EFFECTS OF MANDIBULAR PROTRACTION APPLIANCE-IV IN THE TREATMENT OF CLASS II MALOCCLUSION: A CEPHALOMETRIC INVESTIGATION

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To evaluate the nature of Class II correction with MPA-IV in the treatment of Class II Division 1 malocclusions. Twenty-five subjects in the age range of 10-12 years were chosen for the study. The subjects were divided among control group (n=10) and treatment group (n=15). Prefollow-up and postfollow-up lateral cephalograms of control subjects, and pretreatment and posttreatment lateral cephalograms of the treatment subjects, were traced manually and subjected to the pitchfork analysis. MPA-IV significantly restricted the forward growth of maxilla ($p<0.05$). The appliance had no effect on the mandibular growth enhancement. Sagittal skeletal relationship improvement was significantly more in the treatment group subjects ($p<0.01$). Distal movement of the maxillary dentoalveolar segments, mesial movement of the mandibular dentoalveolar segments, Class II molar correction and overjet correction were significantly more in the treatment subjects ($p<0.001$).

Conclusions: Mandibular protraction appliance IV was an effective fixed functional appliance in the correction of Class II Division 1 malocclusion. However, subjects who can tolerate greater dentoalveolar compensation for the correction of their Class II malocclusion are best treated with mandibular protraction appliance IV.

Class II malocclusion is a common problem in orthodontic patients and most Class II malocclusions are due to the deficiency in the anteroposterior position of the mandible.[1] In nonextraction approach of treatment, many appliances have been designed to correct the Class II malocclusions. However, functional appliances have been used for many years to correct Class II malocclusions.[2-8] The choice of the functional appliance depends on many factors, including the patient cooperation. The mandibular protraction appliances (MPA) are non-compliant rigid fixed functional appliances that holds the mandible anteriorly and correct the Class II anteroposterior discrepancy.[8-11] The MPA-IV is a latest version of mandibular protraction appliances and has many advantages over its three previous versions and also over other fixed functional appliances.[11] Case report study suggested that the changes produced by mandibular protraction appliances were primarily dentoalveolar with distal movement of the maxillary dentoalveolar process and mesialization of the mandibular dentoalveolar process.[8-11] Recently a study was reported describing the skeletal and dentoalveolar changes with MPA-I, II and III on the treatment of Class II malocclusions.[12] However, there is not a single study so far in the literature mentioning the effects of MPA-IV. Thus the aim of this present study was to evaluate the nature of Class II correction with MPA-IV in the treatment of Class II Division 1 malocclusions.

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Material and Methods

The treatment samples for this study were selected from the department of Orthodontics and Dentofacial Orthopedics, RAMA Dental College, Hospital and Research Centre, Kanpur and the con-

trol subjects were chosen from department of Orthodontics and Dentofacial Orthopedics, CDER, AIIMS, New Delhi. Total 25 subjects in the age range of 10-12 years were chosen for the study. Each chosen subject met the following criteria:

- Class II Division 1 malocclusion with normal maxilla and retrognathic mandible.
- Bilateral full cusp Angle Class II molar relationship.
- Permanent dentition with full complement of teeth.
- Mandibular plane angle in the range of 20^0-25^0.
- Minimal or no crowding and spacing in either arch.
- Overjet of 6-10mm.

Group-1 (Control group) comprised of 10 subjects (Male = 5, Female = 5); they received no treatment but followed for approximate 6 months. Group-2 (Treatment group) comprised remaining 15 subjects (Male = 7, Female = 8); they treated with the multibonded fixed appliance and the MPA-IV.

All the subjects in the treatment group were treated with preadjusted edgewise appliance (MBT technique, .022" slot). Both the arches were leveled upto .021" × .025" stainless steel wire and then the MPA-IV was ligated for the Class II molar and skeletal corrections. The mandible was advanced to an edge-to-edge incisor position and the length of the MPA IV was determined by the distance from the distal aspect of the maxillary molar tube to the occlusal stop on the mandibular archware between canine and first premolar. All the subjects were followed in every 4 weeks for approximate period of 6 months. Then the MPA IV was removed and the finishing of occlusion was done with same fixed appliances.

