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ABSTRACT

A STUDY OF DEEP OVERBITE CORRECTION WITH LINGUAL ORTHODONTICS

by

Randall K. Bennett

The purpose of the present study was to cephalometrically evaluate the bite plane effect associated with deep overbite correction in cases treated exclusively with the Ormco-Kurz™ lingual orthodontic appliance, and to evaluate whether differences existed between dolichofacial and brachyfacial facial types. Variables involved in the bite plane effect; incisor intrusion and proclination, as well as molar extrusion and mandibular rotation were measured. Fifty-nine cases were evaluated by means of computer digitized tracings of pretreatment and posttreatment lateral cephalograms. Mandibular incisor proclination of 4.5 degrees, mandibular incisor intrusion of 2.3 mm, lower anterior facial height opening of 1.3 mm and maxillary incisor intrusion of 1.2 mm all contributed to correction of the deep anterior overbite. No significant differences existed between dolichofacial and brachyfacial facial types for any of the variables measured.

Key words: Lingual orthodontics, deep overbite, bite plane effect, intrusion.

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A STUDY OF DEEP OVERBITE CORRECTION WITH LINGUAL ORTHODONTICS

by

Randall K. Bennett

A Manuscript submitted in Partial Fulfillment of the Requirements for the Degree Master of Science in Orthodontics

June 1988

Each person whose signature appears below certifies that this manuscript in his/her opinion is adequate, in scope and quality, in lieu of a thesis for the degree Master of Science.

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I also wish to give special recognition to Dr. Craven Kurz, for his generosity and expertise.

A very special "thank you" goes to my beautiful wife Shelley, for her assistance and patience.

INTRODUCTION

Studies in recent years have indicated that the percentage of adults seeking orthodontic treatment is steadily increasing[18-21]. Breece and Nieberg[6] concluded that the primary reason that adults do not seek orthodontic treatment is the embarrassment of wearing "braces" that are visible. The need for a truly esthetic orthodontic appliance led Dr. Craven Kurz to begin experimenting with lingually bonded brackets in 1973. The development and refinement of the lingual orthodontic appliance has occurred since that time through the efforts of Dr.C. Kurz, Dr.M. Alexander, Dr.R. Alexander, Dr.K. Fujita, Dr.J. Gorman, Dr.J. Hilgers, Dr.V. Kelly, Dr.R. Scholz and Dr.J. Smith, as well as many others. The lingual orthodontic appliance enjoyed popularity in the early 1980's, but that popularity has decreased in recent years, due in part to the inherent difficulty of treating patients from the "lingual".

Articles have been written on the characteristics of the the lingual orthodontic appliance, and several studies on its treatment effects have been carried out[71-95].

One of the lingual orthodontic appliances is the Ormco-Kurz™ lingual appliance which incorporates a bite plane on the maxillary anterior brackets that is parallel to the occlusal plane and archwire. Clinically, it creates immediate disclusion of the posterior teeth through a bite plane effect which is of importance in opening a deep anterior overbite[82]. The direction of incisal biting force on the anterior bracket bite plane results in a compressive rather than a shearing force being placed on the bracket which serves to aid in keeping the bracket bonded to the tooth.

One of the many challenging objectives in the treatment of malocclusion is the correction of excessive anterior overbite[7,36,38,61].

The tooth movements which may be utilized to level the arches and reduce the deep overbite are: 1) extrusion of premolars and molars, which is associated with a clockwise opening rotation of the mandible; 2) intrusion of the incisors, which is not associated with rotation of the mandible; 3) labial proclination of the incisors, which is not associated with rotation of the mandible; 4) a combination of the above movements[17].

The objectives of this study were to cephalometrically evaluate the bite plane effect and various tooth movements associated with deep overbite correction in cases treated exclusively by means of the Ormco-Kurz™ lingual orthodontic appliance, and also, to evaluate whether differences in overbite correction existed between the dolichofacial and brachyfacial facial type patterns. This was to be accomplished by quantitatively measuring 1) overbite correction, 2) incisor intrusion, 3) incisor proclination, 4) molar extrusion and 5) mandibular rotation.

LITERATURE REVIEW

The etiology of deep anterior overbite has been discussed in the past with infraclusion of posterior teeth suggested as the primary cause by some authors [7,16,24,29,50] and supraclusion of anterior teeth by others[31,32,44,69]. Some authors propose both posterior tooth infraclusion and anterior tooth supraclusion as contributory factors in the development of an excessive anterior overbite[28,38,55,61,63]. The characteristics of and ideal overbite have also been discussed in past literature[40,56,57].

Frequent indications for the correction of excessive anterior overbite are aesthetic reasons, periodontal damage, functional disturbances and growth inhibition of the mandible in Class ll division 2 malocclusions[14]. A deep anterior overbite may be corrected by a variety of methods. Hunter in 1771, Fox in 1883, Quimby in 1883 and Bonwill in 1889, all described various forms of biteplates to unlock the occlusion[66]. Kingsley is generally credited for introducing the biteplate to American dentistry in 1876 [54]. Ainsworth[1], Grieve[25] and Guilford[26] used inclined planes attached to incisor bands to correct deep anterior overbites. Jones[33] Steadman[57] and Strang[61] advocated a multi-banded technique.

The effect of the biteplate on the dentition has been controversial in past literature. Some authors have concluded that overbite correction with a removable bite plate was achieved primarily by means of posterior molar extrusion[2,4,27,54].

Others have concluded that intrusion of the incisor teeth accompanied correction of the overbite[38,69]. Both anterior intrusion and posterior extrusion have been reported by others[8,11,57,60].

The topic of intrusion has received considerable attention in past literature. Steigman and Michaeli[58] state that the dispute about the possibility of active intrusion of teeth is now a thing of the past. Intrusion has been both observed and measured by many authors[7,13,34,35,46,59]. Graber[22] however, suggests that most observed clinical incisor intrusion is actually "holding" of the incisors and eruption of the posterior teeth.

The means by which intrusion is achieved has been controversial as well. Graber[22] states that an extremely strong force is required to intrude teeth; force sufficient to tear and unsplice fibers as well as rupture blood vessels. In contrast, another text edited by Graber[23] states that more rapid intrusion is obtained by light forces. Ricketts[49], Burstone[7] and Thurow[65] all suggest that intrusion is best accomplished by very light continuous forces.

The relationship between overbite correction and incisor flaring or proclination has been discussed previously[10,39,46,65]. Burstone[7] states that labial proclination or "pseudo intrusion" of the incisors is often mistaken for intrusion. Labial tipping of the incisors lowers the incisal edge of the tooth relative to the occlusal plane and can be mistaken for actual apical movement of the root of the tooth.

The characteristics of different facial types have also been addressed in the literature. Biomechanical, morphologic and physiologic differences have been observed between the high mandibular plane, skeletal open bite, dolichofacial growth patterns and the low mandibular plane, skeletal closed bite, brachyfacial patterns [5,45,48,49,51,52,64,70]. Ricketts[49] states that the short anterior vertical facial height patient would benefit best from mandibular rotation in correcting a deep anterior overbite. However, the strong muscular function of the brachyfacial patient resists molar extrusion and the accompanying mandibular rotation. Even though treatment may allow some mandibular rotational opening, a return to the original facial height is usually seen.

Ricketts[49] and Burstone[7] state that mandibular rotation is undesirable in the long anterior facial height type patient because the already excessive facial height is increased further. As well, the antero-posterior discrepancy between maxilla and mandible in a Class II relationship is worsened. Nanda[42] and Porter[47] recommend that extrusion of molars be avoided in order to improve stability of the overbite correction. Bite opening by incisor intrusion is often the recommended treatment in the correction of deep overbite[7,49].

Many refinements in the lingual orthodontic technique have been made which now allow the clinician to achieve excellent results in the treatment of malocclusion. Lingual orthodontic brackets are routinely bonded indirectly to the teeth which has greatly simplified bracket placement. Even though simplified archwire sequencing and newer instrument designs have streamlined the lingual orthodontic technique, many practitioners are reluctant to incorporate it into their practices. Some of the reasons may be the difficulty treating cases with a lingual appliance, the difficulty of incorporating "lingual" in an established "labial" practice, and a previous negative experience in the developmental years of the lingual appliance.

The first generation of lingual orthodontic brackets were contraindicated for deep overbite cases as the brackets would shear off from anterior occlusal forces. Dr. Kurz then incorporated a bite plate into the maxillary anterior brackets which placed a compressive force on the brackets when under occlusal loading and served to minimize the problem of anterior brackets shearing off the tooth surface[85]. Stronger adhesives have virtually eliminated premature debonding of anterior or posterior brackets and most cases can be successfully bonded and treated with bonds rather than bands on both the first and second molars. The bite plate also helped to immediately disclude the posterior teeth and open the bite, which made the anterior lingual bracket an indication for excessive anterior overbites.

METHODS AND MATERIALS

Lateral cephalometric pretreatment and posttreatment radiographs of 100 nonextraction deep overbite cases treated exclusively with the Ormco-Kurz™ lingual appliance and continuous archwires were retrieved from the records of Dr. Craven Kurz in Beverly Hills, California. Fifty-nine of these cases met all of the following criteria and were used in the study:

1. Cases selected were of nongrowing adult patients who did not exhibit any visible cephalometric facial growth during treatment.
2. Cases were selected on the basis that they exhibited at least three millimeters of overbite correction between pretreatment and posttreatment radiographs.
3. Cases selected for this study had no particular intrusive mechanics employed other than the bite plate incorporated in the maxillary anterior lingual brackets. No sectional or segmented arch mechanics were employed and neither reverse nor accentuated curves were placed in the archwires to help open the bite.
4. Cases selected had all incisors present with no history of trauma to the incisors and no cosmetic alteration to the incisal edges during treatment.
5. Cases selected exhibited clear pretreatment and posttreatment lateral cephalograms which were taken on a Quintsectograph 200* using a standardized target to subject midsaggital plane distance of 152.4 cm (5 feet) and a subject to film distance of 15.5 cm.

