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Assessment of Correction of Cervical Hypolordosis in Class II Skeletal Patients with Mandibular Retrognathism after Twinblock Therapy

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Abstract:-
BACKGROUND: The anatomy of cervical spine plays a pivotal role in maintaining the head posture and craniofacial morphology. It was also essential for the normal functioning of the stomatognathic system. Studies show an association between subjects with Class II Skeletal malocclusion due to retrognathic mandible, and altered craniofacial morphology. These subjects are prone to develop compensatory cervical hypolordosis. The aim of this study was to evaluate the changes in cervical lordosis before and after treatment of Class II skeletal patients with retrognathic mandible by Twin block therapy.

MATERIALS & METHODS: Sixteen subjects (8 Males &8 females) aged between 10-13 years with skeletal Class II malocclusion with retrognathic mandible were chosen for the study. They were given standard twin block appliance and evaluated for changes in cervical curvature after the Twin blockphase. Pre and post treatment craniofacial skeletal changes and cervical curvature change were assessed using lateral cephalograms. Paired t test was used to evaluate the cephalometric changes between T0 and T1.

RESULTS: There was no statistically significant difference in the age and treatment duration among the subjects. In the lateral cephalogram, between T0 and T1, there was a significant difference in the SNB, ANB, AR-GO, AR-GN, LI-GO-GN and the craniocervical angles SN/CVT and MP/CVT. However there was no statistically significant difference in SNA, MP and the craniocervical angles SN/OPT and MP/OPT and the cervical lordosis angles OPT/CVT and CVT/EVT.

CONCLUSION: The null hypothesis was rejected because there was a difference in the cervical curvature before and after mandibular advancement by Twin block therapy. There was improvement in the sagittal relationship between maxilla and mandible after Twin block therapy. There was a significant change in the middle segment of the cervical column, which could indicate a change in the cervical curvature to a normal lordotic curve.

Keywords:- *Twin block, cervical column, Lordotic curve.*

I. INTRODUCTION

A Comprehensive knowledge of the biological principles governing the growth and development of craniofacial complex is essential for proper diagnosis and treatment of both morphological and functional disturbances in the masticatory system and adjoining structures. A substantial and a neglected factor that seems to have an influence in the structural and functional development of craniofacial complex is the posture of head and neck.

It has been documented in the literature that subjects with dolichofacial patterns and larger mandibular plane inclination are characterized by extended head posture and a forward inclined cervical column whereas subjects with brachyfacial patterns and smaller mandibular plane inclination angle have a markedly backward curved upper cervical spine.[10]

Thus, various anecdotal findings have been documented regarding the association between cervical posture and craniofacial morphology, which was later confirmed by many cross sectional and longitudinal studies.

Cranio-cervical angle was found to have a significant and consistent association with craniofacial form. It was reported that subjects with smaller cranio-cervical angle had, on average, a smaller anterior facial height with increased mandibular prognathism and those subjects with larger cranio-cervical angle had a larger anterior facial height with retrognathism of maxilla and mandible and a larger mandibular plane inclination.[1] Hence, growth coordination between changes in craniofacial morphology and postural changes exists and that this coordination is centred on the development of the mandible.[32]

The causal and effect relationship between cervical posture and craniofacial morphology have been explained. There were no associations between skeletal and postural changes during the early mixed dentition phase but the smaller cranio-cervical angle during 9-10 years was later followed by marked forward growth of maxilla and mandible, whereas larger cranio-cervical angle subjects during that period later resulted in vertical facial development and that was also noted on the vertical positional change of hyoid bone. Henceforth, the cranio-cervical angle measured 2- 4 years before the peak pubertal growth velocity could give a predictive information regarding subsequent facial development.[7]

The mechanism however remains unclear. The influence of gravity on head posture and craniofacial morphology have been excluded, considering very little or no association of cranio-vertical angle with craniofacial development.

