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Comparison of Different Craniofacial Patterns with Pharyngeal Length and Width

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Abstract

Background:*Variation in dimension of upper airway is related to changes in craniofacial growth. The objective of this study is to compare the length and Antero posterior width of upper pharyngeal airway in samples of skeletal class I and class II caseshaving differentsaggital growth patterns.*

Materials and method:*300 lateral cephalograms were selected and subdivided into six subgroups on the basis of Angle's and Steinern'sangle, then traced and six different linear measurements were tabulated. The normality of data was analysed by the Shapiro-Wilk test. ANOVA test was used to check differences in mean value between groups and pairwise comparison was done using Tukey's HSD post hoc test.*

Result *-Class II and classI hyperdivergent growth pattern cases have significantly narrower upper pharyngeal space and longer pharyngeal length than other subgroups.*

Conclusion *-It can be concluded that classII hyperdivergent cases are prone to narrowing of airway space as a result retruded or retropositioned mandible and any kind of dimensional changes of airway may hamper the craniofacial growth and develop OSA in older patient.*

Keywords- Sagittal*, vertical growth pattern, pharyngeal anteroposterior width, pharyngeal length, cephalometry, orthodontics*

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I. Introduction

Air is essential for life and for optimal airflow, sufficient anatomic dimensions of the airway is mandatory as this plays an important role in growth of the craniofacial structures.[1]Upper airway is divided into nasopharynx, oropharynx and hypopharynx.[6]Obliteration of nasopharynx and oropharynx alter breathing pattern that may disturb craniofacial growth[4]. Muscular and postural alteration of the tongue, mandible and imbalanced forces exerted by orofacial musculature and tongue cause the retropositioned mandible and malocclusion .[5]

vertical facialgrowth [occurs] by the growth changes in nasion, downward growth of maxilla and dentoalveolus[6]. Whenvertical facial growth is more than thevertical growth of condyle,mandible rotates in a downward and backward direction.[6] This usually results in narrowingof pharyngeal space. Few studies show skeletal class II malocclusion cases with retrognathic mandible have narrower antero-posterior pharyngeal dimension and are more prone to upper airway disorders like obstructive sleep apnoea.[7]So, during diagnosis and treatment planning for orthodontic case it is important to assess pharyngeal structures to evaluate and understand the cause of airway narrowing also.

Therefore, the purpose of this study is to compare pharyngeal length and oropharyngeal airwaywidths in class I and class II malocclusion & to derive relation between different growth pattern groups & pharyngeal dimension as well.

II. Matrials And Method

This cross-sectional analytical study was conducted at department of orthodontics and dentofacial orthopaedics of Guru Nanak Dental Sciences and research, Kolkata, West Bengal, India with three hundred Pre-treatment lateral cephalogram of patients reported for orthodontic treatment. Fourteen to twenty-five years old patients were selected.

class (acc to anb values)	group (acc to sn-gogn values)	no.of samples in each group	no. of female samples	no. of male sample
Class 1(0-4 degree) (150)	Hypodivergent (< 32 degree)	50	38	12
	Normodivergent (33-37 degree)	50	37	13
	Hyperdivergent (>38 degree)	50	30	20
Class II (> 4 degree) (150)	Hypodivergent (< 32 degree)	50	38	12
	Normodivergent (33-37 degree)	50	41	9
	Hyperdivergent (> 38 degree)	50	30	20

Any data presenting with the history of- previous orthodontictreatment, cleft lip and cleft palate, presence of pharyngeal pathology, mouth breathers, patients with obstructive sleep apnoea, history of orofacial trauma and any surgical history of oropharyngeal region have been excluded from the study. Lateral cephalograms were taken by X Mind Pano D +., in NHP, teeth in CO and lips at rest. Patient's head were positioned in the machine with the sagittal plane parallel to the plane of film and ear rods were kept mildly contacted with the external auditory meatus. During linear measurements magnification factor of the device (1.1) was considered. All cephalograms were traced manually over matte lead acetate paper (0.003 inches thick, 8X10 inches) using an illuminated viwerand 3H tracing pencil by single operator.
Two angular and fourteen landmarks were identified for pharyngeal linear measurement as follow:

