A CHALLENGE TO CLASSICAL FACIAL PROPORTIONALITY STUDIES: CONVENTIONAL PROFILE & 3D PHOTOGRAPHY VERSUS SILHOUETTES

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A CHALLENGE TO CLASSICAL FACIAL PROPORTIONALITY STUDIES:

CONVENTIONAL PROFILE & 3D PHOTOGRAPHY VERSUS SILHOUETTES

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DEDICATION

"Work Smart, Try Hard, Never Quit," was the words my father spoke to me with every challenge in life. I dedicate my thesis to him who inspired me to follow in his footsteps in dentistry and the Navy. To my Uncle RE, a retired Coast Guard Captain who was always able to help me be clear in my thoughts; my mother and Aunt Barbara who offered continual support in my pursuit of higher education. Finally, to my pageant directors, Texas moms, and every woman in the pageant world with whom I have had the pleasure to work, thank you for the camaraderie and encouragement to provide me an avenue of combining my two passions, orthodontics and beauty.

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I would like to thank Dr. Curtis Marsh, who encouraged, supported and mentored me with the evolution of my research project. To Dr. Carroll-Ann Trotman, thank you for your expertise in three-dimensional analysis. Lastly, thank you Dr. Brent Callegari for keeping me focused on the finish line.

ABSTRACT

The purpose of this study was to evaluate the perception of facial attractiveness presented in a silhouette, profile photograph and in a 3-dimensional photograph to see if there is a correlation of perceived attractiveness between oral surgeons, orthodontists, and lay people. Secondly, if there is an agreement of attractiveness when examining the same subject in silhouette and in photographs, then determine if the subject falls within the ideal norms of facial proportions and soft tissue esthetics used by orthodontists and oral surgeons alike. It was hypothesized that the evaluators' perceptions of facial attractiveness when evaluating silhouettes is not closely tied to perceived beauty when looking at facial profile photographs or at three dimensional photographs. The methods involved first identifying female subjects ages 18-35 years of Caucasian or Hispanic descent from beauty pageants. After consents were signed, each subject had their profile photograph and 3-dimensional image made. Next, the photographs were used to fabricate silhouettes for a timed photographic slideshow. Then the evaluators (five oral surgeons, five orthodontists, and five laypersons) evaluated the silhouettes based on attractiveness using a visual analog scale as seen in classical studies. Each silhouette was displayed for 10 seconds and rated on a visual analog scale from 1 to 10. Two weeks later, the same evaluators were shown the same group of women's profile photographs for 10 seconds and rated them again on a visual analog scale. Two weeks thereafter this procedure was repeated with a 3-dimensional image that rotated 180 degrees for 15 seconds. Again they rated the entire 3-dimensional photograph for level of attractiveness using a visual analog scale. All slides were randomly sorted and the evaluators did not know the ages, pageant history,

or even if they were looking at the same persons. The results found that among the evaluator groups, the orthodontists and the laypeople had similar mean scores when compared to each other in all three viewings. The oral surgeons' scores were significantly lower in all three viewings, however increased notably in the last viewing of the 3dMD^{TM} images. A linear regression analysis was done to confirm that facial convexity, orthodontic treatment with and without extractions affected the perception of facial attractiveness. The subjects who fell outside the cephalometric norms were perceived to be less attractive than those who fell within them. In addition, the ANOVA found that when the viewings of silhouette, profile picture and 3dMD^{TM} image were compared to the evaluator groups as a whole, all proved to be statistically significant. Therefore, results confirm the hypothesis that evaluators' perceptions of facial attractiveness when evaluating silhouettes is not closely tied to perceived beauty when looking at profile photographs or three dimensional images. However, when comparing groups of evaluators, orthodontists and laypeople's perception of attractiveness was similar when comparing silhouettes, profile pictures and 3dMD^{TM} images but was considerably different when compared to oral surgeons. Incorporating 3dMD^{TM} imaging with patient records will provide additional information that will assist clinicians in diagnosis and treatment planning.

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I. BACKGROUND AND LITERATURE REVIEW

A. Introduction & Background

Cleopatra, Mona Lisa, Aphrodite de Milos, and Marilyn Monroe all represented beautiful female faces of their time and demonstrated that the perceptions of beauty are constantly changing. The Neoclassicism of beauty has evolved throughout the ages from the Egyptians' Old Kingdom to the Golden Age of the Greeks. The documentation of beauty by the Romans and several hundred years later, the influence of the artists of the Renaissance have evolved the concept of beauty to be a balance of facial proportions and harmony (Peck and Peck 1970, Farkas et al. 1985). For example, the Greeks preferred a more flattened and retrusive profile, while today many societies favor a convex and fuller profile with protrusive lips (Peck and Peck 1970). The standards of beauty vary tremendously among persons, racial groups, and according to one's socioeconomic status. That is, culture, society, income, age, and race all play a part in determining beauty. Facial attractiveness is important to human interaction. Beauty can have power in social settings and can be a positive influence in all areas of civilized society (Pancherz et al. 2010).

Orthodontists have a unique and important role in changing soft tissues and facial proportions of the face thereby changing one's perceived appearance from unattractive to attractive (Nanda and Ghosh 1995). There have been numerous studies evaluating children's soft tissue and facial proportions through adolescence, but little data is available on adults (Nanda and Ghosh 1995, Farkas et al. 1992). Presently, with increasing number of adults seeking orthodontic therapy, many whom received

orthodontic treatment as children, there is a need to get more data on how adults' facial and soft tissues mature and age through the years to enhance future appearance with today's treatment.

The face attracts the most attention to a person because it is the most variable part of the body (Farkas and Kolar 1987). Variability reveals different sizes, shapes, and proportions and how each feature on the face can interact with each other. Previous studies noted that esthetics can be made scientific (Rickets 1982). There are divine proportions that can be applied to faces which are a major contributor to orthodontists achieving their goals. These divine proportions when compared to facial proportions in both sexes remain constant during growth (Ferring and Pancherz 2008). Can we hypothesize that facial beauty can be measured especially among a vast range of ages? Is beauty timeless?

Photographs show a two dimensional documentation of the face but lack depth. Current research with 3-dimensional technology demonstrates that including this depth provides a clearer picture of a person's facial and soft tissue proportions and provides better data to reveal facial changes (Edler et al. 2010, Gross, et al. 1996, Trotman et al. 1996).

The subject of facial esthetics, particularly providing harmony and balance in facial proportions is important in orthodontics. Equality of facial thirds (trichion to glabella, glabella to subnasale and subnasale to menton) from the profile view and frontal view are part of the orthodontic facial norms assessed for facial balance by orthodontists and oral surgeons alike. Can one study a segment of the population that

has been acclaimed previously as possessing these qualities of facial esthetics to see if this holds true?

Perception of beauty has always been subjective; thus the phrase, “beauty is in the eye of the beholder.” Finding objective data in what makes a person beautiful is difficult at best. One of the objectives of orthodontic treatment is to establish ideal occlusion within a well-balanced, proportional face that is esthetically pleasing. There are many cephalometric and anthropometric measures for evaluating the soft tissue profile noted in the literature (Farkas et al 1985, Ricketts 1982, Reidel 1957). Some of these measures are based on scientific normative data; others are subjective estimates such as measures of golden proportions. These values are a way to attempt to measure ideals and can serve as a guide to quantifying facial balance in diagnosis and treatment planning.

B. Facial Esthetics Derived from Beauty Pageant Contestants

The perception of modern concepts of facial esthetics as viewed by the general public has always been questioned in orthodontics. In 1955 Dr. Reidel challenged this perception by utilizing thirty beauty pageant contestants from the Seattle Seafair Week. Each pageant contestant was photographed, x-rayed, and a brief history and oral exam was performed. Tracings were made from their lateral head films. Eleven angular measurements, five linear measurements, and four soft tissue thickness measurements were made on each head film. For orthodontists in 1955, the ideas of facial esthetics were based on works of art, a mental image of a stable occlusion under the soft tissue drape, and personal concepts of proportionality. The women for this study had various malocclusions (majority were Class I) and only four had received prior orthodontic therapy. The Seattle Seafair group had the same skeletal characteristics as persons selected on the basis of normal occlusion only, with a slight protrusiveness of the maxillary denture base. The mandibular incisors from the Seafair group were five degrees more proclined than established norms and the maxillary incisors were slightly more upright. These were compensatory differences secondary to a protrusive maxillary denture base. The millimetric measurements supported the findings of the angular measurements. A large degree of variation existed in the soft tissue thickness; of note was the fact that the two women who showed lip strain had lip thicknesses less than 9mm. On 14 tracings, the chin and lips fell on one plane (see figure 1). Measurements of the winner of the contest all fell within accepted norms. Dr. Reidel concluded that the skeletal patterns of the girls were within normal ranges and the dental pattern showed compensatory inclinations of the maxillary and mandibular

incisors. In addition it was concluded that the public's concept of acceptable facial esthetics was in good agreement with the standards established by orthodontists on the basis of normal occlusion, (see figure 2).

Figure 1: Upper lip, lower lip and chin fell along the same plane (Reidel 1957).

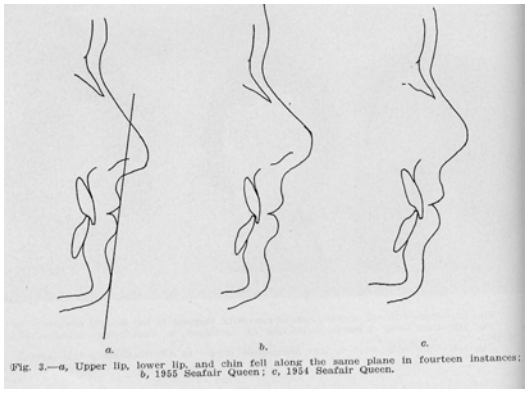


Fig. 3.—*a*, Upper lip, lower lip, and chin fell along the same plane in fourteen instances; *b*, 1955 Seafair Queen; *c*, 1954 Seafair Queen.

Figure 2: Past Winners of Seattle Seafair Pageant (Reidel 1957).

Fig. 3A.
Fig. 3B.
Fig. 3C.
Fig. 3A.—Upper lip, lower lip, and chin fell along the same plane in fourteen instances.
Fig. 3B.—1955 Seafair Queen.
Fig. 3C.—1954 Seafair Queen.

However, the perception of beauty and the idea of what is beautiful have evolved through the ages to modern day. Philosophers would discuss that any beautiful creation would have certain geometric symmetries that would harmonize into an attractive face. Since harmony was due to an observance of proportions, it would seem reasonable to assume these proportions were fixed quantities. To study the effect of facial esthetics using cephalometric analysis, Peck and Peck conducted a study with a sample of 52 young adults that consisted of professional models, beauty contest winners and performing stars noted for facial attractiveness. They took cephalometric x-rays and photos and evaluated them with 11 points. They found that the majority of the sample fell within the pre-established standards. Many, however, exhibited a fuller, protrusive dentofacial pattern, more full than what the standards would permit (Peck and Peck 1970). Not only did they evaluate the adults radiographically, but also from frontal and profile photographs, which revealed there can be asymmetries in soft tissue noted in one view and not the other. This emphasizes the importance of evaluating patients from multiple views because the degree of asymmetry can serve to characterize an esthetically pleasing face. Facial harmony is subjectively defined as the orderly and pleasing arrangement of the facial parts in profile (see figure 3), while facial orientation is the relation of the facial profile elements to the head. Lastly, facial proportion is defined as the comparative relation of facial profile elements to the head; all three play a role in determining the attractiveness of an image. They concluded in their study that the general public prefers a fuller, protrusive dentofacial pattern that is outside the norms used in orthodontic cephalometric analyses. This challenges the way orthodontists and oral surgeons evaluate the face and underlying skeleton in their

diagnosis and treatment planning of their patients. As seen in figure 4 with the composite photographs of Miss Massachusetts 1961, 1962 and 1963, facial esthetics can tolerate a degree of soft tissue asymmetry. Understanding how this can serve to characterize and individualize an esthetic pleasing face is vital to diagnosis and treatment. By placing more emphasis on the soft tissues of the profile and heightening esthetic awareness of the face by the patient, clinicians need to go outside the norms to develop a realistic concept on what can be accomplished for their patients on an individual case-by-case basis.

Figure 3: Diagrammatic Profile Landmarks, Harmonious Profile Flow, Facial Harmony (Peck and Peck 1970).

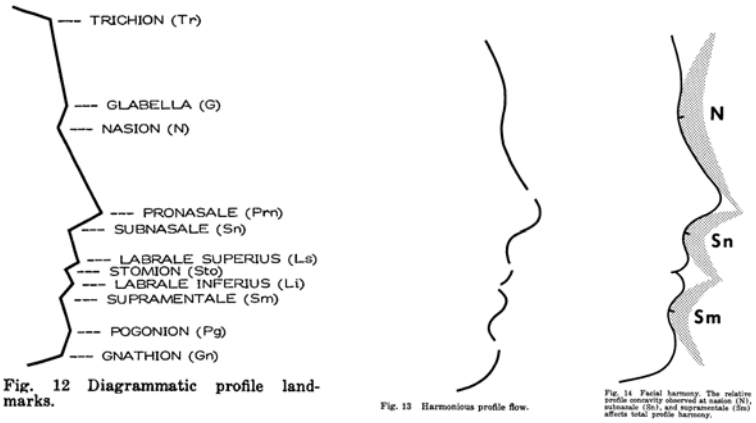
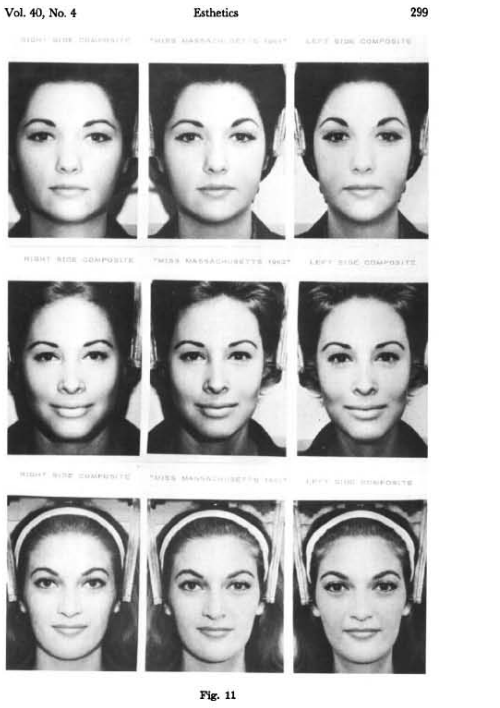


Fig. 12 Diagrammatic profile landmarks.

Fig. 13 Harmonious profile flow.

Fig. 14 Facial harmony. The relative profile concavity observed at nasion (N), subnasale (Sn), and supramentale (Sm) affects total profile harmony.

Figure 4: Right and Left side Composite Photos of Miss Massachusetts 1961, 1962, 1963 (Peck and Peck 1970).



Now, 30 years later, Dr. Sarver noted in his book that “any analysis based on cephalometric or facial normative values has one inherent weakness that is beauty is not the norm (Sarver 1988).” In addition, he acknowledges Dr. Farkas who has the most comprehensive recent studies of facial proportions which have extensive cross-sectional facial measurements from Canadians and Northern Europeans. The proportional relationship of the height and width is more important than absolute values in establishing the overall facial type (see figure 5). The ideal face can be divided vertically into equal thirds adjacent to hairline, nasal base and menton (see figure 6). Arnett and Bergman (1993) cite thirds to be between 55-65mm. Ideal nasal width should be approximately 70% of nasal height. The rule of fifths describes the ideal

transverse relationships of the face. The face is divided sagitally into five equal parts from helix to helix of the ears. Each of the segments should be approximately one eye distance in width. Normative values for eyes are the following: interpupillary width 65mm, intercanthal width 35mm, and outercanthal width 9.8cm. Facial esthetics have been of great interest to orthodontists in the years since Angle, Hellman, Case and Farkas. Many opinions of what constitutes an attractive face have come from various sources and have been more than adequately covered in the orthodontic literature. For example, there are variations of the general profile inclination in the most attractive faces (see figure 7). Nonetheless, there's still a lack of emphasis on how this correlates to the general public's opinion on what is attractive. As previous noted as the perception of beauty evolves through time so is a need for a current study to evaluate facial attractiveness.

Figure 5: Ethnic Variations in Craniofacial Morphology (Farkas and Kolar 1987).

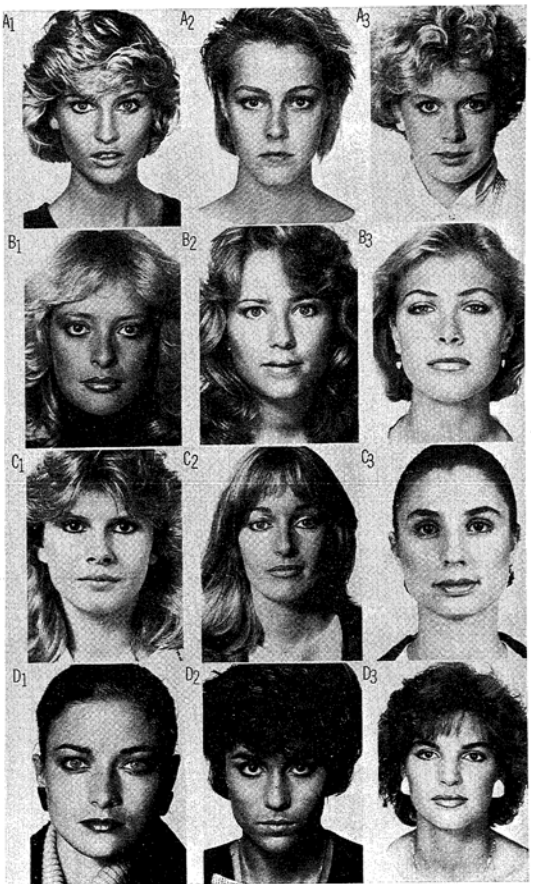


Figure 3. Ethnic variations in craniofacial morphology found in attractive faces. *A*, Anglo-Saxon faces. *B*, Germanic faces. *C*, Slavic faces. *D*, Latin faces. A_1, B_1, C_1, and D_1 are the slides that were awarded the highest scores among the frontal views in their respective ethnic subgroups.

Figure 6: Profile Proportions (Farkas et al 1984).

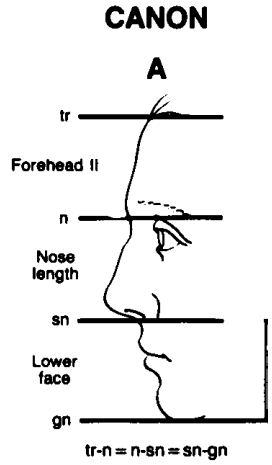


Figure 7: Variations of the General Profile Inclination in the Most Attractive Face (Farkas and Kolar 1987).

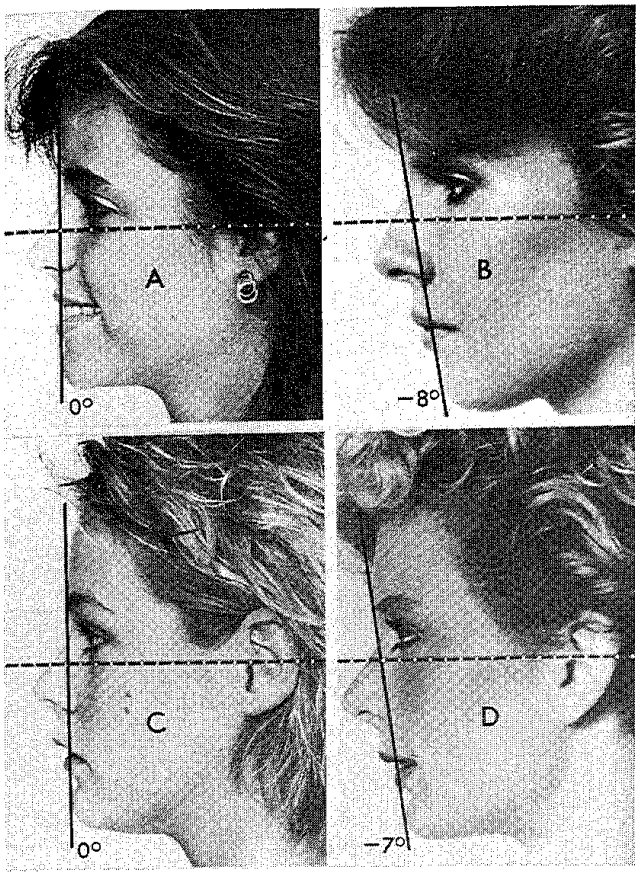


Figure 10. Variations of the general profile line inclination in the most attractive faces (*A* and *B*) and in the faces of the attractive group (*C* and *D*). The general profile line connects the glabella and the most protruded point of the chin (pogonion). The inclination of this line from the vertical is determined when the head is oriented in the Frankfurt horizontal.

C. Three Dimensional Analysis

The subject of facial esthetics is a subject not just limited to the dental specialties of orthodontics and oral and maxillofacial surgery, but one which interests a multitude of professions. Most often the general public will evaluate facial attractiveness from a frontal photo while orthodontists will do the same but with a profile picture instead. Drs. Proffit and Sarver discuss the special considerations in diagnosis and treatment planning to improve dental and facial esthetics. This includes an evaluation of the frontal and vertical facial relationships, the rule of fifths discussed earlier, and an evaluation of the smile (Graber 2005). In the past, orthodontists and oral surgeons have used a two-dimensional (2D) profile picture and cephalometric tracing to help patients understand what can be accomplished since this was the standard of care. However, with the technological advancement of three-dimensional (3D) imaging, computers allow practitioners to predict treatment changes utilizing the patient's pretreatment images. Now clinicians can truly show patients what will result with treatment and in the future this will become the new standard of care (Graber 2005).

In the mid 1990's three-dimensional (3D) analyses became a growing area of research as the technology became available. The 3D imaging methods have been used to study facial asymmetry in stereophotogrammetry, video and laser scanning. In relating this to the face and the study of orthodontics, Drs. Gross, Trotman and Moffat compared the amplitude of facial motion using 3D and 2D imaging with facial landmarks during five maximal facial animations (smile, lip purse, grimace, eye closure and cheek puff) in four subjects and found more amplitude in 3D versus 2D analysis. Next, in a follow up study they did a case report where they tested the reliability of a 3D video

imaging method for measuring facial function by means of a set of repeated facial animations. Here, they found the 3D video cameras exhibited excellent reliability in amplitude of motion for the landmarks over all animations in comparison to three 60Hz video cameras (Gross et al. 1996). The avenue of taking records both in 3D and 2D can provide more diagnostic information for the clinician in formulating a treatment plan. In addition the various dimensions of 3D imaging can indicate how facial proportions and features can be emphasized or deemphasized to improving overall facial esthetics.