Soft tissue stretching hypothesis could explain the mechanism behind the relationship between craniofacial development and cervical posture, according to which the obstruction of upper airways, through neuromuscular feedback, could lead to a postural change in the cervical column, which in-turn passively stretches the soft tissues, thereby redirecting the growth of maxilla and mandible in a caudal direction.[23]

Other factors that have been related to the position of cervical vertebra are age, ethnicity, gender, craniofacial morphology, temporomandibular dysfunction and orthodontic therapy.[19]

Functional appliance treatment is considered to be an effective solution to overcome the deficiency in jaw growth during the pubertal growth peak period. These functional appliances seem to alter the activity of various muscle groups that influence the function and position of the mandible, which in-turn creates a “viscoelastic stretch “, redirecting the forces produced by the appliance to the underlying skeletal tissues and brings about orthopedic and orthodontic changes.

The effect of functional orthopedic treatment of the skeletal Class II to the head posture was also investigated. It was noted that changes occurred in the craniocervical system after mandible was repositioned in a more anterior position. Cervical lordosis was found to increase after mandibular advancement by functional appliances.[13]

The twin block was introduced by Clark in 1982. It consists of separate upper and lower interlocking occlusal bite blocks, which results in mandibular advancement. It was the most preferred functional appliance since its introduction mainly because of its uncomplicated design and ease of use for the patients, which facilitates speech and mastication to some extent and has proved to be associated with good patient compliance. Because the Twin block is one of the most common functional appliances prescribed to the patients for dentofacial orthopedic correction, it is necessary to evaluate its treatment effects.[4]

A plenteous studies have been published regarding the craniofacial skeletal and dentoalveolar effects of twin block appliance, however only very few studies have been done to evaluate the cervical posture after twin block therapy, the results of which have shown that craniocervical angle altered after twin block therapy and these have been done mainly in relation to upper and middle segment of the cervical column.

Therefore, this study was undertaken to evaluate the changes in cervical curvature after twin block therapy and the association between the upper, middle as well as the lower segment of cervical column and mandibular advancement.

II. MATERIALS AND METHODS

- **STUDY DESIGN**
  Prospective Longitudinal study.

- **STUDY CENTER**
  This was a single centred study performed in the Department of Orthodontics & Dentofacial Orthopaedics, Tamilnadu Government Dental College & Hospital (TNGDC & H), Chennai-3.

- **STUDY DURATION**
  This study duration was 15 months.

- **ETHICAL CLEARANCE**
  The study protocol was approved by the Ethical committee of Tamilnadu Government Dental College and Hospital, Chennai. Ethical clearance number: 4/IRB/2019.

- **STUDY SAMPLE**
  Sixteen subjects (8 Males&8 females) aged between 10-13 years with skeletal Class II malocclusion with retrognathic mandible are selected for the study.

- **Inclusion criteria**
  - Skeletal Class II malocclusion with retrognathic mandible with over jet of 5 to 10 mm.
  - SNA- 80 TO 84 (°)
  - SNB- <78 (°)
  - ANB- >4 (°)
  - At least half-cusp class II molar relationship
  - Average growth pattern.
  - SN-MP- 28 TO 30 (°)
  - Pubertal growth period.
  - CVMI STAGE 3-4

- **Exclusion criteria**
  - History of previous orthodontic treatment.
  - Craniofacial and mandibular pathology.
  - Systemic Muscle and joint disorders.
  - Any significant medical history.

III. METHODOLOGY

A. *MATERIALS*

Lateral cephalograms of the study subjects taken before treatment (T0) and after treatment (T1).

B. *STANDARDISATION OF LATERAL CEPHALOGRAM*

- The cephalostat is standardized for all the radiographs. It allows the midsagittal plane of the individual to remain parallel to the Xray film and perpendicular to the X-ray beam.
- All Lateral cephalograms will be taken by one technician to obtain constancy in the radiographic images.
- It is recommended a distance of 152.4 cm between the X-ray source and midsagittal plane and a distance of 15cm between the X-ray film and midsagittal plane.

