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RESEARCH ARTICLE

PHARYNGEAL AIRWAY CHANGES IN PATIENTS TREATED WITH TWINBLOCK THERAPY: CBCT STUDY

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Abstract

The purpose of this study was to evaluate the effect of Twinblock on pharyngeal airway.

Material and Methods total CBCT record of 45 subjects of North Indian in the age range of 11-15 years were assessed.Out of these 45 subjects,25 treated skeletal class II malocclusion and 20 control Skeletal class I relationship subjects were selected.The subjects were divided into three groups control, pretreatment and posttreatment Groups.The CBCTwas used to measure the following variablesHeight,Width,length, cross-sectional areas at PNS plane, U plane, Eplane and pharyngeal airway volume. Student 't' test and chi-square test, linear regressiontest and Pearson correlation wereused for statistical analysis.

Results-After twin block treatment pharyngeal airway measurements statistically significant difference were found in pharyngeal airway parameters except Wg, Vp and CSAp.No statistically significant difference were found between pretreatment and control group. Correlation coefficient showed negative correlation between Hpand Wp and Wn andLg as one parameter increase other parameters decreased.Rest all other parameters shows positive correlation.

Conclusion-PharyngealAirway parameters were significantly increased after Twin Block Therapy in both the genders. The shape of Nasopharynx and Glossopharynxturned more elliptic in transverse plane whereas shape of Palatopharynxturned more circular.

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Introduction:-

The Pharynx is a tube-shaped structure that extends superior to inferiorly from the cranial base and end at the level of the inferior surface of the sixth cervical vertebra.The pharynx can be subdivided into three parts The nasopharynx, oropharynx and hypopharynx. The pharynx also plays an important role in respiration and deglutition.[1,]During the

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first 4 years of life, 60% of craniofacial development is completed and 90% of development take place by age 12 years. On the base of this observation at an early age it is easy to perform any intervention to open the airway.[3]

The relationship between the size of the nasopharyngeal airway space and its relation to the morphology of the face, the mandible is a highly debated subject. If there is a decrease of the nasopharyngeal airway space nasal breathing becomes very difficult due to which mouth breathing habits developed. As a result, the normal balance between oral and perioral structures is disturbed.[4]The pharyngeal airway space may be affected by various conditions like anteroposterior skeletal relation[5],maxillary forward positioning[6],functional forward shifting[7],and head posture[8]. Hencerespiratory function and airway volume are highly relevant to the orthodontic specialty.In Class II Division 1 malocclusionbackwardlyplaced mandible causes functional, aesthetic, and psychological problems and induces a backward placement of the tongue and hyoid bone that may ultimately lead to a decrease in upper airway volume.[9]Twin Block appliance after treatment caused positive increase in oropharyngeal dimensions, posterior airway space and a more anterior movement of hyoid bone.Nowadays the advances the three-dimensional technology providing a better accuracy in measurements in comparison between three-dimensional CBCT and two-dimensional lateral cephalograms. proper visualization of pharyngeal airway and volumetric measurements also become possible.[10] Therefore, the aim of the present study is to evaluate the three-dimensional effects of twin block appliance on the pharyngeal airway changes by using CBCT assessment.

Materials and Methods:-

In our study CBCT record of 45 subjects in the age range from 11 to 15 years were assessed. Approval was obtained from the Institutional Ethics Committee, before starting this study (no.84 ECM II B/P 29). Out of these 45 subjects, 25 treated subjects of skeletal class II malocclusion and 20 control subjects of skeletal class I malocclusion were selected.

The following inclusion criteria were fulfilled: Treatment Group subjects were between 11-15 years of age with retrognathic mandible SNB <76[13], Overjet of 6 to 10 mm, Skeletal class II relationship on the basis of [ANB[11]>4 and beta angle[12]<27^{0}] and control Group were between 13-15 years,Skeletal class I relationship on the basis of[ANB[11]2-4and Beta angle[12] 27^{0}-35^{0}], Overjet of 1-3mm.Cervical vertebral maturation stages of CVMI-2 to CVMI-4[14],No history of prior orthodontic treatment.Figure 1a,b

Subjects with Skeletal class III relationship, anterior open bite, severe proclination of the anterior teeth, Previous history of nasal respiratory complex surgery with facial and spinal abnormalities[torticollis,scoliosis] Pharyngeal pathology, nasal obstruction, enlarged adenoids or tonsils, mouth breathers were excluded.

The Selected subjects were divided into three Groups on the basis of treatment Control [Group I], Pretreatment[Group II], and post-treatment [Group III].Groups were further subdivided into male and female subgroups as Group IA [female], Group IB [male], Group IIA [female], Group IIB [male], and Group III A [female] , Group III B [males] respectively. **[Table.1]**The CBCT records were taken by Carestream CS 9300C by the same radiographer using a standardized technique,data exported in the DICOM (Digital Imaging and Communication in Medicine) format then imported Into Dolphin 3D 11.9 Premium for three-dimensional evaluation of volume, cross-sectional area, and linear and vertical measurements of pharyngeal airway space. All lateral Cephalograms were digitized using Dolphin imaging.Thepharyngeal landmarks and planes used in CBCT are depicted in Figure 2,Figure 3.

