A Comparative Cephalometric Study of Class II, Division 1 Nonextraction and Extraction Cases

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Class II, Division 1 malocclusions represent approximately fifteen to twenty percent in a general population.[1-3] Naturally, due to their often obvious skeletal and dental deviations, a greater percentage of patients with Class II, Division 1 malocclusion seek treatment, and they comprise forty-nine percent in a clinical population.[4] Consequently, clinicians are confronted more with Class II, Division 1 cases than other classes.

Numerous articles have been published to elucidate the intricacies of Class II treatment. Most studies were based on observation, evaluation, and treatment of such cases,[5-17] while others were comprised of experimental studies on animals.[18,19]

Mechanotherapy utilizing a cervical headgear is often viewed as the potentially most expedient means of treating a Class II, Division 1 malocclusion, and thus is frequently used routinely rather than discriminately. Fortunately, such mechanotherapy very often produces satisfactory results without extraction of permanent teeth. In some instances an amazing degree of correction is obtained. However, in other instances certain teeth must be removed to obtain a stable result. Obvious extraction cases involve a significant discrepancy between basal bone and the dentition or marked bimaxillary dental protrusion. Excluding such obvious cases, there are some which initially are thought to require no extraction, but during treatment an extraction procedure is required.

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Usually, correction of a Class II malocclusion with headgear therapy is obtained by a restraining effect on the growth of the maxilla, while the mandible grows to articulate with the opposing unit in a proper manner. A delicate balance of the quantity and the vector of the jaw growth, therefore, is of cardinal importance in obtaining a satisfactory result. One without the other invariably invites an inevitable extraction procedure. Questions are then raised. With which skeletal pattern can a Class II malocclusion be treated satisfactorily without extraction of teeth, and with which type of skeletal pattern would extraction of teeth be necessary?

Excluding cases with a significant crowding and/or a marked bimaxillary protrusion which would obviously require extraction, cephalometric analysis of Class II nonextraction and extraction cases reveals differences in the skeletal pattern associated with each group. A difference was particularly evident in the vertical component of the skeletal frame for each group when evaluated by means of the overbite depth indicator (ODI).[4] Similarly, in the horizontal aspect a differentiation of each group in the skeletal patterns observed was attained by means of the anteroposterior dysplasia indicator (APDI).[20] This study, therefore, was conducted to differentiate the two patterns, e.g., Class II, Division 1 nonextraction and extraction patterns by means of the ODI and APDI analysis methods.

MATERIALS AND METHOD

Thirty Class II, Division 1 cases without extraction and twenty-five Class

II, Division 1 cases with extraction were selected from the author's files. The different circumstances which these two groups presented were that both groups began treatment with a cervical headgear and full banding edgewise appliance with no intention of having extraction of permanent teeth, but the latter group later required extraction of either four first premolars or two maxillary second molars about a year after the onset of treatment because mandibular growth was not sufficient to overcome the skeletal imbalance. These two groups, therefore, were evaluated to determine differences of cephalometric skeletal patterns. The evaluation was obtained by means of the overbite depth indicator (ODI) for the vertical component and the anteroposterior dysplasia indicator (APDI) for the horizontal component.

The ODI[4] is a resultant angular reading obtained from the angle of the A-B plane to the mandibular plane plus or minus the palatal plane angle in relation to the Frankfort horizontal plane. When the palatal plane relates to the Frankfort plane in an upward and forward fashion, the angle obtained is considered negative. Conversely, if the plane slopes downward and forward, it is read as a positive angle. To obtain the ODI reading the figure of the palatal plane angle is either subtracted from or added to the angle of the A-B plane to the mandibular plane depending on whether the reading is positive or negative.

The APDI[20] is also a resultant angular reading obtained from the facial plane angle in relation to the Frankfort horizontal plane plus or minus the A-B plane angle, and plus or minus the palatal plane angle.

