A CEPHALOMETRIC INVESTIGATION OF SOFT TISSUE PROFILE

Protocol

by

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INTRODUCTION AND PURPOSE

Soft tissue morphology is greatly influenced by the constituent muscles and the underlying dentition and skeletal framework. A subjective evaluation of facial esthetics often is a determining factor in orthodontic diagnosis and treatment planning. Although the orthodontist assumes a primary role in evaluation of the facial esthetics, a consideration of both the family dentist's and the patient's concept of esthetics would seem to be warranted, considering the highly personal nature of the contemplated changes.

A number of cephalometric analyses have be utilized to evaluate the esthetic profile. It is the purpose of this study to consider the applicability of some of the existing standards as applied to a random sample of males and females at both an orthodontic treatment age and a postretention age:

1. in evaluation of consideration of facial harmony by three specific groups of observers (orthodontist, general dentist and lay persons);
2. in determination of which specific cephalometric measurements will most readily distinquish a pleasing profile;
3. in an attempt to develop a concept of an overall pleasing profile.

REVIEW OF THE LITERATURE

Concept of Pleasing Profile

The role of orthodontic treatment in the achievement of improved facial esthetics has long been recognized. For example, Angle (1907) thought that treatment executed without extractions produced an optimal facial form, as exemplified by a variety of faces that were considered ideal by Angle--Apollo Belvedere, Donatello's Saint George, Michaelangelo's David and Nefertite, Queen of Egypt (Angle, 1970; Baum, 1966).

Although the importance of careful analysis of the soft tissue may be generally accepted, Hambelton (1963) states

> . . . we cannot stereotype this easily and certainly the mind's eye of every orthodontist does not see the same flatness or fullness of every profile.

Thompson (1889) and Herzberg (1952) felt that some form of balance and harmony among the elements of the soft tissue of the face would result in a pleasing appearance. Such vague statements have lead to further investigation.

Many have attempted to develop a method to quantify the concept of a pleasing profile. Reidel (1957) analyzed the facial patterns of the Seattle Seafair princesses (girls selected to represent their communities as a more or less ideal young female type, by judges unknown to the contestants) and concluded that the opinion of the general public was in close agreement with the established standards.

Burstone (1958) developed an integumental analysis based on the selection of acceptable facial esthetics by three artists.

Peck and Peck (1970), on the other hand, found by utilizing a sample composed of models, beauty contest winners and performing stars, that the public favored a fuller, more protrusive profile than some cephalometric standards would consider ideal. The sample utilized in this study consisted of forty-nine females and only three males. This is important, inasmuch as a difference exists between the profile preference of males and females (Baum, 1966; Cox and van der Linden, 1971).

Cox and van der Linden (1971) utilized a Q-sort frame in the evaluation of profiles by a group of observers. This method enabled the observers to rank the profiles into a distribution of decreasing facial harmony. Their sample consisted of a single age group of eighteen to twenty year olds. In addition, many of the angular and linear measurements were related to bony nasion and pogonion. He concluded

> . . . that persons with poor facial esthetics in general have relatively more convex faces and, particularly among boys, more anteriorly positioned incisors.

Hershon et al. (1974) attempted to determine how accurately one perceives his own profile. Swedish females were asked to recreate their own and desired profiles on a mechanical device. The results indicated that the sample group underestimated less desirable features; however, a significant correlation existed between a simulation of one's own and desired profiles.

It is apparent that it has been difficult to develop a truly

objective analysis of facial esthetics. Attempts have been made to quantify the elements of a pleasing profile and develop cephalometric standards. A wide variety of samples have been utilized; however, many have been preselected based on some supposed attribute. A number of factors must be considered, as well as the concepts and ideals of many individuals.

Growth Changes

Obviously, growth may have an important impact on the appearance of various dentofacial esthetics. The development of cephalometrics and longitudinal studies (Broadbent, 1931; Broadbent, 1937) has greatly enhanced the understanding of the contribution of growth to facial harmony. This allowed for a precise roentgenographic technique that might be utilized to measure these changes.

Bjork (1951) has demonstrated that the profile becomes less convex with increased age. This is due to mandibular growth, resulting in the mandible becoming more prognathic than the maxilla (Bjork, 1951; Lande, 1952).

Subtelny (1959) made a longitudinal study of soft tissue profile of subjects ranging in age from six months to eighteen years. He also concluded that the soft tissue profile becomes less convex with age, but not to as great a degree as the underlying skeleton.

Obviously, growth will have a profound effect upon the soft tissue and

> . . . we must take into consideration these factors of growth that are occurring directly around and over the structures with which we are working (Hambelton, 1963).

It is necessary to understand that treatment changes would most likely

be more dramatic.

Treatment Change

Since treatment per se will not be considered (although a pre- and post-retention age sample is being utilized), treatment effects on soft tissue will be briefly discussed.

Wylie (1955), in a cephalometric evaluation of twenty-nine cases treated by Charles Tweed, found

> . . . a low correlation between lingual movement of the lower incisal edge and straightening of the soft tissue angle of convexity.