In our study 3 vertical, 6 linear, 3 volumetric, and 3 cross-sectionalparameters related to the pharyngeal airway were measured by CBCTFigure 4,Figure 5,Figure 6and Figure 7. Data so obtained were subjected to statistical analysis.Data were summarized as Mean + SD. The variables were compared between the Groups by Student't test and chi-square test. Pearson correlation analysis was used to assess the association among variables. The estimation of the linear relationship between the variables for different Groups are calculated by regression. All analyses were performed on SPSS Software version 18.

Result:-

The comparative evaluation ofthe Mean, Standard Deviation of various pharyngeal parameters between the control and pretreatment groupsHn,Vn, were found to be highly significant**[P<.0001**] whereasHp, CSAn,, CSAp, CSAg were moderately significant [**P<.01]** andWn, Ln, Wp, Vp were just significant**(P<.005).[Table 2]**

The comparison between pretreatment and post-treatment parametersHn, Hp, Hg, Wn, Ln, Wp, Lg,Vn,CSAn, and CSAgwere Highly significant [P<.0001]. WhereasVp and CSAp were moderately significant. (P<.01)**[Table 3].** On comparison between control and post-treatment, no statically significant difference was found for any parameters[p> 0.05].[**Table 3]**The linear regression analysis shows the highest goodness of fit of the equation was seen for Lp [length along U plane] [R^2 = 0.941] and the worst fit was seen in the Vp [Palatopharynx volume] (R^2=0.143, p=0.063).**(Table 4).**The Pearson correlation analysis showed a significant and positive correlation between Hn and Hg (r=0.52, p<0.01), Wn and Vn (r=0.46, p<0.05), Wg and Vp (r=0.55, p<0.01), Vg and CSAp (r=0.57, p<0.01), Vg and CSAg (r=0.49, p<0.05), CSAp and CSAg (r=0.45, p<0.05) suggesting that improvement in one may be directly associated to improvement in other. **[Table 5]**Hp and Wp (r=-0.49, p<0.05), and Wn and Lg (r=-0.54, p<0.01) showed a significant and negative correlation suggesting that an increase in one may be associated to a decrease in the other**.[Table 5]**

Discussion:-

The pharynx is a tube-shaped structure that starts supero-inferiorly from the cranial base and, ends at the level of the inferior surface of the sixth cervical vertebra.[2] There is an important relationship between the pharyngeal airway dimensions and the various anteroposterior and vertical facial growthpatterns.[22]According to Joseph[23]hyperdivergent subjects had a narrower anteroposterior pharyngeal dimension in comparison to the normodivergentsubjects.in skeletal Class II subjects, small pharyngeal airway dimensions and backward positioning of the mandible created a unestheic effect on the patient's facial appearance and mandibular growth. After Twin block treatment the upper airway showed a significant improvement in size of the nasopharynx, oropharynx and hypopharynx.[24] In our study subjects in the age range from 11 to 15 year for the treatment group were selected because patients should be actively growing to achieve a favorable skeletal change during Twin block treatment and coincides with the pubertal growth spurt a more rapid growth response may be observed. Some studies showed that the greatest effect of functional appliance is produced when it is used during the peak in mandibular growth.[29]Ceylan[30] and Laine T[25]found that there is no correlation between gender and nasal airway which state that there is no sexual dimorphism seen in most of the parameters of the pharyngeal airways and this supports our study.

In our study vertical parameters were increased significantly in posttreatment as compared to pretreatment. This finding was supported by the finding of Li et al.[24] who found that after the Twin block treatment mandible advanced by 3.52+2.14 mm in the horizontal direction and 3.77+2.10mm in the vertical direction respectively.On comparison linear parameters in control and pretreatment mean values of Wn, Ln and Wp were found to be significantly higher in the control Group. Joseph[23] also find a similar finding who stated that in class II malocclusion subjects nasopharyngeal airway shows narrow spaces as compared to class I normal subjects.All the linear parameters were found to be significantly higher in the post-treatment Group except Wp [width at u plane].Thomas et al.[27] showed that after mandibular advancement average change in upper pharyngeal width was average 1.08 mm which was highly significant. Kyung et al.[28] found in his study that after 7.7mm forward and downward movement of the mandible with a mandibular advancement appliance statically significant enlargement of depth was 3.3mm at retropalatal, 1.4mm retroglossal and enlargement of width was 2.2mm retropalatal and 3.3mm at retroglossal.

All the volumetric parameters were found to be significantly higher in posttreatment as comparison to the pretreatment group. This shows that after twin block treatment pharyngeal volume increases significantly and our finding was supported by Li et al.[24] andElfekyet al.[32] who evaluated the three-dimensional effect of twin block appliance on the pharyngeal airway and they found that after treatment, airway parameters significantly increase in nasopharyngeal and oropharyngeal airway volume..In our study no significant difference was found between control andpost treatment among volumetric parameters. It reflects that after twin block treatment pharyngeal volume increases significantly in class II malocclusion subjects, and becomes near to control subjects. Vinothet al.[33] demonstrated the effects of different functional appliances, on the pharyngeal airway and found that these appliancesincreases in oropharyngeal dimensions and the posterior airway space.

