A PHOTOMETRIC SOFT-TISSUE PROFILE ASSESSMENT IN A WESTERN CAPE SAMPLE

BY

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DECLARATION

I, ... declare that **"A PHOTOMETRIC SOFT-TISSUE PROFILE ASSESSMENT IN A WESTERN CAPE SAMPLE"** is my own work and that all the sources I have quoted have been indicated and acknowledged by means of references.

SIGNED: .....

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DEDICATION

This thesis is dedicated to four orthodontists through whose effort and dedication, a postgraduate programme at the University of the Western Cape was realized:

DR P DE WET

DR R GINSBERG

DR J KONVISER

DR M LUCCHESI

ABSTRACT

Cephalometric norms for the soft-tissue profile presently utilized in this country, are based almost entirely on North American Caucasian and Negroid studies. Orthodontists use these standards as a guide in the treatment of all sections of the South African population. Various studies have conclusively shown that the soft-tissue profile differs both racially, and from country to country. In recent years the number of patients presenting for orthodontic treatment at the University of the Western Cape has increased significantly. The need has therefore arisen for the establishment of soft-tissue profile trends in the Western Cape area.

A select sample of "Coloured" male and female subjects, of average age 18.9 years and 18.6 years respectively were evaluated. Life-size silhouette photographs were obtained by using a modified photocephalometric technique. Tracings were made of these photographs and comparisons made with the cephalometric soft-tissue norms of Ricketts, Steiner, Holdaway, Burstone, Sushner and Connor and Moshiri.

The results of this study have shown that the soft-tissue profile of the "Coloured" sample investigated differs from that of the Caucasian, and to that of the American Black. The Holdaway, Ricketts and Steiner profile norms, established for Caucasian and Black patients also, are not applicable to the "Coloured" sample investigated. The Burstone values similarly do not apply.

OPSOMMING

Kefalometriese norme vir sagteweefselprofiel wat in hierdie land gebruik word, is meesal gebasseer op die Noord Amerikaanse Kaukasiese en Negroiëde studies. Ortodontiste gebruik hierdie standaarde as handleiding in die behandeling van alle seksies of groepe van die Suid-Afrikaanse bevolking. Verskeie studies het bevind dat die sagteweefselprofiel van ras tot ras en ook van land tot land verskil. In die jongste tyd het die aantal pasiënte wat by die Universiteit van Wes-Kaapland se Tandheelkundige Departement vir ortodontiese behandeling aangemeld het, aansienlik toegeneem. Gevolglik het die behoefte ontstaan vir die totstandkoming van sagteweefselprofiel tendense in die gebied Weskaap.

'n Selektiewe groep van "Kleurling" manlike en vroulike proefpersone met 'n gemiddelde ouderdom van 18,9 jaar en 18,6 jaar onderskeidelik is ge-evalueer. Lewensgrootte silhoeëtfoto's is verkry deur die gebruik van 'n aangepaste fotokefalometriese tegniek. Hierdie foto's is vergelyk met die kefalometriese sagteweefselnorme van Ricketts, Steiner, Holdaway, Burstone, Sushner en Connor en Moshiri.

Die resultate van hierdie studie het aangedui dat die sagteweefsel-profiel van die "Kleurling"-groep wat ondersoek is verskil van die Amerikaanse Kaukasiese en Negerbevolkingsgroepe. Holdaway, Ricketts en Steiner se profielnorme wat geskep is vir Kaukasiese en Swart pasiënte is nie van toepassing op die "Kleurling"-groep wat ondersoek is nie. Die Burstone waardes is ook nie van toepassing nie.

TABLE OF CONTENTS

		Page
1.	TITLE	i
2.	DECLARATION	ii
3.	ACKNOWLEDGEMENTS	iii
4.	DEDICATION	iv
5.1	ABSTRACT (English)	v
5.2	ABSTRACT (Afrikaans)	vi
6.	TABLE OF CONTENTS	vii
7.	INTRODUCTION	1
8.	REVIEW OF THE LITERATURE	
8.1	Facial Aesthetics: A historical perspective	9
8.2	The influence of aesthetics on orthodontic thought	13
8.3	Growth effects and the soft-tissue profile	18
8.4	Soft-tissue profile changes and treatment	23
8.5	Soft-tissue profile quantitation in orthodontics	27

		Page
8.6	Soft-tissue profile preferences	42
8.7	Racial differences and the soft-tissue profile	50
9.	MATERIALS AND METHODS	
9.1	The population Sample	59
9.2	Subject Selection	64
9.3	Materials	69
9.4	Experimental Procedure	76
9.5	Measurements	80
9.6	Statistics	86
10.	RESULTS	87
11.	DISCUSSION	103
12.	CONCLUSION	112
13.	APPENDICES	
13.1	Appendix I:	116
13.2	Appendix II:	118
13.3	Appendix III:	122
13.4	Appendix IV:	125
14.	REFERENCES	128

INTRODUCTION

Throughout recorded history and even before, as evidenced by archeological artifacts, man has been aware of beauty and the concepts of facial aesthetics (Peck and Peck, 1970). It is not surprising therefore, that the orthodontic literature has, since the time of Angle (1907) become pre-eminently concerned with the study of aesthetics.

Beauty has often been viewed as a subjective quality, defined by the eye of the beholder. The scientific pursuit of a matter, of such intrinsic subjectivity, therefore, must inevitably become obscured in controversy because of the numerous factors that could influence a study of this nature. Powell and Rayson (1976) alluded to a few of these variables which included facial expression, lightening, posture, growth, and ageing, to which could be added neural influences, mood, hairline, complexion, amongst others. In this perspective then, facial aesthetics, based as it is, largely on a lateral profile view, is therefore merely a static appreciation of the ideal facial form.

However, despite the effects of these subtleties on aesthetic appreciation, soft-tissue profile assessment has become an important component in orthodontic diagnosis and treatment planning. Further, the recently acquired ability to clinically intervene, and alter facial structures by means of orthognathic and plastic reconstructive

surgery, has necessitated the development of standards for soft-tissue aesthetic assessment. These standards for soft-tissue profile quantitation take the form of linear and angular measurements, which evolved gradually as a result of work done by eminent orthodontists (Steiner, 1962; Ricketts, 1968; Holdaway, 1983).

Standards of facial aesthetics differ from culture to culture, and from one age to another. Numerous studies in the fine arts, social sciences, and in medicine (Peck and Peck, 1970; Graber, 1980; Lucker, 1980), have supported the existence of an "attractiveness stereotype", that evidently permeates present day society and is seen to transcend all cultural, historical, racial and sociological barriers.

Many arguments have been proposed to explain the almost universal acceptance of these stereotypal norms. Not surprisingly, the role of advertising and the mass communication media has strongly been implicated; there is indeed no undermining of the role played by commercial interests in dictating the demands and aspirations of facial beauty (Peck and Peck, 1970).

It has been postulated that proportion within certain selected areas of the face, predisposes toward a desirable facial form (Muzj, 1956; 1983); indeed, are we then not merely endeavouring to determine

whether balance and harmony exists within the facial components? The study of facial aesthetics, as applied to the study of orthodontics, then really concerns itself with the identification of and reproduction of ideal balance and proportion within the soft-tissues.

Up until the 1950's, soft-tissue assessments were based almost entirely on the dentoskeletal pattern. However, the work of Burstone (1958), and Subtelny (1959) amongst others, have shown that such profile evaluation techniques, relying on hard-tissue cephalometric standards, might not lead to the desired improvement in facial form because of the variability of the integumental structures.

Traditionally use has been made of various lines, and arcs to evaluate the soft-tissue profile (Burstone, 1958; Ricketts, 1960; Steiner, 1962; Gonzalez-Ulloa, 1968; Worms et al, 1976, Holdaway, 1983). Numerous studies have also been directed at different aspects of the soft-tissue profile, some have evaluated the effects of growth and treatment on the soft-tissues (Elsasser, 1951; Wisth, 1974), others have tested the profile preferences of the public (Riedel, 1957; Foster, 1973), while others still, have assessed the racial differences of the soft-tissue profile (Downs, 1956; Connor and Moshiri, 1985). Currently, much work is being directed at evaluating the patient's self-perception of malocclusion, including the determination of the social and psychological factors involved in malocclusion (Graber and Lucker, 1980; Shaw et al, 1985).

These various studies have emphasized the need to consider the age and sex of the patient when applying soft-tissue norms. While soft-tissue profile changes following treatment have been described, these appear unpredictable and much controversy still prevails. There is, however, conclusive evidence from the literature, that soft-tissue profile norms differ amongst the various ethnic groups (Uesato, 1968; Sushner, 1977). Norms for Caucasians, Negroes and Orientals, used during diagnosis and treatment planning, should therefore be cognitive of these findings, notwithstanding, however, consideration for the personal preferences of the patient.

In South Africa, where the population is composed of various ethnic groups, orthodontists are often confronted with the problem of the proper facial type peculiar to the different ethnic group. In this country, orthodontic treatment objectives and planning are based on North American Caucasoid values and this is often in conflict with the treatment results desired for the Western Cape population that is under investigation.

The need therefore exists for a cephalometric or alternatively a photometric evaluation of the different racial groups that comprise the population of South Africa. The population sample under investigation, namely the "Cape Coloured", have been shown by various workers (Dreyer, 1978; Thomas, 1981) to be a definite population entity with its own unique features. In recent years many have become orthodontically aware and present in large numbers to the orthodontic department at the University of the Western Cape for

treatment. There has, therefore, arisen an urgent need to establish soft-tissue profile trends that would assist in orthodontic diagnosis and justify treatment.

The socio-political enigma in this country dictates that patients presenting for treatment at this hospital, are mainly of mixed descent ("Coloured"). It is almost beyond doubt that differences in the soft-tissue structures of this disparate group are to be expected. Therefore, though be it that the Caucasoid dominance in many of these patients are strongly apparent, it seems unfair in the light of the literature to apply such norms to all of the patients in this diverse group.

However, whether the "Cape Coloured" is a separate racial group, or whether certain racial characteristics predominate over others, is a debatable issue, and does not fall under the scope of this research project. This study broadly sets out to establish trends as opposed to norms in selected facial soft-tissue profile parameters, for the population presenting for orthodontic treatment at the dental faculty of the University of the Western Cape.

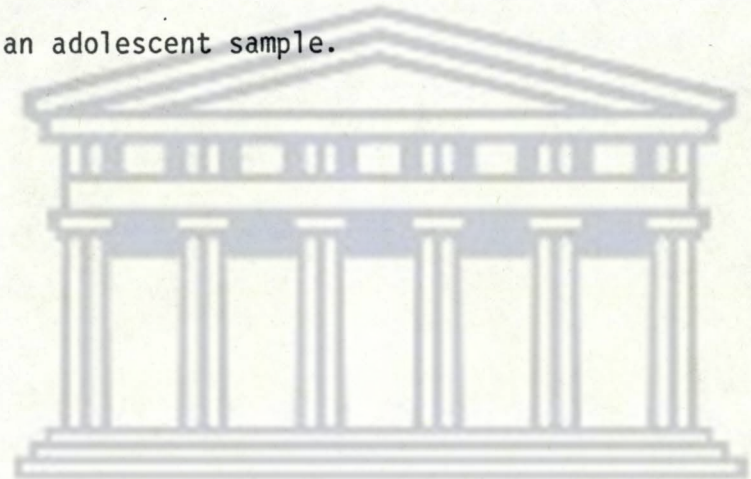
Having outlined the broader objectives of this study, the specific aims are:

1. To analyse a sample of life-size silhouette profile photographs depicting young adults from a select Western Cape population group, using standard soft-tissue analyses.

2. To compare the values obtained with established soft-tissue profile norms.

3. To propose a set of soft-tissue values for use in the diagnosis and treatment planning of adult patients attending this hospital.

4. Finally, based on the finding of this study, to motivate for a cephalometric investigation of subjects of similar age, as well as an adolescent sample.



REVIEW OF THE LITERATURE

FACIAL AESTHETICS: A HISTORICAL PERSPECTIVE

Many workers in various fields of study including anthropology, the fine arts and the healing arts, have, over the years, shared a common interest in facial aesthetics (Peck and Peck, 1970). However, despite this almost universal appeal, Lusterman (1963) felt that many orthodontists had their own ideas and ideals concerning aesthetics.

Aesthetics has often been defined as the science of the beautiful, as applied to works of art, with a view to the understanding, explanation and, perhaps, evaluation thereof (Pepper, 1974). A modern concept of aesthetics, however, encompassed more than physical or natural beauty; the beauties of human emotion, existence and experience, similarly, concerned the aesthetician (Peck and Peck, 1970).

The Websters Collegiate dictionary defined aesthetics as "the branch of philosophy dealing with the beautiful chiefly with respect to theories of its essential character, tests by which it may be judged, and its relation to the human mind". Powell and Rayson (1976) defined "Facial aesthetics" as the study of the variations that may occur in facial appearance on the one hand, and the individual response of the observer to these variations on the other.

The term first appeared in the literature as recently as 1753 in Alexander Baumgarten's "Reflections on Poetry" (Baumgarten, 1753).

Baumgarten had recognised the need to include sensory and perceptual cognition in certain areas of appreciation, and, drawing on the Greek word for perception namely "Aisthesis", he coined the word "aesthetics" for the science of perceptual cognition. It should be emphasized, however, that the development and conceptualization of the principles underlying the appreciation of those qualities that are pleasing to the eye dated back to the ancient Greeks (Powell and Rayson, 1976).

Peck and Peck (1970) suggested that aesthetic awareness probably developed some 35,000 years ago in Paleolithic man. However, ancient Egypt, nearly 5,000 years ago, appeared to be the first culture to have recorded aesthetic attitudes in art, while classical Greece became the first to sensitively express the qualities of facial beauty through philosophy and sculpture (Peck and Peck, 1970).

During the fourth and fifth centuries B.C., the period often referred to as the Golden Age of Greece, many canons or rules were prescribed for ideal bodily proportions and harmonious anatomic relationships in human representations (Carpenter, 1959). Works of art during this era displayed an ideal form, and its proportions could be readily analysed with their combination inspiring an almost mathematical concept of beauty (Powell and Rayson, 1976). This mathematical assessment of beauty was derived on the assumption that beautiful creations respected certain geometrical laws (Fischer, 1965); alternatively stated, the schematized nature of beauty was based on

the belief that an object conforming to an accepted formula of proportion would be beautiful (Powell and Rayson, 1976). However, all beautiful objects may not necessarily conform to any established formula. Similarly, there are many beautiful faces which do not conform to classical proportions and to which mathematical formulae do not apply. Nonetheless, Osborne (1970) felt that the significance of proportion could not totally be ignored and was an important asset to the artist.

During the early Grecian period, the human body was considered the most perfect example of symmetry and eurhythmy (Seghers et al 1964) and this was amply illustrated by Ricketts (1981) in the use of the Golden number (Golden proportion), described as the point at which division of a line segment is such that the ratio of the larger segment to that of the smaller segment equals the ratio of the original segment to the length of the longer segment. The value of the ratio (called Phi) approximated 1.618, and was given the Greek symbol Φ. Ricketts suggested that many relations which were conceived to be beautiful to the human eye or which were comforting or pleasing to the human psyche, followed these proportions. He further noted that the face appeared to show the best harmonic proportions according to the Golden section.

In their study on facial aesthetics, Peck and Peck (1970), observed that, from the end of the fourth century A.D., harmonious proportions

in art were no longer being governed by nature but by principles of moral significance. They observed a new appreciation of the aesthetic sense with the emphasis on spiritual beauty. It was not until the Renaissance in the fifteenth century that Western Civilization once more concerned itself with the classical traditions of Greek and Roman art. The works of Michelangelo typified the return to the schematized nature of art form (Peck and Peck, 1970).

Peck and Peck (1970) also noted that art seemingly traced a recurring pattern of "classical movement" followed by "anticlassical movement", from the Renaissance to the present. This contemporary art form, however, did not provide much insight into aesthetic preferences in facial beauty. Many of the faces rendered in modern art seemed to defy objective study as they tended to be abstract interpretations by the artist rather than concrete representations. Powell and Rayson (1976) attributed this to the great diversity of art works from other parts of the world, which profoundly influenced the thinking and value judgments of Western art.

THE INFLUENCE OF AESTHETICS ON ORTHODONTIC THOUGHT

Facial aesthetics was considered early in the history of orthodontics. John Hunter (1803), often regarded as the father of orthodontics, had by the turn of the eighteenth century, already suggested that the prime objective of such treatment was to beautify the appearance of the mouth.

Two eminent clinicians namely, Calvin Case and Edward Hartley Angle, made significant contributions during the pioneering days of orthodontics and were widely quoted for their preoccupation with aesthetics, the fine arts, and its influence on orthodontic thinking (Downs, 1948; Goldsman, 1959; Neger, 1959).