Lateral cephalograms with teeth in occlusion were recorded for all subjects. For control group subjects' lateral cephalograms were recorded at the beginning and end of observation period. For subjects of treatment group, lateral cephalograms were recorded before start of treatment, before ligation of MPA IV, after removal of MPA IV and at the end of fixed orthodontic treatment. Lateral cephalograms recorded before ligation of the MPA IV and after removal of the MPA IV were considered for analysis to evaluate the effects of MPA IV appliance. All the cephalograms were recorded with the same machine with same settings.

The pitchfork analysis was used to evaluate the skeletal and dentoalveolar changes that contributed to the correction of Class II malocclusions.[13] The pitchfork diagram summarizes the various components of changes (Figure-1). Pretreatment and posttreatment cephalograms were traced for each subject at the same time, as suggested by Johnston.[13] All the measurements were made three times manually, with an electronic digital caliper, and the means were used for statistical analysis.

Statistical Method

Descriptive statistics were calculated for all the caphalometric parameters. The comparison between control and treatment group was performed by means of Mann-Whitney U test with SPSS software. Probability (p value) of 0.05 was considered statistical significant.

Results

The mean age of the subjects at the beginning of the study and the duration of the study are shown in table-1. The results of all measurements in the pitchfork analysis are shown in table-2 and figure-2 & 3. Positive values are those contributing to the correction of Class II malocclusion and negative values are those that aggravated the Class II relationship.

The skeletal changes are shown in table-2 and figure-4. The forward movement of the maxilla in the treatment group subjects (1.46mm) was significantly less than that in the control group subjects (2.05mm). ($P < 0.05$) The mean change in the mandibular growth in the control and treatment subjects was comparable and not significant statistically. The

Table-1:- Mean age at the beginning of study and duration of the study among control and treatment groups.

Variables	Control Group (n=10)	Treatment group (n=15)
	Mean ± SD	Mean ± SD
Age in months	130.30 ± 6.48	134.13 ± 5.76
Treatment duration in days	199.60 ± 25.43	179.53 ± 17.58

Table-2:- Treatment changes for all measurements

Variables	Control Group (n=10)					Treatment Group (n=15)					Mann-Whitney U test	
Variables	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max	Z	Sig.
Maxilla	-2.05	-2.18	0.51	-2.97	-1.26	-1.46	-1.52	0.87	-3.64	0.00	-2.163	*
Mandible	3.38	3.42	0.64	2.38	4.21	3.72	3.88	1.30	1.22	5.96	-1.193	NS
ABCH	1.33	1.18	0.40	0.64	1.98	2.26	2.60	1.01	0.00	4.02	-2.581	**
Total U6	-1.13	-1.01	0.56	-2.00	0.00	1.72	1.64	0.49	1.20	3.10	-4.162	***
Total L6	0.14	0.50	1.02	-1.94	1.24	1.89	1.87	0.36	1.00	2.42	-4.106	***
Molar Correction	0.34	0.53	0.93	-1.46	1.31	5.87	6.02	1.00	4.13	7.68	-4.161	***
Total U1	-0.60	-0.71	0.55	-1.28	0.69	1.72	1.64	0.49	1.20	3.13	-4.161	***
Total L1	-0.59	-0.56	0.16	-0.84	-0.38	1.89	1.87	0.36	1.00	2.42	-4.161	***
Overjet Correction	0.14	0.35	0.63	-1.08	1.22	5.87	6.02	1.00	4.13	7.68	-4.161	***

