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Unveiling the Effects of Orthognathic Surgery & Twin Block Appliance on Pharyngeal Airways, Hyoid Bone & Tongue Position.

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Abstract
Objective: *The purpose of the Study was to determine and compare changes after orthognathic surgery & Twin Block Appliance in upper and lower pharyngeal airways (ULPA), Hyoid Bone & Tongue Position.*
Methods : *50 Lateral Cephalograms were evaluated for 11 Parameters (8 for ULPA dimensions , 2 for Hyoid Bone Position & 1 for Tongue Position) - the sample was subdivided into 5 Groups of 10 Lateral Cephalograms each – Group I being Lateral Cephalograms of subjects with Skeletal Class I relation as Control Group , Group II consisted of Lateral Cephalograms of patients before Orthognathic Surgery , Group III consisted of Lateral Cephalograms of patients after Orthognathic Surgery, Group IV consisted of Lateral Cephalograms of patients before Twin Block Appliance therapy & Group V consisted of Lateral Cephalograms of patients After Twin Block Appliance therapy . Independent samples t – test was used for statistical analysis, and a P – value < .05 was considered statistically significant.*
Results: *There was increase in Nasopharynx (U2, P < 0.047) & hypopharynx (L1, P < 0.044) airway dimension , hyoid bone was placed posteriorly (H1 , P <.032) in Group V compared to Group IV . There was increase in Nasopharynx dimension (U2, P < 0.42) , Hyoid Bone was placed superiorly (H2 , P < 0.02) in Group V compared to Group I. There was increase in Nasopharynx (U1 - P < 0.002 , U2 - P < 0.001) & Hypopharynx dimension (L1 , P < 0.007) in Group III compared to Group I. . There was increase in Nasopharynx (U1 - P < 0.001 , U2 - P < 0.004) & Hypopharynx dimension (L1 , P < 0.015) & Hyoid bone was placed inferiorly in Group III compared to Group V. In group III , Patients who underwent Mandibular Advancement Surgery , Hyoid Bone was placed Superiorly (H2 , P < 0.023) when compared to patients who underwent Mandibular Setback Surgery. Tongue position changes were not statistically significant when compared between different groups.*
Conclusion: *Orthognathic Surgery (both Mandibular Advancement & Reduction) & Twin Block appliance bring about significant changes in ULPA dimensions & Hyoid Bone position.*
Keywords: *Cephalometry, Pharyngeal Airway, Twin Block, Hyoid Bone Position, Tongue Position*

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I. Introduction

Mandibular setback surgery improves the occlusion, function, and esthetics by changing the position of the mandible, but it can also cause narrowing of the pharyngeal airway space (PAS) and changes in the position of the hyoid bone and the tongue [1.] Pharyngeal airway narrowing can cause obstructive sleep apnea syndrome (OSAS)[2]. Riley et al[3] suggested that mandibular setback might contribute to further development of OSAS after surgery, and it could be associated with airway patency because airway resistance appears to increase after surgery[4]. Kawakami et al[4] demonstrated that PAS was maintained shortly after mandibular setback surgery, whereas the hyoid bone moved inferiorly to compensate for the reduction in the oral volume. The positions of the tongue and the hyoid bone are also thought to change after mandibular setback surgery.[5-7]

The incidence of sleep-disordered breathing (SDB) among school-aged children is approximately 2–10%,[8] and narrowing of the Upper & Lower pharyngeal airways (ULPA) is a common feature in these patients.[9] To date there is no consensus on whether the SDB in adolescents is an extension of a childhood disorder or simply a representation of early manifestation of the adult form of sleep apnea, for which mandibular retrognathism is considered one of the risk factors.3 In children and adolescents with SDB the position of the mandible is more retrognathic in relation to the cranial base.[10] As a result the space between cervical column and the mandibular corpus decreases and leads to a posteriorly postured tongue and soft palate, increasing the chances of impaired respiratory function during the day and possibly causing nocturnal problems such as