The coordinates for each landmark were recorded with a Scriptel SPDseries model 1212T digitizer* interfaced with a Macintosh SE* computer on-line during the measurement process utilizing a modified Quick Ceph™96 * software program. Data was then transferred to a Statistics Package for the Social Sciences (SPSS) program for data analysis. (* see Appendix)

Tracings were digitized by a single investigator. Superimpositions were carried out according to the recommendations for ABO certification. Pretreatment cephalometric landmarks were identified and digitized on a T1 acetate template to produce a T1 tracing. After the T1 template was superimposed on point Sella, point Nasion and the anterior cranial base structures of the T2 radiograph, the posttreatment cranial and maxillary skeletal landmarks were digitized. The T2 mandibular skeletal landmarks were located and digitized after superimposing the T1 template on the T2 mandibular symphysis, lower border and ramus. Posttreatment dental landmarks were finally digitized.

Landmark identification and digitizing errors were determined statistically by tracing the same radiograph three different times at each tracing session. The standard deviations for each measurement were averaged giving a mean angular measurement error of ± 0.60 degrees with a range of ±0.35 - ±0.75 degrees and a mean linear measurement error of ±0.40 mm with a range of ±0.35 - ±0.50 mm.

Twenty-eight cephalometric landmarks were digitized on each tracing[96]. A user defined analysis was then defined on the Quick Ceph™ program to create twenty-three measurements to facilitate quantitative interpretation.

Facial type was determined by using four of the angular measurements used in the Rickett's Analysis[49]. The number of standard deviations from the norms for Lower Facial Height (LFH), Mandibular Arc (MA), Mandibular Plane (MP), and Facial Axis (FA) for adult nongrowing male and female patients were averaged to give a numerical facial type index number. Patients with an index number value more negative than -1.50 were classified as severe dolichofacial, between - 1.49 and 0.00 as mild dolichofacial, between 0.00 and+1.49 as mild brachyfacial, and greater than +1.50 as severe brachyfacial. The range of index numbers was from -3.06 to +2.41.

Changes for the entire sample were evaluated and comparisons were then made between the total dolichofacial and total brachyfacial subgroups, as well as between severe dolichofacial, mild dolichofacial, mild brachyfacial and severe brachyfacial subgroups.

Intrusion for the purposes of this study was defined as the movement of the centroid of the root in an apical direction along the original long axis of the tooth. The geometric center of the root or centroid was selected because this is the theoretical point around which labial or lingual tipping would occur during intrusive movement[7]. As this was a retrospective study with unknown variables such as force magnitude and duration, moment to force ratios, etc., a theoretical centroid location was felt to be acceptable. A point 16 mm from the maxillary incisal edge and 14 mm from the mandibular incisal edge was selected as the theoretical centroid position based on average tooth and root lengths[12,30]. Intrusion values were obtained by measuring the distance between the pretreatment centroid position and the posttreatment centroid position along the pretreatment long axis by means of trigonometry formulas programmed into the software as illustrated in the appendix. It should be noted that this method of calculating intrusion along the pretreatment long axis of the incisor will often give different intrusion values than measuring vertically from centroid, perpendicular to a given plane. We felt that pure intrusion was better defined as the apical movement of the incisor along it's long axis.

Cases were classified by sex, age in months, treatment time in months, Angle classification, and facial type index number. Means and standard deviations for each measurement were calculated for the total group and each of the subgroups, including total dolichofacial, total brachyfacial, severe dolichofacial, mild dolichofacial, mild brachyfacial, and severe brachyfacial.

A student's t-test was performed on all treatment change means to determine which changes were significantly different from zero. Correlation coefficients were calculated for each variable combination to determine whether significant relationships existed between variables. ANOVA (Analysis of Variance), was performed to evaluate and determine significant differences between the total dolichofacial and total brachyfacial groups. ANOVA was also carried out to evaluate differences between the four subgroups. ANOVA was then carried out to determine which factors were significantly responsible for overbite change.

Finally a stepwise multiple regression was performed to determine which variables were most important in effecting overbite change. It should be noted at this point that any retrospective clinical study by nature is hampered by unrecognized and unmeasured variables that may act as confounders and that the significance or insignificance of results for groups of small sample size may or may not be valid. Due to the number of statistical tests being done in this study, even though the alpha level $< .05$ is controlled for each test individually, it is not controlled when simultaneously looking at multiple tests. Thus, emphasis should be placed on general trends and patterns.

RESULTS

The sample which was comprised of 19 males and 40 females is listed in Table I by sex and Angle classification for the entire group as well as each subgroup.

Table II lists the mean ages and treatment times for the sample. The mean age for the total sample was 29 years 8 months with a female age range of 18 years 3 months to 52 years 6 months, and a male age range of 19 years 1 month to 36 years 9 months. As can be seen from the table the ages were consistent with those expected for non-growing patients. The mean treatment time for the sample was 25 months with a range of 7 to 39 months.

Table III lists the T1 and T2 mean values for each variable. Table IV lists the mean changes as well as t-test significance for each variable. Results in Tables III and IV show:

1. Overbite change of at least 3 mm occurred for each patient. A mean overbite correction of 4.9 mm was noted for the total group with a range of 3.0 to 12.8 mm. A mean overjet correction of 2.0 mm occurred with a range of -7.6 to +5.2 mm. Both overbite and overjet change were highly significant at $p < .001$.
2. Intrusion of the mandibular incisors was significant for all groups. Intrusion of maxillary incisors was significant for all groups except the severe dolichofacial subgroup. The mandibular intrusion values are roughly double that of the maxillary. These values do not necessarily represent maximum incisor intrusion or mandibular rotation values as radiographs taken were at the end of treatment and not after the initial 3 - 6 months of treatment when maximum intrusion and rotation may have occurred .

3. Angular measurements for mandibular rotation (LFH, MP and FA) as well as the linear measurement for mandibular rotation (Lower Anterior Facial Height-LAFH) show an autorotation of the mandible which is insignificant for the severe dolichofacial and severe brachyfacial subgroups and significant for the other subgroups. No subgroup exhibited significant molar extrusion of both maxillary and mandibular molars.
4. Upper incisor proclination did not change significantly in any of the groups. Lower incisor proclination was significant for all but the severe dolichofacial and severe brachyfacial subgroup. The interincisal angle was within a range of normal at the end of treatment for all groups.

Table V displays correlation coefficients for variables of interest in this study. No correlation was found between facial type index number and intrusion, molar extrusion, mandibular rotation, overbite change, overjet change, incisor proclination or interincisal angle change. There was no correlation found between overbite change and incisor intrusion or molar extrusion. Negative correlations existed between maxillary and mandibular incisor intrusion and mandibular rotation. Specifically, as LFH and LAFH changes occurred that rotated the mandible open, the amount of intrusion achieved decreased. A positive correlation existed between mandibular first molar extrusion and LAFH change, in that as the molar extruded the anterior facial height increased.

ANOVA was performed to evaluate the differences between groups. No significant differences were discovered between any of the groups for any of the treatment changes being observed. Thus, there was no significant difference between any of the groups with regard to incisor intrusion or proclination, mandibular rotation, molar extrusion, overbite, overjet, or interincisal change. The groups were all significantly different with regard to pretreatment facial type index variables [LFH, MP, MA and FA] as well as LAFH.

A general linear hypothesis was performed with an analysis of variance to determine which variables were significant in determining overbite change. Intrusion of both upper and lower incisor, proclination of the lower incisor and mandibular rotation were all factors in the overbite change observed in this sample. The data was then subjected to a stepwise multiple regression analysis which indicated that the most important factor in overbite change was lower incisor proclination, followed in importance by mandibular incisor intrusion, mandibular rotation and finally maxillary incisor intrusion.

DISCUSSION

The purpose of this study, as already mentioned, was to examine factors leading to overbite correction in cases treated with a fixed lingual appliance and to determine if differences in the observed changes existed between facial types.

In achieving overbite correction this study shows that the mean interincisal angle for the total group and each of the subgroups was in the range of normal before treatment with the exception of the severe brachyfacial group which had a higher mean interincisal angle than normal of 138.3 degrees. The severe dolichofacial group exhibited the lowest mean pretreatment interincisal angle of 125.2 degrees. Each of the groups were treated to a normal interincisal angle range of 125 - 131 degrees. No significant upper incisor proclination change was observed, however statistically significant proclination of the lower incisor was observed. Thus, on the average, even though the lower incisor was proclined, the resultant interincisal angle was within a normal range after treatment. The groups with greater average lower incisor to mandibular plane angles were the brachyfacial patients[74]. Mean posttreatment interincisal angles were generally less obtuse than pretreatment interincisal angles which may lead to less posttreatment relapse of the deep overbite according to Schudy[53] and Strang[62].

Burstone[7] states that labial tipping of an incisor around its centroid produces pseudo-intrusion. Although the pseudo-intrusion helps correct the deep overbite, it is often confused with genuine apical movement of the tooth along it's long axis. Intrusion in this study was measured along the long axis but the proclination of the incisor was taken into account in order to eliminate a pseudo-intrusion measurement. Quantitative intrusion values may be inaccurate in studies which measure intrusion along the long axis without accounting for angular changes of the incisors[7,10,46].

The method used to measure intrusion in this study is shown in the appendix. Significant mean intrusion values were observed for the mandibular incisor for all groups. Significant intrusion of the maxillary incisor was observed for all except the severe dolichofacial group. It may be that the smaller root surface of the lower incisors led to almost double the amount of intrusion observed in the mandibular incisor as compared to the maxillary incisor.

The severe dolichofacial group only exhibited mandibular intrusion, overbite and overjet changes that were significant. It should be noted that molar extrusion, mandibular rotation and incisor proclination were insignificant, which is desirable for this particular facial type[49].

The severe brachyfacial group did not exhibit significant molar extrusion, mandibular rotation or incisor proclination. Ricketts[49] has discussed the instability associated with posterior extrusion and the associated mandibular rotation in this facial type. Significant changes observed in this group were incisor intrusion, overbite and overjet change.

Both the mild dolichofacial and mild brachyfacial groups exhibited mandibular rotation ranging from 0.6 to 1.2 degrees angular change and 1.0 to 1.6 mm of vertical opening. Both groups also had significant incisor intrusion.

