International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 10; Issue 04 (A); April 2021; Page No.24138-24145
DOI: http://dx.doi.org/10.24327/ijcar.2021.24145.4784

Research Article

# COMPARISON OF SOFT TISSUE CHANGES AND LOWER INCISOR STABILITY IN CASES TREATED WITH FIXED FUNCTIONAL APPLIANCES AND WITH BILATERAL MAXILLARY FIRST PREMOLAR EXTRACTION IN CLASS II DIVISION 1 MALOCCLUSION PATIENTS

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**A R T I C L E I N F O**

***Article History:***
Received 4th January, 2021
Received in revised form 25th February, 2021
Accepted 18th March, 2021
Published online 28th April, 2021

***Key words:***

Fixed Functional Appliances, Angle Class II, Bicuspid Extractions Lower incisor Overjet Soft tissue

**A B S T R A C T**

***Objectives:*** To determine the labiolingual stability of lower incisors and to compare the soft tissue facial changes in cases treated with complete fixed functional appliance therapy and bilateral maxillary first premolar extraction treatment in patients with Class II division 1 malocclusion.

***Methods:*** The sample consisted of 20 patients, divided into two groups. Group 1 comprised 10 patients treated with bilateral extraction of maxillary first premolars with a mean age of 16.90yrs (SD= 3.07). Group 2 consisted of 10 patients treated with fixed functional appliance associated with fixed appliances, with an initial mean age of 17.20yrs (SD=2.04). Soft tissue changes and lower incisor position changes were assessed on pre-treatment, post-treatment and post retention lateral cephalograms of patients.

***Results:*** According to the results, there was no inter-group difference regarding the soft tissue changes and lower incisor inclination status. There were a statistically significant proclination and relapse of lower incisors in both groups. However, the lower incisors showed a greater tendency to procline and relapse in the fixed functional appliance group.

***Conclusion:*** Both the treatment approaches provided adequate improvement in the facial esthetics but the different treatment methods used in the two groups did not result in any significant soft tissue differences post-treatment. Though not statistically significant, the tendency to procline lower incisors and relapse was greater with fixed functional appliances.

***Clinical Relevance:*** This study helps the orthodontist to make a better diagnosis and treatment plan by comparing the soft tissue changes and lower incisor stability with two treatment modalities for correction of the same malocclusion.



## INTRODUCTION

In the present day and time, there is increased concern regarding facial esthetics among orthodontic patients and their parents; making it a major motivating factor for seeking orthodontics treatment.

Class II malocclusions are commonly observed in orthodontic practice [1]. These can be treated using an assortment of treatment protocols. Since these treatment protocols affect the dentofacial components, orthodontists are frequently confronted with the need to assess the soft tissue facial changes that result from a variety of orthodontic techniques for the correction of the same malocclusion, particularly ones concerning the contrasts between treatment protocols with and without extractions. [2-4]

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The extraction of upper premolars is often chosen as an alternative in non-growing Class II patients, for some patients with significant overjet, or in patients in whom previous treatment attempted using headgear or functional appliance treatment have failed to achieve Class I canine relationships.[5] This dentoalveolar approach to treatment, however, is often assumed to result in negative facial profile effects citing "dishing in the face" as a reason not to extract. Fascinatingly, there have been very few previous studies on soft tissue treatment effects in Class II cases with only two upper premolar extractions. [6-12]

A fixed functional appliance can save both time and trouble in non-compliant patients. Its primary effect is on the teeth and the adjacent dentoalveolar structures. This treatment effectively shortens the duration of therapy, and the best use of the remaining growth of a patient beyond the pubertal growth spurt can be made.

The two different treatment methods discussed above have the same purpose i.e. correction of the exaggerated overjet to obtain optimal dentofacial esthetics. It is usually assumed that the skeletal and dental changes produced by premolar extraction in the maxillary arch can be considerably different from those produced with fixed functional appliances as the mechanism and point of application of force is different for both the treatment modalities. Thus this may affect the overall facial esthetics of the patient which is the most significant goal of contemporary orthodontics.

Another point of concern is as to which method of treatment is more stable. Incisor stability has been defined in terms of tooth inclination and incisor alignment. It is generally accepted that the position of the lower incisors is of clinical importance in treatment planning. The A-Po line is closely related to the structures influencing lower incisor position, and the modifying effects of treatment and growth can be visualized, moreover, it is uncomplicated by the need for extensive analysis.

Very few studies have compared the soft tissue treatment results and stability obtained by extraction of maxillary first premolar and fixed functional appliance therapy. It would be interesting to observe the differences between these techniques for compensating Class II malocclusions.

This will help orthodontists identify and understand the potential differences between these techniques and their influence on the overall treatment planning for Class II patients seeking orthodontic intervention.

***Objectives of the Study***

1. To compare the soft tissue changes after complete fixed functional appliance non-extraction and maxillary first premolar extraction treatment in patients with Class II division 1 malocclusion.
2. To determine the labiolingual stability of lower incisors in cases treated with fixed functional appliance non-extraction and maxillary first premolar extraction.

## MATERIALS AND METHODOLOGY

The sample consisted of lateral cephalometric films of patients with Class II division 1 malocclusion who were treated with either extraction of only maxillary first premolars(G1), or treated using fixed functional appliance (G2), and having Class 1 canine relationship post-treatment were selected from the files of the Department of Orthodontics, DAPMRV Dental College, Bangalore, India. The patient records were used to determine their initial age, gender and treatment progress. Sample selection was based exclusively on the initial anteroposterior molar and incisor relationship, regardless of any other dentoalveolar or skeletal cephalometric characteristics.

