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Clinical Photographic Analysis of Dentofacial Midline Asymmetries

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CLINICAL PHOTOGRAPHIC ANALYSIS
OF
DENTOFACIAL MIDLINE ASYMMETRIES

by

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A Thesis in Partial Fulfillment
of the Requirements for the Degree
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Each person whose signature appears below certifies that he has read this thesis and that in his opinion it is adequate, in scope and quality, as a thesis for the degree of Master of Science.

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NOTICE

The following manuscript was prepared as a partial fulfillment of the requirements for a graduate degree from Loma Linda University Graduate School under the discipline of the School of Dentistry.

While the format in general is governed by the criteria of a conventional Graduate School Thesis, it is in actuality a manuscript which is readily amenable for publication in a scientific journal.

CHAPTER I

INTRODUCTION

Normal asymmetry of the human body, and in particular the face and dental arches, has been discussed in the medical and dental literature for many years. At the subjective point of disfigurement, normal asymmetry becomes abnormal (Lear, 1968). For the orthodontist, the most common form of treatable asymmetry is the dentofacial midline discrepancy. If the dental midline does not coincide with the facial midline, esthetics may suffer. If the upper and lower dental midlines (embrasure between the central incisors) do not coincide, one entire dental arch may be skewed or rotated (Harper, 1948; Cheney, 1961; Lundstrom, 1961), both may be skewed or rotated, crowding or spacing of teeth may exist, or a unilateral tooth size discrepancy may be present.

Historically, the problems involved in symmetry analysis have been twofold. First, the location of a reliable median sagittal reference plane was of major importance. Second, the development of a device or technique to accurately analyze the asymmetry was needed.

The difficulty in finding a good median facial plane has been due to the variability of median sagittal landmarks. These soft tissue landmarks rarely fall on a straight line

(Sutton, 1969). Sutton therefore proposed that the midline be defined as "equidistant from the extremities", or for his particular study, midway between the zygions as measured on a frontal photograph. Woo (1937) however, in a biometric study of normal skulls, found the left zygomatic bone to be generally larger than its analogue. Lear (1968) defined the median plane of the face as an "abstraction" determined by an averaging of the central anatomical points. In theory, the facial midline should coincide with that of maxilla, or specifically, with the median palatal raphe. The raphe, or certain points along it, has been used as a reference plane in symmetry studies of the maxillary arch by Adler, 1948, Hunter, 1953, Lebret, 1962, Lear, 1968, and Chafekar, 1971. While the raphe may be reliable for analysis of the maxilla by itself, in some cases it may not coincide with the facial midline (Harper, 1948; Cheney, 1961; Lundstrom, 1961). This problem could then result in a dentofacial midline discrepancy.

In the symmetry studies sited thus far, various devices and techniques were used for analysis. While these devices and techniques differed, their main intent was to change the three-dimensional object to be measured (e.g. face, palate, dental arch) into two dimensions for simplification of measurement.

The devices and techniques used to produce the two-dimensional image can be divided into four types: mechanical, xerographic, photographic, and modified radiographic. Mechanical devices were generally surveyor-like tracing instruments.

A metal pointer or scribe was traced around the dental arches and along the median raphe on a carefully oriented cast. This tracing was simultaneously transferred to paper via a parallel linkage with an attached writing implement. The predecessor of such devices was the symmetroscope of Grunberg (1911) modified by Adler (1948). The Korkhaus symmetrograph (1930) was used by Lebret (1962) and a modification by Lear (1968) in their research. The stereograph (Schwarz, 1933) was used in the studies of Hunter (1953) and Lundstrom (1951, 1961). Difficulties involved with these devices were that the dental cast had to be precisely oriented to the median and occlusal planes, and it was tedious, time consuming and limited in precision (Singh, 1964). Lear (1968) stated that while the tracings were readily made, appreciable errors may arise from tolerances in the parallelogram linkage.

Singh and Savara (1964) proposed the use of a Xerox machine to reproduce dental casts in two-dimensions. This technique is quick, simple and the distortion of the image is negligible. Measurements can be readily made from the Xerox image. Xerography of dental casts was also used by Mazaheri (1971) to study arch form in cleft palate patients. A Xerox machine, however, may not always be available to the clinician (Chafekar, 1971).

General photographic techniques have been applied to analysis of lateral facial asymmetry (Sutton, 1968) and advocated as an anthropometric tool by Gavan (1952) who felt its use could eliminate much error inherent in direct measurement and observation. Singh (1964) pointed out that for accuracy, photographic techniques require critical calculation of enlargement factors, object-to-image distances, orientation of camera and subject and careful control of lighting.

A modified radiographic technique of dental cast symmetry analysis was devised by Lear (1968). His technique required positioning of the cast on a symmetrograph, waxing and casting a "clasp" from molar to molar on the facial surfaces, and then radiographing the "clasp". Right and left halves of the film could then be superimposed on a given reference plane for analysis. Chafekar and Cleall (1971) proposed a simplification of Lear's technique which eliminated the waxing and casting step. They injected a bead of barium sulfate paste around the middle one-third of the facial surfaces from molar to molar. They then radiographed the cast using a double film pack. One of the two identical films could then be inverted and superimposed over the other for analysis.

The aforementioned devices and techniques are not without their problems. All require the use of dental casts, therefore none can be used directly on the patient. They are generally time consuming, except for xerography, and most require special equipment. For these reasons the techniques discussed may not be clinically practical. The clinician should have a method by which he may diagnose asymmetries and follow his treatment progress in such cases quickly and easily.

In the present study, dental midline discrepancies are analyzed using an "averaged" facial midline as the reference plane. The technique employs the use of an Orthoscan intraoral camera (Unitek) using Polaroid film. This produces a "life size" two-dimentional image of the dental arches directly from the patient within a matter of seconds. The camera is modified with a positioning device which relates the facial midline to the maxillary arch. The positioning device houses a midline pointer which is visible in the intraoral photograph. Thus, when the positioning device is aligned with the facial midplane, the pointer will represent this plane in the maxillary arch photograph.

The development of a quick and simple yet precise method of dentofacial midline analysis could benefit the clinical orthodontist. The ability to accurately diagnose dental midline asymmetries during initial or finishing stages of therapy would enable more precise treatment planning. Without such a tool, the clinician would generally rely on direct observation and estimation to make his diagnosis.

The purpose of this paper is to present a clinical photographic technique of dentofacial midline analysis and to compare its precision with that of direct observation.

CHAPTER II

METHODS AND MATERIALS

This clinical photographic technique of dental arch midline analysis employs an Orthoscan intraoral camera (Unitek Corp., Monrovia, California) (Fig. 1). The camera is modified with a positioning device which is used to relate the facial midline to the maxillary arch photograph. (Fig. 2).

