Original Article

To Evaluate and Compare the Aligning Efficiency of Clear Aligners and Nickel Titanium Arch Wires In Unraveling Lower Anterior Crowding - A Prospective Study

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ABSTRACT

Introduction- The purpose of this prospective study was to compare the aligning efficiency of two modalities- clear aligner therapy and fixed appliance using nickel titanium wires, in the lower anterior region.

Method- The sample included 20 patients who had mild to moderate crowding were selected, and randomly divided into two groups-Aligner group & NiTi group. Records were taken at 4 week intervals till 12 weeks in both the groups. The crowding was measured at all stages using the Little's irregularity index using a caliper and then summed up to give the total irregularity score

Result-The result of this study showed that over a fixed time the Mean for Little's Irregularity Index scores was compared using Repeated measures of Anova and this difference was found to be statistically significant for both the groups. The maximum change in the score was observed between zero to four weeks of treatment for both modalities.

Conclusion- The results of this study indicate that both clear aligners and conventional fixed therapy are effective in the resolution of lower anterior crowding. However, when the two groups are compared, the differences found were not statistically significant. This indicates that clear aligner therapy is an effective treatment modality for mild to moderate malocclusions.

Key words: Clear aligners, Niti Archwires, Efficiency, Crowding, Comparison.

INTRODUCTION

Today, in this modern world of orthodontics, various new techniques have been developed to make the treatment more comfortable and esthetic for the patient. The patient has a plethora of options to choose from based on factors such as cost, treatment time, esthetics, comfort and so on. Owing to these factors, more adult patients have sought orthodontic treatment and demand for aesthetic appliances has increased in recent years.[1]

Even though the frequency of malocclusions in adults is equal to or greater than that observed in children and adolescents, Adults, however, are often averse to wearing traditional fixed appliances with wires, bands, and brackets.[2,3] Possible explanations for this include fear of pain or discomfort and esthetic concerns associated with general orthodontic treatment.[4] Adults are also more conscious of discoloration and unpleasant odor related to orthodontic treatment. Moreover, hygiene and periodontal health are confounding factors associated with adult treatment.[5]

Current advances in Orthodontics have broadened the possibilities of esthetic orthodontic appliances offered to patients. Some of the options offered today are -esthetic labial appliances (plastic brackets, ceramic brackets, esthetic coated arch wires), lingual appliances and the relatively newer clear aligners.

However, it would not be wise to compromise on the treating efficiency of the appliance for the esthetic appeal. It is therefore necessary to carefully analyze and compare the treatment effects of an esthetic appliance with a conventional one.

Clear aligners are indicated for patients with mild to moderate crowding, spacing, non-skeletal constricted arches and in relapsed cases after fixed appliance therapy.[6] In addition, patients with nickel allergies are good candidates for clear aligners, since traditional brackets and wires contain some component of nickel in stainless steel. Also, due to the aligners being removable by concept, less oral hygiene maintenance issues are likely to be encountered, making patients with special needs good candidates for such appliances.[6-8]

Very few studies have been conducted to assess the actual treatment efficiency of clear aligners.In a systematic review, Lagravere and Flores-Mir stated that a strong conclusion could not be made regarding the treatment efficiency of this kind of an appliance.[9]

Nickel titanium wires are most commonly used for the purpose of alignment of teeth in day to day practice in the labial technique.[10] According to various studies, these have been found to be more effective and less time consuming than stainless steel wires for resolving crowding of lower anterior teeth.[10-13]

These wires have the advantages of super-elasticity, torsional strength, stress constancy, physiological compatibility, shape memory, dynamic interference and wear resistance hysteresis over other wires. As a result, nickel titanium wires are more powerful in regions of shorter inter-bracket span, such as lower incisors.[12]

However, little clinical research has been published to comprehensively compare the effectiveness of clear aligner to nickel titanium arch wires for the purpose of alignment of crowded lower incisors.[10] Previous literature has focused on description of both systems individually.

Aim and Objectives of the Study

1. To evaluate the aligning ability of clear aligner in mild to moderate lower anterior crowding cases
2. To evaluate the aligning ability of nickel titanium wires in mild to moderate lower anterior crowding cases
3. To compare the efficiency of clear aligner and nickel titanium arch wire in mild to moderate lower anterior crowding cases

Materials and Methodology

Source of the study:

The present study was prospective in nature. It involved a sample size of 20 patients who reported for treatment to the Department of Orthodontics and Dentofacial Orthopedics. Pre-treatment records including alginate or polyvinylsiloxane impressions and photographs were taken for the study.

