

**PROFILE PREFERENCES FOR THE CHINESE FEMALE :**

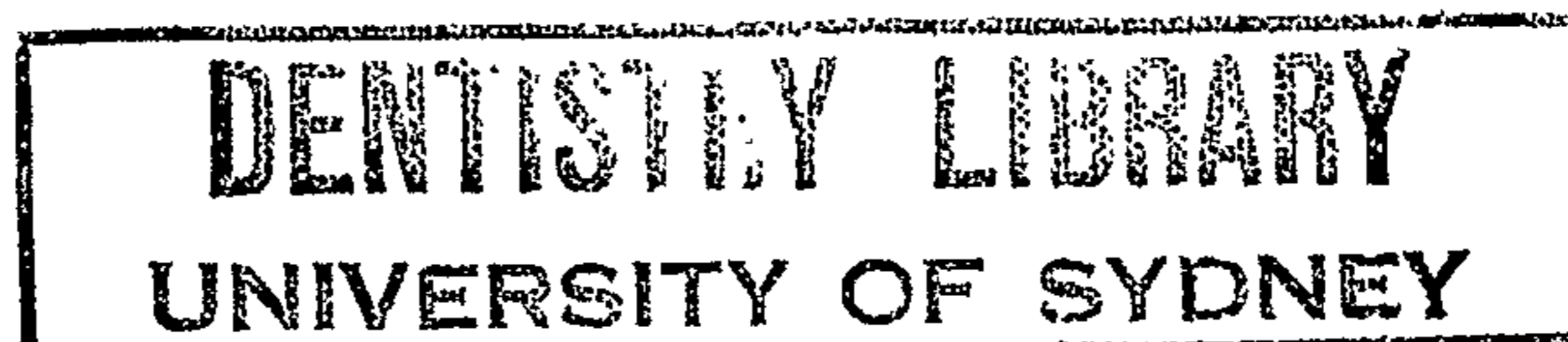
**a comparison between the Chinese public**

**and the orthodontists in Sydney.**

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## ABSTRACT

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This study investigates the profile preferences of the Chinese public and the orthodontists in Sydney. Standardised black and white profile photographs, using natural head position, were taken of female Chinese subjects, aged between 16 to 24 years. A weighted plumbline, with a 5 cm ruler attached, was taken as the true vertical. Twenty-two profiles were selected and shown as slides to four groups of judges : Chinese public (N=113), Caucasian public (N=40), Chinese orthodontists (N=13) and Caucasian orthodontists (N=37). To monitor the judges' reliability, three profiles were duplicated (14% of the sample size) and were randomly interspersed with the other slides, without forewarning the judges. The judges were asked to rate each profile in terms of attractiveness on a 7-point Likert-type scale.

The profile photographs used in the research survey were enlarged to live dimensions (1:1). The profile outline was traced and digitised. Nineteen soft tissue profile variables were measured. Seven soft tissue profile variables were found to be statistically significant as indicators of attractiveness : nasolabial angle, labrale superius to subnasale perpendicular to the true horizontal, upper lip to subnasale-pogonion plane, labrale inferius to subnasale perpendicular to the true horizontal, lower lip to subnasale-pogonion plane, midfacial to total face height (Na-Sn : Na-Me') and vertical lip to chin ratio (Sn-Stm : Stm-Me'). In particular, the lower lip variables : the labrale inferius to subnasale perpendicular measurement and the lower lip to subnasale-pogonion plane were found to be powerful determinants of profile attractiveness.

This study showed that all four groups of judges have fairly similar profile preferences. It may be concluded that the profile preferences of the Chinese public in Sydney is similar to that of the orthodontists. All groups of judges sampled preferred a straight profile with a more retrusive upper lip and lower lip and a slightly more obtuse nasolabial angle than the racial norms for the Chinese population.

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## INTRODUCTION

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In Australia, there is an increasing proportion of Chinese patients seeking treatment both in the field of orthodontics and orthognathic surgery. This is mainly due to the increasing numbers of Chinese migrants from China and South-East Asia into Australia. However, the Chinese community also has a greater awareness of facial appearance and aesthetics.

Little research investigating the Chinese perception of facial aesthetics has been performed. The facial characteristics typical of this ethnic group are completely different from that of the Caucasian population. Thus, Caucasian norms and criteria for facial aesthetics are not necessarily valid for the Chinese population.

Martin (1964) and Peck and Peck (1970) have found that both black and white Americans are highly influenced by the mass media and share a common aesthetic standard for judging beauty in the female face. Both groups prefer the Caucasian-type face.

It has been well-documented that Chinese generally have a greater tendency toward bimaxillary dentoalveolar protrusion and Class III malocclusion than Caucasians (Hong 1960; Wei 1965, 1968; Chan 1969, 1972; Yen 1973; Enlow 1982; Foo and Woon 1984; Foo 1986; Cooke and Wei 1989; Lew et al 1989). The orthodontists, maxillofacial surgeons and plastic surgeons are often faced with the question: "Do the Chinese living in Australia prefer the dentoalveolar characteristics which are more

typical of their culture or do they prefer a more Caucasian facial profile?"

The orthodontic literature generally focuses on aesthetic values of the clinician rather than the general public. Some authors, including Peck and Peck (1970), believe that ultimately, aesthetic preference should lie with the patient and the parents. Thus, it is important to define the facial characteristics that constitute what the Chinese living in Australia consider an attractive profile. This may aid the orthodontist to plan appropriate treatment for the Chinese patient.

**SECTION I :**

**REVIEW OF LITERATURE**

## CHAPTER 1 : FACIAL AESTHETICS IN PROFILE

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### 1.1 DEFINITIONS

Aesthetics is defined in "Webster's Collegiate Dictionary" 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". The word aesthetics was derived from the Greek word "*aisthetikos*", meaning "perceptive, especially by feelings". Therefore, in discussing esthetics, we are concerned essentially with subjective reactions, ie. how we feel about things that we see (Lusterman 1963).

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 observers to these variations on the other.

Peck and Peck (1970) believed that the formalised studies of psychology and sociology have helped transform esthetic judgment from simply a visual "feeling" to an understanding exercise in visual perception. They believed that the study of the face as the "esthetic stimulus", and the nature of the "esthetic response" or the observer's perception are of equal importance.

Burstone (1958) stated that facial form may be abstracted into two planes of space, - frontal and sagittal. The midsagittal plane produces an outline which commonly is referred to as the profile. So, with the lateral

surface of the face oriented perpendicular to the camera, the profile along the median sagittal plane may be recorded photographically (Peck and Peck 1970).

As mentioned by Lucker (1980), although the face is usually seen from a multitude of perspectives and angles, angular views and three-dimensional representations complicate precise measurement of the face. Facial features have commonly been studied in full frontal and profile views. Powell and Rayson (1976) advocated using the three-quarter face view in addition for a more complete analysis of the face. Burstone (1958), Peck and Peck (1970) and Barrer and Ghafari (1985) believed that although the complexities of facial esthetics may not be totally expressed in one method of analysis, a profile view of the face provides information necessary for diagnosis and treatment planning of dentofacial problems. So, emphasis has been placed on the profile view, since many dentofacial malformations as well as therapy changes are more evident in this plane of space. Orthodontically, the lateral profile view is the most significant aspect of the face, - profiles have been evaluated by using cephalometric or photometric references (Ricketts 1968; Stoner 1955; Anderson et al 1973; Merrifield 1966); linear and angular measurements (Bowker and Meredith 1959; Burstone 1959; Neger 1959; Hambleton 1964; Subtelny 1959; Holdaway 1983 a, b); or combinations of metric, angular, and proportional measurements (Burstone 1959; Subtelny 1959; Rudee 1964; Powell and Rayson 1976).

In this study, the soft tissue characteristics seen in the aesthetically-pleasing face will only be examined from the profile view. Photographic records will be used exclusively.

## 1.2 AESTHETIC PERCEPTION AND FACIAL PREFERENCES

Lucker (1980) stated that aesthetic perception is the concept of beauty, taste and art acquired through our senses. Thus each person's concept of beauty is a matter of one's own innermost sensibility and understanding which is conditioned by one's past experiences, motivational state and direction of attention.

Prall (1967) indicated that "aesthetic experience is an experience of an object (or a person) as apprehended delightfully. This is primarily apprehended through the senses." Since disagreement are so common between aesthetic judgements, it would appear that the processes of apprehension in the case of beauty differ from person to person much more widely than the processes of perception of ordinary sense qualities.

Adcock (1962), a psychologist wrote that our "aesthetic experience is derived from the pleasure of perception". Our perception is derived from several sources:

1. our innate senses;
2. the achievement of perceptual meaning;
3. the development of form concepts; and
4. by conditioning.

As mentioned by Peck and Peck (1970), our perception of faces is influenced by the development of form concepts, as the more frequently we observe a particular facial pattern, the more likely we perceive it as "correct". Also, often by selective conditioning, people make presumptive judgements in their perception of faces. For example, the public

frequently assumes that the bearer of a severe Class II or Class III pattern is a slow, dull individual.

Wuerpel (1937) believed that each person's concept of beauty is a matter of one's own innermost sensibility and understanding. However, there is considerable agreement among many of us that certain faces fall well within the definition of beauty or harmony of form, and vice versa.

The ancient adage, "Beauty is in the eye of the beholder" sums it all up. The appreciation of facial aesthetics is largely a subjective one, despite great scientific efforts to measure and define it (Ricketts 1981, 1982). However, there are certain well recognised factors which influence and help mould a person's perception of facial aesthetics. The appreciation of beauty is influenced by a diversity of factors such as culture, racial heritage, mass media (films, TV, advertising, magazine, etc), the society one lives in and even political and racial prejudices (Martin 1964).

The face is the most important means of self-identification and self-presentation of a person in everyday life. Particular importance is placed on a pleasing facial appearance by society. An attractive and pleasant face enhances the social value of the individual and opens doors to social, educational and career opportunities which results in their living more satisfying and comfortable lives than their unattractive peers (Berscheid 1980).

The profound psychological effects of facial aesthetics on social interaction and development of self-image influence one's perception of facial beauty. Therefore, it is not merely vanity that prompts people to

turn to facial alteration procedures such as cosmetic surgery or orthodontic treatment to seek improvement of their facial appearance (Graber and Lucker 1980; Jacobson 1984).

### **1.3 THE DEVELOPMENT OF FACIAL AESTHETICS AND ITS EFFECT ON ORTHODONTIC THOUGHT**

Peck and Peck (1970) traced the aesthetic heritage and noted that the Egyptians are among the very first of ancient cultures to record their appreciation of aesthetics in the form of sculptures. Statues of royalty found in tombs and monuments tend to display the Egyptian ideal of beauty, harmony and proportion. The idealised Egyptian of the Old Kingdom (2,600 to 2,000 B.C.) exhibited a round, broad face with a sloped forehead, weak brow ridge, prominent eyes, evenly contoured nose, thickened lips, and a mild yet positive chin. Bimaxillary dentoalveolar prognathism is evident in the lower face. The later period (1,000 years later) was represented by the face of Queen Nefertiti, who was considered to have well balanced facial features, and a well-developed mandible.

Grecian influence on facial aesthetics has been immense. Grecian sculptures which flourished during the fourth and fifth century B.C., often called the Golden Age of Greece, revealed different standards of ideal facial proportions from the Egyptian times. The classical Greek face as depicted in the sculptures is oval, slightly tapered toward the chin. In profile, the face exhibits an anteriorly prominent forehead. Also characteristic is a straight sweep from the forehead to the nose tip, allowing only a faint concavity at the root of the nose, and a well-

defined mentolabial sulcus. Generally, the lower face seems well-proportioned and within the orthodontic concept of the orthognathic profile.

The early orthodontists had been very much influenced by the facial aesthetics of the Greek sculptures. Angle (1907) gave us his concept of an ideal profile in Apollo Belvedere, in which "Every feature is in balance with every other feature and all the lines are wholly incompatible with mutilation or malocclusion."

Woolnoth (1865) as cited by Peck and Peck (1970) in his facial profile classification said, "The straight face is considered the handsomest, and may be detected by drawing a straight line from the top of the forehead to the bottom of the chin without intersecting more than a portion of the nose and a very small part of the upper lip."

Angle (1907) realised that the classic profile of Apollo Belvedere as a standard of beauty is "impracticable and misleading, for notwithstanding the beautiful harmony of proportion of that face ..... its range of application has been found to be very limited in gauging the harmony or disharmony of other faces."

Riedel (1957) explored the various sources that have influenced the concept of facial aesthetics among orthodontists. Three primary sources were found :

1. The first source of aesthetic idealism was probably derived from paintings, drawings and ancient sculptures.
2. The second developed through the influence of such men such

as Grieve and Tweed, who developed concepts of aesthetics based upon accepting as pleasing or satisfactory, a face with a stable denture and incisors in an uncrowded upright position.

3. The third concept of aesthetics was based upon orthodontic cephalometric standards or norms based on "normal occlusion" developed by orthodontists, such as Margolis, Steiner, Downs and others.

Powell and Rayson (1976) believed that with modern aesthetic concepts in orthodontics, it is futile to apply formulae of ideal appearance universally, the appearance of each face should be evaluated independently. The experienced eye of the clinician or the judgment of the patient's family are superior to any formula that can be devised for facial appearance. Treatment must be designed to encompass this diversity while producing the optimal enhancement within the individual face. They also emphasized that the objective of improved appearance is not always compatible with stability of the occlusion; a compromise in facial appearance must frequently be accepted in the interest of occlusal stability.

#### **1.4 FACIAL PREFERENCES OF THE GENERAL PUBLIC**

As questioned by Peck and Peck (1970), "Do most people like the same faces or are their aesthetic preferences as random and diversified as their backgrounds and experiences?" Does the general public share similar facial preferences as orthodontists?

Wylie (1959) remarked that the layman's opinion of the human profile is every bit as good as the orthodontist's and perhaps even better since it is not conditioned by orthodontic propaganda.

A few studies involving the general public's assessment of good facial aesthetics have been done. As mentioned by Lucker (1980), there have been two general approaches to the study of facial aesthetics :

1. Subjects considered to be physically attractive are identified, and the physical attributes that make them attractive are determined. These subjects are usually public figures celebrated for their good looks, but occasionally they are just individuals judged to have good facial aesthetics by a group of clinicians.
2. One group of individuals are required to evaluate the attractiveness of another group of individuals. The individuals evaluated are usually chosen either to represent a normal population or to represent variability on particular dimensions. Faces are presented either from the frontal or lateral perspective, and they are depicted with either line drawings, silhouettes, or facial photographs.

Two often quoted studies done by Riedel (1957) and Peck and Peck (1970) illustrate the first type of approach to the study of facial aesthetics. However, different conclusions were drawn from the results.

Riedel (1957) analysed the dentofacial relationships of thirty Seattle Seafair princesses and their queen. He found that the public's concepts of acceptable facial aesthetics were apparently in good

agreement with standards established by the orthodontists on the basis of normal occlusion.

Peck and Peck (1970) examined a sample of fifty-two American white subjects (49 females and 3 males), all whom were professional models, beauty contest winners, and performing stars who were noted for their facial attractiveness as judged by the public. The samples were analysed by using Margolis, Downs and Steiner's analyses. They concluded that the general public preferred a fuller, more protrusive dentofacial pattern than that set as customary cephalometric standards.