To clinically assess the value of this photographic analysis of midline, a study was devised to compare direct observation with this photographic technique. Five orthodontic patients with mild but obvious dentofacial midline discrepancies were evaluated (Fig. 3) as to the location (right or left) and extent (in millimeters) of their discrepancy. Five examiners consisting of orthodontic students and instructors evaluated each patient using any aids normally employed to assist their direct observation such as a millimeter rule, mirror, or straight edge. Each examiner was instructed to (1) locate the facial midline of the patient, (2) determine the distance and direction of deviation of the maxillary central incisor embrasure from that midline, and (3) determine the distance and direction of the mandibular incisor embrasure to the midline. A photographic analysis was then performed on each patient by one operator. One maxillary and one mandibular photograph would generally suffice for use in clinical practice. For this study however, five maxillary photographs were taken so that the amount of data accumulated would be comparable to that of the direct observation phase.

The procedure was as follows: Centric relation contact points were marked on the teeth with articulating paper. The operator manually assisted the patient with mandibular positioning and with biting. The most obvious contact points between upper and lower teeth were recorded on paper as to their exact location. Generally one set of contact points on each side was sufficient. The modified camera was inserted into the patient's mouth for the maxillary photographs. Careful positioning of the vertical member at midnasion, and of the horizontal member parallel with the eyes was necessary for establishment of the median sagittal line. This also prevented tipping of the camera to the right or left. Positioning of the horizontal member equidistant from right and left superciliary ridges, viewed from above, was needed to prevent a rotated position of the camera around the vertical axis. After positioning was accomplished the exposure was made. This step was repeated four more times, each time removing and reinserting the camera (Fig. 4). The lower arch was then photographed once after visually centering the camera without using the positioning device. A three-by-four inch piece of acetate tracing paper with a straight line drawn down its center was placed over the first maxillary photograph so that the line was exactly superimposed over the midline pointer. At this stage, measurement was made of the distance from the upper central incisor embrasure ($\underline{I}$) to the constructed midline. The central incisors and brackets were then carefully traced with a sharp pencil. The right and left contact points previsouly noted were traced. The acetate was then inverted and placed over the mandibular photograph so the upper and lower contact points coincided as in the mouth. This step has correctly related the maxillary and mandibular photos in centric relation and has graphically shown where the averaged facial midline lies in relation to both arches (Fig. 5). Measurements were then made of the distance from the lower central incisor embrasure ($\overline{I}$) to the midline. The measurements and their computed difference were recorded to the nearest 0.25mm. The right-left direction of the deviation from the midline was also recorded. The tracing and measurement steps were then repeated with each of the four additional maxillary photographs. The same mandibular photograph was used for all five superimpositions.

The precision of this photographic technique is in a large part dependent on the camera positioning device and the ability of the operator to position it correctly. For this reason, a test of the repeatability was performed in which one operator took eight separate maxillary photographs on one patient. A composite tracing was made of all eight "midlines" projected from the midline pointer. Superimposition for this composite construction was over the central incisors and brackets. The midpoint of the range of these midlines was marked where they passed through the embrasure of the central incisors. To facilitate measurement, an opaque projector was used which enlarged the tracing five fold. Measurements were made from each "midline" to the arbitrary midpoint at the centrals and the standard deviation was computed (Fig. 6).

To determine the possible variation in camera positioning from one operator to another, a similar test was performed. Three operators took a total of ten (3, 3, and 4) maxillary photographs on the same patient. Each operator was given the same instructions as to the positioning and use of the camera. These photographs were then analyzed as in the single operator test.

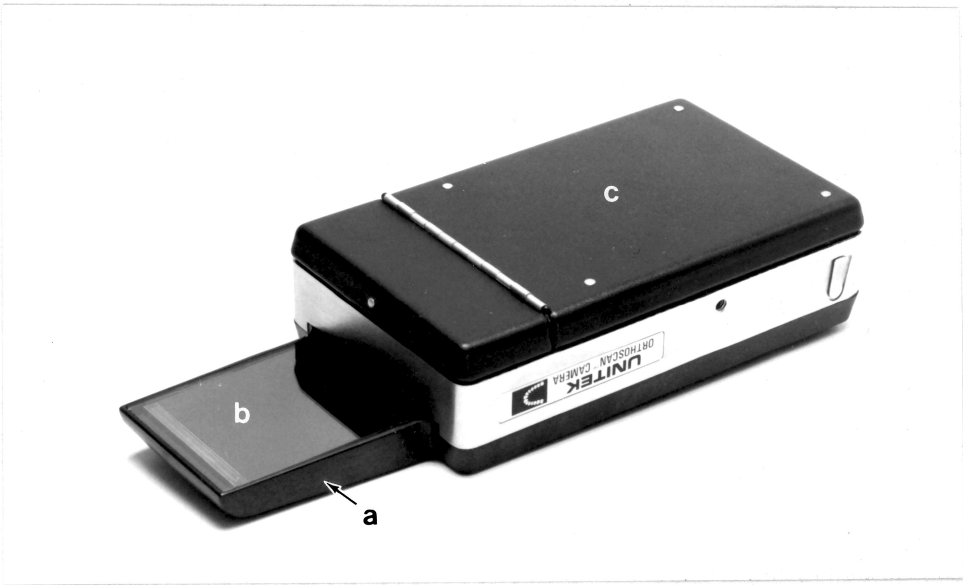


Figure 1. Orthoscan camera (Unitek) showing a. camera mouthpiece, b. mouthpiece window, and c. Polaroid film back.