Study subjects:

A total of 20 patients who would be undergoing orthodontic treatment using Kline clear aligners or 0.022x0.028" MBT appliance (single company) were selected for the study. All mechanics were consistent with a non-extraction treatment plan.

Sample Size Calculation

Hence Sample size was calculated using G Power Software (version 3.0.10). Based on the calculated effect size of 0.89 (based on previous study), 5% level of precision, 95% confidence level and 80% power of the study. The sample size for the study was 20 i.e 10 samples per group.

Criteria for selection of sample:

1. INCLUSION CRITERIA

- Adult (non-growing) patient
- Healthy, compliant and motivated patients who can visit clinic regularly
- Mild to Moderate lower anterior crowding according to Little's irregularity index(1975)14
- Non extraction treatment plan .
- No special measures to alter speed of tooth movement

2. EXCLUSION CRITERIA

- Large restorations in lower anterior teeth
- Prosthetic replacements in lower anterior teeth
- Gross gingival/periodontal problems in lower anterior teeth

STUDY DESIGN

On the basis of Little's irregularity index[14], a sample size of 20 patients having mild to moderate crowding will be selected, and will be randomly divided into two groups(Table 1):

GROUP 1	GROUP 2
Clear aligner therapy 10 patients	Nickel titanium arch wires 10 patients

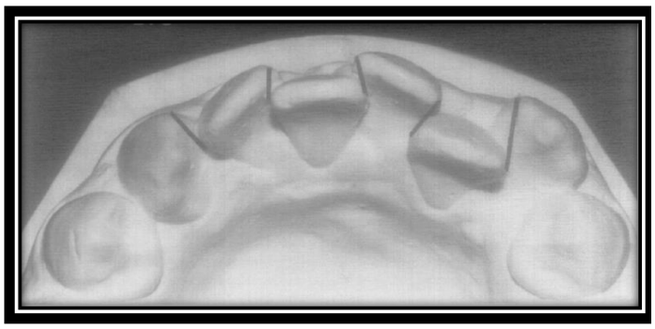
For group 1: Pretreatment records including study models, cephalometric radiographs and photographs were made. A well detailed dental impression was made for the same using polyvinyl-siloxane impression material & sent to the lab for fabrication of clear aligner. Records taken at 4 week intervals till 12 weeks.

For group 2: Pretreatment records including photographs and alginate impressions were collected. Fixed mechanotherapy with MBT, 0.022 slot was started. Appropriate dimensions of Nickel titanium arch wires (single company) were introduced for the correction of crowding .Records at 4 week intervals till 12 weeks

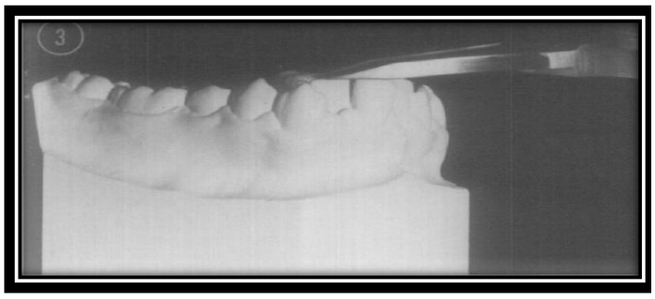
Finally, the treatment outcomes of both the groups were evaluated and then compared using Little's Irregularity Index (1975) [14] for correction of crowding within a fixed time period. Statistical analysis was preformed to obtain the results.

Method of measurements made in the study

The crowding was measured at all stages using the Little's irregularity index [14] where the linear distance between one contact point to adjacent contact point of mandibular anterior teeth is measured using a caliper and then summed up to give the total irregularity score(Figure 1).



The calipers should be held only parallel to the occlusal plane, measuring only horizontal linear displacement of the anatomic contact points (Figure 2)



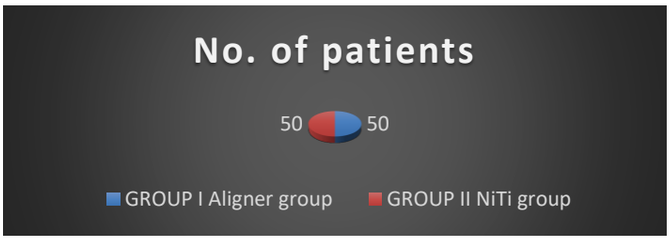
The irregularity score is then further classified into different groups based on the amount of crowding present as given in Table 1.

This study measured the change in the irregularity score over a fixed time period to analyze the amount of resolution of crowding achieved.

