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Effect of Forsus-assisted mandibular advancement on the adaptation of craniocervical posture – A retrospective study

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Abstract

BACKGROUND and OBJECTIVE: Skeletal Class II malocclusion patients frequently exhibit an extended craniocervical position. The study's objective was to evaluate how the craniocervical posture has changed following skeletal class II correction using the Forsus fatigue-resistant device (FFRD).

METHODOLOGY: A retrospective analysis was undertaken using the pre- and post-treatment records of 35 skeletal class II patients who used the FFRD to achieve class II correction. The metrics suggested by Solow and Rocabado were used to evaluate the cranial and cervical positions. Eleven angular parameters were evaluated to determine the relationship between the mandibular ramus and the skull as well as the upper and middle craniocervical positions. To compare the parameters before and after fixed functional therapy, a Wilcoxon signed rank test was used.

RESULTS: Significant differences were obtained in the parameters SNA, SNB, and ANB post-FFRD. Significant differences were also noted in NL/OPT, NSL/OPT, FH/CVT, FH/OPT, NSL/CVT, NL/CVT, ML/CVT, FH/RL, and oropharynx position.

CONCLUSIONS: The upper and middle craniocervical posture altered significantly with the FFRD. Skeletal class II correction obtained with FFRD delivered the patients a more erect craniocervical posture.

Keywords:

Craniocervical angulation, fixed functional appliance, head posture, retrognathic mandible FFRD, sagittal discrepancy skeletal class II malocclusion

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Introduction

Skeletal class II malocclusion with a prevalence between 15% and 30% in the majority of populations is one of the more prevalent developmental anomalies.[1–5] Significantly detrimental esthetic, psychological, and social repercussions from this malocclusion are likely to occur.[3,4] Functional appliance therapy is regarded as an effective method for treating mandibular deficit in patients who are growing. 41% of patients seeking orthodontic treatment have a Class II division I malocclusion; the majority of these patients are growing, and there are a variety of functional appliances available to rectify skeletal connections.[5] Functional appliances function by modifying the activity of different muscle groups that affect the mandible's position and function. However, multiple recent articles show that patient noncompliance with treatment in orthodontics has been a problem for more than 40 years.[5-9] Therefore, greater interest is currently focused on fixed appliances such as the Forsus fatigue-resistant device (FFRD) requiring minimal patient compliance. Apart from the other orofacial hard and

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soft tissue structures, there is also another parameter that is highly influenced by the position of the mandible, which is craniocervical angulation. It was Schwarz in the year 1926 who observed a correlation between the maxillomandibular position and the head posture.[10] The craniofacial structures and the cervical spine are morphologically and functionally connected structures that are influenced by each other's growth patterns.[11-13]

It was postulated that the pattern of breathing influences head posture or vice versa and as a result craniofacial growth.[14] Some authors have also discovered radiographic evidence that children with long face syndrome associated with Angle's Class II malocclusion, and cervical spine kyphosis also lacked an upright head posture with excessive overjet and overbite noted in patients with kyphotic head posture.[11,15,16] In one of the most recent studies, it was inferred that the craniocervical posture of persons with Class II malocclusion caused by mandibular retrognathism with a reduced vertical dimension is more inclined forward.[12] Since FFRD is one of the most common fixed functional appliances used, it is vital to study its treatment effects also. Although several studies have been conducted in the past assessing its skeletal, dentoalveolar, and soft tissue outcomes, none have been conducted to evaluate its effect on craniocervical angulation. Thus, the current research aims to investigate the effect of FFRD on the craniocervical posture post-mandibular advancement.

Methodology

The Saveetha Dental College and Hospital, SIMATS, Department of Orthodontics, India, was the site of the retrospective study that constituted lateral cephalograms of FFRD-treated Class II malocclusion patients. The ethical approval was granted by the Human Ethical Committee at the Saveetha Institute of Medical Sciences (IHEC/SDC/ORTHO-2003/21/105). All cephalograms were performed with the patient's lips at rest and their heads in their natural head positions (NHPs). Utilizing a Carestream CS 9600 with rigid head fixation and a 165 cm film-to-tube distance, all cephalograms were taken. After applying the eligibility requirements, a total of 48 patient records were chosen, and information was gathered. The study was carried out using the patient's cephalograms as a guide; therefore, the patient's consent was not necessary. Cephalometric analyses by Solow (1976) and Rocabado (1983) were used to establish the craniocervical posture. A total of 11 angle measurements were employed to represent the rotation of the mandibular ramus and the upper and middle cervical postures [Tables 1 and 2]. Figure 1 shows a patient who has been fitted with a Forsus™ appliance. FACAD software was used to perform all the cephalometric analyses [Figure 1]. Each patient's chronological age and cervical stage were recorded. The typical course of FFRD treatment was 5.5+/-4.1 months. The same skilled orthodontist performed all the cephalometric tracings.