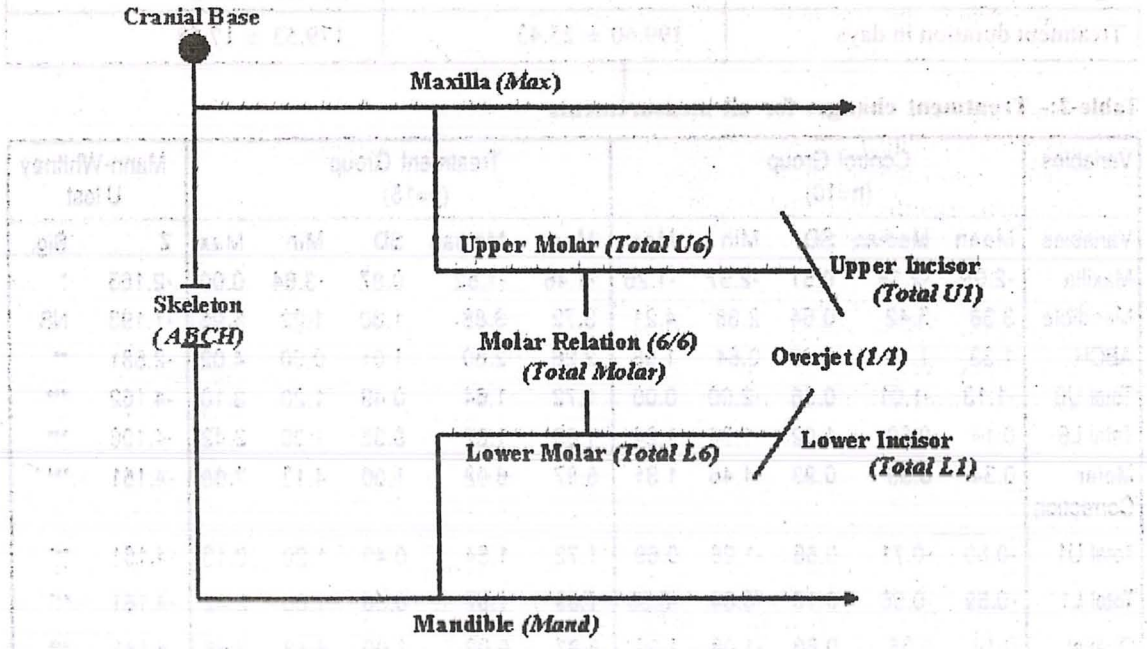
NS Non-Significant, * P <0.05, ** P <0.01, *** P <0.001

anteroposterior apical base change (ABCH) is the relationship between the maxillary and mandibular base made a mean positive contribution for Class II correction. The apical base change in the treatment subjects was significantly more than the control subjects (P<0.01) and also contributed to a greater extent for the molar and overjet correction.

The dental changes are shown in table-2 and figure-5. In control group subjects, the mean forward movement of the maxillary first molar (U6) was 1.13mm; where as in treatment group subjects, the mean distal movement of the maxillary first molar was 1.72mm. The movement of the maxillary first molars between the groups was significantly different (P<0.001). The mean total movement of the mandibular first molar (L6) was 0.14mm in control subjects and 1.89mm in treatment subjects, and the difference was statistically highly significant (P<0.001). Molar correction is the algebraic sum of ABCH + total U6 + total L6. Molar correction in the treatment subjects was significantly greater than in the control subjects (P<0.001). The ABCH contributed maximum for the Class II molar correction in the control and treatment group subjects.

The change in maxillary incisor position (U1) in control subjects was –0.60mm. This was very less when compared with the maxillary skeletal position

Fig-1: The Pitchfork diagram. Cranial Base = Base of the cranium; Maxilla = Maxillary change in relation to the cranial base; Mandible = Mandibular change in relation to the cranial base; ABCH = The antero-posterior change in the relationship between the maxilla and mandible; Total U6 = Total upper molar movement; Total L6 = Total lower molar movement; Total Molar = ABCH + Total U6 + Total L6, the change in the molar relationship; Total U1 = Total upper molar movement; Total L1 = Total lower molar movement; Overjet = ABCH + Total U1 + Total L1, the change in incisor relationship.