Cox and van der Linden (1971) used the second approach in the study of facial aesthetics. Eighty-seven male and eighty-seven female silhouette profile photographs were used as the selection base to differentiate between good and poor facial aesthetics. These profiles were evaluated independently by ten orthodontists and ten laymen, who were asked to discriminate between the most and least attractive profiles using a Q-sort frame method. Four groups of eighteen persons were formed, representing males and females of the two categories. The two professionally different groups of evaluators showed no significant differences in their ratings. An analysis of the facial pattern from the lateral cephalograms showed that in both sexes, persons with poor facial balance have more convex faces. However, they found that the ranges in variation in the groups with good facial aesthetics were larger than the generally accepted cephalometric standards.

Iliffe (1960), a British psychologist, conducted a nationwide survey of preferences in feminine beauty, with the help of a national daily newspaper. Twelve black and white three-quarter profile photographs

of adults from twenty to twenty-five years of age were published in the paper. None of the subjects was a professional "beauty" (ie. film actress or model). Readers were asked to select and indicate their order of preference for the prettiest face. The 4355 valid returns were analysed and results were correlated to the age, occupation, sex and region from which the respondents came. The positive correlations were significantly high suggesting that a common basis for judging facial beauty indeed existed and was shared by men and women of all ages in all parts of England in almost all occupations. Iliffe believed that a possible explanation for the origin of this common basis of judgment, is that "culturally determined norms" are transmitted through education (and perhaps through familiarity with the visual and dramatic arts).

Udry (1965), a sociologist conducted a parallel investigation using the same twelve facial photographs in the United States. The study drew over 100,000 responses from Americans. Udry found that there was not only a significant agreement among the replies as to who were the prettiest, but there was international agreement as well. The three top choices in the American study were identical with the British results. Beyond the first three girls the aesthetic selection order in both studies differed only slightly. Udry believed that the similar aesthetic agreement in both cultures is maintained by close cultural contact through mass media (especially movies). He found that the American beauty preferences showed greater uniformity than the British; the explanation he offered was that feminine beauty has become such an important focus of American culture, and consensus is so reinforced by the mass media that opinion has become highly standardized in all social groups.

Foster (1973), Lines et al (1978) and De Smit and Dermaut (1984) limited the profile variables by the construction of artificial profile lines in their studies. Foster and Lines et al reported significant differences of opinion concerning male profiles as compared to female profiles. However, De Smit and Dermaut observed no significant differences between the same profiles for both sexes. In all three studies, the findings indicate that the facial profile preferences of the participants regardless of training, or cultural background, and sex are not significantly different.

Foster (1973) asked six diversified groups (general dentists, art students, orthodontists, a black lay group, a Chinese lay group, and a white lay group) to choose the profile most pleasing for males and females at ages eight, twelve, sixteen and adult. The results indicate that all the groups seem to share a common aesthetic standard. It is interesting that all groups judging these profiles appear to recognise that fuller lips suggest youth. This age difference was noted as early as 1865 by Woolnoth (as cited by Peck and Peck, 1970). He stated that "convex faces ..... retain a youthful appearance beyond the natural periods, and are found by observation and experience to last much longer than the concave or straight. Concave faces give young persons somewhat of an old fashioned appearance" (this is probably associated with perceptions of the edentulous profile).

## 1.5 ETHNIC CONCEPT OF FACIAL AESTHETICS

Huggins and McBride (1975) believed that facial aesthetics change from culture to culture. They are affected by ethnic preferences, in the various groups, - Caucasian, Negroid and Oriental. However, there appears to run through human civilisation a thread of continuity, overriding cultural, historical and ethnic choices, which selects certain characteristic facial proportions as being aesthetically pleasing and desirable.

Martin (1964) in his research, examined the relationship between racial group membership and judgment of female beauty by males. Ten facial photographs of black females were ranked by a panel of judges from the least Negroid (or with most Caucasian appearance) to the most Negroid. Then three "racial groups" - American whites, American blacks and African (Nigerian) blacks were asked to rank the photographs according to attractiveness. He found that American whites and American blacks share a common aesthetic standard for judging beauty in the female face - "the Caucasian facial model". So, Caucasian features are considered more attractive than Negroid features in American society. However, the African blacks find the more Negroid features more attractive than do American whites and blacks, though their aesthetic judgment were in closer agreement with the American whites than with the American blacks. Apparently, the sample in Nigeria has been influenced by the English norms for judging feminine beauty, in view of the previous colonial rule, and the English and American mass media (movies, TV programs, magazines) present there.

Martin (1964) and Peck and Peck (1970) believed that the

aesthetic agreement among the Americans is largely the product of many cultural mechanisms and reinforcements operating in their society. The mass media is very influential in unifying people's tastes which provide daily reinforcement for facial stereotypes. This explanation of the public being highly "educated" by the mass media is shared by many others, including Iliffe (1960), Udry (1965), Foster (1973), Srisuk (1982).

DeLoach (1978) studied the preferences and opinions of 224 North American black women, regarding black female facial profiles in general, and their attitude toward their own profiles. He found that a significant majority of respondents preferred the straighter profiles; this preference was consistent among all age groups. A significant degree of disfavour was registered for the "Class II - deep" extremely bimaxillary protrusive profile and the "Class III" profile types. However, a substantial number of respondents desired no change in their profiles, regardless of their own profile type.

Satravaha and Schlegel (1987) in their study of Thai females, mostly of Chinese origin, found significant differences between standard white profile and their study population. They believed that proper blending of the integumentary profile produces an aesthetically pleasing face, and this varies in different ethnic groups.

Chan (1969) found that the Chinese has much more protrusive lips than the Caucasians. These protrusive lips contribute to the convex profile of the Chinese. He placed forth the question in the discussion of his thesis : "Should the Chinese patients be treated to a convex profile with protruding lips?" He noted that this is rather controversial, and it

depends on many factors. The older generation appeared to prefer a more convex profile with fullness of lips. But with the influx of western influence through the media, he wondered if the previous concept of beauty still holds today.

Kiyak (1981) compared the aesthetic values held by Caucasians and Pacific-Asian immigrants (of whom, the majority were Chinese) who had resided in the United States for 3 years or less. The respondents were asked to rate the attractiveness of facial drawings of females. He found that, while differences emerged, aesthetic ratings were unrelated to racial typology. For example, the Asians chose bimaxillary prognathism as least attractive, even though it is a frequent racial characteristic among them. In contrast, bimaxillary retrusion, infrequent among Asians, was rated most attractive.

Khor (1986) compared the profile preferences, between 20 Chinese and 20 Caucasian University students in Australia, using profile silhouettes. He found that there was a high percentage of agreement between these 2 groups. However, the Chinese preferred a fuller perioral region, though too much protrusion was undesirable; while the Caucasians preferred a flatter perioral region.

## CHAPTER 2 : SOFT TISSUE PROFILE EVALUATION

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### 2.1 THE SOFT TISSUE COVERING OF THE FACE

Superimposed upon the dentoskeletal framework lies a variable soft tissue mass comprising of epithelium, connective tissue, and muscle. The integumental or soft tissue covering of the face is of importance and concern to the orthodontist. During treatment it is possible to produce changes in the dentoalveolar region and the hence the soft tissue profile of an individual. These changes in the soft tissue profile may be due to alterations implemented by treatment and concomitant growth.

Burstone (1959) stated that variation in this soft tissue veneer can influence the following :

1. facial form and aesthetics,
2. muscle balance of the orbicularis oris complex and hence, the stability of the anterior dental segment.

In investigating integumental extension patterns, Burstone found that the soft tissue mass of the face lying inferior to subnasale is quite thick in comparison to the mass of the glabellar region. This difference , in part, reflects the high degree of development of the orbicularis oris complex. The upper lip gradually becomes thinner from subnasale to labrale superius. The horizontal extension at inferior labial sulcus and pogonion (which Burstone referred to as menton) is less than any other region of the lower face. Burstone found the greatest variation in horizontal and vertical extension values in the lower face, especially in the lips.

Downs (1948), Steiner (1953), Riedel (1950, 1957) believed that the soft tissue profile is closely related to its underlying skeletal and dental structures. They believed that, if the teeth are arranged according to given standards, the soft tissues will drape over them in a harmonious manner. On the other hand, others like, Burstone (1958, 1959), Bowker and Meredith (1959), Altemus (1963), Hambleton (1964), Cox and van der Linden (1971) believed that the external covering of the face, - made up of integument, adipose tissue, connective tissue and muscles, - does not always distribute itself in a uniform, orderly manner over the underlying dentoskeletal framework. They demonstrated that integumental structural extension and postural variations exist in the soft tissue veneer covering the teeth and bone which can exaggerate or mask the dentoskeletal disharmonies.

Subtelny (1959, 1961), however, indicated that all parts of the soft tissue profile do not directly follow the underlying skeletal profile. He found that the position of the soft tissues covering the upper face, exclusive of the dental area, does not closely reflect the position of the hard structures of the same area. In contrast to this, the position of the soft tissue covering the lower jaw as well as the mandibular and maxillary dentoalveolar areas is strongly dependent on the position of these hard tissue structures

Many, like Burstone (1958, 1959) and Hambleton (1964) indicated that because the soft tissue may vary in different persons in thickness, length, and postural tone, it is necessary to study directly the integumental contour of the face, in order to consider facial harmony adequately. To illustrate this, Burstone (1958) compared two Class II division 1 cases having similar dentoskeletal patterns but with different

integumental contours.

Altemus (1963) also, felt that the correction of occlusal disharmonies alone is not always sufficient for optimum results from orthodontic treatment because the denture relates differently to the soft tissue profile in different individuals. This is especially true where diverse racial groups are being treated. Not only are there observable differences in the dentoskeletal configurations of the heads and faces of different racial groups; but there are also observable differences in the integumental of soft tissue mass of these racial groups. This was earlier stated by Lightoller (1925). Altemus compared the soft tissue mass of the profiles of North American Caucasian and Negro children of approximately the same age. He found that one of the major areas of dissimilarity between these two groups was in the orodental area. The lips and teeth were more protrusive in the latter group. He noticed that there is a great variability in the soft tissue covering of the faces of these individuals, and concluded that each individual must be judged for harmony and balance in his/her face.

Studies on profile changes during growth and treatment by many investigators have revealed that the relationship between hard and soft tissues is a complex one. This implied that it is necessary to study directly the integumental contour of the face, since hard tissue measurements can deviate considerably from the facial form which the patient expresses with the soft tissues.

### 2.1.1 SOFT TISSUE FACIAL COMPONENTS

The external nose, as described in Gray's Anatomy, is composed of the frontal processes of the maxilla, the nasal bones, hyaline cartilages, fibrous tissue and some fatty tissue in the lower part of the ala nasi. The covering of the nose consists of muscles (procerus, nasalis and depressor septi), as well as nerves, a generous blood supply, and numerous sebaceous glands. It is covered externally by skin and internally by mucous membrane. The form and profile of the nose depend upon both the bony and cartilaginous components and the overlying muscles and the integument.

The lips are two fleshy folds which surround the oral orifice. They are formed externally of skin and internally of mucous membrane, and these two layers enclose the orbicularis oris muscle, blood vessels, nerves, areolar tissue, and numerous small labial salivary glands (Warwick & Williams 1973). Lightoller (1925) noted that the upper lip is anteriorly a solid muscular organ with no fat and little, if any, fibrous tissue intervening between the muscle and the skin.

The cheeks form a large part of the sides of the face, and are continuous in front with the lips, the junction being indicated externally on each side by the nasolabial sulcus. The cheeks are composed of a muscular stratum, and a variable but usually considerable amount of adipose tissue, together with areolar tissue, vessels, nerves and buccal glands, covered with skin externally and with mucous membrane internally (Warwick & Williams 1973).

The integumental chin is very closely related to the position of the

bony chin (Subtelny 1959, 1961). It consists of muscle (ie. the mentalis), fatty and fibrous tissues, nerves, and blood vessels (Hambleton 1964).

### 2.1.2 MUSCLES OF THE MOUTH

The shape of the oral orifice and the posture of the lips are controlled by a complex assembly of muscles. These include elevators and retractors of the upper lip (levator labii superioris alaeque nasi, levator labii superioris, zygomaticus major and minor, levator anguli oris, and risorius), depressors and retractors of the lower lip (depressor labii inferioris, depressor anguli oris, and mentalis), and a sphincter (orbicularis and buccinator) (Lightoller 1925; Warwick & Williams 1973).

The variety of movements which the lips can execute is due to the large number of muscles entering the orbicularis oris :

The levator labii superioris alaeque nasi, the levator labii superioris, the zygomaticus minor, and the levator anguli oris, all raise the upper lip.

The zygomaticus major draws the the angle of the mouth upwards and laterally as in laughing.

The risorius pulls the lips laterally and tightens them against the teeth.

The depressor labii inferioris and the depressor anguli oris draw the lower lip downwards and laterally.

The mentalis raises and protrudes the lower lip, and at the same time wrinkles the skin of the chin, in drinking and also in expressing doubt or disdain. Electromyography shows, it is claimed, fairly continuous activity in mentalis, even to some extent in sleep.

The buccinator compresses the cheek against the teeth, as it is used in mastication to prevent food escaping into the vestibule of the mouth; it can also compress the blown out cheek. (Romanes 1967; Warwick & Williams 1973).

Facial expression, as in revelation of emotional state, intentions, and so forth, serves obvious social functions. But the facial musculature is used even more frequently and importantly in speech. The muscles converge upon the mouth from each side to control the intricate labial movements of speech. The facial musculature is also important in feeding and drinking, in all their phases.

The orbicularis oris is made up of several strata which surround the orifice of the mouth but have different directions. It consists partly of fibres derived from the other facial muscles which pass into the lips, and partly of fibres proper to them. Of the former, a considerable number are derived from the buccinator, and form the deeper stratum. Superficial to this is a second stratum, formed by the levator and depressor anguli oris, which cross each other at the angle of the mouth; the fibres of the levator pass to the lower lip, and those from the depressor to the upper lip, along which they run to the skin near the anterior median line. Fibres are also derived from the levator labii superioris, the zygomaticus major and minor, and the depressor labii inferioris; these intermingle with the transverse fibres just described, and have principally an oblique direction. Nine muscles converge on each of the two angles of the mouth and interlace here at a palpable nodular mass, called the *modiolus*. This can be fixed in a given position by the combined action of the zygomaticus major, levator anguli oris and the depressor anguli oris. These thus serve to fix the attachments of the

orbicularis oris and buccinator in this area. Within the lips the fibres of the orbicularis oris are divisible into two fasciculi, the marginal and peripheral. These combine laterally to form the labial bands which are traceable to the modiolus. The proper fibres of the lips are oblique, and pass from the deep surface of the skin to the mucous membrane, through the thickness of the lip. Finally, there are fibres by which the muscle is connected with the maxillae above, and with the mandible below. In the upper lip these constitute the incisivus labii superioris; the additional fibres in the lower lip constitute the incisivus labii inferioris, on each side. Both the upper and lower fibres arise from close to the midline and are continuous with the other muscles at the angle of the mouth (Lightoller 1925; Warwick & Williams 1973).