- Establishing a comprehensive set of angular and linear cephalometric measurements.
- The obtained cephalograms are traced manually by the same examiner on acetate tracing paper.
- Intraclass correlation coefficient is used to measure the intra-examiner reliability. A score closer to 1 indicates good agreement of the data.

C. TREATMENT PROTOCOL

- The parents or guardians of the patients were notified about the purpose of the study and informed consent was obtained from each one of them before commencing the treatment.
- Patient who satisfied the inclusion criteria was given standard twin block as a fulltime wear appliance after taking prefunctional lateral cephalogram (T0).
- Single phase advancement of mandible was done for all the patients.
- Review of the patients was done once in every four weeks.
- The treatment was continued till the treatment objectives of class 1 molar relationship, normal over jet and overbite, pterygoid response is achieved.
- Post functional lateral cephalogram (T1) was taken and skeletal parameters were compared between T0 and T1.

D. CEPHALOMETRIC PARAMETERS

- N- Nasion point.
- S- Sella point.
- A-The most posterior midline point in the concavity of the maxillary base between anterior nasal spine and prosthion.
- B- The most posterior midline point in the concavity of the mandibular base between the infra-dentale and pogonion.
- Ar- The intersection of posterior ramal border with the inferior border of the posterior cranial base.
- Go-The point that on the jaw angle is most inferiorly, posteriorly and outwardly directed.
- Gn- Most anteroinferior point on the mental symphysis.
- L1-line connecting incisal edge and root apex of the most prominent mandibular incisor.
- Cv2tg-tangent point of the superior, posterior extremity of odontoid process of the C2 vertebra.
- Cv2ip-the most inferio-posterior point on the body of the 2nd cervical vertebra.
- Cv4ip- the most inferio-posterior point on the body of the 4th cervical vertebra.
- Cv6ip-the most inferio-posterior point on the body of the 6th cervical vertebra.
- SN- Sella Nasion line, line through S and N.
- SNA- Angular relationship of maxilla to cranial base.
- SNB-Angular relationship of mandible to cranial base.
- ANB-Angular relationship of maxilla to mandible
- OPT- odontoid line, line through cv2tg and cv2ip
- CVT –upper part of cervical spine, line through cv2tg and cv4ip
- EVT- lower part of the cervical spine, a line through cv4ip and cv6i

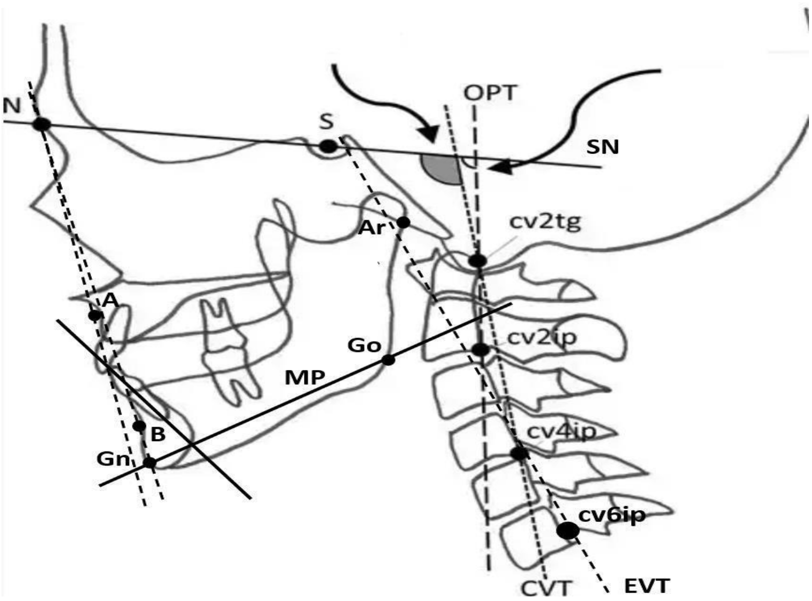

Fig. 1: Cephalometric landmarks

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Fig. 2: Pretreatment cephalogram

