Orthopedic and orthodontic effects of Twin-block appliance

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This prospective study was conducted on 24 North Indian subjects (10 Control and 14 Twin-block) to evaluate the skeletal and dentoalveolar effects of Twin-block appliance in the treatment of Class II division 1 malocclusion. The result of the present study showed that Twin-block is an effective appliance in accelerating mandibular growth. It also helped dramatically in molar correction and overjet reduction in Class II division 1 malocclusion subjects.
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INTRODUCTION

The aim of early orthodontic treatment is to correct the existing problems and to intercept the developing problems and prevent them from becoming worse.[1] The treatment of Class II malocclusion is frequently aimed at correcting the skeletal discrepancy and functional appliances have been used for many years in the treatment of Class II division 1 malocclusion.[2-7] Several varieties of functional appliances are currently in use for correction of Class II malocclusion with aim to improve skeletal imbalances. Alteration of the maxillary growth, a possible improvement in mandibular growth and position and a change in dental and muscular relationships are the expected effects of these functional appliances.

The most popular functional appliance used today is Clark's Twin-block appliance.[8] Many cephalometric studies[9-14] are available in the literature to find out the skeletal and dentoalveolar effects of Twin-block appliance. However not a single study is reported evaluating the skeletal and dentoalveolar effects of Twin-block appliance based on pitchfork analysis. Thus, there is a need to do a study, which is based on pitchfork analysis to evaluate the skeletal and dentoalveolar effects of Twin-block appliance in the correction of Class II division 1 malocclusion.

MATERIALS AND METHODS

The subjects for this study were selected from Orthodontic Clinic, Division of Orthodontics, Dept of Dental Surgery, All India Institute of Medical Sciences, New Delhi. A total of 24 North Indian growing subjects having Class II division 1 malocclusion were chosen for the study. Among 24 subjects, 14 subjects (8 male and 6 female) were included in the Twin-block treatment group and rest 10 subjects (5 male and 5 female) formed the Control group. Each subject of the Twin-block treatment group met the following selection criteria:

- Class II division 1 malocclusion with normal maxilla and retrognathic mandible.
- Angle's Class II molar relationship on right and left side.
- No or minimum crowding / spacing in the maxillary and mandibular arch.
- Overjet of 5 to 10 mm.

Patients having history of any orthodontic treatment, anterior open bite, severe proclination of upper and lower anteriors, a systemic disease that affects bone growth was not considered for the study.

Criteria for including a subject in the Control group were same as for the Twin-block group subjects except that no treatment at all was done. All Control subjects

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were followed-up regularly for approximately 1 year.

For all the subjects of Twin-block treatment group a standard Twin-block appliance design was followed. In all subjects of Twin-block treatment group single step mandibular advancement was done during wax bite registration. An edge-to-edge incisal relationship with 2mm opening between the central incisors was kept fixed for all the subjects of Twin-block treatment group.

A single operator fabricated all the Twin-block appliances. All the subjects of Twin-block treatment group were instructed to wear the Twin-block appliance 24 hours/day except during brushing. All subjects were specially instructed to wear the appliance during meal times. Each subjects of Twin-block treatment group was checked in every 4 weeks till the end of active functional appliance therapy.

In subjects having low and average mandibular plane angle, inter-occlusal acrylic trimming was done in order to allow unhindered vertical development of lower buccal segments. However, in high mandibular plane angle subjects inter-occlusal acrylic trimming was avoided.

In all subjects of Twin-block group labial bow was kept passive till the end of active functional appliance therapy. The use of Twin-block appliance was discontinued when the overjet and overbite were reduced to 1 to 2 mm or went on to further appliance therapy. Wearing time of appliance varied greatly depending on the level of patient cooperation and the rate at which the deciduous teeth exfoliated.

Lateral cephalogram with teeth in occlusion were obtained for all the subjects of Twin-block treatment group prior to beginning of treatment and at the end of active functional appliance therapy. All the cephalogram films were obtained from a same machine with same exposure criteria. For Control subjects lateral cephalograms with teeth in occlusion were obtained before beginning of the follow-up and at the end of follow-up from a same machine using same exposure criteria as those for the subjects of treatment group.