Whether clinicians and the general public prefer viewing 2D or 3D images when evaluating facial relationships, a thorough investigation must be done. A person's face and the format in which it is presented can have profound social significance. Todd et al. investigated whether the preferred facial relationship chosen by orthodontists, maxillofacial surgeons and the general public is Class I and whether 2D or 3D images had any effect on ranking facial attractiveness (2005). Orthodontists, oral surgeons and the general public assessed 2D and 3D facial scans of two males and two females that had been morphed to produce five images that produced various skeletal patterns. Each evaluator ranked the images in order of preference after seeing them in 2D and 3D formats. In 2D the clinicians preferred the Class I facial image more frequently than the general public. Conversely, in the 3D format, the general public chose Class I as their preferred image more often than the clinicians. Results showed no consistency between the findings for 2D and 3D images between the two groups of evaluators and there was too great a degree of variation to say that a difference between 2D and 3D facial images was evident (Todd, et al. 2005). Clearly, orthodontists and oral surgeons play a deciding role in the determining the patient's facial esthetics, however the

patient's perception of their own face must be taken into account before treatment planning. With no consistent findings and large variations in both professionals' and lay persons' opinions, it reminds us that beauty and facial attractiveness is still a complex and subjective measurement that requires more research.

D. Soft Tissue Paradigm

For over 100 years, orthodontic therapy has been largely practiced based on Angle's ideas of the perfect occlusion. If the teeth are arranged on a smooth curve of occlusion and a Class I molar relationship exists, then normal occlusion would result (Proffit 2007). Angle emphasized that you could create the ideal face by fitting in all the teeth. However the emphasis on having excellent occlusion meant that facial esthetics had to be sacrificed. The idea of natural dentition stating teeth must fit together regardless of how this affects the face has evolved much like the perception of beauty in facial proportions and esthetics. In the late 20th century, orthodontists started to place more importance on facial esthetics than dental occlusion. This was due to several factors, first the patients had a greater awareness of their facial appearance and pursued treatment that would improve their overall facial esthetics. Second, patients expected a greater degree of involvement in planning treatment, the arrival of orthognathic surgery made it possible to correct facial proportions that were otherwise not treatable. Third, the development of computer imaging provided a visual guide for orthodontists to show effects of treatment on facial appearance. Lastly there was an increased in multidisciplinary treatment with other healthcare specialists (Proffit 2007). This resulted into a new direction where the soft tissues in the face serve as the guide to achieving perfect harmony and balance. This paradigm shift was revolutionary in that treatment and diagnostic information gathered needs to encompass these thoughts and the esthetic awareness with which patients present. During the first century of orthodontics the ideal dental occlusion was the only goal regardless of how treatment affected the face. With the more current focus on facial esthetics, soft tissues now

largely determine the orthodontic treatment. Hence in the 21st century, orthodontists have evolved their philosophy of placing dental and facial esthetics their focus in treatment planning. The Soft Tissue Paradigm has brought a new focus, where ideal occlusion is the exception and esthetics is the rule (Ackerman et al. 1999). Soft tissues determine the limitations of orthodontic treatment, from the perspective of function and stability and limitations in a patient's own face. This paradigm shift brought an explosion of new ideas and information which advanced the field of orthodontics.

Traditionally, orthodontics could only change the position of teeth and affect the position and posture of the lips. With recent advances in orthognathic surgery, the orthodontist can now affect the balance of the nose, lip, chin and surrounding soft tissues. Drs. Nanda and Ghosh believe that the quality of facial esthetics benefit from harmonized dental and skeletal relationships but it is not entirely dependent on them (1995). Recognizing that the orthodontic specialty went too far with its obsession of placing teeth at certain angulations to the basal bone and its potential deleterious effects on facial esthetics drove the need for research to find a balanced facial profile. They developed a series of facial profiles based on an original ideal constructed profile for evaluation by members of the dental profession. Profiles were presented as black silhouettes to avoid the effect of distractors. Nose, lips, chin, the angle of facial convexity, and the facial angle were all varied and evaluated by 545 dental professionals. According to the study, an ideal balanced facial profile is straight in males, but convex in females. More lip protrusion was acceptable when a larger nose or chin was present in either males or females (Czarnecki et al.1993). Evaluation of facial esthetics is subjective, because balance and harmony of facial components do

not necessarily mean an attractive face. It is now common to hear that treatment goals should be geared to the achievement of an overall facial balance as well as to acknowledge how distractors, such as a large nose or retrusive chin, can affect the overall facial beauty of an individual's face. An evaluator's ideal concepts of beauty can differ based not only on race and sex, but also from when they evaluate one individual to the next depending on the balance and harmony they see within the patients' facial proportions. In their study, Czarnecki et al. refocused orthodontists on the consideration of harmonized facial structures as a primary goal of treatment (1993).

Translating these new thoughts of having the soft tissue as a foundation to orthodontic diagnosis and treatment planning plays a new twist in how orthodontists, oral surgeons and society view facial attractiveness (Arnett and Bergman 1993). "A person's ability to recognize a beautiful face is innate, but translating this into defined treatment goals is problematic. Recognizing beauty is neither practiced nor is it difficult but the perception of beauty is an individual's preference with culture bias (Arnett and Bergman 1993)." Some orthodontists believe that occlusion and facial beauty are interdependent. This study looked at key landmarks relevant to optional orthodontic and surgical orthodontic treatment. They further discussed that when the normal values for height to width of 1.3:1 for females and 1.35:1 for males (established by Farkas, see figure 8) are taken into consideration, corrections of asymmetries within the facial thirds can be achieved and harmony can be restored to the face (Arnett and Bergman 1993).

Figure 8: Facial One Thirds (Arnett and Bergman 1993).

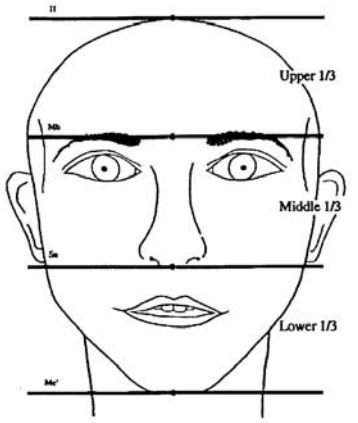


Fig. 6. Face is divided into thirds by drawing lines through hairline *(H)*, midbrow *(Mb)*, subnasale *(Sn)*, and soft tissue menton *(Me')*.

Today, the effect of teeth on facial esthetics has become the primary objective of orthodontic treatment. Changes in the dentition affect the soft tissue which in turn affects the patient's overall facial proportions. Drs. Dickens, Sarver, and Proffit observed the treatment results on over 1367 individuals who received orthodontic treatment and evaluated facial soft tissue measurements; including philtrum height, commissure height, maxillary incisor display at rest and smile, the amount of gingival display on smile, and incisor crown height. Patients ranged from 7 to 40 years of age. They found the length of the philtrum is short initially and then increases faster than commissure height at adolescence. Maximum display of maxillary incisor is at age 11 for females and age 12 for males (2002). Post adolescence, incisor display at rest and smile, gingival display on smile, and lip separation at rest all decrease. Orthodontic profiles flatten over time, while facial and soft tissue dimensions increase vertically and horizontally over time. As one might expect, there are variations in dimensions and

proportions within all age groups evaluated. Modern orthodontics has shifted its focus on soft tissue profile, placing a greater emphasis on how treatment can affect facial proportions over time. Orthodontists are often the first healthcare providers to diagnose and treat esthetic problems in growing children and monitor these children through their childhood years, adolescence and adulthood. Hence their role becomes crucial in planning for maturational and aging changes of the soft tissues of the face that occur long term. With the increasing number of adult patients pursuing orthodontic treatment, there is a greater need than ever for orthodontists, oral surgeons, and these patients to collaborate on diagnosing and treatment planning decisions, especially in forecasting which treatment will produce the best long term results in facial appearance.

E. Divine Proportions

In 1982 Dr. Ricketts presented a study that soundly suggested facial esthetics can be made scientific by utilizing the geometrical ratio of 1.618, often associated with the rule of golden proportions. He found that the Fibonacci numbers express the same ratio and applied them to ten photographs in frontal view of Caucasian people from magazines. Eight of ten photos possessed this ratio and he confirmed that one can mathematically define beauty through what he termed the Divine Proportion (Ricketts 1982). Also known as the golden section, golden ratio, golden mean or golden cut, the proportions are the most appealing to the human eye, and are symmetrical using Phi (1.618). In his follow up study, *Divine Proportions in Facial Esthetics,* he continued to look at dozens of photographs, and found that from trichion (top of face or hairline), to menton (inferior border of soft tissue chin) represented the total face. The eye at the lateral cantus in relation to the total face was found to be in a proportion of 1.618, hence the location of the golden ratio. In addition to the location of the eye, the ala of the nose and mouth are all areas of the face that are in the golden ratio when compared individually, to the total face height. According to Dr. Ricketts the Divine Proportion aids in finding where the patient's esthetic fault lies and can be used as a tool to lead to better treatment outcomes especially in surgical cases.

The scientific value of Rickett's study is questionable, therefore is possible that his theory of Divine Proportions apply to societies' views of attractiveness thirty years later? Drs. Pancherz, Knapp, Erbe, and Heiss tested Rickett's hypothesis that facial beauty is measureable by comparing attractive and non-attractive faces of females and males with respect to Divine Proportions (2010). Their study analyzed the frontal view

of facial photos of 90 cover models from fashion magazines and 34 non-attractive persons from a group of former orthodontic patients (see figure 9). Utilizing Rickett's method, five transverse and seven vertical facial reference distances were measured and compared with corresponding calculated divine values (π=1.618). It was noted that the attractive individuals had facial proportions closer to the divine values than non-attractive ones, thus implying that Rickett's hypothesis that facial beauty is measurable to some extent.

Figure 9: Reference Distances in the Transverse and Vertical Plane (Pancherz et al. 2010).

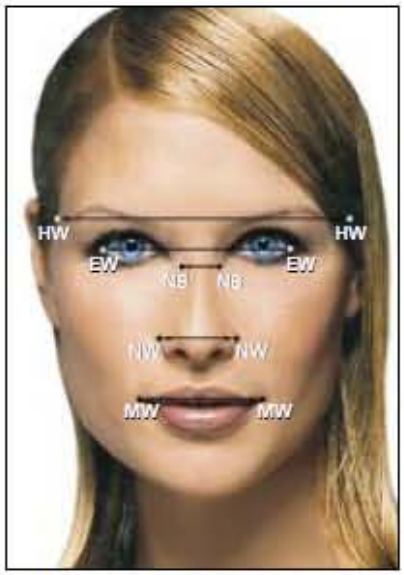


Fig 3 Reference distances in the transverse plane. NW-NW = nose width (base value), NB-NB = nose bridge width, MW-MW = mouth width, EW-EW = eye width, HW-HW = head width.

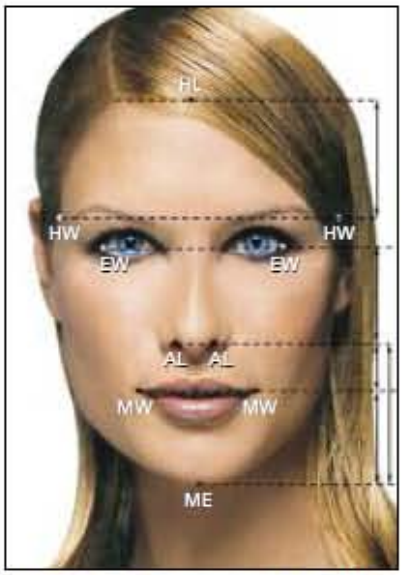


Fig 4 Reference distances in the vertical plane. AL-MW = nose-lip distance (base value), EW-AL = nose height, MW-ME = chin height, HL-HW = forehead height, AL-ME = lower face height, EW-MW = upper face height, EW-ME = total face height.

Facial beauty can imply success, and esthetics within a face do not depend on any single feature, but are viewed as a whole entity that contributes to overall

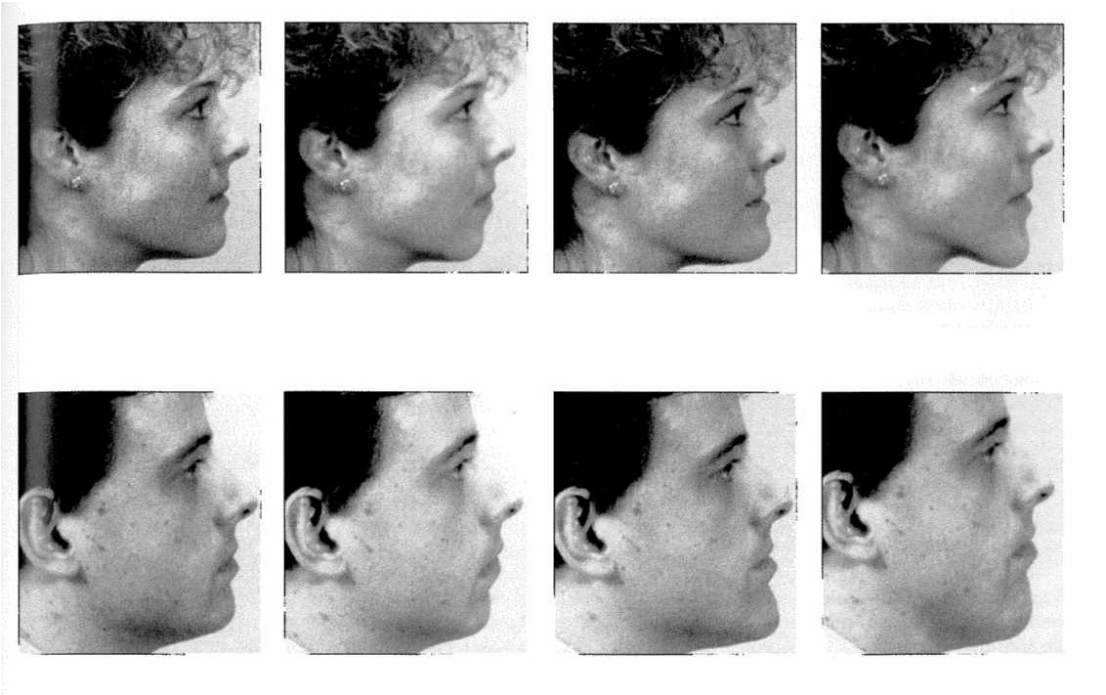
attractiveness. The divine proportion is said to have a unique quality in facial balance, harmony and beauty, yet the assessment of facial attractiveness is much more complex. It should be kept in mind that the divine proportions are not absolute determinants of facial attractiveness since it is quite possible that other methods of evaluation would lead to an equally favorable outcome. Individual esthetic character of facial features, not just their proportions, can significantly influence the assessment of facial beauty and attractiveness (Pancherz et al. 2010).

F. Classical Profile Studies

As noted in Divine Proportions, there is variation in the most natural faces, when observing from the lateral (profile) view as opposed to the frontal view. This is because everyday people generally perceive each other from the front and not from the side. That is, the general population evaluates the attractiveness of another face from the frontal and not the lateral view. This view is the most critical for the evaluation of another's individual's attractiveness. Yet the lateral view gives depth to the face and helps give each face its particular individuality. As noted in the introduction, the human face is highly variable and complex. A set of lines and angles cannot adequately define an esthetically pleasing face. To further assess attractiveness, Lundstrom et al., used panels of evaluators that consisted of four orthodontists, eight orthodontic residents, four artists and four lay people to assess frontal and profile views of untreated subjects from a profile photograph only (1987). Each photograph was rated from very good looking (1) to very disharmonious (5). All photos were evaluated twice, with a one week interval between the two evaluations, to measure the degree of consistency. Different panels of assessors showed good agreement in ranking profiles into five categories ranging from very good looking to very disharmonious. These authors found that patients who had average or horizontal growth patterns had more pleasing facial esthetics (Lundstrom et al. 1987). A horizontal growth pattern would indicate that the posterior face height increased relative to anterior face height resulting in a forward growth evident as a straight or concave facial profile.

Likewise, Cochrane et al. used black and white photos of four adult Caucasian patients (two male, two female) for profile assessments by groups of orthodontists, maxillofacial surgeons, dental students, and lay people (1997). All photographs were manipulated with Adobe® Photoshop to produce Class II, Class III and long face profiles for a total of forty patients. A series of four photographs were shown to 40 orthodontists and 40 lay people (see figure 10). Each assessor was asked to rank each series in order of most pleasing facial profile to least pleasing facial profile. They found that the orthodontists preferred profile was Class I, 40 times more versus the lay person. Laypersons noted the Class III or long face profile was their preferred choice. The Class II profile was chosen most often as the least attractive by both groups (Cochrane et al. 1997). A Class I or straight profile is when a line drawn from the forehead to the chin forms 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). A convex profile therefore indicates a skeletal Class II jaw relationship, whereas a concave profile indicates a skeletal Class III jaw relationship. The study showed that orthodontists prefer a Class I profile, more so than laypeople, and that there is variation among orthodontists and non-orthodontists when considering what is the most attractive profile. What people find less attractive is just as important as what they find most attractive. It is crucial in treatment planning to ascertain what the patient's expectations are.

Figure 10: Series of 4 profiles of Subject 1 and Subject 3 (Cochrane et al. 1997).



Orthodontists and oral surgeons most often plan their treatment to produce an ideal Class I occlusion and skeletal relationship. Cochrane et al. investigated to see if orthodontists, oral surgeons, dental students and laypersons preferred a facial profile that had been conformed to a Class I profile (1999). Photographs of two male and two female adult subjects with Class 1 profiles were taken and then manipulated via a computer program into Class II, Class III and long face profiles. Each participant group ranked each group of four photos in order of their attractiveness. Evaluating only black and white photos, 40 orthodontists, 38 surgeons, 40 fourth-year dental students, and 40 members of the general public ranked them. Both orthodontists and oral surgeons chose a skeletal Class I relationship as the most attractive. There were differences between orthodontists and the fourth-year dental students as well as between orthodontists and evaluators from the general public. There were differences also

based on the sex of the assessor; where the female assessors ranked Class I profiles as most attractive whereas males ranked Class III profiles as most attractive (Cochrane et al. 1999). Results of this study confirmed that clinicians and the general public tend to view facial esthetics differently, with the general public demonstrating the greatest variation in what they consider attractive.

When the manipulations are removed and different malocclusions are evaluated before and after orthodontic treatment would clinicians find similar conclusions? Kerr and O'Donnell used frontal and profile photos for evaluations of different malocclusions before and after orthodontic treatment of sixty subjects who were equally divided among Angle Class I, Class II Division I, and Class III malocclusions (1990). Their evaluators were comprised of four orthodontists, four dental students, four art students, and four parents of children having orthodontic treatment. Each photograph was rated from very good looking=1 to very disharmonious=5 (Lundstrom et. al. 1987). Each slide shown was frontal, and profile picture before and after orthodontic treatment. They determined that Class I faces were rated higher than those of Class II Division 1 or Class III patients. Furthermore they found that art students and parents rated faces more favorably than the dental professionals, and that full face views were perceived as more attractive than profile views with exception of Class I group (Kerr and O'Donnell 1990).

Orthodontists often concentrate on the profile and the different vertical facial thirds of the face, whereas patients focus on their frontal view and their face as a whole. During treatment planning, orthodontists and oral surgeons can emphasize profile esthetic outcomes. However, a patient's perception of an attractive profile may differ from the clinician's perspective (Cochrane et al. 1999, Bell et al. 1985). Many patients

come to orthodontists and oral surgeons because they are self conscious of their dental and facial appearance. Since facial attractiveness is important to the orthodontist, oral surgeon and the patient, any differences in the perception between these groups needs to be thoroughly understood.

Phillips et al. investigated the effects of different levels of dental training with respect to rating facial attractiveness (1992). Three views (two full faces and one profile) of 18 orthodontic patients were presented to 16 orthodontic residents, 17 dental students and 71 undergraduate students using a 100mm visual analog scale. For 80% of the patients, the rankings of these ratings differed considerably, with not one viewed consistently rated as most attractive. The authors showed that orthodontic residents rated subjects as being more attractive than other raters and that there are variations to be noted by a clinician's background, experiences and training. From this, the authors concluded that the facial attractiveness score may be influenced by the effect of the assessor's specialty program (Phillips et al. 1992).

A more recent study done in 2008 challenged the perception of profile among lay persons, dental students and orthodontic patients (Tufekci et al. 2008). Their participants answered a questionnaire to see how they felt about their own profile and chose a silhouette among those that were shown that they felt resembled their own profile (see figure 11). Individuals who characterize themselves with a Class II or Class III profile were unsatisfied with their appearance. They suggested that about half the population cannot characterize their own profile (Tufekci et al. 2008).

Figure 11: Silhouettes representing A) Class 1, B) Class II, C) Class III, D) Straight Profiles (Tufekci et al. 2008).

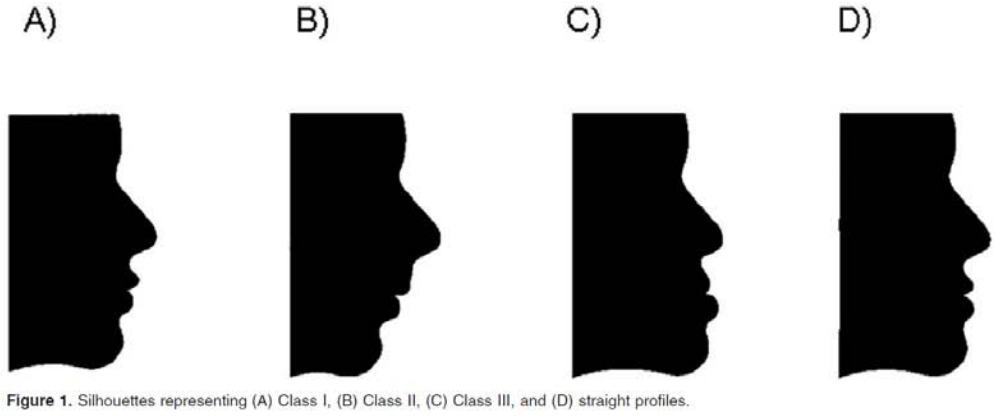


Figure 1. Silhouettes representing (A) Class I, (B) Class II, (C) Class III, and (D) straight profiles.

In some cases, orthodontists, oral surgeons, and lay persons perceived changes in profile differently. There have been several studies to determine whether clinicians and the general public differ in their perceptions of facial attractiveness. Several authors have shown agreement among these groups, (Kerr and O'Donnell 1990, Cox and Van der Linden 1971, Romani et al. 1993) while others show no correlation in agreement of opinion (Peck and Peck 1970, Lines et al. 1978, Prahl-Andersen et al. 1979, Davidenko, 2007, Cochrane et al. 1999).

Because facial esthetics are an important component of diagnosis and treatment planning of a case, both the orthodontist and oral surgeon must be aware of the societal norms associated with optimal facial attractiveness. Maple et al. evaluated the perception of facial attractiveness in profile digital photographs that were incrementally altered in different combinations of mandibular anteroposterior and vertical facial heights in the lower facial third to determine whether clinicians and consumers can

agree in their perception of facial attractiveness. They used digital profile and cephalometric x-rays of three men and three women and altered them with aid of Dolphin Imaging software (see figure 12). They found there was an agreement of facial proportions and that ideal facial proportions should serve as a guide for clinicians when examining frontal and profile views to evaluate facial attractiveness (Maple et al. 2005). However, there is more to beauty than ideal facial proportions. Clinicians must understand how the patient perceives facial attractiveness and the anticipated outcome of treatment. The advancements in digital imaging have assisted oral surgeons and orthodontists in both treatment planning and communication with the patient. Providing the patient with more realistic predictions, representation of facial outcomes can ensure they have an understanding of what options are available. However, these representations are based on computer prediction software that incorporates algorithms of soft tissue changes that can have some potential inaccuracies.

