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Correlation Between Lower Pharyngeal Airway and Chin Throat Angle in Class II Div 2 Malocclusion

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ABSTRACT

Normal airway is one of the important factors for the growth and development of craniofacial structures. Narrow lower pharyngeal airway is considered as one of the factors for obstructive sleep apnea but there is no clinical evidence for early detection of narrowed lower pharyngeal airway , hence the aim of the present study was to find any correlation between degree of submental cervical angle and lower pharyngeal airway dimensions in class II div 2 subjects and also to evaluate quantitatively the influence of submental cervical angle on lower pharyngeal airway to aid clinicians in early diagnosis of narrow lower pharyngeal airway. This retrospective cross-sectional study was performed on the pre-treatment lateral cephalometric films of 50 Class II div 2 subjects of aged between 14 and 30 years from multicentres in Tamil Nadu . All cephalograms were traced digitally by using FACAD software. The assessment of Chin Throat Angle (CTA) and Lower Pharyngeal Airway(LPA) was done according to Legan and Burstone analysis and McNamara airway analysis respectively. Independent sample t test and Pearson correlation coefficient were analyzed .Mean and standard deviation of lower pharyngeal airway and chin throat angle was 7.91 and 3.04 and 125.03 and 10.61 respectively. The value of -.340 indicates a highly negative significant correlation between CTA and LPA. Highly negative significant correlation was found between Chin Throat Angle (CTA) and Lower Pharyngeal Airway(LPA). If chin throat angle is increased correspondingly, lower pharyngeal airway is decreased in class II div 2 subjects.

KEY WORDS: CHIN THROAT ANGLE (CTA), LOWER PHARYNGEAL AIRWAY(LPA), SKELETAL CLASS II DIV2 MALOCCLUSION.

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INTRODUCTION

The function of respiration is important in orthodontic diagnosis and treatment planning. Normal airway is one of the important factors for the growth and development of the craniofacial structures (Claudino et al. 2013; Indriksone & Jakobsone 2015; McNamara 1981). On an average normal upper pharyngeal airway space is 15-20 mm while lower pharyngeal airway (LPA) space is 11-14 mm. Skeletal features such as retrognathic maxilla and mandible and vertical maxillary excess in class II patients may lead to narrower anteroposterior dimensions of the airway(Dunn, Green & Cunat 1973; Joseph et al. 1998). The lower oropharyngeal airway dimension is decreased in skeletal class II, division 2 group, (Uslu-Akcam 2017, McNamara 1984; Ravikumar et al. 2019).

Submental-cervical angle is an important factor in perception of facial profile attractiveness (Moreno, Bell & You 1994). Surgical procedures like mandibular and/or chin setback procedures may lead to an increase in submental fullness, an obtuse submental-cervical angle due to reduction in submental length leading to a potential deterioration in submento-cervical aesthetics. Conversely, mandibular advancement and/or advancement osseous genioplasty tend to improve submento-cervical aesthetics(Naini 2011).

The magnitude of the deviation of chin-throat angle ,whether it is due to an underlying dentoskeletal discrepancy, the overlying submental-cervical soft tissues or a combination of the two, is an important factor in deciding requirement of surgery. In an excessive submental-cervical angle, the treatment planning may be straight forward. However, in borderline cases, the decision may be transferred from subjective clinical judgement to objective, evidence-based guidance based on data from studies investigating perceptions of facial attractiveness (Naini et al. 2012). Rainbow scale has been validated as reliable measurement tool for the assessment of the cervicomental angle(Van Dongen et al. 2020). Normal cervicomental angle is 105-120 degree (Ellenbogen & Karlin 1980; Patel 2006).

The use of lateral cephalograms in determining the pharyngeal airway is acceptable as Cephalometric films are highly reliable and reproducible in determining airway dimensions (Malkoc et al. 2005).Assessment of dental and skeletal anomalies as well as soft tissue structures and form can be done with cephalometry. Clinical detection of narrowing of the pharyngeal airway may facilitate early recognition of obstructive sleep apnea. Many studies have assessed the airway by means of cephalometry in subjects obstructive sleep apnea, different malocclusions and also in patients following orthodontic treatments)(Arya et al. 2010; Batool et al. 2010; Hora et al. 2007); Joy et al. 2020). Therefore, the aim of the present study was to find any correlation between degree of submental cervical angle and lower pharyngeal airway dimensions in class II div 2 subjects and also to evaluate quantitatively the influence of submental cervical angle on lower pharyngeal airway to aid clinicians in early diagnosis of narrow lower pharyngeal airway which is considered as one of the factors for obstructive sleep apnea.