Wylie concluded:

> We should expect improvement of the facial profile if we can retract the upper incisors. If it is necessary to retract the lower incisors to do so, obviously we cannot look for much improvement in the face until we upright both teeth.

Rudee (1964) found a correlation (r=.7) between the retraction of the upper and lower incisors and the upper and lower lips.

Hershey (1972) measured the distance from skeletal and soft tissue points to the nasion-pogonion line and showed a rather high degree of correlation between incisor retraction and soft tissue retraction.

Others have investigated the response of soft tissue to treatment and found a great degree of variability (Roos, 1974; De Laat, 1974; Garne, 1974). Essentially, the changes in soft tissue may not be equivalent to those of the skeletal profile.

Soft Tissue Analysis

There has been a great deal of effort made to analyze and

describe the soft tissue profile. Many of the studies have been based on clinical experience, isolated cases or very biased samples (Peck and Peck, 1970).

Since many analyses have been devised, only those to be utilized in this study will be discussed.

Ricketts has suggested the use of the so-called "esthetic plane," a line from the tip of the nose to the chin (Ricketts, 1957; Ricketts, 1961). The lips should be located behind this plane, with the lower lip 2 mm. ahead of the upper lip.

An analysis described by Merrifield (1966) is formed by constructing a line from the chin to the most protruding lip tip extending to the Frankfort plane. The inner angle of these two lines is termed the "Z" angle. The ideal measurement would be 78°.

The "profile determinant plane" was utilized by Bash (1958). It is formed by a line from Glabella to soft tissue pogonion. Linear measurements are made perpendicularly to this plane from various soft tissue points. This was considered to be a good soft tissue plane for the following reasons:

1. It is a true soft tissue reference plane, because it is only associated with soft tissue.
2. It connects the most anterior vertical extremities of the soft tissue profile.

Vertical linear measurements were made in this same study parallel to the profile determinant plane. The total facial height was the distance between nasion (Ns) and menton (Ms) (see Fig. VI).

Much emphasis has been placed upon the position of the lower

incisor in relation to favorable soft tissue contour. Williams (1969) suggested that

> . . . in either treated or nontreated persons with harmonious or well-balanced lips, it will be found that the incisal edge of the lower incisor is at or close to the AP (diagnostic line).

Ricketts felt that the lower incisor should be placed near the AP line, which will exist at the end of treatment. This position will take into consideration the facial pattern (Ricketts, 1964).

Tweed also emphasized the importance of the lower incisor and its relation to the "Tweed Triangle" (Tweed, 1954). He states,

> In virtually every instance, those patients possessing balance and harmony of facial proportions had mandibular incisors that were upright over basal bone (Tweed, 1962).

Holdaway analyzed the soft tissue profile by relating the soft tissue line (from chin to upper) in an angular measurement to the NB line.

1. Lower lip should be on the soft tissue line.
2. Soft tissue angle of 7°.
3. 9 mm. from the tip of the nose to the soft tissue line at thirteen years old.

Lip thickness was measured by Hasstedt (1956). Linear measurements were made from various hard tissue landmarks to the soft tissue. These were primarily concerned with the areas most effected by incisor position.

Obviously, evaluation of soft tissue must consider the configuration of the dentoskeletal framework. As a result, the Down's analysis (Downs, 1939) will be utilized in this evaluation. Although

this analysis tends to be widely employed, a basic criticism is the sample selection utilized in establishment of the mean values. His sample consisted of only twenty children, twelve to seventeen years of age, with excellent occlusions.

A number of analyses have been presented and will be employed in this study. In addition, numerous others exist. This study will attempt to evaluate the concept of pleasing profile as expressed by a wide variety of observers. This will, in turn, be considered in terms of a number of cephalometric soft tissue analyses. The applicability of particular values as precise treatment objectives will be evaluated.

MATERIALS AND METHODS

This investigation will utilize standard lateral roentgenocephalograms of both males and females in two specific age groups. Profile silhouette photographs will be made from the cephalograms. These will in turn be evaluated by three groups of observers.

General Description

The sample will consist of ninety-six males and ninety-six females. The ages were selected to approximate the pre-treatment and post-retention ages, i.e. eleven and eighteen, respectively. Each group of ninety-six will then be divided into subgroups of forty-eight each.

In many earlier studies of facial profile, the samples were selected based on a specific criteria, i.e. excellent occlusion, beauty queens, a certain malocclusion, etc. This study will attempt to eliminate most elements of preselection of the sample, other than a wide range of profiles.

In order to develop a reliable range of profiles, only the ANB angle will be utilized in the selection. The ANB angle has been shown to be the "single best discrimination" in the Steiner analysis (Holdaway, 1956; Harris et al., 1972). As a result, the sample will consist of a range of ANB angles from -1° to 10°.

The profiles will be evaluated by ten orthodontists, ten family dentists and ten lay persons. The family dentist category will

include at least one pedodontist and two oral surgeons. Each group of forty-eight will be evaluated independently of each other by the observer. Each observer will arrange the profiles according to a normal distribution, and Q-sort frame will be constructed (Stephenson, 1964).