Lightoller (1925) noticed in the orbicularis oris proper : the *pars peripheralis* which forms the main bulk of the muscle extending from the rima oris outwards in an ever-thinning sheet; the *pars marginalis* which is limited to the red lip area and would therefore seem to vary in different subjects according to the amount of red lip showing. The *pars marginalis* takes origin in the deepest portion of the modiolus just adjacent to the mucous membrane, then curls around the whole thickness of the *pars peripheralis* and eventually lies wholly anterior to this. The labial tractors ie. the levator labii superioris and inferioris insert into the deep tissues of the red lips area. Both the *pars marginalis* and the labial tractors are defined on the skin surface by the amount of red lip showing when the lips are relaxed and closed. Therefore, with a powerful *pars marginalis* and less or equally powerful labial tractors, little or no red lip is shown. With a weak *pars marginalis* and equally weak labial tractors, a similarly small amount of red lip might be expected. With a weakened *pars marginalis* but still powerful labial

tractors, the maximum of red lip is expected to be visible.

The zygomaticus major and minor and the levator labii superioris are sometimes more or less concealed by a thin sheet of muscle, named the *musculus malaris*, and continuous with the orbicularis oculi. This was more commonly observed in the Australian aboriginal, the American negro, South Sea Islander and the Japanese (Lightoller 1925).

The mentalis is a conical fasciculus, at the side of the frenulum of the lower lip. It arises from the incisive fossa of the mandible and descends to be attached to the skin of the chin (Warwick & Williams 1973).

## 2.2 METHODS OF SOFT TISSUE ANALYSIS

There are many methods of hard tissue analysis based on the lateral cephalogram . In comparison, there are fewer comprehensive soft tissue analyses available to the clinician. This is partly due to the problem of lip posturing and the reliability and reproducibility of the various soft tissue landmarks (Wisth and Boe 1973; Hillesund et al 1978; Khor 1986). There is also the difficulty in predicting the eventual soft tissue outcome with growth and treatment.

Historically, many great artists, like Leonardo da Vinci and Abercht Durer had tried to describe standards of classical beauty. In their drawings, they used a series of vertical and horizontal lines to divide the face into various proportions.

Soft tissue profile analysis can be done from lateral profile photographs (Stoner 1955; Neger 1959; Peck and Peck 1970; Larrabee et al 1985; Satravaha and Siegel 1987; Yuen & Hiranaka 1989) or from the soft tissue outline on lateral cephalograms.

Simon (1926) as cited by Burstone (1958), and Hellman (1939) advocated systematic measurement and analysis of the face. They constructed lines and angles, and did measurements directly from the patient and photographs for use in orthodontic diagnosis and classification. After the clinical introduction of X-ray cephalometrics, the profile photograph became a rather passive facial record. However, a soft tissue profile analysis can provide valuable information in the development of a concept of facial aesthetics, and as a supplement to other diagnostic records.

Peck and Peck (1970) recommended that profilometric analysis be done on oriented facial photographs. In this way the orthodontist may evaluate subjective factors such as facial topography, muscle contours, and the structural elements of the side of the face while constructing the angular measurements. They advised that the photographs be taken with the subject in a cephalostat. Standardised head positioning is thus assured for comparative purposes.

## **2.3 TOTAL FACIAL PROFILE ANALYSIS**

### **2.3.1 ANTERO-POSTERIOR ASSESSMENT OF FACIAL PROFILE**

Profitt and Ackerman (1986) in their clinical assessment, place the patient in natural head position, either sitting upright or standing, and looking at a distant object, to establish the following :

1. Divergence of the face, which is defined as an anterior or posterior inclination of the lower face relative to the forehead (originally coined by Hellman). Anterior divergence (face slopes anteriorly) or posterior divergence (face slopes posteriorly) can be compatible with good facial aesthetics and proportions; in fact a degree of facial divergence is a racial and ethnic characteristic. For example, American Indians and Orientals tend to have an anteriorly divergent face, while whites of Mediterranean ancestry tend to have a posteriorly divergent face.
2. Profile convexity or concavity is detected by viewing the relationship between two lines, one dropped from the bridge of the nose to the base of upper lip, a second extending from that point downward to the chin. These line segments should form a

nearly straight line. An angle between them indicates either profile convexity (upper jaw prominent relative to chin) or profile concavity (upper jaw behind chin).

The "soft tissue angle of convexity" was described by Wylie (1955) as the angle that is roughly the soft tissue equivalent to the bony landmarks which defined Downs' angle of convexity (nasion - point A - pogonion). The angle involves the prominence of the forehead, the most prominent point on the upper lip, and the most prominent point on the soft tissue chin. The acceptable range was found to be between 6.5 to 16 degrees.

Burstone (1958, 1967, 1975), Legan and Burstone (1980) and Hunt and Rudge (1984) described the overall horizontal soft tissue profile, by using the angle of facial convexity, or facial contour angle (glabella - subnasale - soft tissue pogonion). Legan and Burstone (1980) suggested that the mean for adults is  $12 \pm 4$  degrees, which indicates that the soft tissue profile normally demonstrates definite convexity. As the angle of facial convexity becomes a smaller positive or a negative value, the profile is suggestive of a Class III skeletal and dental relationship. A clockwise angle is positive, and a counterclockwise angle is a negative. As the positive angle increases, the profile becomes more convex, suggesting a Class II skeletal and dental relationship.

Subtelny (1959) employed two methods to evaluate the convexity of the soft tissue profile :

1. Soft tissue profile convexity (soft tissue nasion - subnasion - soft tissue pogonion)

This is designed to focus upon soft tissue structures which are

closely analogous to the structures utilised for measuring the degree of convexity of the skeletal profiles.

2. Total soft tissue profile convexity, including the nose (soft tissue nasion - tip of nose - soft tissue pogonion)

This is devised so that the nose can be included in the measurements of facial convexity, as the nose has a marked influence upon the total soft tissue profile.

The soft tissue facial angle was used by Stoner (1955) as part of his facial contour analysis from profile photographs. The facial angle is formed by the intersection of facial plane (line drawn from the depth of concavity at the base of the nose to a tangent to the chin) and Frankfort horizontal (drawn from tracion or the lowest margin of the tragus as it passes posteriorly on the ear to orbitale). For excellent Caucasian profile, the mean is  $87.7 \pm 2.9$  degrees; the range is from 79.0 to 92.0 degrees.

Neger (1959) in his soft tissue profile analysis from oriented profile photographs, also used this same angle, which he called pogonial angle (angle Pg). In his sample of good, acceptable, average profile with excellent occlusion, the mean is  $88.1 \pm 2.9$  degrees; the range is from 81 to 95 degrees.

The soft tissue facial angle was defined by Holdaway (1983 a) as the angular measurement of a line drawn from soft tissue nasion (where the sella-nasion line crosses the soft tissue profile) to the soft tissue pogonion, relative to the Frankfort horizontal plane. A measurement of 91 degrees is ideal, with an acceptable range of  $\pm 7$  degrees. This gives an assessment of the soft tissue chin prominence in the facial profile.

Peck and Peck (1970) in their profilometric analysis study from lateral profile photographs employed the soft tissue orientation plane. This is constructed by drawing the facial line from nasion to pogonion (N-Pg) and bisecting it. The midpoint (P) is then connected with tragion (T) to form the orientation plane. The facial angle (F) is formed by the intersection of the the orientation plane with the facial line at point P. It is read as the inside inferior angle and serves as an index of profile orientation. In their sample of aesthetically pleasing faces, the mean facial angle is  $102.5 \pm 2.7$  degrees; the range is from 96.0 to 106.5 degrees.

Satravaha and Schlegel (1987) cited the work of Schwarz (1951) for profile form and profile flow analyses. For these two analyses, the Frankfort horizontal plane (FHP), - the line joining tragion and soft tissue infraorbitale - is used as the horizontal reference plane. Two vertical lines, line A from infraorbitale and line B from nasion, are drawn perpendicular to Frankfort horizontal plane.

1. Profile form compares the horizontal relationship of soft tissue subnasion to line B. If subnasion lies anterior to line B, the facial profile is considered to be prognathic; if subnasion coincides with line B, the profile is orthognathic; and if subnasion lies posterior to line B, the profile is retrognathic.
2. Profile flow compares the horizontal relationship between soft tissue pogonion and lines A and B. If pogonion is positioned more anteriorly towards line B, this is called a "forward shift" of the chin; if pogonion is located midway between lines A and B, the profile is orthognathic; if pogonion is located more posteriorly, this is called " backward shift".

The nose has a significant influence on the soft tissue profile. There have been many angular and linear measures developed to characterize the nose. There are two soft tissue angles most commonly used in plastic and orthognathic surgery: the nasofacial and the nasolabial angles.

The nasofacial angle is the angle formed by the intersection of the line joining glabella and soft tissue pogonion with the line which defines protrusion of the nose from the facial plane. The ideal nasofacial angle for Caucasian is between 36 to 40 degrees, according to Powell and Humphreys (1984).

Legan and Burstone (1980) and Hunt and Rudge (1984) considered the nasolabial angle an important measurement in assessing the anteroposterior maxillary dysplasia. The nasolabial angle takes into account the inclination of the columella of the nose and the position of the upper lip. An obtuse nasolabial angle suggests a degree of maxillary hypoplasia or lack of lip support, whereas an acute nasolabial angle indicates upper lip prominence.

There are various definitions of nasolabial angle. Burstone (1967) and Lo and Hunter (1982) defined the nasolabial angle as the angle formed by the intersection of a line originating at subnasale tangent to the lower border of the nose and a line from subnasale to labrale superius. Legan and Burstone (1980) defined the nasolabial angle (Cm - Sn - Ls) as the angle formed between the line connecting columella point and subnasale and the line from subnasale to labrale superius. The mean value is  $102 \pm 8$  degrees.

Powell and Humphreys (1984) described the nasolabial angle as the

angle from a line tangent to the most anterior point of the the columella (Cm) to the subnasale (Sn), and a line intersecting the subnasale and the mucocutaneous border of the upper lip. The range is between 90 to 120 degrees.

Hunt and Rudge (1984) measured the nasolabial angle as the anterior angle formed between the Frankfort plane and a line tangent to the upper lip through subnasale. This angle normally approximates 90 degrees. They suggested that the nasolabial angle should be studied relative to the Frankfort horizontal plane, since the shape of the columella would influence the magnitude of this angle.

According to Holdaway (1983 a), nose prominence can be measured by means of a tangent at the vermilion border of the upper lip perpendicular to Frankfort horizontal plane. This measures the nose from its tip in front of the line and the depth of the incurvation of the upper lip to the line. Arbitrarily, those noses under 14 mm are considered small, while those above 24 mm are in the large or prominent range.

### 2.3.2. VERTICAL ASSESSMENT OF THE FACIAL PROFILE

Angular and linear vertical measurement of the integumental profile can also be performed using soft tissue landmarks from either photographs or lateral cephalograms.

Legan and Burstone (1980) in their vertical facial height proportionality assessment suggested that the ratio of the distances glabella to subnasale (G - Sn) and subnasale to soft tissue menton (Sn - Me'), measured perpendicular to the Horizontal Plane, should be approximately 1 : 1 in normal adults. The lower third of the face (Sn - Me') can be divided into thirds. The length of the upper lip ie. subnasale to stomion superius (Sn - Stm<sub>s</sub>) should be approximately one third of the total, and the distance stomion inferius to soft tissue menton (Stm<sub>i</sub> - Me') should be about two thirds. Stated another way, this ratio of Sn - Stm<sub>s</sub> : Stm<sub>i</sub> - Me' should be 1 : 2.

Powell and Humphreys (1984) used another method for evaluating vertical facial height proportions. The ratios for the midfacial height (Na' - Sn) is 43% and the lower facial height (Sn - Men') is 57% of the total length from nasion to menton. They suggested that the nasion (Na') point marks the upper limit of the nasal length and is far more reproducible than glabella (G).

Ricketts et al (1979) as cited by Hunt and Rudge (1984), suggested that in the anterior soft tissue height assessment, the distance from the eyebrow to subnasale and from subnasale to soft tissue menton should be approximately equal. When measured perpendicular to Frankfort plane the mean for this distance is 66 mm in normal Caucasian males

and 60 mm in females. The distances from subnasale to lower lip vermilion and lower lip vermilion to soft tissue menton should be equal for ideal balance in the lower third of the face. The clinical average is 33 mm in males and 30 mm in females.

Peck and Peck (1970) identified four angular measurements which can be used to measure vertical height :

1. The nasal angle (Na) measures nasal height from nasion to pronasale. The mean is 23.3 degrees and the range is 20 to 27 degrees.
2. The maxillary angle (Mx) measures maxillary height from pronasale to labrale superius. The mean is 14.1 degrees, with a range of 12 to 17 degrees.
3. The mandibular angle (Mn) measures mandibular height from labrale superius to pogonion. The mean is 17.1 degrees, with a range from 14 to 20 degrees.
4. The total vertical angle (TV) is the total dimension from nasion to pogonion. The mean value is 54.5 degrees with a range of 47 to 62 degrees.

The vertex of all these angles is at tragion.

Cutcliffe (1974) as cited in Worms et al (1976), suggested as a general rule of thumb, that the total facial height between the eye and the soft tissue menton can be divided into fifths. The upper facial height (eye - subnasale) is  $\frac{2}{5}$ , the upper lip length (subnasale - stomion) is  $\frac{1}{5}$ , and the lower lip length the remaining  $\frac{2}{5}$ . Another proportionality that is helpful in assessing the lower facial height (subnasale - menton) is that the upper lip length is one half of the lower lip length.

