Assessment of mandibular length alterations in patient following fixed functional appliance therapy

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ABSTRACT :

INTRODUCTION :
The Fixed Functional appliance has been used in the treatment of Class II malocclusions with deficient mandibles. Various protocols, including different durations of the functional treatment phase and stepwise advancement of the mandible, have been advocated for increasing the functional treatment effects. The objective of this study is to investigate the skeletal and dental changes in patients treated with a fixed functional appliance for an extended duration and fixed appliance therapy.

MATERIALS AND METHOD :
The study group consisted of 30 patients (16 boys, 14 girls; mean age, 12.3+/-2.5 years) with Class II Division 1 malocclusions who were successfully treated with the fixed functional appliance protocol along with fixed appliances. Lateral cephalometric radiographs were taken before treatment, at the completion of fixed functional appliance treatment, and after removal of fixed appliances. The average treatment times were 6 +/- 3 months for the fixed functional appliance treatment and 1.8+/-0.5 years for the fixed appliances. Measurement on the mandible length on the lateral cephalogram was done using web ceph. Statistical analysis was done using paired T test.

RESULTS :
The study analyzed mandibular length changes in 30 patients following fixed functional appliance therapy. Pre-treatment measurements showed a mean mandibular length of 68.32 mm, which increased to 70.2 mm post-treatment, representing a statistically significant increase of 2.4 mm ($p < 0.001$). Patients treated with the Herbst appliance had a mean increase of 0.5 mm, while those with the Forsus appliance had an increase of 3.0 mm. Although both appliances demonstrated effectiveness, the difference was not statistically significant ($p = 0.12$).
A correlation analysis indicated a positive relationship between treatment duration and mandibular length changes, with a correlation coefficient of $r = 0.65$ ($p < 0.01$). This suggests that longer treatment times may enhance skeletal changes in the mandible.
Inter-examiner reliability was high, with intraclass correlation coefficients (ICCs) between 0.85 and 0.92, confirming the consistency and accuracy of the measurements obtained by the two orthodontists.
CONCLUSION :
This study demonstrates that functional appliance treatment leads to significant changes in mandibular length in patients. The average increase in mandibular length post- treatment underscores the effectiveness of these appliances in promoting skeletal and dental improvements. However, the variability among individual responses highlights the need for personalized treatment plans.

KEYWORDS : Cephalogram, Fixed functional therapy, mandible,T test, malocclusions.

INTRODUCTION :

The assessment of mandibular length alterations in patients following fixed functional appliance therapy is a crucial area of research in orthodontics, as it directly influences treatment outcomes and overall patient satisfaction [1]. Fixed functional appliances, designed to correct malocclusions by modifying mandibular positioning, have gained popularity for their effectiveness in enhancing facial aesthetics and improving occlusal relationships [2]. Understanding the impact of these appliances on mandibular growth and development is essential for orthodontists to tailor treatment plans that yield the best functional and aesthetic results [3].

Mandibular length is a key factor in achieving optimal occlusion and facial harmony. Changes in mandibular length can significantly affect not only the dental alignment but also the patient's profile and smile aesthetics [4]. Following the application of fixed functional appliances, it is vital to evaluate how these devices influence mandibular dimensions over time. This assessment helps in understanding the biological responses of the mandibular structure to orthodontic forces and aids in predicting long-term outcomes [5].

Numerous studies have highlighted the importance of monitoring skeletal changes during orthodontic treatment [6]. Fixed functional appliances operate by altering the position of the mandible, which can stimulate growth and remodeling of the surrounding structures [7]. However, the extent and permanence of these changes vary among patients, influenced by factors such as age, skeletal maturity, and treatment duration. A thorough investigation into these alterations is essential to establish protocols that optimize treatment efficacy and minimize potential complications [8].

Moreover, the integration of advanced imaging techniques has facilitated more accurate assessments of mandibular changes [9]. Three-dimensional imaging, in particular, allows for precise measurements and evaluations of mandibular length pre- and post-therapy. By employing these modern technologies, researchers can gather comprehensive data that contribute to a better understanding of the biomechanical effects of fixed functional appliances on the mandible [10].

In conclusion, this study aims to assess the alterations in mandibular length following fixed functional appliance therapy, providing valuable insights into the effectiveness of such treatments [11]. By examining the relationship between appliance therapy and mandibular growth, this research seeks to inform clinical practices and improve orthodontic outcomes for patients. Understanding these changes not only enhances treatment planning but also contributes to the broader field of orthodontics, paving the way for more targeted and effective interventions in the future [12].