The means, standard deviations, and t tests on the ODI, the APDI, and the patient's ages of the pretreatment, posttreatment, and the follow-up observations were tabulated. Also, the mean values of the ODI and the APDI were plotted on the X-Y coordinates to observe their significant differences.

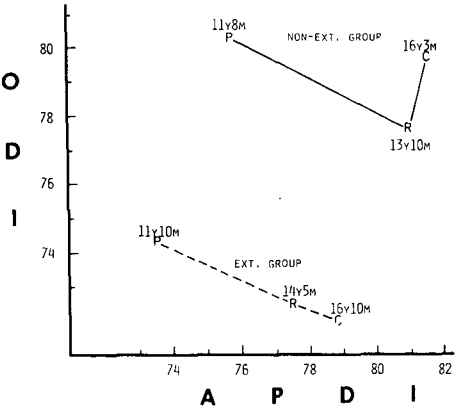

Fig. 1 A graphic summary on comparisons of ODI and APDI values on Class II, Division 1 nonextraction and extraction cases. The two groups are significantly separated by the means of ODI measurement. The APDI measurements are also found lower in the extraction group. P. The mean at pretreatment period. R. The mean at onset of retention period. C. The mean at completion of follow-up period.

Results

Pretreatment evaluation (Fig. 1):

Statistical tabulations of the ODI values on the nonextraction group showed the mean of 80.32 degrees while the extraction group showed 74.34 degrees. The difference that existed between these two means was computed as significant at the one percent level of confidence according to the t test (Table I).

The means of APDI were 75.62 degrees for the nonextraction group versus 73.72 degrees for the extraction group. The mean difference of the groups was shown at the five percent level of significance (Table II).

The mean ages at the time of pretreatment evaluation differed only two months at 11 years and 8 months for the nonextraction group and 11 years

TABLE I

Comparisons of ODI Values on Class II, Div. 1 Nonextraction and Extraction Cases

	Mean	S.D.	S.E.	t
Pretreatment ODI				
Nonext.	80.32	4.46	0.81	4.95*
Ext.	74.34	4.45	0.89	
Posttreatment ODI				
Nonext.	77.60	4.01	0.73	4.19*
Ext.	72.42	5.17	1.03	
Follow-up Observation ODI				
Nonext.	79.62	4.16	0.76	6.01*
Ext.	72.04	5.19	1.04	

N = 30, nonextraction
N = 25, extraction
* = significant at one percent level.

TABLE II

Comparisons of APDI Values on Class II, Div. 1 Nonextraction and Extraction Cases

	Mean	S.D.	S.E.	t
Pretreatment APDI				
Nonext.	75.62	4.21	0.77	1.82**
Ext.	73.72	3.35	0.67	
Posttreatment APDI				
Nonext.	80.90	3.42	0.62	3.36*
Ext.	77.46	4.17	0.83	
Follow-up Observation APDI				
Nonext.	81.42	3.58	0.65	2.63**
Ext.	78.78	3.86	0.77	

N = 30, nonextraction
N = 25, extraction
* = significant at one percent level.
** = significant at five percent level.

and 10 months for the extraction group. The difference according to the t test showed no significance (Table III).

Posttreatment evaluation (Fig. 1):

The ODI means at the end of active treatment were 77.60 and 72.42 degrees for the nonextraction and the extraction groups, respectively. The difference between the two means was tabulated as significant at the one percent level of confidence. When the means of pretreatment and posttreatment values were compared, both groups showed a slight drop in the ODI figures (Table I).

TABLE III

Treatment Age Comparisons on Class II, Div. 1 Nonextraction and Extraction Cases

	Mean	S.D.	S.E.	t
Pretreatment				
Nonext.	11Y8m	1.11	0.20	0.52
Ext.	11Y10m	1.07	0.22	
Posttreatment				
Nonext.	13Y10m	1.07	0.19	2.04*
Ext.	14Y5m	0.95	0.67	
Follow-up Observation				
Nonext.	16Y3m	1.11	0.20	2.11*
Ext.	16Y10m	1.17	0.23	

N = 30, nonextraction
N = 25, extraction
* = significant at five percent level.