Table 1: Table representing the landmarks and reference lines used and their description

Landmarks and reference lines	Description
NSL	Through the points of Nasion and Sella
FH	Through Porion and Orbitale
NL (Nasal Line)	Maxillary plane
ML (Mandibular line.)	Lower mandibular border through menton
OPT (Odontoid process tangent)	Tangent through the most posteroinferior point on the odontoid process
CVT (Cervical tangent)	Tangent through the most posteroinferior point of the 4^{th} and 6th cervical vertebrae
RL (Ramus line)	Tangent through the mandibular ramus (posterior border)
OPT/CVT (Cervical curvature)	Angle formed by the intersection of cervical and odontoid process tangents
ML/RL (Mandibular angle)	Angle between the ramal line and the mandibular line

Figure 1: FFRD on a patient

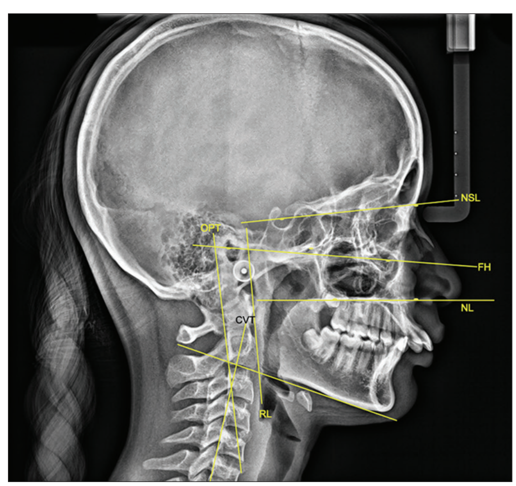

Figure 2: Constructed lines representing the different planes

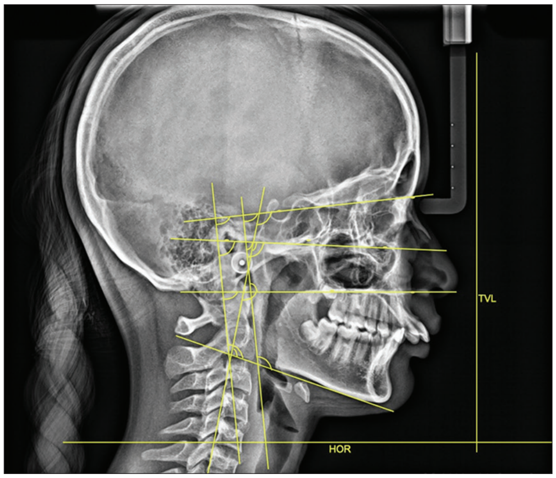

Figure 3: Angles representing the middle and lower craniocervical posture and relationship of the ramus to the cranium

Table 2: Angular measurements representing the upper and middle craniocervical posture and the relation of the ramus in relation to the cranium

Angles that depict the position of the upper craniocervical region	
NSL/OPT	Between OPT and NSL
FH/OPT	Between OPT and FH
NL/OPT	Between OPT and NL
ML/OPT	Between OPT and ML
Angles that depict the position of the middle craniocervical region	
NSL/CVT	Between CVT and NSL
FH/CVT	Between CVT and FH
NL/CVT	Between CVT and NL
ML/CVT	Between CVT and ML
Angles that show how the mandibular ramus rotates in reference to the cranium	
NSL/RL	Between RL and NSL
FH/RL	Between RL and FH
NL/RL	Between RL and NL

Two weeks apart, the tracings were redone, and the average was used to get the final value [Figures 2 and 3]. Pre and post treatment tracing of a patient treated with FFRD has been presented. [Figure 4].

Inclusion criteria

1. Cephalograms of patients with retrognathic mandible aged between 9 and 16 years
2. ANB>4 as a result of the retrognathic mandible
3. Half cusp or a full cusp class II molar relationship
4. Records of patients with positive VTO on forward mandible posture.