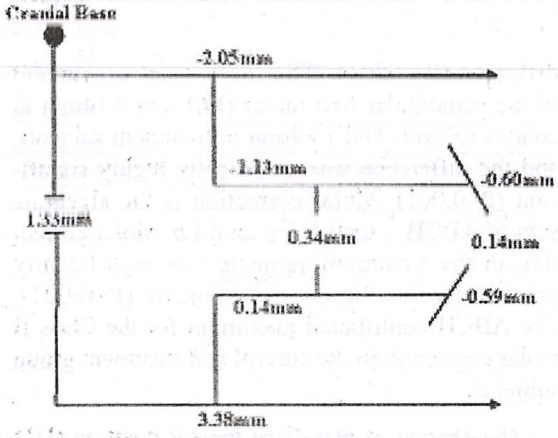


Fig-2:- Pitchfork changes in the control group subjects.

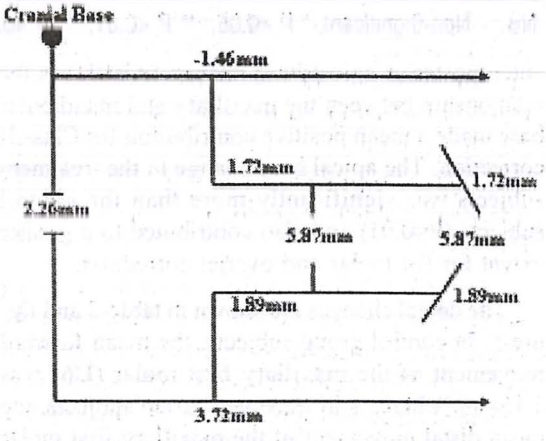


Fig-3:- Pitchfork changes in the treatment group subjects.

change (-2.05mm), and it is a good example of dentoalveolar compensation. In the treatment subjects, maxillary incisors moved 1.72mm palatally. The difference in the maxillary incisor position change between the control and treatment subjects was statistically highly significant (P<0.001). Mandibular incisors (L1) in the control subjects were uprighted 0.59mm; this was unfavorable for Class II correction. In the treatment group subjects, mandibular incisors proclined 1.89mm; and such proclination also helped the overjet correction. The difference in mandibular incisor position change between the control and treatment subjects was statistically highly significant (P<0.001). The change in overjet is the total change in maxillary and mandibular incisor relationships; it is the algebraic sum of ABCH + total U1 + total L1. Overjet correction in control and treatment subjects was 0.14mm and 5.87mm respectively. Inter-group comparison showed a statistically highly significant difference (P<0.001) in overjet correction between two groups.

Discussion

The results of the present study showed that the forward growth of the maxilla was significantly less in the treatment subjects. When the mandible was postured forward by the MPA-IV, a reciprocal force acted distally on the maxilla, thus restricting the forward growth of the maxilla. Other mandibular protraction appliances also restricted the forward growth of the maxilla.[12] Many previous studies also reported restriction in the forward growth of the maxilla with other fixed functional appliances.[14-17] However, few studies reported no effect of fixed functional appliances on the forward growth of the maxilla.[18,19]

The effect of functional appliance therapy on the mandibular growth is one of the major controversies in orthodontics. Many studies have claimed that extra mandibular growth occurs with the removable and fixed functional appliances.[6,16,20-23] In the present study MPA-IV induced only 0.34mm extra mandibular growth in the treatment group subjects. This suggested that the appliance had no effect on the extra growth of mandible. This could be because the appliance delivers an anterior force component on the mandible through the mandibular dental arch rather than mandibular skeletal base. Other mandibular protraction appliances also had no significant effect on the mandibular growth[12] and many previous studies also reported similar findings with other fixed functional appliances.[17,24,25] However, few studies reported significant increased in mandibular length with Herbst appliances[6,19,24] and mandibular anterior repositioning appliance[19].