The APDI mean values were 80.90 and 77.46 degrees for the nonextraction and the extraction groups, respectively. The pretreatment and posttreatment values were found to show a considerable increment of 5.28 degrees for the nonextraction group, while the extraction group increased 3.74 degrees (Table II).

The mean ages at the posttreatment period were 13 years and 10 months for the nonextraction group and 14 years and 5 months for the extraction group indicating that treatment took about two years for the former and about two and a half years for the latter. This difference was found significant at the five percent level of confidence (Table III).

Follow-up evaluation (Fig. 1):

Follow-up observations were made on the average of 2 years and 5 months after treatment for both groups at the mean ages of 16 years and 3 months and 16 years and 10 months for the nonextraction and the extraction groups, respectively. Again the difference between the two means was significant at the five percent level (Table III).

The ODI value in the nonextraction group was found to return toward the initial value from 77.60 degrees at the posttreatment to 79.62 degrees at the follow-up observation period. On the other hand, the ODI in the extraction group showed a slight drop in the mean values by 0.38 degrees from a reading of 72.04 degrees (Table I).

The mean APDI values in both groups showed a slight increment of 0.52 degrees for the nonextraction group, and 1.34 degrees for the extraction group. Their means were 81.42 and 78.78 degrees, respectively. The mean difference was computed as significant at the five percent level (Table II).

Discussion

Statistical evalutions of the groups verified that both the ODI and the APDI were significantly lower in the extraction group. Therefore, it is reasonable to state that the higher the ODI and the APDI values a case possessed, the lesser the incidence of extraction of permanent teeth; conversely, the lower the ODI and APDI values, the greater the likelihood of extraction. The figure of ODI, in particular, was much lower in the extraction group. This seems to suggest that not only is the horizontal component of the skeletal pattern an important aspect to consider, but the vertical component is an even more sensitive dimension to consider for diagnosis and treatment planning.

In a previous study it was found that the higher the ODI value an individual possessed, the greater the probability that a deep overbite existed. The advisability of extraction lessened as the ODI increased.[4] Conversely, the lesser the ODI value a person presented, the greater the chance an open bite or an open-bite tendency was present increasing the probability of extraction procedures. The mean ODI value in the normal population was 74.7 degrees with a correlation coefficient value of 0.588 which was found to be the highest among many measurements tested.[4] In a similar manner a large sample (874 cases) of the malocclusion population was studied. The findings indicated that the greater the value of the APDI away from the mean a patient possessed, the greater the frequency of mesioclusion. Conversely, the lesser the APDI figure from the mean a case presented, the greater the incidence of distoclusion.[20] The mean value of the APDI in the normal population was 81.4 degrees. The correlation coefficient value was 0.643, and was found to be the highest among a number of measurements tested.[20]

The present study corroborates the findings of the ODI and APDI studies. It demonstrates that cases with high ODI values did not warrant extraction of permanent teeth. Treatment efforts to conserve the full complement of teeth were successful. On the other hand, in cases with lesser ODI values, inevitable extraction of permanent teeth was involved to obtain a satisfactory result with subsequent stability. Low ODI in a Class II malocclusion, in general, is indicative of a skeletal pattern with a steep mandibular plane angle and/or a negative palatal plane angle. This type of skeletal pattern usually produces a considerable amount of mesial component of force. In such cases the axial inclinations of the permanent teeth are usually mesial. This, in turn, creates a condition that is difficult to treat. It is because of this reason that extractions are warranted in low ODI cases.