Exclusion criteria

1. Cephalograms of adult patients
2. Patients with class II malocclusions due to prognathic maxilla
3. Patients with TMD disorders.

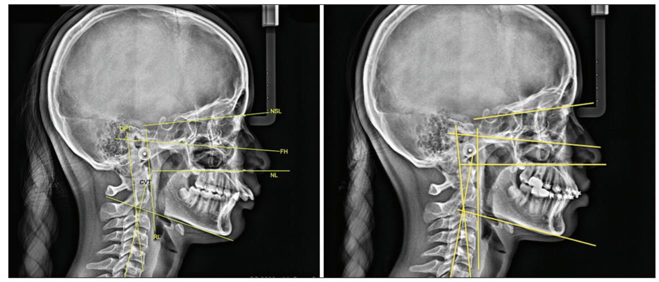

Figure 4: Pre- and post-cephalometric radiographs of a patient treated with FFRD

Statistical analysis

The statistical analysis was performed using SPSS version 23.0. The G* Power version 5.0 was used to calculate the sample size. The sample size was determined by Kamal *et al*.'s study,[17] which examined the cervical spine position following twin block therapy. To check for the normality of the data, the Shapiro–Wilk test was used, and the Wilcoxon test was used to compare the parameters at T0 and T1. The significance threshold was set at 0.05.

Results

The study's power was determined to be 90%, and the total sample size was determined to be 48. The Wilcoxon signed rank test was conducted after the normality test findings revealed that the data were not parametric. Table 3 displays the means and standard deviations of all cephalometric variables at the pre- and post-treatment time points. SNB angle, SNB angle, and ANB angle showed statistically significant differences when pretreatment and post-treatment data were compared (p 0.05). The post-FFRD parameters SNA, SNB, and ANB showed significant variations. ML/CVT, FH/CVT, NSL/CVT, NL/CVT, and NL/OPT, which represented the upper and middle craniocervical positions, as well as FH/RL, which reflected the ramus position about the cranium, the oropharynx position, all showed significant differences.

Discussion

The primary goal of the current study was to examine how class II patients who underwent fixed functional therapy with FFRD altered their craniocervical posture in response to a change in mandibular position. A more posterior rotation of the ramus with respect to the cranium and higher values for the parameters characterizing craniocervical angulation were both found in the baseline data of the class II patients before therapy, all of which were indicative of an extended head position. The craniocervical position and ramus rotation in relation to the cranium were examined using the criteria proposed by Solow and Rocabado.[18,19] The results of the present investigation indicate that in class II individuals,

Table 3: Mean, SD values of the parameters at T0 and T1, the mean difference and its standard deviation (MD+/-SD) and the *P* values (Wilcoxon signed rank test) representing the level of significance

Parameter	T0	T1	Mean Difference	*P* value- Intragroup comparison (Wilcoxon signed rank test)
Upper craniocervical position				
NSL/OPT	98.1+/-9.6	95.4+/-7.8	-2.7+/-5.2	0.02*
FH/OPT	90.2+/-8.6	87.9+/-6	-2.3+/-5.3	0.02*
NL/OPT	88.6+/-7	87.6+/-6.2	-0.9+/-4.1	0.05*
ML/OPT	65.3+/-7.7	64.1+/-5.3	-1.1+/-5.4	0.2
Middle craniocervical posture				
NSL/CVT	111.4+/-9.4	101.6+/-14.9	-9.8+/-18.4	0.004*
FH/CVT	103.6+/-7.6	97.5+/11.1	-6+/-12.5	0.004*
NL/CVT	101.9+/-7.3	97.2+/-11.1	-4.6+/-11.4	0.02*
ML/CVT	78.6+/-3.5	73.7+/-11.5	4.9+/-13.5	0.02*
NSL/RL	88+/-4.1	89+/-6.6	1+/-4.1	0.7
Ramus to cranium				
FH/RL	80.2+/-2.4	78.9+/-2.3	-1.2+/-1.5	<0.001*
NL/RL	78.5+/-1.7	78.7+/-2.6	0.1+/-2.1	0.8
Oropharynx	10.9+/-2.3	9.7+/-1.6	-1.1+/-2.1	0.002*
Maxillomandibular relationship to the cranium				
ANB	3.8+/-2.1	3+/-1.5	-0.8+/-2.5	0.02*
SNB	75.1+/-4.1	77.1+/-4.4	2+/-1	<0.001*
SNA	79.3+/-4.1	80.1+/-4.1	0.8+/-2.3	0.02*