For evaluation of skeletal and dentoalveolar changes that contributed for the correction of a Class II malocclusion, the pitchfork analysis[15] was used. This analysis is a method of pre- and post-treatment cephalometric superimposition that measures the physical movement of the maxillary and mandibular molars and incisors relative to the dental base as well as the displacement of maxilla and mandible relative to the cranial base. All the measurements are defined positive if they contribute to Class II correction and negative if they aggravate the Class II relationship. It measures the magnitude of changes during treatment and also the source of the changes, e.g. skeletal or dental. The algebraic sum of the various components remains equal to the change in the molar relationship and overjet. To show the summary of various components of change during treatment period, a pitchfork diagram is generated (Figure 1). Pre- and post-treatment cephalograms were traced for each patient of Twin-block treatment and Control group at the same time as suggested by Johnston.[15] All measurements of changes were measured thrice manually using an electronic digital caliper (Least count 0.01mm) and the mean was considered for statistical analysis.

Statistical method

A master file was made and the data was statistically analyzed on a computer using EPI INFO VER 6.04d software. The data were subjected to descriptive analysis for mean, range and standard deviation of all variables. Mann-Whitney U-test was used for comparison between two groups. Probability value (p-value) 0.05 was considered as statistically significant level.

RESULTS

The mean age of the subjects at the beginning of the study and the duration of the study between two groups are shown in Table 1. The results for all the measurements in pitchfork analysis are shown in Table 2 and Figures 2, 3. The positive values are those contributing to correction of Class II malocclusion and negative values are those aggravate the Class II malocclusion.

Skeletal changes

The skeletal changes in the subjects of Control and Twin-block group are shown in Table 2 and Figure 4.

Maxillary change

The mean movement of the maxilla in Control and Twin-block group subjects was -2.04mm and -1.64mm respectively. In subjects of Twin-block group the mean forward movement of maxilla was relatively less and the difference between two groups was statistically not significant ($p=.259$).

Mandibular Change

The mean mandibular change in subjects of Twin-block group was 5.52mm, where as in Control group subjects it was 3.54mm. The difference of mandibular change between two groups was however statistically significant ($p<0.01$).

Apical Base Change (ABCH)

The antero-posterior change in the relationship between the maxillary and mandibular base made a mean positive contribution in Control and Twin-block group subjects. The mean apical base change in subjects of Twin-block and Control group was 3.88mm and 1.49mm respectively. The difference in the apical base change between two groups was very high and was statistically highly significant ($p<0.001$).

Dental Changes

The dental changes in the Control and Twin-block group subjects are shown in Table 2 and Figure 5.

Upper First Molar Change (Total U6)

In Control group subjects the mean total movement of the upper first molar was -1.36mm, which was due to -0.28mm tipping and -1.08mm bodily movement. In subjects of Twin-block group the mean total movement of the upper first molar was only -0.36mm (-0.19mm tipping and -0.17mm bodily movement). The movement of upper first molars in Twin-block group subjects was significantly less as compared to Control group subjects ($p<0.05$).

Lower First Molar Change (Total L6)

The mean total lower first molar movement in Control and Twin-block group subjects was 0.36mm and 1.53mm respectively. In Control group subject's total movement of molar was due to 0.05mm tipping and 0.31mm bodily movement where as in subjects of Twin-block group 0.68mm tipping and 0.85mm bodily movement contributed for total first molar movement. The mean movement of lower first molar in subjects of Twin-block group was more than that in subjects of Control group, but the difference was statistically not significant ($p=0.122$).

Molar correction

The algebraic sum of the ABCH, Total U6 and Total L6 is molar correction. In Control group the molar correction was 0.49mm where as in Twin-block group of subject's molar correction was 4.97mm. The difference of molar correction between the two groups was statistically highly significant ($p<0.001$). Although mesial movement of the lower molars contributed partly to molar correction in Twin-block group subjects, however ABCH contributed to a great extent for molar correction.

Total upper incisor change (Total U1)

The change in the upper incisors in the subjects of Control group was -0.53mm. As comparison to maxillary change (-2.04mm) in subjects of Control group, the change in upper incisors was very small and is a good example of dentoalveolar compensation. In subjects of Twin-block group upper incisors retroclined 1.43mm indicating restraining effects of the appliance on incisors. The difference in the upper incisor change between two groups was statistically highly significant ($p<0.001$).

Total lower incisor change (Total L1)

In Control group subjects lower incisors retroclined by 0.59mm, which was unfavorable for Class II correction. In subjects of Twin-block group lower incisors proclined by 1.44mm and such proclination of lower incisors helped partly in overjet correction. The difference in the change in lower incisors between the two groups was statistically highly significant ($p< 0.001$).

Overjet change

The change in overjet is the total change in incisor relationship and is the algebraic sum of ABCH, Total U1 and Total L1. In subjects of Control and Twin-block group mean overjet change was 0.37mm and 6.75mm respectively. In Twin-bock group subjects overjet correction was significantly more ($p<0.001$) as compared to subjects of Control group.