The following three cases demonstrate the interpretation of the ODI and the APDI as adjuncts to cephalometric differential diagnosis. In Figure 2A (patient R.S.), a pretreatment cephalometric analysis indicates that the girl, 10 years and 8 months old,

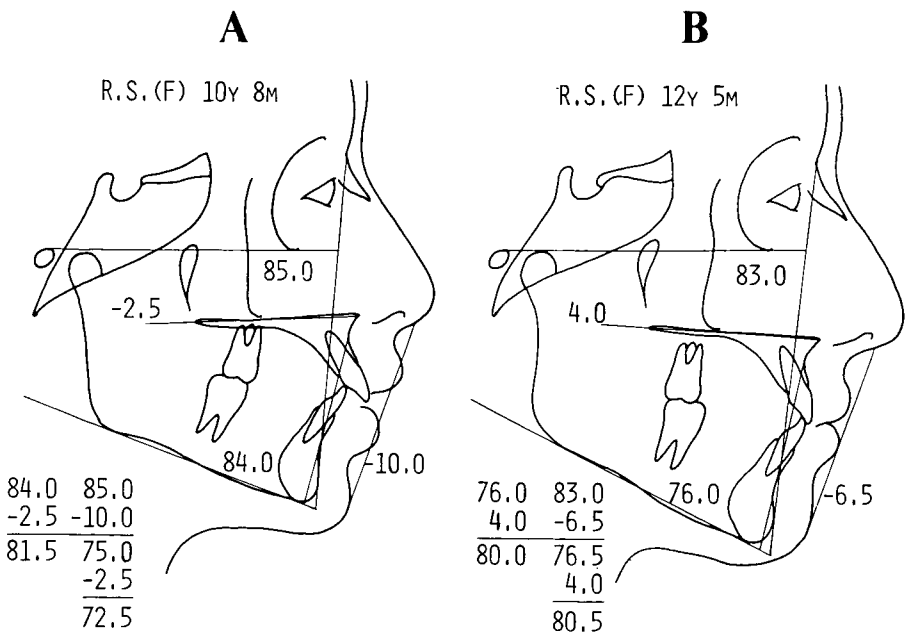

Fig. 2 A. Patient R.S., a 10 year, 8 month old girl, with a Class II, Division 1 malocclusion. B. The posttreatment tracing. No extraction was performed. An excellent result was achieved with full treatment along with headgear therapy.

possesses a moderate Class II, Division 1 malocclusion with a deep overbite and a moderate bimaxillary protrusion. After a treatment period of less than two years with a cervical headgear and full banding, an excellent result was achieved along with marked improvement in facial esthetics (Fig. 2B). The initial APDI was considerably low at 72.5 degrees to designate the case as a skeletal Class II pattern in the horizontal aspect. Vertically, the ODI showed 81.5 degrees suggesting a deep overbite pattern. At the end of treatment the ODI figure dropped a degree and a half to 80 degrees while the APDI figure improved eight degrees to 80.5 degrees. This youngster has shown an appreciable amount of mandibular growth. The palatal plane dropped downward and forward by 6.5 degrees. The facial plane angle was reduced by two degrees to 83 degrees while the mandibular plane increased by two degrees to 22 degrees. The A-B plane angle was improved from minus 10 to minus 6.5 degrees while the ANB angle dropped from 6 to 3.5 degrees. Initial ODI and APDI figures supplemented other diagnostic criteria to confirm the advisability of attempting nonextraction treatment which produced an excellent and stable result.

At the age of 13 years and 1 month, a female patient (K.T.) was transferred to the author's office. Her occlusion was in a cusp-to-cusp relationship with a moderate bimaxillary protrusion (Fig. 3B). Initially, the patient had a Class II, Division 1 malocclusion with an insignificant amount of crowding in both arches (Fig. 3A). The original treatment plan was to attempt a nonextraction procedure utilizing cervical headgear mechanotherapy. However, the use of a headgear for a period of ten months produced no improvement to ensure a good prognosis. Cephalometric analysis revealed that the skeletal pattern was poor in both horizontal