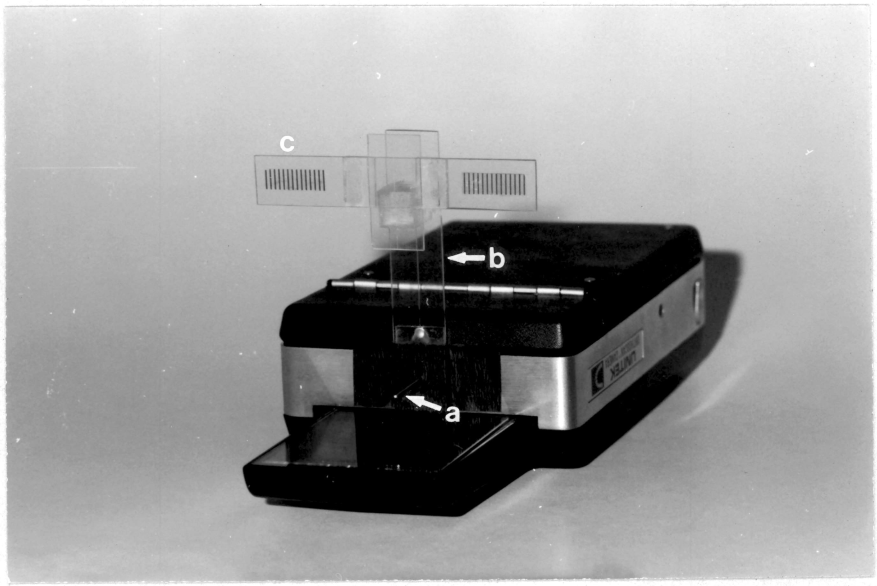
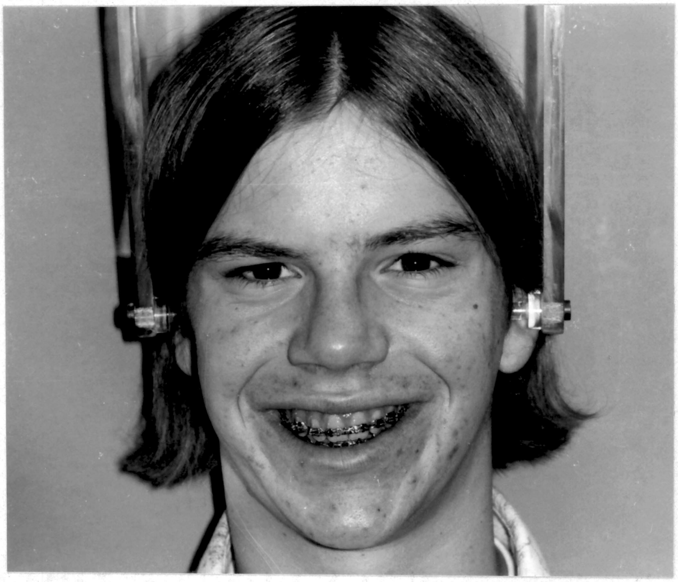
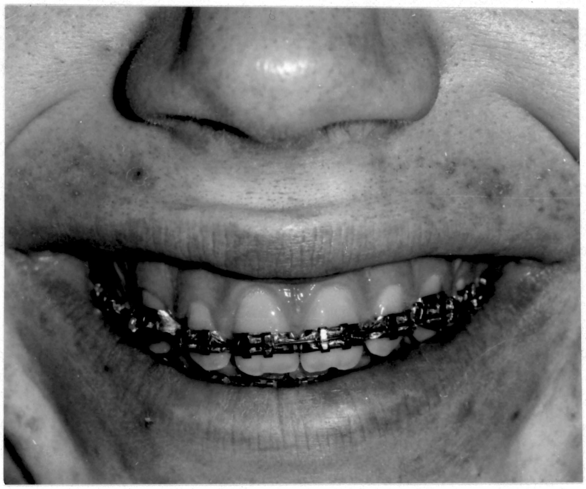


Figure 2. The Orthoscan, shown modified with the camera positioning device: a. midline pointer. b. vertical member with median line marked. c. the horizontal member may be adjusted up or down to fit various facial sizes.



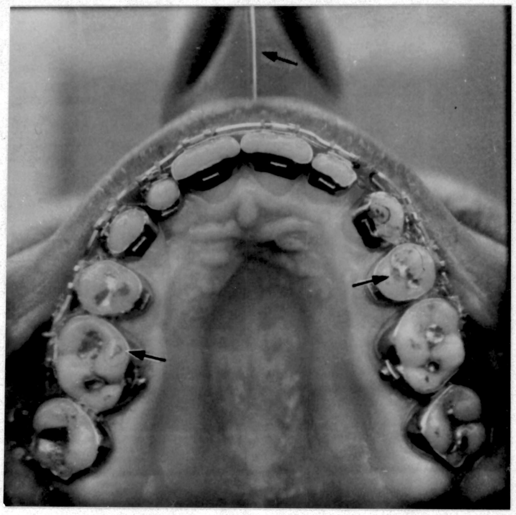
a



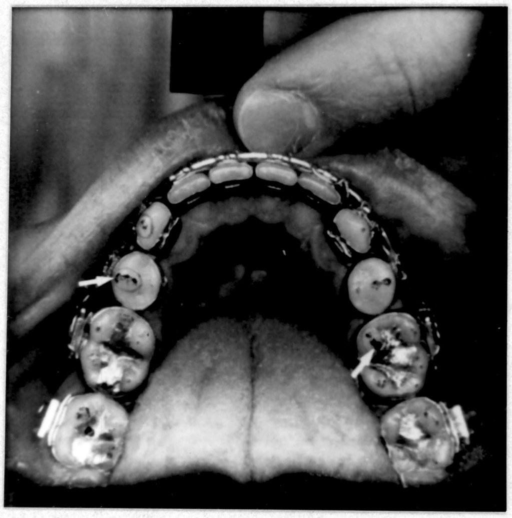
b

Figure 3. Presented is a typical patient evaluated in this study. a. Note the discrepancy between the facial "midline" and the maxillary central incisor embrasure. b. Note the discrepancy between upper and lower central incisor embrasures.

Figure 4. The modified camera is positioned for the maxillary photograph.