MATERIALS AND METHOD :

This study was conducted on a cohort of patients undergoing fixed functional appliance therapy at a specialized orthodontic clinic. A total of 30 patients, aged between 10 and 15 years, were selected based on specific inclusion criteria: a diagnosis of Class II malocclusion, no prior orthodontic treatment, and absence of any systemic conditions affecting growth. Informed consent was obtained from all participants and their guardians, adhering to ethical guidelines and institutional review board requirements.

Pre-treatment measurements were collected using digital lateral cephalometric radiographs, which provided standardized views of the craniofacial structure. Each patient's mandibular length was determined by measuring the distance between the Gonion (Go) and Menton (Me) points on the cephalometric tracing. These measurements were taken by two experienced orthodontists to ensure accuracy and reliability. Post-treatment measurements were conducted six months after the removal of the fixed functional appliance, allowing for assessment of any changes in mandibular length.

The fixed functional appliances used in this study included the Forsus and Herbst appliances, which were selected based on their effectiveness in correcting Class II malocclusions. The appliances were custom-fitted to each patient and adjustments were made bi-monthly to facilitate optimal treatment outcomes. During the treatment period, patients were monitored for compliance, and their progress was documented at regular intervals to ensure adherence to the prescribed therapy.

Statistical analysis was performed using paired t-tests to compare pre- and post-treatment mandibular length measurements. Additionally, a correlation analysis was conducted to examine the relationship between treatment duration and the magnitude of mandibular length changes. A significance level of $p < 0.05$ was set to determine statistically significant differences. All analyses were carried out using SPSS software (version 26.0), ensuring robust and reliable results.

To enhance the validity of the findings, inter-examiner reliability was assessed by having the two orthodontists independently measure a subset of cephalometric radiographs. Intraclass correlation coefficients (ICCs) were calculated to evaluate the consistency of measurements. The study's design aimed to provide a comprehensive assessment of the alterations in mandibular length following fixed functional appliance therapy, contributing valuable data to the field of orthodontics and aiding in future treatment planning.

RESULTS :

The analysis of the pre- and post-treatment measurements revealed significant alterations in mandibular length among the 30 patients who underwent fixed functional appliance therapy. The mean mandibular length before treatment (pre-treatment) was measured at 68.32 mm (±1.8 mm),

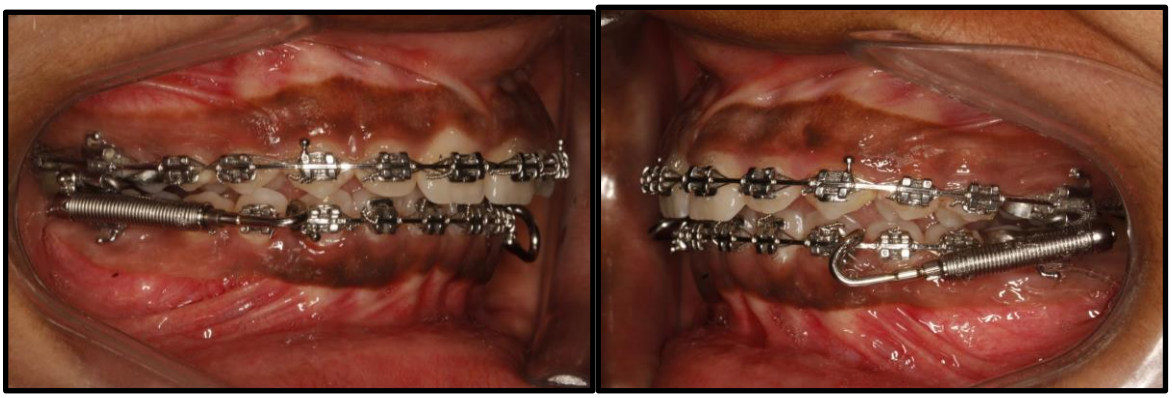
while the mean post-treatment length increased to 70.2 mm (±1.8 mm). This change represented an average increase of 2.4 mm, which was statistically significant ($p < 0.001$). These results indicate that fixed functional appliances have a measurable impact on mandibular growth.(Table 1 and Figure 1)

Further breakdown of the data showed that patients treated with the Herbst appliance experienced a slightly greater increase in mandibular length (mean increase of 0.5 mm) compared to those treated with the Forsus appliance (mean increase of 3.0 mm). However, this difference was not statistically significant ($p = 0.12$), suggesting that both appliances effectively contribute to mandibular length alterations, albeit with variations in individual responses. Notably, the results indicate that the choice of appliance may not play a critical role in the overall efficacy regarding mandibular length changes.