After twin block treatment pharyngeal cross sectional parameters increases significantly and becomes near to the control subjects. This was supported by the finding of Kyung et al.[28] in his study also showed that change in cross sectional area with the oral appliance which is used in obstructive sleep apnea.Hnand Hg, Wn and Vn, Wg and Vp, Vg and CSAp,CSAp and CSAg was significantly and positively correlated with each other and Hp and Wp, Wn and Lgwas significantly and negatively correlated with each other. [**Table 5]**,All these correlation suggest that after the treatment with Twin Block, the upper airway expanded, The greatest changes of volume and mean cross sectional areas occurred at Nasopharynx and Glossopharynx with significant enlargement. The Nasopharynx and

Glossopharynx turned more elliptic in transverse shape compared with the pretreatment. Whereas Palatopharynx turned more circular after the treatment with Twin Block as width at Palatopharynx [wp] decreased in transverse dimension. This was supported by the finding of Li et al.[24]In our study Pharyngeal parameters are positively correlated with mandibular advancement with Twin block therapy and shows significant overall improvement. Our study was retrospective in nature with small sample size, so the caution must be exercised when interpreting the results, and the result obtained from this study must be verified with a large sample size and prospective study.

Figures

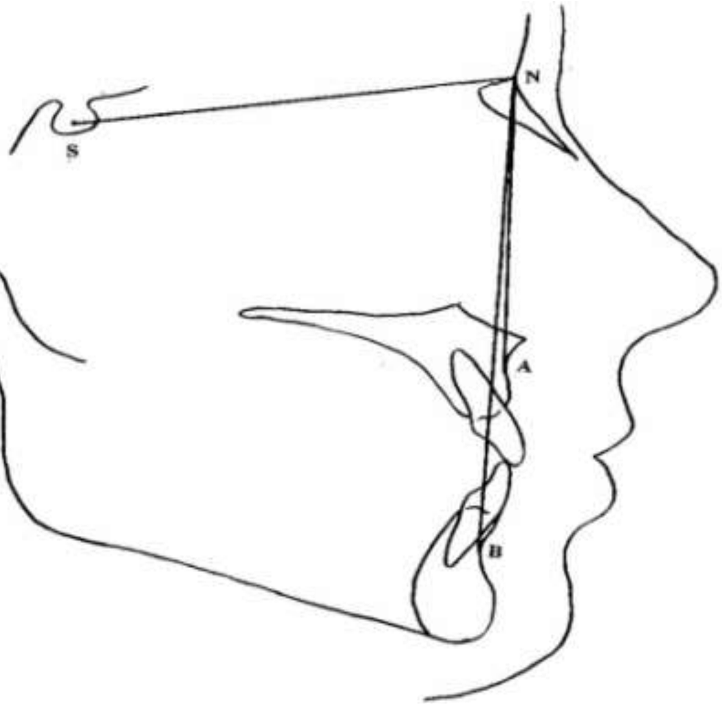

Figure 1 a:- ANB angle (in degrees).