a



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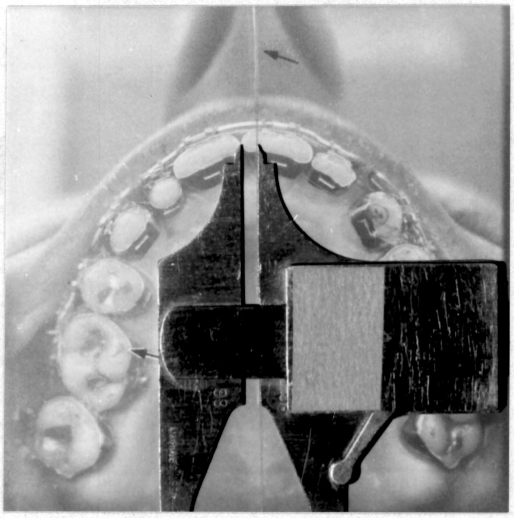
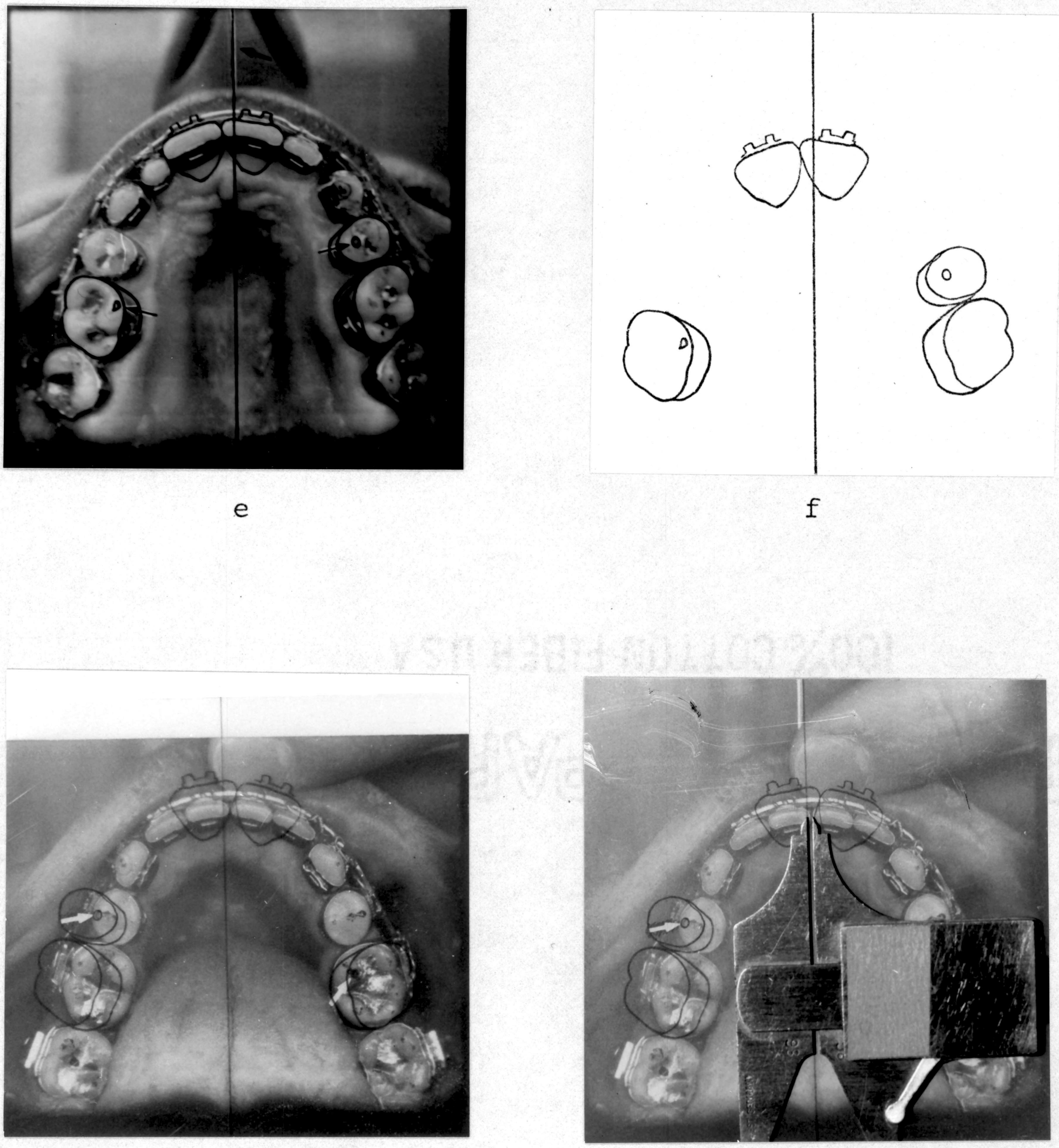


d

Figure 5. Shown are the steps in photoanalysis of midline discrepancy used in this study. a. Maxillary Orthoscan photo. Arrows indicate midline pointer and recorded contact points. b. Mandibular Orthoscan photo showing contact points. c. The acetate with center line is superimposed over midline pointer. d. Measurement of distance I to midline is made. (Fig. 5 continued on next page.)



e f g h

Figure 5. e. Teeth and contact points are traced on acetate. f. The finished tracing. g. The tracing is inverted and superimposed on the contact points of mandibular photo. h. Measurement of distance $\overline{I}$ to midline is made.

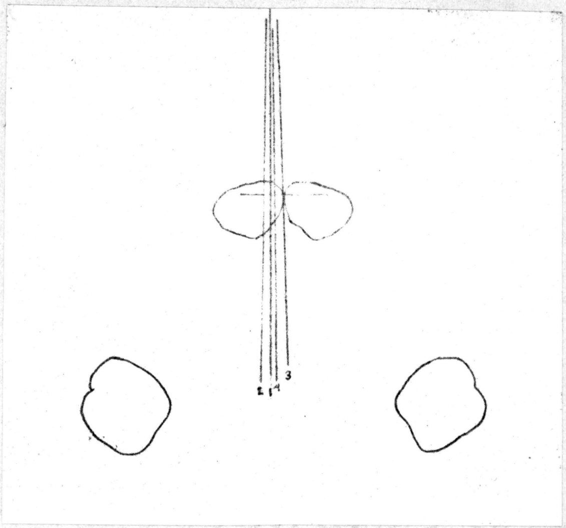


Figure 6. Shown is a composite tracing of the single operator test of camera positioning repeatability. For reasons of clarity only four of the eight midlines (includ-ind the extremes) have been illustrated.

CHAPTER III

RESULTS

The results of the comparison between photographic analysis and direct observation of midline discrepancies are presented in Tables I, II, and III. The raw data for each patient may be seen in Table IV. Graphic representations of the data in Tables I, II and III is shown in Figure 7 and Figure 8.

Figure 7a shows the mean and range obtained from the measurements of the distance between the facial midline (or midline indicated by the pointer) and the maxillary central incisor embrasure ($\underline{I}$). The direction of the $\underline{I}$ to midline is also indicated on the graph.

Figure 7b is essentially the same as Figure 7a but the statistics are for $\overline{I}$ to midline.

Figure 7c represents the difference between measurements of $\underline{I}$ to midline and $\overline{I}$ to midline. That is, it shows the linear horizontal discrepancy between the maxillary central and mandibular central embrasures.

Figure 8 presents the mean values of the ranges from Tables I, II and III. It should be noted that the range is a satisfactory measure of variability for a sample of this size (Dunn, 1967). The range may also be considered an indication of precision since precision increases as the range approaches zero.

The results obtained from the tests of repeatability of camera positioning with one operator and with three operators may be seen in Table V.

TABLE I

THE RANGE OF FIVE INDEPENDENT MEASUREMENTS FOR EACH PATIENT
Measurements are from $\underline{I}$ to facial midline

Patient	Range (mm)	
	Direct Obs.	Photographic
A	3.0	1.0
B	1.5	1.75
C	1.0	1.0
D	2.0	2.25
E	1.0	1.0
Mean	1.7	1.4
Std. Err. Mn.	0.37	0.26

t=-0.661

TABLE II

THE RANGE OF FIVE INDEPENDENT MEASUREMENTS FOR EACH PATIENT
Measurements are from $\overline{I}$ to facial midline

Patient	Range (mm)	
	Direct Obs.	Photographic
A	2.5	1.0
B	0.5	2.0
C	1.0	1.0
D	4.0	2.75
E	1.5	1.25
Mean	1.9	1.6
Std. Err. Mn.	0.62	0.34

t=-0.424

TABLE III

THE RANGE OF THE DIFFERENCE BETWEEN MEASUREMENTS OF $\underline{I}$ TO
MIDLINE AND $\overline{I}$ TO MIDLINE FOR EACH PATIENT