A. **Point 1**: Point of intersection of posterior pharyngeal wall and palatal plane
B. **Point 2:**(Menton) - Most inferior point on mandibular symphysis
C. **Point 3**: Most anteroinferior point on third cervical vertebra
D. **Point 4**: Point of intersection of a line connecting point 2 and point 3, with posterior pharyngeal wall
E. **Point 5:** Posterior nasal spine(PNS)- Tip of posterior spine of palatal bone in the mid sagittal plane
F. **Point 6**: Intersecting point on posterior pharyngeal wall by the extended palatal plane (line connecting ANS to PNS)
G. **Point 7**: Point on the soft palate with narrowest posterior palatal airway.
H. **Point 8**: Point on the highest convexity of soft palate
I. **Point 9**: Tip of the soft palate
J. **Point 10** Point on the posterior pharyngeal wall with the widest distance from tip of soft palate.
K. **Point 11**: Intersecting point of mandibular plane and posterior border of base of tongue
L. **Point 12**: Point on the pharyngeal wall where the distance to point 11 is maximum.
M. **Point 13**: Epiglottic fold
N. **Point 14**: Point on the posterior pharyngeal wall where distance to E is maximum

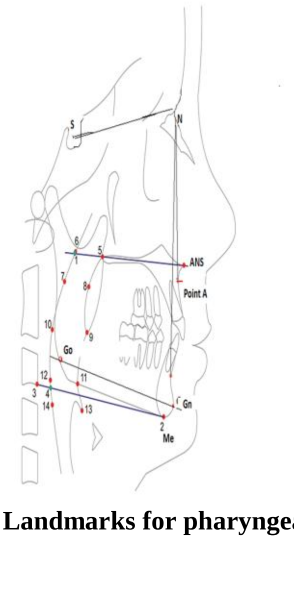


Figure 1: Landmarks for pharyngeal measurement

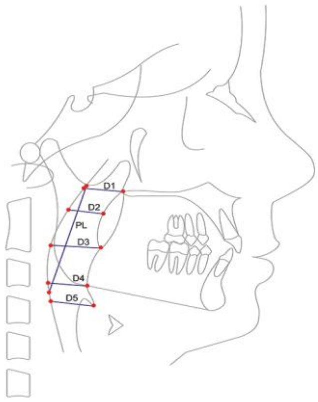


Figure 2:Various Pharyngeal measurements

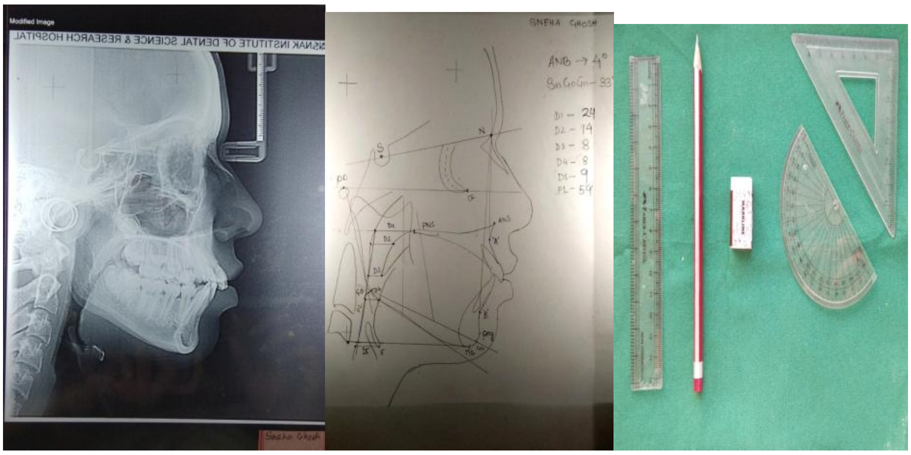


Figure 3: Later cephalogram, tracing of lateral ceph and equipments

By connecting the various landmarks pharyngeal airway measurements were done as follows
a.Vertical length measured from point 1 to point 4 is pharyngeal length
b. Width measured from point 1 to point 5 is D1[retropalatal pharyngeal width]
c. Width measured from point 7 to point 8 is D2 [do]
width measured from point 9 to point 10 is D3 [do]
e. Width measured from point 11 to 12 is D4 [retroglossal pharyngeal width]
f. Width measured from point 13 to point 14 D5 [retro epiglottic width]