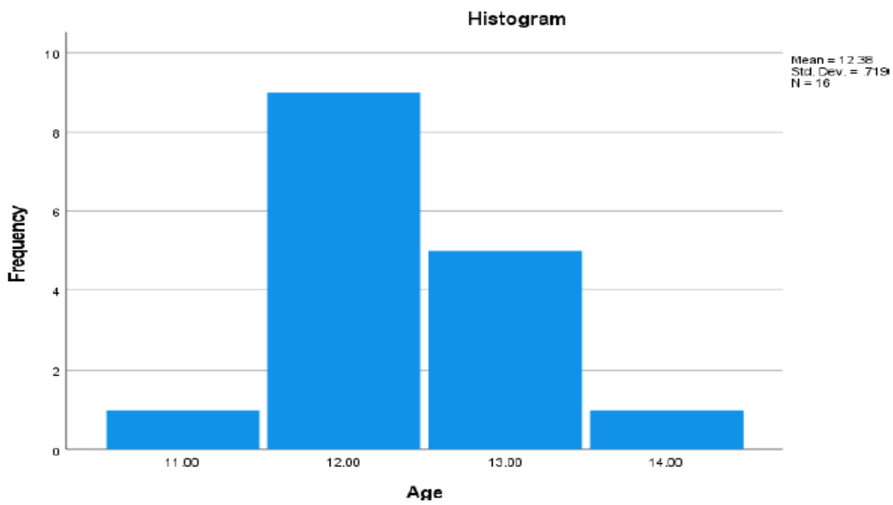
Fig. 3: Post functional cephalogram

E. STATISTICAL ANALYSIS OF DATA

The data obtained was analyzed using SPSS software (version 28.0). Normality of the data was assessed using Shapiro wilk test. Differences in Mean age and treatment duration among the subjects were analyzed using Mann Whitney U test. Differences between pre- and post-treatment measurements were analyzed using Paired sample T test. Intra-rater reliability was analyzed using Intra class correlation coefficient test. The p-value was set as 0.05 and the results were considered to be statistically significant if the p-value was less than 0.05.

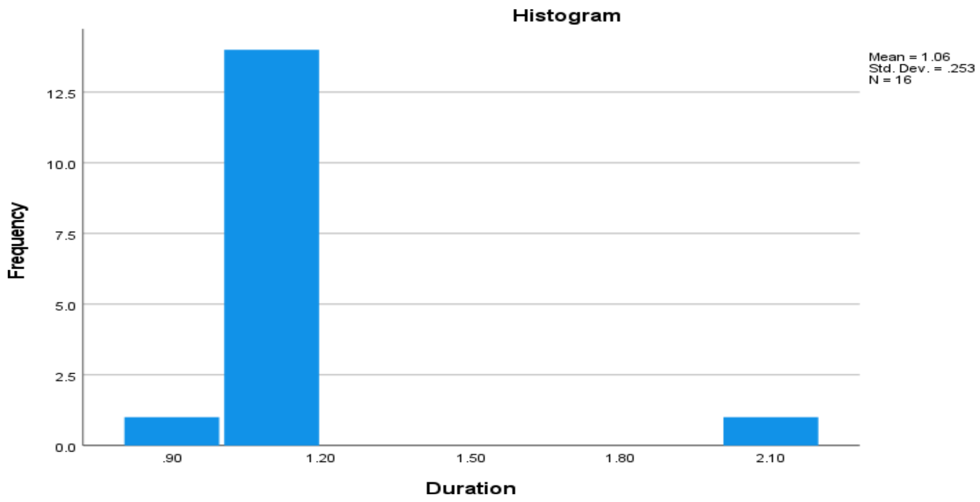
IV. RESULTS

GRAPH 1



Graph 1: depicts the distribution of age among the subjects.