Patient	Range (mm)	
	Direct Obs.	Photographic
A	1.25	0.5
B	1.5	0.5
C	0.5	0.25
D	2.5	0.75
E	1.5	0.25
Mean	1.45	0.45
Std. Err. Mn.	0.32	0.09

t=-2.998

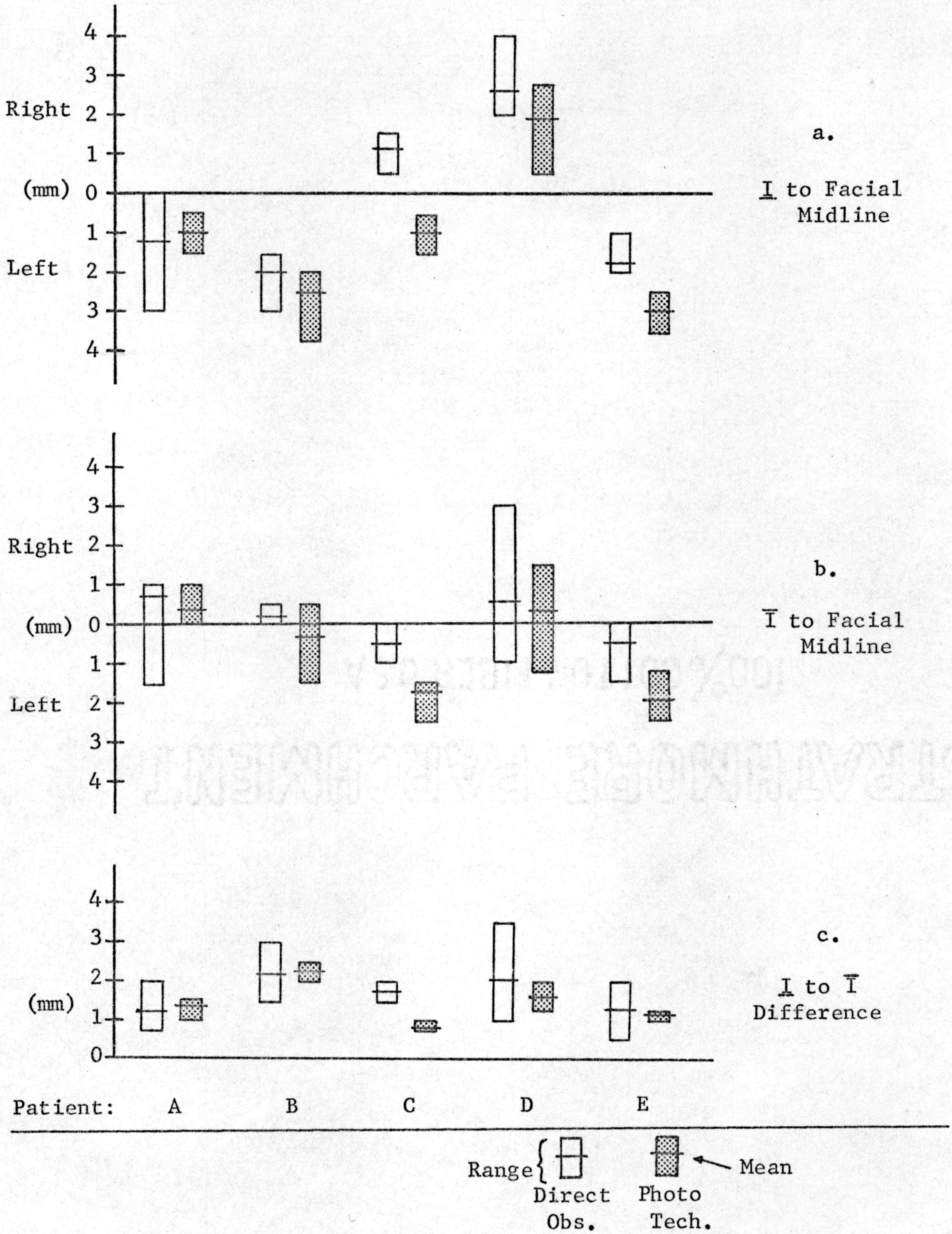


Figure 7. Graphical representation of the data in Tables I,II,andIII is shown in a, b, and c.

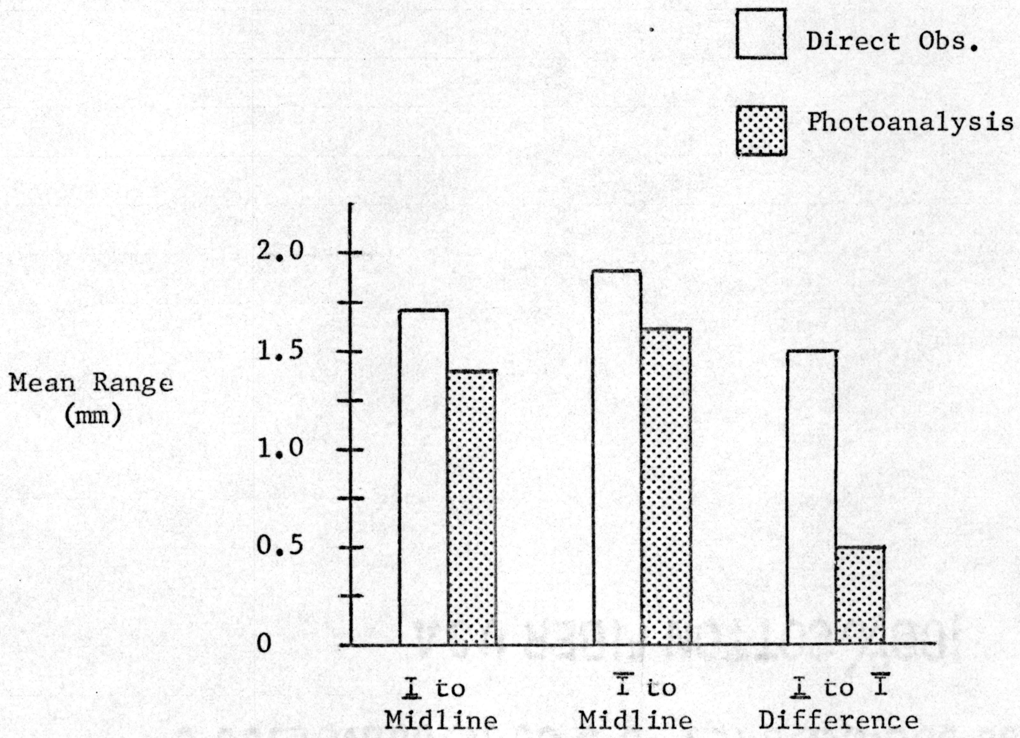


Figure 8. Graphical representation of the mean ranges (data in Tables I, II, and III) is shown. The range is an indicator of variability.