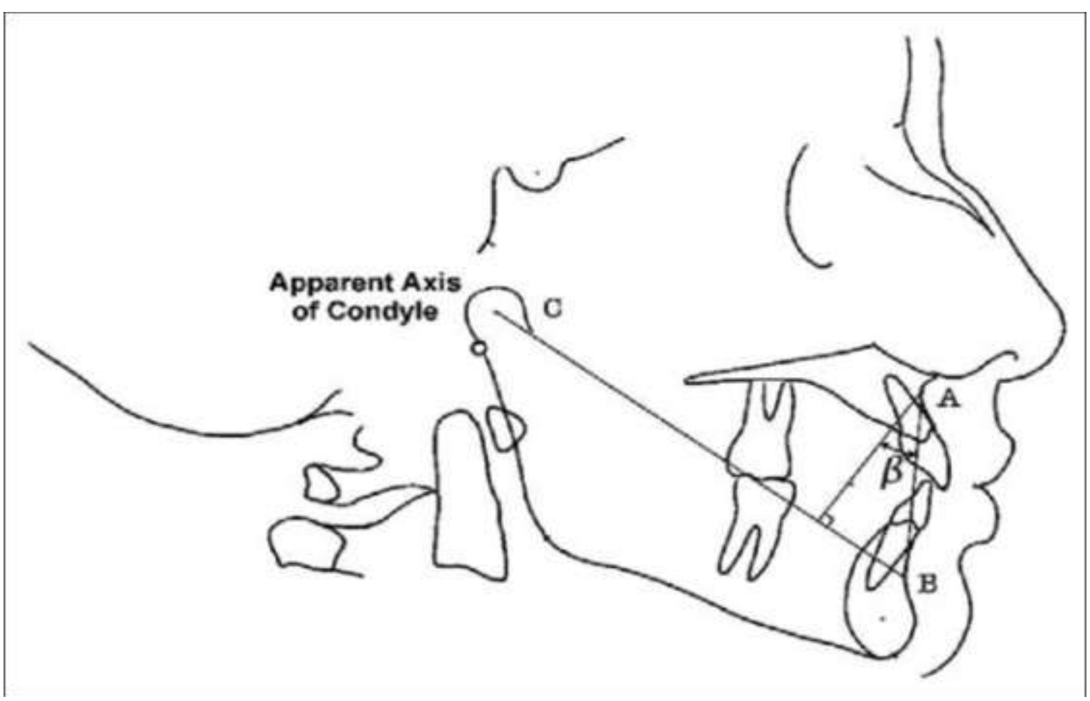

Figure 1 b:-Beta angle (in degrees).

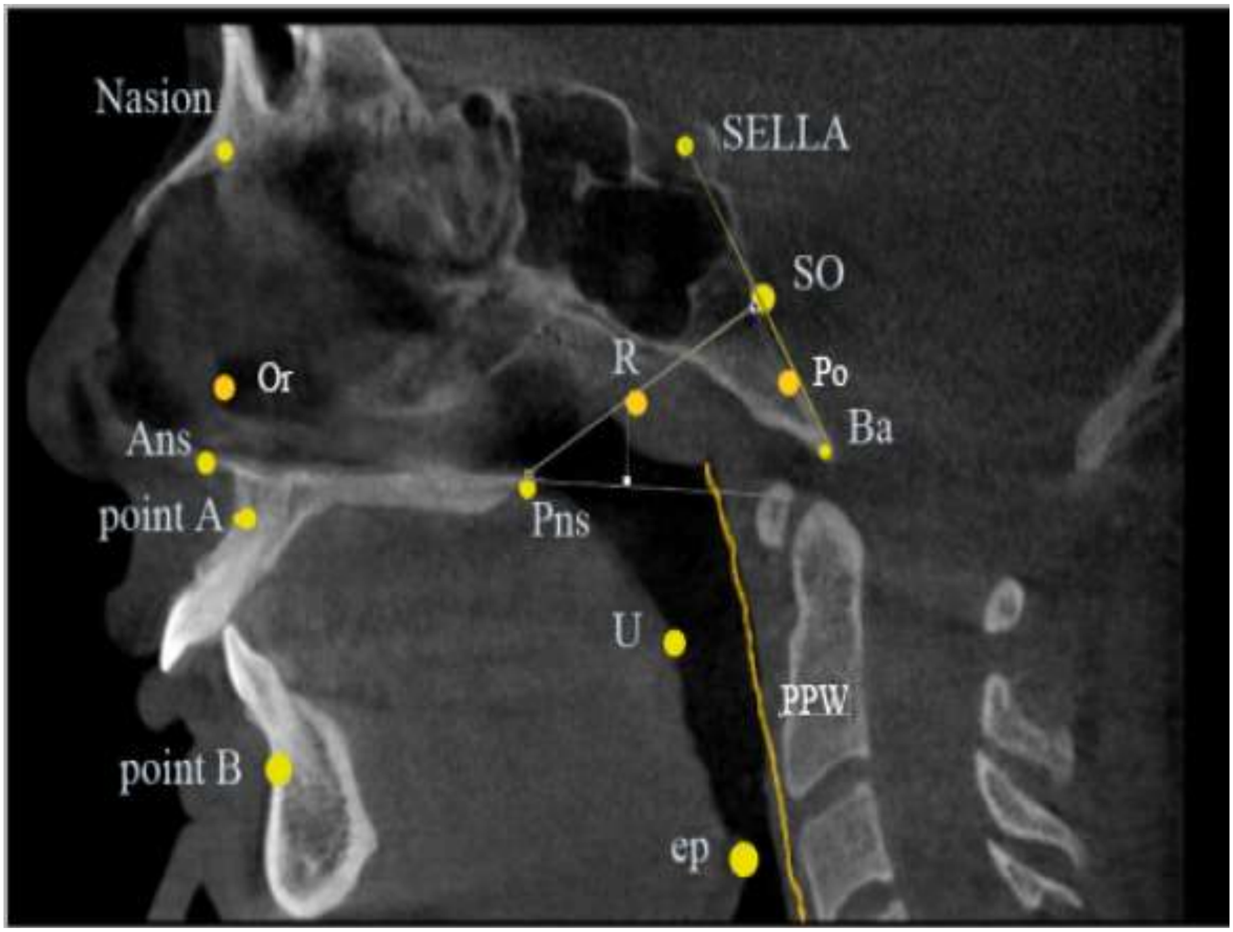

Figure 2:- Pharyngeal landmarks used in study.