Levy[17] states that deep bite cases are probably treated with a combination of incisor intrusion and proclination and also molar extrusion producing mandibular rotation. The results of this study point to these three variables as being factors in overbite correction in lingually treated cases. Some clinicians[72,85] have observed intrusion accompanied by minimal mandibular rotation in lingually treated cases. Thus far several studies have observed intrusion with the lingual appliance[76,82].

Past literature has indicated that various differences exist between low angle brachyfacial and high angle dolichofacial patients. Mechanical advantages as well as increase biting forces in the brachyfacial patient have been proposed[5,45,48,49,51,52,64,70].

Theoretically, one might expect to observe significantly greater intrusion of the incisors in the brachyfacial groups with increased biting forces. Also, one might expect to see more extrusion of posterior teeth and mandibular rotation in the dolichofacial group. However, no differences between low and high angle groups for either mandibular rotation or incisor intrusion were observed in this study.

Williamson[67,68] reports that as long as posterior teeth are in contact, the masseter, medial pterygoid, temporalis and lateral pterygoid contract to assist in closing. He also reports that if the posterior teeth are kept out of contact either by anterior teeth or a synthetic object such as a leaf gauge; the masseter, medial pterygoid and temporalis cease to contract. It is possible that the bite plane effect of the lingual bracket, by keeping the posterior teeth separated during an initial period of time after bonding of the brackets, serves to reduce masseter, medial pterygoid and temporalis contraction forces. This might essentially serve to equalize the biting forces between the brachyfacial and dolichofacial patients, in that all patients, as long as the occlusion is only on the anterior lingual brackets, are capable of only very weak occlusal forces. Theoretically then, the incisor intrusion and posterior extrusion values would not be significantly different.

Even though there were significant treatment effects which were observed in the study, there was no correlation between variables which would allow the clinician to predict how much intrusion or mandibular rotation to expect during treatment based on any pretreatment variable.

Some authors have observed resorption associated with intrusion[3,13,15] while it is reported that the resorption associated with intrusion is not significant[13,37]. Moyers and Bauer[41] state that continuously applied intrusive forces should be avoided whereas Ricketts[49] and Thurow[65] advocate light continuous forces during intrusion. Further studies are needed to determine whether the intermittent biting forces associated with biteplate induced intrusion are associated with significant amounts of resorption.

As the percentage of adults seeking orthodontic care increases the orthodontic profession will continue to face the challenge of providing an esthetic mode of treatment. Lingual orthodontics may be able to partially satisfy that demand and for that reason more research regarding the lingual treatment of malocclusion is needed.

CONCLUSION

The results obtained in a study of fifty-nine patients treated with fixed Ormco-Kurz™ lingual orthodontic appliances show:

1. no significant differences between facial types for any treatment effect. ($p < .05$)
2. a mean maxillary incisor intrusion of 1.2 mm (significant at $p < .001$)
3. a mean mandibular incisor intrusion of 2.3 mm (significant at $p < .001$)
4. a mean maxillary molar extrusion of 0.5 mm (significant at $p < .01$)
5. a mean mandibular molar extrusion of 0.6 mm (significant at $p < .01$)
6. a mean mandibular rotation of approximately 1° (significant at $p < .001$)
7. interincisal angles were kept within a normal range

Overbite correction occurred as a result of the following factors in order of importance: mandibular incisor proclination, mandibular incisor intrusion, mandibular rotation and maxillary incisor intrusion. There was no significant difference for intrusion, extrusion, or mandibular rotation values observed between facial types.

APPENDIX

GLOSSARY

MA	Mandibular Arc angle
LFH	Lower Facial Height angle
MP	Mandibular Plane angle
FA	Facial Axis angle
LAFH	Distance in mm. from ANS to Pm point
OB	Overbite: the vertical overlap of the incisal edges of upper and lower incisors measured perpendicular to the occlusal plane
OJ	Overjet: the horizontal overlap of the incisal edges of upper and lower incisors measured parallel to occlusal plane
INC	Interincisal angle
MX6	Distance from the distal contact point of the maxillary first molar to Frankfort Horizontal in mm
MD6	Distance form the distal contact point of the mandibular first molar to Mandibular Plane in mm
T1	Pretreatment
T2	Posttreatment
Centroid:	The geometric center of the root
U1LA	Line from upper incisor centroid along the long axis to Sella-Nasion line
U1 P	Line perpendicular to Sella-Nasion line from upper incisor centroid
U1SN	Angle formed between upper incisor long axis and Sella-Nasion line
COSU1	Cosine value of angle between U1LA and U1P
CORRU1LA	Distance on corrected T2 upper incisor long axis from T2 centroid to Sella-Nasion line
MXINT	Maxillary intrusion: the distance in millimeters between T1 and T2 centroids measured along the T1 long axis
L1LA	Line from lower incisor centroid along the long axis to Mandibular Plane
L1 P	Line perpendicular to Mandibular Plane from lower incisor centroid
L1MP	Angle formed between lower incisor and Mandibular Plane
COSL1	Cosine value of angle betwee L1LA and L1CP
CORRL1LA	Distance on corrected T2 lower incisor long axis from T2 centroid to Mandibular Plane
MDINT	Mandibular intrusion: the distance in millimeters between T1 and T2 centroids measured along the T1 long axis

* Quintsectograph Corporation, Los Angeles, California
* Scriptel Corporation, Columbus Ohio
* Apple Computer, Inc., Cupertino, California
* Orthodontic Processing, Loma Linda, California

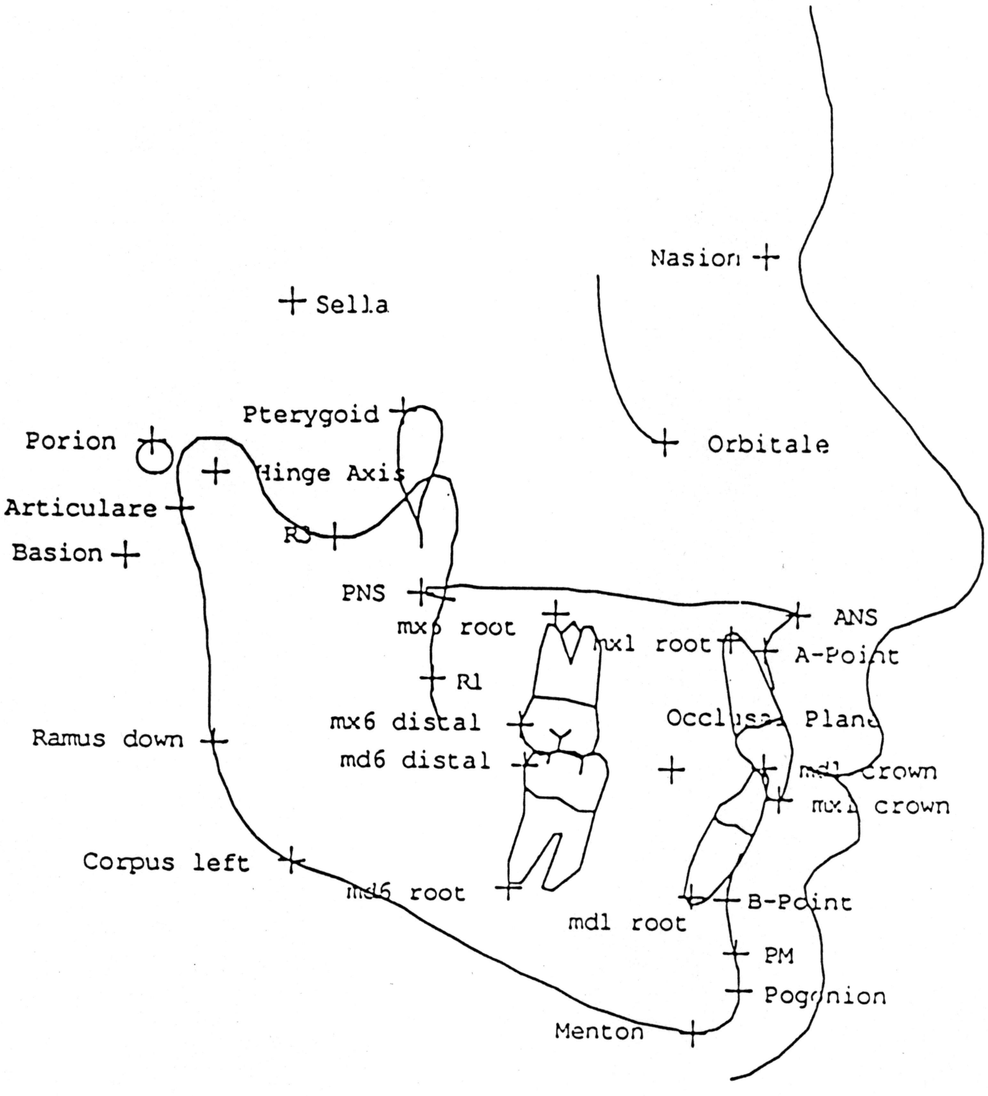

Figure 1: Location of Quick Ceph landmarks.

