5).

Lip competence' is a morphological term rather than a particular lip function performance (6). The growth of lips continues up to age 17, and lip competency should be expected to develop by the age of 13 (7,8). Competent lips are considered those in which patient can close their lips without strain when their mandible remains at clinical rest position and have no muscular activity

(9). However, if an individual is unable to close lips without strain and excessive separation of lip is visible at resting position, it is attributed to 'lip incompetence' and an obvious strain in perioral muscles (m. orbicularis oris and m. mentalis) is usually evident (6,10).

Fränkel advocated that growth of oral and nasal cavity depends on three important contacts which include contact of tongue base to the soft palate, lips competency and contact of tongue tip with upper central incisor lingual surfaces (11). In the incompetent lip seal, maxillary arch becomes narrow and mandible rotates downward and posteriorly due to excessive force of buccal musculature on the maxilla and depression of the tongue on the floor of oral cavity (1). Increased total anterior facial

height is reported in cases of incompetent lip seal due to posterior rotation of mandible and increased inter-basal angle (2). Fricke et al. have also reported increased lower anterior face height due to high inter-basal angle between maxilla and mandible in patients with incompetent lips (12). In a study by Harari et al., posterior facial height was found to be proportionally lower than anterior facial height in children with open mouth posture (13). Leonardo et al. reported higher skeletal Class II tendency in patients of incompetent lips (14).

Incompetent lips may also be seen in patients with hypotonic muscles and general body weakness. Open mouth posture may be considered as a reason for the development of skeletal class II and vertical facial pattern, hence showing its importance to diagnose and treat the function by therapy (12). No study assessing the effect of ILS on skeletal pattern has been conducted among Pakistani population. So, this provides a strong rationale to conduct this research in Pakistani population, as geographically and genetically every population is different. If results of this study show differences in sagittal and vertical measurements among patients with competent and incompetent lips, the possible role of lip competence in development of proper skeletal relationship could be identified and it may become possible to predict developing skeletal malocclusion ahead of time in patient with incompetent lips. Thus, the objective of this study is to evaluate the differences in craniofacial skeletal pattern among subjects with competent lip seal and incompetent lip seal.

## **MATERIAL AND METHOD:**

The research was carried out at Orthodontics department Karachi Medical and Dental College, Pakistan. The duration of the study 2 months following a permission granted by Ethical Review Committee. A cross-sectional study design was used. Through the

application of WHO sample size calculator, taking incompetent lip seal as 21.62% of the total sample, margin of error as 5% and 95% of the interval; the sample size was obtained as 261 (5). Inclusion criteria was the male and female healthy orthodontic patient, age between 16-35 years old, and capable of following verbal command using both competent and incompetent lips and good quality lateral cephalometric radiograph post-treatment. The exclusion criteria involved prior orthodontic therapy or orthognathic surgery, a history of trauma, craniofacial syndrome and unilateral face.

The sample of 261 subjects, 177 females and 84 males (mean age  $19.59 \pm 3.58$  years) was constituted by random selection from patients who visited Orthodontic OPD. Verbal informed consent was taken from the patients. The lips were examined for competence with the masticatory and facial muscles at rest (15). Mandibular rest position was achieved by asking subject to swallow saliva (6). Normal vertical-lip relationship at rest should consist of a mean gap of 2 mm with mandible in centric occlusion (16,17). Clinical evaluation was conducted to test the lip seal based on the visualization of muscle tension in the mental region. The participants were grouped into two. The m. masseter and m. orbicularis contractions detected on any lip closure lip separation greater than 34 mm were considered incompetent lip seal (18). Competent lip seal group included up to 3mm lip separation and no contraction of closing muscles observed.

Lateral cephalograms were carried out to skeletal measurements on pre-treatment skeletal structures. All cephalograms were taken under standard conditions in same radiographic centre. A single investigator had to perform the anatomic tracings and localization of dentoskeletal landmarks to minimize the possibility of bias. 9 landmarks were distinguished on the lateral

cephalogram consisting of Nasion (N), Silla turcica (S), Orbitale (Or), Porion (Po), Point A (subspinal), Point B (supramental), Anterior nasal spine (ANS), Posterior nasal spine (PNS), Menton (Me), Gonion (Go) and Gnathion (Gn).