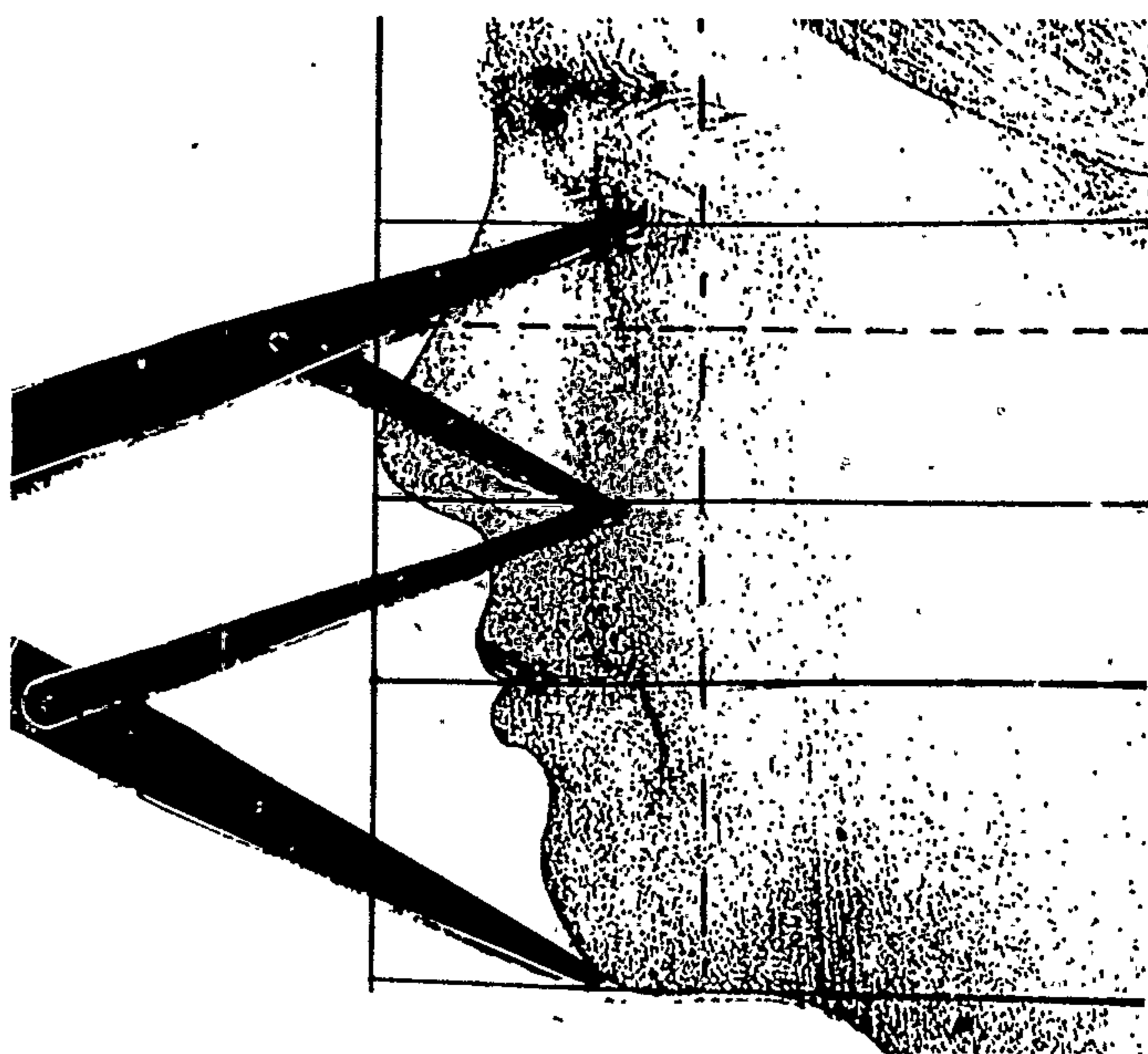


Fig 2.1 Golden proportion from eye-nose-chin (Ricketts 1981).

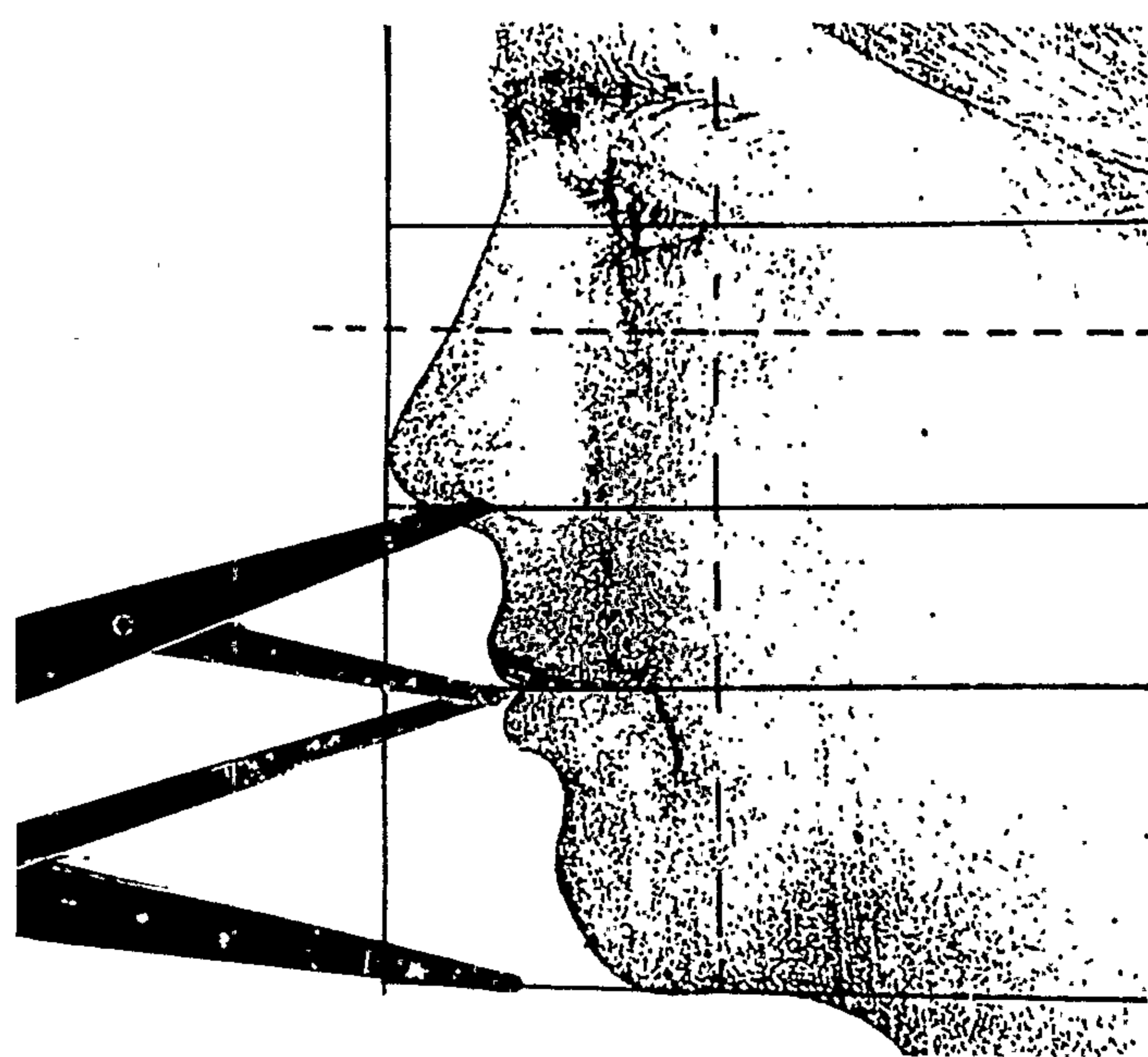


Fig 2.2 Golden proportion from nose-mouth-chin (Ricketts 1981).

Ricketts (1981, 1982) proposed the concept of the "Golden Section" or the "Divine Proportion" or "Phi" for the analysis of structural harmony and balance of the face in all dimension. This golden relation (1 : 1.618 or its reciprocal 0.618) can be measured with the golden divider. Upon widening the divider, the longer side is 1.618 times the shorter side and the shorter side is 0.618 the length of the longer. In turn, the longer side is 0.618 the length of the total outer measurement. For vertical proportion in the profile aspect, divine proportion is recognised in the eye - alar of the nose - chin positions (Fig 2.1); the alar of the nose - lip embrasure - chin positions (Fig 2.2).

#### **2.4 LOWER FACIAL PROFILE ASSESSMENT**

According to Angle (1907), the "mouth defined by the lips is a most potent factor in making or marring the beauty and character of the face". The soft tissue contour of the lower third of the face has been studied extensively by orthodontists, as orthodontic treatment by altering the dentoalveolar region may produce changes in the external or integumental contours of the face (Burstone 1958; Hambleton 1964; Spradley et al 1981).

Evaluation of lip protrusion can be done by relating the lips to a true vertical line passing through the concavity at the base of the upper lip (soft tissue A point) and through the similar concavity between the lower lip and chin (soft tissue B point). The lip should lie along or only slightly in front of this line. If the lip is significantly forward from this line, it can be judged to be protrusive; if the lip falls behind the line it is retrusive. Lip protrusion, like facial divergence, is strongly influenced by

racial and ethnic characteristics. Whites of Northern European origin have relatively thin lips and minimal lip prominence. Whites of Southern European and Middle Eastern origin normally have more lip prominence than their Northern cousins. Orientals and Blacks normally exhibit even greater lip prominence. This difference means that a degree of lip prominence normal for many Whites would be considered retrusive for many Orientals or Blacks (Proffit and Ackerman 1986).

Burstone (1958) in his analysis of the lower third integumental profile, used contour angles to describe the profile components to each other.

1. Maxillomandibular contour (ACDF). Angle formed by the intersection of upper facial and anterior lower facial components.
2. Labiomandibular contour (CDF). Angle formed by the intersection of interlabial and mandibular components.
3. Maxillary sulcus contour (ABC). Angle formed by intersection of subnasal and superior labial components.
4. Mandibular sulcus contour (DEF). Angle formed by the intersection of inferior labial and supramental components.

The landmarks used are : subnasale (A), superior labial sulcus (B), labrale superius (C), labrale inferius (D), inferior labial sulcus (E), and menton (F).

(NB. Burstone's soft tissue menton is equivalent to soft tissue pogonion, as used in this thesis.)

Ricketts (1957, 1960, 1968, 1981) proposed a line tangent to the chin and the nose, which he called the "esthetic plane" or "E" plane to evaluate lip relation to the other profile structures. In Caucasians, by

adulthood, the lips should be contained within this line, with the contour of the lips smooth, and the mouth closed with no strain. The upper lip is ideally located 2 mm farther behind the line than the lower lip. As the nose grows and the chin develops, the lips gradually appear to contract into the face. In the juvenile stages, the lips may start slightly ahead of the esthetic plane; by adolescence, the lower lip drops behind this line and continues to retract in adulthood.

Ricketts (1968) noted that most people object to lips that protrude beyond the E plane. Lip prominence seemed to be an undesirable trait and an unacceptable situation, particularly in adults. However, fullness of the lips and mouth prominence are characteristics of the young. He also noticed that many women object to excessively flat mouths or puckered lips later in life because the prominent denture and the full mouth constitute a mark of youth, whereas flat mouths suggest old age.

Ricketts (1981) noted that in the Oriental and Black races, the nose tends to be proportionally shorter and slightly wider and, particularly in the Black, the lips are somewhat thicker than that seen in White populations. He felt that a good objective in these situations would be to achieve easy closure of the lips with little or no strain, pursing or excessive mentalis action.

Steiner (1960) suggested the "S" plane, that is drawn from the chin to the middle of the "S" formed by the lower border of the nose and the upper lip. He believed that in good faces, the lips often fall on this line and that lips ahead of it would, on an average, be too full, whereas those falling behind it would give too flat an appearance as related to other parts of the profile.

Holdaway as cited by Hambleton (1964) suggested the use of H angle for soft tissue profile diagnosis. The H angle is formed by the "H" line (a line tangent to the soft tissue chin and the upper lip) and the line NB. Holdaway believed that when the ANB angle is 1 to 3 degrees this H angle should be 7 to 9 degrees to produce a pleasing profile. Changes in the ANB angle would also mean similar changes to the H angle. Holdaway (1983 a) redefined his H angle as the angle measurement of the H line to the soft tissue nasion - pogonion line or soft tissue facial plane. He found this angle to be a better indicator of the prominence of the upper lip in relation to the over-all soft tissue profile, and it takes into account the variability of the chin area that is not considered by the ANB angle. For Caucasians, the ideal H angle is 10 degrees, when the skeletal profile convexity measurement (the linear measurement from point A to the hard tissue line nasion - pogonion) is 0 mm. The best range is from 7 to 15 degrees as dictated by the convexity present. As indicated by Holdaway, there is no single H angle that can be set as an ideal for all types of faces, but it will increase proportionately as the skeletal convexity increases.

The upper lip form is important in the study of profile form, especially with regard to orthodontic treatment. Holdaway (1983 a) took the upper lip form or curl as the linear measurement from the superior sulcus depth to a perpendicular to Frankfort horizontal and tangent to the vermilion border to the upper lip. The ideal superior sulcus depth is 3 mm, with a range of 1 to 4 mm.

Holdaway (1983 a) noted that the lower lip is considered ideal when it is 0 to 0.5 mm anterior to the H line. The contour in the inferior sulcus area should fall into harmonious lines with the superior sulcus

form. The inferior sulcus is taken as the point of greatest incurvation between the vermillion border of the lower lip and the soft tissue chin and is measured to the H line.

Merrifield (1966) suggested a line drawn tangent to the soft tissue chin and the most procumbent lip extending superiorly to intercept the Frankfort Horizontal plane. The inferior angle formed by the intersection is called the Z angle, which indicates the extent of lip protrusion. The mean is 81.4 degrees, with a range of 71 to 89 degrees.

Burstone (1967, 1975) used a plane that connected subnasale and soft tissue pogonion to evaluate the relative protrusion or retrusion of the lips. Lip protrusion or retrusion is measured as a perpendicular linear distance from the subnasale-pogonion plane to the most prominent point on the upper and lower lips. In a normal adolescent sample, the upper and lower lips lie ahead of the subnasale - pogonion plane. The mean for the upper lip is 3.5 mm anterior to the line, and the lower lip is 2.2 mm anterior to the line. Burstone selected the subnasale-pogonion plane of reference as he believed that it is a plane of minimal variation with orthodontic treatment in non-growing individuals. Burstone felt that although an esthetic plane joining the nose and the chin is useful for evaluating the facial form, there is so much variation in nose form and length that the nose should be avoided in the evaluation for lip protrusion.

## 2.5 STRUCTURAL BASIS FOR ETHNIC VARIATIONS IN FACIAL FORM

Hooton (1931), as cited by Lusterman (1963) defined a race as "a great division of mankind, the members of which, though individually varying, are characterised as a group by a certain combination of morphological and metrical features, principally nonadaptive, which have been derived from their common descent".

Among most of the world's different racial or ethnic groups, either the brachycephalic or dolichocephalic type of head form tends to predominate in any given group (Fig 2-3). However, a distribution range from one extreme to the other also usually exists within a group, even though one particular side of the range is more common. An intermediate type of head form (mesocephalic) can also occur (Enlow 1982).

Dolichocephalic head form tends to predominate in the northern and southern edges of some parts of Europe, England, Scotland, Scandinavia, northern Africa, and some Near and Middle Eastern countries (eg. Iran, Afghanistan, India, Iraq and Arabia). Brachycephalic head form tends to predominate in Middle Europe (the "Alpine" head form). A third type of head form, termed Dinaric can be found at the geographic interface between the dolicho- and brachycephalic regions of the world. Such areas include regions located between Middle and Northern Europe, between Middle and Southern Europe, and between Europe and the Near East. This head form is characterized by the posterior part of the skull being brachycephalized and flattened, whilst, the anterior part of the skull has retained the relative narrowness that characterized the dolichocephalic pattern.