Ten samples of age 12-20yrs were randomly selected and assigned under each group – extraction group (G1) and fixed functional group (G2).

***Extraction group (G1)***

This group had 10 patients (3 boys,7 girls) with a mean age of 16.90yr (SD= 3.07), who underwent extraction of upper first premolars. Preadjusted edgewise appliance (PEA) brackets with an 0.022-inch slot were used for all the patients. Retraction mechanics was applied to the upper anterior teeth on a 0.019 x 0.025 -inch stainless steel archwire (Fig 1). Conventional mechanics was used for the lower arch after retraction of the upper arch was completed. The posttreatment occlusion displayed a Class II molar and a Class I canine relationship with reduced overjet.

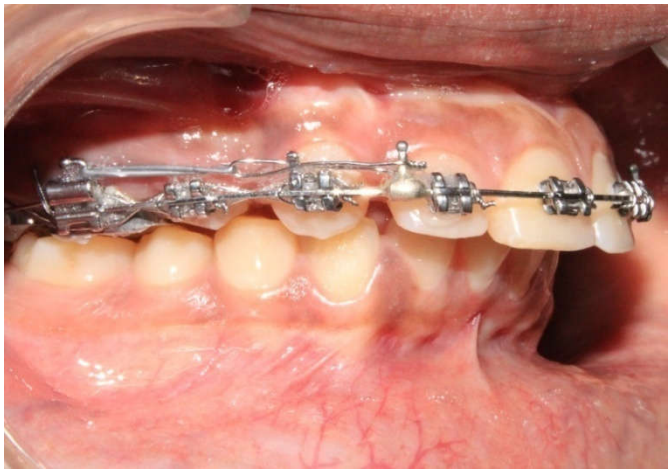


**Fig 1** Retraction mechanics for a G1 patient

***Fixed Functional Appliance group (G2)***

The Fixed functional appliance group consisted of 10 patients (6 boys, 4 girls) treated with fixed functional appliances associated with fixed appliances with an initial mean age of 17.20yrs (SD=2.04), preadjusted edgewise appliance (PEA) brackets with a 0.022-inch slot were used. The fixed functional appliance was placed on 0.019 x 0.025-inch SS wires as prescribed by the manufacturer in the maxillary and mandibular arch on either side (Fig 2). The posttreatment occlusion displayed a Class I molar or slightly overcorrected Class I molar with Class I canine relationship with reduced overjet

**Fig 2** Fixed functional appliance attached in the maxillary and mandibular arch

Lateral cephalometric radiographs of good quality with hard and soft tissue structures discernible, in centric occlusion, with the lips at rest were collected at pre-treatment (T1), end of treatment (T2) and post retention (T3) for both the groups.

All the cephalometric radiographs were hand-traced on acetate paper by the same investigator to avoid bias. Linear and angular measurements were performed to the nearest 0.5 mm and 0.5 degrees respectively. When the central incisors overlapped, an average of axial inclinations of both was used.

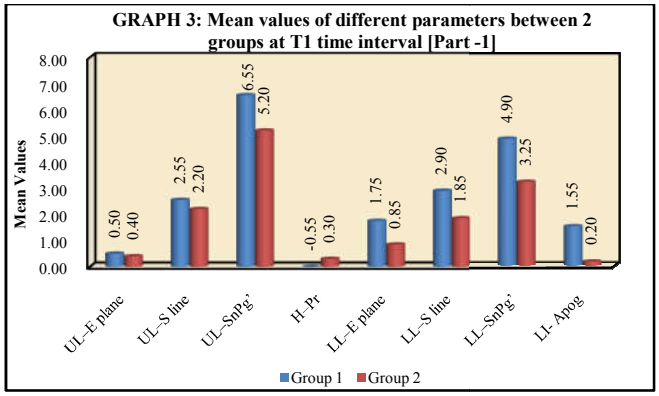
**Following parameters were used to compare T1 and T2: (Table 1)**

| | |
|---|---|
| UL–E line | Distance from the upper lip to the esthetic plane of Ricketts |
| UL–S line | Distance from the upper lip to Steiner's S line. |
| UL–SnPg' | Distance from the upper lip to the subnasale–soft tissue pogonion plane (a line from Sn to Pg ') |
| H–Pr | Distance between H line and the most anterior point on the nose |
| LL–E plane | Distance from the lower lip to the esthetic plane of Ricketts (a line from Pg.′ to Pr) |
| LL–S line | Distance from the lower lip to Steiner's S line |
| Z angle of Merrifield | The angle formed by the intersection of the Frankfort horizontal plane and a line connecting soft tissue pogonion and the most protrusive lip point |
| LL–SnPg' | Distance from the lower lip to the subnasale–soft tissue pogonion plane. |
| H.NB | Angle formed between H line and line from Nasion to Point B. |
| Nasolabial angle | Formed between a tangent to the lower border of the nose and a line joining the subnasale. with the tip of the upper lip (labrale superius) |