The ABCH value represents the maxillomandibular differential, the movement of the mandible relative to the maxilla. A positive value indicates that the mandible outgrew the maxilla, and a negative value means that the maxilla outgrew the mandible. In our study the maxillomandibular differential was 1.33mm in the control subjects; 2.26mm in the treatment subjects and the difference was significant statistically. This significant maxillomandibular difference in treatment subjects could be due to the significant restriction in the forward growth of maxilla. Thus the orthopedic action of the MPA IV appliance in restricting the forward growth of the maxilla resulted greater skeletal change in the maxilla and consequently greater improvement in the Class II skeletal relationship. This observation agree with the result of other mandibular protraction appliances[12] and also with the result of many other fixed functional appliances.[14-19]

Dentoalveolar changes with fixed functional appliances have been widely discussed in the literature.[12-15,17-19,30] Distal movement of the maxillary molars or restraint of the maxillary molars as maxilla moves forward and mesial movements of the mandibular molars are ideal conditions for the correction of the Class II molar relationship. The primary change with the mandibular protraction appliances, as compared with normal growth, consisted of distalization of the maxillary dentoalveolar process.[8-12] In the present study maxillary first molars were also moved distally. Many

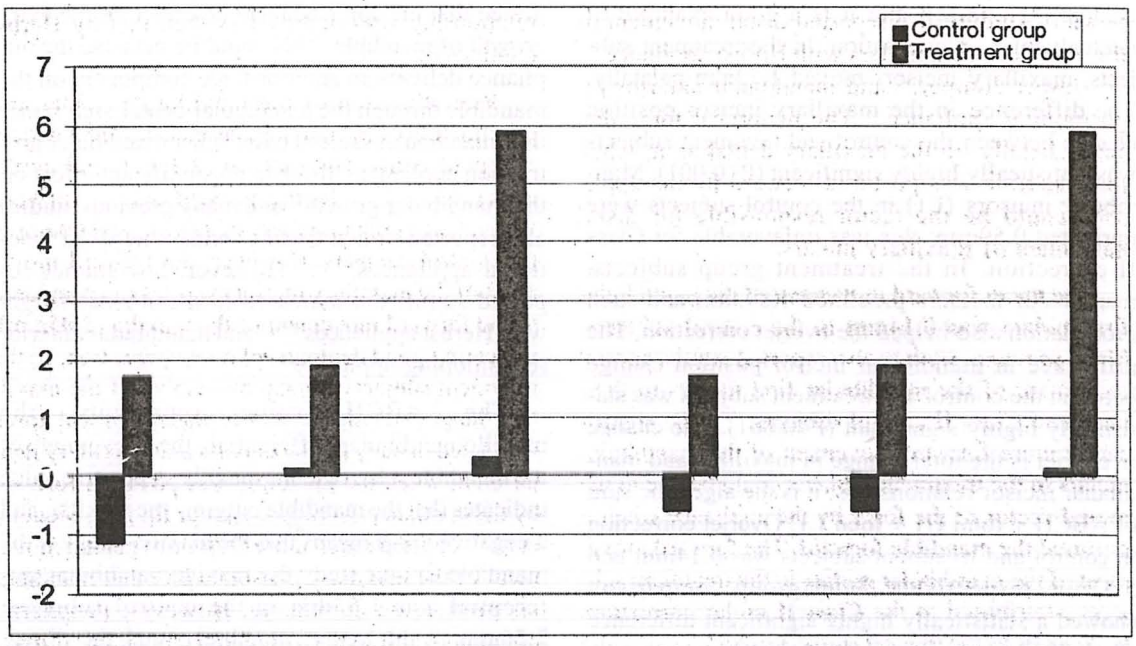


Fig 4:- Comparison of skeletal changes among control and treatment groups subjects.