TABLE I V

VISUAL AND PHOTOGRAPHIC MEASUREMENTS FOR EACH PATIENT

Patient A

Observer	$\underline{I}$ to midline(mm)	$\overline{I}$ to midline(mm)	Diff: $\underline{I}$ to $\overline{I}$
1	-3.0	-1.0	2.0
2	-1.25	-0.5	0.75
3	-2.5	-0.5	2.0
4	0	+1.5	1.5
5	0	+1.5	1.5
Range	3	2.5	1.25
Mean	-1.35	+0.7	1.25
Photo			
1	-1.5	0	1.5
2	-0.5	+1.0	1.5
3	-1.0	0	1.0
4	*	*	
5	*	*	
Range	1.0	1.0	0.5
Mean	-1.0	+0.33	1.33

Patient B

Observer	$\underline{I}$ to midline(mm)	$\overline{I}$ to midline(mm)	Diff: $\underline{I}$ to $\overline{I}$
1	-1.5	+0.5	2.0
2	-1.5	0	1.5
3	-2.0	0	2.0
4	-2.0	+0.5	2.5
5	-3.0	0	3.0
Range	1.5	0.5	1.5
Mean	-2.0	+0.2	2.2
Photo			
1	-2.0	+0.5	2.5
2	-3.75	-1.5	2.25
3	-2.0	0	2.0
4	-2.0	0	2.0
5	-3.0	-0.5	2.5
Range	1.75	2.0	0.5
Mean	-2.55	-0.3	2.25

- Left
+ Right

* Only three photographs were taken.

TABLE IV
(Continued)

Patient C

Observer	$\underline{I}$ to midline(mm)	$\overline{I}$ to midline(mm)	Diff: $\underline{I}$ to $\overline{I}$
1	+1.0	-0.5	1.5
2	+1.5	-0.5	2.0
3	+1.5	0	1.5
4	+0.5	-1.0	1.5
5	+1.5	-0.5	2.0
Range	1.0	1.0	0.5
Mean	+1.2	-0.5	1.7
Photo			
1	-0.75	-1.5	0.75
2	-0.5	-1.25	0.75
3	-1.25	-2.0	0.75
4	-1.5	-2.5	1.0
5	-0.75	-1.5	0.75
Range	1.0	1.0	0.25
Mean	-0.95	-1.75	0.8

Patient D

Observer	$\underline{I}$ to midline(mm)	$\overline{I}$ to midline(mm)	Diff: $\underline{I}$ to $\overline{I}$
1	+2.0	+0.5	1.5
2	+4.0	+3.0	1.0
3	+2.0	+0.25	1.75
4	+2.5	-1.0	3.5
5	+2.5	0	2.5
Range	2.0	4.0	2.5
Mean	+2.6	+0.55	2.05
Photo			
1	+2.25	+0.75	1.5
2	+2.75	+1.5	1.25
3	+2.25	+0.75	1.5
4	+0.5	-1.25	1.75
5	+1.75	-0.25	2.0
Range	2.25	2.75	0.75
Mean	+1.9	+0.3	1.6

\- Left
\+ Right

TABLE IV
(Continued)

Patient E

Observer	$\underline{I}$ to midline(mm)	$\overline{I}$ to midline(mm)	Diff: $\underline{I}$ to $\overline{I}$
1	-2.0	0	2.0
2	-2.0	-1.0	1.0
3	-2.0	0	2.0
4	-2.0	-1.5	0.5
5	-1.0	0	1.0
Range	1.0	1.5	1.5
Mean	-1.8	-0.5	1.3
Photo			
1	-3.25	-2.25	1.0
2	-3.5	-2.5	1.0
3	-3.0	-1.75	1.25
4	-3.25	-2.0	1.25
5	-2.5	-1.25	1.25
Range	1.0	1.25	0.25
Mean	3.1	-2.0	1.2

- Left
+ Right

TABLE V

SINGLE VS. TRIPLE OPERATOR TEST ON CAMERA POSITIONING REPEATABILITY

	One Operator (n=8)	Three Operators (n=10)
Range (mm)	2.4	2.0
Std. Dev. (mm)	0.39	0.35

CHAPTER IV

DISCUSSION

Cursory analysis of the data from Tables I and II suggests that photoanalysis may be slightly more precise than direct observation. The mean, range, and standard deviation are lower in the photographic technique. However, a t-test was performed and showed that the mean difference between the two methods was not significant at the .05 confidence level. This suggests that there is no significant difference in precision between the two methods when measuring $\underline{I}$ to midline and $\overline{I}$ to midline.

The data presented in Table III shows a greater mean difference than in Table I or II. The t-test showed this difference to be significant at the .05 level. Thus, measurement of the discrepancy between the upper and lower dental midlines seems to be more precise using photoanalysis than by direct observation.

It is felt that variation in camera positioning was responsible for the largest error in this technique. Precision in measurement of $\underline{I}$ to midline and of $\overline{I}$ to midline is largely dependent on camera position. Precision in measurement of $\underline{I}$ to $\overline{I}$ is only dependent on the exactness of tracing, superimposition and measurement. This may explain why there was significantly more variation in measurements of $\underline{I}$ or $\overline{I}$ to midline than in $\underline{I}$ to $\overline{I}$.

Lack of precision in the photographic phase of this study may be attributed to variation in camera positioning and to optical distortion.

The amount of positioning variation is reflected in the standard deviation calculated from the tests on repeatability of camera positioning. From the single operator test the standard deviation is ± 0.39mm. Is should be stated that this is only a test of precision in camera positioning and not of accuracy in midline determination.

From the multi-operator test, the precision of camera positioning seems to be at least as good as with a single operator. The standard deviation was calculated to be ± 0.35mm at the central incisor embrasure.

Based on the results of these two tests, variation in positioning should not differ with the use of one, versus the use of several, camera operators. Thus, to simplify the research design, one operator was used in the photographic phase of this study.

The second possible reason for lack of precision is in the camera optical system. The Orthoscan manual (Unitek, 1972) states that the photographic image is "life-size" but later specifies that an exact 1:1 image is only obtainable on a plane 4.5 millimeters from the window of the camera mouthpiece. Objects which are closer to the window than 4.5mm will measure larger than life-size in the lateral dimension; those which are farther away will measure smaller (Fig. 9). The correction factor is one percent per millimeter of deviation. There is no apparent dimensional change of the image in an anteroposterior direction.