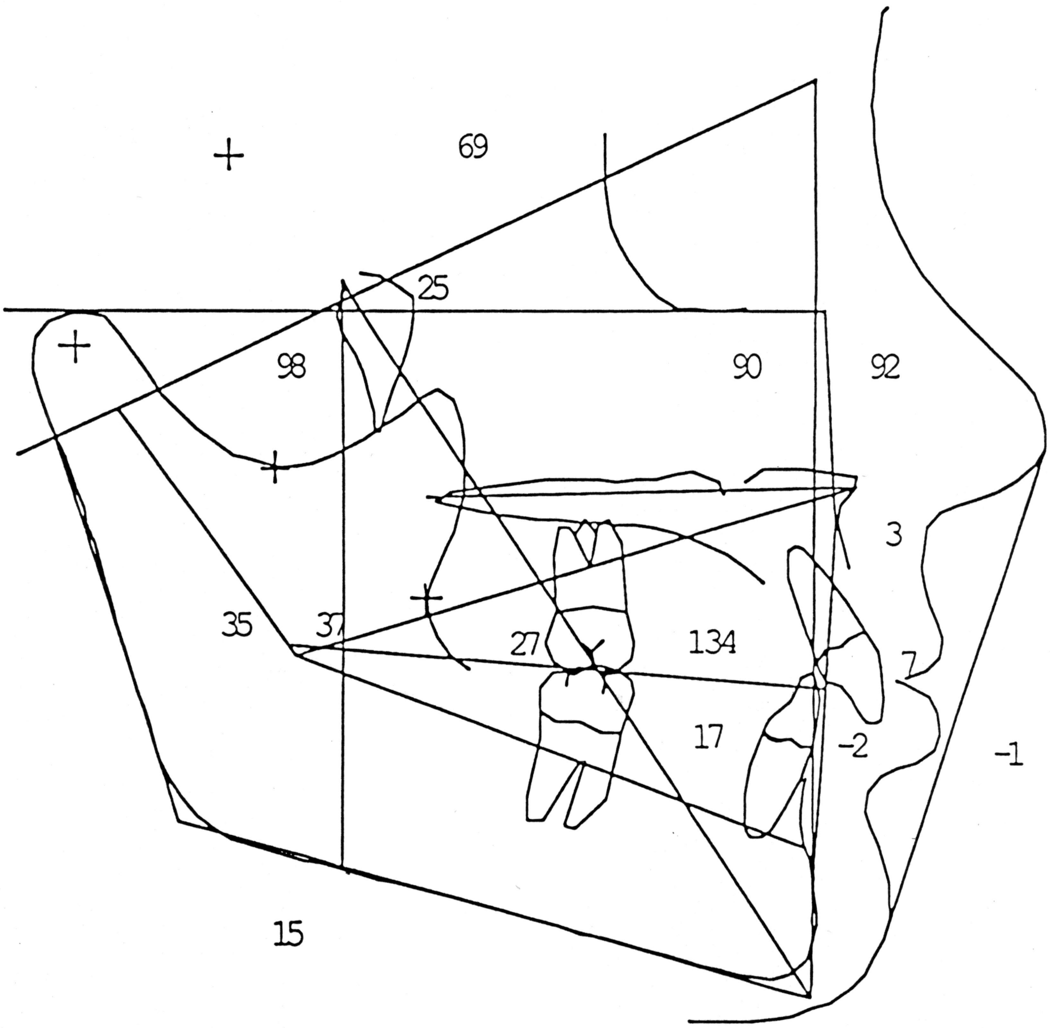

Figure 2: Example of a brachyfacial patient using the Rickett's Analysis.

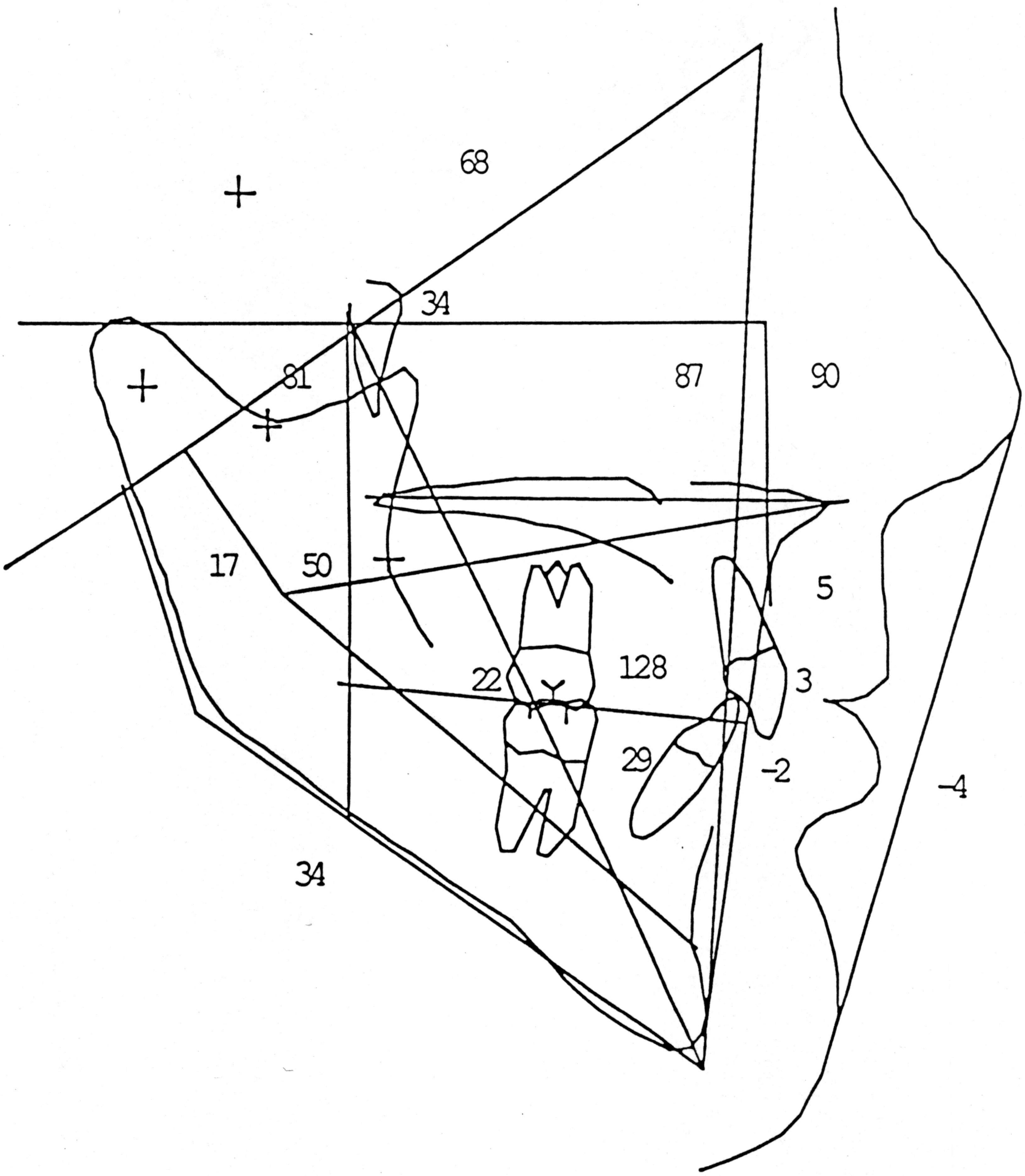

Figure 3: Example of a dolichofacial patient using the
Rickett's Analysis.

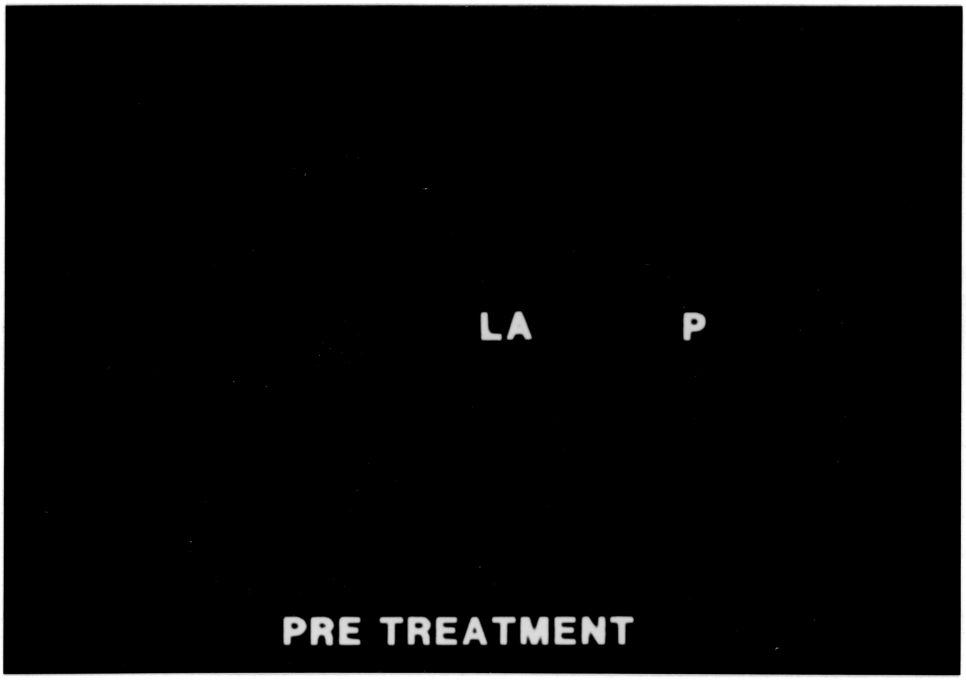

Figure 4: The T1 centroid to the base plane distance is measured along the incisor long axis (LA). The T1 centroid to base plane distance perpendicular to the base plane is measured (P). The cosine of the angle formed by LA and P is calculated by the formula: COS T1= P / LA

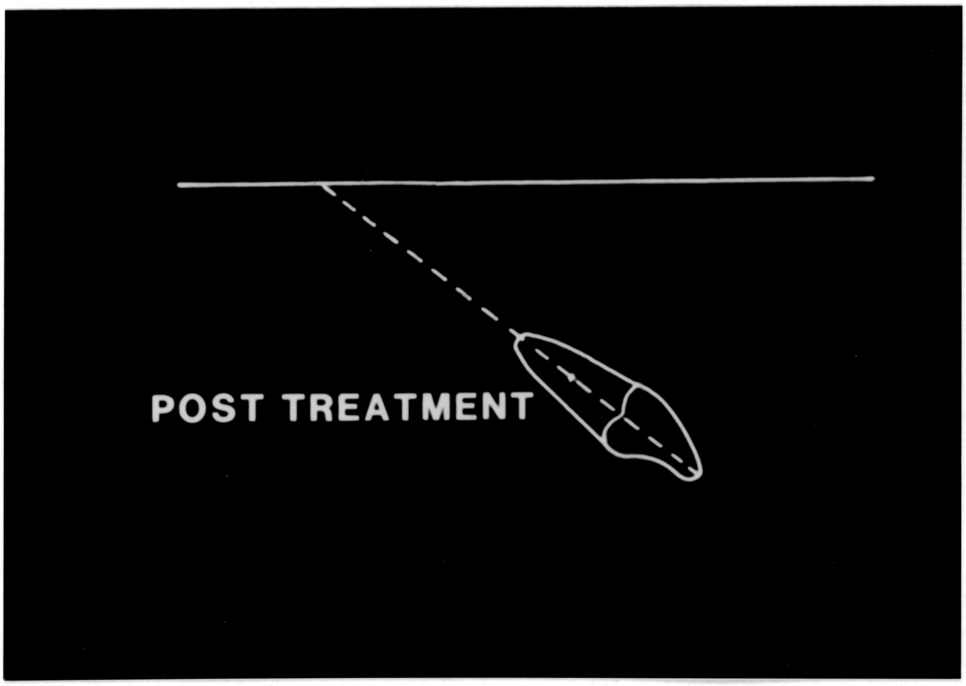

Figure 5: The T2 centroid to base plane distance perpendicular to the base plane is measured to obtain a T2 value for P.