GRAPH 2



Graph 2: depicts the distribution of treatment duration among the subject

	MALES	FEMALES	TOTAL	P VALUE
AGE	12.38±0.74	12.37 ± 0.74	12.37± 0.72	0.798
DURATION	0.99±0.04	1.13±0.35	1.06± 0.25	0.442
TEST OF SIGNIFICANCE – MANN WHITNEY U TEST *SIGNIFICANCE AT THE LEVEL OF p<0.05				

Table 1: DISTRIBUTION OF AGE AND TREATMENT DURATION

Distribution of age and treatment duration were given in table 1. On assessing the normality of the data for age and gender using Shapiro wilk test, data were not normally distributed. On comparing the distribution of age and gender among the subjects using Mann Whitney U test, the results were not statistically significant, which implies no difference in distribution of age and treatment duration among the subjects.

	Intraclass Correlation	95% Confidence Interval	
		Lower Bound	Upper Bound
Single Measures	.995	0.989	0.998

Table 2: ASSESSMENT OF INTRA-RATER RELIABILITY

Intra-rater reliability of the data tested using Intraclass Correlation Coefficient test were given in Table 2.Intra-rater reliability was tested using Intraclass correlation coefficient, and the value was found to be 0.9, which indicates good reliability of data.

Variables	N	Minimum	Maximum	Mean	SD
SNA	16	79	85	81.688	2.024
SNB	16	72	79	75.438	2.337
ANB	16	3	8	6.25	1.437
AR-GO	16	29	42	36.375	3.631
AR-GN	16	81	95	88.562	3.864
LI-GO-GN	16	90	110	101.875	5.476
MP	16	20	39	28.375	5.136
SN-OPT	16	90.00	110.00	102.812	6.102
SN-CVT	16	93.00	112.00	105.062	6.082
OPT/CVT	16	1.00	5.00	2.625	1.088
CVT/EVT	16	1.00	24.00	12.625	7.311
MP-OPT	16	54.00	82.00	70.250	7.488
MP-CVT	16	57.00	84.00	72.750	7.488

Table 3: CEPHALOMETRIC MEASUREMENTS AT T0

The mean cephalometric measurements at T0 were given in Table 3. All these values were found to be normally distributed. The mean value for ANB is 6.25 degree, SNA (81.68 DEGREE), SNB (75.43DEGREE), and MP (28.3degree) which implies that the observed data satisfies the inclusion criteria of the study.

Variables	N	Minimum	Maximum	Mean	SD
SNA	16	79	84	81.25	1.844
SNB	16	76	81	78.562	1.896
ANB	16	1	4	2.687	0.793
ARGO	16	31	47	41.25	3.992
ARGN	16	87	100	94.312	3.911
LIGOGN	16	95	121	105.625	6.662
MP	16	21	38	28.812	4.942
SNOPT	16	90	110	102.5	6.022
SNCVT	16	94	113	105.56	5.819
OPTCVT	16	1	6	2.875	1.408
CVTEVT	16	1	26	12.812	8.368
MPOPT	16	55	82	70.625	7.491
MPCVT	16	58	84	73.437	7.438