MATERIAL AND METHODS

This retrospective cross-sectional study was performed on the pre-treatment lateral cephalograms of 50 individuals who were selected from the databases of multi centres in Tamilnadu. The primary inclusion criteria were subjects of Tamil Nadu origin, only skeletal Class II div 2 malocclusion of either gender (Ceylan & Oktay 1995; Gupta & Subrahmanya 2014; Linder-Aronson & Leighton 1983), ANB angle greater than 4 degree confirmed after cephalometric tracing,(Ali 2018; Ardani, Sanjaya & Sjamsudin 2018; Chang 1987; Ferrazzini 1976; Oktay 1991; Riedel 1957; Santo & Del Santo 2006), between the age group of 14 and 30 years(Gonçalves, Raveli & Pinto 2011; King 1952) and no previous history of orthodontic treatment and any other pathologic pharyngeal or nasal obstructions .

Exclusion criteria were subjects with craniofacial syndromes or any other asymmetry, enlarged adenoids or tonsils, history of any other respiratory disorders,skeletal Class I or III malocclusions and radiographs with poor quality which made it difficult to identify the soft tissue landmarks were excluded.All cephalograms had been taken by using a standardized technique, with Frankfort horizontal plane parallel to the floor, with lips in a relaxed position(Arnett, William Arnett & Gunson 2004; Raghav et al. 2014). All collected cephalograms were traced by using FACAD software for the confirmation of class II div 2 malocclusion. After the confirmation of the obtained data, cephalograms were traced again for evaluating correlation between lower pharyngeal airway and chin-throat angle.Cephalograms were traced and measured using the following landmarks and reference lines Soft tissue menton (me'), the lowest point on the contour of the soft tissue chin found by dropping a perpendicular from horizontal plane through menton.

C, intersection between submental line and cervical line
Submental line(sm) is a tangent to the submental contour passing through soft tissue menton (me')

Cervical line(ce) tangent to the anterior soft tissue contour of the neck above and below the thyroid prominence.

Legan and Burstone analysis was used to measure Submental-cervical (chin-throat angle) (sm-ce) angle, formed by the intersection of Sm line and Ce line(Legan & Burstone 1980).

McNamara airway analysis was used to measure the lower pharyngeal airway. Lower pharyngeal width was measured from the intersection of the posterior border of the tongue and inferior border of mandible to closest point on the posterior pharyngeal wall(McNamara 1981).

10 cephs were retraced by the same observer after a period of 2 weeks to assess intraoperator bias.

Statistical analysis: Independent sample t test was done to determine the mean and standard deviation of chin throat angle and lower pharyngeal airway. Pearson correlation coefficient was done to determine the correlation between chin throat angle and lower pharyngeal airway.

Figure 1: Legan and burstone analysis was used to measure Submento-cervical (chin-throat angle) (sm-ce) angle, formed by the intersection of Sm line, submental plane and Ce line ,cervical plane

Figure 2: 2: McNamara airway analysis was used to measure the lower pharyngeal airway. Lower pharyngeal width was measured from the intersection of the posterior border of the tongue and inferior border of mandible to closest point on the posterior pharyngeal wall.

RESULTS AND DISCUSSION

Results of 50 patients are reported.Mean and standard deviation of lower pharyngeal airway was 7.91 and 3.04 (Table 1)Mean and standard deviation of chin throat angle was 125.03 and 10.61 (Table 1).Pearson correlation coefficient was done to determine the correlation between chin throat angle and lower pharyngeal airway. The value of -.340 between chin throat angle and lower pharyngeal airway indicates highly negative significant correlation between chin throat angle and lower pharyngeal airway (Table 2).