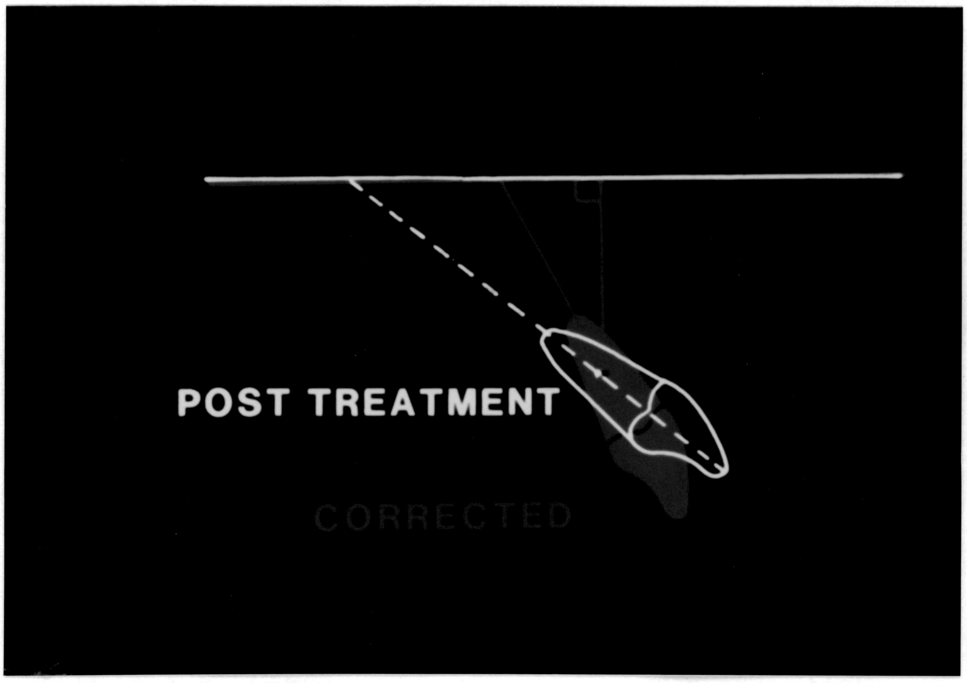

Figure 6: A corrected T2 long axis measurement is calculated using the formula
CORR T2 LA = T2 P / COS T1

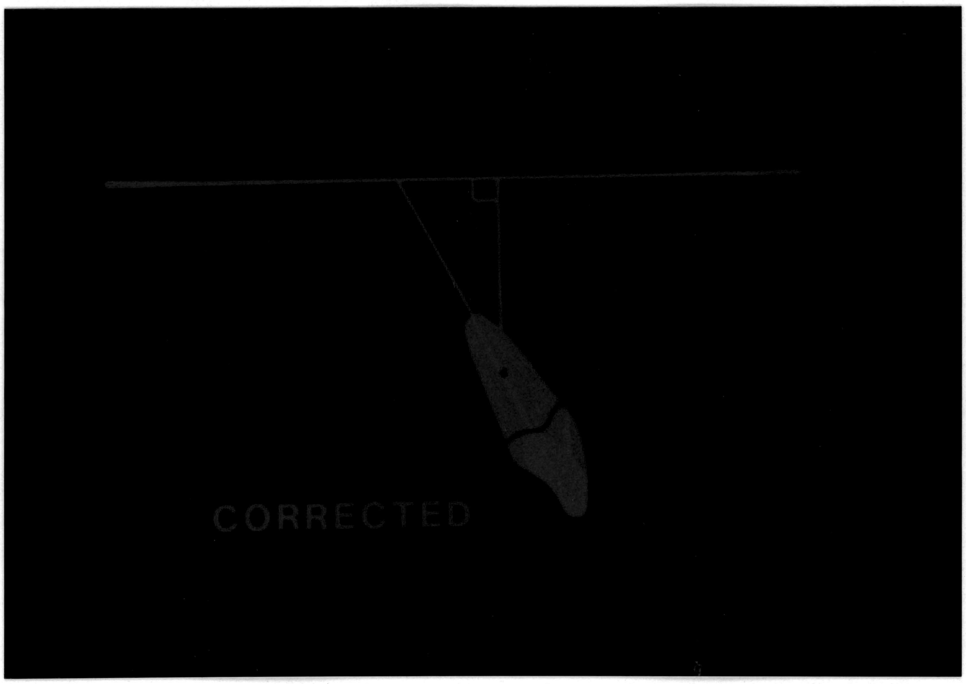

Figure 7: Intrusion is then calculated: Intrusion = T1 LA minus CORR T2 LA

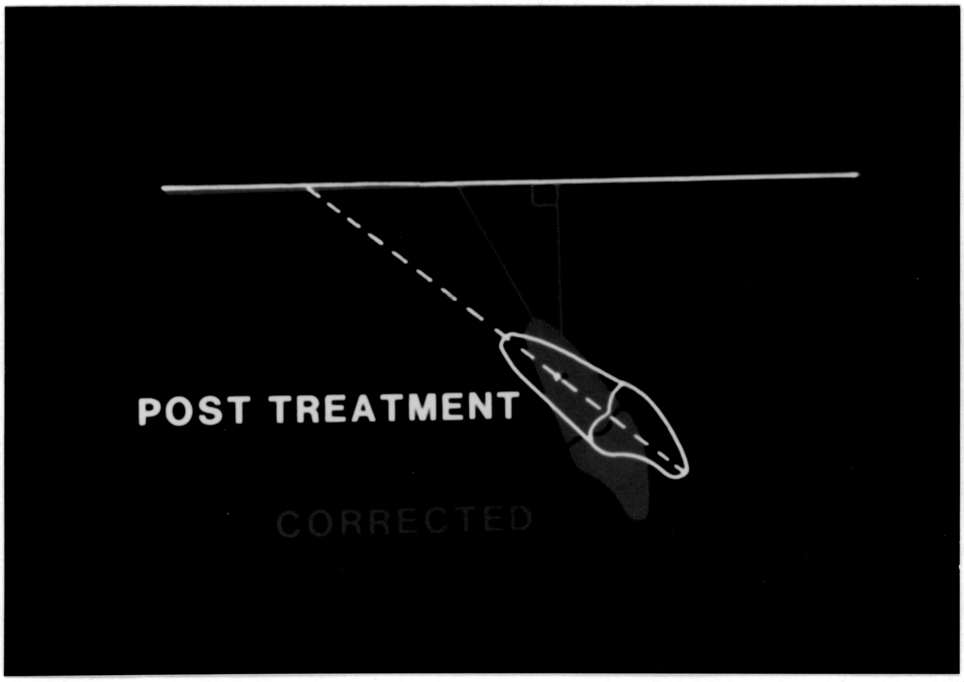

Figure 8: For example: Given a T1 P value of 79.3 mm and a T1 LA value of 85.4 mm the COS T1 value would be calculated as 79.3 / 85.4 = 0.93. Given a T2 P value of 76.3 mm, the CORR T2 LA value would be calculated as 76.3 / 0.93 = 82.0. Given a CORR T2 LA value of 82.0 the actual amount of intrusion measured would be 85.4 minus 82.0 = 3.6 mm.