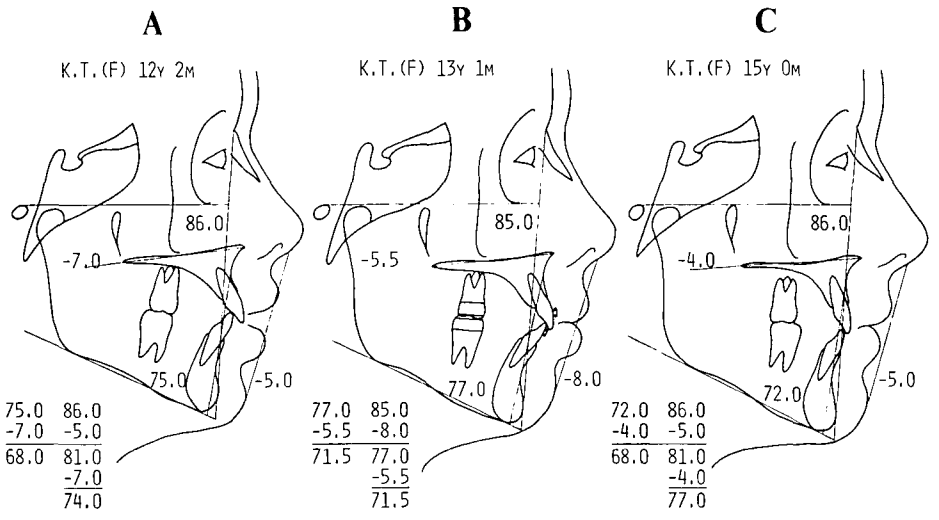

Fig. 3 A. Patient K.T., a 12 year, 2 month old girl with a Class II, Division 1 malocclusion. B. No improvement was produced despite headgear therapy for a period of a year. Therefore, the four first premolars were removed to achieve a satisfactory result. C. The posttreatment tracing shows appreciable improvement in occlusion and facial esthetics.

and vertical components. The ODI of 68 degrees certainly was indicative of a lack of harmony in the vertical component suggesting a strong bite-opening tendency. The APDI was also very low at 74 degrees indicating that the case possessed a definitive Class II skeletal pattern. This case, therefore, warranted the extraction of four first premolars with headgear support. After almost two years of treatment since the extraction, the dentition was finally brought into a more functional and stable occlusion (Fig. 3C). The ODI readings showed no change from the initial value to the posttreatment value. An improvement of only three degrees of the APDI, from the initial 74 to 77 degrees of posttreatment value, was observed. The level of a posttreatment APDI at 77 degrees, however, certainly could not ensure the stability of occlusion unless a certain compromise was made. In this case the extraction of premolars was the compromise.

A tracing of another Class II, Division 1 malocclusion with no crowding in either arch is shown in Figure 4A. Cephalometric analysis on this 11 year and 4 month old boy revealed that, in most respects, the treatment plan would not warrant extraction of permanent teeth if the headgear therapy could be successful. The initial treatment plan, however, was incorrect. The ODI was at 69 degrees and an open-bite tendency was present. After a year and a half of treatment with a high-pull headgear and full banding edgewise appliance, the occlusion developed into an anterior open bite with the molars still in a cusp-to-cusp relationship (Fig. 4B). The palatal plane is sloped upward and forward by minus five degrees. Consequently, a deficient posterior vertical dimension existed for the maxillary second and third molars. Therefore, since the third molars appeared well-formed and positioned favorably, the maxillary second molars were extracted. Only ten months after the extraction, a satisfactory occlusion was obtained (Fig. 4C). Mechanically, Class II and anterior vertical elastics were utilized to correct this malocclusion. In retrospect, appreciation of the