In 1907, Angle wrote that"the study of orthodontia is indissolubly connected with that of art as related to the human face. The mouth is a most potent factor in making or marring the beauty and character of the face." In this regard, he appeared to have been considerably influenced by his friend, Wuerpel, an art teacher. He doubted the validity of using lines and rules in aesthetic evaluation, but firmly believed that excellence of occlusion was mandatory for proper facial harmony and balance. He used the Apollo Belvedere sculpture-work to assess ideal facial form.

Wuerpel (1937) outlined the need for the orthodontist to appreciate the facial type being treated namely, Greek, Roman, Greco-Roman,

Semitic or Mongoloid. He warned against distorting the face during orthodontic treatment and also stressed the need to consider the length and direction of the line forming the upper lip, from the end of the nose to the beginning of the lip.

Despite the Angle concept for ideal occlusion, other clinicians have since then stated that functional and aesthetic harmony of the teeth and face were more important than having a full complement of teeth (Cryer, 1904; Case, 1908; Downs, 1948).

Bishara et al (1985) observed that, despite the early concern for, and preoccupation with, facial aesthetics, no attempts were made to either quantify the static facial pattern or to quantify growth changes. They suggested that Simon (1926), with his technique of "photostatics", was probably the first to attempt such an approach. By means of photographs, this method related the contour of the profile to the Frankfort horizontal and orbital planes.

Milo Hellman (1927), who adapted physical anthropology to orthodontic research, noted that faces could be categorised into specific types, based on certain recognisable parameters. In his studies, he made use of graphic methods to represent his data, hence the "profilogram" - a diagrammatic polygon representing the face in midsaggital section, incorporating measurements of depth and height, but not width. This midsaggital profile could be used as a measure

of prognathism. In 1939, he abandoned the "profilogram" for the "wiggle", which incorporated measures of height, width and depth. The latter represented a plot of an individual's data relative to a symmetrical polygon constructed from the average range.

With the introduction of the cephalometer by Broadbent in 1931 and the application of his original technique for analysing cephalometric radiographs, a new era in orthodontic thinking developed. The Broadbent analysis was followed by several important and outstanding methods (Wylie, 1947; Downs, 1948; Steiner, 1953; Tweed, 1954; Coben, 1955; Sassouni, 1955; Ricketts, 1960; Jacobson, 1975), for analysing the dentofacial pattern.

Tweed (1936, 1954) gave special attention to facial aesthetics. He recognised the need for extraction in orthodontics to obtain an aesthetically balanced and stable dentition. His philosophy was perceived around the relationship of the lower incisors to their supporting basal bone. He applied the average Frankfort mandibular incisor angle of his successful cases as a treatment goal to establish both stability and improved facial appearance. It was interesting to note that Tweed (1953) placed aesthetics first in his list of treatment objectives, as he was convinced that good occlusion was possible only where there was a reasonable balance between the various components of the dentofacial complex. Though he proposed the use of his "diagnostic triangle" in treatment planning and diagnosis, Tweed (1944) felt that the "eye of the orthodontist"

should become the deciding factor in determining whether the desired facial harmony had been achieved. It is notable that he had a preference for a straight profile (Downs, 1956).

From a study of 20 individuals with excellent occlusion, Downs (1948) concluded that there was a definite facial pattern for persons possessing excellent occlusions. Those cases with poor functional or aesthetic balance were the result of faulty dentoskeletal patterns and could be detected using his cephalometric analysis.

He recognised the need for his dentoskeletal analysis to be representative of the external soft-tissue contours and hence described a photographic method using the Frankfort horizontal as a reference plane (Downs, 1956). Three facial types were described, namely, mesiognathic, retrognathic and prognathic. The author also emphasized the significance of applying the angle of convexity for typing a face.These and other studies, notably that of Steiner (1953) and Holdaway (1956), though not directly involving the soft tissues, would by inference, appear to implicate and, at the same time, recognise the importance of these structures in diagnosis and treatment planning.

Following the publication of Tweed's articles, Bishara et al (1985), in a review of the literature, observed that the 1950's saw a spate of research involving cephalometric skeletal analyses and facial aesthetics. Most of the studies notably dealt with

aesthetics. Most of the studies notably dealt with dentoskeletal analyses, with the assumption that the soft-tissue profile configuration was intimately related to the underlying structures. However, the work of Burstone (1958) and Subtelny (1959) highlighted the necessity of doing an independent soft-tissue analysis during diagnosis and treatment planning.

The problem of facial harmony and the interrelations of the dentofacial complex, while consistently occupying the attention of dentists, and orthodontists in particular, has always been an elusive concept because of the wide diversity inherent in the morphogenetic pattern and also due to the nebulous and indefinite nature of the subject itself (Goldsman, 1959).

Just as general rules have been proposed for tooth positions, standardized linear and angular measures have been put forward for evaluation of the soft-tissues, for example by Burstone (1958), Steiner (1962), Merrifield (1966), Ricketts (1968) and Holdaway (1983). These values were prescribed to indicate to the observer whether the facial profile was balanced and harmonious (Powell and Rayson, 1976).

GROWTH EFFECTS AND THE SOFT-TISSUE PROFILE

Burke (1980) was of the opinion that the clinical orthodontist was mainly interested in bony growth, as the changes he effected were the result of tooth movement through bone. However, since the days of Angle (1907), changes in the soft-tissues induced by such treatment have always interested the orthodontic profession.

Fundamental to the understanding of these treatment changes would be knowledge of the related growth changes taking place during and after treatment (Burke, 1980). He concluded from an earlier study in 1979 that the adolescent growth spurt for girls was earlier but smaller than for boys, who were still growing at age 16 years. By this time, the growth for girls had almost ceased (Burke, 1979).

Despite the subjective nature of facial aesthetics, several investigations have shown that people generally were aware of what constituted a balanced face (Forsberg and Odenrick, 1979). These studies on profile preferences and several other studies involving profile quantitation, notably by Steiner (1962), Merrifield (1966), Ricketts (1968) and Holdaway (1983), have influenced aesthetic norms and standards in use today.

However, several facial growth studies employing direct measuring techniques (Hellman, 1932; Elsasser 1951; Pelton and Elsasser, 1955), indirect measurements derived from cephalometric radiographs

(Burstone, 1959; Bowker and Meredith, 1959; Subtelny, 1959; Posen, 1967; De Koch et al, 1968; Chaconas, 1969; Wisth, 1972; Chaconas and Bartroff, 1975; Forsberg and Odenrick, 1979) and, more recently, stereophotogrammetry (Burke and Beard, 1967; Burke, 1980), have shown that the proportions of the soft tissues were continuously undergoing growth changes. Thus, Forsberg and Odenrick (1979) warned against not considering such changes whilst prescribing aesthetic norms for growing children.

Subtelny (1959) related the soft tissue profile of the face to the underlying dentoskeletal structures and showed that forward displacement of the soft-tissues due to growth, between the ages of 0-18 years, was least at the level of nasion and highest at the level of the tip of the nose. Similarly, forward displacement took place at the level of point A due to soft tissue growth. Displacement at the level of pogonion was, however, more related to underlying bony changes than to soft tissue changes. The nose grew downward and forward through adolescence and continued well into adulthood, enlarging at the rate of one third mm per year. Subtelny concluded that this growth caused thickening of the upper lip over point A.

Bowker and Meredith (1959) studied profile variations on 48 North American Caucasians, at 5 and 14 years of age. A number of vertical and horizontal measurements relative to the integumental profile and a line extending through nasion and pogonion were carried out. Horizontal growth increase was greatest in region of the tip of the

nose which averaged 7.3 mm. They also showed that for the age period 5 to 14 years, there was much greater vertical increase in the nasal region of the integumental profile than in the labial region.

Hambleton (1964) noted that the convex profile of a seven year-old, tended to lose a large amount of this procumbency as the maxillary bone appeared to recede, the lips grew longer, the nose grew forward, and the chin became more prominent. He cautioned against the probability of producing an unfavorable result in the profile if disregarding these factors. Hambleton also felt it necessary to be cognisant of the growth direction of the jaws.

In analysing 3 attractive adult profiles taken from magazine covers, Ricketts (1957) found the lower lip on average 2 mm posterior to the E-line. In children between the ages of 7 and 12 years with a good lip relation, the lower lip was, however, on or slightly posterior to the E-line. Later, an analysis of a significant sample of adults showed the lower lip to be situated on average 4 mm posterior to the E-line (Ricketts, 1968). However, in the growing individual who underwent orthodontic treatment, he recommended a distance of 2 ± 3mm behind the aesthetic plane.

In a cross-sectional study by Forsberg and Odenrick (1979) on individuals aged 8, 12 and 25 years, the lower lip at 12 years was found to be almost on the E-plane for boys, while, in the case of girls, it was on average almost 2 mm behind the plane. In the

adult, this measurement was about 4 mm. They attributed these changes to the greater forward growth of the nose in relation to the other soft tissue structures of the face. This study clearly showed that the distance from the lips to the E-line increased progressively from the youngest to the oldest. Forsberg and Odenrick (1979) hence emphasized the need to consider the growth changes that occurred in relation to the lips and E-plane and similarly recognised the need to adapt existing norms, which have primarily been derived from adults.

Huggins and McBride (1975) noted that growth for the female was generally almost completed by the time treatment was sought, whilst, in the male, growth was still progressing. The continued forward growth of the lips thus altered the values of those parameters normally used for profile aesthetic assessment. Chaconas and Bartroff (1975) observed that at 12 to 14 years of age when most orthodontic treatment was performed, about 25% of nose growth had still to occur in girls, while twice as much had to occur in boys.

In a study on early adult changes in the facial profile, Sarnäs and Solow (1980) showed small increments in certain soft tissue dimensions, including nose height (½mm) and upper lip length (½mm) over a 5-year period from 21 to 26 years of age. The authors felt that consideration for these growth changes occurring after puberty, would enhance the understanding of post-retention changes that may occur after orthodontic treatment. This study supported the

longitudinal study of Forsberg (1979) who showed continued forward growth of the nose and retrusion of the lips from 24 to 34 years of age in males and females.

Bishara et al (1985) described growth changes that were age- and sex-specific for six soft-tissue parameters commonly used by orthodontists in diagnosis and treatment planning. These parameters included the angle of total facial convexity, the angle of facial convexity, the Holdaway soft-tissue angle, the Merrifield Z-angle, the Ricketts upper lip to E-plane and the Ricketts lower lip to E-plane. Results from this study revealed that the four angular measurements evaluated did not show similar changes with age. The authors suggested that for greater accuracy, more than one of the parameters involved in this study, namely, the two angles of soft-tissue facial convexity, the Holdaway soft-tissue angle, and the Merrifield Z-angle, be considered in evaluation of the soft tissue profile. The authors also presented cephalometric soft-tissue norms for the parameters studied. This data was age- and sex-specific and could be employed in soft-tissue appraisal.

From the above, it was apparent that parameters employed for aesthetic profile evaluation should be age- as well as sex-specific. Surprisingly most, if not all, of these parameters have been derived from adult populations. This emphasizes the need to derive similar trends for an adolescent group.

SOFT TISSUE PROFILE CHANGES AND ORTHODONTIC TREATMENT

The number of investigations into growth and treatment changes of the soft-tissue profile were relatively modest in comparison to similar studies for the hard tissues (Roos, 1977).

These studies were necessary to assess the dentoalveolar and basal changes taking place with treatment and the effects it could have on the soft-tissue profile. The general aim had been to predict soft tissue changes associated with anticipated hard tissue changes (Saxby and Freer, 1985).

Rudee (1964), in a study on 85 patients from his practice, showed a mean ratio of 2.9:1 for maxillary incisor retraction to upper lip retraction, a 0.59:1 relationship of lower central to lower lip retraction and a 1:1 relationship of upper central to lower lip retraction. Though the average upper lip retraction was one third that of the upper incisor, more lips were found that retracted one half of the distance (2:1) or as much as the upper incisor (1:1).

Hershey (1972), in a study of thirty-six adult females, showed that incisor retraction produced on average a reduction in lip fullness, but noted that this was unpredictable. The best correlation was found between the lower incisors and the lower lip which produced a 1:1 relationship. The upper lip was less predictable.

Wisth (1974), reporting on the relationship between upper incisor retraction and upper lip response, found a ratio of 2:1 for cases with an overjet of 3-4 mm and 3:1 for cases with an overjet of 8-10 mm.

A study by Roos (1977) supported earlier findings (Burstone, 1958; Subtelny, 1959), showing that the degree of correlation between changes in the soft-tissue profile and associated changes in the skeletal profile, varied during orthodontic treatment. There was a good correlation between the displacement of subspinale (A point), incision inferior, and supramentale with their overlying soft-tissue structures. The relation between incision superior and labrale superior was not as good. On average, the ratio for the upper incisor to upper lip retraction was about 2.5:1, while that for lower incisor to lower lip was approximately 1:1. Roos reported that the thickness of the upper lip increased after treatment, supporting similar findings by Ricketts (1960), Anderson et al (1973), and Wisth (1974). He reported a decrease in thickness of the lower lip. Ricketts (1960) and Anderson et al (1973) found no increase in the thickness of the lower lip, while Wisth (1974) reported an increase in thickness.

In a duplication of the study by Rudee (1964), Garner (1974) reported similar results on a Negro sample despite the Negro lips being thicker and larger when compared to the Caucasian norms presented by Burstone (1958). The maxillary incisor retraction to

upper lip ratio reported by Rudee was 2.9:1, while, in this study, a ratio of 3.6:1 for the total sample and 2:1 for the female Negro sample, were recorded. The lower incisor to lower lip relationship was 1:1. Garner noted, however, that the extent of lip response was not always predictable.

Holdaway (1978) maintained that the unstrained upper lip will follow incisor retraction on a one-to-one ratio. Schulhof et al (1978) quoting the work of Ricketts, offered a rule of thumb that, as the upper incisor was retracted, the upper lip would follow it back two-thirds of the amount retracted and would thicken the remaining one third.

Koch et al (1979), on the contrary, felt that the improvement of the soft-tissue profile by dental movement was very limited. They agreed that growth of the nose and chin had a marked influence on the facial profile, but felt that the effects of orthodontic treatment on the lip profile was relatively small. The authors believed that expedient use of the pubertal growth period during treatment would promote optimal profile changes.

Waldman (1982) wrote that treatment planning for a patient with a convex profile should take into account the soft tissue changes that may occur with correction of the antero-posterior position of the maxillary incisors. In a study of 41 Angle Class II cases, he found an average ratio of 3.8:1 for upper incisor to upper lip retraction.

Waldman also showed an increase in the nasolabial angle with lingual tipping of the incisors.

Hillesund et al (1978) further highlighted the problems of assessing soft-tissue changes resulting from growth or treatment by outlining the differences in using a "closed" lip position as opposed to a "relaxed" lip position. From this study, they concluded that the flattening of the lips from the "relaxed" to "closed" position was likely to mask some of the lip response to incisal retraction. The authors felt that the thickening of the lips described by some researchers, might have been due to the relief of lip strain following incisor retraction, especially in patients with large overjets where reductions or flattening of 2.5mm have, on average, been recorded. They promoted the use of the "relaxed" lip position as it resulted in better production of lip position and morphology. In this study, the authors also showed that the registration of soft-tissue reference points in the horizontal plane was found to be within ± 1 to 1.5 mm of the first registrations.

The results from these studies clearly showed that the soft-tissue profile did not always reflect concommitant changes in the underlying skeletal profile during orthodontic treatment. The response was indeed variable if not conflicting; certain parts of the soft-tissue profile showed a stronger association with underlying skeletal changes, while other parts tended to be more independent (Roos, 1977).

SOFT TISSUE PROFILE QUANTITATION IN ORTHODONTICS

Over the years, profiles have been evaluated by using anthropologic, cephalometric, or photometric linear or angular measurements (Barrer and Ghafari, 1985). These linear measurements were used to determine size, distance and proportion, while the angular measures were primarily used to describe relationships among planes in the face.

According to Lucker (1980), two general approaches to the study of facial aesthetics were adopted. The one approach endeavoured to identify those subjects considered physically attractive and, thereafter, to determine the physical attributes that made them attractive. These individuals were photographed or radiographed in standard positions, and measurements were then obtained from these records. Quite often, the desired average values or selected anthropometric measures served as norms representing the public's aesthetic taste.

The other approach commonly employed required one group of individuals to evaluate the attractiveness of another group from line drawings, silhouettes or facial photographs. The individuals being evaluated were often chosen either to represent a "normal" random population sample or to represent variability on specific facial dimensions. Variability in anthropometric measures were correlated with variability in attractiveness judgments to determine which physical dimensions were related to aesthetic judgments.

A third approach, and probably the forerunner to facial quantitation, was based almost entirely on dento-skeletal norms. These early dento-skeletal analyses (Downs, 1948; 1956; Steiner, 1953; Tweed, 1954) assumed that balance and harmony of the hard structures would result in an ideal aesthetic facial form. The numerous formulae for facial balance represented early attempts at profile quantitation and prescription.