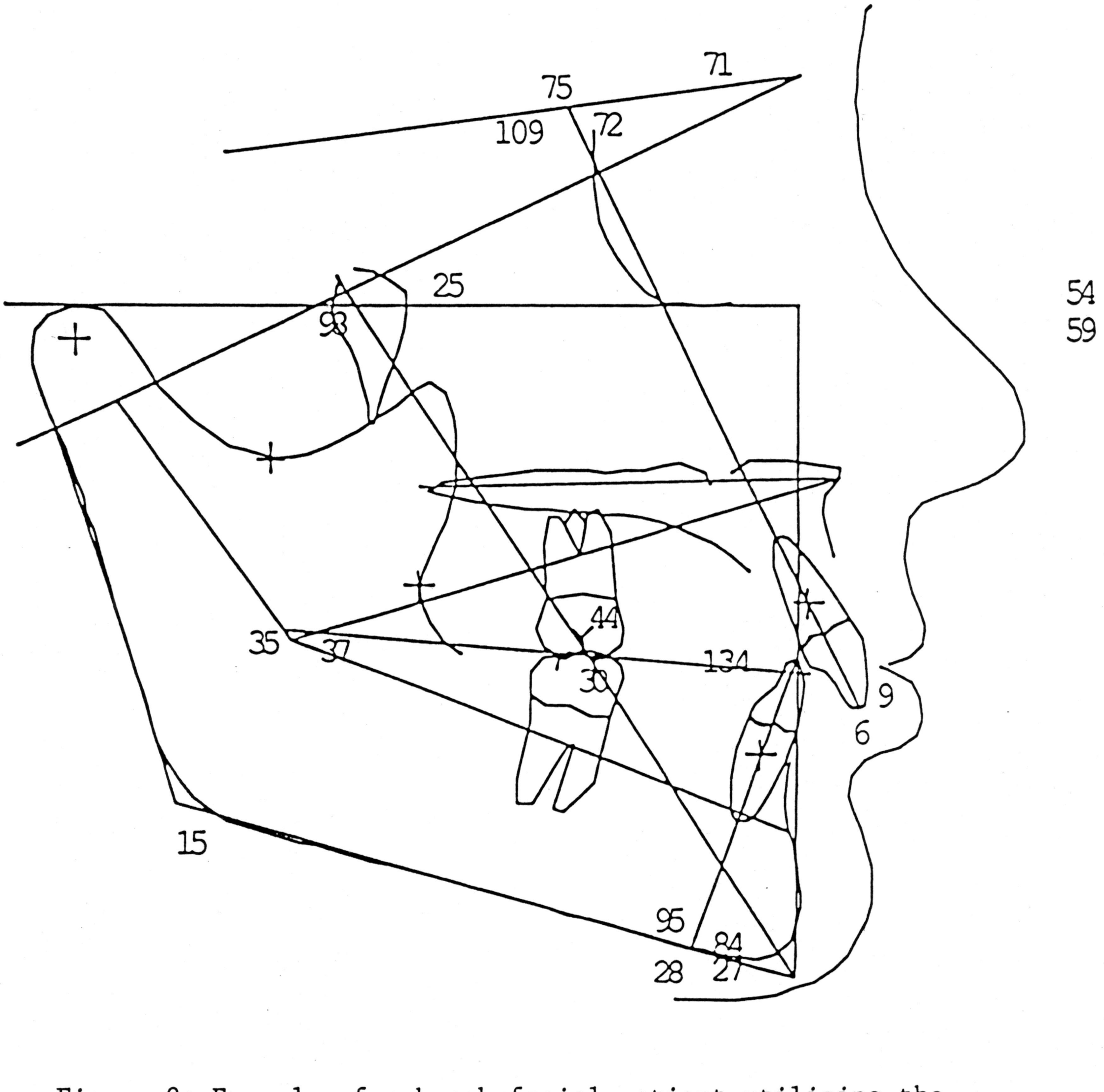

Figure 9: Example of a brachyfacial patient utilizing the User Defined Analysis prepared for this study.

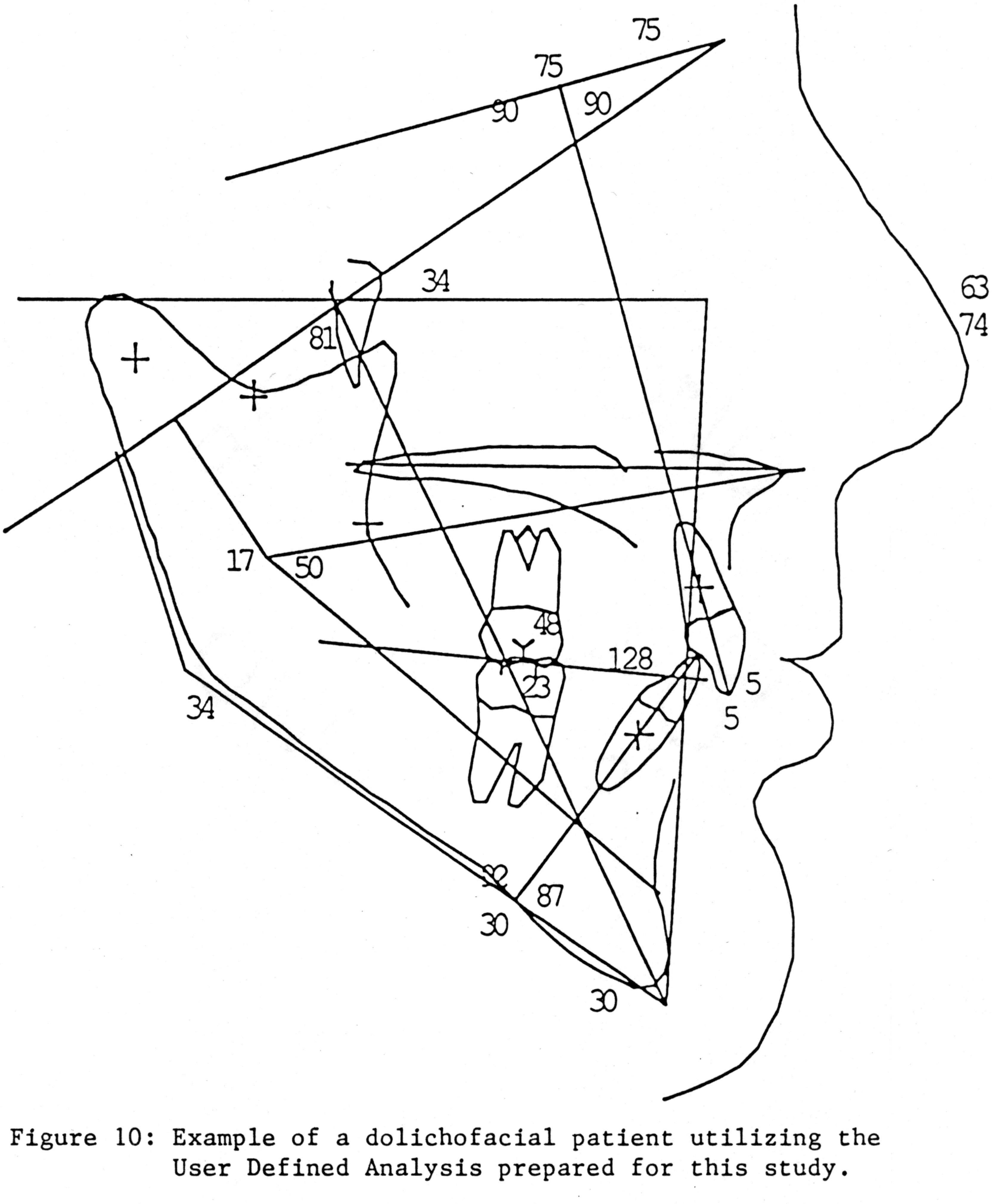

Figure 10: Example of a dolichofacial patient utilizing the User Defined Analysis prepared for this study.

TABLE 1 : DISTRIBUTION FREQUENCY BY SEX AND ANGLE CLASSIFICATION FOR EACH SUBGROUP.

	Male	Female	Class I	Class II Division I	Class II Division 2
Mild Dolichofacial	6	13	5	10	4
Severe Dolichofacial	0	5	1	4	0
Total Dolichofacial	6	18	6	14	4
Mild Brachyfacial	10	18	8	14	6
Severe Brachyfacial	3	4	2	4	1
Total Brachyfacial	13	22	10	18	7
Total Group	19	40	16	32	11

TABLE II: MEAN AGE AND TREATMENT TIME FOR TOTAL SAMPLE.

	Mean	Range
Male Age	30 yr 4 mo	19 yr 1 mo - 36 yr 9 mo
Female Age	34 yr 3 mo	18 yr 3 mo - 52 yr 5 mo
Treatment Time	25 mo	7 mo. - 39 mo.

TABLE III : MEAN PRETREATMENT AND POSTTREATMENT VALUES AND STANDARD DEVIATION FOR MEASURED VARIABLES

		Total Group		Total Dolicho		Total Brachy		Severe Dolicho		Mild Dolicho		Mild Brachy		Severe Brachy	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Mandibular Arc															
	T1	29.4	5.6	24.8	4.7	32.5	3.7	17.5	3.7	26.7	2.60	32.1	3.4	34.5	4.50
Lower Facial Height															
	T1	44.7	4.8	48.7	4.0	42.1	3.4	51.7	5.8	47.8	3.00	43.3	2.6	37.3	1.80
	T2	45.8	5.1	49.8	4.1	42.9	3.6	52.9	6.7	49.1	2.80	44.1	2.9	38.4	2.30
Mandibular Plane															
	T1	22.7	6.2	28.5	4.4	18.8	3.7	34.3	3.3	26.9	3.30	19.9	3.1	14.3	1.90
	T2	23.4	6.3	29.1	4.7	19.5	3.8	35.2	3.6	27.5	3.50	20.6	3.2	14.9	2.30
Facial Axis															
	T1	89.5	4.7	85.2	3.1	92.5	2.9	81.1	2.5	86.3	2.30	91.5	2.1	96.4	2.60
	T2	88.9	4.9	84.5	3.7	91.9	3.1	80.1	3.4	85.7	2.80	91.0	2.5	95.9	2.3
Lower Ant. Facial Height															
	T1	63.3	6.6	67.7	5.2	60.3	5.7	69.0	8.5	67.3	4.30	61.3	5.7	56.4	4.10
	T2	64.6	7	69.2	5.5	61.4	6.1	70.4	9.4	68.9	4.3	62.3	6.3	57.8	3.5
Overbite															
	T1	5.9	2.0	5.6	2.0	6.1	2.0	4.9	0.9	5.8	2.20	5.7	1.6	7.4	3.00
	T2	0.9	1.1	0.9	0.8	0.8	1.2	0.8	0.8	0.9	0.90	0.9	1.4	1.0	0.60
Overjet															
	T1	5.1	1.7	4.8	1.3	5.3	1.8	5.9	1.3	4.5	1.20	5.1	1.5	6.1	2.90
	T2	3.1	1.6	3.3	1.6	2.9	1.6	2.8	1.1	3.4	1.70	3.1	1.8	2.4	0.50
Interincisal Angle															
	T1	131.2	13.7	129.2	15.0	132.6	12.7	125.2	12.4	130.2	####	131.1	11.5	138.3	####
	T2	127.3	8.4	127.7	7.3	127.0	9.1	127.4	10.2	127.7	6.70	126.3	9.6	129.9	6.90
Upper Incisor Angle															
	T1	102.5	9.8	100.0	11.0	104.2	8.6	98.3	8.3	100.5	####	104.2	7.5	104.5	13.1
	T2	101.2	6.6	97.8	6.2	103.6	5.9	92.6	7.1	99.2	5.40	103.3	6.2	104.8	5.30
Lower Incisor Angle															
	T1	94.8	6.3	93.4	5.3	95.8	6.9	92.1	6.5	93.7	5.10	96.2	6.0	94.0	####
	T2	99.3	6.8	96.5	6.3	101.2	6.5	94.8	9.2	96.9	5.60	101.2	5.9	101.3	8.80
Upper Molar															
	T1	45.8	3.7	46.9	3.4	45.1	3.8	45.9	2.8	47.1	3.60	45.2	3.3	44.9	4.60
	T2	46.3	3.7	47.3	3.4	45.7	3.9	46.1	2.5	47.6	3.60	45.7	3.4	45.4	5.70
Lower Molar															
	T1	29.2	3.2	29.7	3.2	28.8	3.1	28.1	4.2	30.1	2.90	29.1	2.9	28.0	3.80
	T2	29.7	3.6	30.6	3.8	29.2	3.4	28.5	4.8	31.1	3.40	29.2	3.1	28.8	4.50

TABLE IV : TREATMENT CHANGES FOR MEASURED VARIABLES LISTED BY MEAN VALUE AND STANDARD DEVIATION.
T TEST SIGNIFICANCE FOR $p < .05$ DENOTED BY " * ", $p < .001$ DENOTED BY " † ", DEGREES DENOTED BY " ° ".