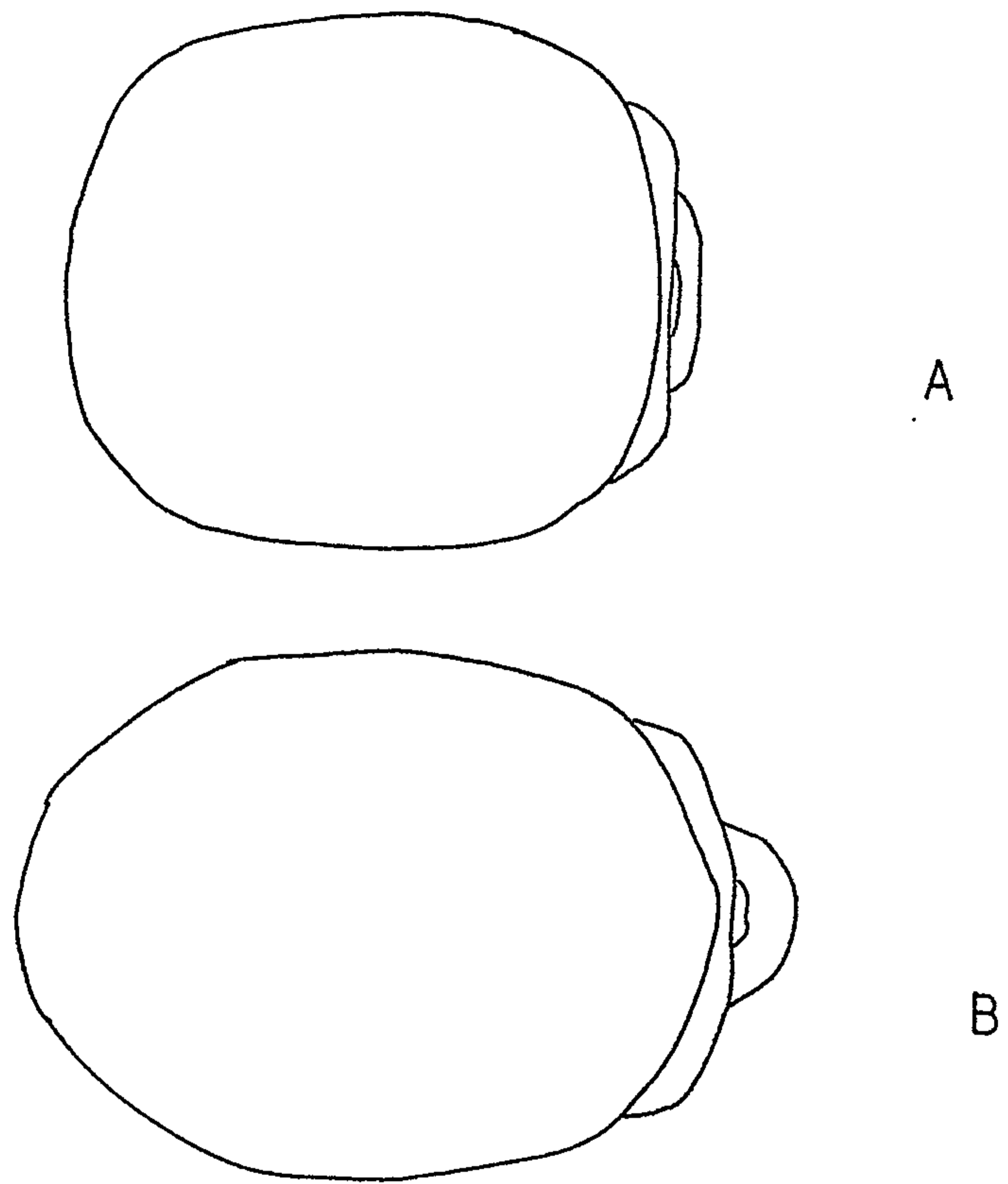


Fig 2.3 A. Brachycephalic head form. B. Dolichocephalic head form.

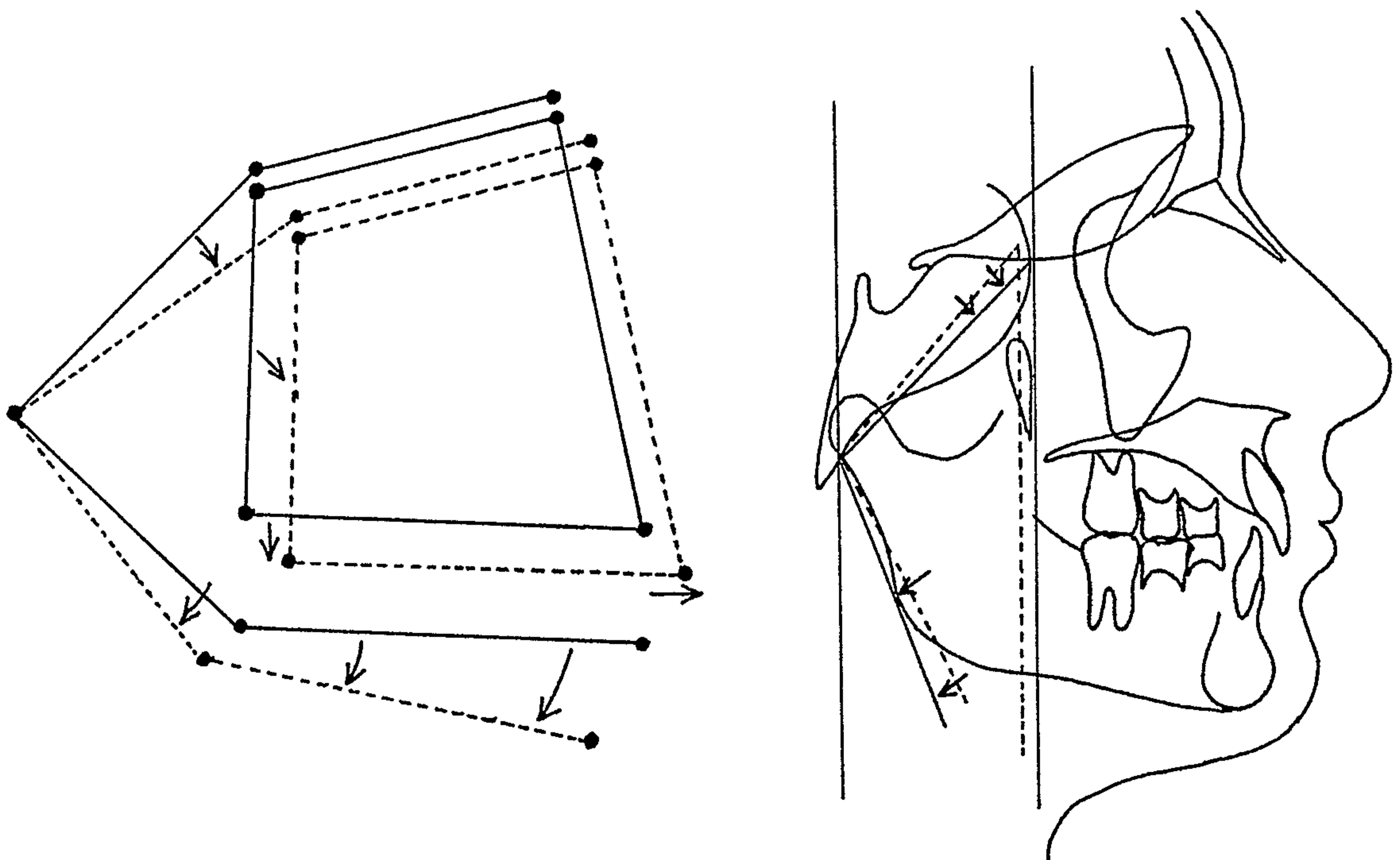


Fig 2.4 The facial pattern that is characteristically seen in many Caucasian groups (Enlow 1982).

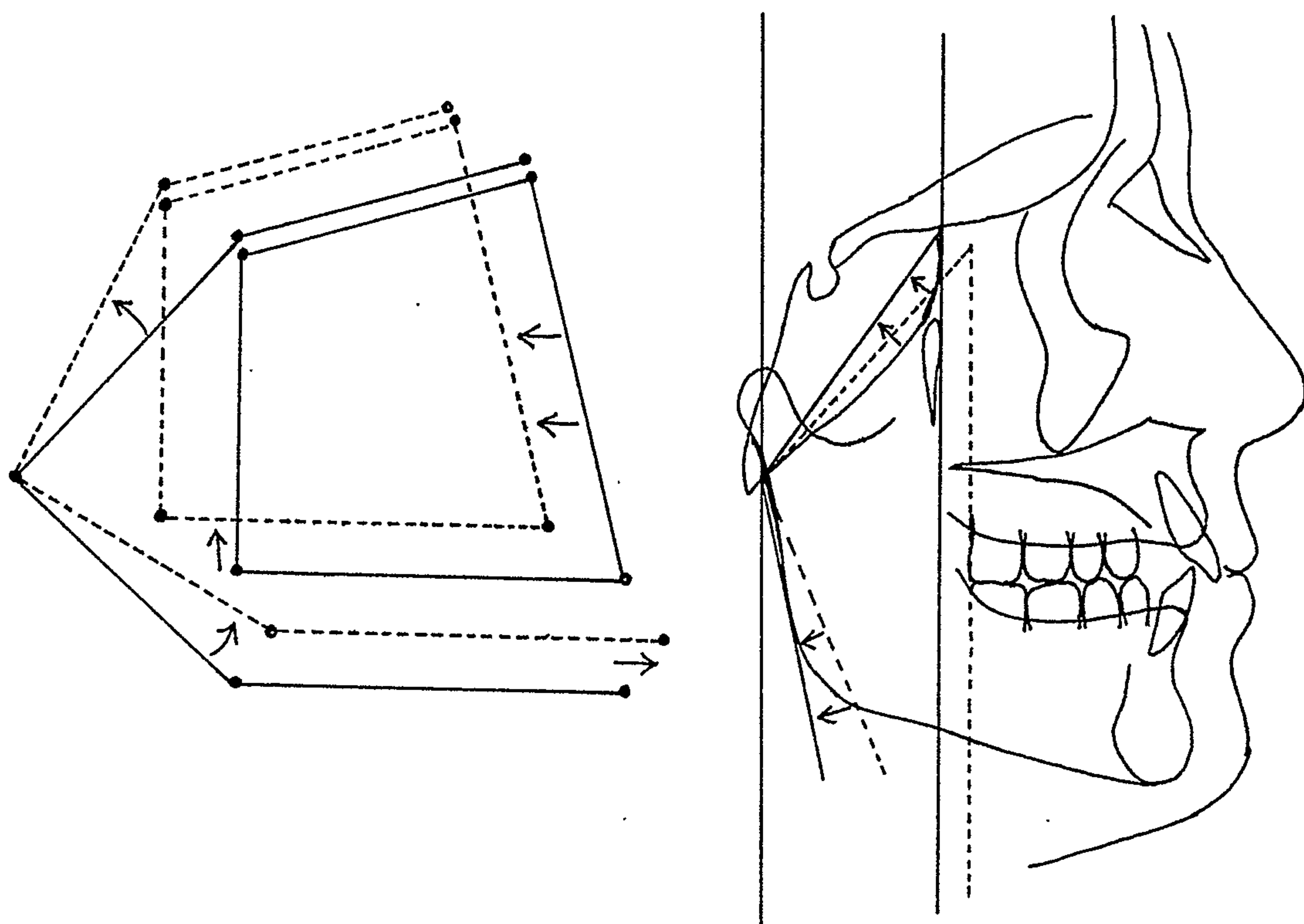


Fig 2.5 The facial pattern that is characteristically seen in many Oriental groups (Enlow 1982).

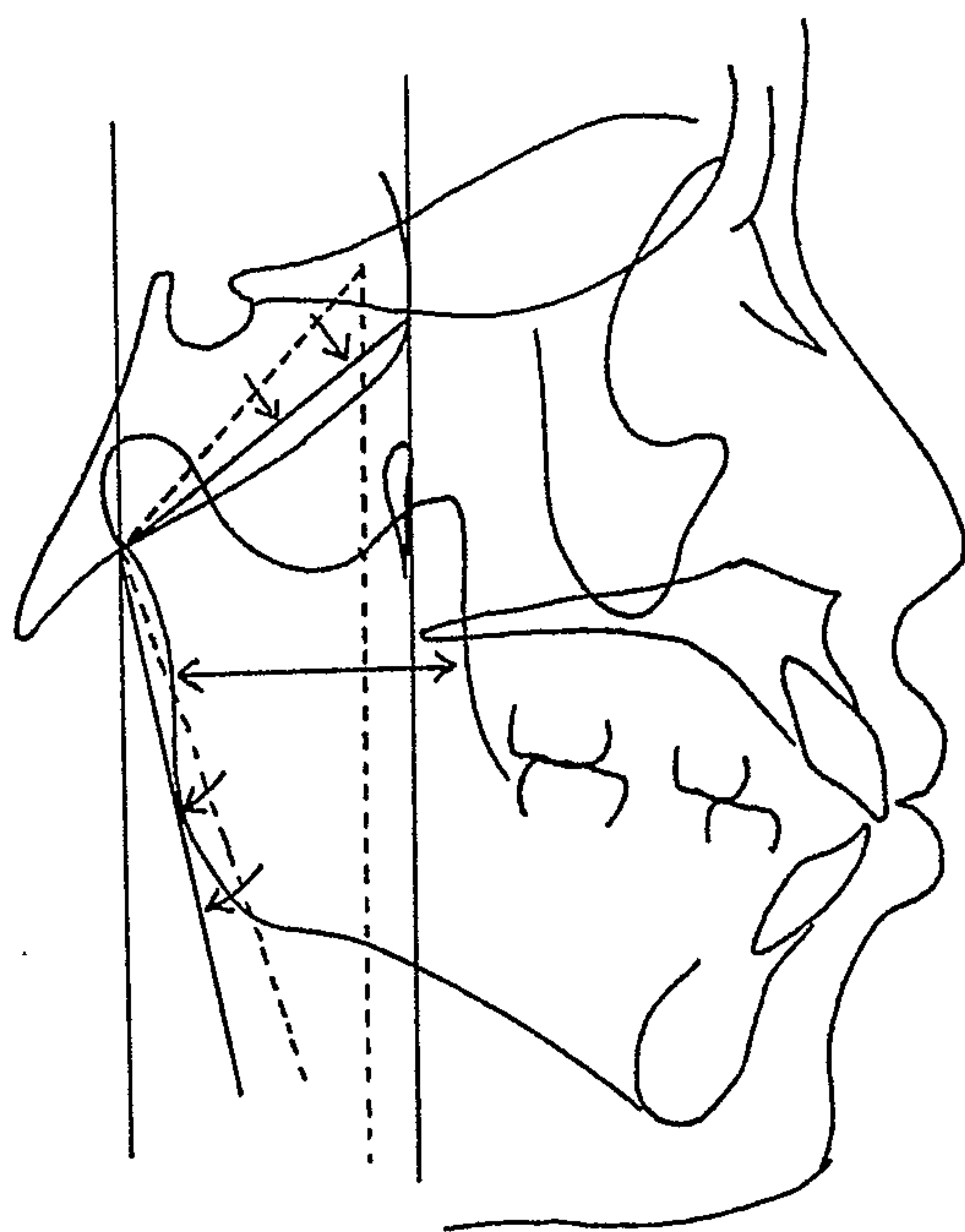


Fig 2.6 The facial pattern that is characteristically seen in Negroid groups (Enlow 1982).