Quantitation of the facial profile for scientific application could be traced to the early eighteenth century when anthropologists first attempted to categorize races and to describe evolutionary changes occuring in man (Camper, 1794). Milo Hellman (1927) was the first to adapt physical anthropology to orthodontic research. Using anthropometric methods, he reported his findings on the growth and development of the human face.

Simon (1926), at about the same time, developed his concept of "photostatics" to quantify changes in the facial profile. He divided the head into planes and related the contour of the profile to the Frankfort horizontal and orbital planes. Using this method, Simon could measure soft-tissue growth and other changes.

In a study of the soft tissues of the face, Hellman (1939) found that the facial features of sixty-two males with normal occlusion had extremely variable faces and that the dimensions of the facial features studied were not all normal.

With the introduction of cephalometrics by Broadbent in 1931, the work of Hellman (1927) and the "photostatic" concepts of Simon (1926) assumed secondary importance and a new era in orthodontics followed. Following the Broadbent analysis, several cephalometric analyses were described which provided significant knowledge to the body of orthodontic thought. The study of facial aesthetics either by cephalometrics or the photographic method increased, and consideration for the soft tissue profile assumed greater importance.

Riedel (1950) studied soft-tissue profile outlines and submitted them to orthodontists for aesthetic evaluation. He found a high level of agreement as to what constituted a pleasing face. Soft-tissue profiles which were considered to be pleasing revealed skeletal parts arranged in a straight line, with little or no dental protrusion. However, soft-tissue profiles adjudged as poor had convex skeletal patterns and dental protrusion. It was evident that the orthodontic profession lacked objective criteria for facial assessment since all that could be gained was a classification of "poor, fair or good" (Ricketts 1957).

Later, in a cephalometric appraisal of thirty candidates of the 1955 Seattle Seafair beauty contest, Riedel (1957) found that about half of the contestants had the upper lip, lower lip and the chin aligned in a straight line, which was in contradiction to the accepted norms of artists who proposed that the nose, lips and chin lie in a straight line. He concluded from quantitative assessment of the

soft-tissues that the profile was closely related to the underlying skeletal and dental structures. The skeletal patterns of these Seafair princessess were similar to earlier studies by orthodontists on the basis of occlusion alone (Downs, 1948; Riedel, 1950). Riedel concluded that the public's concept of acceptable aesthetics was similar to those of orthodontists on the basis of occlusion alone.

In 1952, Hertzberg, using photographs, described the profiles of those subjects he considered to be "in balance", and noted that the chin, upper lip and lower lip fell on a vertical line through subnasion or subnasale. Spradley et al (1981) observed, however, that no mention was made of any horizontal plane or the method by which the vertical reference line was constructed on the photographs.

Stoner (1955) described a quantitative analysis of the soft-tissues which could be applied either to a cephalogram or directly on a profile photograph. He related the lower lip to the chin, the upper lip to the lower lip and then related these tangents to the facial plane (Nasion-pogonion). The facial plane was also related to Frankfort Horizontal. A number of angular measurements were prescribed as standard values for profile evaluation.

Edmondo Muzj in 1956 presented a simplified profile analysis based on the correlation between the upper and lower parts of the face. This correlation between those parts of the profile, extending from the frontal point to subnasale and then downwards to gnathion, was made

possible by dividing the common "frontal-facial angle" into two by the Bolton-subnasale plane. This analysis which took into account the "total profile" was verified statistically. Using this analysis, Muzj was able to describe various profile types. The inherent problems in using the Frankfort plane were also outlined in this study.

In a later article, Muzj (1982) outlined the development and application of his profile analysis. He described the four types of morphological characteristics that constituted the facial system namely, fundamental generic characters (common factors), constitutional characters, racial factors and physiognomic characters. In terms of his treatise, a correlation represented a ratio of quantitative and qualitative reciprocity between body organs. Hence, profile studies performed on only one part of the face were invalid as "every character contributing to a system of the body, including the facial system, is a function of one or more other characters". In this article, Muzj replaced the Bolton-subnasale plane by the palatal plane. An artificially constructed point "Virtual ANS" separated the upper and lower parts of the face. Muzj observed that the two sides of the "frontal facial angle" kept the same relationship of inclination in the Caucasian race. The degree of opening, however, varied. The relationship of other "key characters" of the profile lines namely, gnathion, incision, nasion and their application to race classification, were also described. According to this study, normality was judged by the proportional relations between the nasofrontal segment that constituted the upper

face and the dental region that constituted the lower face.

Poulton (1957), performed a statistical test to determine which angles on a lateral cephalogram would present a strong correlation to facial aesthetics. He concluded from his study that the angle of convexity, the angle SNA, the angle between the lower incisor and the mandibular plane, and the angle between the SN plane and the mandibular plane could be employed as a useful indicator of good or poor facial aesthetics.

Ricketts (1957) felt that the nose and chin were the most convenient areas from which the lips could be evaluated. The "esthetic or E-plane" connected these two landmarks. This study revealed that the upper lip was 4mm and the lower lip 2mm posterior to the plane. Ricketts (1968) subsequently no longer regarded the upper lip necessary in profile evaluation and prescribed a value of 4mm ±3 for the lower lip.

Ricketts in 1968 culminated his research on the E-plane with an article entitled "Esthetics, environment, and lower lip relation" in which he attempted to organize, clarify and classify lip conditions for analytic value. According to this law, Ricketts observed that "in the normal white person at maturity, the lips are contained within a line from the nose to the chin, the outline of the lips are smooth in contour. The upper lip is slightly posterior to the lower lip when related to that line, and the mouth can be closed with no

strain". The author also studied oblique and frontal dimensions of the face and constructed lines referred to as cheek and papillary planes respectively. Ricketts noted, too, that individuals with prominent cheeks appeared more attractive with fuller lips, and vice versa. He also observed that most people objected to lips that protruded beyond the E-plane, but noted that prominence of the lips and mouth were characteristic to the young. More recently, Ricketts (1981) described the use of an instrument called the "Golden divider" to assist in quantitative analysis of the facial profile.

Burstone (1958) noted that marked variation existed in the soft tissues covering the dentoskeletal framework and believed it necessary to directly study the integumental contour of the face in order to adequately assess facial harmony. The author studied the profiles of 40 individuals selected by three artists from the *Herron Institute, and described a method of measuring the integumental profile by angular means. Two types of reading were used namely, inclination angles which represented profile components relative to the nasal floor (skull) and contour angles representing profile components relative to each other. Burstone suggested that graphic comparison to the Herron sample by means of his integumental profile grid would simplify facial analysis or the study of soft-tissue growth and treatment changes.

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In the following year Burstone (1959) described a method of measuring horizontal and vertical soft tissue extentions (thickness between two landmarks). From this study, he established "integumental extention" standards both for adults (post-retention age group) and adolescents (post-treatment age group). The findings revealed sex differences, with areas below the nose being generally thicker in the male.

Burstone (1967) noted that in present day society, where conformity was appreciated and sometimes demanded, it appeared desirable for the orthodontist to stereotype faces. Dentoskeletal and soft-tissue standards of normal or desirable faces could serve as a guide in stereotyping the facial appearance of treated orthodontic patients (Burstone, 1958; 1959). In a study on lip posture and its role in treatment planning, Burstone (1967) reported that a small vertical space or interlabial gap of about 1.8mm was present between the upper and lower lips in the "relaxed" lip position. He showed from samples of dentulous and edentulous persons that there was an anteroposterior posture of the lips, independent of the dentoalveolar structures.

Lindquist (1958) evaluated the relationship of the lower incisors to facial aesthetics and observed that many orthodontists regarded the proper position of the lower incisors to be fundamental for the attainment of a balanced facial profile. Many formulae were presented for improved facial aesthetics based on the position of the lower incisors, with the assumption that a correct position of these

teeth would result in proper facial balance. The author evaluated Tweed's (1953) Frankfort mandibular incisor angle (FMIA), Down's (1956) lower incisor to A-Po plane, Holdaway's lower incisor and chin point relationship to the NB plane, and Steiner's (1953) lower incisor to NB plane (angular and linear). The results were found to be widely divergent, but consistent within each group. Lindquist recognised the need to consider the chin in aesthetic assessment for orthodontic purposes.

Bowker and Meredith (1959) described a quantitative method for assessing the integumental profile by relating certain points of the face to a "nasion pogonion line". These measurements perpendicular to the nasion-pogonion line through points nasion, tip of nose, concavity of upper lip, labiomental groove and convexity of the chin, were presented as standard values when evaluating the integumental profile of the face.

Neger (1959) introduced a method to evaluate or assess the soft-tissue profile in a quantitative manner from a profile photograph or a cephalogram. Using the Frankfort horizontal and nasion as a frame of reference, he described six angular relationships for the upper lip, lower lip and chin. The author interestingly related these components to a cranial reference, and this study could be regarded as an "upside-down" version of Stoner's (1955) study. The "pogonial angle" (inferior inner angle of Na-Pog to Frankfort Horizontal) was similar to the facial angle described

earlier by Downs (1948). Various standard measurements for these soft-tissue components were prescribed. The author concluded from his study that a proportionate change or improvement of the soft-tissue profile did not necessarily accompany extensive dental changes, hence one could not rely entirely on a dentoskeletal analysis for accurate information on the soft-tissues. Neger, therefore, stressed the need to evaluate the soft-tissue profile as a separate entity, apart from the dentoskeletal analysis.

Subtelny in 1959 also indicated that the correlation between hard and soft-tissue changes was not strictly a linear one. He measured horizontal and vertical relationships and found that not all parts of the soft tissue profile directly followed the underlying skeletal structures.

Steiner (1962) used the S-line to assess soft tissue profile balance. This line was drawn tangent to the chin and through a point midway on the lower border of the nose. Steiner observed that in good Caucasian faces, the lips often fell on the S-line at average orthodontic age. Lips ahead of the S-line would on average be too full, whereas those falling behind it be too flat when related to other parts of the profile. This analysis where the lip position was more definitely defined, took into consideration a large or small nose and a large or small chin and harmonized them with the lips.

Hambleton (1964) was of the opinion that no formula or analysis could

provide a soft tissue line that would please all orthodontists and quoted Subtelny (1961) who suggested that it existed only in the "minds eye" of the individual practitioner. Hambleton further quoted numerous studies showing that the preference of the public was towards a flat or straight profile, an opinion also held by Riedel (1957). The inability to stereotype faces, as well as the variation in profile structures, necessitated an independent assessment of the soft-tissue during treatment planning. He evaluated several soft-tissue analyses and found the Holdaway H-angle, formed by the intersection of the line NB to the H-line, most useful. This angle took into consideration the underlying structures by virtue of its relation to the NB line and the ANB angle.

Holdaway (1964) described the significance of the H or "harmony" line in profile assessment, which passed tangent to the chin-point and the upper lip. Holdaway related the angle formed by this line and line NB (skeletal) with the ANB angle. If the ANB angle was greater or smaller than 1 to 3 degrees, the same number of degrees was added or subtracted from the H-angle. He concluded that for an ideal case, both the upper and lower lips should be on the H-line and the proportions of the nose to the upper lip formed a harmonious S-curve. This linear measurement, from the tip of the nose to the H-line for a patient 13 years of age with an average nose, was 9 mm.

Holdaway (1983) described a comprehensive analysis on soft tissue assessment wherein a number of different parameters were considered.

Included in this analysis was a finding of 2.5 mm for upper lip curvature, with a value of 1.5 mm for thin lips and 4.0 mm for thick lips, which would still indicate balance. Holdaway also described a soft tissue H-angle between the H-line and soft-tissue Nasion-Pogonion which was shown to correlate with the angle of facial convexity. The upper sulcus depth to the H-line should ideally be 5mm, with a measurement of 3mm, for short and/or thin lips, and 7mm for thicker lipped individuals. The author also provided values for upper lip thickness and upper lip strain. Values of lower lip to H-line (0mm) and lower sulcus depth to H-line (5mm) were also provided.

Merrifield (1966) made use of the "profile line" and the Z-angle to give a critical description of lower face relationships and thereby supposedly eliminated the vagueness of so called "eye judgement". This line was tangent to the soft-tissue chin and the most anterior point of either the lower or upper lip, whichever was most procumbent, and extended to reach the Frankfort plane. Merrifield noted that in a pleasing profile, the upper lip was tangent to this line, while the lower lip was similarly tangent or slightly behind the profile line (not more than 2mm). The Z-angle formed by the intersection of the profile line and Frankfort horizontal described an angular relationship for the lower face. In the 11 to 15 year age group, the average Z-angle was found to be 78° ± 5°, with females demonstrating higher Z-angle values than males. However, in adults the average Z-angle values were 80° ± 5°, with males exhibiting

higher values than females. Merrifield also believed that total chin thickness should be equal to or slightly greater than the upper lip thickness.

Mario Gonzalez-Ulloa (1968) recognised the need for a vertical plane of reference to assess the facial profile. He constructed his Meridian 0° through nasion, running perpendicular to the Frankfort Horizontal. These axial references provided a useful method for the evaluation of the facial structures. In faces recognised as being beautiful, the author felt that all facial segments should be tangential to the Meridian 0°.

George Uesato (1968) used the Ricketts E-line and the Steiner S-line to illustrate his concept of facial aesthetics for North American Japanese subjects. He showed that an aesthetically balanced profile for this racial group was one in which the upper and lower lip were positioned between the E- and S-lines.

In a comprehensive study on facial aesthetics, Peck and Peck (1970) also described a photographic profilometric analysis to provide an objective view of the profile. Standard values for the facial angle, the maxillofacial angle, the nasomaxillary angle, the nasal angle, maxillary angle, mandibular angle, and total vertical dimension from nasion to pogonion were presented. The authors emphasized their consideration for the nose in their profilometric analysis.

Sushner (1977) carried out a photographic study on one hundred attractive looking North American Blacks This study, done on 8" x 10" black and white photographs compared the Ricketts, Steiner and Holdaway soft-tissue values to the Negro individual. Sushner also described the use of his Nasion-Pogonion line to quantitate the lips and chin in a vertical and horizontal dimension. He concluded that Negro males and females were more protrusive in soft-tissue profile than Caucasian males and females. Though a "standardized photographic technique" was employed, it is unclear whether life-size photographs were being evaluated or whether consideration had been given for the magnification effect when carrying out linear measurements on these photographs.

Spradley et al (1981) described a method of soft-tissue evaluation making use of a true vertical reference plane passing through subnasale. The subjects were radiographed in the natural head position, thereby, establishing a true horizontal reference plane. It was concluded from this study that the use of the subnasale vertical, perpendicular to the Frankfort horizontal plane was the most accurate method of profile assessment. The authors noted that this method of sagittal soft-tissue assessment was not dependent on the position of the chin, which in itself could be deficient.

Saxby and Freer (1985), in a statistical evaluation of the correlations among hard and soft-tissue reference points, concluded that the ANB angle was strongly related to the soft-tissue profile.

They also observed that the Ricketts E-line, the Steiner S-line and the soft-tissue facial plane were equally suitable as base references in the assessment of the soft-tissue profile. They felt, however, that the soft-tissues were affected by a variety of variables such as skeletal relationships, dental positions, soft-tissue thickness, and function. The effects of growth during treatment further compounded the problem.

In the light of what has been written, it is well to remember the words of Fricker (1982) who wrote that in the fields of reconstructive surgery and orthodontics, it was of the utmost importance to define the needs of the patient, not only in the provision of post-operative satisfaction, but also in the assessment of the extent of the patients expectations of change. Fricker cautioned that there was no absolute quantitative norm for beauty and an individual's concept of beauty was based on many variables, including the persons ethnic, racial, and aesthetic influences, as well as personal experiences.

SOFT-TISSUE PROFILE PREFERENCES

Early studies on profile preferences until the 1960's would seem to indicate a public bias toward the typical "Hollywood" profile, which appeared relatively straight or flat (Riedel, 1950, 1957; Goldsman, 1959; Neger, 1959; Hambleton, 1964). Hambleton (1964), however, in an analysis of art form from the time of the Egyptians to the present, suggested that there was a "constantly changing concept of profile beauty". Orthodontists of the day notably concurred with the public in their appreciation of facial aesthetics (Riedel, 1957; Burstone, 1959).

Riedel (1957) studied the facial pattern of Seattle Seafair princesses and concluded that public opinion as to what constituted acceptable facial aesthetics was in good agreement with the standards established by orthodontists on the basis of normal occlusion alone.

In an investigation of the dentoskeletal pattern of Caucasian adults, Goldsman (1959) commissioned a group of artists from the *Herron and Buffalo Art Institutes to select his sample. He found unanimity in their choice, and emphasized the wide diversity seen in the facial types chosen. Orthodontists, however, chose faces that tended to be flat or vertical and Goldsman, therefore, suggested that orthodontists were possibly prejudiced in their concepts of facial aesthetics.

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Buffalo Art Institute, Buffalo, New York.

Peck and Peck (1970) analysed the faces of 52 professional models, beauty contest winners and other performing stars who were noted for their facial attractiveness. They found that the general public admired a fuller and more protrusive dentofacial pattern than the cephalometric standards that Margolis (1947), Downs (1948) and Steiner (1953) had prescribed. Cox and van der Linden (1971) cautioned, however, that this sample consisted of forty-nine females and only three males.