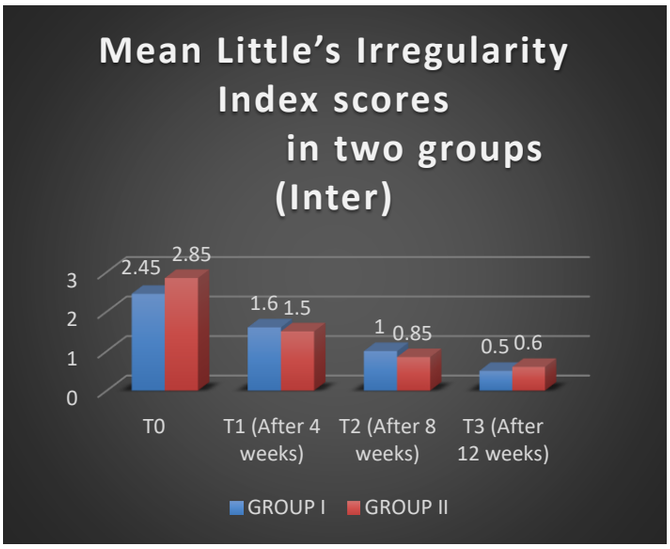
RESULTS

Data was entered into Microsoft Excel spreadsheet and was checked for any discrepancies. Summarized data was presented using Tables and Graphs. The data was analyzed by SPSS (21.0 version). Shapiro Wilk test was used to check which all variables were following normal distribution. The scores of Little's Irregularity Index were normally distributed. Independent t test (P^a value) and Repeated measures of Anova (P^b value) was used for comparing with respect to continuous and normally distributed variables (p-value was more than 0.05). Level of statistical significance was set at p-value less than 0.05.

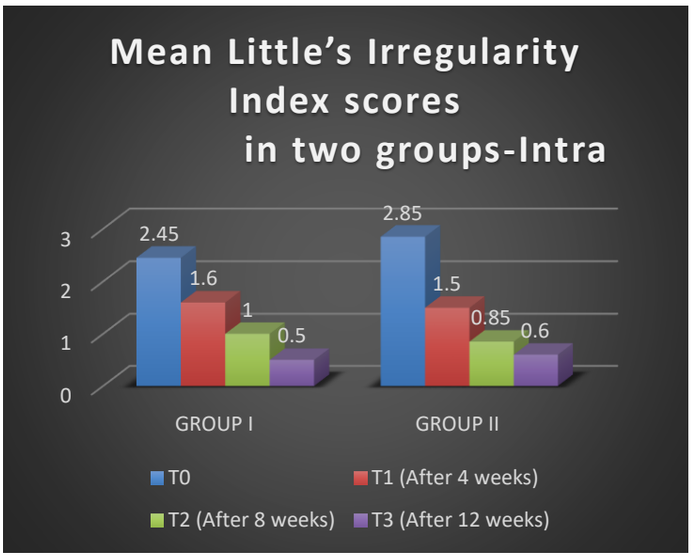
The result of this study showed that significant changes were produced in the score for Little's irregularity index over a fixed time period for both the groups- aligners as well as conventional mechanics. Demographic details are shown (Fig 3).



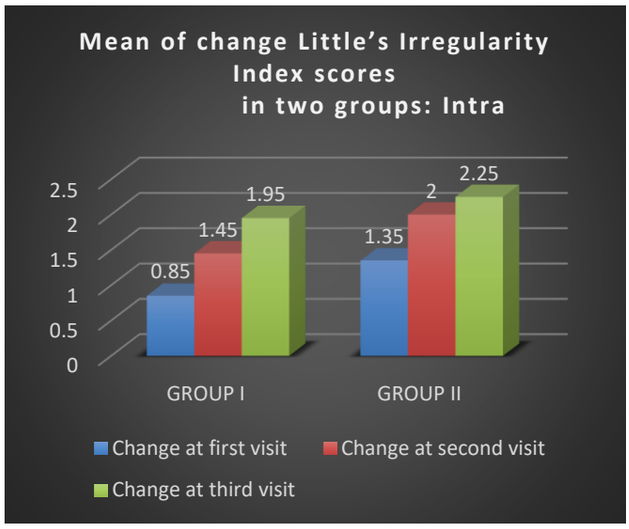
The Mean for Little's Irregularity Index scores was compared using Independent Student 't' Test and this difference was not found to be statistically significant at T1,T2,T3 (Figure 4).