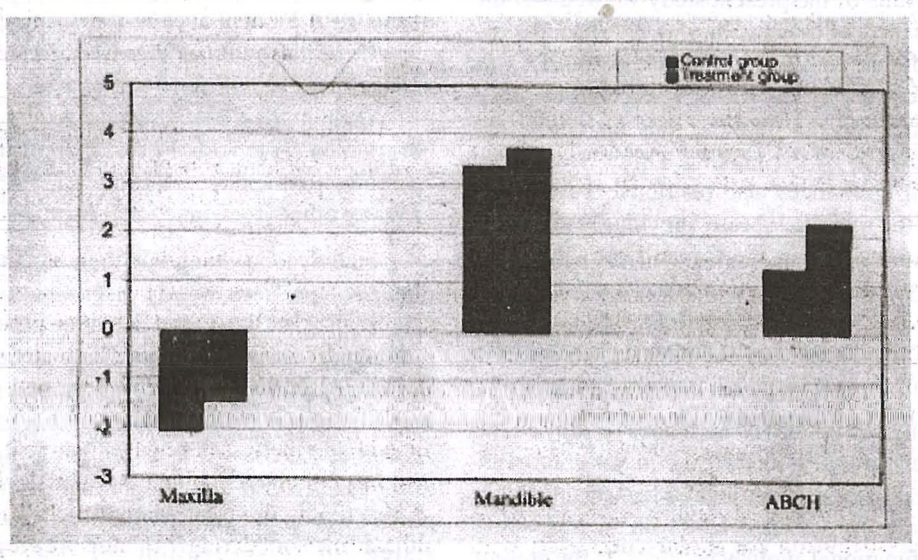


Fig-5:- Comparison of dental changes among control and treatment groups subjects.

previous studies also reported distal movement of the maxillary first molars with Herbst appliance,[14-16,18] Jasper Jumper,[17] and mandibular anterior repositioning appliance.[19] The reciprocal force that acted distally on the maxillary dental arch, when the mandible was postured forward by the appliance could be the factor responsible for distal movement of maxillary molars.

The mean forward movement of the mandibular first molars was 0.14mm in the control subjects. Many previous studies also reported similar mesial movement of the mandibular first molars in their untreated Class II control subjects.[19,27] The significantly more forward movement of the mandibular molars in the treatment subjects could be due to the mesial vector of the force by the appliance when it postured the mandible forward. The forward movement of the mandibular molars in the treatment subjects contributed to the Class II molar correction. In contrast to the present study, Siqueira et al.[12] and de Oliveira et al[17] reported slightly more mesial movement of the mandibular molars with other mandibular protraction appliances and with Jasper jumper appliance respectively. However, Pancherz[16] and Pangrazio-Kulbersh et al.[19] reported slightly less mesial movement of the mandibular molars with herbst and mandibular anterior repositioning appliance respectively. Thus the effect of mandibular protraction appliance IV on the mandibular molars was also similar to that with other fixed functional appliances.

The total molar movement (molar correction) in the treatment subjects was largely due to the dentoalveolar changes rather than apical skeletal base change. Only 38.50% of the skeletal change contributed for molar correction in the treatment group subjects. Vanlaecken et al.[14] reported 7.2mm molar correction by herbst appliance and 43.1% contributed by skeletal change. However, Pangrazio-Kulbersh et al.[19] reported slightly more (47.0 %) skeletal contribution for molar correction with mandibular anterior repositioning appliance. Thus the present study showed that the skeletal contribution of MPA IV in the correction of Class II molar relationship was slightly less than that by Herbst appliance.

Retroclination of the maxillary incisors and proclination of the mandibular incisors are a widely accepted consensus with fixed functional appliances.[12,14-17,19,24,25] In the present study, forward movement of the maxillary incisors was 0.60mm in the control subjects. However, the forward movement of the maxillary incisors was less as compared to the forward movement of the maxilla (2.05mm), indicating good dentoalveolar compensation. In the treatment subjects, palatal movement of the maxillary incisors could be due to the reciprocal force that acted distally on the maxilla and maxillary dental arch, when the mandible was postured forward by the appliance. In contrast to our finding, Siqueira et al.[12] reported much more (2.86mm) palatal movement of the maxillary incisors with other mandibular protraction appliances. However, Pancherz[16] noted no significant change in the position of maxillary incisors in the subjects treated with herbst appliance as compared to the untreated control subjects. Thus the present study showed that the palatal movement of the maxillary incisors was less as compared to the other mandibular protraction appliances[12] and also to the other fixed functional appliances.[14,16,18]