snoring, upper airway resistance syndrome, and obstructive sleep apnea (OSA) syndrome.[11,12].The literature[13,14] also supports the notion of narrow ULPA and many anatomical adaptations in the ULPA among subjects with retrognathic mandibles. Robin[15] used an intraoral appliance to bring the lower jaw forward in newborns with mandibular deficiency, thereby preventing posterior relocation of the tongue during sleep and the occurrence of oropharyngeal collapse. Today this concept is widely used in dentofacial orthopedics. There are various removable and fixed functional appliances used routinely to stimulate mandibular growth in skeletal Class II growing patients. Similar oral appliances are also used in adult OSA patients to prevent upper airway collapse during sleep.[16,17]

Schendel and Epker[20] reported that the hyoid bone tends to return almost to its original preoperative position after a certain postoperative period following mandibular advancement with maxillomandibular fixation. LaBanc and Epker[21] reported immediate postoperative movement of the hyoid bone in an anterior direction, but, at the same time, they emphasized the ''highly variable'' nature of the postoperative positions of the hyoid. Most studies describe changes in hyoid bone position and pharyngeal airwaysize 1 to 2 years postoperatively.[18,19,21,22,23-25,26-28.]

The purpose of the Study was to determine and compare changes after orthognathic surgery & Twin Block Appliance in upper and lower pharyngeal airways (ULPA), Hyoid Bone & Tongue Position.

II. Materials And Methods:

SOURCE OF DATA:

Study sample consisted of 50 Lateral Cephalograms from the Record Section, Department of Orthodontics & Dentofacial Orthopaedics, Darshan Dental College & Hospital, Udaipur, and Rajasthan.

STUDY DESIGN:

The sample of 50 Lateral Cephalograms was collected and divided into 5 groups, comprising of 10 in each group.

Group I: consisted of 10 Lateral Cephalograms of Untreated subjects with Skeletal Class I relation as Control Group.

Selection criteria for SK.CL I Subjects.
1. Beta Angle → 27° - 35°
2. WITS analysis : 0 mm ± 1 mm
3. ANB of $2^{\circ} \pm 1^{\circ}$

Group II: consisted of 10 Lateral Cephalograms of patients BEFORE Orthognathic Surgery.
4 Patients requiring Mandibular Reduction Surgery & 6 Patients requiring Mandibular Advancement Surgery were selected based on following criteria.
For Patients Requiring Mandibular Reduction Surgery were selected based on :
1. Beta Angle → $> 40^{\circ}$
2. WITS analysis – < -2 mm
3. ANB of < -3°

For Patients Requiring Mandibular Advancement Surgery were selected based on :
1. Beta Angle → $< 27^{\circ}$
2. WITS analysis → > + 3 mm
3. ANB of $> 5^{\circ}$

Group III: consisted of 10 Lateral Cephalograms of patients of Group II AFTER Orthognathic Surgery.

Group IV: consisted of 10 PRE Treatment Lateral Cephalograms of patients to be treated with Twin Block Appliance.

For Patients Requiring Twin Block Appliance were selected based on :
1. Beta Angle → $< 27^{\circ}$
2. WITS analysis → > + 2 mm
3. ANB of $> 4^{\circ}$

Group V: consisted of 10 Lateral Cephalograms of patients of Group IV AFTER Twin Block Functional Appliance Treatment.

Lateral cephalometric radiographs were exposed with the patients seated in an upright position with Frankfort horizontal plane paralleled to the floor. The Lateral cephalograms were traced on acetate paper & were evaluated for 11 Parameters (8 for ULPA dimensions , 2 for Hyoid Bone Position & 1 for Tongue Position) . Each measurement was performed twice by the primary investigator, and mean values were used for computations. The Landmarks & Measurements to evaluate the 11 Parameters measured in this study are outlined in Figures 1 and 2 and Table A.