Figure 12: Stimulated vertical and horizontal changes (Maple et al. 2005).

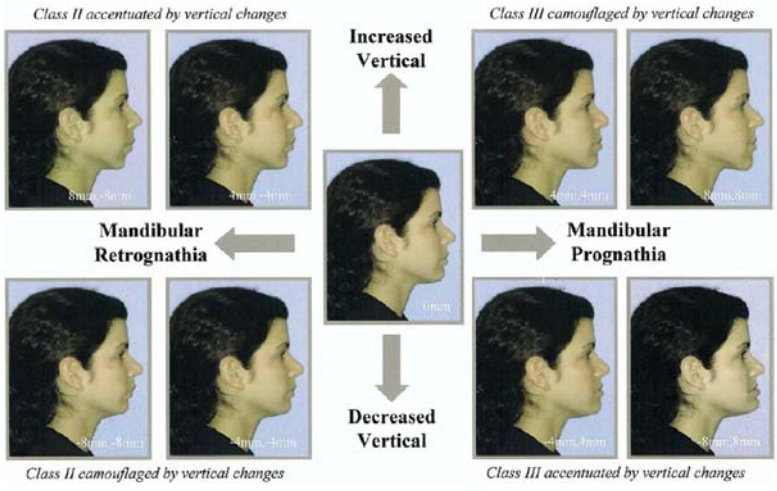


Fig. Simulated vertical and horizontal changes.

Cox and Van der Linden compared the esthetic standards of 10 orthodontists and 10 lay persons by having them evaluate black and white silhouettes in a Q-sort arrangement (1971). This meant that the most beautiful profile had to be placed in the first row and the least attractive in the last row to create a normal distribution of decreasing facial harmony (see figure 13). Each group of twenty nine photographs was evaluated individually. After grading full-head silhouettes for good facial balance in grades from best to worst, it was concluded that the cephalometric radiographic analysis did not show statistically different opinions between the two groups. The persons rated with the worst facial esthetics had more convex profiles while the ranges of variation in the groups with good facial esthetics were larger than the generally accepted ones. A number of faces with good facial harmony were found to be associated with malocclusions (Cox and Van der Linden 1971). This study raised the question as to whether; cephalometric standards have been set too rigidly and with too little freedom for variation.

Figure 13: The Q-sort arrangement of profiles (Cox and Van der Linden 1971).

Fig. 1. The Q-sort arrangement according to the normal distribution for one of the six test groups. The most attractive profiles are shown on the left side, and the least beautiful ones on the right side.

In the past, to evaluate facial proportions via profile and attractiveness, various techniques have been used involving silhouettes, (Cox and Van der Linden, 1971, Lines et al. 1978, DeSmit and Dermaut, 1984) (see figure 14), line drawings, (Prahl-Andersen et al. 1979) and photographs (Kerr and O'Donnell 1990, Peck and Peck 1970). Lines, et al. used line drawings to confirm noteworthy discrepancies in profile preferences for males and females; it is ideal for females to have less prominent noses than males and for males to have more prominent noses in relation to their chins (1978). In addition, they found orthodontists preferred both men and women to have slightly more prominent lips, while oral surgeons liked flatter lip prominence. Prahl-Anderson et al. used line drawings of profiles to confirm a difference in scoring and need for orthodontic treatment depending on the professional or lay status of the evaluators, see figure 15 (1979). They noted a significant difference existed in the subjective evaluation of the morphological characteristics in the dentofacial region between the dentists, orthodontists and parents. Parents rated more pictures with acceptable profiles not requiring orthodontic treatment than did the orthodontists and dentists alike. This clearly indicated that laypeople and dental professionals differ in their evaluation of facial esthetics and need for intervention of treatment.

Each technique has its advantages and disadvantages. Silhouetted facial profiles provide a simple yet powerful way to study facial perception. They carry a rich amount of information about gender, age, and attractiveness of the face (Davidenko 2007). Photographs provide more texture information and show features such as the shape of the eyes, the color of the complexion, and the quality of the hair in which the layperson can perceive attractiveness of the face. Many aspects play a role in the

evaluation of beauty whether it is the perception of balance, symmetry, or youth. From these studies, it is possible to conclude that the perception of attractiveness is, in fact, limited.

Figure 14: Different facial profiles to be ranked (DeSmit and Dermaut 1984).

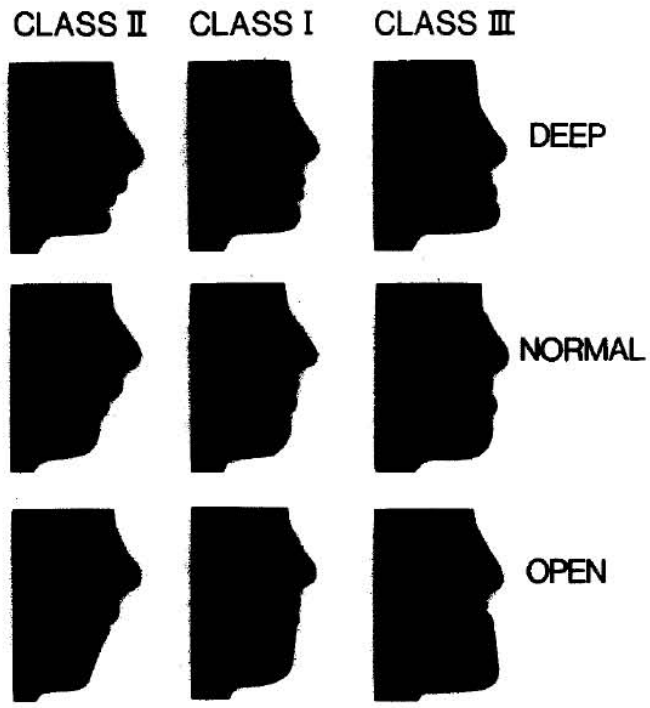


Fig. 1. Different facial profiles to be ranked.

Figure 15: Line Drawings of Facial Profiles (Prahl-Andersen et al.1979).

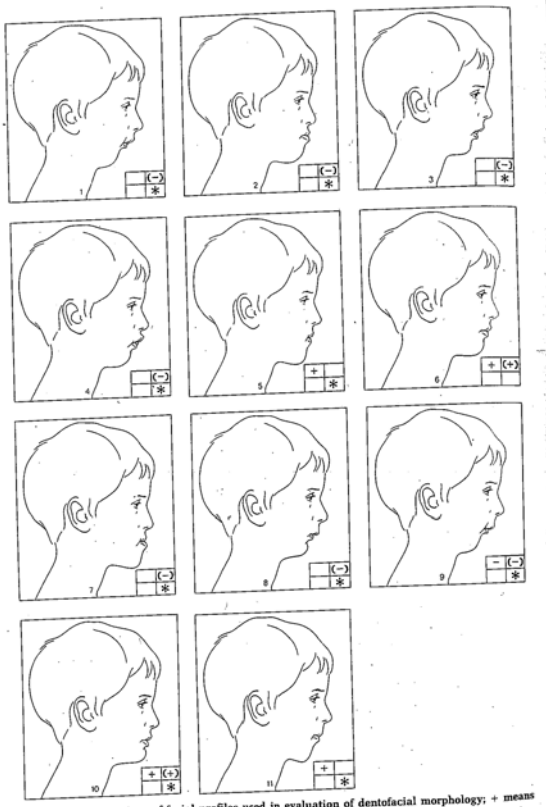


Fig 1 ■ Line drawings of facial profiles used in evaluation of dentofacial morphology; + means rated by majority of parents as normal; – means rated by majority of parents as abnormal, requiring treatment; (+) means rated by majority of dentists and orthodontists as normal; (–) means rated by majority of dentists and orthodontists as abnormal, requiring treatment;* indicates significant difference between parents' and professionals' evaluations, and is placed under highest value.

There are many potential problems in utilizing population normative data of facial heights, proportions or convexity to judge facial attractiveness. That is, facial attractiveness is multifactorial, and therefore an individual's deviation from the norm, no matter how large, may not be clinically meaningful. To address this concern, Howell and Shaw developed a method using visual analog scale (VAS) as a simple, rapid and valid way to assess the perception of facial attractiveness (1985). The visual analog scales allow judges to avoid the bias toward preferred values that is found with the numeric or equal appearing interval scales. Thus we have a method of measurement

used to produce data that can be analyzed and interpreted. Howell and Shaw also showed that with at least a two-person panel and a sample size over 22, a difference can be detected between groups. This includes substituting a two dimensional image for a three dimensional image (1985). This study demonstrated that reliable measures of dental and facial attractiveness can be obtained using a visual analog scale with a small panel of judges examining the attractiveness of human faces presented in color slides. Thereby one can obtain a valid, reproducible and representative rating of these features when examining the human profile.

The above studies show that there is little agreement on the significance of dental and facial appearance. In fact it reemphasizes the point that beauty is truly in the eye of the beholder. When one views them self in the mirror, he or she usually observes only one aspect, the frontal view. Clinicians, however, view patients as a 2D image to assess their facial aesthetics from both a frontal and profile view. Orthodontists are required to study facial beauty, balance, harmony and proportion as perceived through their own eyes and those of the general public. Both Riedel and Peck and Peck concluded in their study of faces of beauty contests winners that the lay people admired a fuller, more protrusive dentofacial relationship than one based on orthodontic standards. When evaluating soft tissues as noted by Nanda et al., the standards of beauty vary tremendously among individuals from different racial groups, and even socioeconomic backgrounds. It is up to the orthodontist and oral surgeon to identify the normal from the abnormal since facial changes can be anticipated with orthodontic treatment and even more with orthognathic surgery.

The ideal skeletal and dental class I occlusion is frequently pursued by orthodontists and oral surgeons alike. During treatment planning, orthodontists and oral surgeons can emphasize profile esthetic outcomes. However, a patient's perception of an attractive profile may differ from the clinician's perspection. Many patients come to orthodontists and oral surgeons because they are self-conscious of their dental and facial appearance. Since facial attractiveness is important to the orthodontist, oral surgeon and the patient, any differences in the perception between these groups needs to be thoroughly understood. The purpose of this research was to challenge the orthodontic facial proportion norms by assessing the observations of facial attractiveness when examining women in silhouettes and facial profile photographs as in classical studies and in photographic 3-D images to assess whether the interactions and magnitude of anteroposterior, vertical and transverse facial dimensions influence perception of facial attractiveness.

II. OBJECTIVES

A. Overall Objective

The purpose of this study is to evaluate the perception of facial attractiveness presented in silhouettes, facial profile photographs and in 3-dimensional photography to see if there is a correlation of attractiveness among providers, and lay people. Secondly, if there is a an agreement of attractiveness when examining the same subject in silhouette, photographs and 3-d images, then determine if the subject falls within the ideal norms of facial proportions and soft tissue esthetics used by orthodontists and oral surgeons alike. This will help determine whether there is concordance between providers and consumers in their perceptions of facial profile attractiveness.

B. Specific Hypotheses

It is hypothesized that the evaluators' perceptions of facial attractiveness when evaluating silhouettes is not closely tied to perceived beauty when looking at facial profile photographs or at three dimensional photographs.

The null hypothesis is there is no difference in evaluators' perceptions of facial attractiveness between viewings of silhouettes, facial profile photographs and three dimensional photographs. In addition there will be no difference between 3 groups of evaluators when viewing the three types of images, silhouettes, facial profile photographs and three dimensional photographs.

III. MATERIALS AND METHODS

A. Experimental Design

Each participant in this study had been deemed previously in some manner by a segment of the population as possessing those qualities of facial esthetics which are pleasing. The samples of participants that were analyzed were beauty pageant contestants noted for their facial attractiveness. The perception of attractiveness in these women ages 18-35 was examined in this study. The orthodontic literature documents that the soft tissues change with age, so the study was limited to adult women less than 35 years of age. Subjects were obtained from local, state and national beauty pageants and consented to have a photograph and 3-dimensional image made in a relaxed position from the front and profile.

Inclusion criteria consisted of the following: subjects must have competed in a pageant in the past, and/or were currently participating in a state/national pageant at the time of recruitment. These pageants included: Miss America, Miss USA, United America, and the Beauties of America pageant systems. Subjects had to be female, between the ages of 18 and 35 and either of Caucasian or Hispanic descent. These two ethnicities have similar soft tissue norms when compared to on another. In contrast, the facial profiles of Asians, South Pacific Islanders and African Americans have been found to differ significantly in classical studies. Other racial and/or ethnic groups were excluded not because they do not display facial attractiveness but rather because many of these groups have been found to differ significantly in soft tissue profile norms. That is they were excluded from this study to limit as many variables as possible. Comparing clinicians' perceptions of soft tissue silhouettes and photographs

of other racial and /or ethnic groups can and should be the topic of an altogether different study.

Part I

Subject Recruitment & Collection of Data

National Directors for the Beauties of America and United America pageants were contacted and given an information letter that was distributed to all pageant contestants, and reigning queens. The information letter (appendix D) instructed the women to contact the principal investigator at the pageant if they were interested in participating in the study. All eligible subjects were then consented prior to implementing any study-related procedures.

Enrollment continued for a three month period from August to October 2011 with a goal of recruiting 30 subjects between 18-35 years of age for this study. Subjects who met the inclusion/exclusion criteria were invited to participate in the study. Informed consent was obtained, using Wilford Hall Medical Center IRB approved forms (appendix B, C). The subjects' were given a copy of the consent form, and another copy was kept in the investigator's research binder.

All subjects used for this study were photographed with a Nikon D90 and 3dMD^{TM} camera. Majority of the subjects were recruited off site at national beauty pageants held in the San Antonio and Austin area. Prior to each pageant an information letter discussing the research was sent out via email to all the contestants in the pageant (see Appendix D). The first pageant where data was collected was the Beauties of America Pageant competition held in the ballroom of the Hilton San Antonio

Airport Hotel, August 5, 2011, located at 611 NW Loop 410, San Antonio, TX 78216. The second pageant was the United America Pageant on Oct. 22, 2011 held at the Wyndam Garden Hotel, 3401 South IH-35, and Austin, TX 78745. In addition, several of the subjects who were unable to make neither pageant had their photograph and 3dMD^{TM} image taken at University of Incarnate Word on Sept. 25, 2011. Lastly, there were subjects who were recruited that had their photos taken at Tri-Service Orthodontic Residency Program in the 3dMD^{TM} image room at Lackland Air Force Base, San Antonio, Texas from Aug. 8 to Sept. 26, 2011.

All subjects filled out the subject information card (appendix A). Since the subjects did not provide a form of identification such as a driver's license, age and date of birth, along with pageant history was requested to validate they met the inclusion criteria of this study. Each subject was consented to agree or disagree to have their facial photos released for publication as noted in appendix B for Wilford Hall Medical Center informed Consent Document and appendix C for HIPPA Authorization Form.

Subjects were not paid for participation in this study.

Instrumentation:

3dMD^{TM}'s imaging systems are the most widely used ultra-fast, high-precision 3D surface imaging devices in leading teaching institutions, hospitals and private practices worldwide with an outstanding reputation for accuracy, speed, and dependability. They offer a powerful software application platform to assess, plan, monitor, evaluate and simulate possible patient treatments. 3dMD^{TM} software solutions are designed to

provide valuable diagnostic information that help dental specialists and surgeons make the best decision for patient treatment.

This along with principal investigator's Nikon D90 SLR camera was used to obtain photographs of all subjects participating in the research. The stunning image quality with its 12.3 effective megapixels and extraordinarily high signal-to-noise ratio, the D90 delivered low-noise images with detail and tonal gradation. High-resolution pictures were produced using Nikon's unique Active D-Lighting technology. In addition, the D90 also uses Nikon's new Face Detection System to render human faces with a newfound sharpness and accuracy. The D90 demonstrated amazing autofocus accuracy by utilizing color and brightness information from its 420-pixel RGB sensor. When shooting in Auto-area AF mode, the camera quickly focused on the main subject by detecting foreground, background and subject position. Moreover, the D90 detected faces when using face priority AF, giving the principal investigator the ideal exposure of all human subjects in this study.

Standardization of Photography.

All subjects' photographs and 3dMD^{TM} images were taken at the pageant/venue at one time and did not require repeated visits for future pictures. After each subject signed the Informed Consent Document (appendix B) and HIPAA Authorization Form (appendix C), they had their photograph taken indoors, sitting down, and approximately five feet from the camera that was mounted on a tripod. Flash was set on Auto to standardize lighting for photos taken. All photos were taken from the subject's right

side. In addition the 3dMD^{TM} system was calibrated with the calibration plates prior to each session with all the subjects.

First, facial profile photos (in repose) were taken with an 18-105mm macro lens on a Nikon D90 SLR in front of a white poster board in a natural head position from a standard distance of five feet. The subjects were instructed to pull hair away from the face, maintain a neutral facial expression, looking straight ahead with lips relaxed and gently held together. The profile photographs from the Nikon D90 SLR were used to fabricate silhouettes and for facial profile picture powerpoint® slide shows in Viewing 1 and 2.

Next, the 3dMD^{TM} image was taken. Again the subjects were instructed to maintain a neutral facial expression, looking straight ahead with lips relaxed and held together. After image was taken it was verified and saved to a designated file. To maintain confidentiality of subjects, each subject was assigned a number known only by the principal investigator.

A total of 41 subjects consented to the study and had their photograph taken. Of the 41 subjects, 30 were qualified to participate in this study. Reasons for disqualification included the subject was of mixed ethnicity and claimed an ethnicity that was outside the scope of the study, the 3dMD^{TM} image did not properly save and therefore there was no image recorded, and lastly several of the ladies photographed were involved in behind the scenes of pageants and had not competed in pageants themselves.

Safeguards for Protecting Information:

Data collected other than facial photos were de-identified for review and analysis by the principal investigator. It was kept on a government computer assigned to the principal investigator. The computer was password and CAC-card protected, and the system was firewall protected. There were no planned linkages with external databases, nor was transmission of the data for collaborative use anticipated. Following completion of the study the data was stored and destroyed in compliance with policies implemented by the WHMC IRB. Each subject who was photographed/3dMD^{TM} image has a shadow record maintained at Dunn Dental Clinic in secured cabinets, the subject was randomly assigned a research number from 1-30 corresponding to their subject number for data collection. This number was inserted into the shadow record as a reference for silhouette and photographic images. All research data has been maintained in a binder categorized by subject number which has been secured in the principal investigator's locked desk, and electronic data has been kept on a government computer assigned to the principal investigator.

All information collected in this study was kept in an electronic database, which was double password protected and the access was restricted to people involved in this study. The research information collected about the subject for this study was not used for any additional research activity beyond what the subject has approved by signing the consent.

Safeguards for Protecting Subjects:

The principal investigator was responsible for the protocol safety monitoring. The principal investigator made study documents (e.g., consent forms, data pulls) and pertinent clinical records readily available for inspection by the local IRB and over sight staff for confirmation of the study data.

Powerpoint® Presentations

After the 30 subjects were selected, each facial profile photograph was loaded into Adobe® Photoshop version 5.0 to fabricate a silhouette-(see figure 16). Again each silhouette was assigned a number only known by the private investigator.

Figure 16: Facial Profile Picture into a Black and White Silhouette

Each 3dMD™ image was loaded into 3dMDvultus™ to produce a video where the image would rotate 180 degrees from right to the left and back left to right (see figure 16).

Figure 17: 3dMD™ Image of Each Subject

All silhouettes, profile pictures and 3dMD™ images were randomly sorted on a timed powerpoint® slideshow with a dark blue background and number listed at the bottom left of the slide. All photos, silhouettes and 3dMD™ images were sized to be the same dimension to remove as many distractions and variables as possible when placed into powerpoint® slideshows. The slides for Viewing 1 (silhouettes) and Viewing 2 (profile picture) were up for 10 seconds. For Viewing 3 (3dMD™ images) the slides were up for 15 seconds each. Each subject was shown on a different slide with each viewing. Only the principal investigator knew which silhouette, match the profile picture and 3dMD™ image.

Evaluators of Subjects

Each powerpoint® slideshow was shown to a group of evaluators. These evaluators consisted of: five oral surgeons, five orthodontists, five laypersons that consisted of administrative and secretarial staff plus one alternate in each group. The reason for alternate in each group was to account for possibility of losing an evaluator along the way in each viewing and ensure there were the same five evaluators in each group (oral surgeons, orthodontists and laypersons) for all three viewings. The evaluators were obtained from Lackland Air Force Base, University of Texas Health Science Center and in the San Antonio area who had no knowledge of the study. Prior to each viewing, the principal investigator informed the evaluators the same instructions-see appendix E evaluator panel script. Each evaluation panel of oral surgeons, orthodontists and laypersons met separately. The location for evaluation panel was at Dunn Dental Clinic Orthodontics Department's conference room D227, building 6418, Lackland AFB, Texas 78236; Wilford Hall Medical Center, Oral Surgery Department conference room, 2200 Bergquist Drive, Lackland AFB, Texas 78236; University of Texas Health Science Center at San Antonio, Dental School, Department of Orthodontics, MC 7910, 7703 Floyd Curl Drive, San Antonio, Texas 78229-3900.

Each evaluator was provided an evaluation form-see appendix F to rate the level of attractiveness for each image shown using a visual analog scale. See example below. Each slide was displayed for 10 seconds (Viewing 1 & 2) and 15 seconds (Viewing 3) and the whole process taking less than 10 minutes. This was done to ensure timeliness as well as a truthful first response.

1. |----------|
Average attractive Very Attractive

After the evaluator marked the scale for each image they were not able to go back to change their answer, nor see the slides of the same subjects more than once. Again as noted in appendix E, no information was given on these images such as age, name, gender, race, whether they have had orthodontics, had teeth extracted, orthognathic/cosmetic surgery, etc.

Viewing 1-Silhouettes

Viewing 1 consisted of showing silhouettes that were randomly sorted on a timed powerpoint® slideshow shown to a group of evaluators. These evaluators consist of: five Oral surgeons, five Orthodontists, and five laypersons. All slides had a blue background, with a white number on the lower left corner of each slide corresponding to number on the evaluator form, see appendix F. See figure 18 below.

Figure 18: Viewing 1 Silhouette Slide Example

Each evaluator rated the level of attractiveness for each silhouette using a visual analog scale. Each slide was displayed for 10 seconds. This ensured timeliness as well as a truthful first response. Next, after all evaluators had seen Viewing 1, the principal investigator used a template to be matched on to each question that provided a rating with assigned numerical value. See below.

1. |----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
(0) (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

Average attractive Very Attractive

1. |----------|
Average attractive Very Attractive

Each image was scored to closet tenth of a point, for example 4.3. If the image was in between two marks it was raised up to closet tenth, for example if it was marked 4.45 it was given the score 4.5. If the evaluator did not mark on the scale for the image, the score was zero.