The most prominent dentoalveolar effect in the treatment subjects was proclination of mandibular incisors. This could be due to the mesial force on the mandibular incisors induced by forward posture of mandible. This finding was in accordance with the effects of similar types of functional appliances[12,16,19,23,24] We found 1.89mm proclination of the mandibular incisors in the treatment subjects during 6 months period. Panchez[16] and de Oliveira et al.[17] also reported exactly similar proclination of mandibular incisors during the treatment with herbst and Jasper jumper appliances respectively. Siqueira et al.[12] reported only 0.92mm proclination of mandibular incisors during 7 months treatment of other mandibular protraction appliances. Variations in the mandibular protraction appliance design could be responsible for such difference.

The change in overjet is the total change in incisor relationship and is the algebraic sum of the ABCH + total U1 + total L1. Mandibular protraction appliance caused a significant reduction of overjet in the treatment group subjects and the ABCH had the maximum contribution for the overjet correction. The amount of overjet correction with MPA IV was similar to the overjet correction by other mandibular protraction appliances[12] and herbst appliances[16]. In our study, the skeletal contribution for overjet correction was only 38.50%. Pancherz also reported similar skeletal contribution for overjet correction with herbst appliance.[16]

This study showed that MPA IV was an efficient fixed functional appliance in the correction of Class II molar relationship and reducing the overjet in patients with Class II Division 1 malocclusion. However, it had no positive effect on mandibular length. It caused significant effects on the mandibular and maxillary dentoalveolar components that helped in the Class II molar and overjet correction. Thus patients who can tolerate greater dentoalveolar compensation for the correction of their Class II malocclusion are best treated with mandibular protraction appliance IV.

Conclusions

The following conclusions were drawn from this present study-

1. The MPA IV appliance was efficient in restricting the forward growth of the maxilla.
2. The MPA IV had no effect on the mandibular growth enhancement.
3. The mandibular protraction appliance IV was effective in correcting the sagittal maxillomandibular skeletal difference.
4. The mandibular protraction appliance IV was efficient in correcting the Class II molar relation and overjet.
5. The mandibular protraction appliance IV was efficient in the distal movement of the maxillary dentoalveolar process and mesial movement of the mandibular dentoalveolar process.

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PROF. J.G. KANNAPPAN PASSED AWAY



Prof. J. G. Kannappan a Senior Fellow of Fauchard Academy, India section left for Heavenly Abode on Thursday the 30th December 2010. He died of heart attack.

Prof. J. G, Kannappan was born on 26th December, 1934. After schooling in rural background, he progressed steadily to take the Master's degree in Dental Surgery from Bombay University in the year 1965. Ever since 1958, he had been an astate teacher and taught students for BDS, MDS, MBBS and MSc, (Forensic Odontology) degree. He also guided M.Phil disscrtations of Madras University. He was Professor Emeritus, the Tamil Nadu Dr. MGR. Medical Univerty. He was an ardent social worker and renderd free dental care service to the people in villages in Tamil Nadu.

He held many covetable positions sush as - Principal, Tamil Nadu Govt. Dental College & Hospital, President - Tamil Nadu Dental Council, Executive committee member, Dental Council of India, President - Indian Orthodontic Society, President - Indian Society for Dental Research and had been Fellow, International Medical Sciences Academy Fellow, Pierre Fauchard Academy Fellow, (HONORIS CAUSA) Indian Board of Orthodontics.

Prof. J. G. Kannappan shall always be remembered for his commendable contributions to the dental education, research and the society at large.

May God bless his soul an eternal peace and grant courage to his hereaved family to bear this irrepairable loss.