	Total Group			Total Dolicho facial		Total Brachy facial		Severe Dolicho facial		Mild Dolicho facial		Mild Brachy facial		Severe Brachy facial	
Sample Size	59			24		35		5		19		28		7	
	MEAN	SD	RANGE	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Age	29.8	7.1	18y3m-52y6m	30.9	8.4	29.1	6.0	31.8	####	30.6	8.10	28.3	6.2	32.5	3.7
Treatment Time	25.0	7.8	7 mo - 39 mo	24.4	8.1	25.5	7.7	21.0	8.80	25.3	7.80	25.6	8.3	24.7	5.10
LFH °	† 1.1	1.3	-0.9 - +5.1	† 1.2	1.3	† 1.1	1.4	1.2	1.10	* 1.2	1.40	† 1.0	1.3	1.1	1.90
MP °	† 0.7	1.1	-1.9 - +3.3	* 0.7	1.1	* 0.7	1.2	0.9	1.30	* 0.6	1.10	* 0.7	1.2	0.5	1.50
FA °	†-0.6	1.1	-3.6 - +2.6	*-0.7	1.0	*-0.5	1.1	-1.0	1.10	*-0.6	1.00	*-0.5	0.9	-0.4	1.70
LAFH [mm]	† 1.3	1.7	-1.0 - +5.6	† 1.5	1.5	† 1.0	1.7	1.4	1.20	* 1.6	1.60	* 1.0	1.4	1.4	2.80
Max. intrusion [mm]	† 1.2	1.4	-2.3 - +4.1	† 1.2	1.5	† 1.2	1.4	0.9	1.10	*1.3	1.60	† 1.0	1.4	* 1.9	1.10
Mand. intrusion [mm]	† 2.3	1.6	-1.5 - +5.5	† 2.4	1.8	† 2.2	1.5	* 2.9	1.30	† 2.2	1.90	† 2.1	1.5	† 2.6	1.20
Overbite [mm]	†-4.9	2.1	-12.8 - -3.0	†-4.4	2.2	†-5.2	2.1	†-4.2	0.90	†-4.4	2.50	†-5.0	1.6	†-6.4	3.00
Overjet [mm]	†-2.0	2.3	-7.6 - +5.2	†-1.5	2.0	†-2.3	2.4	*-3.1	1.90	*-1.1	1.90	†-2.0	2.2	*-3.7	2.60
Interincisal angle °	*-3.9	13.6	-48.5 - +18.1	-1.6	15.1	*-5.5	12.5	2.2	####	-2.5	####	*-4.8	10.8	-8.3	####
Upper incisor angle °	-1.3	8.2	-18.6 - +20.7	-2.2	9.7	-0.7	7.1	-5.8	####	-1.3	9.60	-0.9	6.3	0.3	####
Lower incisor angle °	† 4.5	6.7	-7.6 - +28.5	* 3.1	6.4	† 5.5	6.8	2.7	7.00	* 3.2	6.40	† 5.1	5.5	7.4	####
Upper molar [mm]	* 0.5	1.4	-3.4 - +4.0	0.4	1.4	* 0.5	1.4	0.2	1.80	0.5	1.40	* 0.5	1.3	0.6	1.60
Lower molar [mm]	* 0.6	1.4	-4.0 - +3.3	* 0.9	1.2	0.3	1.5	0.4	1.50	† 1.1	1.10	0.2	1.5	0.9	1.30

TABLE V : CORRELATION COEFFICIENTS FOR PAIRS OF VARIABLES WITH SIGNIFICANCE FOR $p < .05$ DENOTED BY " * ", $p < .001$ DENOTED BY " † ". INSIGNIFICANCE DENOTED BY " ns ".

	LFHΔ	MPΔ	FAΔ	LAFHΔ	MXINT	MDINT	OBΔ	OJΔ	INCΔ
TYPE	ns	ns	ns	ns	ns	ns	ns	ns	ns
MXINT	-.39*	ns	ns	-.44†		ns	ns	ns	ns
MDINT	-.38*	ns	ns	-.41†	ns		ns	ns	ns
OBΔ	ns	ns	ns	-.30*	ns	ns		ns	ns
MX6Δ	ns	ns	ns	ns	ns	ns	ns	ns	ns
MD6Δ	ns	ns	ns	+.36*	ns	ns	ns	ns	ns

TABLE VI : ANALYSIS OF VARIANCE RESULTS INDICATING SIGNIFICANCE OF DIFFERENCES BETWEEN GROUPS AT $p < .001$, WITH " † " DENOTING SIGNIFICANCE, "ns" INSIGNIFICANCE

		2 GROUPS BRACHY VS DOLICHO	4 SUBGROUPS
Facial Type Index Number		0.00†	0.00†
Mandibular Arc	T1	0.00†	0.00†
Lower Facial Height	T1	0.00†	0.00†
	Δ	ns	ns
Mandibular Plane	T1	0.00†	0.00†
	Δ	ns	ns
Facial Axis	T1	0.00†	0.00†
	Δ	ns	ns
Lower Ant. Facial Height	T1	0.00†	0.00†
	Δ	ns	ns
Overbite	T1	ns	ns
	Δ	ns	ns
Overjet	T1	ns	ns
	Δ	ns	ns
Interincisal Angle	T1	ns	ns
	Δ	ns	ns
Upper Incisor Angle	T1	ns	ns
	Δ	ns	ns
Lower Incisor Angle	T1	ns	ns
	Δ	ns	ns
Upper Molar	T1	ns	ns
	Δ	ns	ns
Lower Molar	T1	ns	ns
	Δ	ns	ns

TABLE VII : GENERAL LINEAR HYPOTHESIS LISTING FACTORS INVOLVED IN OVERBITE CORRECTION IN ORDER OF RELATIVE IMPORTANCE.
" † " INDICATES SIGNIFICANCE AT $p < .001$

DEPENDENT VARIABLE	# GROUPS	COVARIATE#1	COVARIATE#2	COVARIATE#3	COVARIATE#4
OB	2	INC†	MDINT†	LAFH†	MXINT†
OB	4	INC†	MDINT†	LAFH†	MXINT†

BIBLIOGRAPHY

1. Ainsworth G. Some thoughts regarding methods and a new appliance for moving dislocated teeth into position. Int Dent J 1904;25:19.

2. Bahador MA, Higley LB. Bite opening: A cephalometric analysis. J Am Dent Assoc 1944;31:343-52.

3. Barrer HG. The adult orthodontic patient. Am J Orthod 1977;72:617-40.

4. Belger I. Cephalometric analysis of growth in subjects using bite plates. Angle Orthod 1956;26:1:42-9.

5. Bench RW, Gugino CF, Hilgers JJ. Bioprogressive Therapy: Part 2. J Clin Orthod 1977;11:661-682

6. Breece GL, Neiberg LG. Motivations for adult orthodontic treatment. J Clin Orthod 1986;20:166-71.

7. Burstone CJ. Deep overbite correction by intrusion. Am J Orthod 1977;72:1-22.

8. Callaway GS. The use of bite plates. Am J Orthod 1940;26:120.

9. Carlyle TD. Overbite: craniofacial associations, treatment and post-treatment changes: a lateral cephalometric study. (Abstract) Am J Orthod 1978;74:685-6.

10. Dahl BL. The effect of a partial bite raising splint on the inclination of upper and lower front teeth. Acta Odont Scand 1983;41:311-14.

11. Dahl BL, Krogstad O. The effect of a partial bite raising splint on the occusal face height. An x-ray cephalometric study in human adults. Acta Odont Scand 1982;40:17-24.

12. Davidian EJ. Using a computer model to study the force distribution on the root of the maxillary central incisor. (master's thesis) Loma Linda University,1967

13. Dellinger EL. A histological and cephalometric investigation of premolar intrusion in the Macaca Speciosa monkey. Am J Orthod 1967;53:325-55.

14. Dermaut LR. Evaluation of intrusive mechanics of the type "segmental arch" on a macerated human skull using the laser reflection technique and holographic interferometry. Am J Orthod 1986;89:251-63.

15. Dermaut LR, DeMunck A. Apical root resorption of upper incisors caused by intrusive tooth movement: a radiographic study. Am J Orthod 1986;90:4:321-6.

16. Dunn R. Vertical overbite or arrested vertical development in molar and premolar region. Int J Orthod 1926;12:685-707.

17. Engel GA, Cornforth G, Damerell JM, Gordon J, Levy, McAlpine J, Otto RL, Walters R, Chaconas SJ. Treatment of deep bite cases. Am J Orthod 1980;77:1-13.