Q-sort Construction

Q-technique is a way of rank ordering objects and then assigning values to them for statistical purposes (Kerlinger, 1973; Cox and van der Linden, 1971). The Q-sort distribution for the group of forty-eight items is seen in Table I. It has a rank order continuum from "most pleasing" to "least pleasing."

TABLE I

Q-SORT DISTRIBUTION

	Score									
Most Pleasing	8	7	6	5	4	3	2	1	0	Least Pleasing
	2	4	5	8	10	8	5	4	2	
	Number									

n=48.

The numbers 2, 4, 5 . . . 5, 4, 2 are the numbers of profiles to be placed in each pile, while the corresponding numbers above are the values assigned to each profile. The center pile is the "neutral pile," into which observers are instructed to place any profile about which they are undecided in the neutral pile. This method provides a reliable manner in which observers might rank profiles in terms of

their concept of a pleasing profile.

Cephalometric Analysis

The eleven highest rated profiles in each group of forty-eight will be combined, as will the lowest rated for each age level. The hard and soft tissue landmarks to be utilized are seen in Tables II & III and Figures I & II. The various cephalometric analyses will be performed for each of these groups. The analyses are listed below and pictured in Figures I & II.

1. Z Angles
2. REP (Ricketts Esthetic Plane)
3. Holdaway Analysis
4. Diagnostic Line
5. Soft Tissue Convexity
6. Tweed Triangle
7. Down's Analysis
8. ANB Angle
9. Soft Tissue Thickness (Hasstedt, 1956)
10. Vertical Evaluation (Bash, 1958)
11. Profile Determinant Plane (Bash, 1958)

All measurements will be made to the nearest 0.5 mm. or 0.5 degree.

Statistical Evaluation

Statistical analysis of the data will consist of calculation of means, standard deviations and t-tests. An attempt will be made to utilize the technique of discriminant function analysis (Harris et al., 1972; Harris et al., 1973; Kowalski et al., 1974).

TABLE II

Where and What is Table I

Hard Tissue Reference Points

Bolton Point (Bo) A point in space about the center of the foramen magnum that is located on the lateral cephalometric roentgenogram by the highest point in the profile image of the postcondylar notches of the occipital bone.

Gnathion (Gn) The lowest, most anterior midline point on the symphysis of the mandible.

Gonion (Go) The external angle of the mandible, located on the lateral roentgenogram by bisecting the angle formed by tangents to the posterior border of the ramus and the inferior border of the mandible.

Menton (Me) The most inferior point on the symphysis of the mandible in the median plane. Seen in the lateral roentgenogram as the most inferior point on the symphyseal outline.

Nasion (Na) The craniometric point where the midsagittal plane intersects the most anterior point of the nasofrontal suture.

Orbitale (Or) In craniometry, the lowest point on the inferior margin of the orbit. The left orbital point is used in conjunction with the poria to orient the skull on the Frankfort horizontal plane.

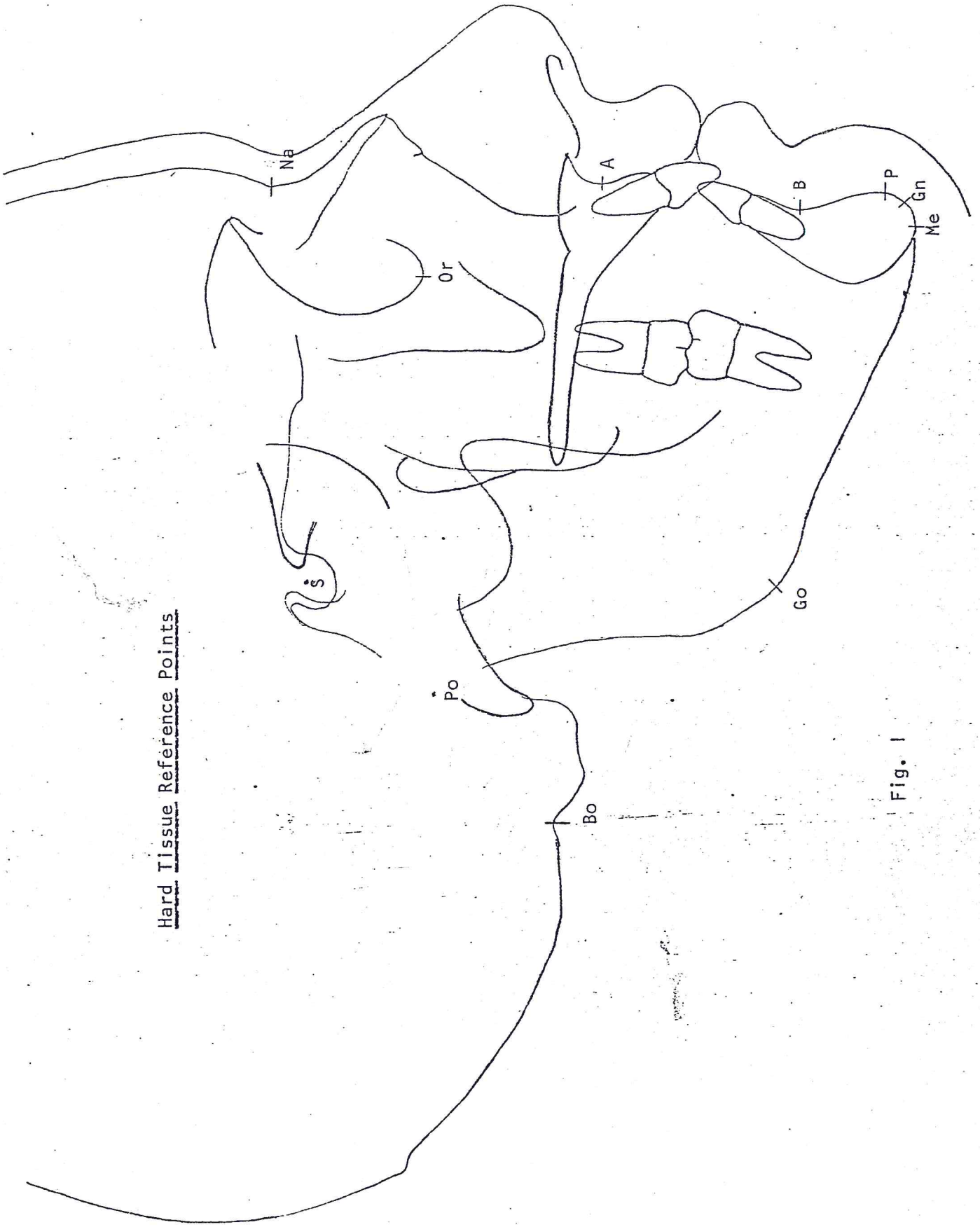
Pogonion (P) The most anterior point on the symphysis of the mandible in the median plane.