*Statistically significant *p*-value

craniocervical angulation increased after fixed functional therapy with FFRD. These results are in line with those of past studies. Kamal *et al*.[17] examined the impact of the twin block on cervical posture and sagittal skeletal measurements. There was a substantial difference between the PF1 and PF2 SNB, ANB, and OPT/CVT angles, indicating an improvement in the sagittal relationships and an increase in cervical curvature. The twin block encourages a craniocervical posture that is more upright. Due to an increase in mandibular length, Khoja *et al*.[20] found improved sagittal skeletal connections with the twin block. There was a significant difference between the groups when the angular measures were compared. However, a combination of uncompensated skeletal and dentoalveolar effects has been linked to the success. This emphasizes the need for a new method to determine how much the bone connections have improved.[21,22]

The cervical position physiologic varies between individuals. According to Meuller, the occipital structures at the intersection of the skull and trunk are a more accurate way to evaluate craniofacial growth than the mandible, which controls the position of the head in space together with a series of muscles.[23] The mandible and cervical spine share a strong anatomic relationship, and interactions between the musculoskeletal system and physiological growth processes influence how the neck is positioned.[24] Furthermore, mandibular size, craniofacial form, and mandibular divergence have all been connected to the cervical spine.[24-28] According to this, the muscles surrounding C2 loosen when the jaw travels downward because it produces a pulling force. Therefore, when the mouth is closed, an occlusion with a reduced vertical dimension will exacerbate muscular tension in the C2 region.[29] The considerable discrepancies between the SN-OPT and MP-CVT angles seen in participants from the Bolton-Brush Growth Study explain this intriguing link between C2 and the mandible.[17,29] The SN-OPT angle in their study significantly increased between the T1 and T2 values of the unexposed group, indicating a change in the upper cervical posture that made it more forward-inclined with a retrognathic mandible. The improvement in mandibular length is accompanied by a decrease in the SN-OPT angle compared to the exposed group (to the functional appliance), which suggests that the spine is being upright and developing a natural curve. The patients in the unexposed group had skeletal Class II malocclusion associated with mandibular retrognathism and a reduced vertical dimension, as seen by the mean mandibular plane angle values. The strong correlation between the MP-CVT angles assessed at T0 and T1 suggests that these individuals would have a stronger physiologic change in their cervical position, which is supported by the compelling results discussed above.[30-33]

Dattilio *et al*.'s study, which found a substantial difference in the middle cervical posture between Class I, Class II, and Class III anteroposterior maxillomandibular connections, is another study that confirms the findings of the current one. In class II patients, Liu *et al*. discovered a direct relationship between the cervical position and ramus rotation. Numerous therapeutic or surgical procedures have also been documented to affect posture.[34] For instance, orthognathic surgery has been demonstrated to alter head and neck posture in Class II patients, including enhanced cervical spine extension and an upright head posture.[34,35] There was no discernible difference in the cervical measures, according to Ohnmeiß *et al*.[36] According to Kamal *et al*., there was a considerable shift in the OPT-CVT angles, which suggested that the middle cervical position had changed. It was discovered that there was a substantial difference in the mean shift of the SN-OPT angle, which can be interpreted as an uprighting of the upper cervical position.[17,29] The mean difference between groups was also statistically different, and the middle cervical position of individuals altered significantly (from T0 to T1). To calculate the probability of changing the cervical position with the FFRD, the cervical parameters were measured. The findings should be interpreted cautiously since not all the patients had an extended head–neck position prior to functional therapy, even if the data show that many other criteria are suggestive of an altered cervical posture.

Single-center research using two-dimensional imaging technology and the lack of a control group are drawbacks of this study. By enlisting a comparison group of people from the neighborhood and using a three-dimensional imaging technique, these flaws can be fixed.

Conclusions

1. Mandibular posture does affect craniocervical angulation in turn the head posture.
2. The upper and middle cranial cervical posture altered significantly with the FFRD and skeletal class II correction with FFRD delivered the patients a more upright craniocervical posture post FFRD therapy.

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Conflicts of interest
There are no conflicts of interest.

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