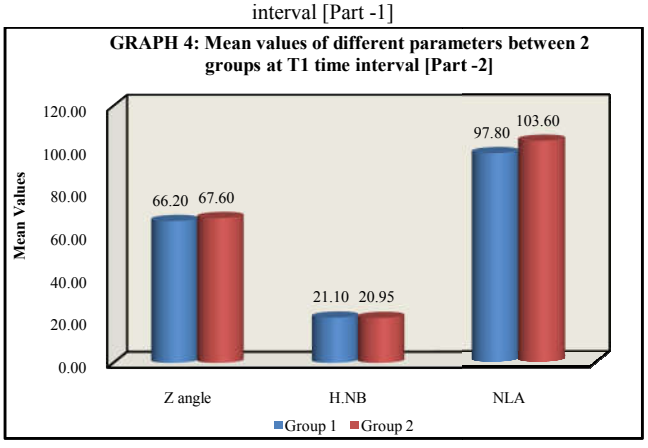
Tracing of the position of lower incisor to A-Po measurement was done on pre-treatment (T1), post-treatment (T2) and post-retention (T3) lateral cephalogram of the patient to measure and compare the lower incisor change and stability in both the groups.

## RESULTS

Comparison of mean values of all study parameters between 2 groups at T1 time showed no statistically significant correlation (P>0.05). (Table 2 and Graph 1,2) Comparison of mean values of all study parameters between 2 groups at T2 time showed no statistically significant correlation (P>0.05) (Table 3 and Graph 3, 4) suggesting that there were no significant differences in soft tissue profiles of Class II division 1 patients treated with extraction of upper premolar, and cases treated with fixed functional appliances.




**Graph 1** Mean values of different parameters between 2 groups at T1 time interval [Part -1]




**Graph 2** Mean values of different parameters between 2 groups at T1 time interval [Part -2]

**Table 2** Comparison of mean values of different study parameters between 2 groups at T1 time period using Mann Whitney Test

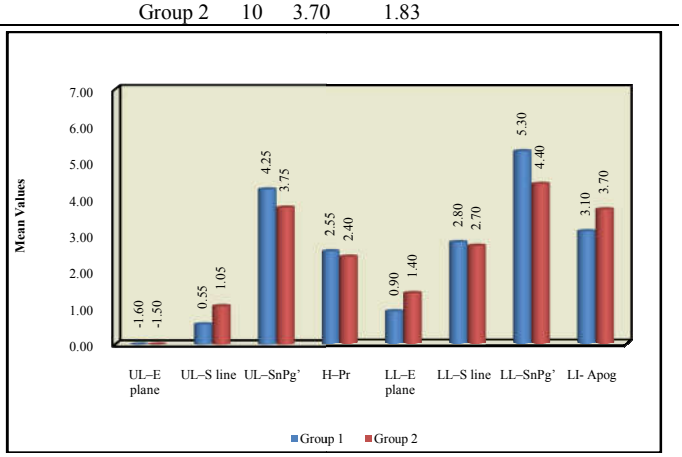
**Comparison of mean values of different study parameters between 2 groups at T1 time period using Mann Whitney Test**

| | Groups | N | Mean | SD | Mean Diff | P-Value |
|---|---|---|---|---|---|---|
| UL–E plane | Group 1 | 10 | 0.50 | 2.00 | 0.10 | 0.82 |
| | Group 2 | 10 | 0.40 | 2.31 | | |
| UL–S line | Group 1 | 10 | 2.55 | 1.66 | 0.35 | 0.54 |
| | Group 2 | 10 | 2.20 | 2.36 | | |
| UL–SnPg' | Group 1 | 10 | 6.55 | 1.07 | 1.35 | 0.06 |
| | Group 2 | 10 | 5.20 | 1.87 | | |
| H–Pr | Group 1 | 10 | -0.55 | 3.85 | -0.85 | 0.49 |
| | Group 2 | 10 | 0.30 | 3.65 | | |
| LL–E plane | Group 1 | 10 | 1.75 | 2.31 | 0.90 | 0.49 |
| | Group 2 | 10 | 0.85 | 2.92 | | |
| LL–S line | Group 1 | 10 | 2.90 | 2.42 | 1.05 | 0.30 |
| | Group 2 | 10 | 1.85 | 2.67 | | |
| Z angle | Group 1 | 10 | 66.20 | 5.27 | -1.40 | 0.47 |
| | Group 2 | 10 | 67.60 | 5.99 | | |
| LL–SnPg' | Group 1 | 10 | 4.90 | 1.93 | 1.65 | 0.06 |
| | Group 2 | 10 | 3.25 | 2.61 | | |
| H.NB | Group 1 | 10 | 21.10 | 5.22 | 0.15 | 0.85 |
| | Group 2 | 10 | 20.95 | 5.73 | | |
| NLA | Group 1 | 10 | 97.80 | 6.80 | -5.80 | 0.17 |
| | Group 2 | 10 | 103.60 | 12.82 | | |
| LI- Apog | Group 1 | 10 | 1.55 | 2.22 | 1.35 | 0.32 |
| | Group 2 | 10 | 0.20 | 2.96 | | |

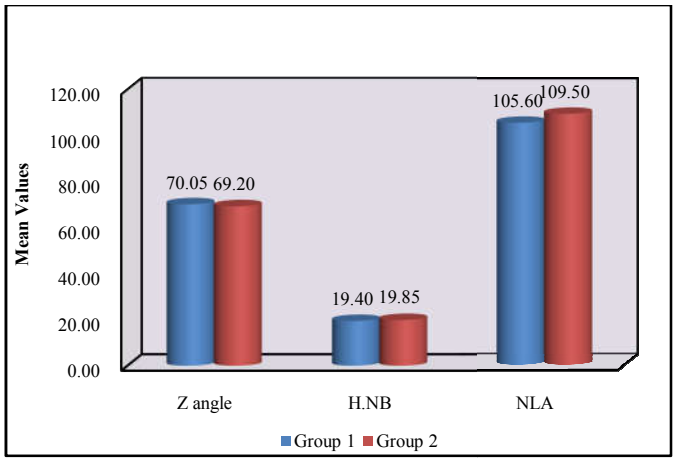
**Table 3** Comparison of mean values of different study parameters between 2 groups at T2 time period using Mann Whitney Test