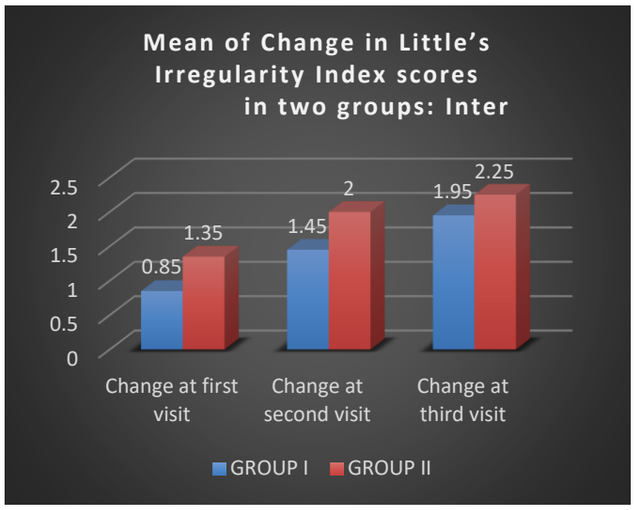
The Mean for Little's Irregularity Index scores was compared using Repeated measures of Anova and this difference was found to be statistically significant for both the groups (Figure 5)



A statistically significant resolution of crowding was seen in both groups (Figure 6).



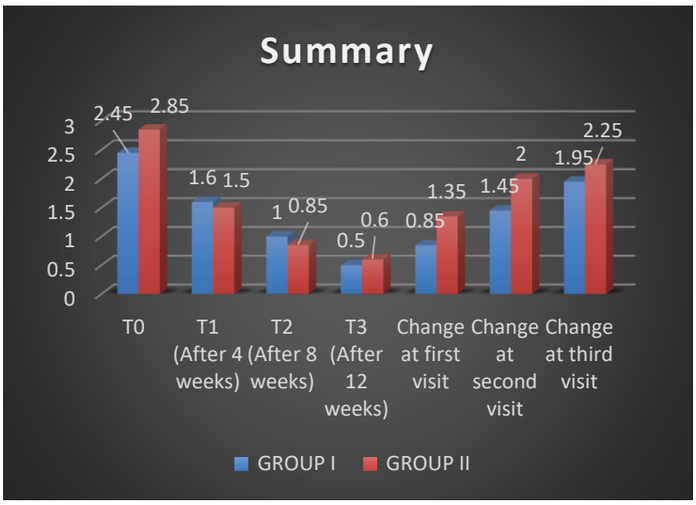
The maximum change in the score was observed between zero to four weeks of treatment for both modalities. When the outcomes of both the groups were compared, it was found that there was a slightly greater resolution of crowding using conventional mechanics, but the difference was not statistically significant (Figure 7).



An overall summary of the results is presented (Figure 8).

DISCUSSION

Though fixed orthodontic appliances have been the backbone of orthodontic biomechanical technique, there is defiance in patients towards braces which are unpleasing in appearance and causing a shift towards an aesthetic invisible appliance. Development of appliances that combine both acceptable aesthetics for the patient and adequate technical performance for the clinician is the ultimate goal.[15]



Esthetic labial options include clear fixed appliances comprising of plastic brackets, ceramic brackets, aesthetic coated arch wires, etc.[15]

The success of clear aligners depend upon the patient compliance, operator control, and can be limited to produce minor tooth movements.[15,16]

However, in the pursuit for more aesthetic appliances, the efficiency of the appliance should not be compromised upon. It is thus, of great importance to compare the treatment efficiency of the newer aesthetic clear aligners with the time tested conventional fixed appliance.

The purpose of this study was to compare the aligning efficiency of two modalities- clear aligner therapy and fixed appliance using nickel titanium wires, in the lower anterior region. The space needed for the resolution of crowding was derived from three sources in this study-proclination of anterior teeth, lateral expansion of the arch and interproximal reduction.

In the present study, reduction in the score for Little's irregularity index was seen for both the groups between zero(T0) to twelve weeks(T3) of treatment time. For the aligner group, the mean reduction of crowding at various stages of alignment was statistically significant (p value=0.001 (Figure 6). These values are suggestive of the ability of clear aligners to relieve mild to moderate crowding efficiently.

The above results are in concordance with the findings by Kravitz N D, Kusnoto B, BeGole E et al who conducted a prospective clinical study to evaluate the efficacy of tooth movement with aligners and found Invisalign™ to produce adequately accurate results.[18]

Krieger E, Seiferth J, Saric I et al who conducted a prospective clinical study on thirty patients to determine the accuracy of Invisalign™ in the anterior tooth region and found Invisalign™ to give satisfactory results[19] and Mancini G E, Carinci F, Avantaggiato I Z A, Puglisi P, Caccianiga G, Brunelli G who

conducted a retrospective study on twenty patients by comparing the pre and post treatment records and concluded that Invsalign™ was effective in achieving good clinical results.[20]

Further in the present study, nickel titanium wire was also found to be successful in resolving lower anterior crowding. For this group, the mean reduction in crowding was statistically significant(p=0.002, Figure 6). These values suggest that nickel titanium wires are successful in effectively resolving lower anterior crowding.