Table 4: CEPHALOMETRIC MEASUREMENTS AT T1

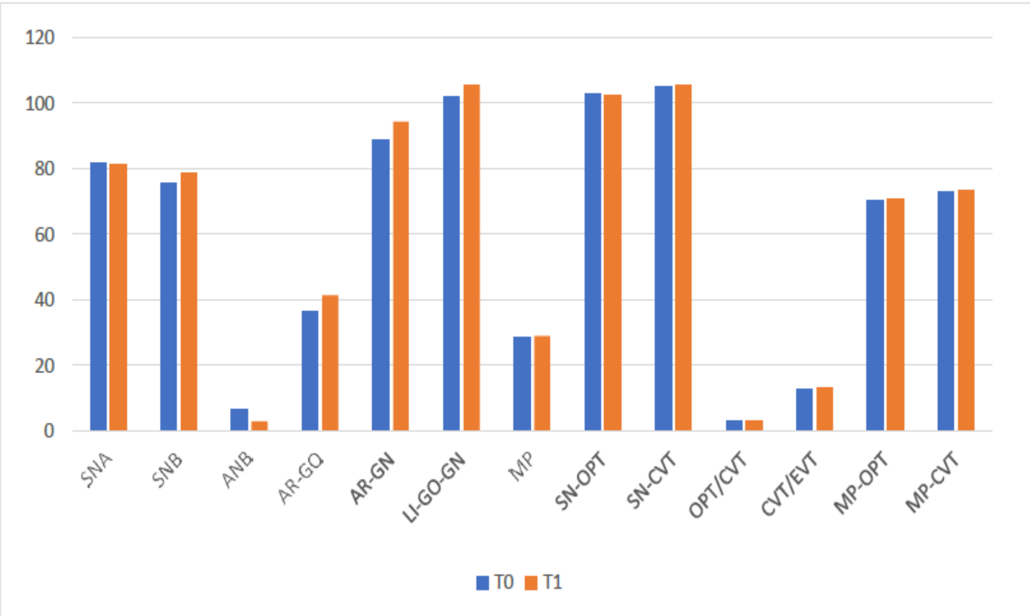
The mean cephalometric measurements observed at T1 were given in Table 4.The distribution of cephalometric measurements among the subjects were found to be normally distributed.

Variables	T0	T1	P value
SNA	81.69±2.02	81.25±1.84	0.371
SNB	75.44±2.34	78.56±1.89	<0.001*
ANB	6.25±1.44	2.69±0.79	<0.001*
ARGO	36.38±3.63	41.25±3.99	<0.001*
ARGN	88.56±3.86	94.31±3.91	<0.001*
LIGOGN	101.88±5.48	105.62±6.66	0.017*
MP	28.38±5.14	28.81±4.94	0.353
SNOPT	102.812±6.102	102.50±6.02	0.060
SNCVT	105.062±6.082	105.56±5.81	0.002*
OPTCVT	2.625±1.088	2.87±1.40	0.362
CVTEVT	12.625±7.311	12.81± 8.36	0.858
MPOPT	70.250±7.488	70.62±7.49	0.083
MPCVT	72.750±7.489	73.43±7.43	0.036*
TEST OF SIGNIFICANCE – PAIRED T TEST *SIGNIFICANCE AT THE LEVEL OF p<0.05			

Table 5: COMPARISON OF CEPHALOMETRIC MEASUREMENTS BETWEEN T0 & T1

Comparison of mean differences between T0 and T1 were given in Table 5.On comparing the differences between T0 and T1 using Paired T test, the result was found to be statistically significant for SNB(p<0.001), ANB(p<0.001), AR-GO(p<0.001), AR-GN(p<0.001), LI-GO-GN(p=0.017), SN-CVT(p=0.002), MP-CVT(p=0.036).The resultwas found to be statistically insignificant for SNA(p=0.371), MP(p=0.353), SN/OPT(p=0.060), MP/OPT(p=0.083), OPT/CVT(p=0.362), CVT/EVT(p=0.858).

GRAPH 3



Graph 3: depicts the comparison of measurements between T0 and T1.

V. DISCUSSION

This study was conducted to determine if there was improvement in the cervical lordotic curve in class II skeletal subjects after growth modification therapy by Twin block treatment.

It was reported in the literature that children who habitually lack an upright head posture have Angle's Class II malocclusion, long face syndrome and kyphosis of the cervical spine. Class II malocclusion is one of the common orthodontic problems and quite often, it is associated with normal maxilla and retrognathic mandible. The treatment for Class II malocclusion with retrognathic mandible during growth period is directed towards growth modification by the use of functional appliances.

Twin block was selected as the appliance of choice for this study as it was widely used in clinical practice for mandibular advancement. Bacetti et al.[9] advocated that optimal timing for twin block therapy is either during or slightly after pubertal peak, as during this period, most of the changes were contributed by orthopedic effect with maximal skeletal effect noted in the mandible. Therefore, in this study, subjects who were in the cervical maturation stage of CS3 -CS4 were chosen to gain maximal benefit from twin block therapy.