There were 14 cephalometric landmarks used for assessment of Pharyngeal airway **1. S (Sella)-** The constructed point is defined as the center of the hypophyseal fossa**2. N (Nasion)-**The most anterior point of frontal nasal suture in the midsaggitalplane**3.Ba [basion]-** The most posterior inferior point of occipital bone at the anterior margin of the foramen magnum**4. So** - The midpoint of line segment S-Ba. **5.R**- The intersection point of line So-PNS and the superior border of Nasopharyngeal airway**6.Point A**-The deepest anterior point in the concavity of the anterior maxilla**7.Point B**-The deepest anterior point in the concavity of anterior mandible .**8 ANS** [**anterior nasal spine]-** The most anterior point on the bony hard palate in the sagittal plane**9 PNS [posterior nasal spine]-**The most posterior point on the bony hard palate in the sagittal plane.**10. Or (Orbitale)-** The inferior point on the orbital margin.**11.Porion-** The most superior point of the outline of external auditory meatus .**12.U-**The tip of the uvula [soft palate]**13.Ep-**The apex point of the epiglottis**14.Condyle C-**The apparent axis of condyle**15.PPW**-lateral soft tissue contour of pharyngeal wall, 1.**FH Plane [The Frankfort plane]**The plane was constructed on both side of Porion (Po) and right of Orbitale**. 2 PNS Plane**A plane parallel to the FH plane through the **PNS,** perpendicular to the sagittal plane. **3 U Plane**A plane parallel to the FH plane through **U,** Perpendicular to the sagittal plane **4.Ep plane** A plane parallel to the FH passing through the perpendicular to the sagittal plane **.**

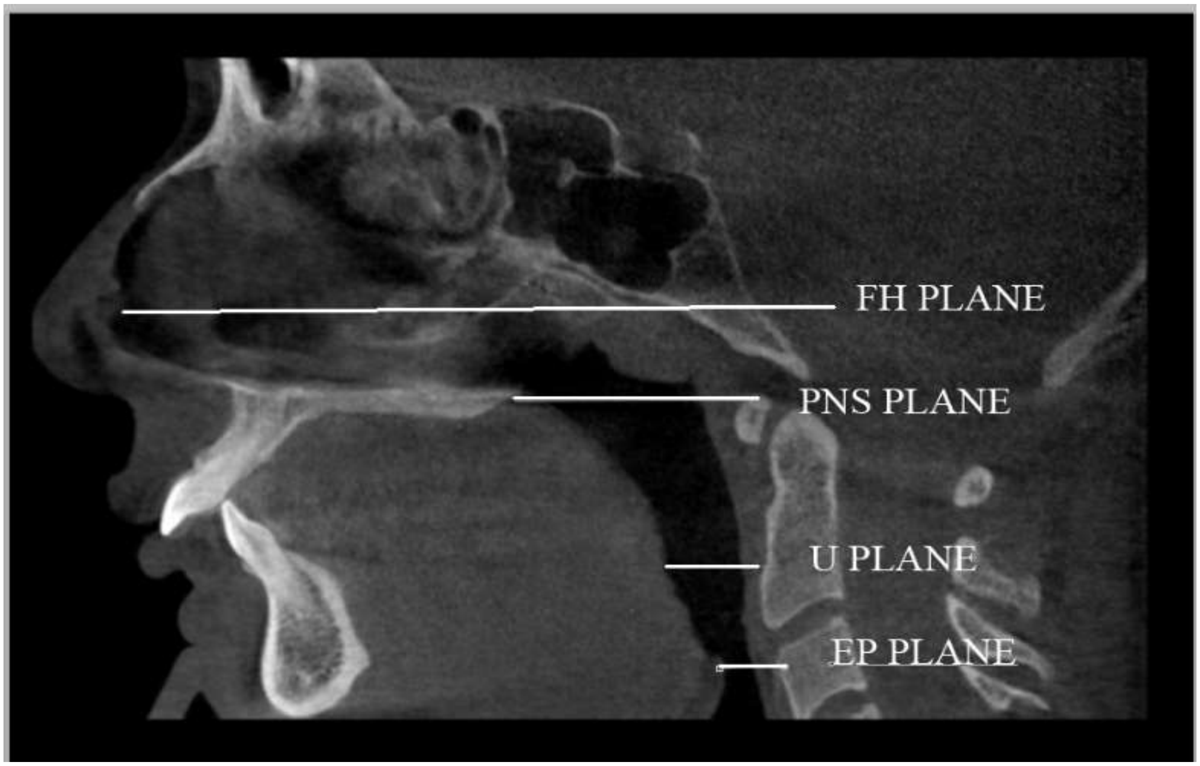

Figure 3:- Reference planes used in study.