These results are consistent with the results obtained in studies conducted by Catia C.A.Q, Jones M.L and Menezes L.M et al[10] who selected a sample of forty five patients and randomly used four different wires for resolution of lower crowding and concluded that nickel titanium wires were most effective in the group, Gravina MA et al[11], Vimalathithan R et al, Kumaran N.K, Rajasigamani K et al[12] who conducted a study on thirty patients by using two different initial levelling wires and found nickel titanium to be a better initial aligning wire than stainless steel wire and West AE et al[13] who selected a sample of sixty two patients and randomly used stainless steel and nickel titanium wires for decrowding the arches, found nickel titanium wires to be more effective in resolving crowding and concluded that they were a better alternative to multi stranded stainless steel wires as initial levelling wires.

In the present study, a comparison was made between the amount of resolution of crowding achieved using the two modalities. It was observed that the change produced over a fixed period in the nickel titanium group was slightly greater than the aligner group. However, this difference was not found to be statistically significant(p=0.567, p>0.05)

This result is similar to the result obtained by Djeu G, Shelton C and Maganzini A[17] who conducted a retrospective cohort analysis on two groups (Invisalign™ and braces) of forty eight patients by evaluating their pre-treatment and post-treatment records using the American Board of Orthodontics objective grading system. According to them, fixed mechano-therapy was more efficient in correcting malocclusions than Invisalign™. [17]

Acar Y B, Kovan A I, Atesx M and Biren S conducted a systematic review of literature to study the efficiency and ability of clear aligners and its comparison with fixed mechanotherapy. From the one hundred ten publications retrieved from their database, three were found to be relevant. They concluded that 1) Sufficient studies were not available to arrive at definite conclusions to compare clear aligner and fixed orthodontic treatment. 2) In simpler cases, Invisalign™ might result in treatment outcomes as good as those of traditional orthodontic treatment. [8]

However, the study conducted by Buschang P H, Shaw S G, Ross M, Crosby D et al[22] showed slightly different results**.** They compared the time efficiency of aligner therapy and conventional edgewise braces in a retrospective study evaluating the records of one hundred fifty aligner therapy patients and one hundred fifty conventional edgewise braces patients. They found that compared to aligners, conventional edgewise therapy required significantly more visits, longer treatment duration, more emergency visits, greater emergency chair time, and greater total chair time. [22]

This study was also supported by the more recent study by Gu J, Tang J.S, Skulski B et al who conducted a retrospective case control study to compare the treatment effectiveness and efficiency of Invisalign™ system with conventional fixed appliances in treating patients with mild to moderate malocclusion. Pre and post treatment records of forty eight patients each of Invisalign™ and conventional therapy were evaluated for treatment outcome, duration and comparison between the two groups using the Peer Assessment Rating Index. Their study concluded that both treatment modalities were successful in management of malocclusion and that Invisalign™ was faster in correction of simple malocclusions. [23]

On the basis of the current study, it can be concluded that both fixed mechano-therapy (using nickel titanium wires) and aligner therapy are effective in resolution of lower anterior crowding. Statistically significant changes were seen in both individual groups. On comparison of the groups, fixed therapy is slightly more effective in resolution of crowding, as seen clinically. But this result could not be correlated statistically.

Limitations of the study- The present study had the following limitations: the study had a small sample size of twenty patients and the patients were not treated by the same operator thus increasing chances of error.

The present study leads to the opening up of the scope for further studies to evaluate and compare resolution of crowding using conventional fixed mechanics and clear aligners, with a long term follow up. Also studies on methods of gaining space for resolution of crowding i.e. proclination of anterior teeth, lateral expansion of the arch or interproximal reduction can follow.

CONCLUSION

This study was done with the aim of assessing the aligning efficiency of one such modality-clear aligners, in the lower anterior tooth region in cases with mild to moderate crowding and comparing the outcome with traditional fixed mechano-therapy. The results of this study indicate that both clear aligners and conventional fixed therapy are effective in the

resolution of lower anterior crowding. However, when the two groups are compared, the differences found were not statistically significant. This indicates that clear aligner therapy is an effective treatment modality for mild to moderate malocclusions.

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