For this technique, dimensional change of the photographic image primarily affects the step of superimposition of the maxillary tracing on the contact points of the mandibular photograph. To illustrate this, assume that the recorded contact points are on a right and left mandibular cusp tip, occluding with a right and left maxillary fossa. When the photographs are made, the cusp tips are in contact with the window of the camera, but the fossae are 4.5mm from it. Thus, the contact points in the upper fossae would be exactly life-size, while those on lower cusp tips would be enlarged 4.5 percent. Since this enlargement is only in a lateral direction, the two lower contacts measure farther apart than the two upper contacts. It is therefore not possible to precisely superimpose the upper and lower contact points. A compromise must be made. In the illustrated case, the compromise would simply be to equally divide the discrepancy between the right and left sides when superimposing. Unfortunately, this example is highly idealized and it cannot be expected to be this simple clinically. Rarely could one expect the right and left contact points to be equidistant from the window of the camera. In addition, it would be extremely difficult to measure this distance at the precise moment of film exposure in order to calculate the amount of distortion. The problem is further complicated in cases with a curve of spee, an extruded tooth or segment, or with vertical asymmetry of the maxilla (Cheney, 1961; Lundstrom, 1961).

For many of the cases in this study, precise superimposition of the contact points could not be achieved. Therefore, an averaged or compromise superimposition had to be performed. Any error due to superimposition would affect the measurement of $\overline{I}$ to midline and $\underline{I}$ to $\overline{I}$. It has previously been shown that much of the variation in the $\overline{I}$ to midline measurements was due to camera positioning. Since the $\underline{I}$ to $\overline{I}$ measurements show little variation (Fig. 7 and 8) it can be assumed that error arising from image distortion would be minimal.

Photoanalysis has shown no advantage over direct observation in measuring discrepancies between facial and dental midlines. Before theorizing on improving the precision of this technique, it would be valuable to review its development to the present stage.

The main premise for the development of a precise method of midline analysis for clinical use is obvious: Before the best treatment can be delivered, a thorough diagnosis must be made. While anterior diagonal elastics may be adequate for correcting midline shifts where the upper and lower incisor embrasures are on opposite sides of the median facial plane (Fig. 10), this treatment used for other types of midline deviations may correct the teeth but worsen the facial esthetics.

To aid in the diagnosis of this problem it was felt that the Orthoscan camera could be employed. The camera is quick and easy to use and produces a "life-size" two-dimentional image which simplifies measurement. A good median sagittal reference plane was originially thought to be the palatal raphe. The raphe, however, was difficult to identify in some photographs, partly because it was not distinct in certain patients, and partly because the camera is not in sharp focus at that distance from the window. In addition, the raphe may actually be 's' shaped in some individuals (Lundstrom, 1961). For these reasons a second reference plane was chosen. A line connecting two "reliable" introoral reference points namely the posterior point of the incisive papilla and the midpoint between the foveae palatina was used. The two foveae were marked in the mouth for ease of visualization on the photograph. In patients with small mouths however, it was difficult, if not impossible, to place the camera mouthpiece far enough posterior to include the foveae in the photograph. Due to this problem, plus the fact that the teeth were not being related to the face, a third median plane was developed. Since most orthodontists tend to visually relate the maxillary centrals to the nose, and since the base of the nose is visible in the maxillary photographs, it was chosen as a facial reference point. A line drawn from a median point on the base of the nose to the posterior point of the incisive papilla was used as the midline reference. It was later noticed that in some cases the line from nose to papilla differed markedly from the other reference lines mentioned. There are two possible reasons for this difference. First, there may be an anatomical reason: The nose may deviate from the true median plane, the maxilla may be displaced laterally or rotated (Harper, 1948; Cheney, 1961), the papilla may not coincide with the palatal raphe (Harper, 1948; Lysell, 1955), or any combination of the above. Second, tipping of the camera mouthpiece to the right or left so it is not perpendicular to the median facial plane would project the nose off center in the photograph (Fig. 11). This second point became apparent when it was observed that two consecutive photographs on the same patient would often show the nose in different positions (Fig. 12).

At this point it was decided that a positioning device should be added to the camera which would meet the following criteria: It should align the camera with the facial midline so that the arch will be centered in the photograph, position the mouthpiece window perpendicular to the facial midline to minimize projection errors, prevent a rotated position of the camera around the vertical axis, house a midline pointer which would be visible in the maxillary photograph, and be adjustable so it can be used with different facial sizes.

Improvement in the precision of this technique is dependent on correction of those factors responsible for error. The main offenders seem to be dimensional inaccuracy of the photographic image and variation in camera positioning. Dimensional inaccuracy of the photographic image is an innate problem within the camera's optical system. Correction factors would be difficult to determine, however, errors due to dimensional inaccuracy seem to be minimal.

It may be possible to improve the camera positioning device, however, an extremely precise measuring instrument has no advantage over a less precise one if the object to be measured is itself not precise. The normal human face has been shown to contain slight asymmetries. The right and left sides may have discrepancies of up to a few millimeters (Halperin, 1931). In addition, operator error in judgement or technique could easily negate the added precision of the positioning device. For these reasons, development of the positioning device beyond its present state was not deemed necessary.

The accuracy of any analysis of midline or symmetry is dependent on the location of the "true" facial midplane. Since the exact location of this midplane is more philosophical than clinical, the orthodontist's analysis is largely judgemental. This study has shown little advantage of Orthoscan photoanalysis over direct visual observation in the diagnosis of dentofacial asymmetry. The lack of definite advantage, plus the added time and expense involved, make this photographic technique clinically impractical.

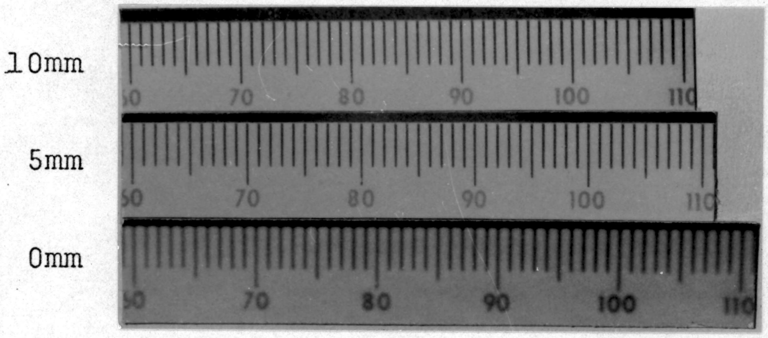


Figure 9. A composite of three Orthoscan photographs of a ruler taken at 0, 5, and 10 millimeters from the mouthpiece window demonstrates dimensional change. This image distortion only occurs in the lateral dimension.