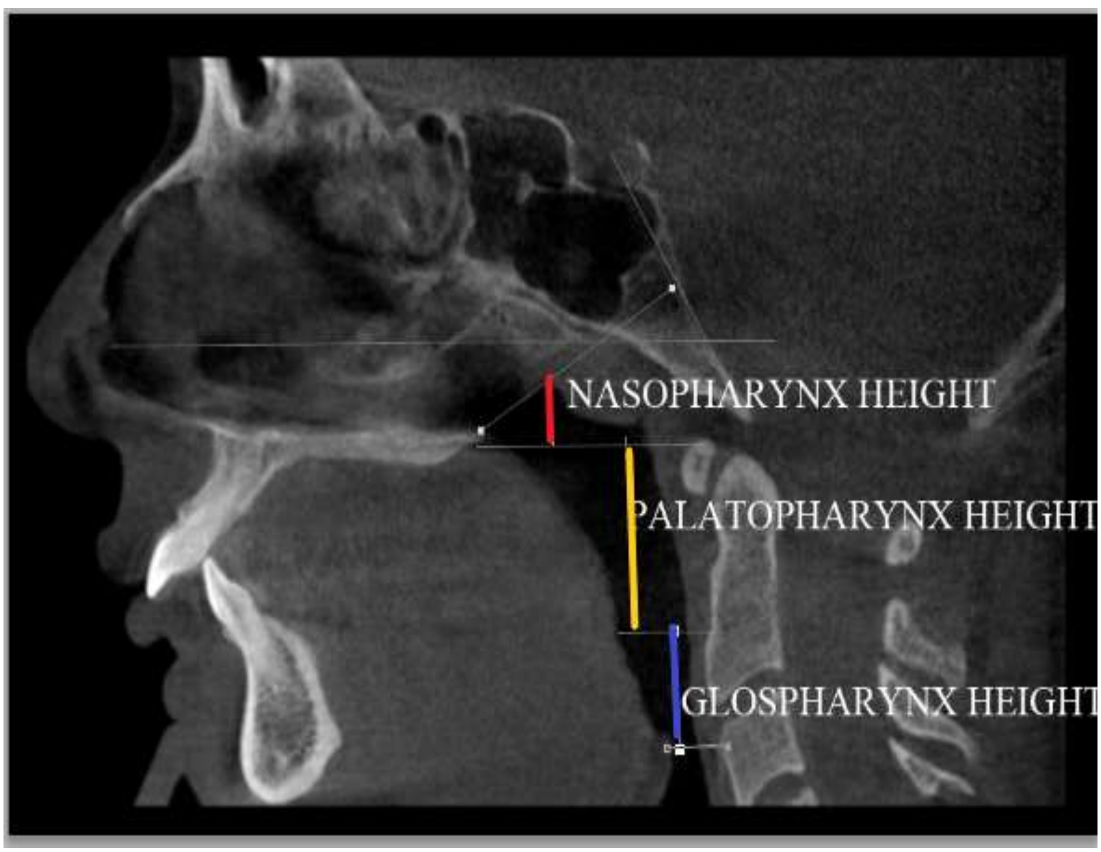

Figure 4:- Nasopharynx Height [red] Palatopharynx Height [yellow] Glossopharynx Height [blue].

HnThe vertical distance between Point R to PNS plane parallel to FH**.Hp**The vertical distance between plane passing through PNS parallel to FH plane, and plane passing through U**. Hg** The vertical distance between plane passing through U parallel to FH and the plane passing Ep

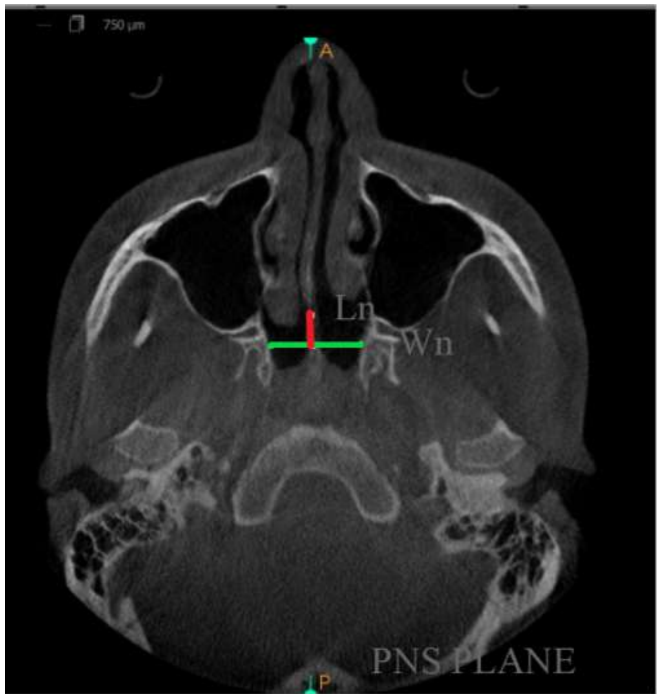

Figure 5:- Length, width and cross-sectional view of PNS plane.