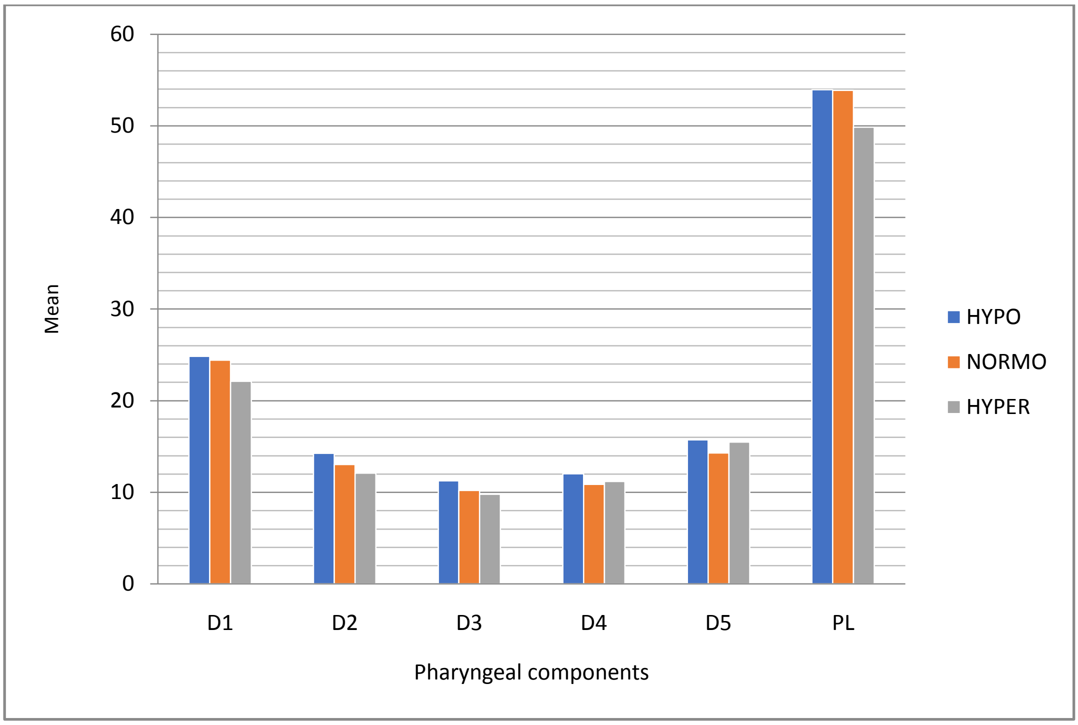
STATISTICAL ANALYSIS

All cephalograms were traced and five sagittal pharyngeal width and pharyngeal length were measured in each sample. The measured values were tabulated. All data were entered into Microsoft excel spreadsheet and analysed by SPSS 20.1. Descriptive and analytical statistics was done. The normality of data was analysed by the Shapiro-Wilk test.The parametric One Way Analysis of Variance (ANOVA) test was used to check differences in mean scores between groups and pairwise comparison was done using Tukey's HSD post hoc test.

TABLE 1: Comparison of mean pharyngeal space [length & width] in millimetre (mm)among different growthpattern of Class I Group (multi-comparison Tukey HSD)

(mm)	HYPO VS NORMO	HYPO VS HYPER	NORMO VS HYPER
D1	0.906	0.019	0.993
D2	0.177	0.005	0.351
D3	0.184	0.039	0.763
D4	0.209	0.433	0.888
D5	0.204	0.947	0.337
PL	0.999	0.002	0.002

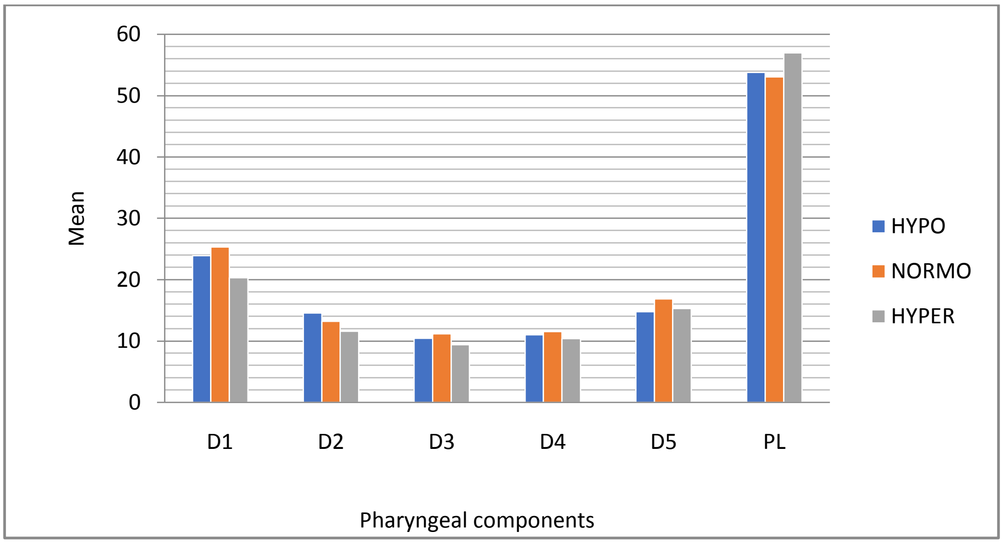
Hypo : Hypodivergent , Normo : Norm divergent, Hyper : Hyperdivergent, HSD: Honestly Significant Differences