In this study, there was significant increase in SNB, reduction in ANB angle, increase in mandibular length and ramal height, indicating an improvement in the maxillomandibular sagittal relationship. Also, in this study, there was no significant change in SNA angle, which is in agreement with most of the studies which states that headgear effect is not seen with twin block but it is in contradictory to the results produced by Mills & Mcculloch and Sidlauskas. Mills & Mcculloch and Sidlauskas et al have reported that there was a statistically significant headgear effect with reduction of SNA angle after twin block therapy.[39]

In this study, compared to T0, there was significant increase in the proclination of lower incisors (LI-GO-GN) at T1, which could indicate that improvement in the sagittal relationship could be the result of combination of skeletal and dentoalveolar effects.

In the literature, it has been stated that facial development is closely related to upper and middle segment of the cervical column and less likely related to lower segment of the cervical column.

Tecco ETal.[13] (2005) found significant increase in the cervical lordosis angle (CVT/EVT) and craniocervical angles SN/OPT and SN/CVT after FR-II therapy with extension of head on the treated group, thereby indicating changes occurring in the entire segment of the cervical column. However, the duration of the study was longer (2.5 years) in comparison to the present study (1 year), so the results could have been the combined effects of growth and the treatment.

Cahide aglarci[43] (2016) found no significant change in the craniocervical angles however he reported significant increase in cervical lordosis angle OPT/CVT and all the measurements related to CVT was found to have increased value at T1 but it was insignificant. He concluded that there was a backward inclination of the middle segment of the cervical column after twin block therapy.

Kamal[54] (2019) reported no significant change in any of the craniocervical angles SNOPT, SNCVT, MPOPT, MPCVT and the cervical lordosis angle OPT/CVT in the Twin block group and a significant increase in SN-OPT angle and reduction in MP-CVT angle in the control group. He concluded that the twin block group exhibited upright craniocervical posture at the end of therapy and SN-OPT could be used as a predictor for changes following the functional appliance therapy. However, the control group in his study is from Bolton brush growth study, which is from white population, making it a least effective comparison to conclude the results.

Alsheiko et al[56] (2021) reported no significant changes in any of the craniocervical angles SN/OPT, SN/CVT, MP/OPT, MP/CVT and cervical lordosis angles OPT/CVT and CVT/EVT and he concluded that despite observing the clinical changes, there was no statistically significant changes in their study because of smaller sample size and lower tongue position, thereby impairing the respiratory space, as the bulk of the space is occupied by acrylic.

The present study showed no statistically significant change in craniocervical angles (SN/OPT, MP/OPT) but they showed a significant increase in the craniocervical angles (SN/CVT and MP/CVT). The present study also showed no statistically significant change in the cervical lordosis angles (OPT/CVT & CVT/EVT), but there was a no significant increase in the OPT/CVT angle.

Most of the measurements related to the middle segment of the cervical column, that is, CVT line, have showed an increase, which could therefore indicate that mandibular advancement with twin block tends to produce a more physiologic cervical lordotic curve. However, it should be noted that there was no significant change in the upper and lower segment of the cervical column.

VI. LIMITATIONS OF THE STUDY

The limitation of this study could be the smaller sample size, a lack of control group, shorter duration of the study and the use of 2D measurement to assess the cervical posture, which compromises the accuracy. A further depth of the knowledge about the cervical posture and its relationship to the mandibular advancement therapy should be investigated with a larger sample size and a matched control group with a more accurate 3D equipment.

VII. CONCLUSION

The null hypothesis was rejected because there was a difference in the cervical curvature before and after mandibular advancement by Twin block therapy. There was improvement in the sagittal relationship between maxilla and mandible after Twin block therapy. There was no significant change in the upper and lower segment of the cervical column.There was a significant change in the middle segment of the cervical column, which could indicate an improvement in the cervical curvature to a normal lordotic curve.

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