The skeletal linear and angular measurements applied to determine the variation in vertical and sagittal pattern of the skeleton among individuals with lip competence and incompetence were:

1. Connection of maxilla with cranial base (SNA): Angle between SN plane and N-A line.

2. Mandible-cranial base (SNB): Angle between snake plane and N-B line.

3. Maxilla-mandible anterior posterolateral position (ANB): Dissimilarity between SNA and SNB angles.

4. Maxilla inclination: Angle between SN plane and Palatal plane (ANS-PNS)

5. Tilting the mandible: Angle between SN plane and Mandibular plane (Go-Gn)

6. Interbasal relationship: Angle between palatal plane and mandibular plane.

7. Y- axis: Angle between line running through S-Gn and Frankfort horizontal plane (Or-Po).

8. Lower facial height ratio: Ratio of lower anterior facial height (ANS-Me) to total anterior facial height (N-Me).

9. Posterior facial height ratio: The ratio between the posterior and total anterior facial height (S-Go / N-Me).

Data gathered was entered into SPSS 23.0. Age and total skeletal linear and angular measurements were individually determined as mean and standard deviation. Effect modifiers i.e. Age and gender have been discussed using stratification. After stratification, independent t-test was used to test the variations of the vertical differences in skeletal measurements of competent lip seal and incompetent lip seal group. P-value that was less than 0.05 was applied as significant.

**RESULTS:**

This study involved 261 subjects. In 64.4 (n=168) and 35.6 (n=93) the subjects were competent and incompetent lip seal respectively. Table 1 showed statistically significant difference on gender between competent and incompetent lip seal group. Table 2 presents comparisons of mean cephalometric measures of competent and incompetent lips seal groups.

Value of SNA and ANB was higher in ILS group in comparison to SNB which was lower in ILS group but this was not statistically significant in the framework of

sagittal skeletal measurements. Competent lips group and incompetent lip group had greater inclination of maxilla (SNPP) and mandible (SNMP), respectively, and were also not statistically significant. The interbasal relationship (PPMP), Y-axis angle and ratio of anterior lower facial height resulted in significant difference between two groups. Subjects that possessed incompetent lip seal recorded greater values of all these measures. We had a relatively lower comparison of the posterior facial height ratio between individuals with incompetent lip seal but no significant difference.

**Table 1: Demographic data of the study sample**

Demographic Data	Competent Group (N=168)	Incompetent Group (n=93)	P-Value*
<b>Gender</b>			0.028
Male	62	22	
Female	106	71	
<b>Age (years)</b>			0.305
<20	91	50	
20–25	67	39	
>26	10	4	
<b>Mean (SD)</b>	19.67 ± 3.74	19.45 ± 3.28	0.716

**Table 2: Comparison of mean skeletal measurements among competent and incompetent lip seal group**

Skeletal Measurements	Competent Lip Seal		Incompetent Lip Seal		Level of Significance (P-value)
	Mean	SD	Mean	SD	
<b>Sagittal</b>					
SNA	81.23	4.04	82.67	3.61	0.784
SNB	77.36	3.74	76.68	3.83	0.581
ANB	3.85	2.96	5.73	3.16	0.485
<b>Vertical</b>					
SNPP	7.60	5.16	6.63	3.58	0.123
SNMP	31.18	6.89	35.01	5.87	0.093
PPMP	23.78	7.33	28.17	5.56	0.007
Y-AXIS	60.86	4.96	63.62	7.36	0.017
LFH	55.10	3.36	56.56	2.64	0.049
PFH	67.52	5.76	64.38	4.59	0.051

## **DISCUSSION:**

Genetic and environmental factors during the childhood may affect the development of maxilla, mandible and overall face. (19,20). Many researchers have reported that oral dysfunction during childhood has as large an effect on maxillofacial growth as do other environmental factors (21-24). Incompetent lips do not only affect facial aesthetics but may also disturb other functions of mouth including food swallowing and phonetics during speech (25). Excessive Lip separation can be multifactorial and is a pathological problem which may lead to serious complications in orofacial region leading to aesthetic, orthodontic and periodontal problems (18).

In the present study the frequency of ILS was found to be 35.6%. This is in consistence with study by Drevensek et al. who also found 35.72% prevalence of incompetent lip seal in 8 to 10 year old children (2). On the other hand, Reinicke and co-workers reported 29% frequency of ILS (26) and Cordasco et al. found 45.5% frequency of ILS in school children (27). This variation in the prevalence is may be due to different age groups used in these studies.