Since each image was in random order, only the principal investigator knew which number on Viewing 1 presented actually correlated to the number assigned to each subject. For example, silhouette shown as number 9 in the powerpoint® slide show was number 37 in the template. All data was inputted in Microsoft Excel© to be analyzed. In the excel sheet, to maintain confidentiality of evaluators, within each group, each evaluator was assigned a letter (A-F) within groups of oral surgeons, orthodontists and laypersons. Only the principal investigator knew the identity of each evaluator and to ensure completeness of the study had the same evaluators for each of the three viewings.

Viewing 2-Facial Profile Photo

To ensure the evaluators in the study did not recognize the subjects there was a two week time period in between Viewing 1 and 2. Facial profile photos (in repose) of the same 30 beauty pageant contestants, were randomly sorted on a timed powerpoint ® slideshow shown to the same group of evaluators. Again, each evaluator rated the level of attractiveness for each photo using a visual analog scale. Each slide was displayed for 10 seconds again to ensure timeliness as well as a truthful first response. After the evaluator marked the scale for each image they were not able to go back to change their answer, nor see the slides of the same subject more than once.

The panels were given no specific information about the faces they were about to see, but were asked to assess facial attractiveness of each one, as far as possible, ignoring make-up, hair style, and clothes. See Figure 19 below.

Figure 19: Viewing 2 Facial Profile Photo Slide Example

Next, after all evaluators saw Viewing 2, the principal investigator used a template, the one from Viewing 1, to be matched on to each question that provided a rating with assigned numerical value. See below, the same was done in Viewing 1.

1. |----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
(0) (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

Average attractive Very Attractive

1. |----------|
Average attractive Very Attractive

Each image was scored to closet tenth of a point, for example 4.3. If the image was in between two marks it was raised up to closet tenth, for example if it was marked 4.45 it was given the score 4.5. If the evaluator did not mark on the scale for the image, the score was noted as void.

Since each image was in random order, the principal investigator knew which number on Viewing 2 presented actually correlated to. For example profile picture shown as number 9 in the powerpoint® slide show was number 37 in template. All data was inputted in Microsoft Excel© to be analyzed. Again confidentiality was maintained for evaluators and subjects alike.

Viewing 3-3dMD^{TM} Images

Again, to ensure the evaluators in the study did not recognize the subjects there was another two week time period in between viewing 2 and 3. Two weeks later, utilizing the 3dMD^{TM} photos of the same beauty pageant contestants, the principal investigator showed their 3-dimensional photograph randomly sorted on a timed powerpoint® slideshow to the same group of evaluators. Each evaluator rated the level of attractiveness for each 3dMD^{TM} image using a visual analog scale. Each slide of 3dMD^{TM} image was shown in a video format where the image rotated 180 degrees from right to left and then left to right, displayed for a total of 15 seconds. Again, the panels were given no specific information about the faces they were about to see, other than to

assess facial attractiveness of each one, as far as possible ignoring make-up, hair style, and clothes. See Figure 19 on following page.

Next, after all evaluators saw Viewing 3, the principal investigator used the same template from Viewing 1 & 2 to be matched on to each question that provided a rating with assigned numerical value. See below, the same was done in Viewing 1 & 2.

1. |----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
(0) (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

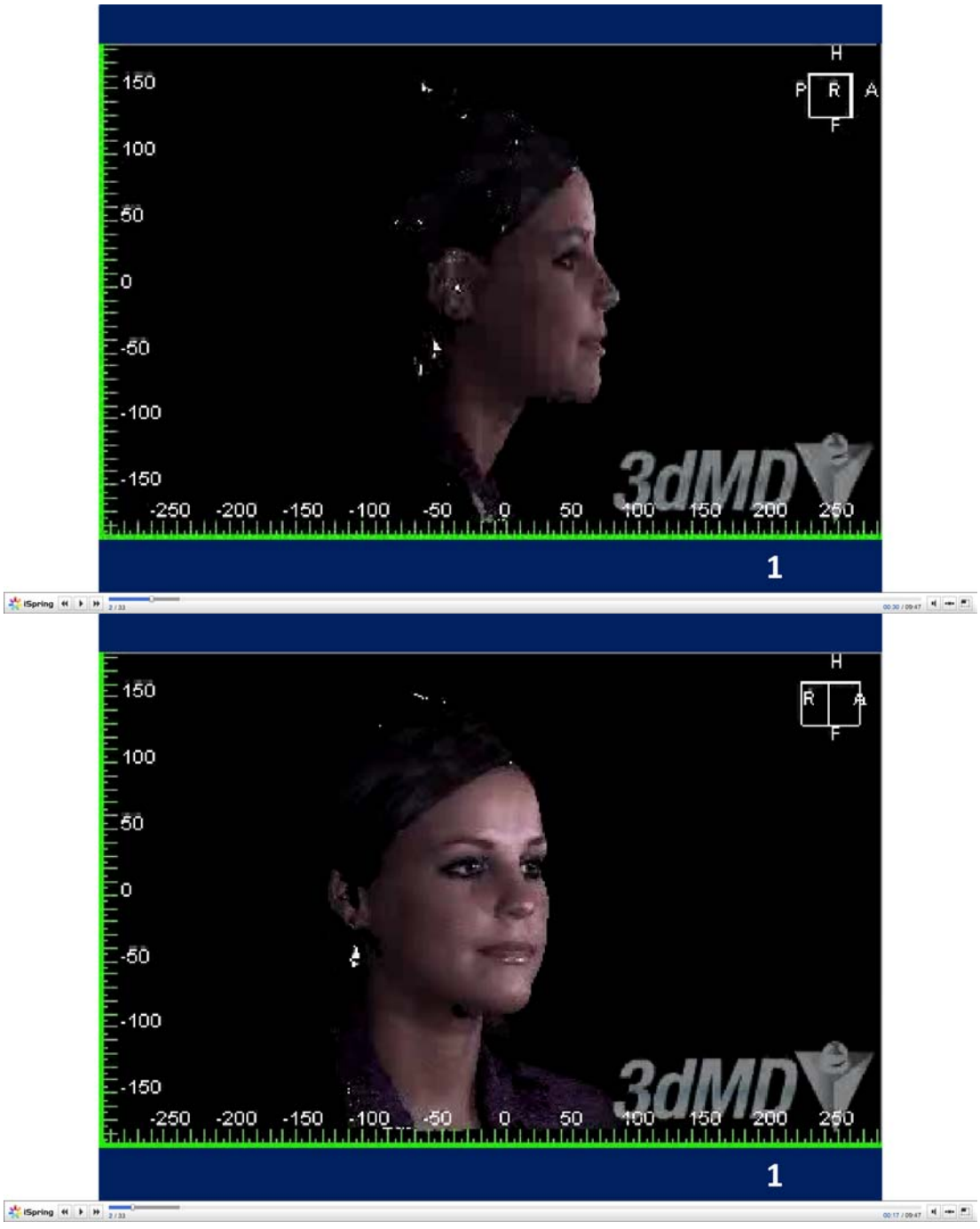
Average attractive Very Attractive

1. |----------|
Average attractive Very Attractive

Each image was scored to closet tenth of a point, for example 4.3. If the image was in between two marks it was raised up to closet tenth, for example if it was marked 4.45 it was given the score 4.5. If the evaluator did not mark on the scale for the image, the score was noted as void.

Since each image was in random order, the principal investigator knew which number on Viewing 3 presented actually correlated to. All data was inputted in Microsoft Excel© to be analyzed. Again confidentiality was maintained for evaluators and subjects alike.

Figure 20: Viewing 3 3dMD^{TM} Image Slide Example

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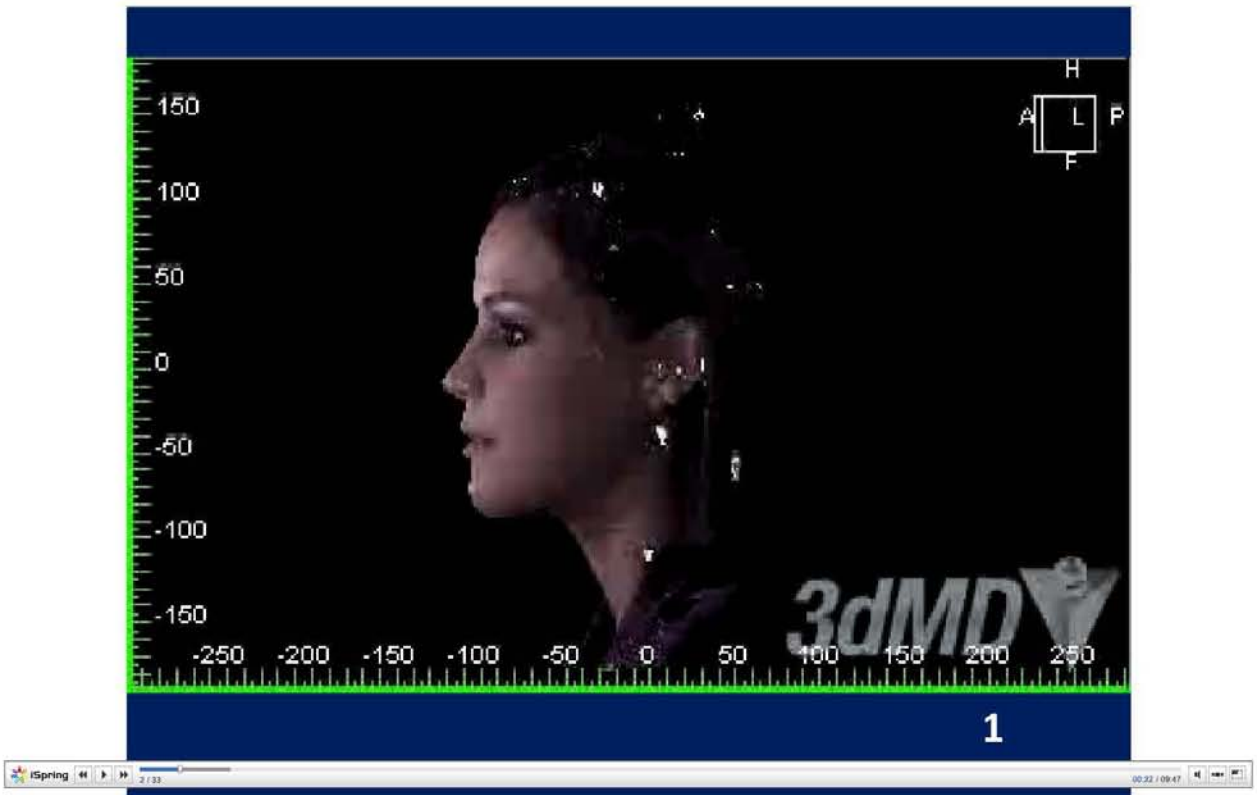
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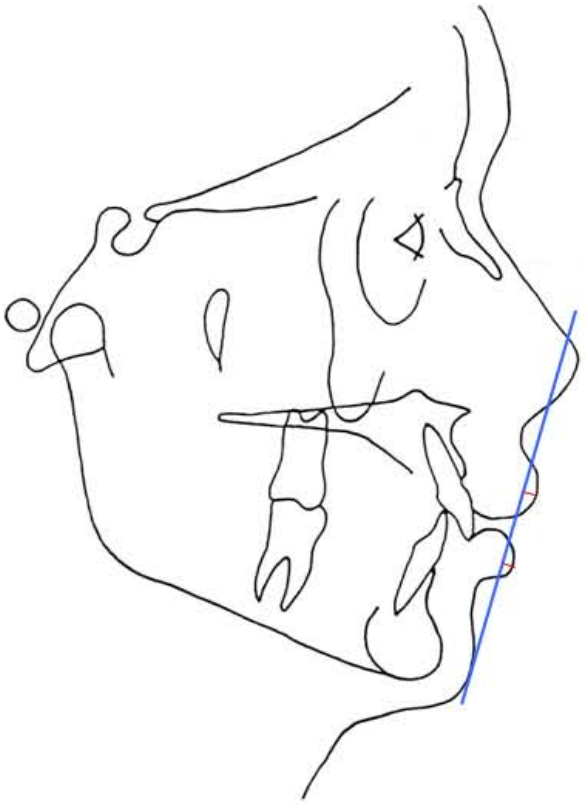
Soft Tissue Analysis

To see how each subject compared with orthodontic current norms' a soft tissue analysis was performed on every subject and the following points were measure on the silhouette and facial profile picture.

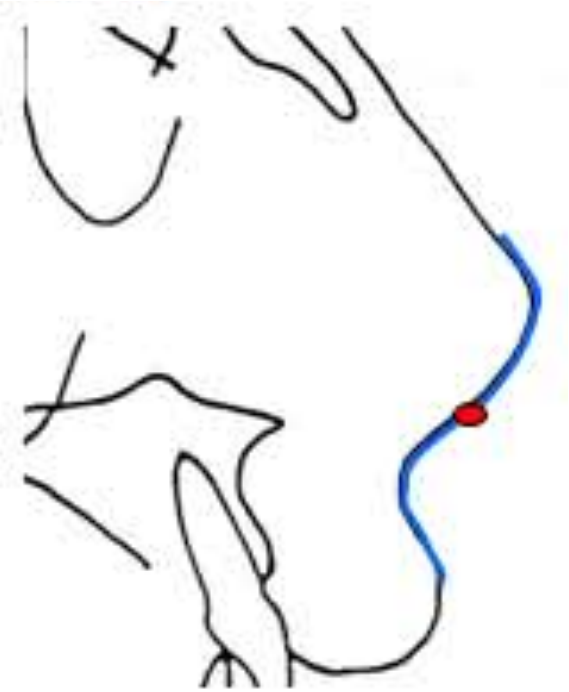
- Upper Lip to S line (mm): A line drawn from soft-tissue pogonion to the mid-point of the S-Shaped curve between subnasale and the nasal tip. Norm: 0 mm ± 1.

Figure 21 Upper Lip to S line (Courtesy of Dr. Fallis).



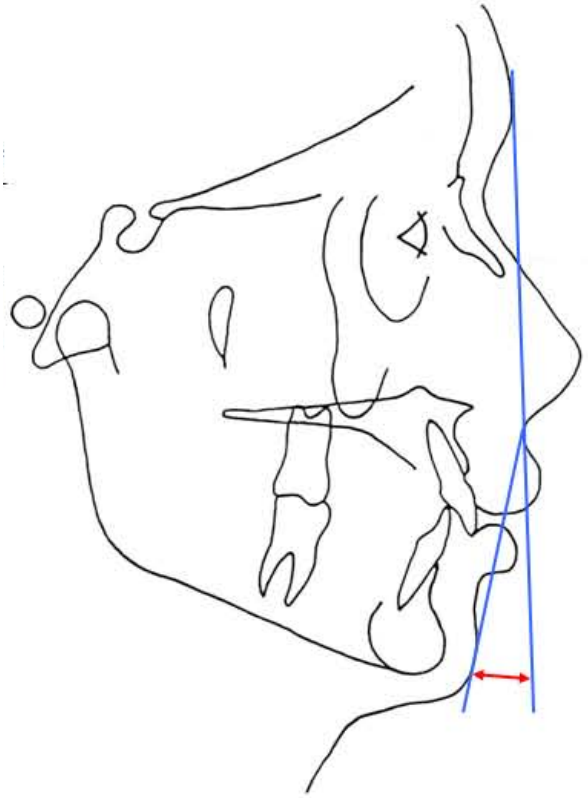
- Lower Lip to S line (mm): A line drawn from soft-tissue pogonion to the mid-point of the S-Shaped curve between subnasale and the nasal tip. Norm: 0 mm ± 1.

Figure 22 Lower Lip to S line (Courtesy of Dr. Fallis).



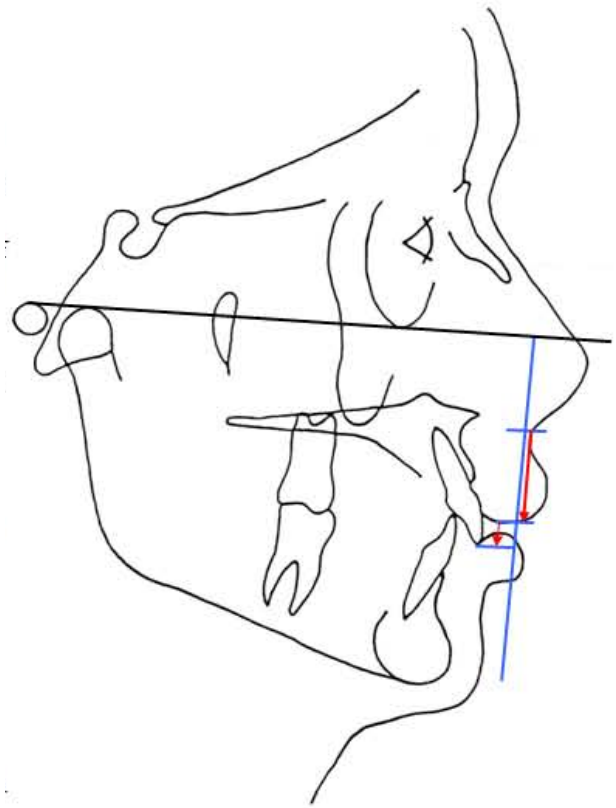
- Facial Convexity (G'-Sn-Po'): The Upper Facial Plane is drawn from soft-tissue Glabella through Subnasale and extended inferiorly. The Lower Facial Plane is then drawn from Subnasale to soft-tissue Pogonion and the angle between the two lines is measured. Norm: 11° ± 4.

Figure 23 Facial Convexity (Courtesy of Dr. Fallis).



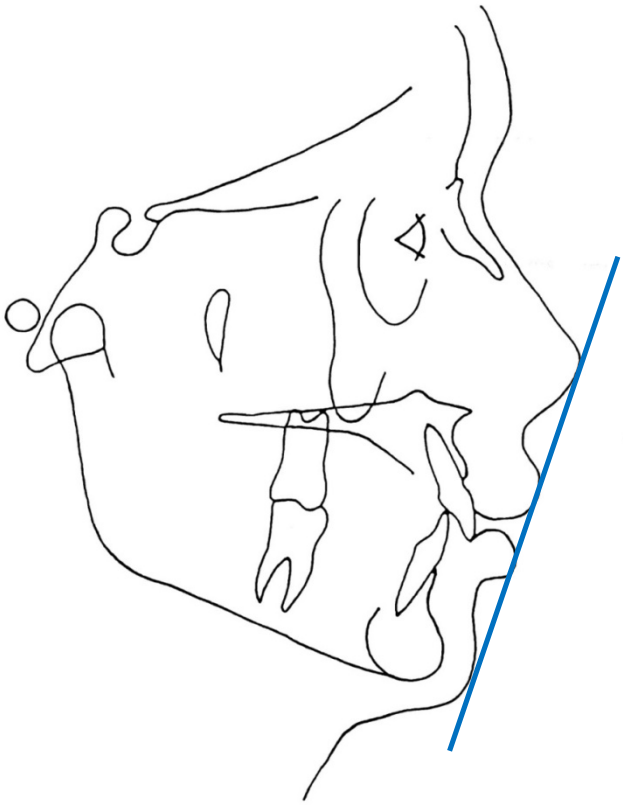
- UL Length: (Sn-Stms perpendicular to FH): Vertical, linear measurement of the upper lip from Subnasale to Stomion Superiorus, measured perpendicular to Frankfort Horizontal. It should be approximately 1/3 of the total lower facial third as measured from Subnasale to Soft-tissue Menton (Sn-Me'). Norm: 22mm ± 2.

Figure 24 UL Length (Courtesy of Dr. Fallis).



- Rickett's E-line (Tip of Nose-Po'): Influenced by size of nose and chin, movement of lower incisors. Norm: -2mm +/- 2 mm at age 9.

Figure 25 Rickett's E-line (Courtesy of Dr. Fallis).



All data was recorded for each subject in tables, see appendix K.

B. Statistical Management of Data

Each group of evaluators used the evaluation form-appendix F to evaluate each viewing of silhouette, facial profile photograph and photographic 3-D image. A visual analog scale of 10 millimeters was used for each subject in each viewing.

Data Analysis

The data collected was a composite rank score on a continuous scale between 0 (low) and 10 (high). This composite rank score was developed for 30 individuals who each had a 3-D image, facial profile photograph and a silhouette of their face. The composite rank score was based on facial attractiveness for each subject's image disregarding makeup, clothing, skin color and hairstyle.

The dependent variables were rating of attractiveness between silhouettes, facial profile photographs and 3D images. The independent variables were the three groups of evaluators and three separate viewings.

Outcome Measures

The outcome measures were ranking of the three sets (silhouettes, facial profile photographs, and 3-D images) of 30 images by three groups of evaluators (five Oral surgeons, five Orthodontists, five laypersons composed of administrative and secretarial staff). The ranking scores were analyzed to find out if there was a difference and/or correspondence between the rankings of the three sets of images and whether the perception of attractiveness correlated well between the three sets of images and/or between the groups of evaluators.

Sample Size Estimation/Power Analysis/Statistical Analysis

Sample size estimation/power analysis: A sample size of 15 evaluators (three groups) ranked three sets of 30 images. Analysis of variance (ANOVA) used repeated measures (F-test) for the ranking scores had a power of 0.99 (99%) with an alpha of 0.05 and an effect size of 0.25. Three groups of evaluators were between a group factor and three groups of images were within a group factor. Multiple comparison tests were used to compare the mean ranking for the three groups of evaluators. Additionally, correlation coefficients were computed for ranking of the three sets of images separately for the three groups of evaluators. Lastly a linear regression analysis was done on the following to see how they correlated to the rating of overall facial attractiveness: facial convexity, type of facial profile (straight vs convex), Rickett's E-line, upper lip to S-line and lower lip to S-line.

IV. RESULTS

The raw scores for each evaluator from viewings 1, 2, and 3 can be found in appendices G, H, and I, respectively.

Soft Tissue Analysis

All subjects had a soft tissue analysis performed in the study. Data for each subject and comparison to orthodontic norms are located in appendix K. The following soft tissue features were examined: facial thirds, upper lip to S line (mm), lower lip to S line (mm), facial convexity (G'-Sn-Po'), upper lip length, and Rickett's E-line. The number of subjects who fell outside one and two standard deviations of the soft tissue norms in each category are listed below in table #1.