Iliffe (1960) concluded from his study on 12 female faces judged by some 4,355 Britons, that a common basis for judging facial beauty existed. These findings were shared by men and women of all ages in all parts of England and from varying social backgrounds. Iliffe (1960) suggested that some intrinsic characteristic like harmony or balance present in the human face and common to all beautiful things probably resulted in these findings. Education was possibly responsible for the transmittance of such culturally determined norms.

Martin (1964) and Linn (1976), who examined cross-cultural differences, showed that American Whites and Blacks shared a common aesthetic standard for the female face when judging beauty namely, the Caucasian facial model. Peck and Peck (1970) suggested that cultural factors, as well as other commercial reinforcing agencies such as television, newspapers, and motion pictures may have contributed toward the creation of this "attractiveness stereotype".

Udry (1965) duplicated Iliffe's study on an American sample and reported similar results. Foster (1973) agreed that television and other mass media may have been responsible for the acceptance of this universal aesthetic norm.

Cox and van der Linden (1971), using a *Q-sort arrangement of good and poor facial proportions, also found concurrence in the aesthetic judgment or preference between two professionally diverse groups of evaluators (10 orthodontists and 10 layman). From this study using silhouette photography, they concluded that persons with poor facial balance generally had a more convex face. Notably good facial aesthetics were found in persons having malocclusion, as well as those possessing normal occlusion. Cox and van der Linden observed that the range of variation within those groups possessing good facial aesthetics were larger than was generally accepted, and hence suggested that cephalometric standards may have been set too rigidly in the past.

Sassouni (1971) believed that society accepted deep-bite skeletal types easier than open-bite facial types. Later, Dongieux and Sassouni (1980), using a Class II deep-bite subject, created seven other facial types by varying the mandibular position. A group of observers from different cultural backgrounds including orthodontists,

*Q-sort Frame used for Seperating and arranging Data, as described by Stephenson (1964).

artists and a peer-group, were asked to judge each picture on a five-point scale. An important finding was the consistency of opinion between the three groups of observers who evaluated the soft-tissue profile photographs. The authors concluded from their study that the Class III open-bite was the least pleasing facial profile type. This study showed that vertical and antero-posterior variation of mandibular position undoubtedly influenced the opinion of observers when assessing facial aesthetics.

Foster (1973) used diversified groups of people including general dentists, art students, orthodontists, a Black lay group, a Chinese lay group and a White lay group, to judge 7 silhouette facial profiles created from a single cephalogram. Each silhouette drawing was altered only about the lips, such that the "full" profile had a protrusion of 12mm from the "straight" face. Each judge was asked to choose the most pleasing profile for males and females at ages 8, 12, 16 and adult. The silhouette drawings were analysed by using the S-, H- and E-lines. Results from this study supported earlier work (Martin, 1964; Linn, 1976), suggesting that diversified groups shared a common aesthetic standard for the posture of the lips. All groups were consistent in assigning fuller lips for younger ages. However, sex differences were clearly evident only in the adult sample. The adult female face, though being 3mm fuller than the adult male face, was still retrusive to established profile norms. Orthodontists preferred a fuller male face in comparison to the other group of evaluators. Public preference toward a straighter male adult profile

might pre-empt changes to existing norms. Presently, the lower lip is approximately 4mm posterior to the E-plane. Foster's study revealed a value of about 8mm. Foster, however, warned that this straighter profile standard be established only in the mature or adult face.

Lines et al (1978) compared the facial profile components considered desirable for males to those considered desirable for females and simultaneously assessed the profile preferences of a large group of participants possessing varying degrees of training in facial aesthetics. These judges were divided into three main categories representing moderately trained (orthodontists), slightly trained (oral surgeons) and untrained individuals (dentists, dental hygienists, dental and medical students and non-professional persons). The authors reported significant differences between the male and female profiles. However, there was no significant difference between the scores of the different groups of persons who participated in the investigation, except that orthodontists preferred both men and women to have slightly more prominent lips than the oral surgeons. The surgeons preferred profiles with more prominent chins and longer columellar lengths than the other groups. Based on these findings, the authors felt that differential treatment planning for the sexes was now possible.

The above study supported the work of Forsberg and Odenrick (1979) who in a cross-sectional study on 8, 12 and 20 year-olds not only

showed significant age related differences in relation to the E-plane of Ricketts (1968), but also described sex-related differences within the age groups.

Spradley et al (1981) used three orthodontists and two oral surgeons to select their sample of aesthetically pleasing or "normal" subjects. They felt that these professionals were routinely involved in diagnosis and treatment planning for the public and hence, no lay person was consulted. From their study, definite sexual differences for the lower third of the face were observed. In general terms, they found that females had slightly fuller lip regions, shallower labial sulci and chins that were relatively as prominent as those of males. The female chin appeared less prominent to that of the male because the lips of the female were more protrusive and the labial sulci shallower or less pronounced.

Kiyak (1981), in a review of the literature, noted that while there was consistency across some ethnic groups in perceptions of facial aesthetics, very little work had been done on the effects of individual and cultural differences on aesthetic appreciation. The author compared the aesthetic values and preferences of Caucasians and Pacific-Asian immigrants to the U.S.A. and found that while differences emerged, aesthetic ratings were unrelated to racial typology or to the individuals own malocclusion. Asians chose bimaxillary protrusions as least attractive despite there being a high frequency of this condition among such individuals. In this

study, it was surprising that the so-called "normal" or straight profile was ranked second in attractiveness by the two groups. The largest group of Pacific Asians (42%) selected bimaxillary retrusion as being most attractive, while the largest group of Caucasoids (41%) chose vertical deficiency as the most attractive facial type.

De Smit and Dermaut (1984) investigated the influence of the anteroposterior maxillomandibular relation, the lower facial height and the form of the dorsum of the nose on the profile preferences of 249 adults with varying orthodontic knowledge. Sex differences, as well as training in orthodontics, were found to have no significant influence on aesthetic ranking of the profile. Further, no differences between the selected male and female profiles were evident, suggesting that the profile preference for the male and female students were similar. The nose dorsum induced significant differences only in Class II normal profiles in which a convex nose was less appreciated. This study revealed that vertical profile characteristics were more important than anteroposterior features in aesthetic appreciation. Open-bite profile types were the least appreciated and the authors, therefore, warned against the creation of long-face features.

It appears from current literature that the "attractiveness stereotype" most appreciated within the female population seems to bea more convex profile than was the situation in earlier years.

Aside from the research of Peck and Peck (1970), the flat or straight adult male profile, seems to be most appreciated. There is universal agreement as to the appearance of this stereotype despite conflict concerning differences within the sexes; these preferences seemingly transcend cultural, racial and social barriers.

RACIAL DIFFERENCES AND THE SOFT-TISSUE PROFILE

Prior to the introduction of cephalometrics, several early anthropologic studies revealed significant skeletal, dental and soft-tissue differences between the races (Fonseca and Klein, 1978).

One such study by Hrdlicka (1928) noted that the face and mouth of the American Black was larger than that of the American White, while the nose was broader, shorter and flatter. He concluded that the profile of the Black male was straight, whereas that of the White male demonstrated a concavo-convex profile.

With the advent of cephalometrics in 1931, several analyses for the skull have been presented by various authors. Cotton et al (1951) used the Downs (1948) analysis to compare Blacks to three other ethnic groups, including American Whites. Blacks demonstrated a protrusion of the maxilla, a convex profile, a steep mandibular plane and flared upper and lower incisors when compared to Whites.

Downs (1956) compared the dento-facial patterns in his study to those done previously on American-born Chinese, American-born Japanese, Negroes, Australian Aborigines, and found significant racial differences. A notable feature was the significant prognathism which still represented dentofacial balance and harmony in these races. Morphologically, the dentoskeletal pattern of the American-born Chinese were closest to the American Caucasoid.

Altemus (1960), using the Downs analysis, found the skeletal pattern more protrusive and the teeth more procumbent in a sample of American Negroes. Later, Altemus (1963) duplicated Burstone's (1959) study on a group of Black patients and concluded that the Negroes had larger mean values in all areas except menton, incision-stomion and glabella which were similar to those found in the Caucasian sample. Altemus (1968) believed that cephalofacial features were the basis whereby man could be classified into various racial types. He showed through the use of a variety of heads and faces representing different racial and ethnic stocks, that it had not been proven scientifically that orthognathic faces were more beautiful or healthier. Altemus (1968) concluded that the relative straightness of the facial profile was a compromise in the relationship of its anatomic parts. He noted that the faces of some ethnic groups closely approximated reference norms prescribed for other ethnic extractions.

Lusterman (1963) studied the soft- and hard-tissue relationships of the faces and heads of persons from varying race-types indigenous to the Western World, to determine whether or not definitive differences existed. Selection criteria used in this study was based on the anthropologist Hooton's (1931) differentiation of the occidental white peoples into four basic European race-types. The skeletal and dental patterns of 125 girls aged 12 to 18 years were compared with the cephalometric criteria established by Downs and Riedel. The soft-tissue was evaluated using the German sculptor Schadow's canon

(1835) and its application by Maliniac (1948), a plastic surgeon. It would appear that the Frankfort horizontal plane was used for orientation. Lusterman devised additional measurements and angles for evaluation of the forehead-nose-lip-chin relationships and also undertook face height measurements. The differences were so marked that he felt it erroneous to set one aesthetic standard for all persons in an evaluation of dentofacial structures. He hoped that orthodontists would adjust aesthetics standards for treatment planning of different race-types.

Drummond (1968) used various measurements from the Riedel (1952) and Holdaway (1956) analysis to identify cephalometric trends in the American Negro. He compared his sample with the norms of forty Southern Caucasian children taken from a study performed at the University of Alabama (Taylor and Hitchcock, 1966) and demonstrated significant differences between the two groups. The American Negro children had a steeper mandibular plane, bimaxillary dental protrusion and an anterior displacement of the maxilla. Drummond further showed that Negro children had a large, strong tongue and very loose flaccid lips that allowed the teeth to be in balance and harmony in a procumbent position. The position of the teeth and the thickness of the lips made the lower face appear very full.

In a review of the literature, Uesato (1968) showed significant skeletal and soft tissue difference between accepted Japanese, and American Caucasoid cephalometric norms. The Japanese pattern tended

towards a Class II relationship. A comparison with American-Japanese, however, showed only subtle differences in the skeletal pattern with the maxillary and mandibular teeth being more procumbent. Uesato (1968) employed the Ricketts E-line and Steiner S-line to quantitate the soft-tissue profile for the American-Japanese. He suggested that lips fall between these two planes for an aesthetically balanced Japanese-American facial profile.

Kowalski et al (1974) compared the distribution of the Steiner (1953) variables in a large sample of American Black and White men. They concluded that the proclination of the lower incisors to the NB line was much higher in Blacks, as was the amount of maxillary prognathism. The interincisal angle similarly was much more obtuse in the Caucasian sample, while the cant of the occlusal plane relative to the cranial base was more severe in the Black population.

Sushner (1977) compared the standard Ricketts, Steiner and Holdaway soft-tissue values to those for a Negro sample and found the Black male and female values to be more protrusive than existing Caucasian norms. The differences were so significant that Sushner believed Caucasian norms, which were currently accepted, were not applicable to Blacks. He also utilized a line from soft-tissue nasion to soft-tissue pogonion for quantitation of the soft-tissue profile.

Fonseca and Klein (1978) carried out a cephalometric comparison between forty American Negro and Caucasian women and demonstrated significant differences. They showed in the Negro sample, that the maxilla and mandible were more protrusive. Further, they also demonstrated that the upper and lower incisors were more proclined and the interincisal angle was more acute. The authors also observed that the middle facial height was shorter, while the lower facial height was longer. Significantly, the lip thickness was approximately the same. However, the projection of the upper and lower lips, as related to the facial plane, was greater for Blacks. Similarly, the projection of the soft-tissue nasal tip was found to be less. The authors concluded from these differences that separate cephalometric norms were mandatory in the treatment of Negro and Caucasian populations.

Jacobson (1978) carried out a comparative cephalometric study between South African Blacks and Whites. A number of significant differences emerged from this study. Notably, the short maxilla was in a forward position relative to the anterior cranial base in the South African Black. This forward position of point A had the effect of increasing the ANB angle. The relative position of point B in both groups were, however, similar. The lower incisors in the South African Black were more labially inclined because of the larger ANB angle. In addition, Jacobson compared his norms to those of American Blacks and found similar measurements, except that the upper incisors appeared to be more labially inclined in the American sample.

Richardson (1980) referred to the difficulty of defining or classifying Homo Sapiens into racial groups and noted that besides the three major racial stocks, that is, Asiatic, Black and White or possibly a separate stock (Australoids) in the South Pacific, little success had been achieved in this regard. He preferred the term "ethnic group" which referred to a nation or population having some common bond eg. a geographical boundary, a culture or language, or being racially or historically related. Richardson compared certain dimensional traits of the human face in several "ethnic groups" including that of American Blacks and noted that the differences in the somatic craniofacial structures of those ethnic groups that had resided for several generations in the same or similar geographic areas were very small. The parameters of the face nearest to the alveolar and dental areas showed the greatest differences among ethnic and racial groups.

He observed, too, that the differences in the means within ethnic or racial groups were often greater than the differences in the means among ethnic or racial groups and doubted the existence of more than one race. Instead, Richardson believed that reference to "race-groups" were better made on the basis of a recent term "ethnic group", that referred to a nation or population having a common bond. He showed that the quantifiable differences in the somatic craniofacial region, of persons from ethnic groups, residing for several generations in the same or similar geographic areas were small. This evidence from his study supported a geographical influence on the somatic facial traits of the major racial groups.

In these preceding pages the relative importance of the soft-tissue profile to orthodontic diagnosis and treatment planning has been clearly highlighted. It is clear too that the soft-tissue profile has been thoroughly researched in the Caucasoid and to a lesser extent in the Negroid race. Statistically significant differences have been shown to exist between these two race groups (Sushner, 1977; Connor and Moshiri, 1985).

To date, however, not much have been done, nor have any soft-tissue norms been prescribed for the "Coloured" population of the Western Cape. Seedat (1983) in an earlier cephalometric analysis on this population group, presented what he regarded as the "typical Coloured face". The soft-tissue profile was ignored and there were no criteria for selection nor any analytical assessment methods for deriving this supposition.

Given the diverse genetic background and indeed being cognisant of the socio-political genesis of this "race-group", one could question the existence of a "typical Coloured face" as opposed to the characteristic Caucasoid or Negroid or Mongoloid face, all of which have been shown to be different. The need for a thorough investigation of the cephalometric or photometric profile trends in the group known as the "Cape Coloured" is thus apparent.

MATERIALS AND METHODS

This project involves a photographic profile analysis of a Western Cape Sample. The materials and methods for the study under consideration shall be discussed under the following headings:

1. **The Population Sample.**
2. **Subject Selection.**
3. **Materials**
4. **Experimental Procedure.**
5. **Measurements.**
6. **Statistical Analysis.**

1. THE POPULATION SAMPLE

The Southern African population comprises four large ethnic groups namely, Bantu-speaking Africans, Caucasians of European origin, "Coloureds" of mixed origin, Asians (predominantly from the Indian subcontinent), and two small groups namely Chinese and the Khoisan (Tyack 1970, Thomas, 1981). Based on Government policy, Blacks, Caucasians, Indians and "Coloureds" live separately in clearly defined residential areas (1950 Group Area Act). Similarly, primary and secondary education is separate and controlled by "Own Affairs" Educational departments (Government Gazette, Vol.219 (8914), 28 Sept. 1983, pp.12,70).

The sample population used in this study was drawn from the so called "Coloured" population group of the Western Cape. This was regarded as being representative of the wider majority of patients attending the Oral and Dental Hospital, University of the Western Cape, for orthodontic treatment. In terms of South African legislature, the "Coloured" people are identified as a distinct "race-group" (Population Registration Amendment Act 106 of 1969).

According to the Population Registration Act 30 of 1950 a "coloured person" ("gekleurde") i.e. a person of colour, is somebody who is neither a white person nor a black (para 1(i)). This Act, in essence an attempt to legally differentiate between the major racial groups in South Africa, did not distinguish explicitly between "Coloured"

and Indian (Asian). An elaborate set of subdivisions were, however, subsequently introduced by Proclamation 46 of 1959, which was amended in 1961, and incorporated into the Population Registration Amendment Act 106 of 1969 (S.A. Institute of Race Relations, 1978). A distinction was thus legally instituted between Cape Coloured, Malay and Griqua on the one hand, Chinese, Indians and "Other Asiatic" on the other hand and thirdly, a residual category of "Other Coloureds" (Wolfgang H. Thomas, 1982).

The Report of the Theron Commission on matters affecting the "Coloured" population group (Theron, 1976), noted that the term "Coloured", was not positively described in the Population Act of 1950; a loose definition linking people of "Colour" was implied. While the Commission refuted the subsequent differentiation into subcategories, it implicitly accepted the group identification of "Coloured".