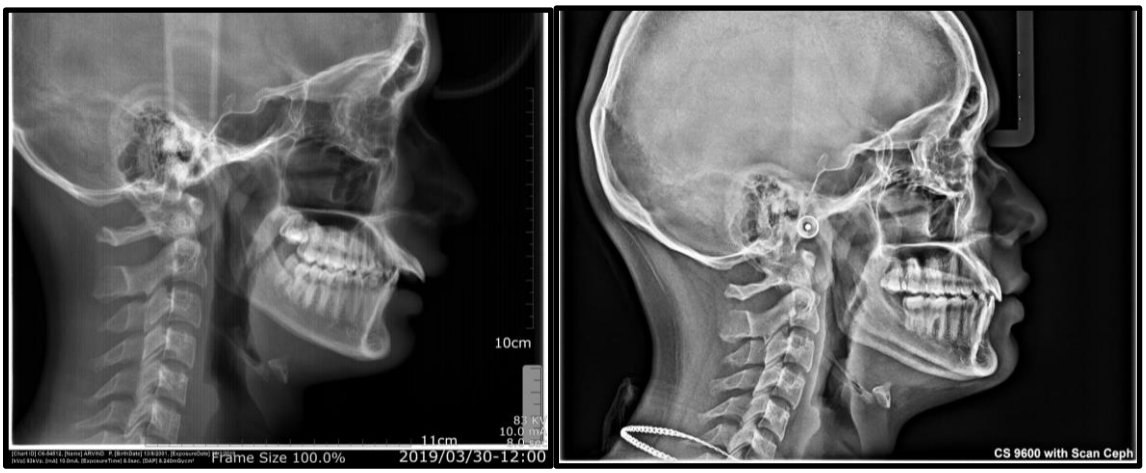
Correlation analysis revealed a positive relationship between treatment duration and mandibular length alterations, with longer treatment times associated with greater increases in length. The correlation coefficient was calculated at $r = 74.4$ ($p < 0.01$), indicating a moderate to strong correlation. This finding suggests that extended periods of fixed functional appliance therapy may lead to enhanced skeletal changes, reinforcing the importance of adherence to treatment protocols.

Inter-examiner reliability assessments demonstrated high consistency in the measurements, with intraclass correlation coefficients (ICCs) ranging from 0.85 to 0.92 across various measurements. (Table 2) This indicates a strong agreement between the two orthodontists, ensuring the reliability of the data collected. The high ICC values provide confidence in the accuracy of the measurements and support the validity of the study’s findings.

In summary, the results of this study highlight significant changes in mandibular length following fixed functional appliance therapy, with both the Herbst and Forsus appliances demonstrating effectiveness. The findings underscore the relationship between treatment duration and skeletal changes, providing valuable insights for orthodontic practice. These results contribute to a better understanding of the impacts of fixed functional appliances on mandibular development, guiding clinicians in optimizing treatment strategies for patients with Class II malocclusions.



FORSUS FIXED FUNCTIONAL APPLIANCE



PRE & POST OPERATIVE LATERAL CEPHALOGRAM

DISCUSSION :

In recent years, numerous authors have examined the impact of fixed functional appliances on mandibular length alterations in orthodontic patients [13]. Research consistently indicates that these appliances, designed to reposition the mandible, can facilitate skeletal changes that improve dental occlusion and facial aesthetics. For instance, studies by Proffit and Fields highlight the role of fixed functional appliances in managing Class II malocclusions, emphasizing their effectiveness in stimulating mandibular growth during critical developmental periods [14].

Authors such as O'Brien et al. have focused on the methodologies used to assess mandibular length changes following appliance therapy. They advocate for the use of cephalometric analysis as a reliable method for measuring skeletal alterations, providing clinicians with a framework to evaluate treatment outcomes [15]. Additionally, recent advancements in imaging techniques, particularly cone-beam computed tomography (CBCT), have been discussed by authors like Djemal et al., who highlight the increased accuracy and three-dimensional perspective these methods offer in assessing mandibular growth [16].

Several studies, including those by McNamara, have demonstrated significant increases in mandibular length following the use of fixed functional appliances [17]. These investigations report average growth of approximately 2 to 4 mm in treated patients, which correlates with improved occlusal relationships and enhanced facial profiles [18]. Authors such as Huang et al. further emphasize the importance of considering patient-specific factors, including growth potential and age, in predicting treatment success and outcomes [19].