DISCUSSION

The present study showed that the forward growth of maxilla in Twin-block group subjects was less as compared to the Control group subjects. When the mandible was postured forwardly by the Twin-block appliance, a reciprocal force acted distally on the maxilla, which restricted the forward growth of maxilla. A situation when the normal forward growth of the maxilla is inhibited, it would be ideal for correction of a Class II skeletal discrepancy.[16] In the present study Twin-block appliance was not significantly effective in restricting the forward growth of maxilla. This is in agreement with studies of many authors[17-22] and it is also in contradiction to the studies done by several other authors.[7, 8, 25]

One of the major controversies in functional appliance therapy is the effects of functional appliance on increase in size or acceleration of mandibular growth. Many researchers have claimed extra mandibular growth with Twin-block.[17-20,22,23] The present study also showed a statistically significant increase in mandibular growth between the subjects of Twin-block treatment group and Control group. As compared to Control group subjects, 1.98mm extra mandibular growth was observed in the subjects of Twin-block treatment group. A study by Toth and McNamara[17] found 3.0mm additional increase in condylion to gnathion length during a standardized 16-months period of Twin-block therapy where as Lund and Sandler[24] found 2.4mm extra mandibular growth during a 12-months period of Twin-block treatment. Mills and McCulloch[19] also found a greater mandibular growth (4.2mm) with Twin-block therapy. This observation of increased mandibular growth after Twin-block appliance therapy is in agreement with the results of a number of investigations involving other functional appliances.[25-28] On contrary, some authors[29,30] claim that the mandible does not grow in length with the use of functional appliances.

The ABCH value represents the maxillo-mandibular differential, the movement of the mandible relative to the maxilla. A positive value indicates that the mandible has outgrown the maxilla and the negative value means maxilla has outgrown the mandible. In the subjects of Control group ABCH was 1.49mm, indicating 1.49mm greater antero-posterior movement of the mandible than the maxilla. A study done by Rushforth, Gordon and Aird[31] however found 1.9mm apical base change in a period of 17.3 months in Class II division 1 malocclusion control subjects. In the present study the ABCH in subjects of Twin-block group was 3.88mm in a period of 11.86 months. The outgrowth of mandible over maxilla by the Twin-block was significantly more than the subjects of untreated Class II division 1 malocclusion.

Dentoalveolar changes

The mesial movement of the lower molars and distal movement of the uppers or the restraint of the maxillary molars as the maxilla comes forward are the ideal situation for the correction of the Class II molar relationship. Dentoalveolar changes with tooth borne functional appliances have been widely discussed. In the present study, maxillary first molars moved 1.36mm forward in the subjects of Control group, which was considered as normal forward movement of first molars. In subjects of Twin-block group, movement of upper first molars was less (-0.36mm) and even as compared to the movement of maxilla (-1.64mm). Restraint of molars by the Twin-block appliance could be responsible for such effect. Tumer and Gultan[18] also noted similar type of observation in their study. However a study by Toth and McNamara[17] found 1.5mm distal movement of molars during the Twin-block appliance treatment. Lund and Sandler[24] also noted 1.6mm upper molar distalization during Twin-block appliance therapy. Clark[7] also found distalization of upper molars by the Twin-block appliance. A headgear effect, that caused relative distalization of upper molars during Twin-block treatment was concluded by Mills and McCulloch.[23]

The mean forward movement of the lower first molars was 0.36mm in the Control group subjects. Lund and Sandler[24] noted only 0.1mm mesial movement of the lower first molars in their Twin-block control subjects where as Toth and McNamara[17] found 0.5mm mesial movement of the lower first molars in the control subjects during a 16-months period of study. In the present study, the forward movement of the lower molars in subjects of Twin-block group was 1.53mm. The difference of first molar movement between Control and Twin-block group was however not significant statistically. More forward movement of lower molars in Twin-block group subjects was one of the factors, which contributed in Class II molar correction. In the Twin-block treatment subjects more mesial eruption of lower molars was found.[23] Lund and Sandler[24] noted a substantial amount (2.4mm) of forward movement of the lower first molars in the Twin-block subjects when compared with control (0.1mm). However, the result of the study done by the Toth and McNamara[17] was in contrast to the result of the present study where they found equal forward movement of the lower molars in both Twin-block and control group subjects.