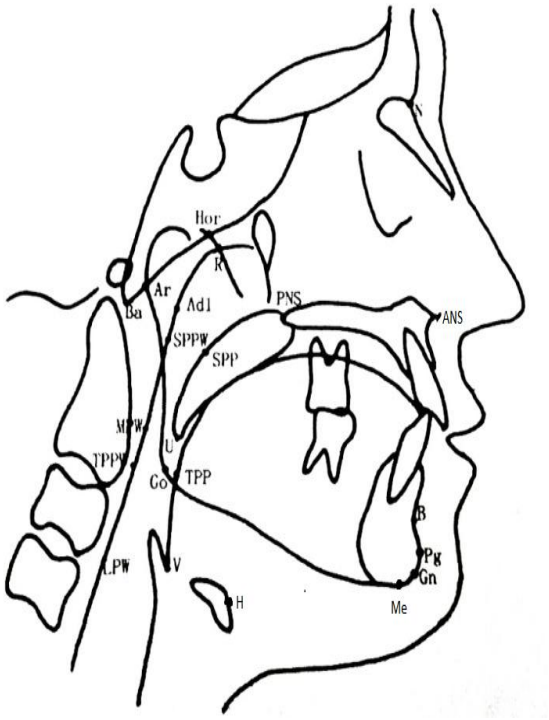


Figure 1.-Cephalometric Landmarks

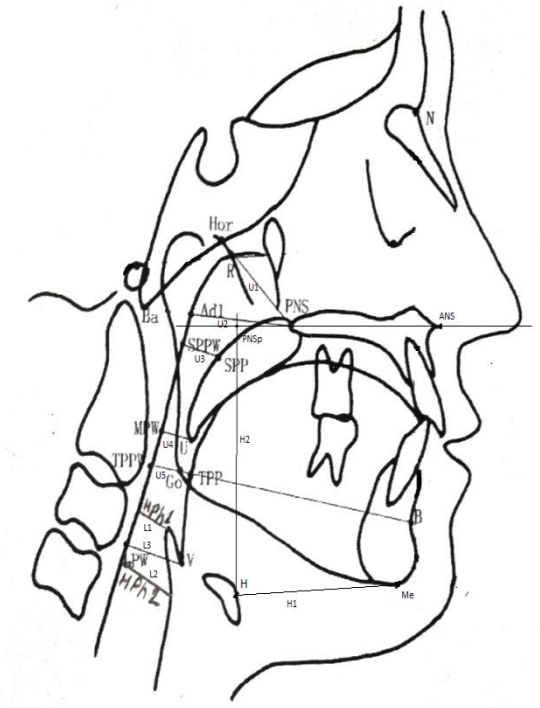


Figure 2. - Cephalometric measurements

Variable (Landmarks)	Definition
Hor	Most inferior point of spheno-occipital Synchondrosis
R	Point of intersection of line from Hor to PNS and posterior pharyngeal wall
Ba	Lowermost point on anterior margin of foramen magnum
Ad1	Point of intersection of posterior pharyngeal wall and line Ptm-Ba
SPPW	Point of intersection of line from soft palate center perpendicular to posterior pharyngeal wall and posterior pharyngeal wall.
SPP	Point of intersection of line from soft palate center perpendicular to posterior pharyngeal wall and posterior margin of soft palate
U	The tip of the uvula
MPW	Foot point of perpendicular line from point U to posterior pharyngeal wall
TPPW	Point of intersection of posterior pharyngeal wall and extension of line B-Go
TB	Point of intersection of base of the tongue and extension of line B-Go
V	The most posteroinferior point on the base of the tongue
LPW	Foot point of perpendicular line from point V to posterior pharyngeal wall
H	The most Superior and Anterior Point on Hyoid Bone
Me	The Most Inferior Point on Symphysis
ANS	Anterior Nasal Spine
PNS	Posterior Nasal Spine
PNSp	Point of Intersection of ANS – PNS line with a line from H perpendicular to ANS – PNS line

Table A

The upper airway (mm) will be assessed according to:
(a) U1 - PNS-R Distance between PNS and R.
(b) U2 - PNS – Ad1: Distance between PNS and Ad1.
(c) U3 - SPP – SPPW: Distance between SPP and SPPW.
(d) U4 -U-MPW - Distance between U and MPW.
(e) U5 - TB – TPPW: Distance between TB and TPPW.