Graph 1: Comparison of mean pharyngeal space [length & depth] inmillimetre (mm)among different growthpattern of Class 1 Group

TABLE 2: Comparison of mean pharyngeal space [length & width] inmillimetre (mm) amongdifferent growthpattern of Class II Group (multicompanies Tukey HSD)

(mm)	HYPO VS NORMO	HYPO VS HYPER	NORMO VS HYPER
D1	0240	0.000	0.000
D2	0.083	0.000	0.026
D3	0.531	0.317	0.033
D4	0.712	0.671	0.231
D5	0.042	0.827	0.158
PL	0.820	0.027	0.004

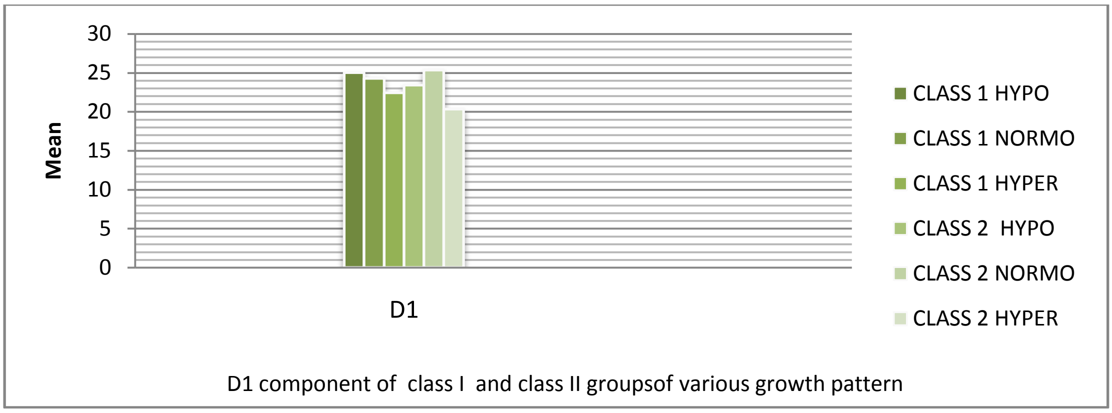


Graph 2: Comparison of mean pharyngeal space [length & depth] inmillimetre (mm)among different growthpattern of Class II Group

TABLE 3: Comparison of mean pharyngeal space [length & width] in millimetre (mm) among different growthpatterns of Class II Group

(mm)	HYPO DIVERGENT		NORMODIVERGENT		HYPERDIVERGENT		ANOVA
	MEAN ± SD	MEDIAN	MEAN ± SD	MEDIAN	MEAN ± SD	MEDIAN	
D1	23.90 ± 4.64	25.00	25.31 ± 4.57	25.00	20.32 ±3.88	21.00	0.000
D2	14.58 ± 3.28	14.00	13.23 ± 4.00	13.00	11.60 ±1.59	12.00	0.000
D3	10.42 ± 2.74	10.00	11.15 ± 3.84	11.00	9.42 ±3.62	9.00	0.042
D4	11.00 ± 4.07	10.50	11.56 ± 3.65	12.00	10.38±3.10	10.00	0.262
D5	14.80 ± 4.78	14.50	16.86 ± 3.94	17.00	15.30 ±3.96	15.00	0.042
PL	53.80 ± 7.0	52.50	53.07 ±5.2	53.00	56.96 ±5.76	56.00	0.004

D1, D2, D3 –Retropalatal pharyngeal width, D4-retroglossal pharyngeal width, D5-retropalatal pharyngeal width,PL- pharyngeal length, ANOVA : Analysis of Variance