In our study, the value for maxillary relation to cranial base was larger in incompetent group and value of mandibular relation to cranial base was reduced in incompetent lip group, suggestive of mandibular retrognathism in subjects with incompetent lips. This is further supported by the larger value of ANB ( $5.73 \pm 3.16$ ) in this group. This is in consistence with findings by Drevensek et al., in which values of SNA and ANB angles were higher in the group of open mouth posture (2). A study by Inada et al. indicated that subjects with ILS have lip as well as mandibular retrusion (5). Furthermore, Basheer et al. mentioned that in children with incompetent lip seal, facial convexity was significantly greater than in normal healthy children (28). This outcome advocates a

skeletal Class II tendency related to lip incompetence.

Results of this study indicated increase in inclination of mandibular plane and decrease in inclination of palatal plane in incompetent lip group. This finding is similar to study by Hassan et al. who claimed that vertically, the most significant outcome related with incompetent lips was steeper plane of mandible and smaller total mandibular length, followed by flat palatal plane (18). Similarly, Sheikh and Ijaz, also reported increased inclination of mandibular plane angle in Class II patients with incompetent lips (29). Gustafsson & Ahlgren also concluded that the cant of mandibular plane was steeper in incompetent lip group as compared to competent lip group (30). Nevertheless, Address and Shamlan, reported average angles of palatal and mandibular plane angles in patients with incompetent lip seal which may be due to different in sample size and age groups (31).

The current study demonstrated that there was a statistically significant difference between the values of interbasal angle, y- axis angle as well as the lower anterior facial height between the two groups where the lower anterior facial height values were higher in lip incompetence group. In incompetent lip seal, posterior facial height ratio was reduced in the subjects. These results are common among patients whose growth pattern is vertical. Other studies have provided similar findings indicating significantly greater anterior lower facial height, steeper mandibular plane, and interbasal angle in incompetent lip seal group that could be due to the vertical and lip growth retarding relative to skeletal growth in particular growing children (2, 33). Similar findings were also reported by Yamaguchi et al. where higher interbasal angle in incompetent lip group was compared to that of competent lip group (6). These results demonstrate that mandibular vertical position is significant in lip competency. It also

validates the evidence that backward and backward rotation of mandible stimulates more anterior facial growth than posterior facial growth in children with open mouth posture (13).

Causes of lip incompetence are multi-factorial (35) and have been ascribed to large ANB angle, large over jet, proclination of the mandibular incisors, increased inclination of mandibular plane, flat palatal plane, anteriorly long facial height, and major antero-posterior discrepancies in skeletal growth (9). It may be hypothesized that dento-facial morphology and functioning highly depends on lip competency and its equilibrium is necessary for normal growth. Hence a thorough assessment of associated skeletal and dental features should be achieved before finalizing any treatment for incompetent lips. Furthermore, patient should be well informed about the treatment planning by keeping all the above discussed variables in mind. Other suitable options of treatment, excluding extraction, should be proposed to the patients, which may include: absolute intrusion of teeth, orthognathic surgery, lip augmentation and/or muscular training to improve lip incompetence (18). This study was limited as age and gender effects on lip10 incompetence were not evaluated. A limitation of this study was diagnosis of ILS being dependent on clinical examination only. In contrast, a more definite diagnosis of lip incompetence can be made by using electromyographic investigation for detection of contraction of m. masseter and m. orbicularis oris muscles (5). Future studies on a longitudinal basis are needed to elaborate more on the etiological background of incompetent lips to differentiate all factors mentioned above and to evaluate age and gender effects on this clinically important problem (18). All of these factors should be considered to develop an improved treatment protocol for lip incompetent patients with skeletal and dental malocclusions (9).

**CONCLUSIONS:** Patients with ILS have higher tendency to develop class II skeletal pattern with mandibular retrognathia, increased inclination of mandibular plane and tendency for clockwise rotation of mandible. Lip incompetence also leads to vertical growth pattern resulting in increased anterior lower face height and decreased posterior facial height. From the findings of this study, author suggests that clinician must take note of developing ILS, as any delay in diagnosis and treatment might cause abnormal craniofacial development resulting in class II and vertical skeletal pattern. So, it is very important to diagnose and to treat the lip incompetence as soon as possible.

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