The Lower airway (mm) will be assessed according to:
(a) L1 - Hph1: hypopharyngeal Space 1: line parallel to mandibular plane drawn at the level of the superior border of C3 and measured from anterior pharyngeal wall (base of tongue) to posterior pharyngeal wall.
(b) L2 - Hph 2: hypopharyngeal Space 2: line parallel to mandibular plane drawn at the level of the inferior border of C3 (third cervical vertebrae) and measured from anterior pharyngeal wall to posterior pharyngeal wall.
(c) L3 - V-LPW : Distance between V and LPW

HYOID BONE POSITION:
(a) H1 – Horizontal Distance from H to Me.
(b) H2 - Vertical Distance from H to PNSp.

TONGUE POSITION: U5 -Distance from TB to TPPW to Determine Anterioposterior Tongue Position.

Statistical analysis:

Statistical procedures for comparison of Cephalometric parameters were performed on the recorded data using SPSS 16.0 software. The intergroup and intragroup comparisons of were performed by using Independent Samples t-Test and a P – value < .05 was considered statistically significant.

For Comparison with the control we have to apply Independent samples t - Test whereas Paired 't' Test can be applied for comparison between pretreatment & posttreatment Evaluation but for Uniformity of Test , Independent Samples t- test was applied for both.

Results

[1]. There was increase in Nasopharynx (U2, $P < 0.047$) & hypopharynx (L1, $P < 0.044$) airway dimension , hyoid bone was placed posteriorly (H1 , $P <.032$) in Group V compared to Group IV .(Table I , Graph I)

[2]. There was increase in Nasopharynx dimension (U2, $P < 0.42$) , Hyoid Bone was placed superiorly (H2 , $P < 0.02$) in Group V compared to Group I. (Table II , Graph II)

[3]. There was increase in Nasopharynx (U1 - $P < 0.002$, U2 - $P < 0.001$) & Hypopharynx dimension (L1 , $P < 0.007$) in Group III compared to Group I. (Table III and Graph III)

[4]. There was increase in Nasopharynx (U1 - $P < 0.001$, U2 - $P < 0.004$) & Hypopharynx dimension (L1 , $P < 0.015$) & Hyoid bone was placed inferiorly in Group III compared to Group V. (Table IV, Graph IV)

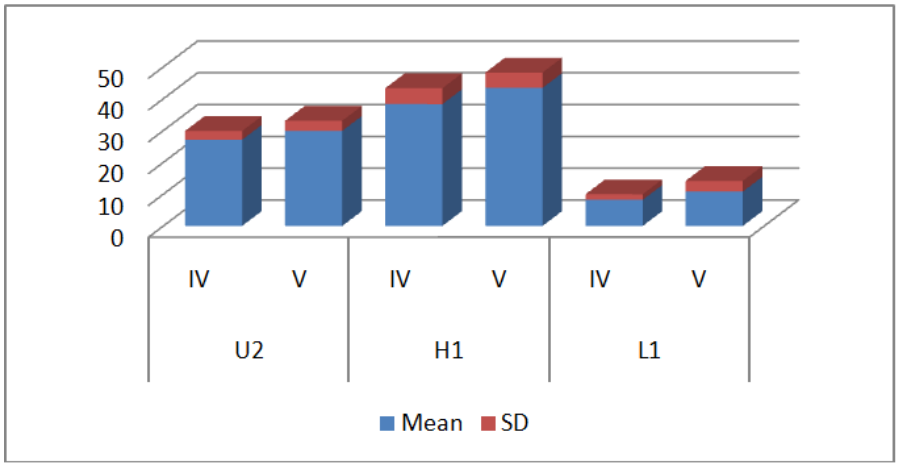
[5]. In group III , Patients who underwent Mandibular Advancement Surgery , Hyoid Bone was placed Superiorly (H2 , $P < 0.023$) when compared to patients who underwent Mandibular Setback Surgery. (Table V, Graph V)

[6]. Tongue position changes were not statistically significant when compared between different groups.