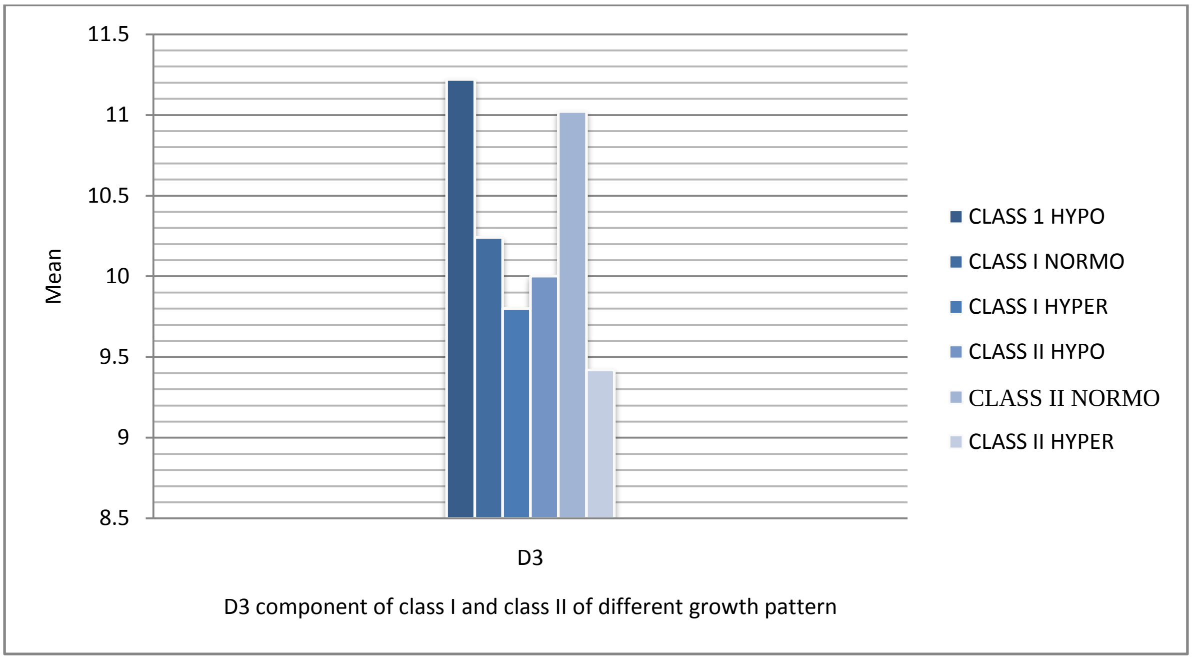
Graph 3: comparison of D1 component of class I and class II groupsof various growth pattern

TABLE 4 : Comparison of mean pharyngeal space [length & width] in millimetre (mm) among different growth pattern of Class II Group (multicomparison Tukey HSD)

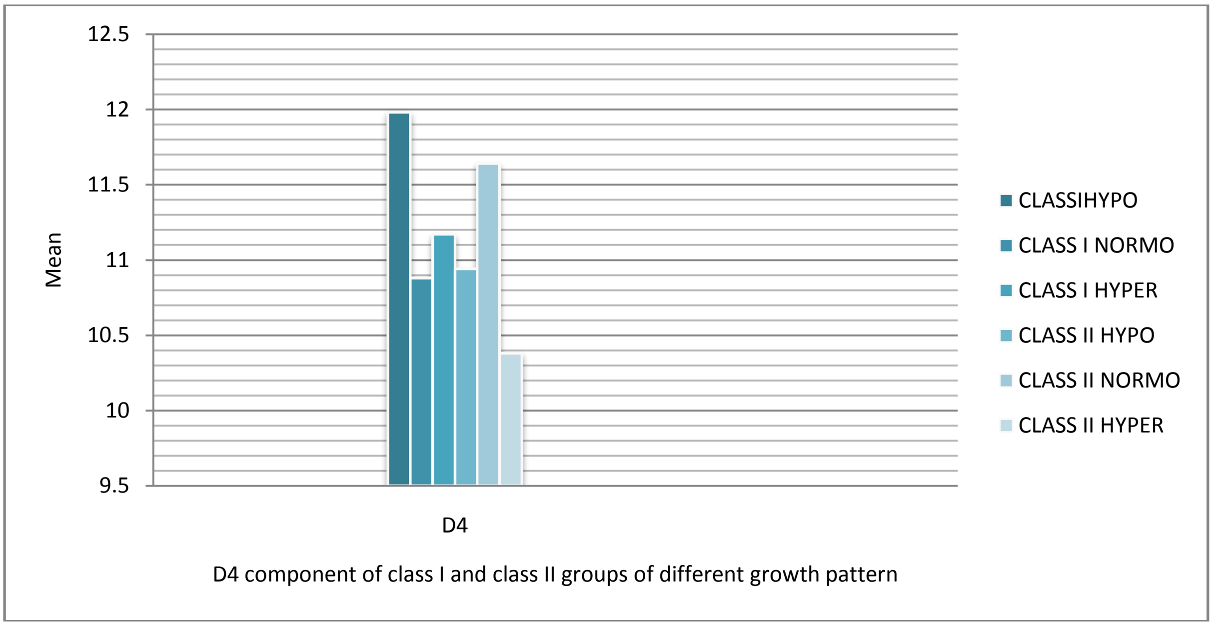
(mm)	HYPO VS NORMO	HYPO VS HYPER	NORMO VS HYPER
D1	0240	0.000	0.000
D2	0.083	0.000	0.026
D3	0.531	0.317	0.033
D4	0.712	0.671	0.231
D5	0.042	0.827	0.158
PL	0.820	0.027	0.004