In the light of these amendments to the Act of 1950, Cloete (1977) defined a "Coloured" as a person who is accepted as a product of mixed White, Bantu and/or Asiatic origins, as well as a person who is accepted as of Malay or Griqua origins. Cloete, however, outlined the absurdity and complexity in using this legislative definition for the "Coloured".

Louw (1982) described the "Coloured" population as a heterogenous ethnic group made up of the descendants of siblings from marriages

between indigenous people and Caucasian settlers to this country, and those of later immigrants from Malaya, India as well as other near and far Eastern countries. According to Thomas (1981), this genetically-hybrid population group, arose from miscegenation in unions both regular and irregular between the various race groups present at the time and after. To the above gene-mix, Thomas (1981) included genetic infusions from the west coast of Africa, Mozambique and Madagascar, as well.

W.H. Thomas (1982) wrote that the very heterogeneity of their backgrounds,and the difference in their socio-economic positions prevented the "Coloured" from constituting any distinct group. Further their geographical distribution was most uneven, which similarly prevented the "Coloured" group from developing into a typical minority group. Whilst they could be regarded as typical "South African", they lacked any cultural or national (group) solidarity.

According to Hall and Morris (1983), the "Cape Coloured and Cape Malay" were more probably an artifact of the South African socio-political environment than of any cultural reality. Nonetheless, despite their observation, it is the guarded opinion of the author that there were many faces within this "socio-political" grouping that have still retained distinctive facial somatic traits, in keeping within their origins.

According to Dreyer (1978), the "Coloured" population of the Cape Peninsula is an established group, having their ethnic origins in the Western Cape. It is likely that their disparate origins may be reflected in a more liberal gene-mix, as opposed to "Coloureds" in other areas of South Africa where genetic-hybridization may be more specific or selective, e.g. Thomas (1981) described different rugae patterns for the *"Peninsula Coloured" and the **"Namaqua Coloured".

Numerous factors, however, have resulted in a gradual drift of "Coloureds" from other areas of South Africa and the Western Cape in particular, to the Cape Peninsula. The long held Government policy of creating in the Cape Province, a "Coloured preferential area", has supposedly afforded better socio-economic conditions for the "Coloured" people in these areas, especially in the urban areas.

The term "Cape Coloured", as implying a select group with certain unique characteristics, is therefore, in a contemporary sense, a misnomer. Hence, in the context of this study the term "Cape Coloured" is loosely used to define those people of mixed origin resident in the Cape Province, as opposed to "Coloureds" in other areas of South Africa. The term merely bears a geographic connotation.

* From the Cape Peninsula
** From the North-West Cape

In 1980 the "Coloured" group constituted about 9 per cent of the total South African population. In the Greater Cape Town area alone there was about 800,000 or 32 per cent of the overall "Coloured" population of the country. In the south western part of South Africa they make up the largest segment of the regional population and in the Western Cape they exert a dominant presence. (W.H. Thomas, 1982). In the Cape Peninsula the "Coloured" population group live in reasonably well defined areas, in accordance with Government policy.

A further enigma of the South African situation is that of persons from one race-type adopting the identity of another, subject to government approval. According to Singh (1986), many South African Indians in the Western Cape have adopted the "Coloured" identity, thereby being better disposed in respect of the more favourable housing and business opportunities that exist. It was felt, however, that this practice was not widespread. Nonetheless, cognisance was given to this complexity during sample selection.

In this study only so called "Coloureds", as earlier defined, from "Coloured" areas and/or attending "Coloured" schools were selected. Indians and Blacks who adopted the "Coloured" identity were excluded. These subjects were sifted according to surname and maternal surname and then thoroughly investigated to rule out the possibility of a change of identity to "Coloured".

2. SUBJECT SELECTION

The subjects used in this study comprised forty-six (46) adult females and thirty (30) adult males, chosen for their attractive and pleasing facial appearance. Since debate was inevitable in deciding how good or excellent these faces might be, they were minimally interpreted, within the context of this study, as being acceptable, based on the work of Burstone (1958). This is especially significant in the light of the intrinsic subjectivity of aesthetic judgment, and, at the same time being mindful that the findings in this study serve merely as a guide to probable soft-tissue profile trends in the "Coloured" ethnic group.

The female sample included five (5) beauty contest winners, and eleven (11) part-time models. The remainder comprised students selected from the matriculation classes of five high schools in the Cape Peninsula. The male sample in this study was drawn entirely from these schools. The five schools were arbitrarily selected for their proximity to the dental faculty at the University of the Western Cape.

The five beauty queens had been winning finalists at two community based carnivals, hosted annually by sporting organizations. In the South African socio-political milieu these sports bodies would be classified "Coloured". As informed by the organizers, these

contestants were chosen for their beauty, poise and intelligence by a panel of judges from different social status levels. The part-time models were employed by the modelling agency for their poise and general good looks.

Selection at the schools were done by the author, assisted by a nursing-sister and the class teacher at each school. The only criteria for selection being a good or attractive facial appearance. Five of the most attractive male and female students from each class, were independantly selected by these three judges. A select group of male and female students were obtained by selecting out those individuals, who had been commonly chosen within the three groups. By employing this method of consensus selection, six of the most acceptable male and female students were finally chosen from this select group, at each school (Figs.1 and 2). The school sample surveyed totalled 630, comprising 341 males and 289 females.

Since this study was one involving the soft-tissues alone, no consideration was given to the dental status of the participants. All the subjects selected were 18 years and older with a mean age of 18.9 years for males and 18.6 years for females (Table 1). The availability of age-specific soft-tissue Caucasoid and Negro norms for comparative assessment, justified the age group under investigation (Sushner, 1977; Forsberg and Odenrick, 1979; Connor and Moshiri, 1985).

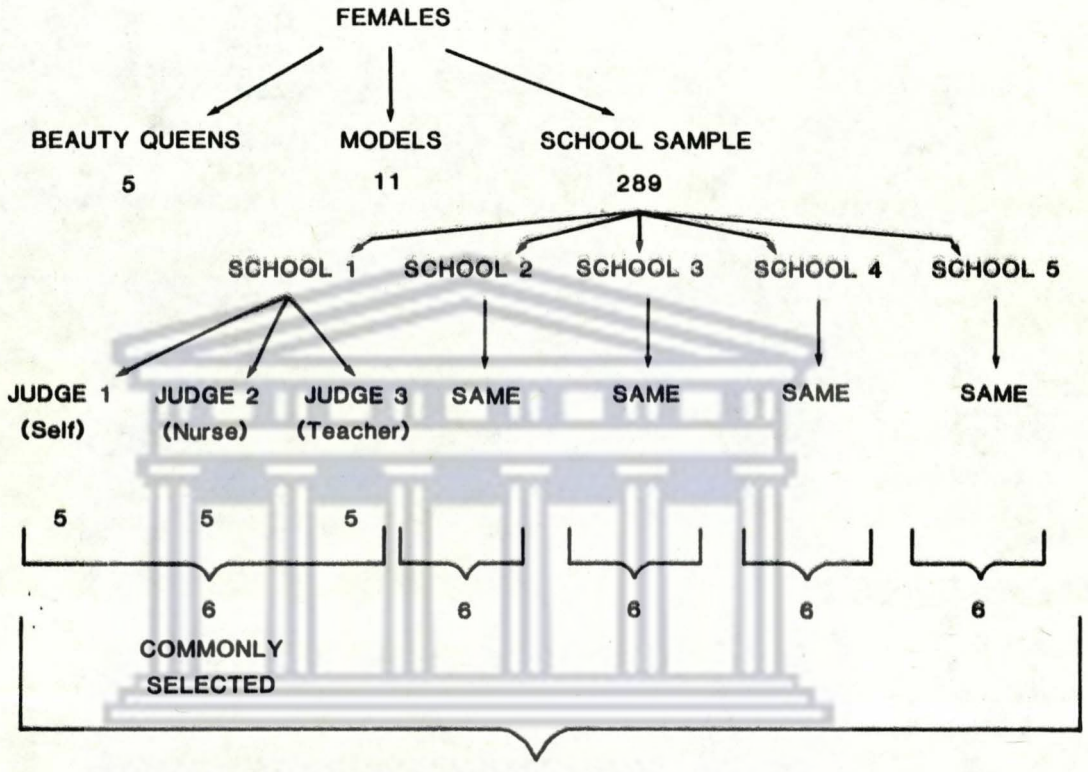


Fig.1 Diagrammatic representation of female sample selection.

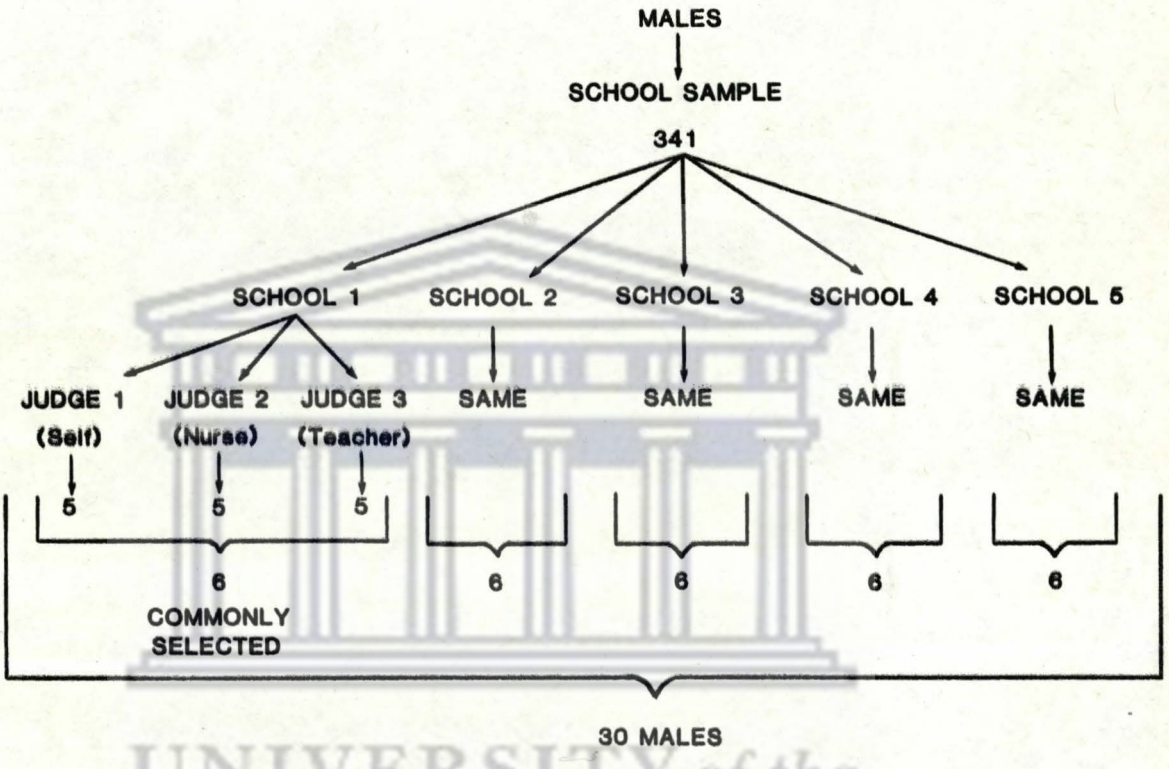


Fig.2 Diagrammatic representation of male sample selection.

TABLE 1: Age Distribution of Sample Evaluated

AGE (yrs)	MALES	FEMALES
18	98	169
19	201	120
20	38	2
21	4	3
22		3
23		4
24		4
TOTAL	341	305
MEAN AGE	18.9 years	18.6 years

3. MATERIALS

Photographic Apparatus

A Nikkormat camera with a 105mm macro-lens was fixed in position to the *cephalostat by a specially designed aluminium bracket (mounting device) that replaced the collimating device (Fig.3). This camera position co-incided with the position of the X-ray tube, the latter having been removed for the purposes of this study (Fig.4). The mounting device also supported a flash "hot shoe" adjacent to the camera.

A metal rod approximately 50 cm long was fixed to the "position adjustment pin" of the cephalometer in the midsagittal plane. Two plumb-lines were suspended from metal rings on this support rod. These were spaced approximately 20cm apart (Fig.5). One plumb-line immediately adjacent to the cephalometer carried two clearly defined markings 10cm apart (Fig.6).

The ear-rods and nasal rest were removed from the cephalometer.

A viewing mirror was placed about 5 feet away, directly in front of the cephalometer, while a direct light source was placed on the left-hand side of the latter (Fig.7).

*Wehmer Cephalostat, Illinois, U.S.A.

Fig.3 Showing the adjustments made to the cephalometer
(a) Red arrow shows the camera in the place of the X-ray tube.
(b) Blue arrow shows the metal rod fixed by position-adjustment-pin of the cephalostat.

Fig.4 Shows the camera in the position of the X-ray tube. The red arrow indicates the camera mounting device, that replaced the collimator.

Fig.5 Shows the support rod with two gravity defined plumb-lines.

Fig.6 Shows the plumb-line with marking 10cm apart.
The red arrow points to the cephalostat position-adjustment-pin.

Fig.7 Shows the light source used in silhouette photography.

Photographic film

All the photographic exposures were taken with 35mm Kodak Plus X film, enlarged and printed on 25cm x 30cm black and white semi-matt paper.

Tracing Materials

The materials used for the tracing technique included *Ozatex "N" .05mm double matt tracing paper, a 4H lead pencil, scotch-tape, a standard millimeter rule, a Vernier Calliper and a protractor. A Sharp scientific calculator EL-5103, was used to perform statistical functions.

*Ozalid Drafting film.

4. EXPERIMENTAL PROCEDURE

Photographic Method

The photographic method employed in this study, to obtain life-size replicas for each subject, was based on the photocephalometric technique employed by Phillips et al (1984). The latter technique was recently described by Hohl et al (1978), for the possible soft-tissue evaluation of orthognathic surgical patients, by the superimposition of coordinated cephalographs and photographs.

The photographs were taken at a fixed distance of 150cm from the midsagittal plane of the subject. However, since the camera was attached to the main assembly of the cephalostat, vertical adjustments were possible.

An "adjusted" natural head position, as described by Moorrees and Kean (1958), was used to position each subject in the cephalostat. The subject was asked to look into the mirror at the reflection of his/her eyes, with the lips lightly touching in the relaxed posture (the "closed-lip" posture of Burstone, 1967).

The two plumb-lines were used to position the head in the coronal plane, thereby, avoiding untoward head-tilt movements. The plumb-line bearing the fixed markings and lying within the photographic field, was used to establish a gravity defined vertical

reference plane. This graduated vertical reference further allowed for life-size enlargement of the photographic image (infravide). Silhouette photographs of the soft-tissue profile were obtained by placing the subject between the camera and a light source. All the photographs were taken with the same camera, using an automatic setting (Fig.4).

All measurements were done on black and white life-size profile photographs (Fig.8). The photographic negatives were developed and enlarged in a standardized manner. The enlargement setting was obtained by enlarging the midsagittal plane film to life-size using the 10cm marking on the plumb-line in the image as a reference.

Further, for comparison with established cephalometric soft-tissue norms; a stated objective of this study, all the relevant horizontal and vertical linear data were enlarged by 8.8% and 9.1% respectively. These values represented the enlargement factor between the head, and the radiographic film, and was calculated for the distance extending from the midsagittal plane of the cephalostat to the cassette holder (Appendix I). The angular measurements remained unaltered by this magnification effect.