The dolichocephalic head form present in many Caucasian groups is usually associated with a more open or "flat" cranial base flexure (Fig 2.4). This tends to produce a more protrusive upper face and a more retrusive lower face. This results in the whole nasomaxillary complex being more forwardly positioned and lowered relative to the mandibular condyle. As the condyle is "higher", there is the tendency for a downward and backward rotation of the whole mandible. Hence, there is a greater frequency of the retrognathic type of profile and a Class II tendency among groups with a dolichocephalic type of head. There is also a high incidence of a "broad" ramus to compensate for the built-in tendency toward mandibular retrusion.

The brachycephalic head form, present in many Mongoloid or Oriental groups, is characterised by a more closed, upright cranial base flexure (Fig 2.5). The broad head form also sets up a wider but anteroposteriorly shorter upper and midfacial region. The result is that the whole upper and midfacial region is also placed less protrusively. There is often a "vertical" character to the whole face; the cheekbones are more prominent-appearing because the upper and middle face is not as protrusive. There is a greater likelihood for this group to have an orthognathic profile, and a relatively prominent chin and mandible. Hence, a greater tendency for a Class III type of malocclusion and a prognathic mandible exists. Bimaxillary protrusion occurs when the mandible tends to be slightly long horizontally, and this causes a forward tipping (proclination) of the upper incisors. The result is a protrusion of both the upper and lower incisor regions. However, the nasomaxillary complex can also be vertically long, and the ramus thus rotates downward and backward as a result. The face does not appear as long as it is wider. The mandibular corpus tends to be horizontally shorter

relative to the maxillary arch, and this factor, together with the backward ramus rotation, contributes to a compensation for the built-in tendency toward prognathism and bimaxillary protrusion. (Enlow 1982).

The Negroid group tends to have an elongated dolichocephalic head form, although there are wider-faced individuals, just as among Caucasians. The cranial flexure is even more open or flatter than in the Caucasians (Fig 2.6). This factor, together with a vertically long nasomaxillary complex causes the ramus (and the whole mandible) to rotate markedly downward and backward. The mandibular corpus tend to be horizontally long relative to the maxillary length, which is similar to the Caucasian pattern. However, the upper part of the face in the Black expands much less and is therefore not nearly so protrusive, a feature which corresponds to that of the Oriental. The mandibular ramus is characteristically broad, more so than in other groups; thereby offsetting an intrinsic tendency for mandibular retrusion and a Class II malocclusion. The very broad ramus places the mandibular corpus (which can also be long relative to the bony maxillary arch) in a resultant protrusive position. This, thus, causes the maxillary incisors to tip labially, and a bimaxillary protrusion is hence produced (Enlow 1982).

### 2.5.1 CHINESE PROFILE VARIATIONS

Many clinicians agree that population norms derived from a given sample are not necessarily valid or accurate for other samples or groups, especially if ethnic variations are involved.

There are distinct racial differences in human skulls and jaws. Aitchison (1964) noticed that the outstanding characteristics of Chinese skulls are the extremely prominent malar arches, the depressed nasal bones and superior maxillae. The Chinese skull gives the impression of a concave face. The receding nasal and maxillary bones are typical features of Chinese skulls.

As mentioned by Enlow (1982), among the Orientals, the Class III and bimaxillary protrusive facial types are much more common. There is a stronger tendency toward an orthognathic profile.

Wong in Cotton et al (1951) looked at 20 American-born Chinese (10 males and 10 females) ranging from 11 to 16 years of age. Wong found that Down's standards did not hold true for the Chinese. When compared, the Chinese presented a Class II facial pattern even though they had normal occlusion and good facial profile according to Chinese concepts of beauty.

Wei (1965, 1968) and Chan (1969, 1972) in their studies also found the Chinese facial profile to be retrognathic compared to Caucasians. Other findings of Wei (1965, 1968) were :

- The retrognathism is most marked in the maxilla.
- The Chinese possess moderate maxillary alveolar prognathy

associated with procumbent maxillary teeth in a small maxillary jaw base.

- The Chinese have a low facial convexity and a relatively flat facial profile.
- The nasal bones in the Chinese are less prominent than in Caucasians, and appear to vary independently of the angle of prognathism and other craniofacial variables.

Hong (1960), Yen (1973), Foo and Woon (1984), and Foo (1986), Cooke & Wei (1989) noticed that when employing an extrafacial vertical reference as advocated by Moorrees and Kean (1958), SN has a greater cant to the true horizontal in the Chinese sample. Thus the apparent skeletal II pattern in the Chinese as shown by the Downs' Analysis done by Wong in Cotton et al (1951), is in fact due to the cant of SN plane.

Foo and Woon (1984) and Foo (1986) did a cephalometric study of Malaysian Chinese with harmonious facial appearances and good functional occlusions; they found that the Chinese face is set back beneath the anterior cranial fossa when compared to the Caucasian face. This is more apparent in the midface. This is probably due to the smaller SN measurement that is inclined to a greater degree caudally. Chan (1972) and Foo (1986) drew conclusions from Wei's (1965) study that this apparent retrusiveness in the midface is due to the shorter cranial base, shorter maxilla, the bridge of the nose is low and the nasal bones are less prominent in the Chinese.

The lips in the Chinese are more prominent compared to the Caucasians. Foo (1986) attributed this to the greater degree of alveolar prognathism and thicker soft tissue profile. Chan (1969, 1972) found

that the upper and lower incisors are much more protrusive in the Chinese than in Caucasians. Since incisors give support to the lips, he thought it logical that the lips of the Chinese should be more protrusive, and these contribute to the convex profile of the Chinese.

Cooke and Wei (1989) did a comparative study of 12 year-old male Chinese and British Caucasians. The Chinese soft tissue profile displayed a less prominent, and more obtuse, nose and chin but more protrusive upper and lower lips. The columella was shorter and the upper lip longer, with a more acute angulation between them, than found in the Caucasians. When superimposed on the nose and forehead region, the profiles are similar down to the nose tip, below which the Chinese male profile is more protrusive over the lips and chin. They found that the conventional cephalometric comparisons (using SN) between the Chinese and Caucasians provided an erroneous comparison of the true life craniofacial forms. When superimposed on the true vertical in the natural head position, the Chinese craniofacial outline form rotates counterclockwise 4-5 degrees and appears relatively more Class III with a more prominent chin. In the natural head position, the true degree of prognathism in the Chinese becomes apparent. The changed comparative intergroup difference observed in natural head position is due to the more caudal angulations of the conventional intracranial reference planes to the true vertical in the Chinese.

Satravaha and Schlegel (1987) in their study of Thai females, mostly of Chinese origin, found significant differences between standard white profile and their study population. They believed that proper blending of the integumentary profile produces an aesthetically pleasing face, and this varies in different ethnic groups. In their study of Thai and

Chinese female subjects, ages ranging from 16 to 21 years, they found the following:

1. The prognathic profile with a backward chin shift is predominant (50% to 60%) in the examined Asian population.
2. The Asian sample has a less convex soft tissue profile in comparison to the Caucasian profile.
3. With relation to Rickett's "E" plane, the upper lip is posterior or on the E plane in 60-70% of cases, and the the lower lip in 28% to 33% of cases.

## **2.6 SOFT TISSUE PROFILE CHANGES WITH GROWTH**

From some of the growth studies done (Bjork 1947; Lande 1952; Subtelny 1959, 1961; Bjork & Skieller 1983), it may be said that with continuing growth, the skeletal profile becomes less convex. The chin usually assumes a more forward and downward position with relation to the forehead.

Bjork (1947) found that an increased prognathism of both the maxilla and the mandible is characteristic of profile changes with age; but the increase is greater in the mandible than the maxilla. This accounts for the straightening of the facial profile from the age of 12 to 20 years in his sample comprising of Swedish males only. Lande (1952) also observed that the mandible tends to become more prognathic between the ages of 7 to 17 years, while the maxilla shows very little change and this reduces the convexity of the face.

Subtelny (1959, 1961) in his longitudinal study from 3 months to

18 years of age, noticed that the maxilla tends to become progressively less protrusive relative to the rest of the skeletal profile with age. This relative retrusion of the maxilla is due to its decelerative growth rate while the rest of the face grows forward. As a result, the skeletal face becomes increasingly less convex as a child grows. Sex differences in facial profile changes are also observed. Female subjects do not usually become as prognathic in the mandibular region, and therefore do not usually attain the same degree of straightness in the skeletal profile when compared to male subjects.

The position of the soft tissue chin is closely related to the position of the skeletal chin. As a result of growth, both the skeletal and integumental chins assume a more forward relationship to the cranium. The integumental chin is closely related the degree of prognathism of the underlying skeletal framework. While the convexity of the skeletal profile tends to decrease with age, the convexity of the total soft tissue profile, including the nose, tends to increase with age. However, the convexity of the soft tissue profile, excluding the nose, tends to remain relatively stable. In this respect, soft tissue changes are not analogous to those exhibited by the skeletal profile (Subtelny 1959, 1961; Wisth 1972).

This indicates that there is a growth differential in the thickness of the soft tissue covering the various aspects of the underlying skeletal profile. Changes take place in the thickness of the soft tissue covering the bony profile, with a proportionally greater increase in the thickness of soft tissue covering the maxillary region than that found in the nasion and pogonion areas (Subtelny 1959). Wisth (1972) and Mauchamp and Sassouni (1973) supported Subtelny's findings, in that the soft tissue

increase at subnasale is greater than at pogonion and that the soft tissue profile, excluding the nose, tends to be fairly stable with age. Subtelny explained that the difference in the forward growth of the bony chin with its overlying soft tissue and the comparatively reduced forward growth of the anterior part of the bony maxillary jaw, seems to be partially compensated for by this differential in the increase in soft tissue thickness covering the maxilla.

The nose grows in a downward and forward direction. Subtelny (1959) noticed that from 1 to 18 years of age, the rate of nasal growth does not seem to decrease appreciably with age, as is typical of the growth pattern established for the skeletal facial structures. This is responsible for the total soft tissue profile increase in convexity with age. Generally, the total profile of the nose is closely related the path of the growth of the nasal bone; the bridge of the nose and the cartilaginous aspect of the nose seem to maintain contour conformity with age. Sometimes there may be a tendency for the nasal bone to deviate from its downward and forward direction. In these instances, there is frequently a hump or elevation of the bridge of the nose (Subtelny 1959). Chaconas (1969) and Chaconas and Bartroff (1975) reported that this humping of the bridge of the nose, as a result of a forward positioning of the nasal bones, is probably caused by a forward growth of the supporting nasal cartilages. Subtelny (1959) indicated that this elevation of the bridge would be less apparent if there is a comparable and associated forward positioning of the more inferior aspect of the nasal profile.

The growth of the lips follows the general growth curve for muscle and other connective tissue within the body (Scammon et al 1930 as

cited by Subtelny 1959). The upper and lower lips show a progressive increase in lip length until approximately fifteen years of age; after this, it appears to slow down markedly. With this increase in lip length there is also an increase in thickness, especially in the vermilion region of the upper lip. The increase in thickness of both lips is considerably greater at the vermilion level than in the regions overlying skeletal points A and B.

Subtelny (1959, 1961) found that the posture of the lips is strongly dependent on the position of the underlying dentoalveolar complex. After about nine years of age, ie. when the upper central incisors have fully erupted, the upper lip maintains a fairly constant vertical relationship to its alveolar process (prosthion) and the upper incisal edges. Similarly the lower lip shows the same relative stability in its vertical relationship to infradentale and the lower incisal edges. The upper lip normally covers about 61% to 67% of the upper central incisor crown. The remainder of the tooth is covered by the lower lip. The anteroposterior posture of the lips is also closely related to their supporting hard tissue structures, ie. the teeth and alveolar processes.

Bjork (1947), Lande (1952) and Subtelny (1959, 1961) found that alveolar processes do not keep pace with the growth of the skeletal bases in a horizontal direction. Subtelny noticed that point A and point B exhibit some stability in their anteroposterior relationship to each other after nine years of age, while their supporting skeletal bases continue to grow and change in anteroposterior relationship. So when the dentoalveolar structures receded and uprighted relative to the skeletal base, the lips, especially the lower lip, were observed to concomitantly become more retruded relative to the facial profile. So, Subtelny

concluded that there is a strong interrelationship between the lips and the dentoalveolar structures.

Ricketts (1960) found that the average convexity of the face decreases with age and the lips become progressively more retracted in relation to the "Esthetic Plane". He suggested that the lips may lie on or ahead of the E-Plane in the early ages of childhood; on it, in middle childhood; and behind it in later life.

## **2.7 SOFT TISSUE PROFILE CHANGES WITH TREATMENT**

In the early orthodontic literature, concern over facial features and facial aesthetics is evident. Hunter (1835), as cited by Angelle (1973), felt that one of the prime objectives of orthodontic treatment was to improve and beautify the appearance of the mouth. Case (1921) stressed that facial outline should be an important guide in determining treatment objectives and procedures. He advocated extraction in some cases of bimaxillary protrusion to retract the procumbent lips. Many studies have since been done to determine profile changes concurrent with orthodontic treatment, and this in part, reflects the importance of facial aesthetics, and the role the orthodontist might have in influencing facial balance.

Lip posture and tonicity and the position of the soft tissue chin are of considerable importance in the aesthetics of the facial profile. Research into the effect of changes in position of the teeth on the soft tissues have been largely concentrated on changes in the lip profile because it seems that most changes in tooth position during treatment

alter lip position.

However, there appears to be some controversy as to the amount of soft tissue changes possible as a result of orthodontic treatment. Some of the controversy relates to the relationships of the hard and soft tissues. Some, like Downs (1948, 1956), Steiner (1953) and Riedel (1957), stressed that the soft tissue profile is closely related to the underlying skeletal and dental structures. On the other hand, Subtelny (1959, 1961) from his longitudinal study of soft tissue profile changes, found that not all parts of the soft tissue profile directly follow the underlying skeletal profile; however, the upper and lower lips closely follow the contour of their underlying dento-alveolar structures. Thus orthodontic treatment which is aimed at dentoalveolar changes, will concomitantly change the soft tissue profile in this region. However, Burstone (1958, 1959) and Hambleton (1964) indicated that a direct relationship could not always exist because of individual variation in the thickness, length, and postural tone of the soft tissue covering the dentoskeletal framework.

Neger (1959) found that a proportionate change or improvement in the soft tissue profile does not necessarily accompany extensive dentition changes.

Soft tissue treatment changes are also complicated by the fact that changes are brought about not only by the treatment alone but also by the normal growth of the soft tissue itself. Koch et al (1979) believed that the possibility of improving the soft tissue profile is limited. The disproportionate growth of the nose and the forward growth of the chin have a marked influence on the facial profile but the change of lip profile that can be effected by orthodontic treatment is relatively small.

They found that the soft tissue profile did not directly reflect the change in the underlying skeletal profile. There was great variability in response of the soft tissue to the retraction of the upper incisor. It is evident that when incisors are retracted, lip tonicity is decreased and the lip becomes thicker, but is retracted together with the hard tissues. Soft tissue change is not easy to measure and, because of individual variations in lip morphology and tonicity, even though the incisor positions may be similar, both the appearance and measurements can differ considerably.

Other studies by Baum (1961), Bloom (1961), Rudee (1964), Hershey (1972), Wisth (1972), Anderson et al (1973), Angelle (1973), Garner (1974), Roos (1977), Oliver (1982), Rains and Nanda (1982), Lin et al (1985), Shue (1985) and many others have shown that the upper and lower lips, forming the lower part of the soft tissue facial profile can be influenced by orthodontic treatment, though it can be very variable.