Orthodontists should have a knowledge of various factors that contribute to craniofacial development , since it can influence the orthodontist's decision on diagnosis and treatment planning (Tourné 1991). Normal anatomical dimensions of the airway are dependent for normal respiration and the function of respiration is in turn important for the cranio- facial growth and development which is very complex and multifactorial. Cephalograms have been used as a reliable diagnostic tool for many years to evaluate facial growth and development and for analysis of dental and skeletal anomalies as well as soft-tissue structures and form.In this cross-sectional study, we have included only skeletal Class II div 2 subjects with no abnormalities to eliminate the confounding effects of sagittal discrepancies. This is the first study that introduced the norms for correlation between chin-throat angle and lower pharyngeal airway in class II division 2 malocclusions by using cephalometric values.

Table 1. Independent sample test to determine the Mean and Standard Deviation of lower pharyngeal airway and chin throat angle.

	N	Mean	Standard Deviation
LPA	50	7.91	3.04
CTA	50	125.03	10.61

Table 2. Pearson correlation coefficient of lower pharyngeal airway and chin throat angle.

		LPA	CTA
LPA	Pearson Correlation	1	-.340*
	Sig. (2-tailed)		.016
	N	50	50
CTA	Pearson Correlation	-.340*	1
	Sig. (2-tailed)	.016	
	N	50	50

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

It is evident that measurements on a two-dimensional cephalometric radiograph cannot reveal the transverse dimension of the airway. For this reason, three-dimensional imaging such as CT, MRI, CBCT scans have been introduced for orthodontic patients but except for some clinical conditions such as obstructions or any other pathology ,impactions, severe asymmetries, craniofacial abnormalities up to now there is no substantial evidence indicating these advanced diagnostic scans to use as routine radiograph in general orthodontic patients due to high economic cost and high exposure of radiation and ethical issues, (El & Palomo 2010; Liedke et al. 2012; Mouhanna-Fattal et al. 2019; Sedentext 2011). Malkoc et al (2005) showed that cephalometric films were significantly reliable and reproducible in determining the pharyngeal airway dimensions(Malkoc et al. 2005) and further Parkkinen et al (2011) confirm in their study that the lateral cephalograms is a valid method for measuring dimensions of pharyngeal airway(Pirilä-Parkkinen et al. 2011).

ANB angle is considered the most commonly used cephalometric measurement for evaluation of anteroposterior skeletal discrepancies(Ali, Manjunath & Sheetal n.d.; Ardani, Sanjaya & Sjamsudin 2018; Chang 1987; Ferrazzini 1976; Oktay 1991; Riedel 1957; Santo & Del Santo 2006) and also considered as one of the most reliable and accurate measurements of the anteroposterior jaw relationship (Ishikawa et al. 2000; Oktay 1991). The pharynx continue to grow rapidly until 13 years of age and then there is minimal growth until adulthood(King 1952). The upper pharyngeal airway depth increases with age, whereas the lower pharyngeal airway depth is established in early life (Handelman & Osborne 1976). The upper pharyngeal airway width increases with age (Ceylan & Oktay 1995; García-Martínez et al. 2016; Gonçalves, Raveli & Pinto 2011) but lower pharyngeal airway width does not show significant difference among the age groups(Gonçalves, Raveli & Pinto 2011). Therefore the age group of present study selected between 14 and 30 years to avoid probability of growth changes.

Gender discrimination was found in Class I and III subjects. No sex differences were detected in Class II subjects (Ceylan & Oktay 1995; Gupta & Subrahmanya 2014; Handelman & Osborne 1976; Linder-Aronson & Leighton 1983; Taloumtzi et al. 2020). Therefore the present study does not discriminate against gender. Basically, orthodontists rated the treatment needs based on soft tissue ,facial appearance and function. Submental-cervical angle is an important factor in perception of facial profile attractiveness. One of the possible reasons for poor submental-cervical aesthetics is retrognathic mandible (Moreno, Bell & You 1994). Morphology of the chin-neck region in profile view is a potentially important determinant of perceived attractiveness and is important for clinicians in correcting facial deformities(Naini 2011). The chin-throat angle is critical in defining chin extension: an acute angle indicates anterior projection and a significantly obtuse angle conveys the impression of reduced extension and the latter is characteristic of aging, along with the development of a double chin, particularly associated with weight gain(Gupta & Subrahmanya 2014).One study reported that pretreatment averages for CTA in class I (116° ± 6.87°), Class II (132.13° ± 13.13°) and Class III (112.22° ± 13.11°) subjects(Haddad & Ghafari 2017).