Tables and Graphs:

Table I

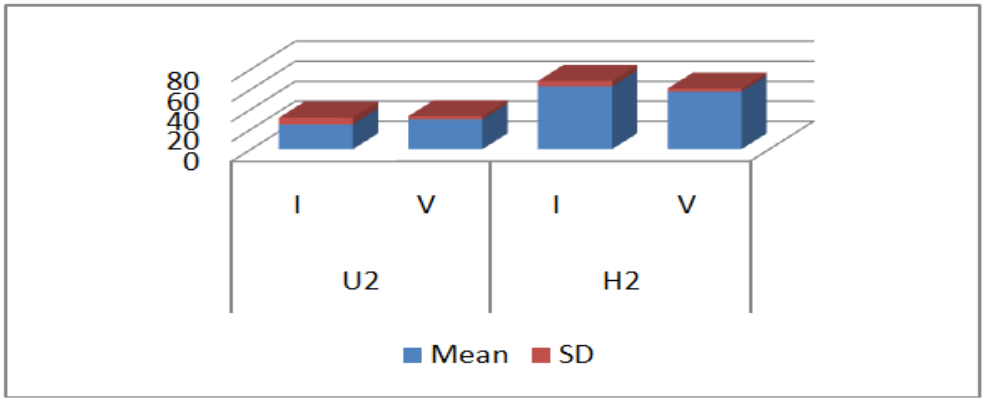
Comparison between Group IV & Group V						
Parameter	GROUP	Mean	SD	Mean Difference	t	*P*
U2	IV	27.1	2.726	2.8	2.128	0.047
	V	29.9	3.143			
H1	IV	38.3	4.99	5.1	2.326	0.032
	V	43.4	4.812			
L1	IV	8.2	1.751	2.6	2.17	0.044
	V	10.8	3.36			



Graph I

Table II :

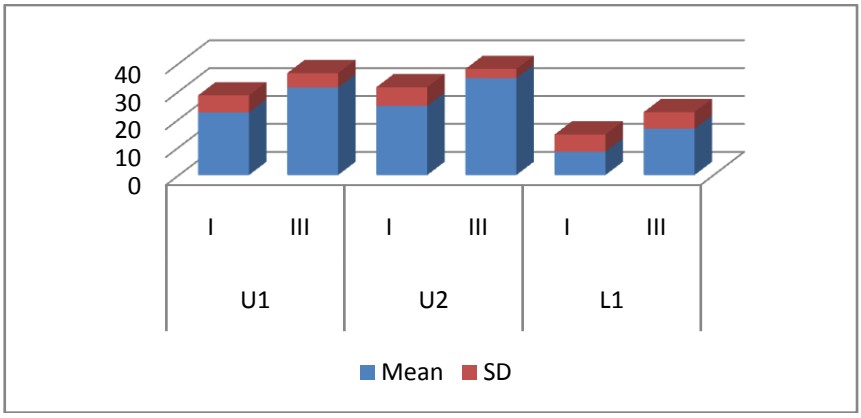
Comparison between Group I & Group V						
Parameter	GROUP	Mean	SD	Mean Difference	t	*P*
U2	I	24.8	6.663	5.1	2.189	0.042
	V	29.9	3.143			
H2	I	62.7	5.559	5.1	2.326	0.02
	V	57.6	2.989			



Graph II

Table III :