**Comparison of mean values of different study parameters between 2 groups at T2 time period using Mann Whitney Test**

| | Groups | N | Mean | SD | Mean Diff | P-Value |
|---|---|---|---|---|---|---|
| UL–E plane | Group 1 | 10 | -1.60 | 1.52 | -0.10 | 0.88 |
| | Group 2 | 10 | -1.50 | 1.90 | | |
| UL–S line | Group 1 | 10 | 0.55 | 1.21 | -0.50 | 0.47 |
| | Group 2 | 10 | 1.05 | 1.86 | | |
| UL–SnPg' | Group 1 | 10 | 4.25 | 0.89 | 0.50 | 0.22 |
| | Group 2 | 10 | 3.75 | 1.72 | | |
| H–Pr | Group 1 | 10 | 2.55 | 3.00 | 0.15 | 0.91 |
| | Group 2 | 10 | 2.40 | 3.63 | | |
| LL–E plane | Group 1 | 10 | 0.90 | 1.96 | -0.50 | 0.82 |
| | Group 2 | 10 | 1.40 | 1.24 | | |
| LL–S line | Group 1 | 10 | 2.80 | 1.38 | 0.10 | 0.91 |
| | Group 2 | 10 | 2.70 | 1.40 | | |
| Z angle | Group 1 | 10 | 70.05 | 4.67 | 0.85 | 0.60 |
| | Group 2 | 10 | 69.20 | 4.69 | | |
| LL–SnPg' | Group 1 | 10 | 5.30 | 1.06 | 0.90 | 0.14 |
| | Group 2 | 10 | 4.40 | 1.58 | | |
| H.NB | Group 1 | 10 | 19.40 | 4.88 | -0.45 | 0.67 |
| | Group 2 | 10 | 19.85 | 4.26 | | |
| NLA | Group 1 | 10 | 105.60 | 5.74 | -3.90 | 0.24 |
| | Group 2 | 10 | 109.50 | 13.02 | | |
| LI- Apog | Group 1 | 10 | 3.10 | 1.65 | -0.60 | 0.32 |
| | Group 2 | 10 | 3.70 | 1.83 | | |




**Graph 3** Mean values of different parameters between 2 groups at T2 time interval [Part -1]




**Graph 4** Mean values of different parameters between 2 groups at T2 time interval [Part2]

A statistically significant change was found in upper lip changes and nasolabial angle in both the groups, but the intergroup differences were not statistically significant. A significant increase was noted in Z-angle for G1 (Mean difference= 3.85°) (P=0.005) while there was no significant change found in G2 (P>0.05) (Table 4, 5) (Graph 5,6,7, 8). The differences were not statistically significant when the groups were compared with each other (P<0.05) (Table 6) (Graph 9, 10).

**Table 4** Comparison of mean values of different study parameters between T1 and T2 time period in Group 1 using Wilcoxon Signed Rank Test

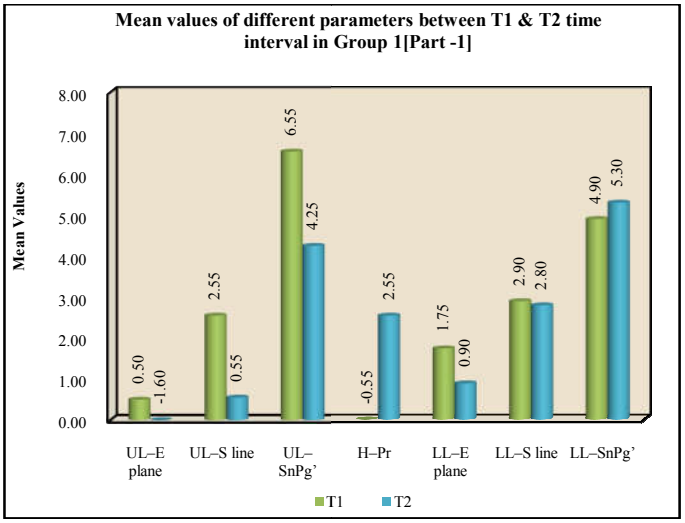
| Comparison of mean values of different study parameters between T1 and T2 time period in Group 1 using Wilcoxon Signed Rank Test | | | | | | |
|---|---|---|---|---|---|---|
| | **Groups** | **N** | **Mean** | **SD** | **Mean Diff** | **P-Value** |
| UL–E plane | T 1 | 10 | 0.50 | 2.00 | 2.10 | 0.007* |
| | T 2 | 10 | -1.60 | 1.52 | | |
| UL–S line | T 1 | 10 | 2.55 | 1.66 | 2.00 | 0.005* |
| | T 2 | 10 | 0.55 | 1.21 | | |
| UL–SnPg’ | T 1 | 10 | 6.55 | 1.07 | 2.30 | 0.004* |
| | T 2 | 10 | 4.25 | 0.89 | | |
| H–Pr | T 1 | 10 | -0.55 | 3.85 | -3.10 | 0.005* |
| | T 2 | 10 | 2.55 | 3.00 | | |
| LL–E plane | T 1 | 10 | 1.75 | 2.31 | 0.85 | 0.83 |
| | T 2 | 10 | 0.90 | 1.96 | | |
| LL–S line | T 1 | 10 | 2.90 | 2.42 | 0.10 | 0.86 |
| | T 2 | 10 | 2.80 | 1.38 | | |
| Z angle | T 1 | 10 | 66.20 | 5.27 | -3.85 | 0.005* |
| | T 2 | 10 | 70.05 | 4.67 | | |
| LL–SnPg’ | T 1 | 10 | 4.90 | 1.93 | -0.40 | 0.27 |
| | T 2 | 10 | 5.30 | 1.06 | | |
| H.NB | T 1 | 10 | 21.10 | 5.22 | 1.70 | 0.09 |
| | T 2 | 10 | 19.40 | 4.88 | | |
| NLA | T 1 | 10 | 97.80 | 6.80 | -7.80 | 0.008* |
| | T 2 | 10 | 105.60 | 5.74 | | |