18. Gottlieb EL. 1981 JCO orthodontic practice study. Boulder: Index Publishers Corporation, 1982.

19. Gottlieb EL. 1983 JCO orthodontic practice study. Boulder: Index Publishers Corporation, 1984.

20. Gottlieb EL. 1985 JCO orthodontic practice study. Boulder: Index Publishers Corporation, 1985.

21. Gottlieb EL, Nelson AH, Vogels DS. 1987 JCO orthodontic practice study. J Clin Orthod 1987;212:646-653.

22. Graber TM. Orthodontics; principles and practice. 3rd ed. Philadelphia: W.B. Sanders Company, 1972:505.

23. Graber TM, Swain BF. Current orthodontic concepts and techniques. Vol 1. 2nd ed. Philadelphia: W.B. Sanders Company, 1975:191.

24. Gray BF. Report of cases emphasizing the importance of securing proper vertical development in the molar and premolar region. Int J Orthod 1926;12:1053-6.

25. Grieve GW. A definite method for stimulating normal growth of the mandible. Int J Orthod 1926;12:307.

26. Guilford SH. Orthodontia. 4th ed. Philadelphia: T.C. Davis and Sons 1905;185.

27. Hemley S. Bite plates, their application and action. Am J Orthod Oral Surg 1938;24:721-36.

28. Howard CC. A discussion of infra- and supra-version occlusion. Int J Orthod 1930;16:1019-34.

29. Howes AE. Altering the overbite. Am J Orthod Oral Surg 1942;28:173-8.

30. Ingle JI, Beveridge EE. Endodontics. 2nd ed. Philadelphia: Lea and Febiger 1976;116,126.

31. Jackson AF. A case of deep overbite showing the principle and application of the removable bite plane in treatment. Am J Orthod Oral Surg 1939;28:745-50.

32. Jackson VH. A consideration of bite planes in orthodontia. Int J Orthod 1922;8:1-19.

33. Jones KW. Some considerations concerning the planning and limitations of retention. Am J Orthod 1956;42:588.

34. Krogstad O, Dahl B. Tooth intrusion and facial morphology. A cephalometric study in adults, using the implant method. Eur J Orthod 1987;9:200-3.

35. Lefkowitz W, Waugh LM. Experimental depression of teeth. Am J Orthod Oral Surg 1945;31:21-36.

36. Magill JM. Changes in the anterior overbite relationship following orthodontic treatment in extraction cases. Am J Orthod 1960;46:755-88.

37. McFadden M. A study of the relationship between incisor intrusion and root resorption. (unpublished masters thesis), Loma Linda: Loma Linda University, 1987.

38. Mershon JV. Possibilities and limitations in the treatment of closed bites. Am J Orthod Oral Surg 1937;23:581-9.

39. Mitchell DL, Stewart WL. Documented leveling of lower arch using metallic implants for reference. Am J Orthod 1972;63:526-32.

40. Moyers RE. Handbook of orthodontics. Chicago: Year Book Publishers Inc 1960;317-21.

41. Moyers RE, Bauer JL. The periodontal response to various tooth movements. Am J Orthod 1950;36:572-81.

42. Nanda R. The differential diagnosis and treatment of excessive overbite. Dent Clin North Am 1981;25:69-84.

43. Neff CW. Tailored occlusion with the anterior coefficient. Am J Orthod 1949;35:309-14.

44. Neustadt E. Tooth elevation versus tooth eruption. Part I. Differentiation between tooth eruption and tooth elevation. Dent Items Interest 1935;57:489-95.

45. Opdebeek H, Bell WH. The short face syndrome. Am J Orthod 1978;73:499-511.

46. Otto RL, Anholm JM, Engel GA. A comparative analysis of intrusion of incisor teeth achieved in adults and children according to facial type. Am J Orthod 1980;77:437-46.

47. Porter LJ. Conservatism in orthodontic procedures and appliances. Am J Orthod Oral Surg. 1947;33:109.

48. Proffit WR, Fields HW, Nixon WL. Occlusal forces in normal- and long-face adults. J Dent Res 1983;62:566-71.

49. Ricketts RM, Bench RW, Gugino CF, Hilgers JJ, Schulhof RJ. Bioprogressive therapy. Book 1. Denver: Rocky Mountain Orthodontics, 1979:25-7.

50. Rogers AP. A consideration of infra-occlusion. Dent Items Interest 1909;31:248-65.

51. Sassouni V. A classification of skeletal facial types. Am J Orthod 1969;55:109-23.

52. Schendel SA, Eisenfeld J, Bell WH, Epker BN, Mischelevich DJ. The long face syndrome: vertical maxillary excess. Am J Orthod 1976;70:398-408.

53. Schudy FF. The control of vertical overbite in clinical orthodontics. Angle Orthod 1968;38:19.

54. Sleitcher CG. Effects of maxillary bite plane therapy in orthodontics. Am J Orthod 1954;40:850-70.

55. Steadman SR. Overbites. Angle Orthod 1940;10:148-54.

56. Steadman SR. The relation of upper anterior teeth to the lower anterior teeth as present on plaster models of a group of acceptable occlusions. Angle Orthod 1952;22:91-7.

57. Steadman SR. Six different kinds of overbites. J Am Dent Assoc 1940;27:1060.

58. Steigman M, Michaeli Y. Experimental intrusion of rat incisors with continuous loads of varying magnitude. Am J Orthod 1981;80:429-36.

59. Stenvik A, Mjor IA. Pulp and dentin reactions to experimental tooth intrusion - a histological study of the initial changes. Am J Orthod 1970;57:370-85.

60. Stolzenberg J. Preliminary report on the newer concepts in the management of bite raising. Am J Orthod 1948;34:725-31.

61. Strang RHW. An analysis of overbite problems in malocclusion. Angle Orthod 1934;4:65-84

62. Strang RHW. Axial inclination of teeth in extraction cases. Angle Orthod 1957;27:11

63. Sved A. Changing the occlusion level and a new method of retention. Am J Orthod Oral Surg 1944;30:527-34.

64. Throckmorton GS, Finn RA, Bell WH. Biomechanics of differences in lower facial height. Am J Orthod 1980;77:410-20.

65. Thurow RC. Edgewise orthodontics. 4th ed. St. Louis: C.V. Mosby Company 1982:116-9,285-6.

66. Weinberger BW. Orthodontics, an historical review of its origin and evolution. Vol I. St. Louis: C.V. Mosby Company., 1926.

67. Williamson E. Occlusion and TMJ dysfunction, Part I. J Clin Orthod 1981;15:333-50.

68. Williamson E. Occlusion and TMJ dysfunction, Part II. J Clin Orthod 1981;15:393-410.

69. Wolfson A. Deep bites in adults. Am J Orthod Oral Surg 1938;24:120-8.

70. Yildirum E. Maximum opening and closing forces exerted by diverse skeletal types. (master's thesis) Loma Linda: Loma Linda University, 1970

71. Aguirre MJ. Indirect bonding for lingual cases. J Clin Orthod 1984;18:565-9.

72. Alexander CM, Alexander RG, Gorman JC, Hilgers JJ, Kurz C, Schulz RP, Smith JR. Lingual orthodontics: A status report, Part 1. J Clin Orthod 1982;16:255-62.

73. Alexander CM, Alexander RG, Gorman JC, Hilgers JJ, Kurz C, Schulz RP, Smith JR. Lingual orthodontics: A status report, Part 5: Lingual mechanotherapy. J Clin Orthod 1983;17:99-115.

74. Alexander CM, Alexander RG, Sinclair PM. Lingual orthodontics: A status report, Part 6: Patient and practice management. J Clin Orthod 1983;17:240-6.

75. Artun J. A post treatment evaluation of multibonded lingual appliances in orthodontics. Eur J Orthod 1987;9:204-10.

76. Baker RW. The lingual appliance: Molar eruption vs incisor depression. (Unpublished masters thesis) Rochester: Eastman Dental Center, 1987.

77. Diamond M. Critical aspects of lingual bracket placement. J Clin Orthod 1983;17:688-91.

78. Diamond M. Improved vision and isolation for direct lingual bonding of the upper arch. J Clin Orthod 1984;18:814-15.

79. Fujita K. New orthodontic treatment with lingual bracket and mushroom archwire technique. Am J Orthod 1979;76:657-75.

80. Fujita K. Multilingual bracket and mushroom arch wire technique; a clinical report. Am J Orthod 1982;82:120-40.

81. Gorman JC, Hilgers JJ, Smith JR. Lingual orthodontics: A status report, Part 4: Diagnosis and treatment planning. J Clin Orthod 1983;17:26-35.

82. Kazley SM. The effects of lingual appliance treatment on the skeleton, dentition, and TMJ. (research project) Rochester: Eastman Dental Center, 1984.

83. Kelly VM. JCO interviews Dr. Vincent M. Kelly on lingual orthodontics. J Clin Orthod 1982;17:461-76.

84. Kurz C. Lingual orthodontics: A status report, 7A: Case reports-nonextraction, consolidation. J Clin Orthod 1983;17:310-21.

85. Kurz C. Personal communication, February:1988.

86. Kurz C, Swartz ML, Andreiko C. Lingual orthodontics: A status report, Part 2: Research and development. J Clin Orthod 1982;16:735-40.

87. Mariotti J. The speech effect of the lingual appliance. (masters thesis), Rochester: Eastman Dental Center, 1983.

88. Matsui M. Brushing method for the lingual-bracket technique. JJOS 1978;37:399-403.

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89. Moran KI. Effective steel ligation for lingual appliances. J Clin Orthod 1984;18:733.

90. Paige SF. A lingual light-wire technique. J Clin Orthod 1982;16:534-44.

91. Scholz RP, Swartz ML. Lingual orthodontics: A status report, Part 3: Indirect bonding. J Clin Orthod 1982;16:812-20.

92. Sinclair PM, Cannito MF, Goates LJ, Solomos LF, Alexander CM. Patient responses to lingual appliances. J Clin Orthod 1986;20:396-404.

93. Smith JR. Lingual orthodontics: A status report Part 7B: Case reports-extraction. J Clin Orthod 1983;17:464-73.

94. Smith JR. Keys to success in lingual therapy. J Clin Orthod 1986;20:250-61.

95. Smith JR. Keys to success in lingual therapy: Part 2. J Clin Orthod 1986;20:330-40.

96. Blaseio G. Quick Ceph™: a computer program. (masters thesis) Loma Linda: Loma Linda University, 1986