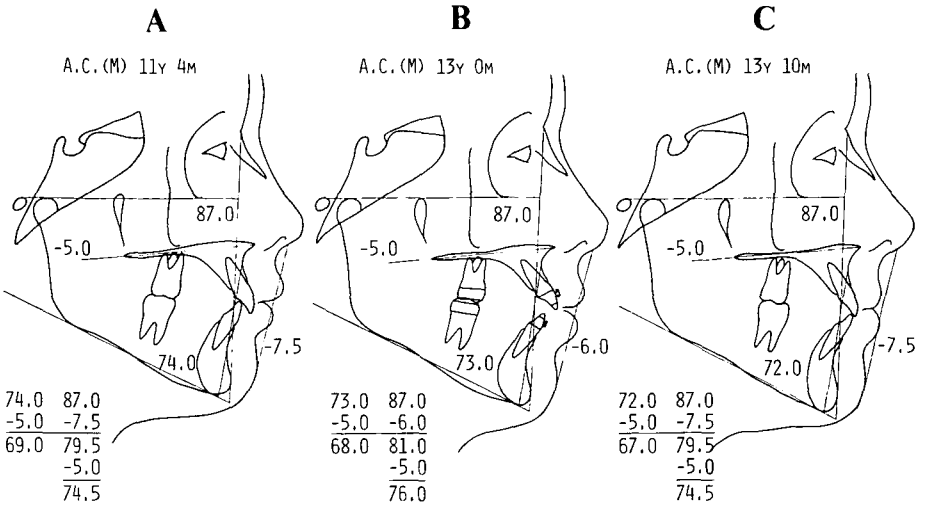

Fig. 4 A. Patient A.C., an 11 year, 4 month old boy with a Class II, Division 1 malocclusion. B. An 18 month treatment with edgewise appliances and a high-pull headgear resulted in an open bite. The maxillary second molars were removed to obtain a stable occlusion. C. The posttreatment tracing, ten months after the extractions.

negative palatal plane as a significant differential diagnostic criterion, as reflected in the ODI computation, would have been appropriate in the initial treatment plan.

The initial ODI figure usually fluctuates a few degrees after active treatment. In most cases it decreases a few degrees. In other words the value of a patient's ODI cannot be readily increased toward the statistical norm if it is low. A malocclusion of a patient must be corrected to suit that particular patient and not the statistical mean when dealing with the vertical component. Quite contrary to the fact is that a value of the APDI is readily changeable with growth after treatment. In fact, the skeletal pattern, expressed in terms of the APDI values, must be changed toward the statistical norm to obtain a stable result. The closer the APDI figure approached the normal mean, the greater the prospect of a stable result. In this respect an improvement of an APDI value is possible during the growth period with headgear therapy. However, the vertical dimension, expressed in terms of the ODI figure, has to be sufficiently higher than the norm to accommodate a full complement of teeth. If an APDI reading is lower than the norm, extraction of certain teeth is usually inevitable. In cases of older teenagers or adults with Class II malocclusion where no growth of the mandible remains, the alteration of the skeletal pattern by means of headgear therapy is extremely difficult or impossible. The treatment in such incidences must involve strategic removal of certain teeth to ensure the stability of occlusion.

Summary and Conclusions

1. Cephalometric tracings of thirty Class II, Division 1 cases without extraction and twenty-five Class II, Division 1 cases with extraction were evaluated and statistically compared by means of the overbite depth indicator (ODI) and the anteroposterior dysplasia indicator (APDI).

2. The mean ODI in the nonextraction group, in particular, was significantly higher than that of the extraction group.

3. Three clinical examples were presented to demonstrate the values of ODI and APDI as adjuncts to cephalometric differential diagnosis.

4. With respect to the vertical component it may be concluded that the lower the ODI value from the normal mean a case presents, the greater the incidence of an extraction procedure as a compromise for the poor skeletal pattern.

5. With respect to the horizontal component the initial APDI reading indicates the severity of skeletal discrepancy. When the posttreatment APDI reading falls below the normal mean, a relapse is probable: the lower the figure a case possesses, the greater the chance of relapse. In such incidences an extraction procedure must be provided to ensure the stability of occlusion.

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