Ln [length along PNS plane]-The longest anteroposterior distance between PNS to PPW. **Wn -**The Transverse widths along plane PNS passing through palatal plane and PPW **CSAn -**The interior soft tissue wall of pharynx along PNS plane in axial view

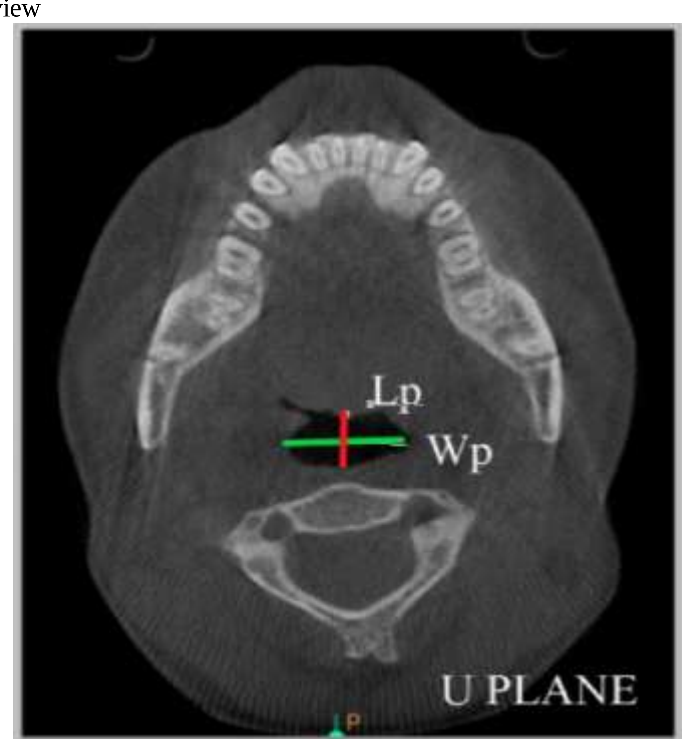

Figure 6:- Length, width and cross-sectional view of U plane.

LpThe longest antero-posterior distance between U plane to PPW,**Wp**The Transverse width passing along Plane U and PPW, **CSAp** The interior soft tissue wall of pharynx along U plane in axial view.

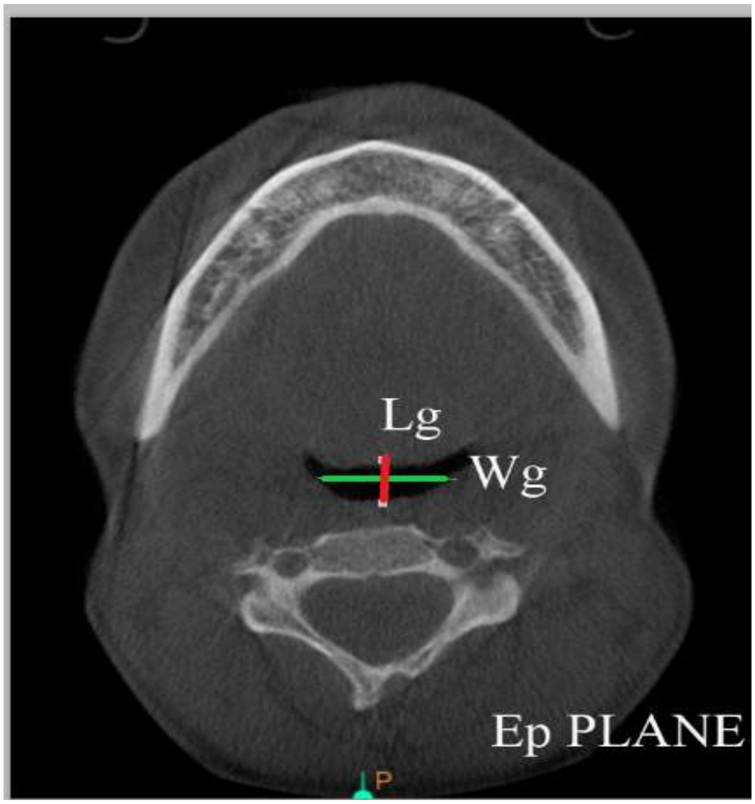

Figure 7:- Length, width and cross-sectional view of Ep plane.

LgThe longest antero-posterior distance between Plane Ep to PPW, **width** The Transverse width passing along plane Ep and PPW, **CSAg**The interior soft tissue wall of pharynx along Ep plane in axial view.

Table1:- Distribution of subjects in different Groups and subgroups:

Group I Control n=20		**Group II Pre-treatment n=25**		**Group III Post-treatment n=25**	
Group IA [female] n=8	Group IB [male] n=12	Group IIA [female] n=12	Group IIB [male] n=13	Group IIIA [female] n=12	Group IIIB [male] n=13

Table 2:- Age Summary of subjects among the control and the treatment [pre and post] group.

Group	**Mean**	**SD**	**t-value**	**p-value**
Control	14.50	1.25	1.56	0.128
Treatment [pre and post treated]	13.89	1.23		

(p value: ns >0.05 Non-significant; *<0.05 Just significant; **<0.01 Moderately significant; *<0.001 Highly significant)**

Table 3: Comparative evaluation of Mean, Standard Deviation of various pharyngeal airway parameters among the Groups, Group I and Group II, and Group II and Group III, and Group I and Group III.