Hypo: Hypodivergent,Normo: Normodivergent, Hyper: Hyperdivergent, HSD:Honestly Significant Difference

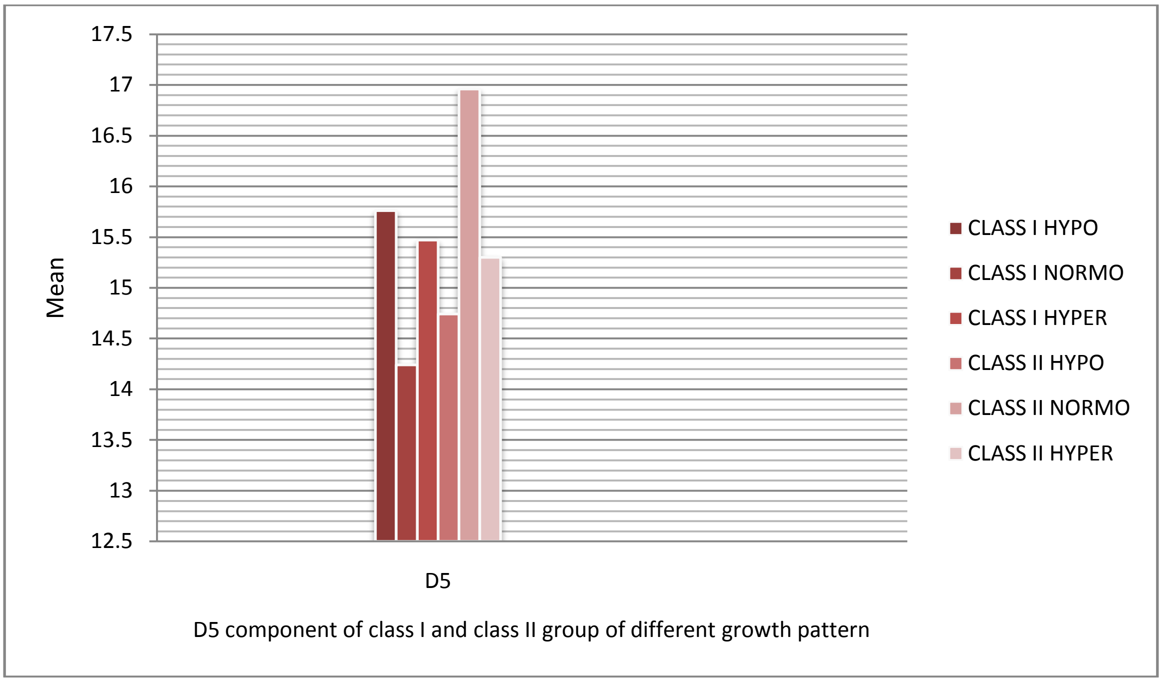
Graph 4 : comparison of D2 component of class I and class II groups of various growth Pattern



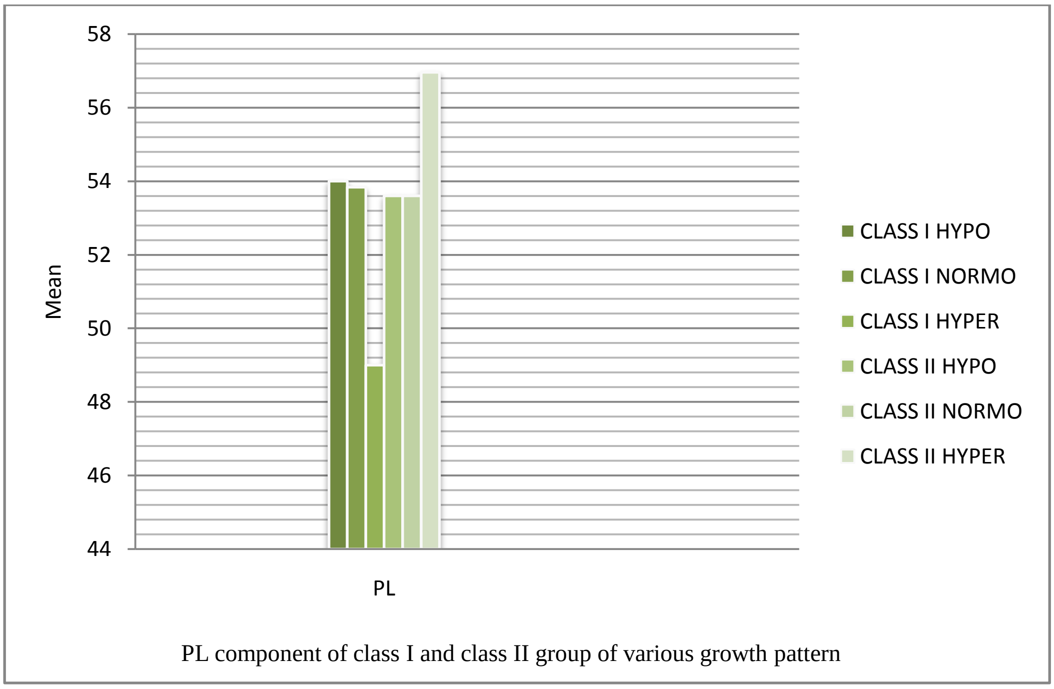
Graph 5: comparison of D3 component of class I and class II groups of various growth Pattern