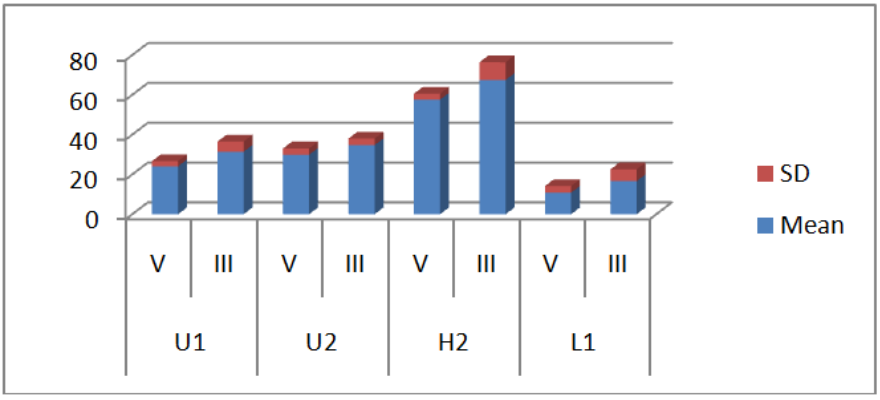
Comparison between Group I & Group III						
Parameter	GROUP	Mean	SD	Mean Difference	T	*P*
U1	I	22.4	6.15	9	3.561	0.002
	III	31.4	5.103			
U2	I	24.8	6.663	9.9	4.21	0.001
	III	34.7	3.302			
L1	I	8.4	6.114	8.2	3.045	0.007
	III	16.6	5.929			



Graph III

Table IV :

Comparison between Group V & Group III						
Parameter	*GROUP*	*Mean*	*SD*	*Mean Difference*	*t*	*P*
U1	*V*	*24.1*	*2.558*	*7.3*	*4.044*	*0.001*
	III	*31.4*	*5.103*			
U2	*V*	*29.9*	*3.143*	*4.8*	*3.33*	*0.004*
	III	*34.7*	*3.302*			
H2	*V*	*57.6*	*2.989*	*9.9*	*3.344*	*0.004*
	III	*67.5*	*8.873*			
L1	*V*	*10.8*	*3.36*	*5.8*	*2.691*	*0.015*
	III	*16.6*	*5.929*			

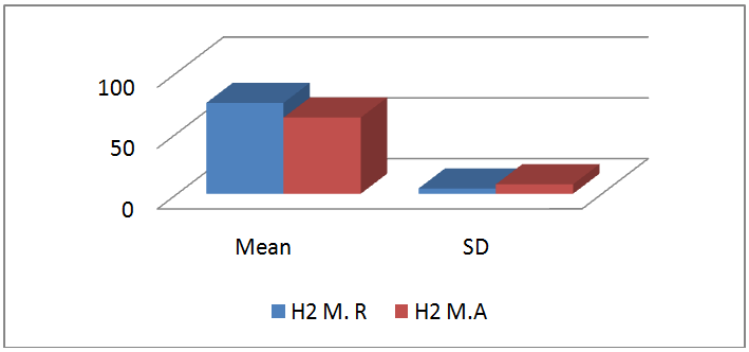


Graph IV

Table V :

INTRA-group comparison in Group III						
Parameter	Sub-division	Mean	SD	Mean Difference	t	*P*
H2	M. R *	74.75	4.349	12.083	2.798	0.023
	M.A **	62.67	7.763			

M.R* means Mandibular Reduction & M.A** means Mandibular Advancement



M.R* means Mandibular Reduction & M.A** means Mandibular Advancement

Graph V

III. Discussion

A normal nasal airway is dependent on sufficient anatomical dimensions of the airway. In addition, the size of the nasopharynx is of particular importance in determining whether the mode of breathing is nasal or oral.

Lateral cephalograms have been used to assess the ULPA in patients after orthognathic surgery.[5-7] Computed tomography and magnetic resonance imaging scans have also been previously used.[29,31] Cephalometric measurements of the ULPA are reliable in diagnosing pharyngeal volumes, although these were 2-dimensional analyses.[30] Riley and Powell[32] reported that ULPA measured by cephalograms was highly correlated with measurements using a 3-dimensional computed tomography scan with considerably high accuracy in predictability. The morphologic changes in the ULPA were measured by using lateral cephalograms in the current series because they are simple, less expensive, easily achieved with reduced radiation, and relatively ease to carry out compared with normative data and other studies.[33]

Most studies that have assessed the changes in ULPA and hyoid bone position of subjects who underwent orthognathic surgery did not use a control group and, therefore, lacked reference measurements. This study included parameters of subjects with Skeletal Class I as control group.