Although, Hambleton (1964) felt that a direct relationship between hard and soft tissue cannot be relied on, the lips can be influenced by orthodontic treatment. Retraction of the upper teeth can produce a dramatic lip change. He noticed that as the lip is retracted, there is also some thickening of the lip. Ricketts (1957) supported this observation, especially in severely protruding cases, whereby the upper lip appears to be thin and stretched; so, as the teeth are retracted, the lip thickness increases. A 2 to 4 mm thickening of the upper lip can be expected in severely protruding cases, and about a 1 to 2 mm increase in cases where the upper incisors are not going to be moved excessively. The lower lip does not thicken but curls backward as a result of upper incisor retraction. An increase of soft tissue on the chin occurs because of loss of

lip strain and loss of chin elevation by the mentalis muscle. (Ricketts 1960).

Holdaway (1983 a) took upper lip strain measurement into account to assess the amount of upper lip retraction possible. He suggested that when there is a taper in the upper lip immediately anterior to the incisor, the lip will thicken following retraction until it approaches the thickness at point A (within 1 mm of the thickness). When the lip strain has been eliminated, further retraction of the incisor will cause the lip to follow the incisors in a one to one ratio. This is predictable in adolescents when the lip thickness at point A is within the normal range (14 to 16 mm). The exceptions are :

1. if the tissue thickness at point A is very thin (9 to 10 mm), the lip may follow the incisor immediately and still retain the taper;
2. if the tissue at point A is very thick (18 to 20 mm), the lip may not follow incisor movement at all.

Adult tissue reaction is similar to the first exception. Even though there may be lip taper, the lips will usually follow the teeth immediately.

Waldman (1982) in his cephalometric study of the influence of hard tissue changes on lip contour, found that the nasolabial angle was increased with uprighting (lingual tipping) of the incisors. Lo and Hunter (1982) found that the increase in nasolabial angle is significantly correlated with the amount of maxillary incisor retraction in the treatment of Class II, division 1 malocclusion.

Rains and Nanda (1982) looked at the upper and lower lip response to upper and lower incisor retraction in 30 late adolescent and early

adult female patients. They found that the lower lip was more variable than the upper lip to differences in the upper incisor movement. The upper lip at labrale superius was found to be more variable with increased retraction of the upper incisors.

Chang (1983) investigated the soft tissue profile changes that occurred with orthodontic treatment in a sample of fifty-two adolescent and young adult Chinese patients, and tested whether these alterations improved the soft tissue profile. Comparisons were made with extraction and nonextraction orthodontic therapy, and retractive and protractive movement of the incisors. He concluded that the soft tissue response varies widely with a given amount of tooth movement, and statistically mandibular lip to incisor relationship is more predictable than that of the maxillary relationship. This was supported by Bloom (1961). Chang also noted that there are significant correlations between flatter lip postures, straighter facial contours, and profile attractiveness.

Lin et al (1985) studied the soft tissue changes during Class III traction on Chinese children. They found that changes in the upper and lower lip relation closely followed changes in angulation of the upper and lower incisors. They also noticed that soft tissue change was often greater than that of the skeletal tissue during orthodontic treatment; so that it is possible for some skeletal Class III patients to obtain an acceptable or more satisfactory soft tissue profile than their skeletal pattern would appear to permit. Shue (1985), also found an improvement in the overall profile with orthodontic treatment of Class III patients, with positive changes in the angles of convexity of both the hard and soft tissues. However, the changes were much smaller than that reported by Lin et al.

## CHAPTER 3 : SYSTEM FOR STANDARDISATION OF FACIAL PHOTOGRAPHS

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### 3.1 STANDARDISED PHOTOGRAPHY

Many authors (Dickason and Hanna 1976; Morello et al 1977; Fricker 1978, 1982, 1985; Crawford 1987) have recommended a 35 mm single reflex camera with 105 mm lens for standardised photography. This focal length provides minimal distortion of facial features.

Facial photographs have the advantage over radiographs, in that one sees the patient as they really are. Also, the general public can relate to these better than to cephalometric radiographs.

Standardisation of photographic techniques and positioning of the subject allow accurate longitudinal serialisation of treatment stages to be documented, and allow meaningful comparison of these stages. If the camera position, the distance from the patient to the camera, and the subject's head orientation are not standardised, this will result in inaccuracies in comparison from one photograph to another. (Fricker 1978, 1982).

Lucker (1980) recommended that in order to assure that there is comparability among photographs and radiographs of all individuals, standardised photographs and radiographs should typically be taken. These records are normally standardised in two ways :

1. Fixed distance between camera to target to insure size constancy among photographic and radiographic records.
2. Standardised head position, for example with head holders.  
Subjects also have to be standardised in their pose, for example in lip posture.

Morrello et al (1977) and Crawford (1987) emphasized the value of uniform photographic records in plastic surgery and orthodontics respectively, to achieve consistency and make valid comparisons. They stressed that the key to success for standardisation of photographic records, is consistency in camera settings, lighting, alignment, and camera and subject positioning. They recommended the 105 mm lens fitted to a 35 mm, single-lens, reflex camera, as this focal length produces the least distortion in facial photography.

Brodbelt (1978) described a mirror system whereby a standardised photographic procedure can be used to obtain an anterior view and both left and right profiles with one exposure. A horizontal black line across the mirror surfaces is used to standardise and calibrate the orientation of the mirrors by alignment to the Frankfort plane. Using a single-lens reflex camera with a centrally located single-point flash, a standardised photographic procedure is established. By focusing at a preset lens distance, a reproducible procedure with correct alignment to the mirrors is also established.

Yuen and Hiranaka (1989) in their photographic study of facial profiles, described their method of standardised photography. The camera is mounted on a tripod at a fixed distance from the reference ruler, attached to a plumb line that hangs vertically from the ceiling. The

photographs are taken with the subjects standing in natural head position with their eyes looking forward and their feet equidistant on each side of the line marked on the floor.

### 3.2 STANDARDISED HEAD POSITION

As stated by Burstone (1958), unless a standard method of subject positioning is observed, all future methods of measurement may well be meaningless. In his studies, the following procedure was used for positioning the patient :

1. The sagittal plane is at right angles to the film with Frankfort horizontal parallel to the floor.
2. The teeth are in centric occlusion, for increasing or decreasing vertical dimension would influence the soft tissue structures.
3. The lips are lightly closed, neither overly relaxed nor tightly closed. In extreme malocclusions, such as Class II, division 1 cases, light closure does not allow the upper and lower lips to have complete contact.

Neger (1959) used a similar method for evaluating the soft tissue profile in a quantitative manner on a profile photograph. The head is positioned with the Frankfort plane parallel to the floor and the median sagittal plane of the patient parallel to the plane of the film, with the optical axis of the camera passing through orbitale. The patient is instructed to place his teeth in occlusion and to keep the lips relaxed and closed without exerting any undue force. If, because of the severity of the malocclusion, the lips cannot be closed, the picture is taken with the lips in a parted position, maintaining occlusal contact.

### 3.2.1 FRANKFORT HORIZONTAL PLANE

Moorrees and Kean (1958) stated that "Frankfort Horizontal is probably the best known and most acceptable approximation of the physiologic horizontal." The Frankfort Horizontal plane has been widely used for orientation of the head in cephalometric recordings. This plane was introduced by Von Ihering (1872), as cited by Moorrees and Kean, for craniometric purposes. This line from Porion to Orbitale was called the German Horizontal, at the 1884 Craniometrical Conference, held in Frankfurt am Main.

Cleall et al (1966) in their study, in which no head holding device was used and in which no attempt was made to correct the position of the head, observed that the Frankfort Horizontal was very close to the true horizontal (90.1 degrees to the true vertical).

### 3.2.2 NATURAL HEAD POSITION

Broca (1862) as cited by Moorrees and Kean (1958), defined the natural head position as "when a man is standing and when his visual axis is horizontal, he (his head) is in the natural position." In order to determine natural head balance, a horizontal or vertical reference line outside the cranium was used, but preference was given generally to the horizontal. It was recognised, however, that a true horizontal line cannot pass through the same two anatomical landmarks in all individuals.

Moorrees and Kean (1958) tested the hypothesis that the natural head position is relatively constant and they found it extremely reliable

for use in radiographic and photographic analyses, ie. a suitable standard of reference from which to measure the relationship of other craniofacial lines. Other studies have also shown the natural head position to be highly reproducible (Bean et al 1970; Solow and Tallgren 1971, 1976; Foster et al 1981; Lundstrom 1981; Cooke and Wei 1988).

The methods used for definition of the natural head position vary among the different authors. The method most commonly used for recording natural head position has been to let the subject orient the head by looking straight into a mirror. Other studies used a light source (Cleall et al 1966), while in others, no external reference was used. Solow and Tallgren (1971) pointed out that determination of the head position by means of an external reference such as a mirror has the disadvantage, that the position obtained may not be the one habitually used by the subject outside the experimental situation

Solow and Tallgren (1971, 1976) investigated two different methods of recording natural head position :

1. Self-balance position, which is determined by the subject's own feeling of a natural head balance. The attainment of the self-balance head position is facilitated by letting the subject tilt the head forwards and backwards with decreasing amplitude until a natural head balance is felt. This is for definition of the head position without external reference.
2. Mirror position which is determined by the subject looking straight into his eyes in the mirror. This is representative of the head position defined by means of an external reference.

The radiographs were recorded with the subject standing in the "orthoposition", which had been defined by Molhave (1958) as the

intended position from standing to walking. Solow and Tallgren selected the orthoposition because it is a habitual symmetrical standing position and had been found to be reproducible in postural investigations. Both recordings were made with the teeth in occlusion. The inclinations to the true vertical showed smaller variability in the mirror position than in the self-balance position, but the differences were not significant. They found that head posture could be reproduced without systematic error, but that head postures achieved by two different methods showed significant differences from each other. A comparison for the two head positions revealed that in the mirror position the head was kept higher than in the self-balance position.

In some studies, for recording the natural head position, the subjects were instructed to sit in a relaxed position and look into their own eyes in a mirror located at a fixed distance away from them (Moorrees and Kean 1958; Bean et al 1970; Larrabee et al 1985).

It has been suggested that the physiologically determined typical head posture in a standing position is the appropriate orientation for lateral skull radiographs or profile photos. The natural head posture orientation has the advantage of being the position in which we normally observe the individual. This should present us with a profile view considered typical for the subject under investigation, even when presented to laymen acquainted with the subject. It has been shown that lateral cephalometric radiographs or profile photographs arranged with respect to a particular cephalometric reference line runs the risk of incurring a forward or backward tip of the head (flexion or extension) from the natural head posture (Lundstrom 1981).

Foster et al (1981) believed that the use of true horizontal in cephalometric assessment would be more meaningful in aesthetic judgement. In clinical orthodontics in recent years, more emphasis has been placed on facial profile and on incisor inclinations. These are judged clinically in relation to a true horizontal or vertical, with the head in its natural upright posture. They believed that the use of intracephalic reference lines was probably developed to overcome the variation of head positioning within the cephalostat. They found that the variation in the reference line relationships was much greater than that due to head positioning errors. So if care is taken over positioning of the patient in the cephalostat so that the head is in a natural posture position, the use of a true horizontal or vertical on the radiograph would give a more reliable assessment than the use of intracranial reference lines. It would also have the benefit that the radiographic assessment would be based on the same standards as the clinical judgement on the patient.

Cooke and Wei (1988a, b) stated that natural head posture is the reproducible, natural, physiologic position of the head obtained when the relaxed subject looks ahead at an external eye reference - for example, a wall mirror. Alternatively, a comfortable "self-balance" position of the head may be defined without resort to any external eye reference. The true vertical and the true horizontal derived from it are usually used to define natural head posture and are themselves defined by the free position taken up by a weighted plumb line. Cooke and Wei found that analyses based on natural head position and the true horizontal should be more clinically relevant, as they would more closely describe the morphology and appearance of the subjects as they truly appeared in life.

Cooke (1990) found that the natural head position deteriorated over time, but showed signs of stabilizing after 1 to 1 1/2 years. However, the variance of natural head position is found to be significantly less than the variance of intracranial reference planes with respect to the true vertical.

Larrabee et al (1985) used the natural head position to obtain reproducible photographic records. No head-holding apparatus was used as they believed, that interfered with the visualisation of the face. In their profile analysis for facial plastic surgery, they substituted the true horizontal for the Frankfort horizontal plane, as they found that the former is a more reliable plane than the Frankfort horizontal as estimated from photographs.

### **3.3 THE PROBLEM OF LIP POSTURING AND THE RELIABILITY OF SOFT TISSUE LANDMARKS**

In the study of soft tissue profile using standardised photography or cephalometric radiographs, there is the problem of lip posturing and the reliability and reproducibility of the various soft tissue landmarks. The position of the lips is affected by a variety of variables including skeletal relationships, dental positions, soft tissue thickness as well as function. Postural variations of the lips introduce inaccuracies in the evaluation of the lip profile (Burstone 1958, 1967; Hillesund et al 1978).

Burstone (1958, 1967) conceded that the lip posture is a variant which cannot be completely standardised. Lip posture, like body posture,

is a muscle-determined position. Therefore, it cannot have the reproducibility that is associated with measurements on hard structures.

Burstone (1967) described two postural positions of the lips :

1. Relaxed lip position, is when the lips are apart and hanging loosely with no effort made at lip contraction. In this position, there is normally an interlabial gap present between the inferior surface of the upper lip and the superior surface of the lower lip. The interlabial gap varies with the length of the lips and the vertical dimension of the jaws as well as the magnitude of dental protrusion. Burstone believed that the relaxed lip position is reasonably reproducible, but, like all muscular positions is somewhat variable. Emotional states also, can strongly influence the contraction and relaxation of the muscle fibres of the lip.
2. Closed lip position, is when the lips are lightly touching in order to produce an anterior seal of the oral cavity.

Although, Burstone (1967, 1975) noted that the starting place for evaluating lip posture is the relaxed position, the patient normally does not assume this pose in his daily activity. Rather, he maintains an effective lip seal which facilitates swallowing, protects the teeth and the gingivae, and adds certain retaining forces to maintain the position of the anterior teeth. So, the postural lip position for the patient during the day is lips closed and during the night, lips apart.

Burstone (1967) observed that there is a great variation in the reproducibility of lip position in patients with dentofacial disharmonies, such as in Class II division 1 and Class III malocclusions. Furthermore, there is no definite way of testing if the patient is truly relaxing his or

her lips. Burstone also pointed out that determination of rest position of the mandible is likewise not highly reproducible or easily obtained. If lip posture is to be evaluated, he believed that the vertical dimension of the jaws should be standardised. The simplest procedure is to have the mandible elevated with the teeth together in occlusion. However, in certain conditions, such as marked overjet, in centric occlusion, the lower lip may be deflected by the maxillary incisors. In such case he recommended that the mandible should be in rest position or opened wider so that a truer representation of lower lip posture may be achieved.