Porion (Po) The point on the upper margin of the porus acusticus externus. The two poria and the left orbitale define the Frankfort horizontal plane.

Sella Turcica (Turkish saddle) (S) The hypophyseal or pituitary fossa of the spheniod bone lodging the pituitary body. The landmark, "S", is the center of sella as seen in the lateral roentgenogram and located by inspection.

Subspinale (A) That point in the median sagittal plane where the lower front edge of the anterior nasal spine meets the front wall of the maxillary alveolar process. (Downs' point "A")

Supramentale (B) The deepest midline point on the mandible between infradentale and pogonion. (Downs' point "B")



Hard Tissue Reference Points

Fig. 1

TABLE III

Soft Tissue Reference Points

Glabella (Gs) The most prominent or anterior point in the midsagittal plane of the forehead at the level of the superior orbital ridges.

Nasion (Ns) The most concave or retruded point in the tissue overlying the area of the frontonasal suture.

Nasal Bridge (Nb) A point along the bridge of the nose halfway between soft tissue nasion and the tip of the nose.

Nasal Tip (T) The most prominent or anterior point of the nose.

Nostrils (N) The midpoint between the tip of the nose and subnasale.

Subnasale (S) The point at which the nasal septum between the nostrils merges with the upper cutaneous lip in the midsagittal plane.

Soft Tissue Subspinale (As) The point of greatest concavity in the midline of the upper lip between subnasale and labrale superius.

Labrale Superius (U) The most anterior point on the margin of the upper membranous lip.

Lip Contact (C) Junction of the upper and lower lips.

Labrale Inferius (L) The most anterior point on the margin of the lower membraneous lip.