There are five visual criteria in restoring the youthful neck, in which one of the criteria is cervical mental angle between 105 degree and 120 degree (Ellenbogen & Karlin 1980).In Class II , obtuse CTA angle was less esthetic than other malocclusions and gives the clinical impression of a double chin or heavy neck(Haddad & Ghafari 2017; Naini et al. 2016). Abnormalities in the craniofacial region have been recognized as a part of the pathophysiology of OSA . Most common abnormalities are narrow posterior airway , elongation of the soft palate, mandibular deficiency, bimaxillary retrusion,and inferiorly positioned hyoid bone (Cistulli 1996). Among these mandibular deficiency in skeletal class II has been reported as predisposing factor to OSA and leads to decrease in the inferior oropharyngeal airway space(Abu Allhaija & Al-Khateeb 2005; Grauer et al. 2009; Hänggi et al. 2008; Miller et al. 2009).Small mandibular length was also a prime causative factor for OSA(El & Palomo 2011; Trenouth & Timms 1999; Zhang et al. 2019).

Lower pharyngeal airway is significantly decreased in OSA patients(deBerry-Borowiecki, Kukwa & Blanks 1988; Riley et al. 1983).Beneficial results have also been obtained in OSA after correcting the posteriorly placed mandible by mandibular advancement surgery or by functional appliances (Kyung, Park & Pae 2005; V et al. 2019). Oropharyngeal airway dimensions became smaller with the increase in ANB angle may be attributable to the different location of tongue and mandibular position with respect to cranial base in Class II malocclusion compared with other skeletal configurations in accordance with the statement given by Balters' philosophy(El & Palomo 2011; Rai et al. 2015).Subjects with skeletal class II division 1 mainly hyperdivergent growth pattern showed decreased lower pharyngeal airway due to mandibular deficiency compared to skeletal class I ('Evaluation of upper and lower pharyngeal airway in hypo and hyper divergent Class I, II and III malocclusions in a group of Egyptian patients' 2015; Kirjavainen & Kirjavainen 2007)

Some studies found that upper pharyngeal airway width is influenced by craniofacial growth pattern alone but not by malocclusion type and lower pharyngeal airway is not influenced by both growth pattern and type of malocclusion. This contradicts the present study(Ackerman & Klapper 1981; Tarkar et al. 2016; 'Upper and lower pharyngeal airways in subjects with Class I and Class II malocclusions and different growth patterns' 2006).

One study found that smallest dimension of lower pharyngeal airway was recorded in the skeletal class II, division 2, hence, the oropharyngeal airway dimension should be carefully considered for treatment timing(Uslu-Akcam 2017).If there is no finding of upper nasopharyngeal airway pathology related to enlarged adenoids or tonsils , early correction of a skeletal class II, division 2 malocclusion might have eliminated the possibility of disturbed respiratory function during sleep, such as snoring(Murat Özbek et al. 1998). Hence in this study, we evaluated the correlation between chin-throat angle and lower pharyngeal airway only in skeletal class II division 2 subjects. In this study, there is a significant correlation between chin-throat angle and lower pharyngeal airway.

Thus, clinical evaluation of chin-throat angle helps in early diagnosis of obstructive sleep apnea and leads to early correction in growing patients and early correction of skeletal class II division 2 malocclusion might have eliminated the possibility of having disturbed respiratory function and OSA later especially in those patients who have retrognathic mandible and smaller lower pharyngeal dimensions. The limitations of the present study is small sample size and 2 D digital cephalograms hence ,we recommended to use 3 D cone-beam computed tomography on large sample size for better assessment of airway dimensions and also to check this correlation between lower pharyngeal airway and chin throat angle.

CONCLUSION

Highly negative significant correlation was found between Chin Throat Angle (CTA) and Lower Pharyngeal Airway(LPA). If chin throat angle is increased ,correspondingly lower pharyngeal airway is decreased in class II div 2 subjects. Hence, Norms of our study was as follows,

IF CTA IS ABOVE 130 DEGREE, LPA IS BETWEEN 3-5 MM,

IF CTA IS ABOVE 120 AND BELOW 130 DEGREE, LPA IS BETWEEN 5-8 MM,

IF CTA IS BELOW 120 DEGREE, LPA IS BETWEEN 9-12MM.

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Conflict of Interest: There is no conflicts of interest

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