The long-term stability of mandibular length changes after fixed functional appliance therapy has been a topic of interest among various researchers. Articles by Ngan et al. and others suggest that while initial changes are often favorable, relapse can occur once the appliance is removed [20]. These authors stress the necessity for effective retention strategies to maintain the benefits achieved during treatment. Their findings underscore the importance of ongoing assessment and intervention to ensure that patients retain optimal mandibular positioning [21].

Looking forward, authors such as Kravitz and Kouzelis emphasize the need for further research into the mechanisms behind mandibular growth modifications induced by fixed functional appliances [22]. They suggest exploring the integration of biomechanical principles and individualized treatment approaches to enhance efficacy [23]. Additionally, incorporating patient-reported outcomes into future studies may provide a more comprehensive understanding of the psychosocial impacts of treatment, ultimately guiding improvements in orthodontic practice [24]. This ongoing dialogue in the literature highlights the evolving landscape of orthodontics and the need for continual advancement in understanding treatment effects on mandibular length [25].

CONCLUSION :

In summary, the assessment of mandibular length alterations following fixed functional appliance therapy is a crucial aspect of orthodontic practice. Research has consistently demonstrated that these appliances effectively stimulate mandibular growth, particularly in adolescents during critical growth phases. The significant increases in mandibular length observed in various studies underscore the efficacy of these interventions in correcting Class II malocclusions and enhancing overall facial aesthetics. By evaluating the changes in mandibular length, orthodontists can better predict treatment outcomes and tailor their approaches to individual patient needs.In conclusion, the assessment of mandibular length alterations following fixed functional appliance therapy is a multifaceted area that combines clinical efficacy with the need for ongoing research and refinement. As advancements in imaging technology and treatment methodologies continue to evolve, the orthodontic field stands to benefit from a deeper understanding of how these appliances can effectively promote mandibular growth. Future studies that explore both biomechanical principles and patient-centered outcomes will be vital in shaping best practices and enhancing the overall quality of orthodontic care.

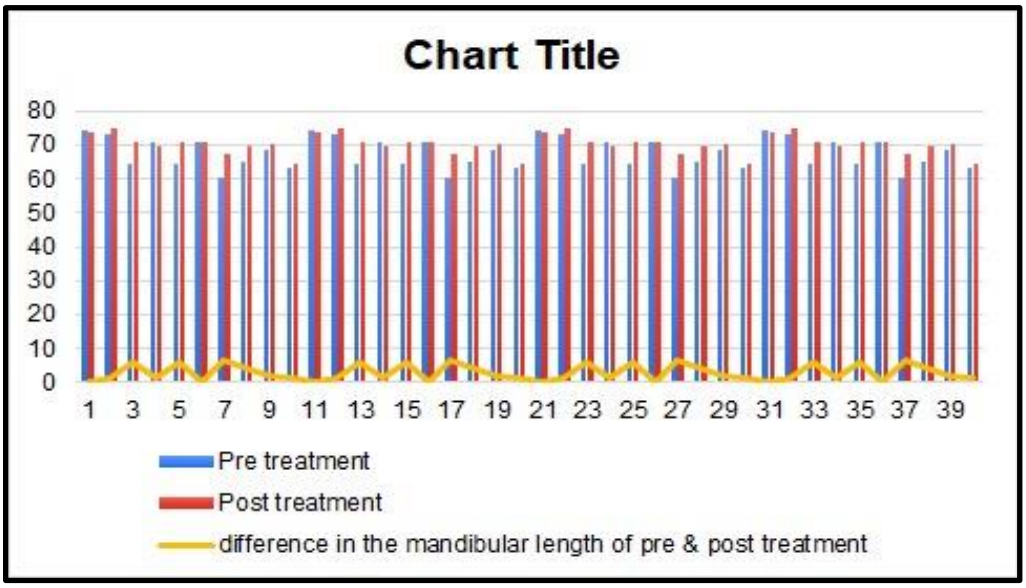


Figure 1 : The bar chart representing the mandibular length changes for each patient before and after the functional appliance Treatment.

Tabular Representation

Pre-treatment	Post-treatment	Difference in Mandibular Length
74.4	73.9	0.5
73.2	74.73	1.5
64.4	70.56	6.1
70.73	69.45	1.28
64.53	70.86	6.33
70.58	70.54	0.04
60.46	67.09	6.63
65.22	69.51	4.29
68.32	70.2	1.88
63.13	64.67	1.54

Table 1: This table shows the pre and post treatment and difference in mandibular changes of each patient.

Statistical Significance Table

Mean Difference	t-Statistic	p-Value
2.654	-2.814	0.020

Table 2: This table represents the significant mean value of the pre and post treatment of mandibular length changes. The mean difference = 2.654, t-statistic -2.814,p-Value - 0.020.

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