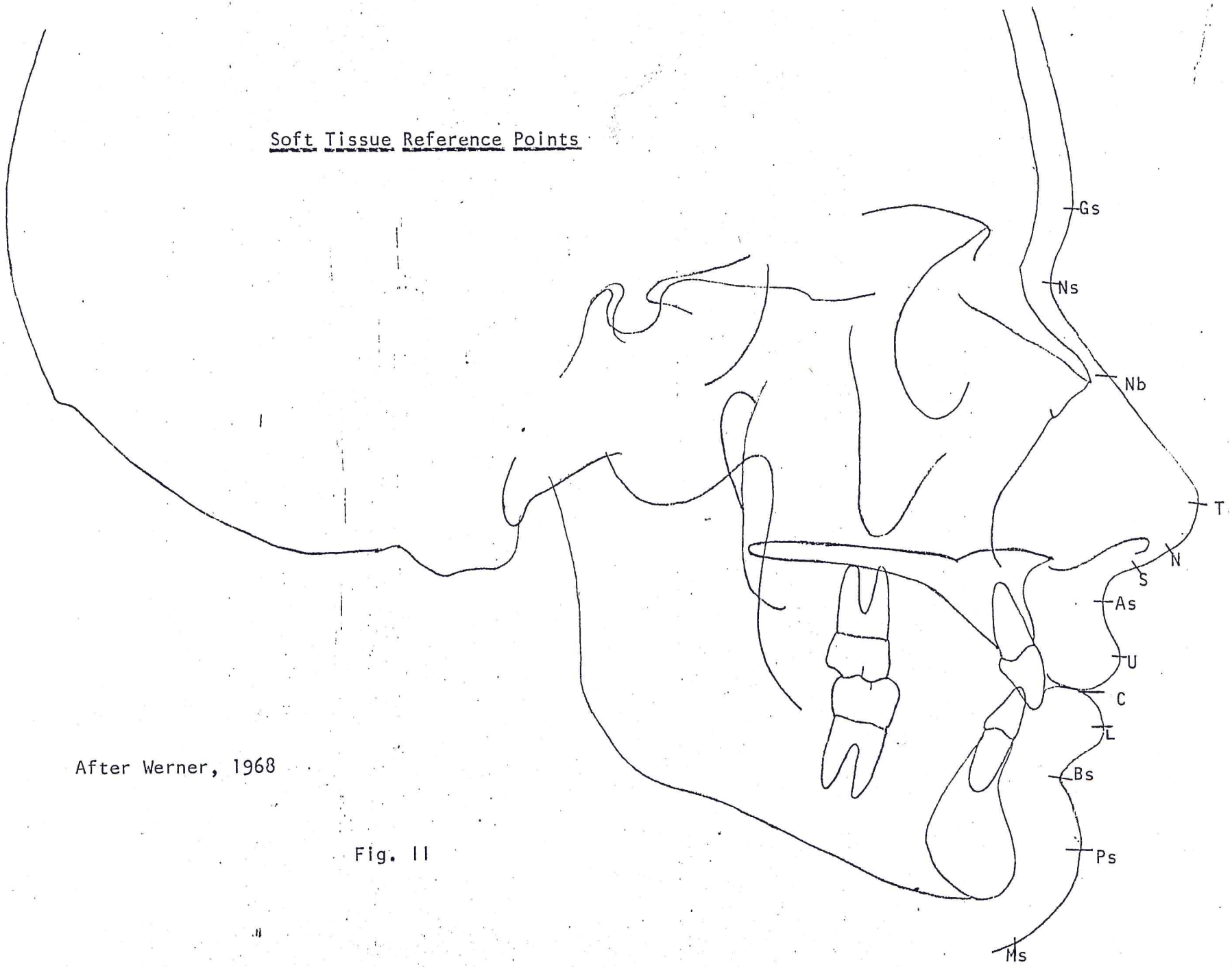
Soft Tissue Submentale (Bs) The point of greatest concavity in the midline of the lower lip between labrale inferius and pogonion.

Soft Tissue Pogonion (Ps) The most prominent or anterior point on the soft tissue chin in the mid sagittal plane.

Menton (Ms) The point where the extended skeletal nasion-pogonion line intersects the soft tissue of the chin.

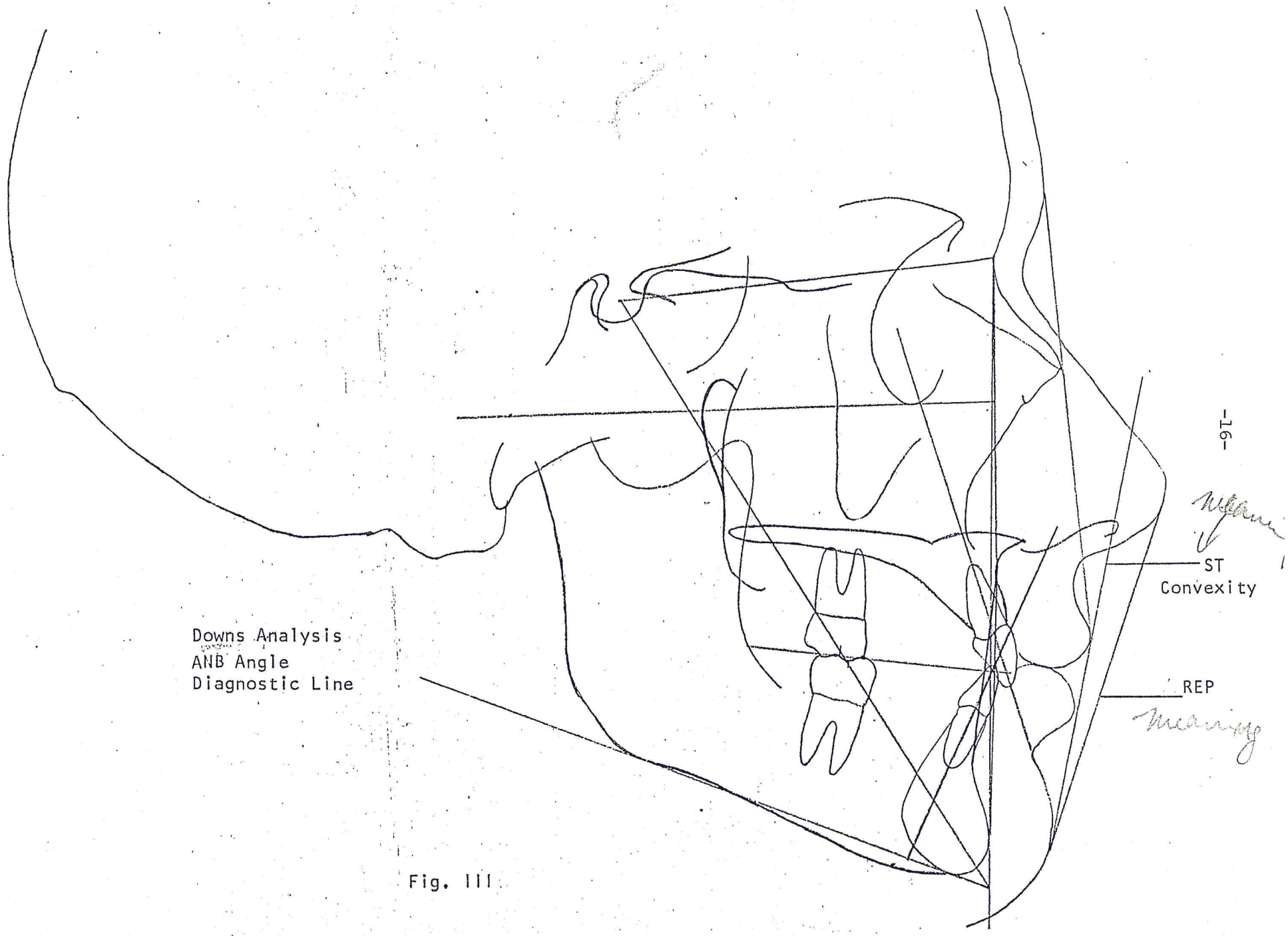
A lower case s affixed to a capital letter designating a skeletal reference point indicates the soft tissue counterpart.