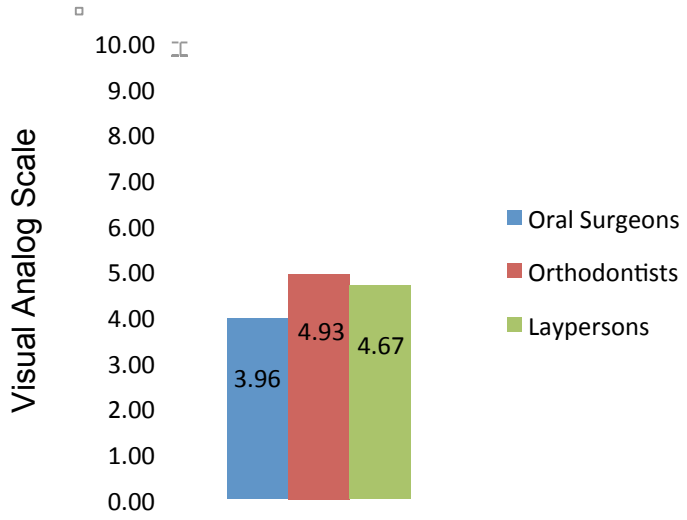
Table #1 Number of Subjects Outside Cephalometric Norms

	1 S.D.	2 S.D.
Facial 1/3	**0**	**0**
Upper Lip to S line (mm)	**9**	**0**
Lower Lip to S line (mm)	**7**	**0**
Facial Convexity (G'-Sn-Po')	**7**	**1**
UL Length	**0**	**0**
Rickett's E-line	**3**	**0**

Viewing: 1 Silhouette

The data for Viewing 1 (Silhouette) are located in appendix G. Orthodontists and layperson evaluators rated the images with mean facial attractiveness scores of 4.93 and 4.67 respectively; the mean facial attractiveness score for oral surgeons was 3.96 (see Chart 1 below). The ranges of scores were: orthodontists 1.0 to 9.1, laypersons 1.1 to 9.5, and oral surgeons 0.0 to 8.7. The median for each group of evaluators was 5.0, 4.4 and 3.5; the mode for each group was 5.9, 5.1 and 2.5 for orthodontists, laypersons and oral surgeons, respectively. Standard deviations noted in order for the three groups were 2.0, 1.7 and 2.1.

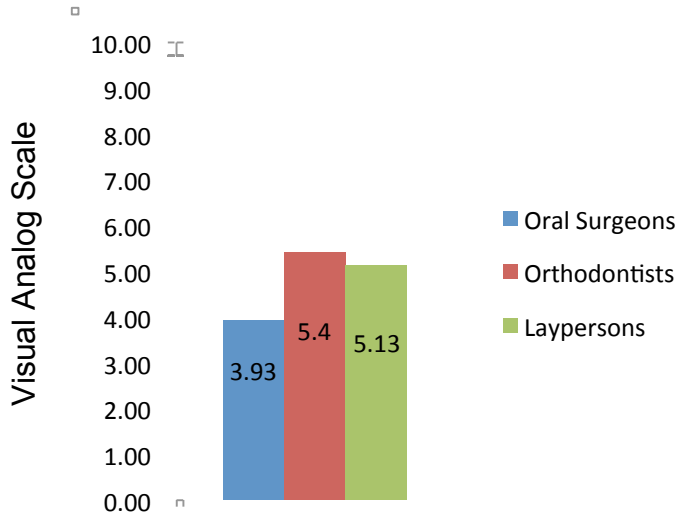
Chart 1 Viewing 1-Silhouettes



Viewing 2: Facial Profile Photograph

The data for Viewing 2 (Facial Profile Photograph) are located in appendix H. Orthodontists and layperson evaluators rated the images with mean facial attractiveness scores of 5.40 and 5.13 respectively; the mean facial attractiveness score for oral surgeons was 3.93 (see Chart 2 below). The ranges of scores for orthodontists were 1.7 to 8.7, laypersons 1.0 to 9.2, and oral surgeons 0.0 to 8.1. The median for each group of evaluators was 5.1, 5.3, and 3.6; the mode for each group was 3.7, 6.7 and 3.3 for orthodontists, laypersons and oral surgeons. Standard deviations noted in order for the three groups were 1.6, 1.5 and 1.6.

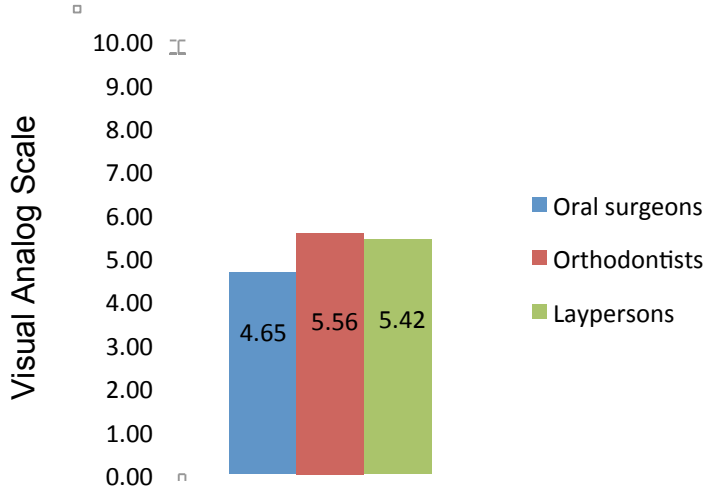
Chart 2 Viewing 2-Facial Profile Photograph



Viewing 3: 3dMD^{TM} Image

The data for Viewing 3 (3dMD^{TM}) Image are located in appendix I. Orthodontists and layperson evaluators rated the images with mean facial attractiveness scores of 5.56 and 5.42 respectively; the mean facial attractiveness score for the oral surgeons was 4.65 (see Chart 3 below). The ranges of scores were: orthodontists 1.9 to 9.3, laypersons 1.6 to 9.6 and oral surgeons 1.0 to 9.2. The median for each group of evaluators was 5.4, 5.4, and 4.8; the mode for each group was 4.6, 5.7 and 6.0 for orthodontists, laypersons and oral surgeons, respectively. Standard deviations noted in order for the three groups were 1.6, 2.0 and 1.9.

Chart 3 Viewing 3-3dMD^{TM} image



A comparison of mean scores for evaluators from each group for viewings 1, 2 and 3 can be seen in charts 4-6 below.

Chart 4 Comparison of Oral Surgeons Evaluators A-E

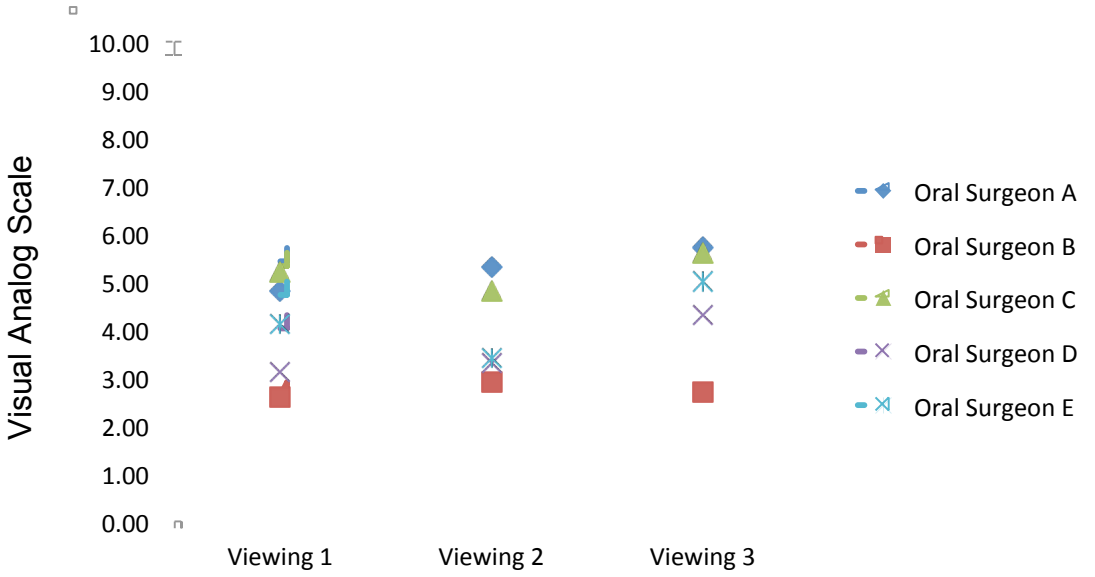


Chart 5 Comparison of Orthodontist Evaluators A-E

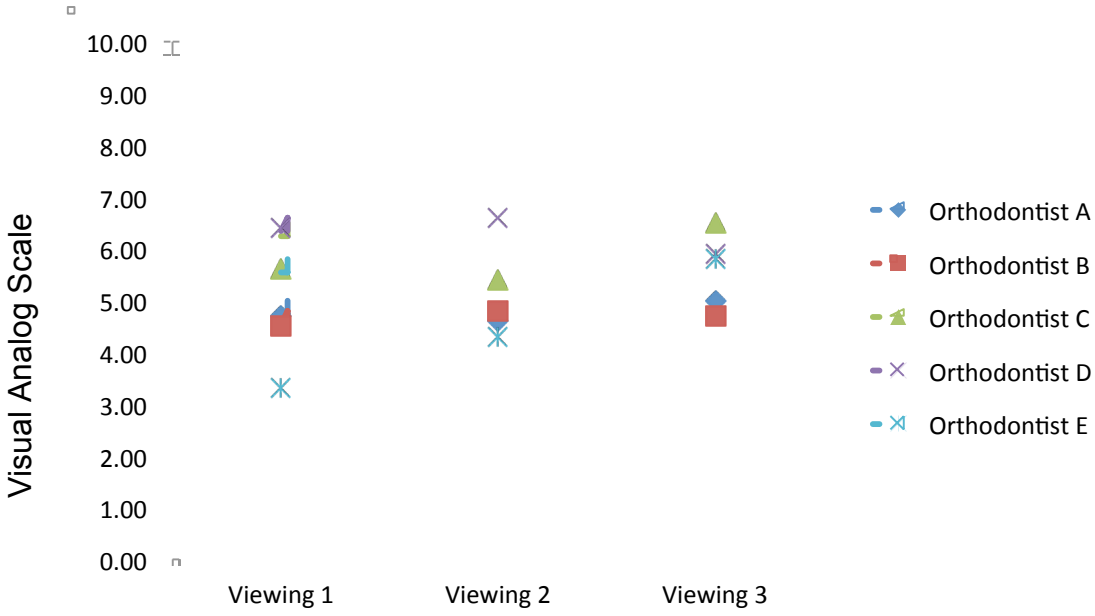
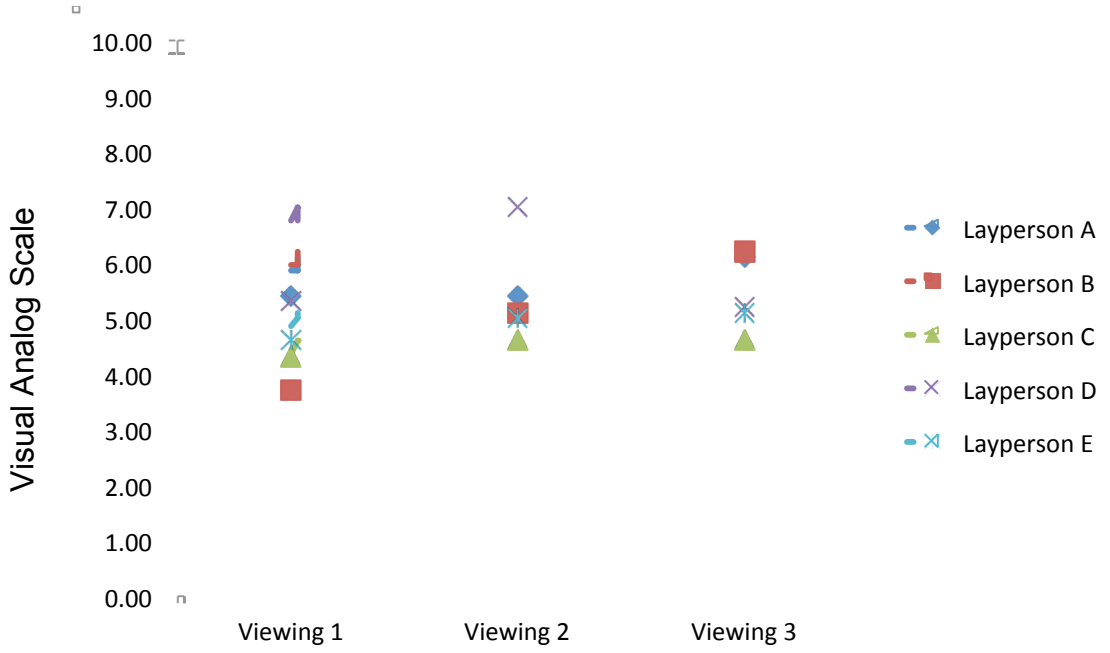


Chart 6 Comparison of Layperson Evaluators A-E



Mean scores for each evaluator group from each viewing are reported in Charts 7-9.

Chart 7 Oral Surgeons Overall Mean Ratings

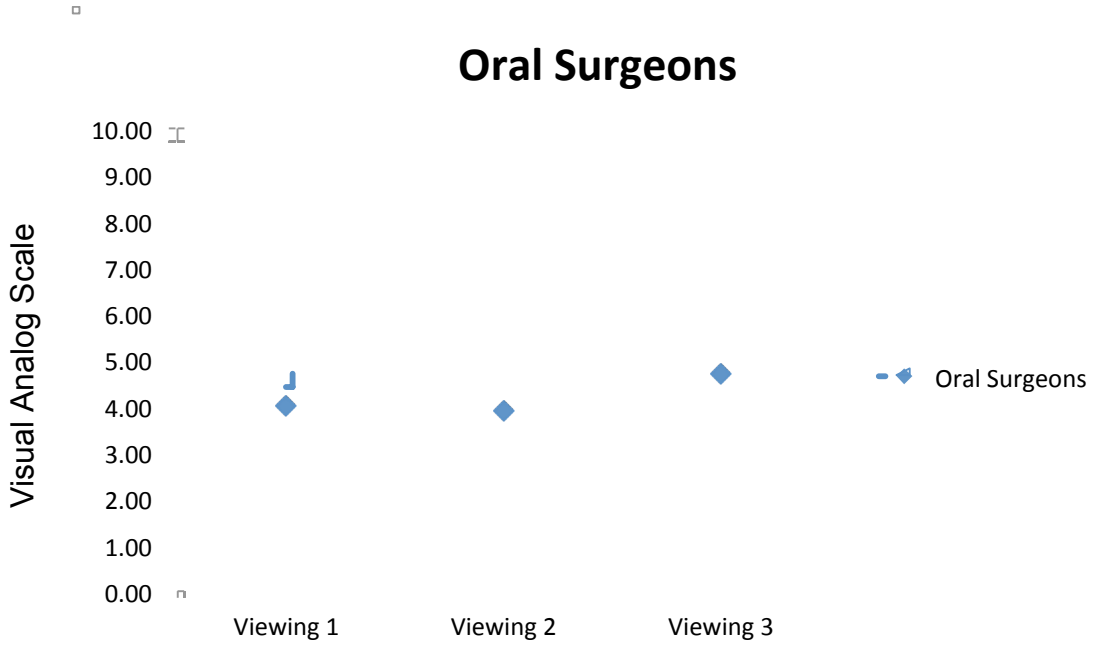


Chart 8 Orthodontists Overall Mean Ratings

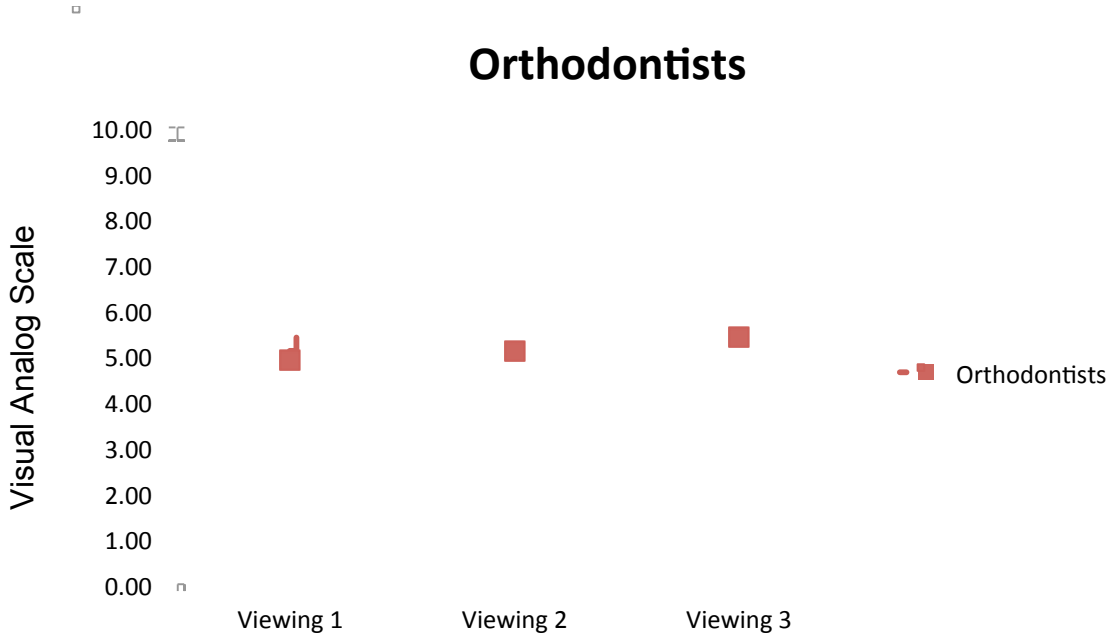
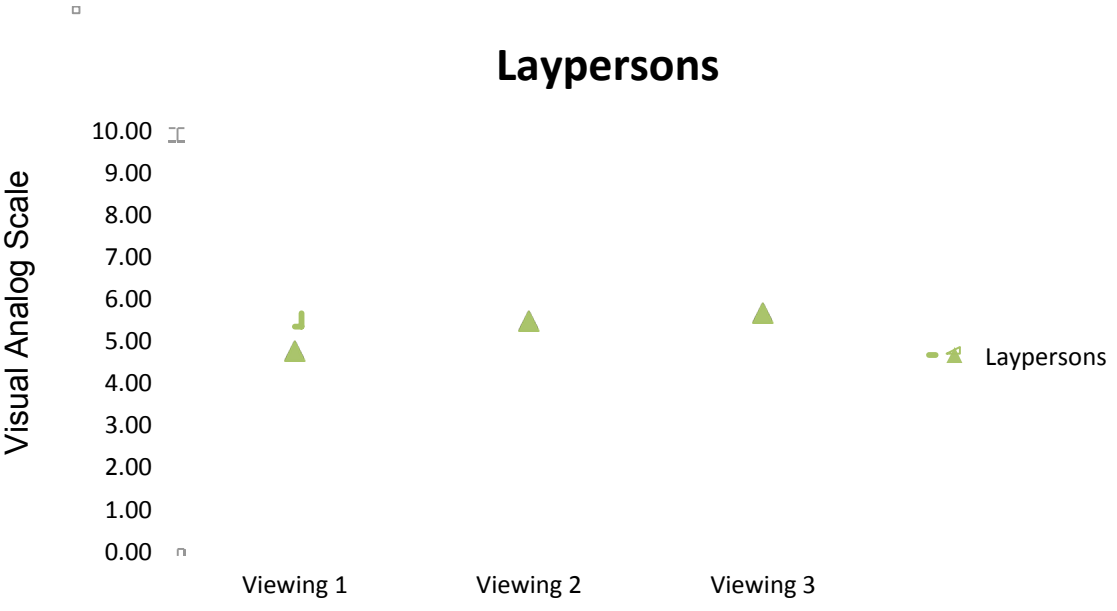


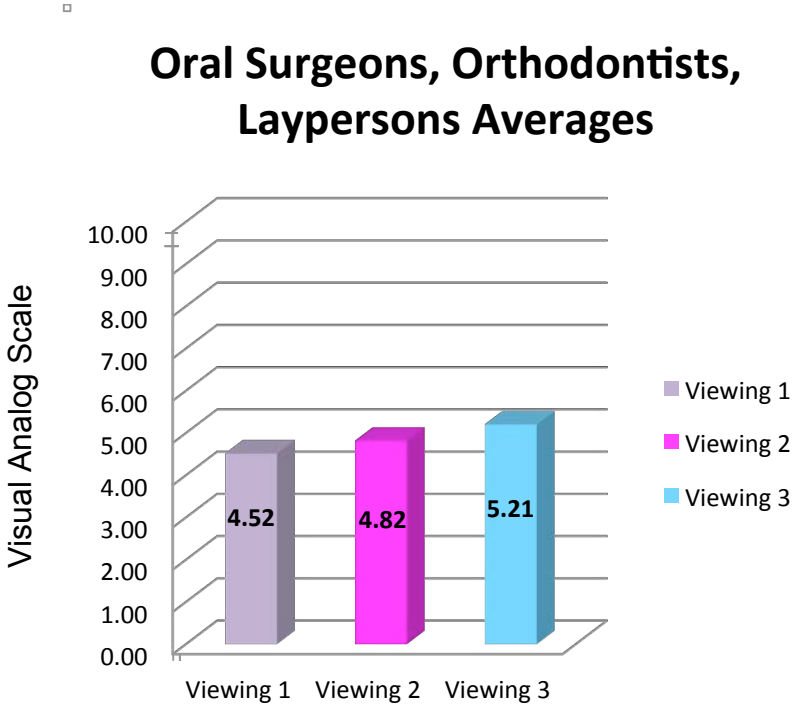
Chart 9 Laypersons Overall Mean Ratings



Viewing 1 v. Viewing 2 v. Viewing 3

When scores from all three evaluator groups were combined for each viewing, visual analog scores increased sequentially for viewings 1 through 3 with mean scores of 4.52, 4.82, and 5.21 respectively. See Chart 10 below.

Chart 10 Combined Scores, Viewings 1 through 3



ANOVA

Analysis of Variance was performed with Statistical Analysis System (SAS®) software. When comparing the viewings to one another and grouping all the evaluators'

ratings, there was a statistically significant difference in the scores based on viewing type.

- Viewing 1 vs 2 (p=0.0003)
- Viewing 1 vs 3 (p=0.0001)
- Viewing 2 vs 3 (p=0.0001)

In addition results from the ANOVA revealed the following variables were all significantly related to facial attractiveness.