* - Statistically Significant

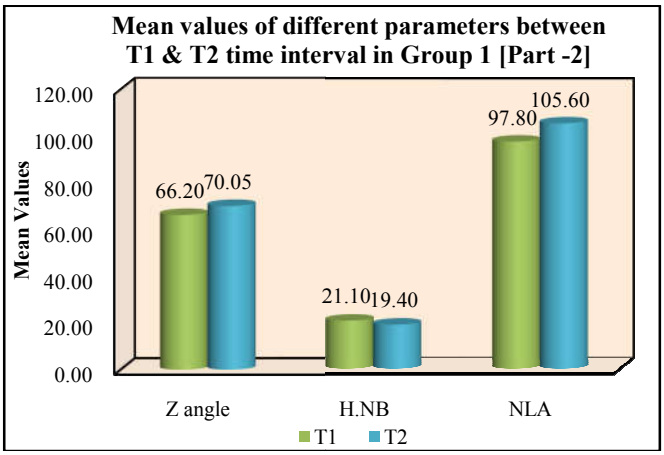
**Table 5** Comparison of mean values of different study parameters between T1 and T2 time period in Group 2 using Wilcoxon Signed Rank Test

| Comparison of mean values of different study parameters between T1 and T2 time period in Group 2 using Wilcoxon Signed Rank Test | | | | | | |
|---|---|---|---|---|---|---|
| | **Groups** | **N** | **Mean** | **SD** | **Mean Diff** | **P-Value** |
| UL–E plane | T 1 | 10 | 0.40 | 2.31 | 1.90 | 0.01* |
| | T 2 | 10 | -1.50 | 1.90 | | |
| UL–S line | T 1 | 10 | 2.20 | 2.36 | 1.15 | 0.01* |
| | T 2 | 10 | 1.05 | 1.86 | | |
| UL–SnPg’ | T 1 | 10 | 5.20 | 1.87 | 1.45 | 0.005* |
| | T 2 | 10 | 3.75 | 1.72 | | |
| H–Pr | T 1 | 10 | 0.30 | 3.65 | -2.10 | 0.02* |
| | T 2 | 10 | 2.40 | 3.63 | | |
| LL–E plane | T 1 | 10 | 0.85 | 2.92 | -0.55 | 0.38 |
| | T 2 | 10 | 1.40 | 1.24 | | |
| LL–S line | T 1 | 10 | 1.85 | 2.67 | -0.85 | 0.22 |
| | T 2 | 10 | 2.70 | 1.40 | | |
| Z angle | T 1 | 10 | 67.60 | 5.99 | -1.60 | 0.26 |
| | T 2 | 10 | 69.20 | 4.69 | | |
| LL–SnPg’ | T 1 | 10 | 3.25 | 2.61 | -1.15 | 0.10 |
| | T 2 | 10 | 4.40 | 1.58 | | |
| H.NB | T 1 | 10 | 20.95 | 5.73 | 1.10 | 0.18 |
| | T 2 | 10 | 19.85 | 4.26 | | |
| NLA | T 1 | 10 | 103.60 | 12.82 | -5.90 | 0.008* |
| | T 2 | 10 | 109.50 | 13.02 | | |