Soft Tissue Reference Points



After Werner, 1968

Fig. 11



Downs Analysis
ANB Angle
Diagnostic Line

Fig. III

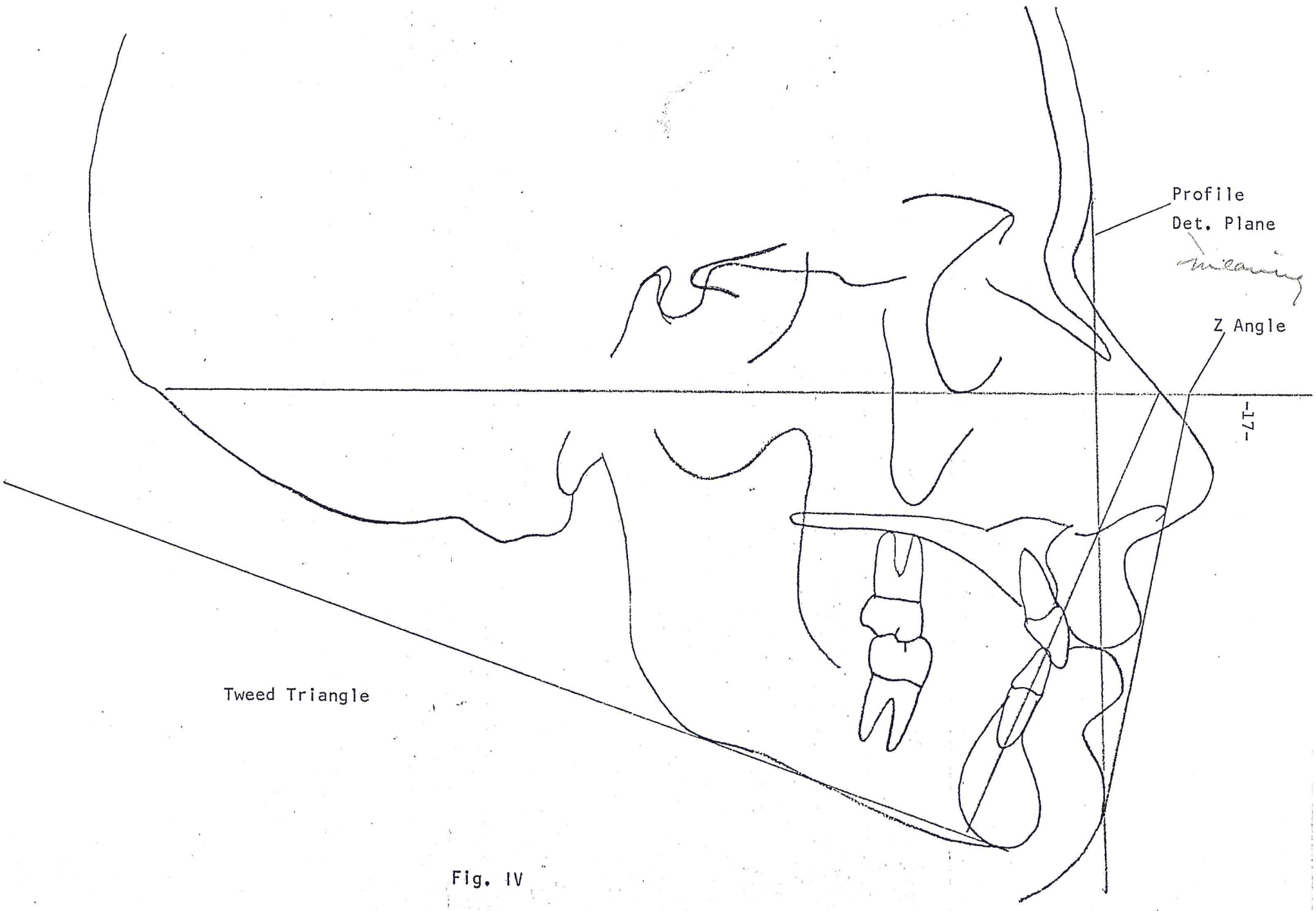


Fig. IV

Holdaway Analysis

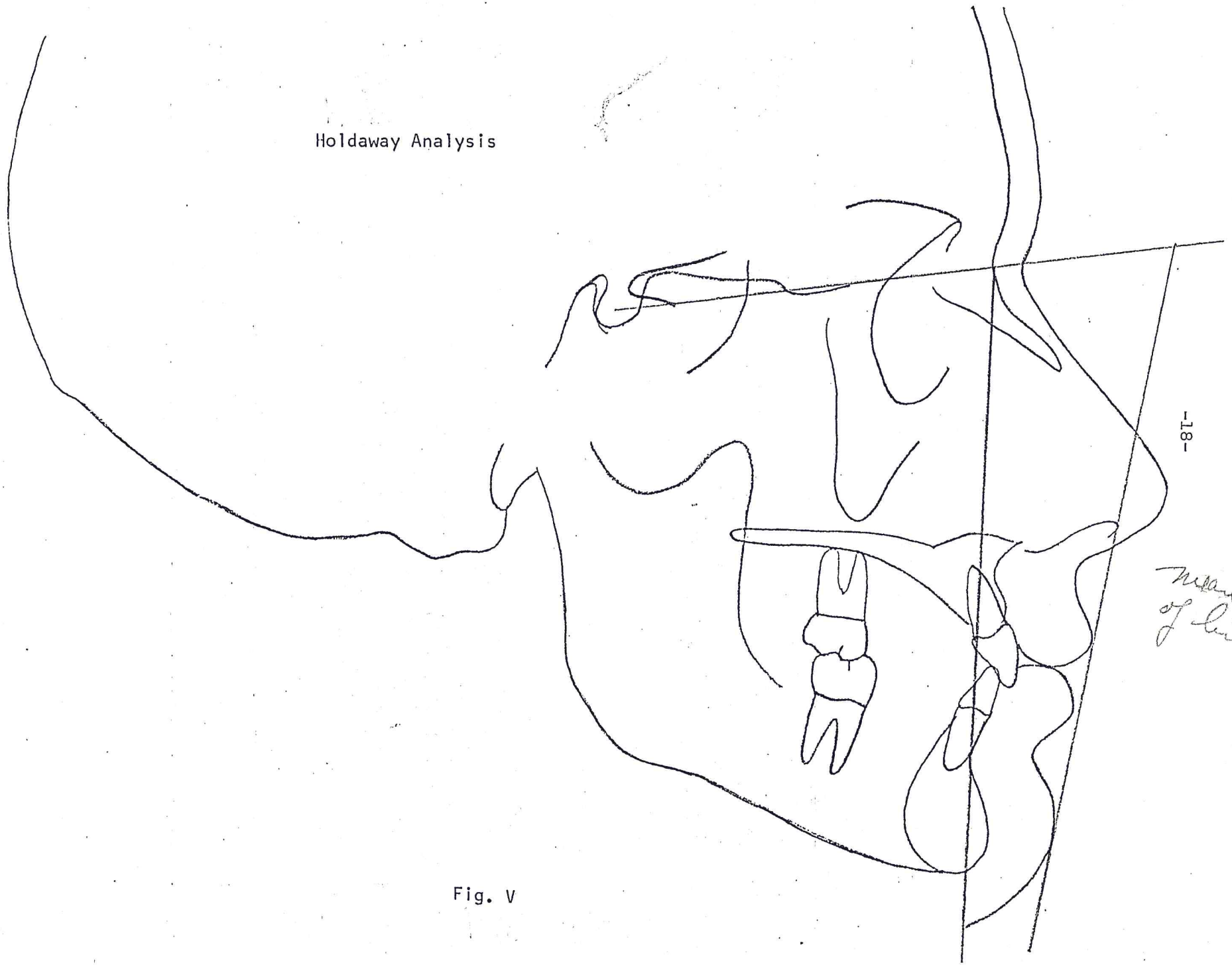
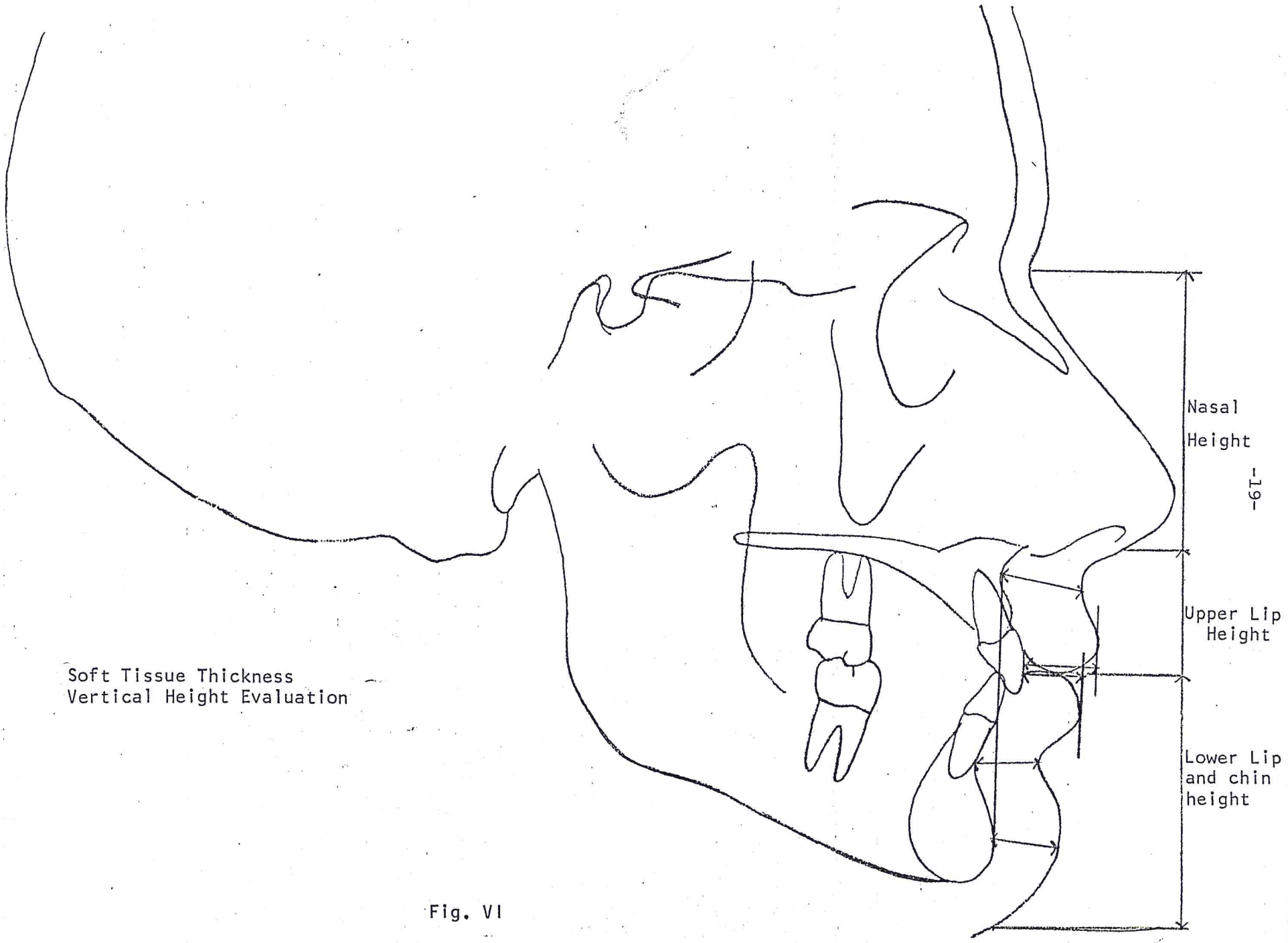