Morphologic changes in the pharyngeal airway after mandibular setback surgery have been previously studied. Several studies have reported that the pharyngeal airway is constricted after mandibular setback surgery.[3,34,35].Kitahara et al[36] reported that Nasopharynx & Hyphopharnyx dimension significantly decreased after surgery. The Present study did not any significant change in ULPA Dimensions between Group II & Group III , however , the present study found significant increase in Nasopharynx (U1-P < 00.2 ,U2-P< 0.001) & Hypopharynx (L1 –P<0.007) dimension in Group III when compared to Group I. The present study also found significant increase in Nasopharynx (U1-P < 00.1 ,U2-P< 0.004) & Hypopharynx (L1 –P<0.0015) dimension in Group III when compared to Group V . This results were similar to a study conducted by NK Sahoo et al [37] who reported an Increase in ULPA Dimension after Orthognathic Surgery.

The anterior displacement of the mandible by the functional appliances influences the position of hyoid bone and, consequently, the position of the tongue and thus improves the morphology of the upper airways.[38] A.K Jena et al[39] reported significant increase in oropharyngeal & Hypopharygeal dimension after Twin – Block Treatment. Our Study showed increase in Nasopharynx (U2,P<0.047) & Hypopharynx (L1,P<0.044) dimension in Group V compared Group IV.However when compared with Group I , Nasopharynx dimension (U2, P<0.042) was increased in group V. When comparing Group III & Group V, Nasopharynx (U1 - P< 0.001, U2 – P < 0.004) & Hypopharynx (L1 ,P < 0.015) dimensions were found to increased in Group III compared to Group V.

The hyoid bone moves downward for physiologic adaptation to the soft tissues after setback surgery.[4] Kitahara et al. reported Inferior & Posterior Movement of Hyoid Bone after Orthognathic Surgery.[36] While, in another study by NK Sahoo et al , it was reported that Hyoid Bone Moved Superiorly & Anteriorly after Orthognathic Surgery.[37] Verma et al Reported forward & upward movement of Hyoid Bone after Twin Block

Appliance Treatment.[40] In our Study, Hyoid Bone is placed posteriorly in Group V when compared to Group IV (H1 , $P < 0.032$).When comparing Group I & Group V , Hyoid bone is placed superiorly in group V when compared to group I (H2 , $P < 0.02$).When comparing Group III & Group V, Hyoid Bone is placed in superiorly (H2-P <0.004) in Group V when compared to Group III. In Intragroup comparison of Group V, Hyoid Bone is Positioned Superiorly in Patients who underwent Mandibular Advancement Surgery when compared to Mandibular Setback Surgery.

AK Jena et al , stated that Soft Palate dimension changes were more noticeable among subjects in whom Class II correction was accomplished by twinblock appliance and were probably due to the more anterior displacement of the mandible, which caused more anterior traction of the tongue away from the soft palate and changed the soft palate dimensions and inclination.[39] However in our study , tongue position changes were satistically insignificant.

IV. Conclusion

- There was increase in Nasopharynx & hypopharynx airway dimension, hyoid bone was placed posteriorly in Group V compared to Group IV.
- There was increase in Nasopharynx dimension, Hyoid Bone was placed superiorly in Group V compared to Group I.
- There was increase in Nasopharynx & Hypopharynx dimension in Group III compared to Group I.
- There was increase in Nasopharynx & Hypopharynx dimension & Hyoid bone was placed inferiorly in Group III compared to Group V.
- In group III , Patients who underwent Mandibular Advancement Surgery , Hyoid Bone was placed Superiorly , when compared to patients who underwent Mandibular Setback Surgery.
- Tongue position changes were not statistically significant when compared between different groups.

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