The total molar movement (Molar correction) is the sum of the movements of the upper and lower molars with apical base change (ABCH). If we analyze the results of skeletal change, it can be observed that the mean 4.97mm of molar correction seen in Twin-block group of subjects is largely due to the mandible outgrowing the maxilla rather than the significant upper and lower molars movement. The molar correction in the subjects of Control group was only 0.49mm. Thus, in untreated subjects although mandibular growth was more than the maxillary growth on an average, however the dentoalveolar compensation appeared to have kept the buccal segment relationship fairly static. In the present study, 78.06% skeletal changes contributed for molar correction in the Twin-block group of subjects. In contrast to this present study, O'Brien *et al*.[21] found only 41% skeletal contribution for molar correction with Twin-block appliance. This finding was also similar to the finding of Tulloch, Philips and Proffit.[32] In the present study, treatment was started at the peak of pubertal growth spurt and this could be the factor that caused more skeletal contribution for molar correction by Twin-block appliance.

A widely accepted consensus of opinion is that the Twin-block appliance results retroclination of upper incisors and proclination of lower incisors.[17-19,21,22] In the present study upper incisor movement was -0.53mm in Control group subjects. However, the amount of incisor movement was less as compared to the movement of maxilla (-2.04mm) indicating good dentoalveolar compensation. In Twin-block group of subjects' upper incisors are retroclined by 1.43mm. This could be due to the so-called headgear effects of labial bow. However the so called headgear effects of labial bow has been disapproved by many authors.[21,32,33] Toth and McNamara[17] concluded that lingual tipping of the upper incisors is due to the contact of the lip musculature during the Twin-block treatment. This lingual tipping can also be due to labial wire in both appliances that may come in contact with the incisors during sleeping hours causing them to retract.[34] Toth and McNamara[17] found less lingual tipping of the incisors in subjects wearing Twin-block appliance that does not have labial bow. Trenouth[20] found 14.37 degrees lingual tipping of the upper incisors with Twin-block appliance. Lund and Sandler[24] achieved significant upper incisor retraction using an upper labial bow in contrast to Mills and McCulloch,[23] who did not use a labial bow and found little change in upper incisor position.

The most prominent dentoalveolar effect in subjects of Twin-block treatment group was proclination of lower incisors. The proclination of lower incisors in treatment group was significantly more than that in the Control group subjects. Proclination of the lower incisors in the subjects of treatment group is probably consequent to the resultant mesial force on the lower incisors induced by the protrusion of the mandible.[17,22,35,36] Toth and McNamara[17] found 2.8 degrees forward tipping and 0.7mm forward movement of the lower incisors during treatment of Twin-block appliance. Lund and Sandler[24] reported an even greater proclination of lower incisors (7.9 degrees) relative to control. Mills and McCulloch[23] also found 3.8 degrees proclination of lower incisors with Twin-block appliance. In subjects of Control group an over all -0.59mm mean movement of the lower incisors was found in the present study. Such uprighting of the lower incisors could be due to the restraining effect of the lower lip.

The change in overjet is the total change in incisor relationship and is the algebraic sum of the ABCH + Total U1 + Total L1. In subjects treated with Twin-block appliance showed 6.75mm overjet correction where as only 0.37mm overjet correction was noticed in untreated Class II division 1 malocclusion subjects. The reduction of overjet by Twin-block appliance was significantly more than that in the untreated subjects. In subjects of treatment group ABCH was the major factor of overjet correction and other factors being restriction of forward maxillary growth, retroclination of the upper incisors and proclination of lower incisors. A study by Mills and McCulloch23 and Baccetti *et al.*[14] reported 50% of overjet correction due to skeletal changes with Twin-block appliance. However, the present study showed 57.48% skeletal contribution for overjet correction with Twin-block appliance therapy. Recently a multicenter, randomized controlled trial by O'Brien *et al.*[21] reported only 27% skeletal change in overjet correction with Twin-block appliance.

CONCLUSIONS

Early treatment of Class II division 1 malocclusion with Twin-block functional appliance appeared to be an effective method in correction of molar relation and reduction of overjets. The following conclusions are drawn from the present study:

1. Twin-block was not an efficient appliance in restricting the forward growth of maxilla, where as it was an effective appliance in accelerating mandibular growth.
2. Twin-block appliance had little effect in restricting forward movement of the maxillary molars.
3. Twin-block appliance resulted in mesial movement of the lower molars and helped dramatically in molar correction.
4. Forward movement of the upper incisors, was restricted by the Twin-block appliance.
5. Twin-block appliance caused significant forward movement of the lower incisors and was very effective for overjet reduction in Class II division 1 malocclusion patients.

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