- Facial Convexity (p=0.0001)
- Upper Lip to S-line (p=0.0471)
- Orthodontic treatment (p=0.0001)
- Comparing oral surgeons and orthodontists (p=0.0001)
- Comparing oral surgeons and laypersons (p=0.0001)

Areas that were found not to be statistically significant (p>0.05) included the following:

- Comparing the orthodontist and layperson (p=0.7747)
- Straight profile vs entire group (p=0.1977)
- Convex profile vs entire group (p=0.1928)
- Lower lip to S-line (p=0.6933)

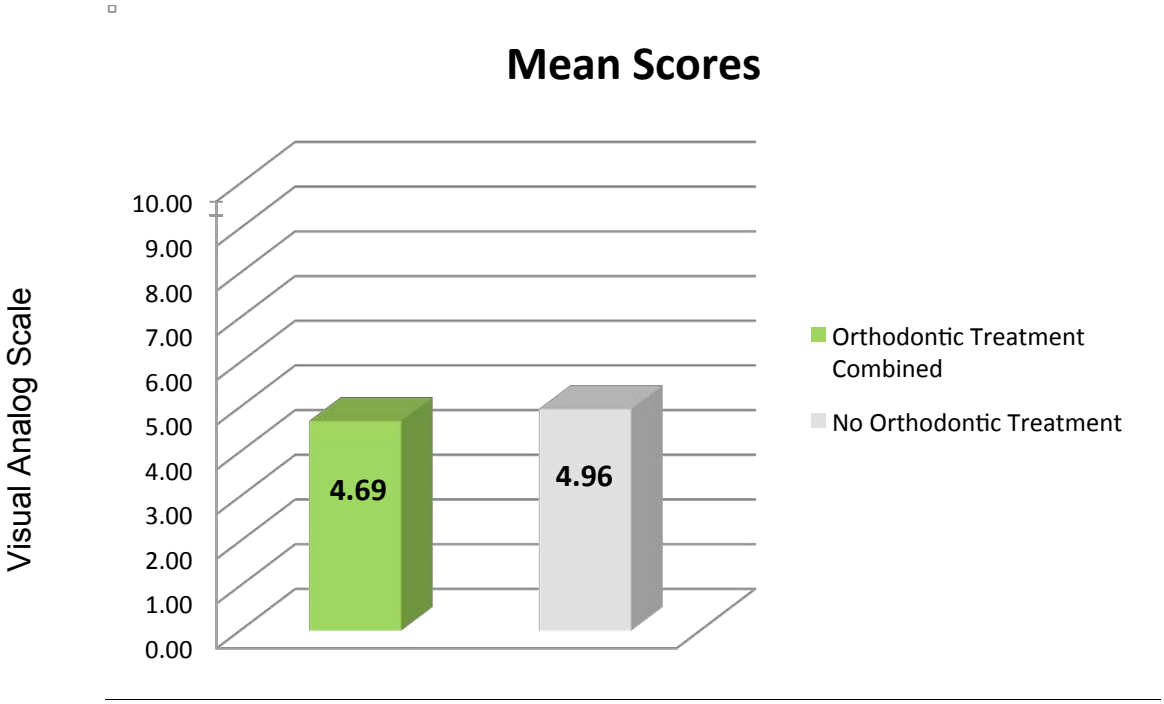
These variables had no statistically significant effect on viewers' ratings of attractiveness.

One trend noted was Rickett's E-line (p=0.0652).

Effects of Orthodontic Treatment

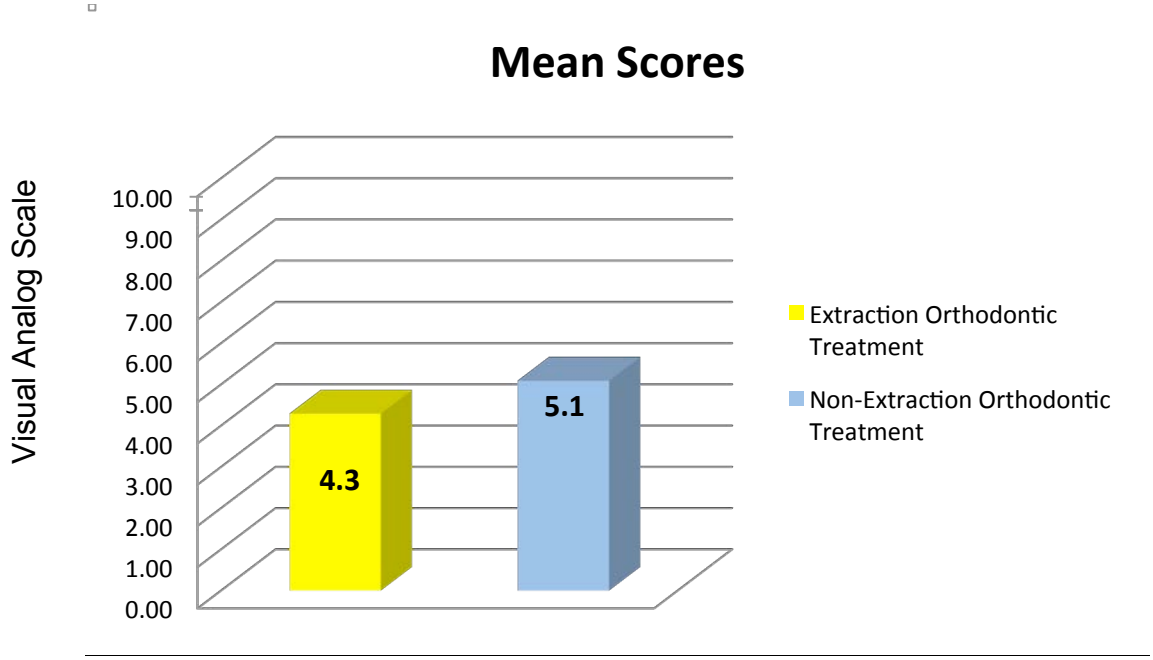
Mean scores for those evaluated whom had undergone orthodontic therapy (both extraction and non-extraction) were shown to differ statistically (p =0.0001) from those whom had never been treated orthodontically.

Chart 11 Mean Scores of Effects of Orthodontic Treatment v. No Orthodontic Treatment



Similarly, those whom had extractions for orthodontic therapy were shown to differ statistically (p=0.0001) from those whom had not had extractions (combined no orthodontics and non extraction orthodontics) with means of 4.3 and 5.1, respectively (see Chart 12).

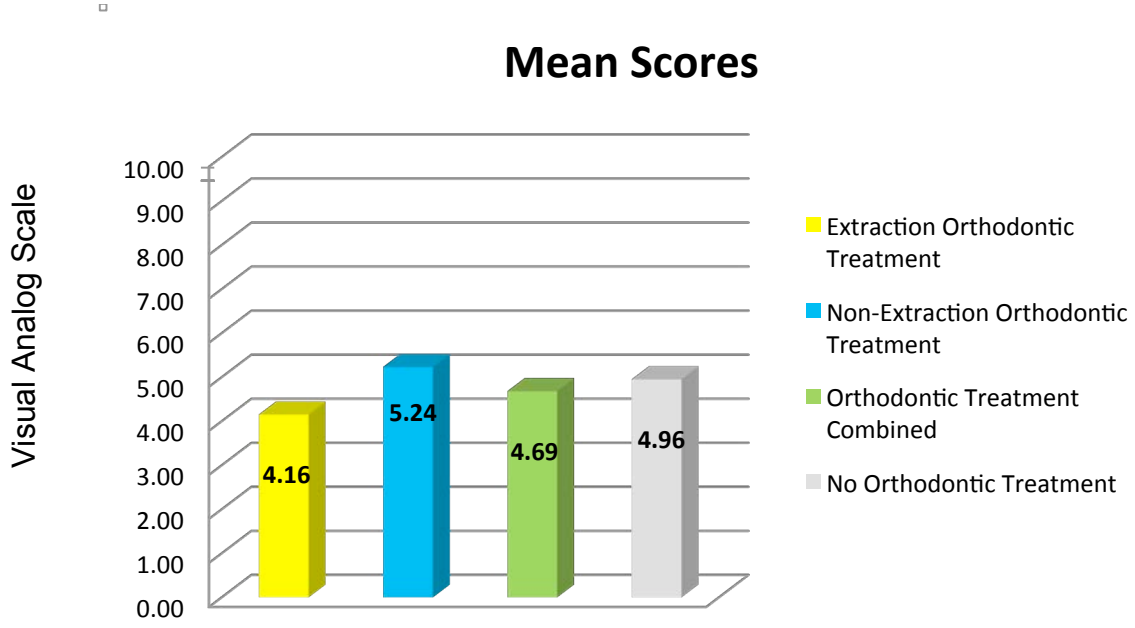
Chart 12 Mean Scores of Orthodontic Treatment with and Without Extractions



The data for effects of orthodontic treatment is located in appendix J. The mean scores for all four groups were noted in Chart 13.

For orthodontic treatment with extractions the mean facial attractiveness score was 4.16; for orthodontic treatment without extractions it was 5.24; orthodontic treatment combining non-extraction and extraction treatment was 4.69 and no orthodontic treatment was 4.96 (see Chart 13 on next page).

Chart 13 Effects of Orthodontic Treatment, Extraction, Non-Extraction and No Treatment



V. DISCUSSION

A. Soft Tissue Analysis

A soft tissue analysis was performed on each of the thirty subjects measuring points of interest, the nose, lips, chin and convexity. The analysis showed that the two thirds of the subjects fell within the pre-established orthodontic norms, while one third of the subjects fell within one standard deviation, and only one subject fell outside two standard deviations in facial convexity. These women were selected to represent a segment of the population deemed to be attractive on the basis of their appearance. These criteria were in agreement with previous studies that evaluated similar groups of attractive female subjects, which concluded that although their subjects were within the orthodontic norms, many had soft tissues that fell outside the norms and were more protrusive than what the standards would permit (Riedel 1957, Peck and Peck 1970). The data support the supposition that the general public today finds a protrusive and fuller profile more acceptable (see appendix K).

One subject (#28) was rated the highest overall score in all three viewings from each group of evaluators. This observation had no effect on the hypothesis, but was an interesting finding to note in this study. (See appendix K #28). For each area of the soft tissue analysis she was within 1mm /1 degree of the norms. In addition she exhibited excellent symmetry, and balanced features which may have attributed to higher ratings across the board from all evaluators alike.

B. Comparing Viewings

In this study, silhouettes, profile photographs and 3dMD^{TM} images were used to display each of the subjects. Silhouettes shown in viewing 1 one eliminated some of

the distracting variables such as hairstyle, earrings, clothing and makeup. Although, focusing on the shape of the face created from the effect of treatment may be valid, in studying the perception of facial attractiveness, it is necessary to judge the entire face including the distracting variables (Maple et al. 2005). This was noted in the results as the scores increased from silhouette, to profile photograph to 3dMD^{TM} (see charts 1-3). As noted by Czarnecki et al., the standards of beauty can vary tremendously among persons, racial groups and eye of the evaluator who can identify normal from the abnormal (1993). The influence of these distracting variables from each of the three viewings needs to more thoroughly researched to see which variable has the most influence on the evaluators and their perception of facial attractiveness. The texture, color, facial, transverse and frontal views from the 3dMD^{TM} images produced stronger scores and higher attractiveness ratings as noted in Appendix I and Chart 3 (Davidenko 2007). However, in viewing 3, the 3dMD^{TM} images shown varied the position of head, therefore this could have affected the perceived attractiveness of the subjects' overall face and thus may have altered the ratings. Todd et al. drew similar conclusions in their research when evaluating facial esthetics and found too great a degree of variation between 2D and 3D facial images (2005). With more research in the 3D arena, standardization processes may improve the results gathered in studies of facial attractiveness.

Comparing mean scores for each of the evaluators denoted A, B, C, D, and E, showed the variation of scores among the similar group of providers (see Charts 4-9). Oral Surgeon B rated all viewings lower than any other evaluator in the entire study and oral surgeon C, D and E rated silhouettes higher than profile views. Orthodontist D

rated the 3dMD^{TM} images lower than any other viewing and than any other providers as did Layperson D; these differing scores certainly affected the overall mean scores for each group. The results revealed the three groups had differing preferences and sensitivities depending on the viewing they were shown. This study agrees with previously published reports in that evaluators were able to detect even the smallest change of facial esthetics with a different viewing (Gross et al. 1995, Kerr and O'Donnell 1990, Cochrane 1999). Orthodontists and oral surgeons study profiles extensively and are trained to focus on the area of interest that pertains to their specialties such as the lip, chin and the dentoalveolar regions which in turn affected the rating of overall facial attractiveness (Tulloch et al., 1992). However, when evaluating these women in different views, their previous clinical experiences may have influenced how providers rated the subjects and in essence how they would treat them. Laypersons rarely notice the profile view of an individual's face unless they view it in a photograph (Cochrane et al. 1997). In addition, the laypersons might also concentrate on other facial features such as complexion, hairstyle, or makeup which can ultimately influence their perception of facial attractiveness.

The results showed that when each viewing of silhouette, profile picture and 3dMD^{TM} image was compared to each other looking at the evaluator groups as a whole, the attractiveness scores all proved to differ in a statistically significant manner (see Chart 10). When transitioning from viewing 1 of silhouettes to viewing 2, facial profile pictures, features such as thin lips, nasolabial angles, shape of noses and chin throat angles may have had a greater influence on how the evaluator scored the profile on the visual analog scale (see appendices G-I). It's possible that silhouettes can mask

several of these features and as the ANOVA comparison revealed, some of the features such as convexity of the face, or the distance of the lips from the S-line may be more apparent in this viewing when compared to lateral profile pictures. This may also have been true in viewing #3, since the 3dMD^{TM} image provided the most information and hence greater persuasion over an evaluator's score. This is in agreement with previous studies that noted full face views are generally rated more attractive then profile views (Kerr and O'Donnell 1989).

Other variables that impacted each viewing noted from ANOVA were facial convexity, upper lip to S-line, and if a subject had orthodontic treatment which included extractions and no extractions of teeth (see Charts 11-13). It's possible that the evaluator noted a multitude of variables that were more apparent in silhouette and facial profile picture and much less with 3dMD^{TM} image which could have correlated with how the image was perceived as attractive or unattractive. The amount of facial convexity ranged from 5 to 20 degrees (normal range is from 7 to 15 degrees). It was noted from the data that as the angle in facial convexity increased, the mean rating scored by the evaluators decreased. Facial convexity was significantly associated with beauty particularly in Viewing 1 and less in Viewings 2 &3. When examining the perception of the 3dMD^{TM} view, its possible evaluators had less time to focus on facial convexity, chins and/or noses and instead focus on the entire frontal view in which potential weaknesses in the areas were less noticeable. 3dMD^{TM} has the advantage of showing a dynamic image of the whole face. Adding the third dimension into this study provided a tremendous amount of visual information that, as noted from data, perhaps allowed a

less judgmental view of beauty. In addition, as the subject's upper lip approached S-line their mean overall attractiveness rating increased, as noted by the data.

Lastly, if the subject had orthodontic treatment this would infer the subject wished to improve their facial esthetics. How well this correlated with those who had extraction treatment in conjunction with orthodontics is debatable. On the subject information card each of the subjects were asked if they had orthodontic treatment, and if they did, whether or not they had teeth removed besides third molars. Orthodontic treatment with and without extractions were variables in this study that were part of the questionnaire in the subject group. Of the 30 subjects, twelve had orthodontic treatment and six of the twelve had extractions. None of the evaluators knew which subject had orthodontic treatment and/or extractions. It was noted that extractions had a significant effect on the perceptions of beauty for silhouettes, profile pictures and 3dMD^{TM} viewings (see charts 11-13, appendix J). In some whose profiles were unfavorable, orthodontic treatment in combination with extractions may have been used to camouflage a skeletal discrepancy which in turn may have affected the facial esthetics negatively. Of the most highly scored participants in all viewings, three had no orthodontic treatment, two had orthodontic treatment and one of those two had extractions. Several of the subjects whom had both orthodontic treatment and extractions were rated very highly by all evaluators, while two others were rated very low. These outlying low scores may have offset the scores of those whose profiles were rated highly (see appendix J). This concurs with previous studies that reported dental extractions do not always lead to a poor esthetic profile, and in some cases can improve overall facial appearance (Bowman and Johnston 2000). This can be exemplified in the following individuals in

society who are admired for their facial beauty: Former beauty queens (Miss America 2000, Miss USA 2005, Miss Universe 2004), royalty (Princess Diana of Wales); supermodels (Heidi Klum, Molly Sims), and celebrities: (Heather Locklear, Renée Zellweger, Jada Pinkett-Smith and Catherine Zeta-Jones). Without seeing these individuals' pre-treatment profiles, it cannot be assumed nor implied that orthodontic treatment was detrimental to their profile.

Lastly Ricketts' E-line was compared to mean attractiveness ratings to look for a correlation. Similar to the S-line, as the lips approach the E-line, the mean attractiveness rating increased.

C. Comparing Evaluators

As each of viewings progressed from silhouette to facial profile picture to 3dMD™ image, each which progressively showed more and more of the subject, the mean attractiveness scores increased. A possible explanation is that as the evaluators had more facial characteristics to focus upon, less attention was focused solely on the profile or profile characteristics. For example, skin color, hair color, chin projection, eye shape, and the size and/or shape of the nose are all factors that could have influenced how a facial profile was assessed (Cochrane et al 1999). The more convex the profile, the less attractive the silhouette or profile photograph was rated by all three groups of evaluators, especially the oral surgeons. However, when the face was rotated in the 3dMD™ image, all three groups rated the images more favorably than the other two viewings.

The less critical appraisal of facial esthetics by the general public (Kerr and O'Donnell, 1990, Cochrane et al. 1999) was expected to be evident in the findings of

this study. Oral surgeons were by far the most critical in all three viewings, with the orthodontists' scores correlating closely with laypersons' scores. This was especially evident when looking at the mean scores of each of the evaluator groups. The mean visual analog score increased from viewings 1 through 3 in orthodontists and layperson groups; however, scores from the oral surgery group remained the same for viewings 1 and 2, but increased dramatically for viewing 3. The reason for this trend is not perfectly clear, however it is possible that the dynamic viewing of the entire face kept the group of oral surgeons from overly concentrating on certain facial features such as a weak chin or large nose, allowing more time on evaluating overall facial beauty.

Humans have a remarkable capacity to perceive, discriminate and remember faces. It was expected that the evaluators might be able to figure out from the facial profile photo (viewing 2) and 3dMD^{TM} image (viewing 3) that they were looking at the same individuals even though the viewings were spaced two weeks apart and subjects were randomly ordered (Davidenko 2007). While some of the evaluators figured this out, most did not until they were informed after the final viewing was completed that they were indeed looking at the same individuals. Most did not also perceive that they were evaluating photos from women who had competed in beauty pageants. The assessment of facial forms is subjective and the variability in results is perhaps not surprising. A woman who has ideal facial proportions on a silhouette may be found attractive when examining her facial profile photograph but not 3dMD^{TM} image and vice versa. This was true of some subjects, but not of the majority, when comparing responses between the different viewings (see appendices G-I).

Differences in the three groups of evaluators played a role in the range of scores among all three types of viewings. Each group of evaluators presented with their own personal bias which may be from their profession, their educational background, and clinical experience. As noted in previous studies, orthodontists preferred a slightly convex profile (as did laypersons in this study) while the oral surgeons like a straight profile with a strong chin (Lines et al. 1978, Prahl-Andersen et al. 1979, Davidenko, 2007). Some facial features such as ears, nose and chin which can be altered with surgical means may be traits unique to a face that an orthodontist or layperson may like because it complements the face.

D. Visual Analog Scale

In this study, the use of the visual analog scale proved to be a simple and rapid method for assessing the perception of facial attractiveness. Results were recorded in millimeters to obtain a better analysis and greater sensitivity in the findings. Measuring a subjective topic such as facial attractiveness raises a number of concerns. As noted in previous studies it can be extremely difficult for consumers and providers alike to interpret the anchor points of average attractive and very attractive (Howells & Shaw 1985, Montini et al 2005). This implied to them that the images they were about to see were from a group of people who are already attractive or very good looking. However, the group selected represented a segment of the population judged to be attractive by society; to get a broader range of answers required a visual analog scale that accounted for that factor. The method of measurement used to produce the ratings was such as to permit the interpretation of the ratings as a continuous variable; this allowed considerable freedom in the matter in which the data could be later handled and

analyzed. In addition, Howells and Shaw (1985) have shown there to be a good correlation between assessments made on live subjects and those made from standardized photographic records.

E. Future Research

Clearly, future investigations are needed with different racial groups and more extreme profiles to get more statistically significant evidence in this area.

For future research, ideally more faces and assessors should be used, but this will also increase the time and effort to complete any evaluation and reduce assessor cooperation. For sake of research, it would add interest if evaluators listed the reason for the grade they gave for each subject. It would also be of interest to ask clinicians whether they thought each subject had orthodontic treatment and/or extractions. Lastly if we were able to obtain radiograph records on all these women that had treatment we could also look at the hard tissue measurements cephalometrically in comparison to their soft tissue measurements.

Finally, another area that could be further developed is to investigate intra-rater reliability. For example, if we placed 10 silhouettes on a table, numbered 1 to 10 to be evaluated, then two weeks later had them reevaluated to check for bias as well as to see if the evaluator would rate the same images differently based on the order of viewing. This would allow comparison judging, where images are ranked when evaluating them in a group, versus judging them individually as was performed in this study.

VI. CONCLUSIONS

Dental professionals must understand a patient's goals and perceptions of normal and how those differ from their own perceptions and goals. The results of this study confirmed that clinicians and the general public evaluate facial esthetics differently, and there is clearly a disagreement on what is perceived attractive. Orthodontists and oral surgeons need to be aware of how the patient perceives his or her own appearance. A failure to communicate may result in patient dissatisfaction despite well planned and executed procedures.

Orthodontists and oral surgeons play a deciding role in determining the esthetic destiny of a patient's face, but they must take into account the patient's perception of their own face before treatment planning. Orthodontists are obliged to study facial beauty, balance, harmony and proportion as perceived, not just through their own eyes but also through those of the general public. Harmony and facial balance are not fixed concepts.

Facial proportions are one of many characteristics to describe facial harmony but are not the only contributing factor. The results from this research showed that there were added qualities beyond facial proportions that affect attractiveness. This includes the convexity of the face, prominence of the lips, the distance of upper lips to S-line, whether or not they had orthodontic treatment, the eyes, the ears, the nose, the lips and the chin.

Everyone admires beauty and it is truly a unique balance in nature. It has been said that everything has beauty, but not everyone sees it. However, studies have

shown that the harmony and more specifically the proportions of a face show that beauty can be mathematically defined (Ricketts 1982). The search for beauty or the "ideal face" has continued to evolve. Beauty may be in the eye of the beholder, but to some extent lies in the hands of the orthodontist and the oral surgeon. The attractiveness of one's face and harmony can be expressed quantitatively. In an attractive face, proportions and relationship of soft tissue features are balanced. When their relationship is disrupted, the disharmony reduces the esthetic quality of the face. Facial esthetics does not depend on any single feature, and there is some evidence that a public agreement of facial beauty exists. Showing only the profile is problematic, because the perception of facial attractiveness appears to be affected by which view of the face is presented, and the preferred view as noted in this study was not consistent across subjects with each of the evaluators.

This study showed that there was a difference in perception of attractiveness of facial esthetics in women between what laypersons and orthodontists perceived when compared what the oral surgeons perceived. In addition, the results confirm the hypothesis that evaluators' perceptions of facial attractiveness when evaluating silhouettes is not closely tied to perceived beauty when viewing profile photographs or three dimensional images. Three dimensional photography has evolved the process of diagnosis and treatment planning in providing the patient and the clinician with more information in planning the outcome of treatment.

Appendix A

Subject Information Card

Number #_____

Name_____

Age_____ Date of Birth_____

Phone Number: _____ email:_____

Race: _____

Have you had braces? (Please circle) __Yes No

If so when and for how long?_____

Did you have any teeth removed? (Please circle) __Yes No

Pageant History, please include previous pageants entered, titles:

_____

_____

_____

Appendix B

FWH20110160H
WILFORD HALL MEDICAL CENTER

INFORMED CONSENT DOCUMENT

(ICD Template Version 6. Jan 08)

A Challenge to Classical Facial Proportionality Studies: Conventional Profile & 3D Photography Versus Silhouettes

INFORMATION ABOUT THIS CONSENT FORM:

You may be eligible to take part in a research study. This form gives you important information about the study. You may be asked to sign in more than one place in this document.