Fig. V



Soft Tissue Thickness
Vertical Height Evaluation

Fig. VI

> The appropriate situation for the application of a discriminant function analysis is one in which there are several groups of individuals, several measurements having been made upon each individual (Harris et al., 1972).

This type of analysis will allow the cephalometric values to be weighted, providing maximal separation of those measurements that will predict the pleasantness or unpleasantness of a particular profile. Those analyses or individual measures with the greatest discriminatory power will then be determined. The computor facilities at Chi Corporation will be utilized.

Cephalometric Error

The tracing error will be evaluated by replication of twenty tracings of the Down's analysis and the Profile Determinant Plane. Root mean squared errors will be calculated.

SUMMARY

A great deal of research has been done in relation to facial esthetics and soft tissue harmony. Although the concept of a pleasing profile is subjective in nature, values have been applied to various analyses as indicators of a "normal or pleasing" profile.

A method of ranking profiles in terms of most pleasing or least pleasing is provided. The study will investigate the subjective feelings of a varied group of observers. The sample will be selected to encompass a wide range of profiles.

Some of the existing analyses will be applied to the profile at the extreme (most and least pleasing) ends of the continuum. The ability of any particular measurement to predict pleasantness or unpleasantness will be determined.

The study will attempt to provide a more reliable method for evaluation of soft tissue.

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What about Stoners soft tissue Analysis

Which analysis used the Seattle Seafair Queens? (Reidel-1957)