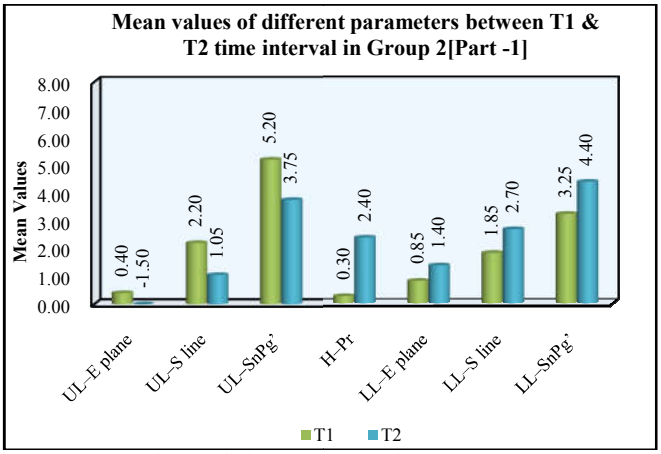
* - Statistically Significant



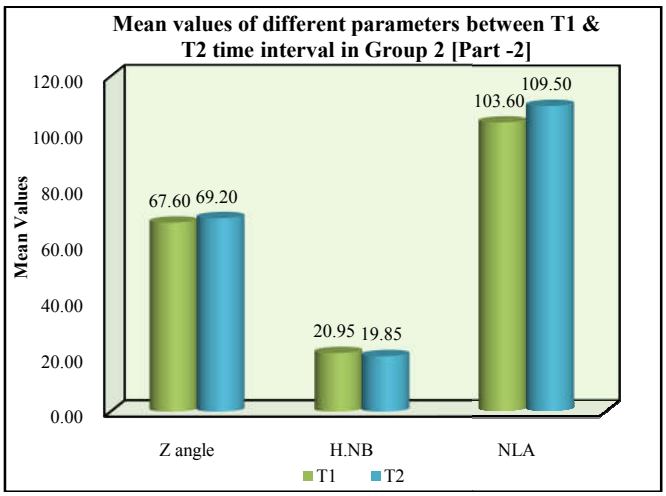

**Graph 5** Mean values of different parameters between T1 & T2 time interval in Group 1[Part -1]




**Graph 6** Mean values of different parameters between T1 & T2 time interval in Group 1 [Part -2]



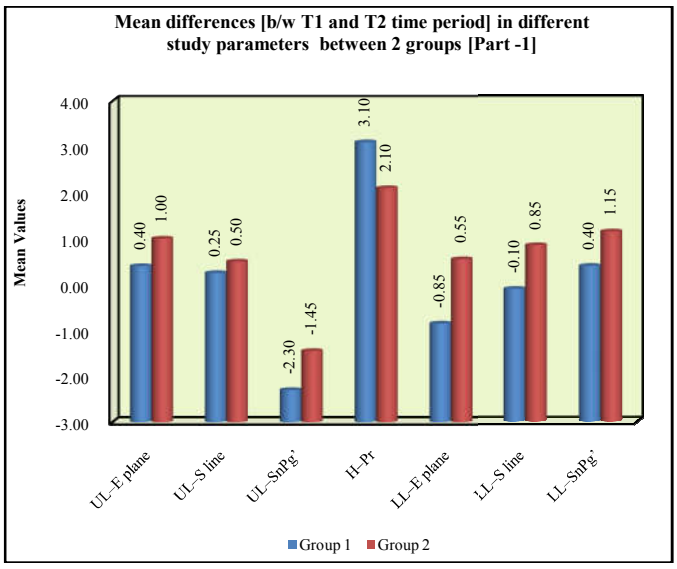

**Graph 7** Mean values of different parameters between T1 & T2 time interval in Group 2[Part -1]



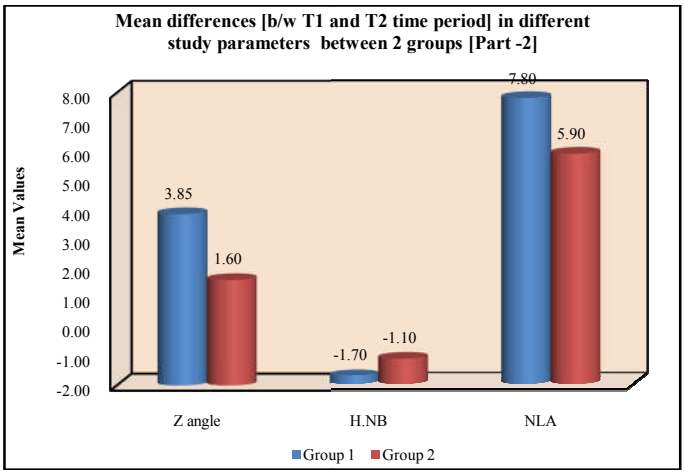

**Graph 8** Mean values of different parameters between T1 & T2 time interval in Group 2 [Part -2]

**Table 6** Comparison of mean differences [b/w T1 and T2 time period] in different study parameters between 2 groups using Mann Whitney Test

| Comparison of mean differences [b/w T1 and T2 time period] in different study parameters between 2 groups using Mann Whitney Test | | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **Groups** | **N** | **Mean** | **SD** | **Mean Diff** | **P-Value** |
| UL–E plane | Group 1 | 10 | 0.40 | 2.91 | -0.60 | 0.94 |
| | Group 2 | 10 | 1.00 | 2.16 | | |
| UL–S line | Group 1 | 10 | 0.25 | 1.40 | -0.25 | 0.49 |
| | Group 2 | 10 | 0.50 | 2.44 | | |
| UL–SnPg' | Group 1 | 10 | -2.30 | 1.18 | -0.85 | 0.13 |
| | Group 2 | 10 | -1.45 | 0.96 | | |
| H–Pr | Group 1 | 10 | 3.10 | 1.84 | 1.00 | 0.22 |
| | Group 2 | 10 | 2.10 | 2.23 | | |
| LL–E plane | Group 1 | 10 | -0.85 | 3.33 | -1.40 | 0.21 |
| | Group 2 | 10 | 0.55 | 2.33 | | |
| LL–S line | Group 1 | 10 | -0.10 | 1.33 | -0.95 | 0.13 |
| | Group 2 | 10 | 0.85 | 2.21 | | |
| Z angle | Group 1 | 10 | 3.85 | 2.47 | 2.25 | 0.22 |
| | Group 2 | 10 | 1.60 | 3.89 | | |
| LL–SnPg' | Group 1 | 10 | 0.40 | 1.17 | -0.75 | 0.18 |
| | Group 2 | 10 | 1.15 | 2.00 | | |
| H.NB | Group 1 | 10 | -1.70 | 2.70 | -0.60 | 0.68 |
| | Group 2 | 10 | -1.10 | 2.73 | | |
| NLA | Group 1 | 10 | 7.80 | 8.39 | 1.90 | 0.85 |
| | Group 2 | 10 | 5.90 | 4.89 | | |