	Parameters	Group-I (Control)		Group-II (Pre treatment)		p-value	Group-II (Pre treatment)		Group-III (Post treatment)		p-value	Group-I (Control)		Group-III (Post treatment)		p-value
		Mean	SD	Mean	SD		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Vertical Parameters	Hn	12.49	1.76	9.86	1.12	<0.001***	9.86	1.12	11.82	1.68	<0.001***	12.49	1.76	11.82	1.68	.200
	Hp	24.95	2.92	22.56	3.02	<.011**	22.56	3.02	24.83	2.58	<0.001***	24.95	2.92	24.83	2.58	.887
	Hg	16.23	2.63	16.32	2.96	.911	16.32	2.96	17.39	3.18	<0.001***	16.23	2.63	17.39	3.18	.195
Linear Parameters	Wn	25.80	2.18	23.79	3.88	.045*	23.79	3.88	26.28	2.95	<0.001***	25.80	2.18	26.28	2.95	.546
	Ln	12.57	3.18	10.33	3.92	.045*	10.33	3.92	11.94	3.74	<0.001***	12.57	3.18	11.94	3.74	.558
	Wp	27.51	5.45	23.99	4.51	.023*	23.99	4.51	17.03	4.39	<0.001***	27.51	5.45	17.03	4.39	.749
	Lp	11.14	2.45	10.38	3.54	.417	10.38	3.54	12.33	4.12	<0.001***	11.14	2.45	12.33	4.12	.260
	Wg	29.96	4.33	27.98	5.35	.188	27.98	5.35	30.47	5.15	0.002**	29.96	4.33	30.47	5.15	.726
	Lg	11.25	2.48	10.59	4.37	.555	10.59	4.37	12.28	3.98	<0.001***	11.25	2.48	12.28	3.98	.314
Volumetric Parameters	Vn	4711.25	1583.75	3292.68	1191.08	<.001***	3292.68	1191.08	4860.8	1470.49	<0.001***	4711.25	1583.75	4860.8	1470.49	.745
	Vp	8294.55	1959.70	7035.48	2139.49	.048*	7035.48	2139.49	8239.92	2095.3	0.018**	8294.55	1959.70	8239.92	2095.3	.929
	Vg	4798.90	2336.70	3569.08	1392.19	.034*	3569.08	1392.19	4782.96	1826.04	0.001***	4798.90	2336.70	4782.96	1826.04	.980
Cross-sectional Parameters	CSAn	366.70	61.17	292.84	77.94	.002**	292.84	77.94	356.4	84.04	<0.001***	366.70	61.17	356.4	84.04	.747
	CSAp	234.30	61.80	180.84	77.57	.016**	180.84	77.57	232.24	81.75	0.005**	234.30	61.80	232.24	81.75	.926
	CSAg	260.65	112.73	191.28	55.24	.010**	191.28	55.24	243.12	72.63	0.001***	260.65	112.73	243.12	72.63	.531

*(p value: ns >0.05 Non-significant; *<0.05 Just significant; **<0.01 Moderately significant; ***<0.001 Highly significant)*

Table 4:- Linear Regression Analysis for Predicting Post Treatment Values of Parameters on the Basis of Pre Treatment Values among the Cases.

Sr No	Measurement Parameters	Linear Predictor Function (y = a + bx)				
		Intercept	Slope	p-value	SE	R^2
Vertical Parameters	Hn	1.86	1.011	**<0.001*** **	0.229	0.458
	Hp	7.483	0.769	**<0.001*** **	0.077	0.814
	Hg	1.064	1.00	**<0.001*** **	0.08	0.871
Linear Parameters	Wn	11.536	0.62	**<0.001*** **	0.091	0.666
	Ln	2.891	0.877	**<0.001*** **	0.079	0.841
	Wp	6.237	0.867	**<0.001*** **	0.092	0.795
	Lp	0.646	1.126	**<0.001*** **	0.059	0.941
	Wg	9.543	0.748	**<0.001*** **	0.126	0.603
	Lg	3.62	0.818	**<0.001*** **	0.083	0.808
Volumetric Parameters	Vn	2546.9	0.703	**<0.001*** **	0.212	0.324
	Vp	5637.8	0.37	0.063	0.189	0.143
	Vg	2270.3	0.704	**0.006** **	0.231	0.288
Cross-sectional Parameters	CSAn	128.76	0.777	**<0.001*** **	0.156	0.520
	CSAp	142.94	0.494	**0.018** **	0.194	0.220
	CSAg	133.15	0.575	**0.029** **	0.247	0.191

(p value: ns >0.05 Non-significant; *<0.05 Just significant; **<0.01 Moderately significant; *<0.001 Highly significant)**

Conclusions:-

- PharyngealAirway parameters were significantly increased after Twin Block Therapy.
- Width and Length of pharynx at the level of Posterior nasal spine, and at the tip of Epiglottis increased, whereas the width of pharynx at the level of uvula decreased with the increase in length and height so that the shape of Nasopharynx and Glossopharynxturned more elliptic in transverse plane whereas shape of Palatopharynx turned more circular.
- Pharynx height was positively correlated with width [at PNS plane, at Ep plane], volume [Nasopharynx, Palatopharynx, Glossopharynx] and cross sectional areas [at PNS plane, at U plane, at Ep plane] as it shows as other parameters increased pharynx height also increased.

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