Hillesund et al (1978) indicated that there is no significant difference in reproducibility whether the lips are closed or in a relaxed state. In fact, the reproducibility of the lower lip in the vertical plane is significantly better with the lips closed than with the lip relaxed in the overjet group and in normal occlusion group. They concluded that there is little reason to recommend any particular method (closed or relaxed lips) in the recording of soft tissue profile. However, if profile changes associated with orthodontic treatment are to be evaluated, it is best to record the patient in relaxed lip position, as the flattening of the lips in closed position may tend to camouflage the lip response to retraction of incisors, particularly with large overjets.

In many soft tissue profile studies, there seem to be some controversy as to how the various authors prefer their subjects to position the lips. In attempts to study the effect of orthodontic retraction of incisors on the lips, some authors (Anderson et al 1973; Oliver 1982; Holdaway 1983 a, b), took cephalograms with the lips in light contact both before and after treatment; whilst some (Bloom 1961; Hershey

1972; Rudee 1964) took the radiographs with lips relaxed; and others (Garner 1974; Roos 1974; Huggins and McBride 1975), did not specify whether or not, a standardised lip position had been used.

Wisth and Boe (1975) indicated that soft tissue landmarks may be more difficult to locate accurately than hard tissue on consecutive cephalograms of the same subject due to less well-defined anatomical structures, and variations in facial expressions. However, in their study to investigate the reliability of cephalometric soft tissue measurements, they found that the errors of landmark location are generally the same for both soft and hard tissue, but variations in facial expressions can change the vertical position of the lip sulcus. They concluded that soft tissue variables generally showed errors of method of the same magnitude as hard tissue variables. Thus, they can be used in clinical evaluations and scientific works with the same reservations as for the hard tissue variables, if cephalograms (or photographs) were taken with the jaws brought together in habitual occlusion and with lightly closed lips. This conclusion was shared by Carlson (1967) and Wisth (1972).

Tulley (1953) showed that the activity of the orbicularis oris muscle reached a minimum when the mandible is in the habitual rest position. However, Wyke (1974) and Bando et al (1972) found that this habitual rest position of the mandible is not a constant in itself. It varies in individuals all the time depending on factors such as head and body posture and emotional state of the person.

Houston (1983) believed that the term reliability should be used to encompass both validity and reproducibility. The occurrence of systematic errors and random errors were discussed. Soft tissue

cephalometric studies are particularly prone to random errors which can be induced by the way the patient poses and the lack of precision in certain anatomic definitions that may lead to difficulty in landmark identification.

The present study is basically descriptive; so the reproducibility of the lip position is not as critical. Although a natural relaxed lip position is preferred (as it reflects the true soft tissue facial features of that particular individual), there is the problem of how the public evaluates the individual with an interlabial gap. As mentioned previously, the postural lip position for the individual during the day is usually closed, and during the night, the lips are often apart.

**SECTION II :**

**ORIGINAL WORK**

## CHAPTER 4 : AIMS OF THE STUDY

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### 4. AIMS

This study investigates the profile preferences of the Chinese public and the orthodontists in Sydney, using standardised facial profile photographs of Chinese females.

This study tests the following hypotheses :

1. The profile preferences of the Chinese public living in Sydney is similar to that of the orthodontists.
2. Generally, the Chinese public prefers a straight profile with only a slight convexity in the dentoalveolar region.

A "2 x 2 factorial" design is used to evaluate the profile preferences in the 4 subgroups of judges. The factors are :

1. Race - ie. Chinese and Caucasian.
2. Profession - ie. the orthodontist and the general public.

Thus, the four groups of judges studied are as follows :

1. Chinese public,
2. Caucasian public,
3. Chinese orthodontists, and
4. Caucasian orthodontists.

## CHAPTER 5 : MATERIALS AND METHODS

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### 5.1 STANDARDISED FACIAL PROFILE PHOTOGRAPHY

Morrello et al (1977), Larrabee et al (1985) and Crawford (1987) emphasized the value of standardised facial photography to achieve consistency and make valid comparisons of patients. As stated by Burstone (1958), a standard method of subject positioning is needed; otherwise, all future methods of measurement may be meaningless.

Stoner (1955), Neger (1959), Peck and Peck (1970), Larrabee et al (1985), and Yuen and Hiranaka (1989) indicated that soft tissue analyses could be done with standardised photographs of the subjects. They described different photographic profilometric analyses to focus attention on the important structural characteristics of the aesthetically pleasing profile.

#### 5.1.1 SELECTION OF SUBJECTS FOR PHOTOGRAPHS

The criteria in selecting the sample for this study were :

1. Females between 16 to 24 years of age, of Chinese ethnic origin.
2. The absence of observable craniofacial syndromes or deformities.
3. The willingness of the subjects to participate in this study, ie. to have their facial photographs taken, and allow their

photographs to be used in the study.

A research proposal application was approved by the Human Ethical Review Committee at the University of Sydney. Informed consent was obtained from each of the subjects photographed (Appendix A - consent form).

Forty-four Chinese females volunteers who fulfilled the above criteria, were recruited from the undergraduate dental students, patients at the United Dental Hospital, and the general Chinese public. The mean age of the 44 subjects was 20.2 years old (range 16.0 to 23.9 years old). Note that a history of orthodontic treatment was not a criterion in selection.

#### **5.1.2 METHOD USED FOR STANDARDISED FACIAL PHOTOGRAPHY**

All photographs for the study were taken by the author. A Canon T70 camera equipped with a FD 105 mm f/2.8 lens and flash was screw-mounted on a removable bracket/platform built to sit in front of the X-ray source housing of the old, existing Bjork cephalometric X-ray machine. The cephalometric machine was used as it allowed easy height adjustments of the camera to the varying heights of the standing subjects. The head-holding cephalostat was dismantled for the photography.

To allow consistent lighting of the subject, all the blinds in the room were pulled down and only the ceiling fluorescent lights were switched on. A sheet of black velvet cloth was used as the background for the

photograph, as this best absorbed the light from the flash, and gave minimal background shadow of the subject.

A pre-set lens distance of 1.2 m was used, and the rest of the camera settings were placed on automatic. As the camera was set against the X-ray source housing, the view-finder of the camera could not be used. Thus, the photographs were taken when a metre ruler, aligned from the subject's infraorbital region to the centre of the camera lens, was judged to be parallel to the floor.

A 5 cm reference ruler was attached vertically to a plumbline suspended from one of the screw mountings for the detached head-holding cephalostat. Hence, the true vertical was derived from the free position taken by the weighted plumbline.

To minimize variability in skin tone and colour, black and white photographs, using Ilford FP4 35 mm film, were taken. The subjects were asked to tie their hair back, so that hairstyles would not influence appearance.

The following procedures were used, to standardise the profile photographs :

1. The camera position was screw-mounted and fixed on a removable platform built in front of the X-ray source housing of the old cephalometric machine.
2. The subjects stood, positioning their feet equidistant on either side of Line A marked on the floor. The front of their shoes touched Line B, marked perpendicular to Line A. This ensured standardisation of the distance from the camera to the mid-

sagittal plane of the subject.

3. The subject's head position was standardised using the natural head position technique. This allows reproducible head position results, without the need of a head-holding apparatus, which would interfere with the visualization of the face (Larrabee et al 1985). The subjects were instructed to stand at ease, relax their jaw, and look into their own eyes reflected in a vertical mirror located 1 metre away.
4. The lip posture was standardised by asking the subjects to relax their lips, swallow and then keep their lips in that position while the photograph was taken. Thus, the lips were lightly touching together, with nil to minimal strain.

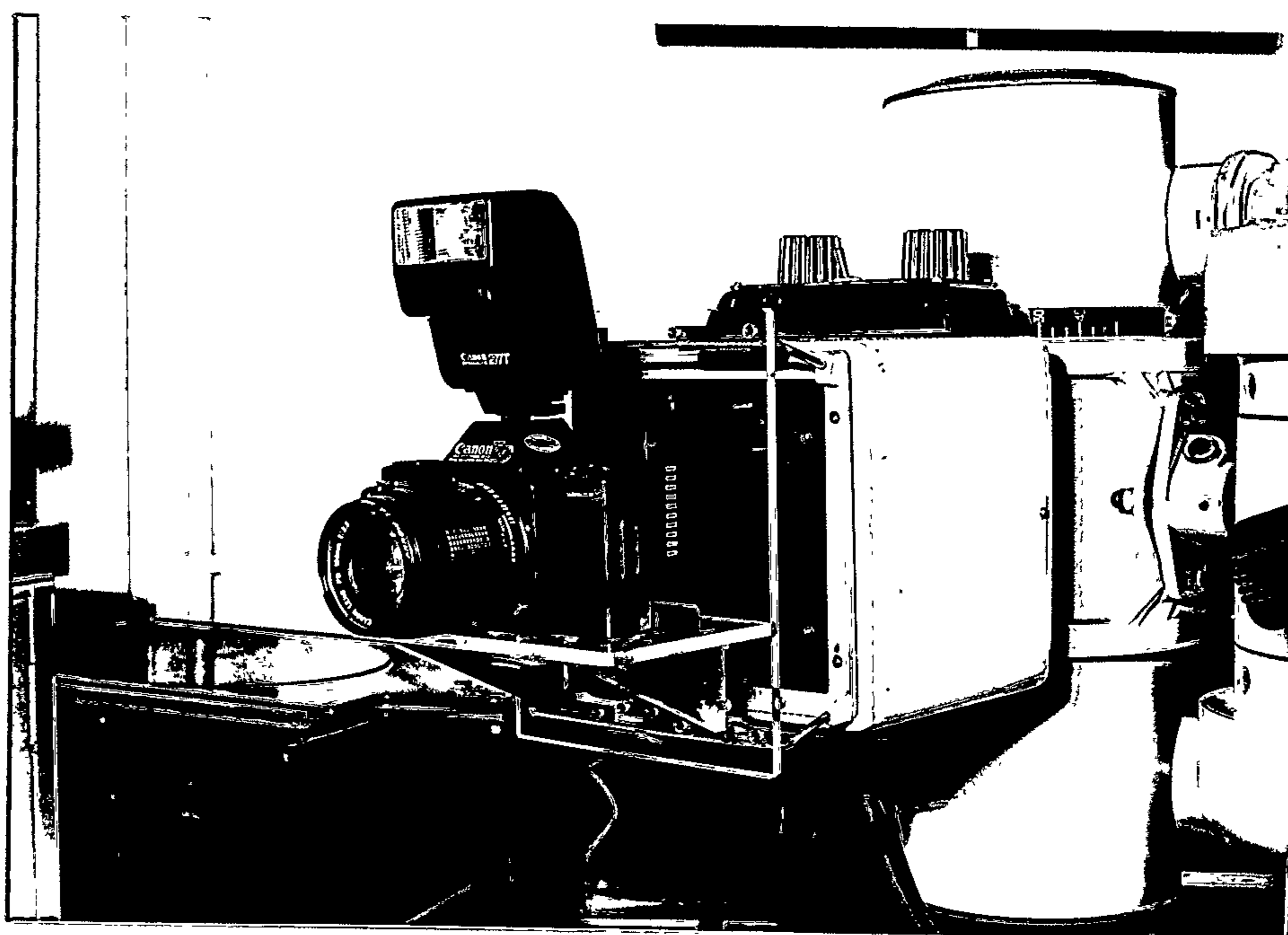


Fig 5.1 Camera mounted on the platform in front of the x-ray source of the cephalometric machine.

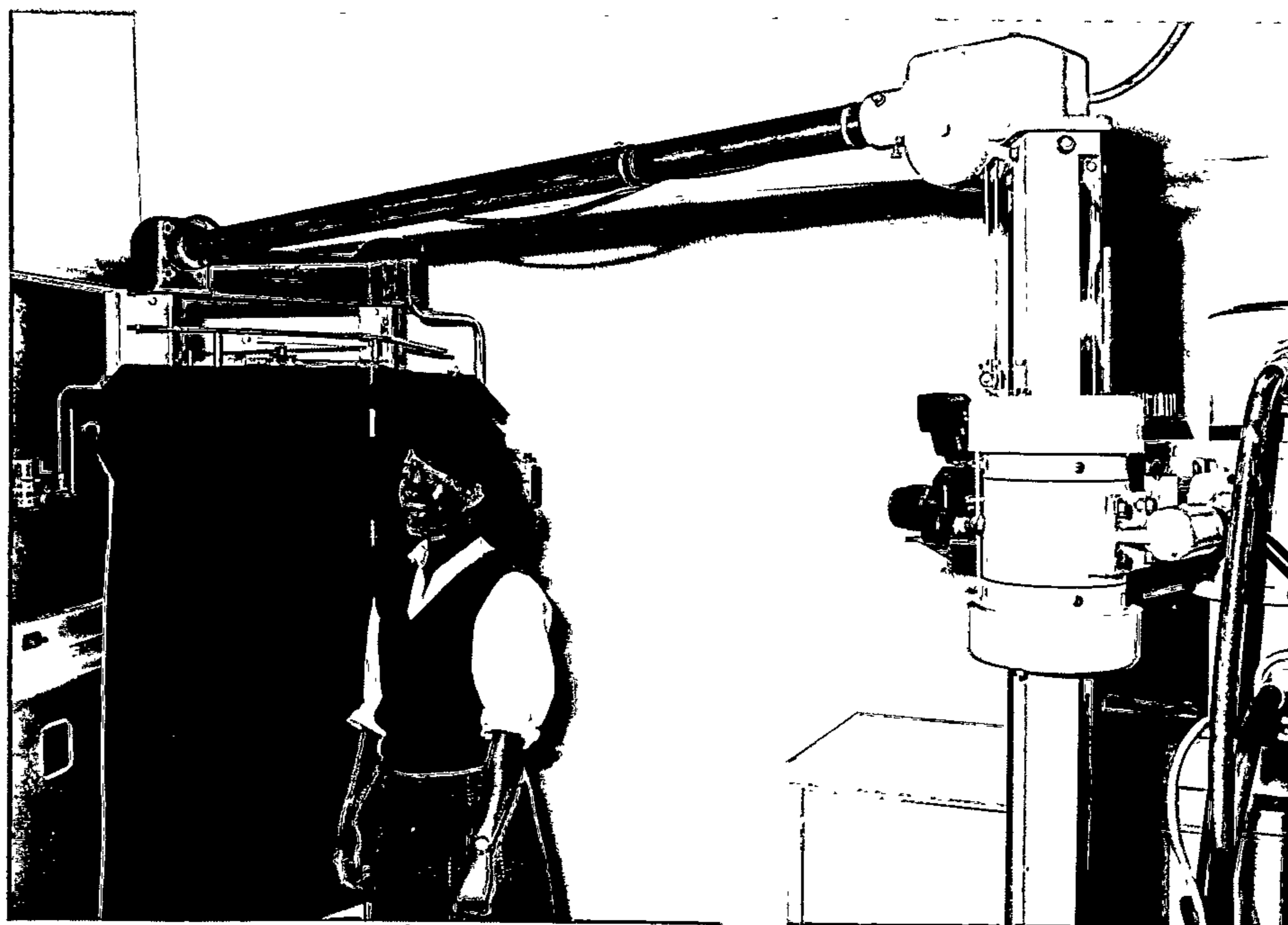


Fig 5.2 Set-up used for standardised photography.



Fig 5.3 An example of the photographs taken.