Tracing Procedure

Cephalometric tracing paper was scotch-taped over each profile photograph and the profile traced with a 4H pencil. A number of

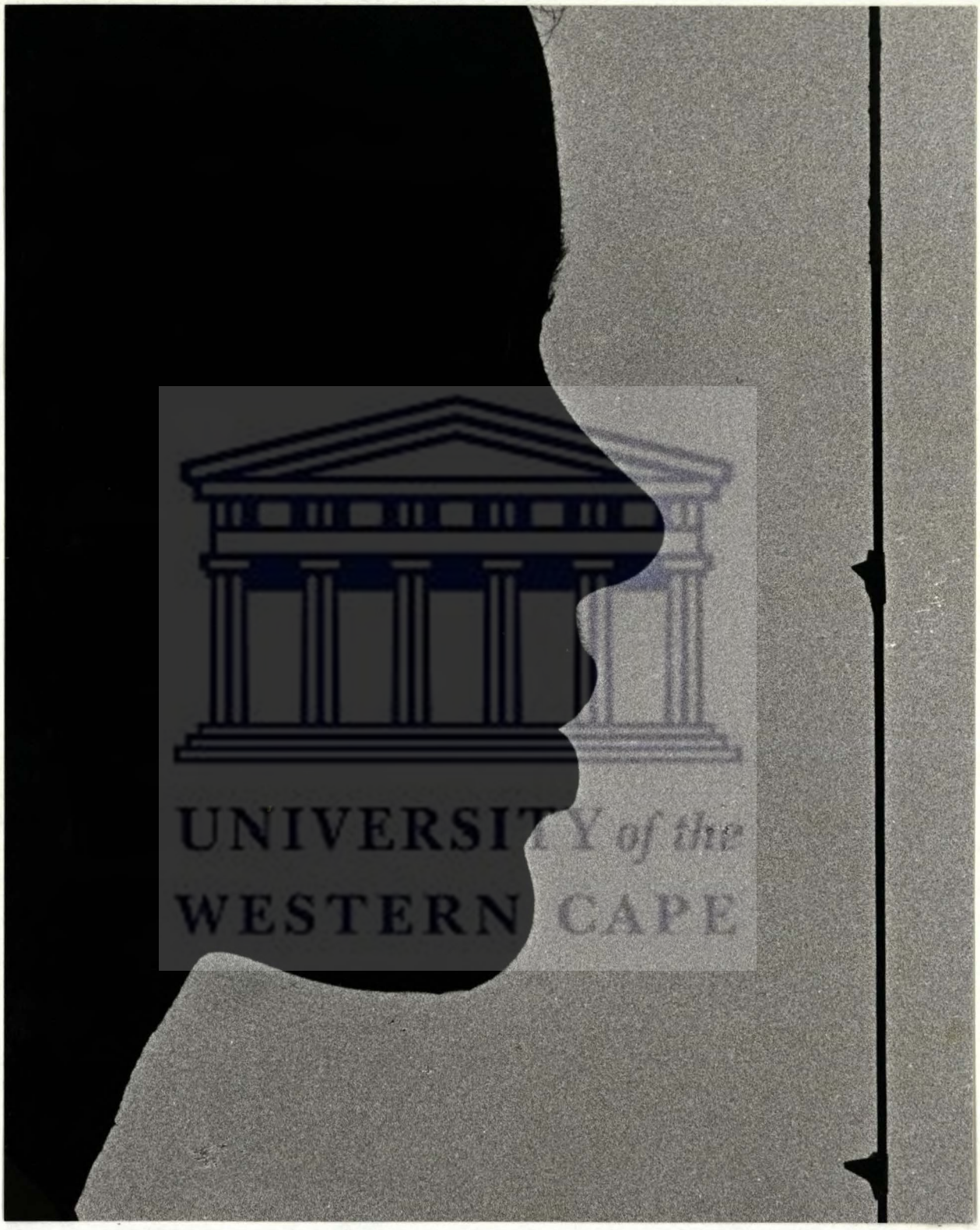


Fig.8 Shows type of silhouette photograph employed in the study.

anatomical landmarks and analytical lines and planes were identified on the tracing for study, as outlined below. Linear and angular measurements were recorded to the nearest millimeter and degree using a Vernier calliper and protractor respectively.

Independent Examiner

Ten photographs were traced by an independent examiner to exclude the probability of any tracing error by the principle examiner. Only one variable was examined. It was decided that the upper lip to the E-line be used, as this represented the first parameter evaluated in the series.

5. MEASUREMENTS

A. Landmarks: (Fig. 9)

Use is made of anatomic points described in the cephalometric studies of Ricketts (1957), Burstone (1958), Steiner (1962), Holdaway (1983), Phillips et al (1984) and these do not wholly represent those anthropometric landmarks proposed by Farkas (1984). These landmarks are listed as follows:

1. G (glabella): the most prominent point in the midsagittal plane of the forehead.

2. N'* (soft-tissue nasion): the most concave point in the area overlying the frontonasal suture.

3. P (pronasale): the most prominent or anterior point of the nose.

4. Cm (Columella point): the most anterior point on the columella (nasal septum) of the nose.

5. Sn (subnasale): the point at which the columella (nasal septum) merges with the upper cutaneous lip in the midsagittal plane.

*A prime (') signifies the soft-tissue equivalent of a hard-tissue landmark.

SOFT-TISSUE LANDMARKS

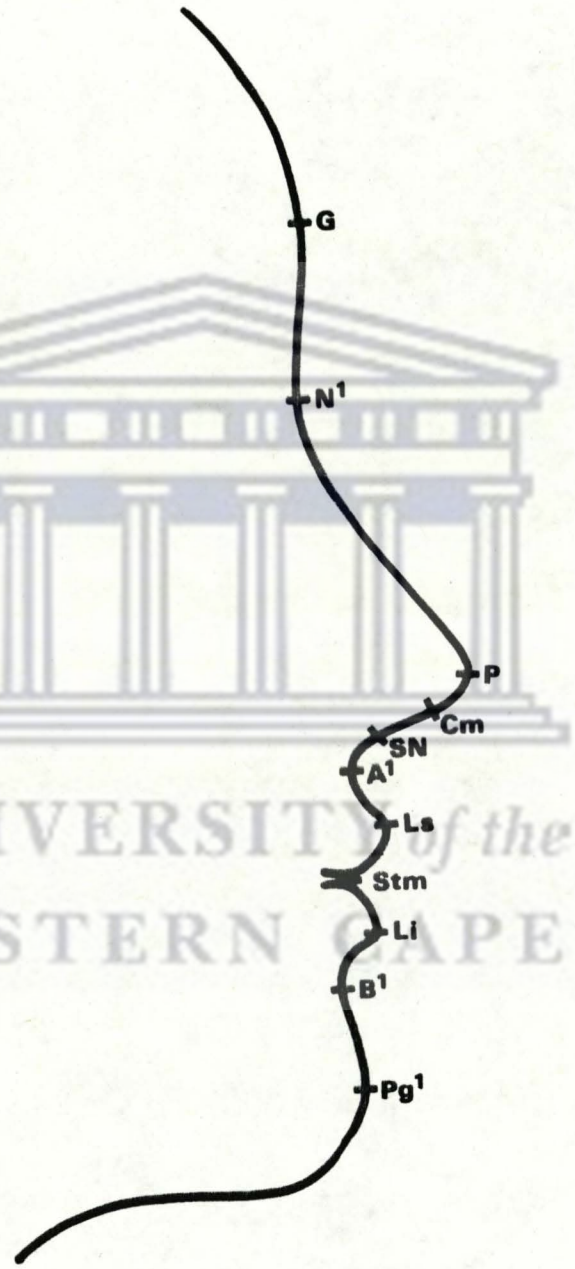


Fig. 9 Landmarks used in soft-tissue analysis

6. A'* (soft-tissue A point or superior labial sulcus): the point of greatest concavity in the midline of the maxillary lip between subnasale and labrale superius.

7. Ls (Labrale Superius): the most anterior point on the convexity of the upper lip.

8. Stm (stomion): the junction of the upper and lower membraneous lips.

9. Li (Labrale inferius): the most anterior point on the convexity of the lower lip.

10. B'* (soft-tissue B point or inferior labial sulcus): the point of greatest concavity in the midline of the lower lip between labrale inferius (Li) and soft-tissue pogonion. Legan and Burstone (1980) refered to this point as Si (mentolabial sulcus), while Farkas (1984) called it Sl (Subliable point - the midpoint of the horizontal labiomental fold skin ridge).

11. Pg'* (soft-tissue pogonion): the most prominent or anterior point on the convexity of the soft-tissue chin.

12. True vertical reference plane: any plane passing parallel to the plumb-line in the mid-sagittal plane.

*A prime (') signifies the soft-tissue equivalent of a hard-tissue landmark.

B. Linear and Angular Dimensions:

Linear Measurements

All horizontal linear measurements were carried out perpendicular to the true vertical reference plane (Fig.10).

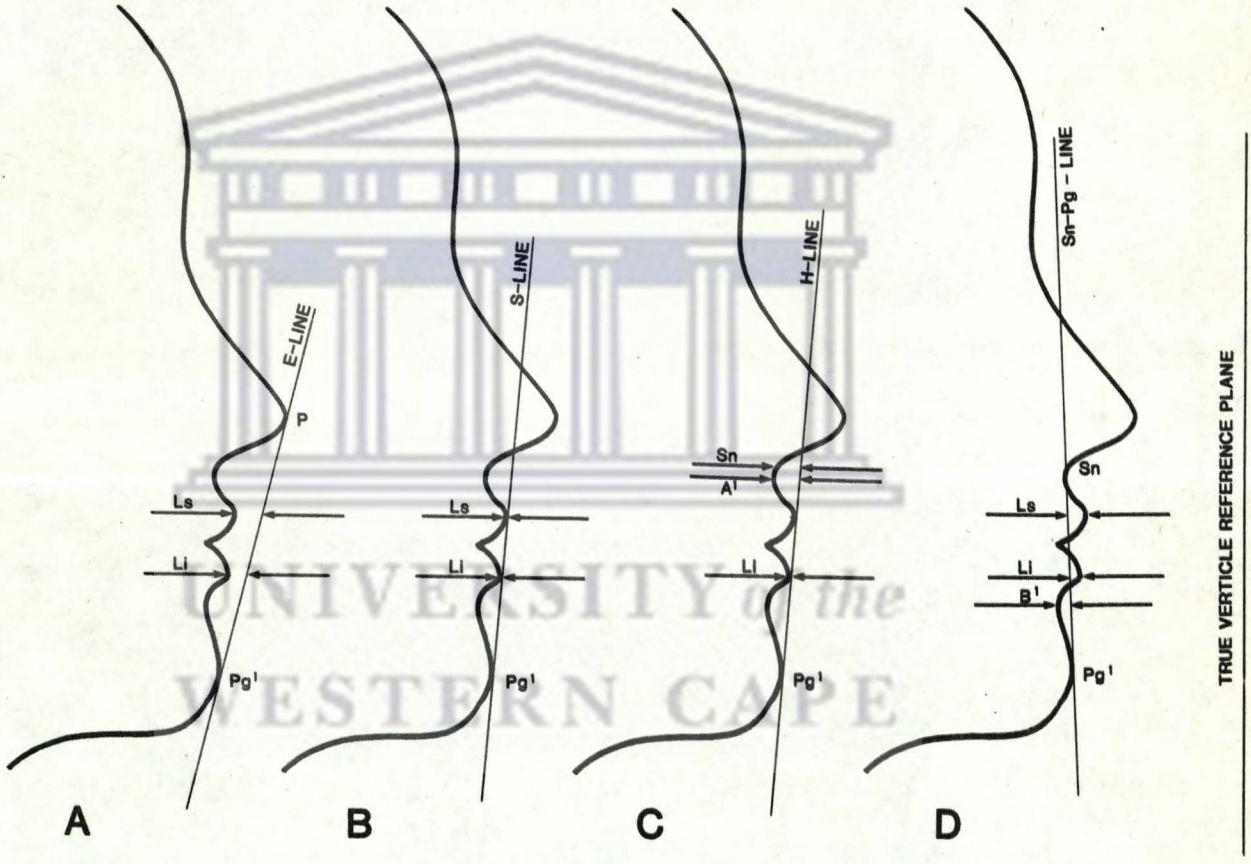


Fig.10 Shows the soft-tissue lines, with the related horizontal linear parameters investigated, A. Ricketts "E" line, drawn tangent to the chin and nose. B. Steiner's "S" line, drawn tangent to the chin and passing through a point midway on the lower border of the nose. C. Holdaway "H" line, drawn tangent to the chin and the upper lip. D. Burstone's "Sn-Pg'" line, drawn tangent to the chin and passing through subnasale (Sn).

1. Ricketts E-line (mm) - a line drawn from the soft tissue chin (Pg') to the tip of the nose (P) (Fig.10A).
   (i) E to upper lip - distance from the E-line to labrale superius (Ls).
   (ii) E to lower lip - distance from the E-line to labrale inferius (Li).

2. Steiner S-line (mm) - a line drawn from the soft-tissue chin (Pg') through a point midway on the lower border of the nose (Fig.10B).
   (i) S to upper lip - distance from S-line to Ls.
   (ii) S to lower lip - distance from S-line to Li.

3. Holdaway H-Line (mm) - a line drawn from the soft-tissue chin (Pg') tangent to the upper lip (Fig.10C).
   (i) H to Subnasale - distance from H-line to Sn.
   (ii) H to soft-tissue A point - distance from H-line to A'.
   (iii) H to lower lip - distance from H-line to Li.

4. Burstone Sn-Pg' plane (mm) - a line drawn from subnasale (Sn) to soft-tissue Pogonion (Pg') (Fig.10D).
   (i) Sn-Pg' to upper lip - distance from Sn-Pg' to Ls.
   (ii) Sn-Pg' to lower lip - distance from Sn-Pg' to Li.
   (iii) Sn-Pg' to soft-tissue point B - distance from Sn-Pg' to B'.

5. Upper Lip Length (ULL) (mm) - The linear measurement between subnasale and stomion along the Sn-Pg' plane.

Angular Measurements:

1. Nasolabial Angle (NLA) (degrees) - The angle formed by joining the points Columella-Subnasale-Labrale Superius (Cm-Sn-Ls) (Fig.11).

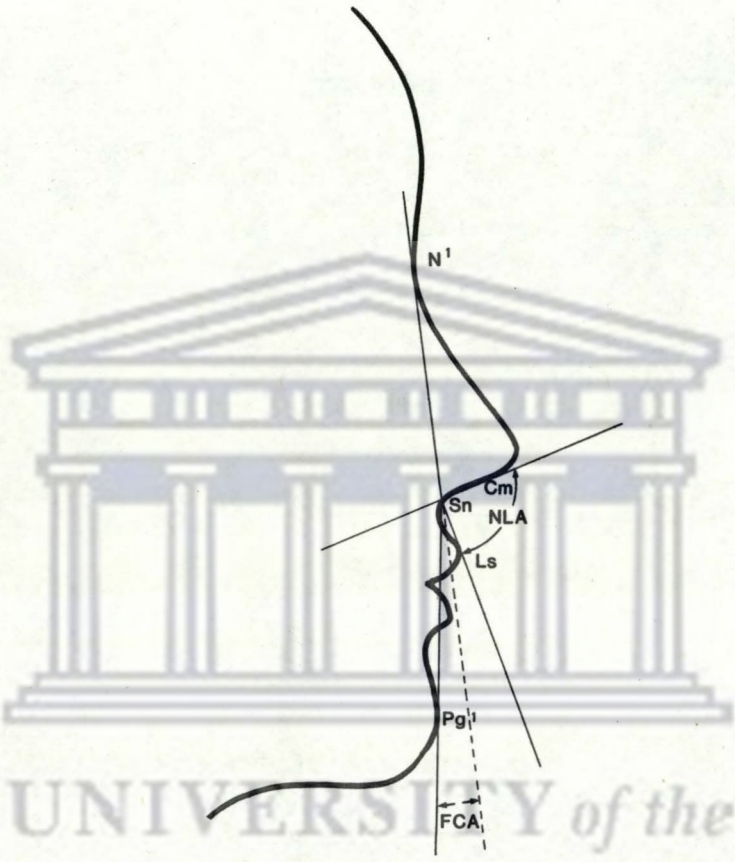


Fig.11 Shows the nasolabial angle (NLA) and the facial contour angle (FCA). An extention of the upper facial plane (N'-Sn) is used to measure the FCA.

2. Facial Contour Angle (FCA) (degrees) - The angle formed by the upper facial plane and the lower facial plane (Fig.11). The upper facial plane extends from nasion to subnasale, while the lower facial plane extends from subnasale to soft-tissue pogonion.

6. STATISTICAL ANALYSIS

The measured values for the male and female sample under study were collected and placed in data tables. Descriptive statistics (mean, standard deviation, range) were calculated from the observed values for each measurement.

The results were subjected to the student t tests, and the significance at the 0.01 and 0.05 levels were determined. Comparisons were made between:

a) "Coloured" male and "Coloured" female

b) "Coloured" and Negro (separately for males and females)

c) "Coloured" and Caucasian (separately for males and females)

In those cases where the results of this study were compared to a standard or universal mean, t-tests for the difference between a sample mean and a population mean were used (Appendix II).

An inter-examiner variability test was also undertaken, using the Pearson's product-moment-formula for the linear correlation coefficient (Appendix II).

RESULTS

1. INTER EXAMINER VARIABILITY TEST

A Pearson product-moment correlation coefficient of 0.992 (Appendix II) showed that there was very strong correlation between the two examiners for the specific variable that was possessed, namely the upper lip to E-line. This clearly indicates that the error resulting from the tracing of the photographs and the identification of the relevant soft-tissue landmark were likely to be very minimal.

2. **MALE AND FEMALE VALUES FOR THE WESTERN CAPE SAMPLE: (Using the four soft-tissue reference planes and two angular measurements).**

The descriptive statistics for each variable under study is depicted in tables 2 to 14. The range, mean, standard deviation and p-values are noted in each table comparing the male and female subjects.