Graph 6 : comparison of D4 component of class I and class II groups of various growth Pattern



Graph 7 : comparison of D5 component of class I and class II groups of various growth Pattern



Graph 8: comparison of PL component of class I and class II groups of various growth Pattern

TABLE 5: Comparison of mean pharyngeal space [length & depth] in millimetre different growthpatterns of Class I and class II group

	CLASS I			CLASS II			
(mm)	HYPO	NORMO	HYPER	HYPO	NORMAL	HYPER	ANOVA
D1	25 ± 5.2	24.28 ±5.36	22 ± 4.3	23.40 ± 4.5	25.34 ±4.6	20.32 ± 3.88	0.000
D2	14.2 ± 3.8	13.00 ±3.41	12 ± 2.9	14 ± 3.7	13.48 ±3.6	11.60 ± 1.5	0.000
D3	11.22 ± 2.9	10.24 ±3.02	9.8 ± 2.9	10 ± 2.9	11.02±3.75	9.42 ± 3.6	0.041
D4	11.98 ± 3.6	10.88 ± 2.9	11.17 ± 3.6	10.94 ±4.00	11.64±3.65	10.38 ± 3.1	0.255
D5	15.76 ± 3.6	14.24 ± 4.3	15 .47 ± 4.5	14 .74 ±4.7	16.96±3.92	15.3 ± 3.9	0.034
PL	54 ± 5.9	53.84 ± 5.9	49 ± 5.3	53.60 ±7.07	53.60±5.13	56.96 ± 5.7	0.000

D1, D2, D3– Retropalatal pharyngeal width, D4–retroglossal pharyngeal width, D5– retroepiglottal pharyngeal width, PL – pharyngeal length, ANOVA – Analysis of variance, Hypo: Hypodivergent, Normo :Normodivergent, Hyper : Hyperdivergent

III. Result:

From tabulated data it is seen that

1.Class I hyperdivergent cases have smaller retropharyngeal space (D1, D2, D3) than the normo& hypodivergent skeletal class I cases.

2. Class 1 hypodivergent(53.95 ± 5.99)group has the greaterpharyngeal length when compared to thenormo(53.95±5.94)& hyperdivergent (49.88 ±5.38) group.

3.Pharyngeal length inhyperdivergent (56.96 ± 5.76) groupis greater than normo (53.07 ±5.2) andhypodivergent (53.84±7.0) group of classII samples.

5. D1 & D2 component of retropalatal width of class II hyperdivergent (20.32, 11.60 & 9.42) group shows statistically significant lesser value when comparedto classII hypodivergentgroup (23.90, & 14.58)

6.D1 and D2 component of class II hyperdivergent group shows a significantly lesser value when compared to both class 1 hypo and normo group

7. D1 component of class I hypodivergent (25.41 ±5.38) and class II normodivergent (25.50 ± 3.70) males are statistically significantly larger than classIIhyperdivergent (20.50 ± 3.9) male samples (p=0.042).

8.Class II hyperdivergentgroup (57 ±80) shows higher pharyngeal length compared to class 1 hyper group (51.57 ±5.41) & the difference is statistically significant (p=0.024).

9.Class I normodivergent females (24.83±5.46) shows larger D1component when compared to class II hyperdivergent (20.20 ± 3.94) females and it is statistically significant(p=0.02)

10.Class II hypodivergent males have larger pharyngeal length than class1 hyperdivergent (p=0.001) as well as hypodivergent females.