**Graph 9** Mean differences [b/w T1 and T2 time period] in different study parameters between 2 groups [Part -1]




**Graph 10** Mean differences [b/w T1 and T2 time period] in different study parameters between 2 groups [Part -2]

Comparison of Lower Incisor – Apog line between different time intervals in both groups showed statistically significant changes. (Table 7,9) (Graph 11). (Table 9) However, the amount of change from T2 to T3 was higher in Group 2. (Table 8,10)

**Table 7** Comparison of the mean value of Lower Incisor - Apog between different time intervals in Group 1 using Friedman's Test

| Comparison of the mean value of Lower Incisor - Apog between different time intervals in Group 1 using Friedman's Test | | | | | | |
|---|---|---|---|---|---|---|
| **Time** | **N** | **Mean** | **SD** | **Min** | **Max** | **P-Value** |
| T1 | 10 | 1.55 | 2.22 | -4.0 | 4.0 | |
| T2 | 10 | 3.10 | 1.65 | 0.0 | 6.0 | 0.002* |
| T3 | 10 | 2.65 | 1.65 | -1.0 | 5.0 | |

* - Statistically Significant

**Table 8** Multiple comparison of mean diff. of LI - Apog b/w 3 time intervals in Group 1 using Wilcoxon Signed Rank Post hoc Test

| Multiple comparison of mean diff. of LI - Apog b/w 3 time intervals in Group 1 using Wilcoxon Signed Rank Post hoc Test | | | | | |
|---|---|---|---|---|---|
| **(I) Time** | **(J) Time** | **Mean Diff. (I-J)** | **95% CI for Diff.** | | **P-Value** |
| | | | **Lower** | **Upper** | |
| T1 | T2 | -1.55 | -3.09 | -0.01 | 0.03* |
| | T3 | -1.10 | -2.48 | 0.28 | 0.04* |
| T2 | T3 | 0.45 | 0.04 | 0.86 | 0.02* |

**Table 9** Comparison of mean value of Lower Incisor - Apog between different time intervals in Group 2 using Friedman's Test

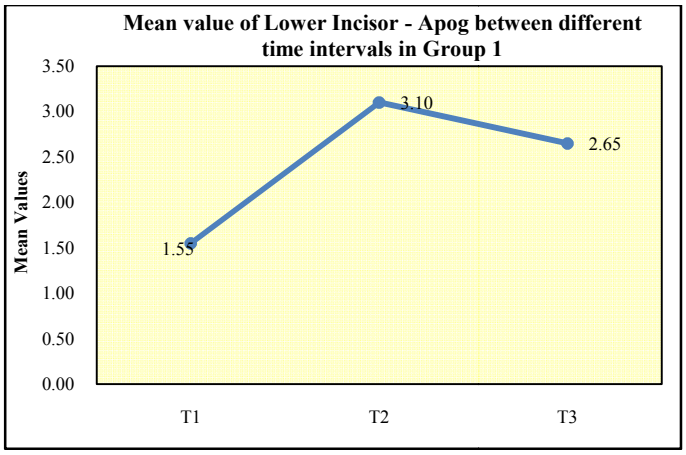
| Comparison of mean value of Lower Incisor - Apog between different time intervals in Group 2 using Friedman's Test | | | | | | |
|---|---|---|---|---|---|---|
| **Time** | **N** | **Mean** | **SD** | **Min** | **Max** | **P-Value** |
| T1 | 10 | 0.20 | 2.96 | -4.0 | 5.0 | |
| T2 | 10 | 3.70 | 1.83 | 0.0 | 5.5 | <0.001* |
| T3 | 10 | 2.05 | 1.89 | -1.0 | 5.0 | |

* - Statistically Significant

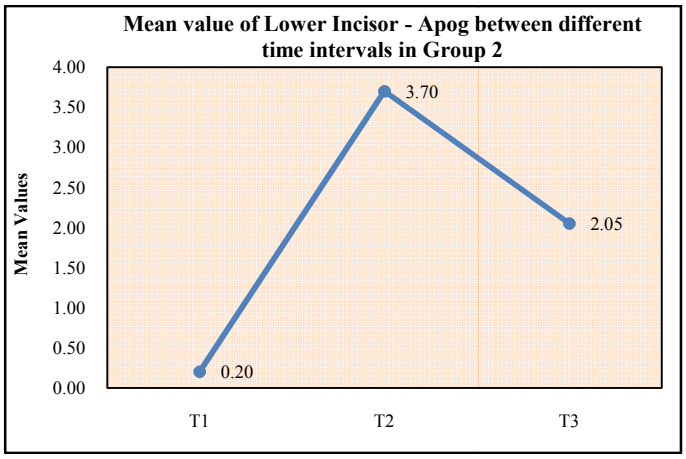
**Table 10** Multiple comparison of mean diff. of LI - Apog b/w 3 time intervals in Group 2 using Wilcoxon Signed Rank Post hoc Test

| Multiple comparison of mean diff. of LI - Apog b/w 3 time intervals in Group 2 using Wilcoxon Signed Rank Post hoc Test | | | | | |
|---|---|---|---|---|---|
| **(I) Time** | **(J) Time** | **Mean Diff. (I-J)** | **95% CI for Diff.** | | **P-Value** |
| | | | **Lower** | **Upper** | |
| T1 | T2 | -3.50 | -5.29 | -1.71 | 0.008* |
| | T3 | -1.85 | -3.47 | -0.23 | 0.01* |
| T2 | T3 | 1.65 | 0.89 | 2.41 | 0.007* |