Table 2: E to Upper Lip (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	-7.0 - 0.0	-2.467	1.624	0.874
"Coloured" female	46	-5.6 - 0.0	-2.704	1.494	

Table 3: E to Lower Lip (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	-3.6 - 2.0	-0.573	1.343	0.032*
"Coloured" female	46	-4.7 - 1.8	-1.348	1.613	

* Significant at 0.05 level
** Significant at 0.01 level

The results in tables 2 and 3 showed a significant difference at the 5% level in the position of the lower lip relative to the E-line. The lower lip of the male was significantly more protrusive than that for the female. There were no differences, however, between the relationship of the upper lip to E-line in both males and females. The negative values for the means indicated that the lips lay behind the E-line of Ricketts. (1957).

Table 4: S to Upper Lip (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	-2.5 - 2.7	0.840	1.225	0.441
"Coloured" female	46	-1.5 - 3.0	0.630	1.104	

Table 5: S to Lower Lip (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	-0.7 - 4.0	1.317	1.073	0.039*
"Coloured" female	46	-1.5 - 3.2	0.739	1.228	

* Significant at 0.05 level
** Significant at 0.01 level

The results in tables 4 and 5, showed no significant difference in the position of the upper lip relative to S-line of Steiner (1962), however, the position of the lower lip in relation to this reference plane was significantly different at the 5% level between male and female. While the position of the upper lip relative to the S-line was almost similar for the sexes, the lower lip was seen to be significantly more protrusive. The positive mean values indicated that the lips lay ahead of the S-line. However, the range for this select sample revealed that some lips were found to be behind the S-line, as indicated by the negative values.

Table 6: H to Subnasale (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	3.1 - 9.5	6.337	1.853	0.152
"Coloured" female	46	2.1 - 8.5	5.693	1.918	

Table 7: H to A' (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	3.6 - 9.1	6.500	1.522	0.239
"Coloured" female	46	3.0 - 9.1	6.037	1.744	

Table 8: H to Lower Lip (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	-1.8 - 2.1	0.987	0.890	0.0022**
"Coloured" female	46	-0.7 - 2.0	0.424	0.657	

* Significant at 0.05 level
** Significant at 0.01 level

The results in tables 6 and 7 showed no significant difference between males and females for the parameters evaluated, that is, the distance of subnasale and soft-tissue point A from the H-line, were similar for the sexes. However, table 8 revealed that the relationship of the lower lip to the H-line, was significantly different at the 1% level. The lower lip in the male was more protrusive when compared to that of the female. The positive values of the means implied that the lips were ahead of the H-line of Holdaway.

Table 9: Ls to Sn.Pg' (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	2.2 - 7.0	4.553	1.257	0.365
"Coloured" female	46	1.7 - 6.7	4.262	1.428	

Table 10: Li to Sn.Pg' (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	1.2 - 6.1	3.850	1.151	0.0051**
"Coloured" female	46	0.4 - 6.0	2.933	1.472	

* Significant at 0.05 level
** Significant at 0.01 level

Table 11: B' to Sn.Pg' (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
"Coloured" male	30	1.2 - 6.6	3.413	1.207	0.0071**
"Coloured" female	46	1.2 - 4.6	2.761	0.847	

* Significant at 0.05 level
** Significant at 0.01 level

Table 9 revealed that the distance from the most anterior point of the upper lip (Ls) to the Sn.Pg'-line, was not significantly different for the sexes. The relationship of the lower lip (Table 10), to this plane, however, was significantly different at the 1% level. The lip in the male was notably, again more protrusive than that for the female. The positive mean values indicated that both the upper and lower lips were ahead of the plane of reference. Table 11 similarly showed a significant difference within the sexes, at the 1% level. The depth of the lower labial sulcus was shown to be shallower in the female.

Table 12: Upper Lip Length (mm) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
Coloured male	30	19.7 - 29.7	24.447	2.313	0.0001**
Coloured female	46	18.5 - 24.8	21.793	1.611	

* Significant at 0.05 level
** Significant at 0.01 level

The results from table 12 demonstrated that the upper lip length in the male, was significantly different to that for the female, at the 1% level. The lips of the male was shown to be longer than that of the female. As was indicated by the range, there were wide variations in the lip length.

Table 13: FCA (degrees) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
Coloured male	30	8.5 - 27.5	19.817	4.348	.0001**
Coloured female	46	5.0 - 22.0	14.174	4.195	

* Significant at 0.05 level
** Significant at 0.01 level

The two angular measurements recorded in this study, namely the facial contour angle (FCA) and the nasolabial angle (NLA), showed differing significance results. The facial contour angle in the male was shown to be significantly different to that for the female at the 1% level. This angle, a measure of facial convexity, was seen to be larger in males than in females.

Table 14: NLA (degrees) measurements recorded

GROUP	n	RANGE	MEAN	S.D.	P Value
Coloured male	30	79.0 - 116.5	98.883	10.816	0.604
Coloured female	46	81.0 - 117.5	100.158	10.147	

Table 14 revealed that there were no significant differences in the means of the nasolabial angle for the "Coloured" male and female participating in this study. There was a wide variation within the measurements recorded.

3. COMPARISON OF A WESTERN CAPE "COLOURED" SAMPLE WITH A CAUCASIAN AND A NEGRO SAMPLE

Caucasoid Sample

Tables 15 to 24 compares the soft-tissue profile values of the "Coloured" sample to Caucasian and Negroid norms. Comparison is made with North American norms in all measurements, except the relationship of the upper lip to the Ricketts E-plane (Table 15), and the measurement of the lower lip to this plane (Table 16), where comparison is also made to the Swedish (Caucasian) norms of Forsberg and Odenrick (1979) (Appendix IV). The latter values were incorporated in this study as Ricketts, since 1968, no longer considered the upper lip in his aesthetic analysis. In table 16, the value "-4", represents the Ricketts' mean. The Caucasian measurements shown in tables 17 to 22, represent the Steiner, Holdaway, and Burstone norms respectively. These soft-tissue standards, notably, were prescribed for an adolescent population group.

Negroid Sample

The Negro values presented in table 15 to 20, are those obtained from a study by Sushner (1977), while the values shown in tables 23 and 24 are from a study by Connor and Moshiri (1985). These norms are prescribed for North American Blacks. The only soft-tissue profile values not obtainable for Blacks are those relating to the Subnasale-Pogonion (Sn-Pg') line (Tables 21 and 22). Comparisons were therefore not possible for these variables.

Table 15: E to upper lip (mm)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	-2.647	1.624	
Negro male	50	-0.33	2.17	< 0.01**
"Coloured" male	30	-2.647	1.624	
Caucasoid male	20	-6.90	3.18	< 0.01**
"Coloured" female	46	-2.704	1.494	
Negro female	50	-0.46	1.77	< 0.01**
"Coloured" female	46	-2.704	1.494	
Caucasoid female	20	-5.34	2.03	< 0.01**

* Significant at 0.05 level
** Significant at 0.01 level

Table 16: E to lower lip (mm)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	-0.573	1.343	
Negro male	50	2.02	2.36	< 0.01**
"Coloured" male	30	-0.573	1.343	
Caucasoid male	20	-4.50	3.68	< 0.01**
Caucasoid male		-4		
"Coloured" female	46	-1.348	1.613	
Negro female	50	1.08	1.91	< 0.01**
"Coloured" female	46	-1.348	1.613	
Caucasoid female	20	-3.44	2.39	< 0.01**
Caucasoid female		-4		< 0.01**

* Significant at 0.05 level
** Significant at 0.01 level

Tables 15 and 16 demonstrated significant racial differences at the 1% level for the various comparisons undertaken. Notably the lower lip in the Negro male and female was found to be protruding beyond the E-line,

as indicated by the positive mean values. The lips of the "Coloured" male and female sample were found to be more protrusive (that is, closer to the E-line), than that for the Caucasian, while being less so when compared to that for the Negro.

Table 17: S to upper lip (mm)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	0.84	1.225	
Negro male	50	5.46	1.76	< 0.01**
"Coloured" male	30	0.84	1.225	
Caucasoid male		0.00		< 0.01**
"Coloured" female	46	0.630	1.104	
Negro female	50	4.25	1.35	< 0.01**
"Coloured" female	46	0.630	1.104	
Caucasoid female		0.00		< 0.01**

* Significant at 0.05 level
** Significant at 0.01 level

Table 18: S to lower lip (mm)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	1.317	1.073	
Negro male	50	4.98	2.15	< 0.01**
"Coloured" male	30	1.317	1.073	
Caucasoid male		0.00		< 0.01**
"Coloured" female	46	0.739	1.228	
Negro female	50	3.87	1.55	< 0.01**
"Coloured" female	46	0.739	1.228	
Caucasoid female		0.00		< 0.01**

* Significant at 0.05 level
** Significant at 0.01 level

The results in table 17 and 18 showed that the relationship of the lips to the S-line were significantly different at the 1% level between

the various racial groups under consideration. Notably none of the mean values were found to lie behind the E-line. The Caucasoid values (0.00mm) indicated in the tables were prescribed for an adolescent sample and since the soft-tissue profile becomes less convex with age, these findings are highly significant.

Table 19: H to Subnasale (mm)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	6.337	1.853	
Negro male	50	7.83	2.77	< 0.05*
"Coloured" male	30	6.337	1.853	
Caucasoid male		5.00		< 0.01**
"Coloured" female	46	5.693	0.283	
Negro female	50	6.23	1.98	> 0.05
"Coloured" female	46	5.693	0.283	
Caucasoid female		5.00		< 0.01**

* Significant at 0.05 level
** Significant at 0.01 level

Table 20: H to lower lip (mm)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	0.987	0.890	
Negro male	50	1.69	1.47	< 0.05*
"Coloured" male	30	0.987	0.890	
Caucasoid male		0.00		< 0.01**
"Coloured" female	46	0.424	0.657	
Negro female	50	1.27	0.94	< 0.01**
"Coloured" female	46	0.424	0.657	
Caucasoid female		0.00		< 0.01**

* Significant at 0.05 level
** Significant at 0.01 level

The comparisons made in tables 19 and 20 were shown to be significant at either the 1 or 5% levels, except for the comparison relating subnasale to the H-line in the Negro and "Coloured" female which showed no significant difference.

Table 21: Ls to Sn.Pg' (mm)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	4.553	1.257	
Negro male	-	-	-	
"Coloured" male	30	4.553	1.257	
Caucasoid male	32	3.5	1.4	< 0.01**
"Coloured" female	46	4.262	1.428	
Negro female	-	-	-	
"Coloured" female	46	4.262	1.428	
Caucasoid female	32	3.5	1.4	< 0.05*

* Significant at 0.05 level
** Significant at 0.01 level

Table 22: Li to Sn.Pg' (mm)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	3.850	1.151	
Negro male	-	-	-	
"Coloured" male	30	3.850	1.151	
Caucasoid male	32	2.2	1.6	< 0.01**
"Coloured" female	46	2.933	1.472	
Negro female	-	-	-	
"Coloured" female	46	2.933	1.472	
Caucasoid female	32	2.2	1.6	< 0.05*

* Significant at 0.05 level
** Significant at 0.01 level

No Negroid norms were available for comparison to the "Coloured" sample. However, the results in tables 21 and 22 showed that the comparison between the "Coloured" and Caucasian male differed significantly at the 1% level, while that for the female at the 5% level. "Coloured" lips are hence more protrusive in relation to the Sn-Pogonion line when compared to that of the Caucasian.

Table 23: ULL (mm)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	24.447	2.313	
Negro male	25	27.72	2.46	< 0.01**
"Coloured" male	30	24.447	2.313	
Caucasoid male	25	24.13	2.59	> 0.05
"Coloured" female	46	21.793	1.611	
Negro female	25	26.34	2.89	< 0.01**
"Coloured" female	46	21.793	1.611	
Caucasoid female	25	21.5	3.55	> 0.05

* Significant at 0.05 level
** Significant at 0.01 level

Table 23 showed that the length of the upper lip (ULL) did not differ significantly between "Coloured" and Caucasian males and females. However, when compared to the Negro, the lips of "Coloured" males and females were shown to be significantly shorter, at the 1% level.

Table 24: NLA (degrees)

GROUP	n	MEAN	S.D.	P Value
"Coloured" male	30	98.883	10.816	
Negro male	25	76.27	18.01	< 0.01**
"Coloured" male	30	98.883	10.816	
Caucasoid male	25	101.19	11.95	> 0.05
"Coloured" female	46	100.158	10.147	
Negro female	25	77.05	15.25	< 0.01**
"Coloured" female	46	100.158	10.147	
Caucasoid female	25	107.34	7.33	< 0.01**

* Significant at 0.05 level
** Significant at 0.01 level

Table 24 showed no significant differences between the "Coloured" male and Caucasoid male when comparing the nasolabial angles. However, all the other racial groups differed significantly from each other at the 1% level. The nasolabial angle (NLA) was shown to be most acute in the Negro.

Table 25 presents a summary of the means and standard deviations for the soft-tissue parameters studied in this select "Coloured" sample, from the Western Cape. The negative values indicate that the parameters being evaluated, lies behind or posterior to the specific plane of reference. These values have been obtained from an adult sample of average age 18.9 years in the male and 18.6 years in the female.

Table 25: Summary of profile trends in male and female samples

VARIABLE	MALE (Average age = 18.9 yrs)	FEMALE (Average age = 18.6 yrs)
E to Ls (mm)	-2.647 ± 1.624	-2.704 ± 1.494
E to Li (mm)	-0.573 ± 1.343	-1.348 ± 1.613
S to Ls (mm)	0.840 ± 1.225	0.630 ± 1.104
S to Li (mm)	1.317 ± 1.073	0.739 ± 1.228
H to Sn (mm)	6.337 ± 1.853	5.693 ± 1.918
H to A' (mm)	6.500 ± 1.522	6.037 ± 1.744
H to Li (mm)	0.987 ± 0.890	0.424 ± 0.657
Ls to Sn.Pg' (mm)	4.553 ± 1.257	4.262 ± 1.428
Li to Sn.Pg' (mm)	3.850 ± 1.151	2.933 ± 1.472
B' to Sn.Pg' (mm)	3.413 ± 1.207	2.761 ± 0.847
ULL (mm)	24.447 ± 2.313	21.793 ± 1.611
FCA (degrees)	19.817 ± 4.348	14.174 ± 4.195
NLA (degrees)	98.883 ± 10.816	100.158 ± 10.147

DISCUSSION

One of the objectives of this study was to determine whether differences existed between the soft-tissue profile of the "Coloured" population group and the universally accepted soft-tissue norms for Caucasians and Negroes (Steiner, 1962; Burstone, 1967; Ricketts, 1968; Sushner, 1977; Forsberg and Odenrick, 1979; Holdaway, 1983; Connor and Moshiri, 1985).

Routine use of North American Caucasoid hard-tissue and soft-tissue cephalometric norms for the orthodontic patients at this hospital have frequently resulted in conflict and variance between treatment planning on the one hand, and treatment objectives, and/or treatment results on the other. It is not uncommon, when treating to these Caucasian norms, that an eight-tooth extraction sequence for these "Coloured" patients is required. This unnecessary, often untenable clinical situation, has generated much discussion about the profile considerations when planning treatment in a so called "Coloured" face.

There are undoubtedly, many patients within the so called "Coloured" group, to which these Caucasian norms could be applied, and likewise at the opposite end of the spectrum, there are many faces that are well suited to the use of North American Negro norms. Nonetheless, clinical experience would seem to vindicate the existence of a large number of patients, to which neither of these norms are suited.

Notwithstanding this wide diversity of facial somatic traits within

the "Coloured" population group, a major problem area encountered in this study was the actual definition or delineation of the population sample. This is especially significant in view of the political genesis of this "race-group". Some of the socio-political implications earlier alluded to, added to the problem of population delineation. An example of this is the vexing problem of a person from one race-group adopting the identity (race classification) of another.

Wolfgang H. Thomas (1982) from the Institute for Social Development at the University of the Western Cape, noted too, that most of the "community's" leaders disputed the existence of a closely knit social entity; they merely recognised the reality of a legally defined group ("Coloureds") in terms of a specific pattern of statutory and conventional discrimination.

To avoid the confusion of such polemic, it became necessary to apply a fairly loose descriptive definition for the population sample under study. Hence in the context of this study, the term "Cape Coloured", implies any person of mixed racial origins residing in the area of the Western Cape.

Further, one of the most misunderstood areas, albeit difficulty in quantitation, is the concept of the ideal soft-tissue profile. Powell and Rayson (1976), highlighted the shortcomings of using the profile view, while the work of Lucker (1980), showed that profile

measurements could be used, for aesthetic judgments.

Traditionally, use has been made of lines, angles and arcs for profile evaluation. However, little focus, or consideration has been given to the effects of racial features or other somatic characteristics on these various profile parameters in use today. Racially dependant traits like lip thickness, lip length or nasolabial angle, amongst others, could inexorably influence, even negate, these universally accepted soft-tissue norms. Similarly, these soft-tissue restraints could have an influence on the universally pervasive "attractiveness stereotype", previously described by sociologists and other researchers in facial aesthetics, with its propensity toward the straight (Caucasoid) profile.