11. Normodivergent female show a larger (25.10) D1 component than class 2 hyper males (20.50) (p=0.003) and hyperdivergent female shows a lesser (11.34) value than normodivergent male (12.69) (p=0.001).

12. depicts that norm divergent females show a larger (25.10) D1 component than class 2 hyper males (20.50) and hyper divergent females show a lesser (11.34) value than normodivergent males (12.69).

IV. Discussion

Incidence of obstructive sleep apnoea syndrome is rising now a days and reduced pharyngeal space due to narrowing of oropharynx is the key clinical presentation.[11] Hyperdivergent patients with vertical maxillary excess and retrusive mandible have narrower anteroposterior airway dimension.Thus knowledge of pharyngeal dimension amongst the various sagittal and vertical facial types is of great importance to orthodontist, especially during orthodontic diagnosis and treatment planning. Zhong et al.[9]found retrusion of mandible and VME in hyperdivergent patients cause narrowing of saggital airway dimension and affect the craniofacial growth.McNamara has found increase in anterior facial height and relative posterior displacement of maxillary complex cause face to become more retrognathic and reduced upper pharyngeal space[6]. In this present study retropalatal (D1,D2,D3) pharyngeal space was found to be decreased significantly in both Angle's class I and class II malocclusion with vertical growth pattern and are similar to the studies conducted by Freitas et al.[8] Yang H Park et al.[10] who demonstrated that Class II vertical growers have significantly narrower upper and lower pharyngeal airways than with Class II horizontal growers. In our study the retroglossal (D4) width significantly smalleronly in class II hyperdivergent growth pattern and retroepiglotic (D5) width is larger in class II normodivergent group in comparison to class I normodivergent samples. The similar result was found by Zhong et al[10] that palato and glossopharyngeal depth decrease in class III to class I to class II malocclusion.Nanda et al. found retroglossal dimension was found to be significantly decreased in class II subjects than class I subjects .

Pharyngeal length, is increased in class II hyperdivergent group than other two divergent patterns and in class I sample hyperdivergent group shows shortest pharyngeal length. Similar result was found in the study conducted by Shastri et al.where in classI subjects pharyngeal length is shorter in high angle cases than normal and low angle cases.There is no study found where class II hyperdivergent group shows a longest pharyngeal length compared to other growth pattern as well as class I sample also.

In this present study hyperdivergent males havelesser retropalatal (D1) dimension than hypodivergent malesirrespective of skeletal class I and classII malocclusion and incrasedpharyngeal length in class II hyperdivergentmales.Class II females show lesser retropalatal depth and increased pharyngeal length than classI females irrespective of growth pattern. Females showing larger retropalatal depth than males but class II hypodivergent males having longer pharyngeal lengththan females. Fogel et al.[12] found in a three-dimensional study that pharyngeal length is longer in males than females and volume is also increased in males. Hui Li et al. also concluded from their 3D study that upper airway dimension is bigger and longer in adolescent males than females.

A study done by A. Abd et al.[13] showed hyperdivergent females showed narrower airway space than males. Though Ceylan and Oktay[2] didn't found any relation between gender and pharyngeal size in younger age group. Ying et al.[14]found boys have larger lateral as well as anteroposterior depth of airway compared to girls. Roseline et al[15]also found larger upper airway in males than females. In our study 2D cephalometric radiograph has been chosen as it is easy to use, economical and less radiation exposure to the patients.Parkinen et al, Major et al.[16], demonstrated lateral cephalogram as a valid imaging method and good screening tool when compared to MRI.The limitation of cephalometry for airway studies is also considered because of inadequate representation of three-dimensional airway structure, low reproducibility, lack of cross-sectional and volumetric measurement is there[19,20].

V. Conclusion

From the study it is concluded that skeletal class I and class II malocclusion subjects with different growth patterns have significant difference in airway dimensions. Subjects with class I malocclusion have wider upper pharyngeal width than subjects with class II skeletal malocclusion. Narrow upper pharyngeal as well as retroglossal width have been found in hyperdivergent growth pattern irrespective of skeletal malocclusion type. Wide upper pharyngeal width has been found in class I males compared to class I females. Increased pharyngeal length has been found in class II males compared to females.

FURTHER SCOPE OF THE STUDY

This topic can be studied in better way by overcoming the limitation of reproducibility and representation of 2D radiograph as well as to measure cross-section and volume of airway by using of cone beam computed tomography. More dentoskeletal parameters and increased number of male samples to be taken and for better results & inferences the airway dimension changes with inhalational and exhalation phase of respiration [57,58] also to be studied.

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