* - Statistically Significant




**Graph 11** Mean value of Lower Incisor - Apog between different time intervals in Group 1




**Graph 14** Mean value of Lower Incisor - Apog between different time intervals in Group 2

## DISCUSSION

Attaining a good and balanced facial profile by estimating the patient's response and profile is one of the most important treatment goals in orthodontics. This study was conducted to compare the soft tissue effects of two different treatment approaches (fixed functional appliance therapy and upper first premolar extraction) and the post retention labiolingual incisor stability of each protocol.

Correction of the Class II malocclusion in G1 was accomplished by retraction of the maxillary anterior teeth into maxillary first premolar extraction space to correct the overjet. On the other hand in G2 correction was achieved by fixed functional appliance therapy.

Since the overall effects and mechanisms of action of different types of fixed functional appliances are similar, this should not impede the results of the study[11,13-18]. Also, the specific treatment effect comparisons with the different appliances were not the focus of this study.

After successful correction of the malocclusion, the comparisons showed no differences in the soft tissue parameters between the two groups. These results are in agreement with previous studies by Janson *et al*[19].

There was a statistically significant change in upper lip position in both the groups; this is in line with Lo and Hunter's research[7] which suggested that the soft-tissue profile closely follow the skeletal structure. It would usually be expected that the group treated with bilateral maxillary first premolar extractions would have a greater upper lip retrusion; however, the results of this study did not show any significant difference.

It is known that the muscle-skeletal-functional complex of the upper lip contributes to the variability observed on alterations of the upper lip with the treatment protocol with premolar extractions[20,21]. Failure to control or measure this variable remains a shortcoming of retrospective soft tissue cephalometric studies.

Though statistically insignificant, the lower lip was found to be slightly retracted in G1, which may be explained by the fact that as the maxillary incisors are retracted the bite opens and the lip tends to return to its normal position. In comparison, an increase in the lower lip protrusion after treatment in G2 was primarily because the lower incisors were considerably proclined during the application of the fixed functional appliance. Controlling the inclination of the lower incisors during treatment by incorporating additional lingual crown torque may prevent lower lip protrusion if not desired as a treatment objective.

The use of linear and angular measurements to assess the profile in this study comes with the subtle implication that these standards may be good indicators of whether or not a face is esthetic. However, the perception of an esthetic face is much more than the sum of these sagittal measurements and the 3-dimensional character all play significant roles in each individual's perception of what constitutes a pleasing facial appearance.

Also, the E-plane is not a completely reliable reference plane owing to the simultaneous changes in the pogonion and pronasale points. Therefore one must also consider the normal maturational changes that bring about 'relative retraction' of the lips,[6,23,24] and the considerable individual variation.

In the present study, the nasolabial angle increased significantly for both the groups after treatment, although G1 showed a greater change. This is in agreement with works of Freitas *et al*[21][30] who observed an increase of the nasolabial angle in cases treated with extraction of four premolars, which also was confirmed by Talass *et al*.[25]

However, the results of this study are contrary to results found by Tadic and Woods[2] who did not find statistically significant alteration of the nasolabial angle in patients treated with extraction of upper first premolars.

The other important issue is that fixed functional treatment group were more liable to lower incisor proclination and relapse than upper premolar extraction treatment, though there was a statistically significant proclination of lower incisor in both the groups. Therefore, extraction treatment can be preferable in patients with excessive lower incisor labial inclination at the beginning of the treatment.

Another concern that arises in using the bilateral maxillary premolar extraction protocols is regarding smile aesthetics. However, previous studies have demonstrated that the extraction of maxillary premolars does not negatively affect smile attractiveness[26-29].

It is difficult to distinguish the soft tissue changes in Class II division 1 patient treated with these treatment modalities. The

underlying reason for this is the high number of variables including differences in soft tissue thickness between individuals, and individual variations in vertical and anteroposterior facial growth[2].

## CONCLUSION

Both the treatment approaches provided adequate improvement in the facial esthetics however the different treatment methods used in the two groups did not yield any significant soft tissue differences. Conversely, the tendency to procline lower incisors and hence the relapse was greater with fixed functional appliances.

Hence, the results of this study help the orthodontist to make a better diagnosis and treatment plan and hence can be relatively more predictable based on variables such as pre-treatment crowding, anchorage preparation, pre-treatment soft tissue thickness, strain around the lips, individual growth patterns, pre-treatment incisor inclination and patient treatment preferences.

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**How to cite this article:**

Purnasri Kimidi *et al* (2021) 'Comparison of Soft Tissue Changes And Lower Incisor Stability In Cases Treated With Fixed Functional Appliances And With Bilateral Maxillary First Premolar Extraction In Class Ii Division 1 Malocclusion Patients', *International Journal of Current Advanced Research,* 10(04), pp. 24138-24145.
DOI: http://dx.doi.org/10.24327/ijcar.2021.24145.4784

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