Please take time to review this information carefully. You should talk to the researchers about the study and ask them any questions you have. You may also wish to talk to others (for example, your friends, family, or a doctor) about your participation in this study. If you decide to take part in the study, you will be asked to sign this form. Before you sign this form, be sure you understand the procedures of the study and what the study is about, including the risks and possible benefits to you.

Please tell the researchers or study staff if you are taking part in another research study.

VOLUNTARY PARTICIPATION:

Taking part in this study is completely voluntary. You should not feel coerced or intimidated into participating in this project. You do not have to participate if you don't want to. You do not have to participate in this study in order to get standard medical treatment. If significant new findings develop during the course of this study that may relate to your decision to continue to participate, you will be informed.

PRINCIPAL INVESTIGATOR:

The Principal Investigator (PI) is the researcher directing this study; the PI is responsible for protecting your rights, safety and welfare as a participant in the research. The PI for this study is

Corinne Devin, DMD, LT, USN,

Resident Tri-Service Orthodontic Residency Program (TORP)

DESCRIPTION/PURPOSE OF RESEARCH (Why is this study being done?)**:**

The objective of this study is to determine if 3-dimensional photography can produce greater benefits for clinicians than traditional 2-dimensional photographs when evaluating orthodontic cases. An increased understanding of the soft tissue profile will help clinicians produce attractive facial results with their patients.

You are being asked to consider participation in this research study. The purpose of this research is to challenge the orthodontic facial proportion norms by assessing the observations of facial attractiveness when examining women in silhouettes as in classical studies and in photographic 3-D images.

In this study we will be using photographs of your face from the front and side to construct silhouettes and photographic 3-D images.

You have been selected to participate in this study because you are between ages of 18-35 years and have met the inclusion criteria. Your participation in this study will end today after the photographs have been taken.

This study will enroll approximately __30___ subjects.

PROCEDURES:

If you decide to take part in this research study, you will be asked to sign this consent form.

Before you participate in any part of this research study, we will explain this study to you and you will be able to ask any questions you wish about the research. Once you understand the procedure and if you decide to take part in this research study, you will be asked to sign this consent form.

Study Procedures - as a participant, you will undergo the following procedures:

- Provide the following information: name, age, race, and pageant history.
- Pose for a frontal and profile photograph of the head and neck only, taken in a relaxed position. You will be instructed to maintain a neutral facial expression, looking straight ahead with lips held gently together.
- All photographs will be taken with 3-dimensional camera (3dMD ©) and a conventional digital camera (Nikon D90 SLR) behind a white poster board in a natural head position.
- Total time to complete this will be approximately 5 minutes.
- The photographs from Nikon D90 SLR will be used to fabricate silhouettes. The silhouettes, photographs and 3dMD © images will be used for a timed powerpoint ® slideshow to be assessed by a panel of evaluators, and each photo will only be shown for approximately 20 seconds or less.
- Other than your photos, all other identifiable information will not be released to the evaluators.
- Facial photos are considered study-related and the release of the facial photos for publication must be approved by each subject through the informed consent process. Please initial the option you choose listed below regarding publication of your facial photos.
    - _____I agree to have my facial photos released for publication provided all identifying information has been eliminated.
    - _____I do not agree to have my facial photos released for publication.

RISKS OR DISCOMFORTS:

There is no known risk associated with this study.

Risks from the overall research plan:

The study also carries the risk of breach of confidentiality.

Risks from the specific research procedures (drug(s), interventions, or procedures)

None.

Are there risks if you also participate in other research studies?

Being in more than one research study at the same time, may increase the risk to you. It may also affect the results of the studies. You should not take part in more than one study without approval from the researchers. There may also be unforeseen risks associated with this or any research study.

WITHDRAWAL FROM THE STUDY:

If you first agree to participate and then you change your mind, you are free to withdraw your consent and discontinue your participation at any time. Your decision will not

affect your ability to receive medical care and you will not be penalized or lose any benefits to which you would otherwise be entitled.

ARE THERE RISKS RELATED TO WITHDRAWING FROM THE STUDY?

If you decide to withdraw from this study early, please discuss your decision with the principal investigator. There is no risk to you if you do not complete the final withdrawal procedures and you can choose not to participate in them.

ADDITIONAL CIRCUMSTANCES OF WITHDRAWAL:

The researcher may withdraw you from the study prior to the study's end and the study, without your consent for one or more of the following reasons:

- Failure to follow the instructions of the researchers and study staff.
- The researcher decides that continuing your participation is not in your best interests.
- The study is cancelled.
- Other administrative reasons.
- Unanticipated circumstances.

BENEFITS:

The investigators have designed this study to learn if the diagnostic 3-D photos is as good as, better, or even worse than the most commonly taken 2-D conventional photos. However, there is no guarantee or promise that you will receive any benefit from this study other than knowing that the information may help future patients.

The possible benefit of your participation in this study will help provide a better understanding between providers and patients in achieving their goals in orthodontic treatment, a beautiful smile.

COSTS: Will taking part in this study cost anything?
The investigators have designed this study so that there is no cost to you to participate in this study.

PAYMENT (COMPENSATION):
You will not receive any compensation (payment) for participating in this study.

ALTERNATIVES TO PARTICIPATION:

Choosing not to participate in this study is your alternative to volunteering for the study.

CONFIDENTIALITY OF RECORDS OF STUDY PARTICIPATION:

Records of your participation in this study may only be disclosed in accordance with federal law, including the Federal Privacy Act, 5 U.S.C. 552a, and its implementing regulations. DD Form 2005, Privacy Act Statement- Military Health Records, contains the Privacy Act Statement for the records.

By signing this consent document, you give your permission for information gained from your participation in this study to be published in medical literature, discussed for educational purposes, and used generally to further medical science. Data collected other than facial photos will be de-identified and presented as anonymous data.

Your records may be reviewed by the U.S. Food & Drug Administration (FDA), the Air Force, the DoD, other government agencies that oversee human research, the WHMC Institutional Review Boards, and Tri-Service Orthodontic Residency Program.

Identifying information will be coded with computer password protection, creation of firewalls around the data, and locking of drawers and offices. All data will be kept at Dunn Dental Clinic.

A copy of this consent will be provided for you. A copy of this consent will be stored by the investigator in a locked cabinet in a locked room. Information collected on this study about you that will affect your medical care will be placed in your medical record. All information about you collected on this study will be kept in an electronic database, which will be double password protected and the access will be restricted to people involved in this study. As soon as possible any link between your identity and the research information will be destroyed. The research information collected about you for this study will not be used for any additional research activity beyond what you have approved by signing this consent.

The study staff advises that you protect your copy of the informed consent document. A breach of confidentiality could occur if you inadvertently lose this document or allow others to view the document. In the unlikely event that you experience a loss of confidentiality, the study staff will take appropriate action to assist you.

Complete confidentiality cannot be promised, particularly for military personnel, because information regarding your health may be required to be reported to appropriate medical or command authorities.

ENTITLEMENT TO CARE:

The researchers have taken steps to minimize the known or expected risks. However, you may still experience problems or side effects, even though the researchers are careful to avoid them. If you believe that you have been harmed, notify the researchers as soon as possible. You may also need to tell your regular doctors.

In the event of injury resulting from this study, the extent of medical care provided is limited and will be within the scope authorized for Department of Defense (DoD) health care beneficiaries.

Your entitlement to medical and dental care and/or compensation in the event of injury is governed by federal laws and regulations, and if you have questions about your rights as a research subject or if you believe you have received a research-related injury, you may contact the Wilford Hall Chief, Clinical Research, (210) 292-7069 or Wilford Hall Medical Center Risk Manager, 210-292-6004.

If you sign this form, you do not give up your right to seek additional compensation if you are harmed as a result of being in this study.

BLOOD, TISSUE & BIOLOGICAL SAMPLES:

No blood or tissue samples will be taken as part of this study.

CONTACT INFORMATION:

Principal Investigator (PI):

The principal investigator or a member of Tri-Service Orthodontic Residency Program staff will be available to answer any questions concerning procedures throughout this study.

Principal Investigator: Corinne Devin, LT, USN, DC Phone: (210) 671-9324

Institutional Review Board (IRB):

The WHMC Institutional Review Board (IRB), the hospital committee responsible for safeguarding your rights as a research subject, has assigned a member of the IRB, who is not part of the study team, to serve as an outside monitor for this study (this person is the Medical Monitor). If you have any questions about your rights as a research subject, research-related injuries or any other concerns that can not be addressed by the PI, you can contact the medical monitor, James A. Barker M.D. at (210) 916-7338. Or mail to: 59th CSPG/SGVUS, 2200 Bergquist Dr, Lackland Air Force Base, Texas 78236.

In addition, if you have any comments, questions, concerns or complaints, you may also contact the Chairperson of the IRB, at (210) 916-8251. Or mail to: 59th Medical Wing/CM, 2200 Bergquist Drive, Lackland Air Force Base, Texas 78236.

Your consent to participate in this study is given on a voluntary basis. All oral and written information and discussions about this study have been in English, a language in which you are fluent.

If you agree to participate in this research sign this section. You do not waive any of your legal rights by signing this form.

SIGN THIS FORM ONLY IF THE STATEMENTS LISTED BELOW ARE TRUE

- You have read the above information.
- Your questions have been answered to your satisfaction.

A signed copy of this form has been given to you.

_____ _____

VOLUNTEER'S SIGNATURE **DATE**

_____ _____

VOLUNTEER'S PRINTED NAME **DOB**

_____

VOLUNTEER'S ADDRESS (street, city, state, zip)

_____ _____ ____-_____-_____

ADVISING INVESTIGATOR'S SIGNATURE **DATE** **PHONE NUMBER**

_____

PRINTED NAME OF ADVISING INVESTIGATOR

_____ _____

WITNESS' SIGNATURE **DATE**

(Must witness ALL signatures)

_____

PRINTED NAME OF WITNESS

_____

Subject's Stamp Plate

PRIVACY ACT OF 1974 APPLIES.

DD FORM 2005 FILED IN MILITARY HEALTH RECORD

Appendix C

WILFORD HALL MEDICAL CENTER

AUTHORIZATION TO USE AND DISCLOSE PROTECTED HEALTH INFORMATION FOR RESEARCH
(APHI Template Version 3, Jan 04)

You are being asked for permission to use or disclose your protected health information for research purposes in the research study entitled:

A Challenge to Classical Facial Proportionality Studies: Conventional Profile & 3D Photography Versus Silhouettes

The Health Insurance Portability & Accountability Act of 1996, Public Law 104-109 (also known as HIPAA), establishes privacy standards to protect your health information. This law requires the researchers to obtain your authorization (by signing this form) before they use or disclose your protected health information for research purposes in the study listed above.

Protected Health Information Definition:

"Any identifiable information (including demographic information) collected from an individual, that is created or received by a health care provider, health plan, employer or health care clearing house, and relates to (a) the past, present, or future physical or mental health or condition of an individual; (b) the provision of health care to the individual and identifies the individual or there is a reasonable basis to believe can be used to identify the individual."

Identifiers:

• ***Names***	• ***Health plan beneficiary numbers***
• ***Phone numbers***	• ***Device identifiers and serial numbers***
• ***Fax numbers***	• ***Internet Protocol (IP) address numbers***
• ***Dates except year***	• ***Web Universal Resource Locators (URLs)***
• ***E-mail addresses***	• ***Ages over 89 (can be grouped as age 90 or older)***
• ***Account numbers***	• ***Biometric Identifiers, including finger & voice prints***
• ***Social security numbers***	• ***Full face photographic images and any comparable images***
• ***Medical record numbers***	• ***Any other unique identifying number, characteristic, or code***
• ***Certificate/license numbers***	• ***Vehicle identifiers & serial numbers, or license plate numbers***
	• ***Address other than state, and first three digits of the zip code***

Your protected health information that may be used and disclosed in this study includes:

- Identified photographs of your face from the frontal and profile being shown to evaluators for 20 seconds.
- The primary investigator will ask for the following demographic information: name, age, race, dates of possible prior orthodontic history (yes or no, if yes, for how long, if they have had any teeth removed- yes or no) and dates of pageant history-including previous pageants entered and titles. None of this information will be disclosed nor seen by the evaluators of this study.

Your protected health information will be used for:

- *The demographic information of the participants will be used to describe the characteristics of the participants in the study. The photographs will be used to identify the facial proportions as well as attractiveness. Profile photographs of the individual's faces will be used to create silhouettes which will also be used to evaluate the facial proportions and attractiveness. The results and pictures taken may be included in a published article. The participant's photo,*

silhouette and 3dMD © image to be featured in print will be contacted by email and telephone.

The disclosure of your protected health information is necessary in order to be able to conduct the research project described. Records of your participation in this study may only be disclosed in accordance with federal law, including the Federal Privacy Act, the Health Insurance Portability and Accountability Act of 1996, 5 U.S.C.552a, and its implementing regulations. DD Form 2005, Privacy Act Statement - Military Health Records, contains the Privacy Act Statement for the records. Note: Protected health information of military service members may be used or disclosed for activities deemed necessary by appropriate military command authorities to ensure the proper execution of the military mission.

By signing this authorization, you give your permission for information gained from your participation in this study to be published in medical literature, discussed for educational purposes, and used generally to further medical science. You will not be personally identified; all information will be presented as anonymous data.

The Principal Investigator may use and share your protected health information with:

- The WHMC Institutional Review Board
- State and Federal Government representatives, when required by law
- WHMC or Department of Defense representatives
- Tri-Service Orthodontic Residency Program

The researchers agree to protect your health information by using and disclosing it only as permitted by you in this Authorization and as directed by state and federal law.

You need to be aware that some parties receiving your protected health information may not have the same obligations to protect your protected health information and may re-disclose your protected health information to parties not named here. If your protected health information is re-disclosed, it may no longer be protected by Federal Privacy Regulations.

You do not have to sign this Authorization. If you decide not to sign the Authorization:

- It will not affect your treatment, payment or enrollment in any health plans or affect your eligibility for benefits.
- You may not be allowed to participate in the research study.

After signing the Authorization, you can change your mind and:

- Notify the researcher that you have withdrawn your permission to disclose or use your protected health information (revoke the Authorization).
- If you revoke the Authorization, you will send a written letter to Corinne Devin, LT, USN, DC 59th DTS/SGDTR, Resident Tri-Service Orthodontic Residency Program, Dunn Dental Clinic, 1615 Truemper St, Suite D-200 Lackland AFB, TX 78236 to inform her of your decision.
- If you revoke this Authorization, researchers may only use and disclose the protected health information already collected for this research study.
- If you revoke this Authorization your protected health information may still be used and disclosed should you have an adverse event (a bad effect).
- If you withdraw the Authorization, you may not be allowed to continue to participate in the study.

This Authorization does not have an expiration date.

During your participation in this study, you will not be able to access your research records. This is done to ensure the study results are reliable. After the completion of the study, you have the right to see or copy your research records related to the study listed above. A Request for Access must be made in writing to Corinne Devin, LT, USN, DC 59th DTS/SGDTR, Resident Tri-Service Orthodontic Residency Program, Dunn Dental Clinic, 1615 Truemper St, Suite D-200 Lackland AFB, TX 78236.
If you have not already received a copy of the Military Health System Notice of Privacy Practices, you may request one. If you have any questions or concerns about your privacy rights, you should contact the Wilford Hall Medical Center Privacy Officer at (210) 292-5082 or 292-5318.

You are the subject or are authorized to act on behalf of the subject. You have read this information, and you will receive a copy of this form after it is signed.

_____ _____

Volunteer's or Legal Representative's Signature **Date**

_____ _____

Volunteer's or Legal Representative's Printed Name **Sponsor's Printed Name**

_____

Relationship of Legal Representative to Volunteer

_____ _____

Signature of Witness **Date**

_____

Printed Name of Witness

Appendix D

Information Letter Sent to Pageant Delegates for Beauties of America Pageant and United America Pageant

Dear Ladies,

I'm so excited to meet you all at the Beauties of America Pageant in San Antonio this August/United America Pageant in Austin this October. My name is Corinne Devin and I have been involved in pageantry for the last 6 years from competing to judging. Also I am an orthodontic resident at Lackland Air Force Base San Antonio, Texas.

At the Beauties of America Pageant/United America Pageant, I will be asking you to participate in my research study. The objective of this study is to determine if 3-dimensional photography can produce greater benefits for clinicians than traditional 2-dimensional photographs when evaluating orthodontic cases.

The purpose of this research is to challenge the orthodontic facial proportion norms by assessing the observations of facial attractiveness when examining women in silhouettes as in classical studies and in photographic 3-D images. To qualify for this research you must be between the ages of 18 and 35 and have experience in pageants.

Your participation in this study will include several facial photos and completing a brief information card. It should take you approximately 5 minutes to complete. There are no risks anticipated by participating in this study. Your participation in this study will be confidential and all responses to the survey will be reported in aggregate and not by individual. Your facial photos will only be reviewed for 15-20 seconds, but your name, age, or any other identifiable information will not be released.

If you do not wish to participate in this study, that is fine. Your participation is entirely voluntary. I will be at the orientation to pass out more information and take facial photos following orientation and during interviews.

If you have any questions, please feel free to contact me at 210-671-9324 or 702-300-0750; usnavygirl07@yahoo.com; corinne.devin@us.af.mil.

Sincerely

Corinne Devin, LT, USN, DC
59th DTS/SGDTR, Resident
Tri-Service Orthodontic Residency Program
1615 Truemper St, Suite D-200
Lackland AFB, TX 78236

Appendix E
Evaluator Panel Script

Welcome, my name is Corinne Devin and I am an Orthodontic Resident at Lackland AFB San Antonio, Texas.

You have been selected to participate in my study evaluating facial attractiveness of the following images shown on power point.

Each slide is numbered and will be displayed for 10 seconds. On the sheet in front of you will find a visual analog scale for each image. On one end of the scale is average attractive and on the other is very attractive. Please mark on the scale where you find the image falls on facial attractiveness. Once it is mark please do not go back and change it.

Your participation in this study will take approximately __3_____ minutes to complete.

In two weeks, I will have you return to look at another set of images. There are no risks anticipated by participating in this study. Your participation in this study will be confidential and all responses to the survey will be reported in aggregate and not by individual.

If you have any questions, please feel free to contact me at _210-671-9324 or 702-300-0750; usnavygirl07@yahoo.com; corinne.devin@us.af.mil.

Sincerely

Corinne Devin, LT, USN, DC
59th DTS/SGDTR, Resident

Tri-Service Orthodontic Residency Program
1615 Truemper St, Suite D-200
Lackland AFB, TX 78236
Front desk: 210-671-9324 or DSN 473-9324
Office: 210-671-9845
Operatory: 210-671-9836
Fax: 210-671-9303

Appendix F

Evaluation Form

Name_____

Please give each silhouette/facial profile photograph/3-D image a rating on the visual analog scale.

1. |----------|

Average attractive Very Attractive

2. |----------|

Average attractive Very Attractive

3. |----------|

Average attractive Very Attractive

4. |----------|

Average attractive Very Attractive

5. |----------|

Average attractive Very Attractive

6. |----------|

Average attractive Very Attractive

7. |----------|

Average attractive Very Attractive

8. |----------|

Average attractive Very Attractive

9. |----------|

Average attractive Very Attractive

10.|----------|

Average attractive Very Attractive

11.|----------|

Average attractive Very Attractive

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Appendix G Viewing 1 Silhouette

Visual Analog Scale Rating -->	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Evaluators																														
Oral Surgeons:																														
1.(A)	3.1	4.8	3.2	2.5	1.7	2.5	5	7.1	8.3	5.4	6.6	2.5	3.1	7.1	5.3	5.4	7.6	4.2	7.7	7.2	5.4	2.9	6.9	3.1	1.8	2.4	1.9	8.1	7.2	5.1
2.(B)	5	2.3	3	1.6	1.2	1.5	4.1	1.8	1.7	1.8	5.5	1.6	2.4	3.5	1.5	1.5	1.3	2.9	3.9	2.2	2	1.5	5	1.7	1.7	1.1	1.4	6.6	4.5	1.6
3.(C)	2.1	7.8	6.6	6.5	2.3	5.7	7.3	6.9	8.7	3.5	4.4	6.8	4.4	5.4	4.3	7.3	3.3	2.3	7.3	3.6	5.8	5.9	7.7	4	1.7	4.5	4.8	6.6	6.6	1.9
4.(D)	3.6	5.8	3.3	2.9	0	0	7.6	1.6	2.1	2.8	7.5	3.2	1.1	4.1	2.3	5.7	2.5	0	5.1	2.6	5.2	3	5.1	2	1.5	2.6	1.3	2.6	3.6	2.9
5.(E)	4.3	3.5	7.1	5.5	3	3.1	2.8	4.4	5.3	2.8	2.8	3	3.2	2.9	4.1	5.3	4.9	1.9	5.4	5.3	8.1	4.9	3.6	5.2	2.5	1.8	2.7	5.3	2.8	4.2
Orthodontists:																														
1.(A)	5.9	3.6	4	4.9	3.2	4.6	6.9	6.5	4	4.1	5.4	6.1	2.9	4.1	3.8	5.6	3.6	5.2	5.2	5.3	5.9	3.4	3.4	3.5	2.6	4.8	4	6.3	8.2	4.5
2.(B)	6.2	4.1	6.6	2.7	2.5	4.6	6.3	5	4.3	3.4	7.5	4.1	3.4	6.7	3.3	6	5.3	2	6.4	5	3.9	2.8	6.4	5.4	2	2.1	2.9	7.8	3.9	3.8
3.(C)	8.3	8.4	5.9	7.5	5.6	7.1	7.8	5.4	2.3	1.8	8.2	5.7	5.6	7.7	7.4	7.6	4.6	3.6	7.1	2.1	3.2	1.8	7.7	5.9	2.1	2.8	8.3	7.7	3.1	6.8
4.(D)	7.8	4.3	6.8	5.7	4.5	5.4	7.8	7.2	7.2	6.5	7.6	7.2	6.5	6.8	6.4	7.7	3.6	6.3	8.1	9.1	6.9	5.9	7	6.2	2.8	5.7	3.7	8.3	6.4	7.6
5.(E)	6	5.1	3.8	2.2	3.5	2.1	5.7	7.9	2.7	1.2	4.5	3.2	1.2	4.6	2.4	4.3	3.3	1.2	4.5	3.2	3.8	1.1	4.5	2.8	1	1.1	5	3.9	2.5	1.5
Lay People:																														
1.(A)	5.9	7.7	5	4.7	6.8	1.8	8.2	6.2	7.5	5.1	7.5	2.9	6.5	4	3.1	9.5	5.1	2.3	7.3	4.9	9.4	3.2	3.1	3.9	1.6	2.7	7	8.6	6.3	4.2
2.(B)	3	3	3.5	3.2	2.1	3	3	3.9	5.4	3.5	4.9	2	3.6	4.1	3.2	4.8	3.9	3	4.4	4.3	4.8	3.5	3.8	4.1	1.9	4.3	2.9	5.5	5.5	3.6
3.(C)	3	4.6	3.1	5.4	4.4	3.2	3.2	3.7	5.9	5.1	2.5	3.5	3.3	6.6	4.1	5.8	4.1	1.4	6	5.1	5.7	4.4	5.7	4.2	1.3	1.4	5.1	6.5	6.9	4.3
4.(D)	2.5	6.5	7.1	4.3	5.5	4.4	7.4	6.4	4.2	5.1	8	3.9	3.7	4.8	5.2	6.8	4.8	4.6	6.9	6.1	7.8	3.7	4.8	4.9	2.6	4.5	5	7.9	4.3	5.3
5.(E)	3.6	5.1	5.6	3.5	1.9	4.4	5.3	3.3	3.4	4	6.7	3.5	6.4	6.4	4.5	6.4	4.4	1.9	5.4	5.3	6	6.8	6.5	3.8	2.5	3.4	3.5	7.5	4.5	2.9