The variables evaluated in this study, were influenced, firstly, by the ethical restraint put on the study (photometric as opposed to cephalometric), and secondly, by the need to measure and compare racial differences, if any (Connor and Moshiri, 1985). It is clear from the data acquired in this study that the "Coloured" profile is more protrusive than that of the White (Tables 2 to 14), while being less so, when compared to that of Blacks (Tables 15 to 22).

The Ricketts (1957), Burstone (1958), Steiner (1962), and Holdaway (1983) soft-tissue profile lines are universally accepted within the orthodontic profession as a measure of aesthetic form (Fig. 10). Ricketts, since 1968, however, considers only the relationship of the

lower lip in his aesthetic analysis. The findings in this study show significant differences in the relationship of lower lip to all the earlier described aesthetic planes (Tables 2 to 10), and hence would be supportive of Ricketts' decision.

The soft-tissue profile of the "Coloured" sample, when compared to the Steiner, Holdaway and Burstone profile analyses (Tables 15 to 21), while not being significantly different in all measurements, was, however, found to be more protrusive than the values presented for North American Caucasians. However, seen in relation to the age discrepancy between the American sample (adolescent), and the "Coloured" sample (adult), these findings assume greater significance. Numerous studies (Subtelny, 1959; Hambleton, 1964; Huggins and McBride, 1975) have demonstrated that the profile becomes less convex with age.

The facial contour angle (FCA - Table 13), an expression of facial convexity, by convention is bounded by the upper facial plane (G'-Sn) and the lower facial plane (Sn-Pg'). Due to the difficulty in locating Glabella, it was felt, however, to use the soft-tissue landmark Nasion, as the superior landmark. The location of Glabella, situated in effect over a large area of convexity, is subject to variation in head posture. Nasion, however, situated as it were, within an easily demarcated and smaller area of concavity at the root of the nose, is thus less likely to be influenced by variation in head posture.

The purpose of using the natural head posture as opposed to the Frankfort Horizontal was important, because this reduced the degree of variation when measuring certain linear parameters and hence this study supported the use of the natural head position as described by Moorrees and Kean (1958). A true vertical reference plane was also incorporated, for standardization in the taking of linear measurements.

The upper lip length (ULL - Table 23), for the "Coloured" sample differed significantly from that of the Negro, the lips of the latter being longer. This difference may be associated with the longer anterior facial height measurements previously described in Blacks (Fonseca and Klein, 1978; Connor and Moshiri, 1985). Upper lip length measurements are found to differ significantly between males and females in the "Coloured" sample. However, these values notably coincided with those for Caucasoids; the lips in the male being longer.

The nasiolabial angle (NLA - Table 24) showed significant differences in three of the four comparisons made. The one comparison which showed no significant differences was that for the "Coloured" male to Caucasoid male. The differences probably relate to variation in nasal and lip contours within the groups being compared. Individuals with thicker lips are likely to show smaller NLA values. The NLA is also regarded as an indicator of the forward position of the maxilla (Connor and Moshiri, 1985). The findings of this study, demonstrates

less protrusion of the maxilla amongst "Coloureds", when compared to Blacks. While the "Coloured" sample showed no significant differences between the sexes, the overall NLA measurement was significantly greater than that of Negroes, but less than that of Caucasoids. There was, however, no significant difference between the "Coloured" and Caucasoid male values.

Closer examination of the data relating to ULL and NLA revealed a lack of consistency within the various parameters that were being tested. The diversity of these findings, clearly highlights the inappropriateness of applying soft-tissue norms universally, without consideration for racial differences. In the so called "Coloured" community, with its diverse genetic background, the random application of soft-tissue norms may be deemed iniquitous. While these Caucasian or Negroid norms are applicable to a section of this population, whose characteristic somatic facial traits predicate its application, the findings of this study have generally shown the soft-tissue profile of "Coloureds" to be different from accepted North American orthodontic standards.

Further, the results from this study have shown that the soft-tissue profile of the "Coloured" male is more convex than that for the "Coloured" female. While universal opinion supported the existence of a straight or orthognathic profile for both the male and female (Riedel, 1957; Hambleton, 1964; Lucker, 1980), there are many studies which have revealed a more convex profile for the female than

for the male (Foster, 1973; Spradley et al, 1981). The findings in this study could be attributed to a sample bias, wherein more males possessing a convex or protrusive profile were examined, or alternatively, the selection of the female participants were subjected to a more rigid application of preconceived selection criteria. These criteria, either consciously or subconsciously, may have been prejudiced or influenced by the desire to represent, or identify with the "universal attractiveness stereotype", with its straight profile.

This study, involving soft-tissue profile trends for the "Coloured", has revealed a wide degree of variation in nose size, shape and contour. Hence, those soft-tissue profile assessment techniques that take into account such variations, namely the Steiner S-line or the Ricketts E-line, would be better suited to profile evaluation in the population sample under investigation. The lips in effect are assessed between the nose and the chin, and consequently is evaluated in relation to either a small or big nose.

In order to test the reliability of this study, it is suggested that a cephalometric investigation be undertaken of these subjects, or alternatively of a new sample, otherwise selected. The difference of the "Coloured" profile to that of Caucasian and Black norms as demonstrated in this study, justifies the need for a full cephalometric investigation of this select population group.

Until such time that a more comprehensive cephalometric study is undertaken on this population group, the findings of this investigation could assist in diagnosis and treatment planning. Alternatively, taking cognisance of these results, accepted Caucasian and Negroid cephalometric standards, (both hard and soft) could be tempered, or adjusted, so as to provide a reasonable compromise.

CONCLUSION

Based on the findings of this study it can be concluded that:

1. The soft-tissue profile of the "Coloured" sample investigated differs from that of the Caucasian, and to that of the American Black.

2. "Coloured" males and females are more protrusive in soft-tissue profile than Caucasian males and females.

3. "Coloured" males and females are less protrusive in soft-tissue profile than American Blacks.

4. The soft-tissue profile of the "Coloured" male is more convex than that for the "Coloured" female.

5. The lower lip of the "Coloured" male is more protrusive than that for the "Coloured" female.

6. The Holdaway, Ricketts, and Steiner profile norms, established for Caucasian and Black patients, are not applicable to the "Coloured" sample investigated. The Burstone values established for Caucasians, similarly do not apply.

7. Should the facial somatic traits of the "Coloured" patient be physionomic to that of the Caucasian, or to that of the Black, then such norms could be applied (Appendix III).

8. A comprehensive cephalometric investigation be undertaken of both, an adolescent and an adult "Coloured" population sample, to substantiate the findings of this study, and also to determine hard-tissue trends for this select Western Cape population group.

9. The following values may act as a guide when the Ricketts, Steiner, Holdaway and Burstone lines are used for "Coloured" patients:

   i) **Males**

      A. The upper lip to the Ricketts E-line, -2.647, SD 1.624mm.

      B. The lower lip to the Ricketts E-line, -0.573, SD 1.343mm.

      C. The upper lip to the Steiner S-line, 0.840, SD 1.225mm.

      D. The lower lip to the Steiner S-line, 1.317, SD 1.073mm.

      E. Subnasale to the Holdaway H-line, 6.500, SD 1.522mm.

      F. The upper lip to the Burstone-line, 4.553, SD 1.257mm.

      G. The lower lip to the Burstone-line, 3.850, SD 1.151mm.

   ii) **Females**

      A. The upper lip to the Ricketts E-line, -2.704, SD 1.494mm.

      B. The lower lip to the Ricketts E-line, -1.348, SD 1.613mm.

      C. The upper lip to the Steiner S-line, 0.630, SD 1.104mm.

      D. The lower lip to the Steiner S-line, 0.739, SD 1.228mm.

      E. Subnasale to the Holdaway H-line, 6.037, SD 1.744mm.

      F. The upper lip to the Burstone-line, 4.262, SD 1.428mm.

      G. The lower lip to the Burstone-line, 2.933, SD 1.472mm.

APPENDICES

APPENDIX I

DETERMINATION OF CEPHALOMETRIC MAGNIFICATION FACTORS

The magnification factor (MF), extending from the midsagittal plane (plane of the plumb-line) to the position of the radiographic film, was determined by using the following formula:

$$\text{Magnification factor (MF)} = \frac{\text{Radiological length (RL) - Actual length (AL)}}{\text{Actual length (AL)}}$$

An aluminium rectangle, of known dimension (actual length), was inserted in the midsagittal plane of the cephalometer and radiographed to determine its radiological length. Using the above formula, horizontal and vertical linear magnification factors of 0.088 (8.8%) and 0.091 (9.1%), were obtained respectively.

The measurements obtained in this study by the photometric method, were enlarged by the relevant magnification factor, to obtain radiological equivalent values, by using the formulae:

$$\text{Radiological length} = \text{Actual length} + (\text{MF} \times \text{AL})$$

APPENDIX II

STATISTICS

The following statistics were used in this study:

1. The student's "t" test

(a) The t test comparison of a sample with a universal mean - when comparing the means of the "Coloured" sample against a known standard value, the following formula was used:

$$t = \left(\frac{x - \mu}{\frac{s}{\sqrt{n}}} \right) = \frac{x - \mu}{S} \times \sqrt{n}$$

(b) The t test comparison of two sample means - where we had two sets of data and wished to compare them to determine whether there was any real difference between the means, the following formula was used:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2} \right) \times \frac{(n_1 - 1)\, s_1^2 + (n_2 - 1)\, s_2^2}{n_1 + n_2 - 2}}}$$

2. The Pearson's correlation coefficient

This formula was used to test the correlation between the two examiners.

(a)

$$r = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\sqrt{\left(\Sigma x^2 - \frac{(\Sigma x)^2}{n}\right)\left(\Sigma y^2 - \frac{(\Sigma y)^2}{n}\right)}}$$

where r = correlation coefficient factor

where n = number investigated

(b) df = degrees of freedom

= n-2

(c) t = "t" value

$$= r\sqrt{\frac{n-2}{1-r^2}}$$

(d) Inter Examiner Variability:

Variable investigated : Upper lip to E-line

Principal examiner : x

Independent examiner : y

Number	x	y	xy	x^2	y^2
1	-1.2	-0.6	.72	1.44	.36
2	-1.3	-1.3	1.69	1.69	1.69
3	0.0	0.0	0.0	0.0	0.0
4	-3.2	-2.6	8.32	10.24	6.76
5	-5.6	-5.3	29.68	31.36	28.09
6	-3.0	-3.1	9.3	9.0	9.61
7	-4.5	4.0	18.0	20.25	16.0
8	0.0	0.0	0.0	0.0	0.0
9	-1.8	-1.6	2.88	3.24	2.56
10	-7.0	-7.3	51.1	49.0	53.29
	27.6	25.8	121.69	126.22	118.36
	Σ x	Σ y	Σ xy	Σx^2	Σy^2

APPENDIX III

INTER QUARTILE RANGES OF THE "COLOURED" SAMPLE

TABLE 26 MALE INTER QUARTILE RANGE

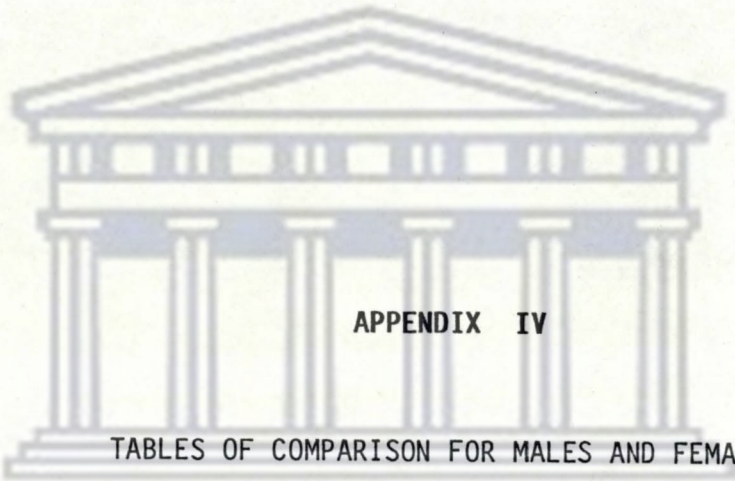
n = 30

VARIABLE	25% QUARTILES	50% QUARTILES	75% QUARTILES
E to Upper Lip	-3.500	-2.200	-1.700
E to Lower Lip	-1.200	-0.500	0.000
S to Upper Lip	0.000	1.200	1.500
S to Lower Lip	0.700	1.400	1.800
H to Subnasale	5.500	6.200	7.300
H to SS	5.500	6.400	7.600
H to Lower Lip	0.700	1.000	1.600
Ls to Sn-Pg'	3.700	4.400	5.600
Li to Sn-Pg'	3.100	3.800	4.400
Li to Sn-Pg'	2.500	3.300	4.200
Upper Lip Length	22.800	24.000	26.200
FCA	17.000	20.500	23.000
NLA	92.000	98.000	109.000

TABLE 27 FEMALE INTER QUARTILE RANGE

n = 46

VARIABLE	25% QUARTILES	50% QUARTILES	75% QUARTILES
E to Upper Lip	-4.100	-2.800	-1.400
E to Lower Lip	-2.600	-1.500	0.000
S to Upper Lip	0.000	0.300	1.600
S to Lower Lip	0.000	0.400	1.600
H to Subnasale	4.300	5.700	7.200
H to SS	4.500	6.000	7.400
H to Lower Lip	0.000	0.200	1.000
Ls to Sn-Pg'	3.100	4.300	5.500
Li to Sn-Pg'	1.800	2.500	4.100
Li to Sn-Pg'	2.200	2.600	3.200
Upper Lip Length	20.400	22.000	23.100
FCA	12.000	14.500	17.000
NLA	93.500	98.000	106.000



APPENDIX IV

TABLES OF COMPARISON FOR MALES AND FEMALES

Table 28 COMPARISON OF MALE VALUES

VARIABLE	CAUCASOID		COLOURED		NEGRO	
	x	S.D.	x	S.D.	x	S.D.
E-Ls	-6.90 Fosberg & Odenrick 1979; n = 20	3.18	-2.647 n = 30	1.624	0.33 Sushner, 1974; n = 50	2.17
E-Li	-4.50 Forsberg & Odenrick 1979; n = 20	3.68	-0.573 n = 30	1.343	2.02 Sushner, 1974; n = 50	2.36
	-4 Ricketts, 1957					
S-Ls	0 Steiner, 1962		0.84 n = 30	1.225	5.46 Sushner, 1974; n = 50	1.76
S-Li	0 Steiner, 1962		1.317 n = 30	1.073	4.98 Sushner, 1974; n = 50	2.15
H-Sn	5 Holdaway, 1983		6.337 n = 30	1.853	7.83 Sushner, 1974; n = 50	2.77
H-Li	0 Holdaway, 1983		0.987 n = 30	0.890	1.69 Sushner, 1974; n = 50	1.47
Li to Sn-Pg'	3.5 Burstone, 1967; n = 32	1.4	4.553 n = 30	1.257		
Ls to Sn-Pg'	2.2 Burstone, 1967; n = 32	1.6	3.850 n = 30	1.151		
U.L.L.	24.13 Connor & Moshiri, 1985; n = 25	2.59	24.447 n = 30	2.313	27.72 Connor & Moshiri, 1985; n = 25	2.46
NLA	101.19 Connor & Moshiri, 1985; n = 25	11.95	98.883 n = 30	10.816	76.27 Connor & Moshiri, 1985; n = 25	18.01

Table 29 COMPARISON OF FEMALE VALUES

VARIABLE	CAUCASOID		COLOURED		NEGRO	
	x	S.D.	x	S.D.	x	S.D.
E-Ls	-5.34 Forsberg & Odenrick 1979; n = 20	2.03	-2.704 n = 46	1.494	-0.46 Sushner, 1974; n = 50	1.77
E-Li	-3.44 Forsberg & Odenrick, 1979; n = 20	2.39	-1.348 n = 46	1.613	1.08 Sushner, 1974; n = 50	1.91
	-4 Ricketts, 1957					
S-Ls	0 Steiner, 1962		0.630 n = 46	1.104	4.25 Sushner, 1974; n = 50	1.35
S-Li	0 Steiner, 1962		0.739 n = 46	1.228	3.87 Sushner, 1974; n = 50	1.55
H-Sn	5 Holdaway, 1983		5.693 n = 46	0.283	6.23 Sushner, 1974; n = 50	1.98
H-Li	0 Holdaway, 1983		0.424 n = 46	0.657	1.27 Sushner, 1974; n = 50	0.94
Ls to Sn-Pg'	3.5 Burstone, 1967; n = 32	1.4	4.262 n = 46	1.428		
Li to Sn-Pg'	2.2 Burstone, 1967; n = 32	1.6	2.933 n = 46	1.472		
U.L.L.	21.5 Connor & Moshiri, 1985; n = 25	3.55	21.793 n = 46	1.611	26.34 Connor & Moshiri, 1985; n = 25	2.89
NLA	107.34 Connor & Moshiri, 1985; n = 25	7.33	100.158 n = 46	10.147	77.05 Connor & Moshiri, 1985; n = 25	15.25

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17/10/95 9a