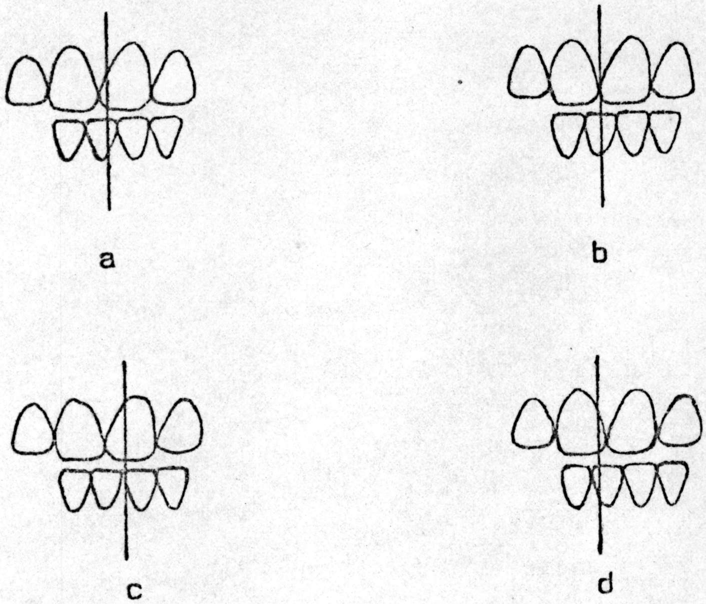


Figure 10. In the illustrations shown above, the dental midline discrepancy is 2mm. The facial midline, however, is related differently in each illustration. Treatment with anterior diagonal elastics would produce ideal results only in illustration a.

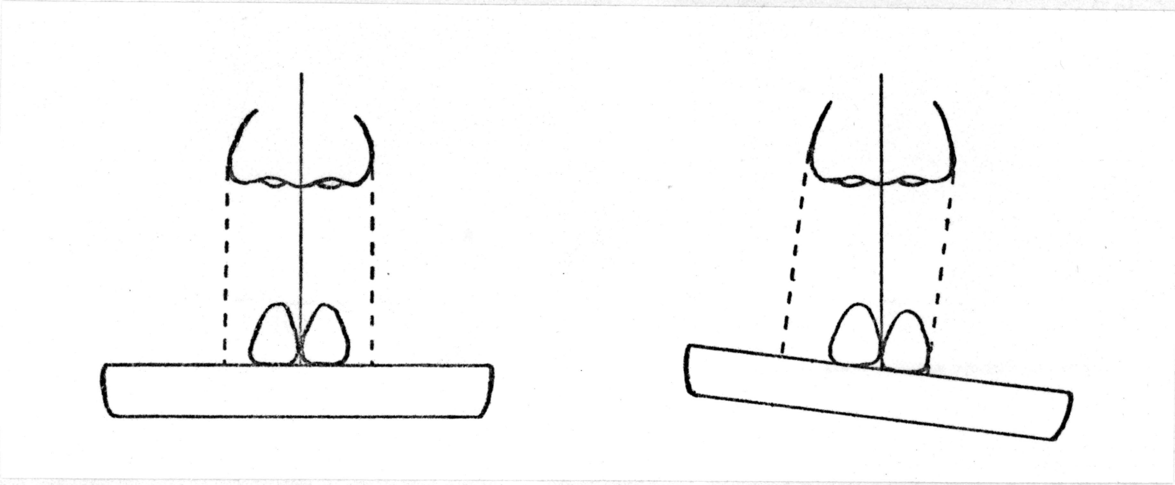


Figure 11. If the camera mouthpiece is not perpendicular to the facial midplane, the nose will be projected off center. An extruded tooth or segment may tip the mouthpiece.

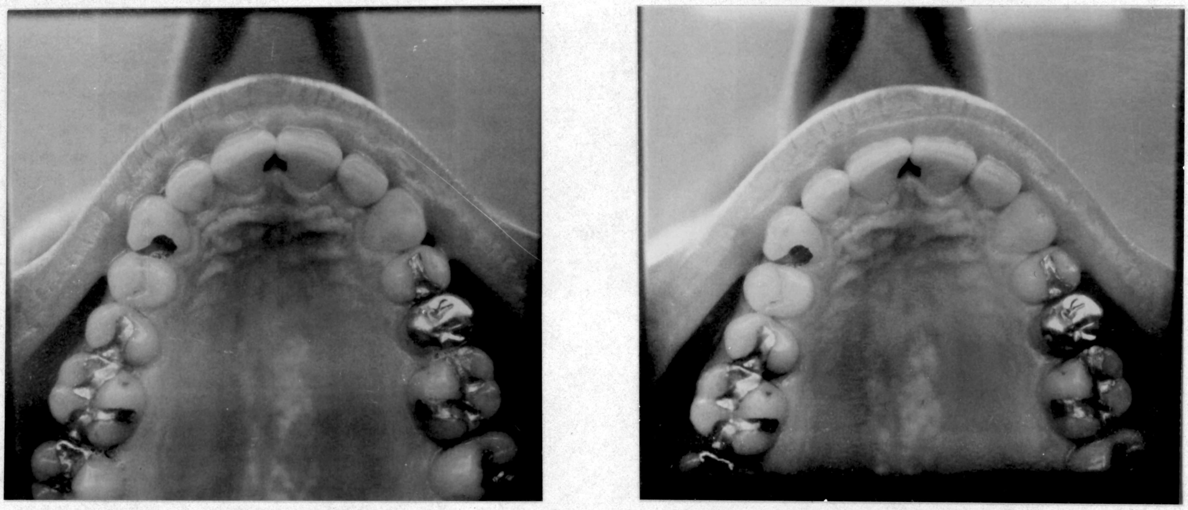


Figure 12. Two consecutive Orthoscan photographs demonstrate the problem described in Fig. 11.

CHAPTER V

SUMMARY

A clinical photographic technique of dentofacial midline analysis was presented and compared with the conventional clinical method, namely, direct visual observation. For both methods, the facial midline was established and used as a reference for analysis of the dental discrepancy.

The study indicated that photoanalysis had minimal advantage over direct observation in the diagnosis of midline asymmetries. Lack of precision seemed to be due to the inherent difficulties in establishing a true facial midplane. The minimal advantage, coupled with the additional time and expense involved, make the clinical practicality of photoanalysis questionable.

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CLINICAL PHOTOGRAPHIC ANALYSIS

OF

DENTOFACIAL MIDLINE ASYMMETRIES

by

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An Abstract of a Thesis
in Partial Fulfillment of the Requirements
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in the Field of Orthodontics

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ABSTRACT

Clinical diagnosis of dentofacial midline asymmetries has been difficult because of the problems in locating a reliable median sagittal reference plane, and because of the complexity and time involved in analysis. For these reasons, the clinician has generally resorted to direct visual observation in diagnosing midline discrepancies. A quick, precise, chairside method of dentofacial midline analysis would be of benefit to the orthodontist.

This study presented a clinical photographic method of dentofacial midline analysis and compared its precision with that of direct observation. The photographic method employed an Orthoscan Polaroid intraoral camera (Unitek) with a positioning device used to relate the facial midline to the maxillary arch photograph. Orthodontic patients with midline discrepancies were assessed by both methods.

The study indicated that photoanalysis had minimal advantage over direct observation in the diagnosis of midline asymmetries. Lack of precision seemed to be due to the inherent difficulties in establishing a true facial midplane. The minimal advantage, coupled with the additional time and expense involved, make the clinical practicality of photoanalysis questionable.