Appendix H Viewing 2 Facial Profile Picture

Visual Analog Scale Rating -->	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Evaluators																														
1.(A)	4.3	4.8	6.6	4.2	5.9	3.3	6.4	6.8	4.2	5.7	6.5	5.9	6	5.3	5.5	3.7	6.7	3.6	6	7.2	6.6	6	4.8	4.5	3.6	3.7	3.7	7.3	5.5	4.5
2.(B)	2.1	2.6	2.6	1.5	3.9	3.8	3.3	2.2	1.4	3.2	4.8	2.7	3	3.3	2.8	1.7	2.4	1.6	4.6	3.2	4.3	2.5	2.1	3.1	1.7	2.6	3	4.4	2.8	3.4
3.(C)	4.3	4	8	6.1	2.9	5.7	2.8	3.8	3.7	7.2	3.6	5.1	3.2	4.5	6.8	3.5	6.2	2.6	5	4.2	8.3	6.1	3.1	7.2	2.7	5.1	3.6	3.7	8.1	3.6
4.(D)	2.1	2.7	4.2	3.1	1.6	1.9	1.6	3.3	3	5.4	5.4	2	3.8	5.4	3.9	3.5	0	2.4	5.5	6.1	3.8	3.6	3	5.2	1.6	1.6	1	6.2	3.2	2.3
5.(E)	4.1	3.3	5.2	3.3	4.1	2.2	2	3.8	1.8	3.3	3	2.5	3.6	2.5	3.3	2.9	5.8	3	4.3	5.1	3.7	2.8	2.1	3.7	1.6	2.5	3.5	6.1	3.1	3
Orthodontists:																														
1.(A)	3.6	4.4	6.1	2.6	4.2	3.7	6.8	4.2	3.1	3.5	8	4.2	2.9	5.5	7	5.1	3.8	5	3.8	8	7.2	3.7	4.4	3.7	2.9	3.2	4	5.7	2.7	4.1
2.(B)	5.5	3.7	5.7	3	4.7	5.2	5.1	4.3	3.4	3.9	7.1	5.4	5.4	6	3.4	4.8	5.1	4.2	7.4	7	4.3	4	4.9	5.3	4.3	2.7	3.8	8.2	3.6	3.5
3.(C)	8.7	4.9	7.4	2.8	6.2	6.7	6.7	5.5	3.1	2.3	8.5	5.1	7.6	4	4.9	3.6	6.7	4.1	7.8	3.7	4.4	5.5	4	3.5	2.6	4.5	7.4	7.8	6.9	6.2
4.(D)	8.4	5.7	5.6	7.1	5.5	6.8	7.7	7.1	7.6	4.9	7.5	6.7	7	6.9	6.1	6.9	4.7	7.1	6.4	7.8	7	5.7	6.2	6.2	4.2	5.6	6.3	8.2	6.9	6.9
5.(E)	5.5	4	6.6	5.7	5.3	3.7	3.4	3.5	3.2	4.1	3.9	2.2	5	4.8	3.4	5.6	5.4	2.7	5.6	4.6	5.8	3.2	4.7	2.7	1.7	1.7	5.1	6.7	3.7	4.9
Lay People:																														
1.(A)	7.7	4.7	6.9	5	5.1	5.1	6.2	3.7	4.4	5.8	6.7	6	6.7	6.4	6	9.2	5.9	2	6.7	7.5	7.2	3.8	5.4	2.7	1.6	2.1	3	8.2	6	5.4
2.(B)	6.3	4.8	5.4	6.1	5.1	3.4	3.8	5.2	4.2	5.2	3.4	4.7	5.7	4.2	6.2	4.9	4.7	3.9	7	5.8	6.1	5	4.6	6.1	5.2	4.1	4.9	6.1	4.4	5.8
3.(C)	3.2	5.1	5.6	6.4	6.6	4.1	4.6	4.3	3.8	5.9	4.7	4.5	4	5.1	2.4	4.7	5.7	1.9	5.4	4.4	5	6.6	5.1	3.4	3.5	2.9	2.8	6.6	4.2	4.9
4.(D)	7.5	8.6	7.7	6.7	7.2	6.7	7.5	6.7	6.5	8.2	8.5	4.2	6.3	7.6	7.2	7.3	6.9	6.8	6.4	8.3	9.2	6.7	7.6	7.2	3.5	5.5	6.1	9.2	4.2	7.2
5.(E)	4.9	5.5	6	5	4.8	4.4	5.1	4.4	4.5	5.4	6.7	4.9	5.5	6.2	6.3	3.1	5.5	4.1	4.4	6.4	4.6	3.7	5.3	4.8	3.6	3.7	4.6	6	4.7	4.6

Appendix I Viewing 3 3dMD™ Image

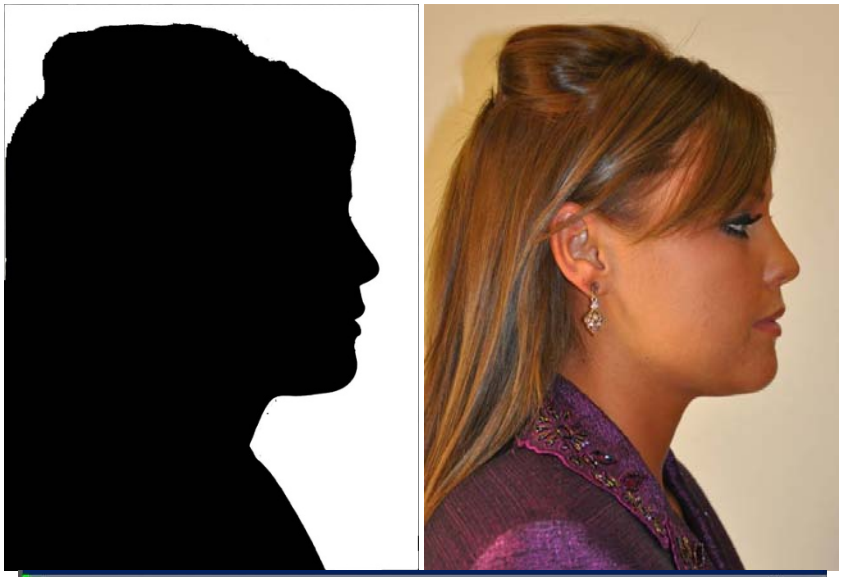
Visual Analog Scale Rating -->	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Evaluators																														
Oral Surgeons:																														
1.(A)	7.1	4.3	5.6	6.8	4.8	5.5	5	4.6	4.6	5.1	6	4.9	5.6	6.3	6.3	5.7	5.1	4.7	6	6.4	6.9	5	6.7	6.7	5.9	5	5.8	7.1	5	5
2.(B)	3.8	2.5	3.5	3.3	3.4	3.7	6.3	1.4	1.1	2.7	2.8	3.1	2	2	2.1	1.4	2.3	2.1	1.9	3	4.3	2.4	2.3	2.2	1.2	1.3	1.9	3.6	3.7	2.5
3.(C)	8.5	4.7	5.8	9.2	3.7	5.3	7	3.8	2.5	5	6	4.1	4.8	6.6	7.5	5.6	4.5	3.5	7.7	7.2	9	3.4	7.1	6.3	4.1	3.6	4.5	8.3	6.2	3.6
4.(D)	8	3.5	7.3	8	5.4	3.4	7	5.7	3.8	2.4	6.4	2.4	1.9	5.7	2.3	4.2	4.8	1	5.9	6.1	3	1.9	5.9	2.7	2.7	2.8	2	5.7	4.2	3.5
5.(E)	7.7	3.9	6	7	7	5.3	6.6	3.9	3.7	6	6	5.9	5.4	6	5.3	5.3	3.7	3.4	5.2	6	4.7	4	4.6	3	3.3	2	3.3	6.9	5.2	3.7
Orthodontists:																														
1.(A)	4.6	3.7	4.2	5.4	6.1	5.5	6.8	5.1	3.9	4.7	5.4	5.6	6	5	6	6.1	4.2	4.6	5.9	5.4	6.5	4.1	5.3	5.1	4.1	3.3	4.6	5.1	3.6	4.9
2.(B)	7.3	5	5	4.1	4.5	5.5	6.3	3.8	3.3	4.4	7.3	5.2	4.5	5.4	4.6	3.8	4.5	2.4	5.7	6.6	5.5	3.3	6.1	4.3	3.3	2.6	3.5	7	1.9	3
3.(C)	9.3	8	8	8.1	8.4	8.4	8.4	6.2	4.4	2.2	8.6	8.5	8.2	7.9	4.4	4.5	7.6	6	8.8	3.7	8.3	5.6	7.6	5.3	4.4	6.7	3.2	8.1	3	3.7
4.(D)	7.9	7.1	6.5	7.1	5.3	6.5	6.6	5.2	6.1	5.3	6.5	6.6	6.4	6.6	4.8	5.7	4.6	6	5.2	5.4	6.7	3.8	6	6.3	4	4.1	5.4	7	4.6	6.5
5.(E)	5.7	3.4	3.4	4.9	2.1	6.2	6.7	5.3	4.9	2.7	7.4	6.1	7.5	7.9	7.4	5	6.4	5.5	6	6.7	7.8	2.5	7.8	5.8	5.2	5	5.2	8.3	8.1	5.9
Lay People:																														
1.(A)	9.5	3.3	8.2	9.8	5.8	8.4	9.6	2.4	1.6	5.7	9.6	7.3	6.4	8	7.8	9.6	4.9	3.1	6.1	5.4	8.7	2.1	5.3	5.3	2.1	2.1	7.7	8.4	4.7	2.9
2.(B)	5.7	3.9	7.2	8.5	6.8	5.9	5.6	4.9	4.1	6.9	4.6	5.1	7.3	6.3	7.9	7.9	5.8	2.9	8	6.8	5.6	5.7	6.4	6	7.4	4.7	5.2	8.9	7.4	6.6
3.(C)	5.2	2.9	5.5	6	5.6	5.7	5.8	3.9	3.9	4.3	6	6	5.4	5.5	3	5.4	5.6	1.8	4.4	4.5	5.3	3.8	6	4.2	2.8	2.6	4.4	4.4	3.9	4.1
4.(D)	9	5.7	6.6	7.7	4	9.2	8.2	4.2	2.9	2	9	5.7	3.7	5.5	6.2	4.2	2.1	3.4	8	3.4	8.4	1.7	4.4	5.1	3.5	2.1	3.1	6.5	3.1	8.1
5.(E)	7.4	4.3	5.5	7.6	5.6	5.4	6.4	4.2	3.7	4.7	7.6	3.8	6	5.4	5.5	4.3	4	3.6	3.8	6.7	4.9	4.4	6.1	4.6	3.6	3.5	4.9	5.3	4	4.7

Appendix J Effects of Orthodontic Treatment

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Evaluators																															
Oral Surgeons:																															
Viewing 1	3.62	4.84	4.64	3.8	1.64	2.56	5.36	4.36	5.22	3.26	5.36	3.42	2.84	4.6	3.5	5.04	3.92	2.26	5.88	4.18	5.3	3.64	5.66	3.2	1.84	2.48	2.42	5.84	4.94	3.14	**3.9**
Viewing 2	3.38	3.48	5.32	3.64	3.68	3.38	3.22	3.98	2.82	4.96	4.66	3.64	3.92	4.2	4.46	3.06	4.22	2.64	5.08	5.16	5.34	4.2	3.02	4.74	2.24	3.1	2.96	5.54	4.54	3.36	**3.9**
Viewing 3	7.02	3.78	5.64	6.86	4.86	4.64	6.38	3.88	3.14	4.24	5.44	4.08	3.94	5.32	4.7	4.44	4.08	2.94	5.34	5.74	5.58	3.34	5.32	4.18	3.44	2.94	3.5	6.32	4.86	3.66	**4.6**
Mean OMFS	**4.67**	**4.03**	**5.20**	**4.77**	**3.39**	**3.53**	**4.99**	**4.07**	**3.73**	**4.15**	**5.15**	**3.71**	**3.57**	**4.71**	**4.22**	**4.18**	**4.07**	**2.61**	**5.43**	**5.03**	**5.41**	**3.73**	**4.67**	**4.04**	**2.51**	**2.84**	**2.96**	**5.90**	**4.78**	**3.39**	**4.1**
Orthodontists:																															
Viewing 1	6.84	5.1	5.42	4.6	3.86	4.76	6.9	6.4	4.1	3.4	6.64	5.26	3.92	5.98	4.66	6.24	4.08	3.66	6.26	4.94	4.74	3	5.8	4.76	2.1	3.3	4.78	6.8	4.82	4.84	**4.9**
Viewing 2	6.34	4.54	6.28	4.24	5.18	5.22	5.94	4.92	4.08	3.74	7	4.72	5.58	5.44	4.96	5.2	5.14	4.62	6.2	6.22	5.74	4.42	4.84	4.28	3.14	3.54	5.32	7.32	4.76	5.12	**5.1**
Viewing 3	6.96	5.44	5.42	5.92	5.28	6.42	6.96	5.12	4.52	3.86	7.04	6.4	6.52	6.56	5.44	5.02	5.46	4.9	6.32	5.56	6.96	3.86	6.56	5.36	4.2	4.34	4.38	7.1	4.24	4.8	**5.5**
Mean Ortho	**6.71**	**5.03**	**5.71**	**4.92**	**4.77**	**5.47**	**6.60**	**5.48**	**4.23**	**3.67**	**6.89**	**5.46**	**5.34**	**5.99**	**5.02**	**5.49**	**4.89**	**4.39**	**6.26**	**5.57**	**5.81**	**3.76**	**5.73**	**4.80**	**3.15**	**3.73**	**4.83**	**7.07**	**4.61**	**4.92**	**5.2**
Lay People:																															
Viewing 1	3.6	5.38	4.86	4.22	4.14	3.36	5.42	4.7	5.28	4.56	5.92	3.16	4.7	5.18	4.02	6.66	4.46	2.64	6	5.14	6.74	4.32	4.78	4.18	1.98	3.26	4.7	7.2	5.5	4.06	**4.6**
Viewing 2	5.92	5.74	6.32	5.84	5.76	4.74	5.44	4.86	4.68	6.1	6	4.86	5.64	5.9	5.62	5.84	5.74	3.74	5.98	6.48	6.42	5.16	5.6	4.84	3.48	3.66	4.28	7.22	4.7	5.58	**5.4**
Viewing 3	7.36	4.02	6.6	7.92	5.56	6.92	7.12	3.92	3.24	4.72	7.36	5.58	5.76	6.14	6.08	6.28	4.48	2.96	6.06	5.36	6.58	3.54	5.64	5.04	3.88	3	5.06	6.7	4.62	5.28	**5.4**
Mean Laypersons	**5.63**	**5.05**	**5.93**	**5.99**	**5.15**	**5.01**	**5.99**	**4.49**	**4.40**	**5.13**	**6.43**	**4.53**	**5.37**	**5.74**	**5.24**	**6.26**	**4.89**	**3.11**	**6.01**	**5.66**	**6.58**	**4.34**	**5.34**	**4.69**	**3.11**	**3.31**	**4.68**	**7.04**	**4.94**	**4.97**	**5.1**
Mean Combined	**5.67**	**4.70**	**5.61**	**5.23**	**4.44**	**4.67**	**5.86**	**4.68**	**4.12**	**4.32**	**6.16**	**4.57**	**4.76**	**5.48**	**4.83**	**5.31**	**4.62**	**3.37**	**5.90**	**5.42**	**5.93**	**3.94**	**5.25**	**4.51**	**2.92**	**3.29**	**4.16**	**6.67**	**4.78**	**4.43**	**4.8**

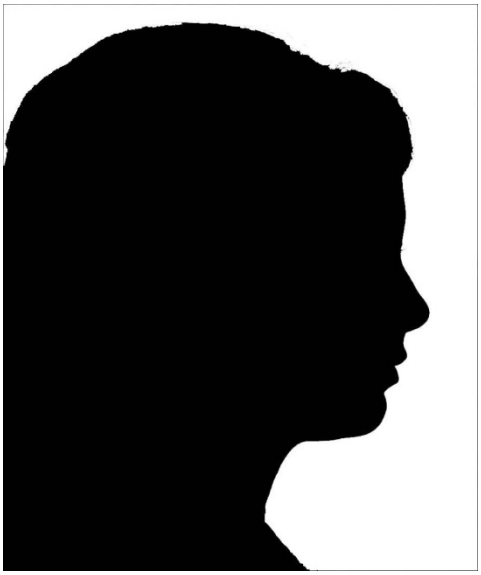
Mean Ext Ortho	**4.16**
Mean Non-Ext Ortho	**5.24**
Mean Ortho Comb	**4.69**
Mean Non Ortho	**4.96**

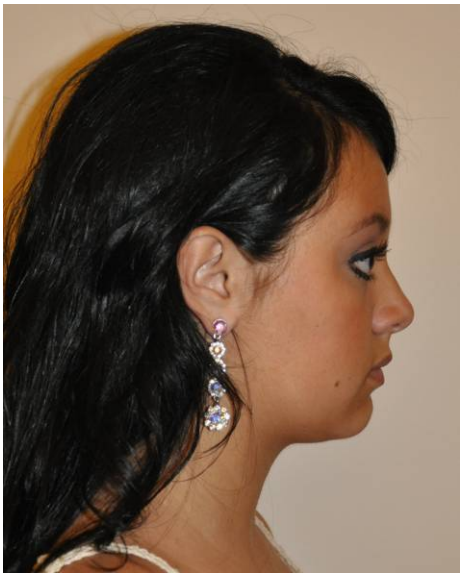
Appendix K: Soft Tissue Analysis



Straight	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-0.5	-0.5	0±1mm
Lower Lip to S line (mm)	-1	-1	0±1mm
Facial Convexity (G'-Sn-Po')	7°	7°	11°±4
ULL:LLL (ratio)	1:2.8	1:2.8	1:2
Rickett's E-line	-1.5mm	-1.5mm	-2±2mm

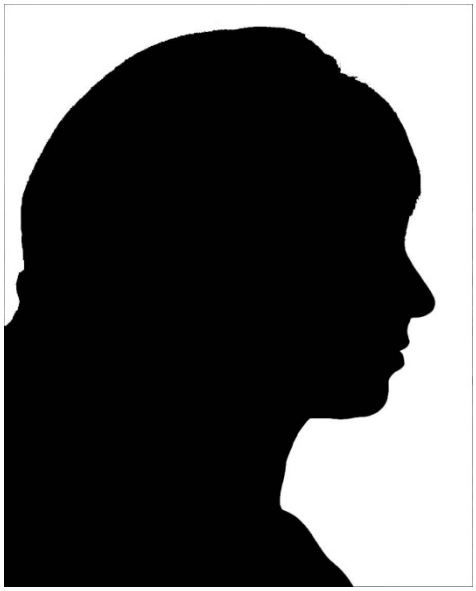
#2





Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	0	0	0±1mm
Lower Lip to S line (mm)	0	0	0±1mm
Facial Convexity (G'-Sn-Po')	13°	13°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-1mm	-1mm	-2±2mm

#3

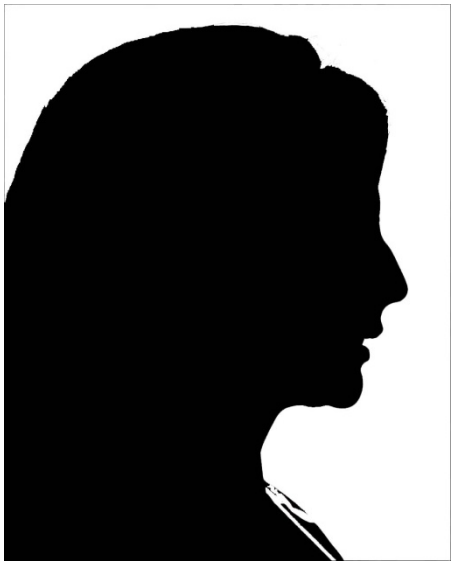


Convex	Silhouette	Facial Profile Picture	Norms for Hispancis
Facial 1/3	1:1 1/3: 1	1:1 1/3: 1	1:1:1
Upper Lip to S line (mm)	0	0	0±1mm
Lower Lip to S line (mm)	1	1	0±1mm
Facial Convexity (G'-Sn-Po')	13°	13°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-1mm	-1mm	-2±2mm

#4 

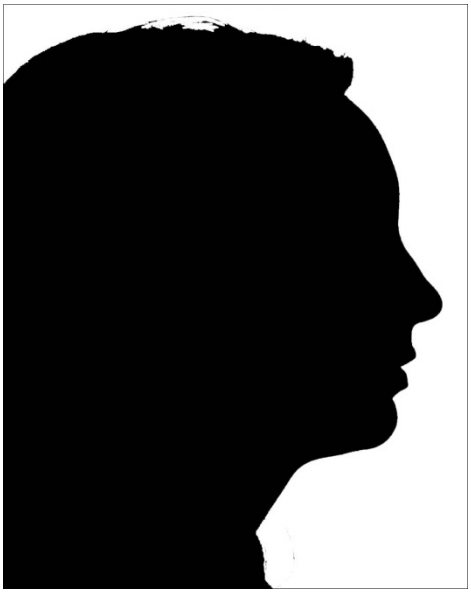
Straight: Posterior Divergent	Silhouette	Facial Profile Picture	Norms for Hispanics
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	1	1	0±1mm
Facial Convexity (G'-Sn-Po')	9°	9°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-3mm	-3mm	-2±2mm

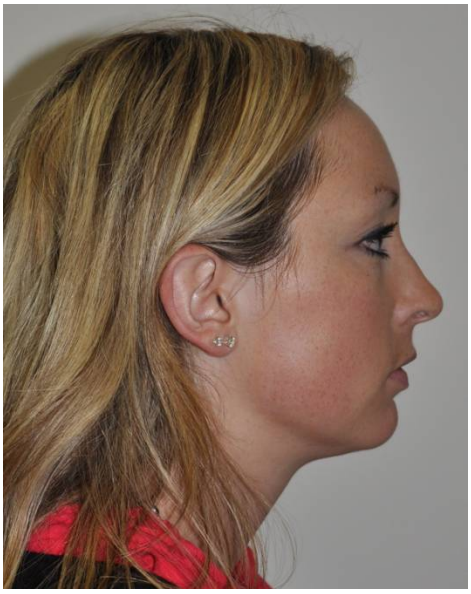
#5

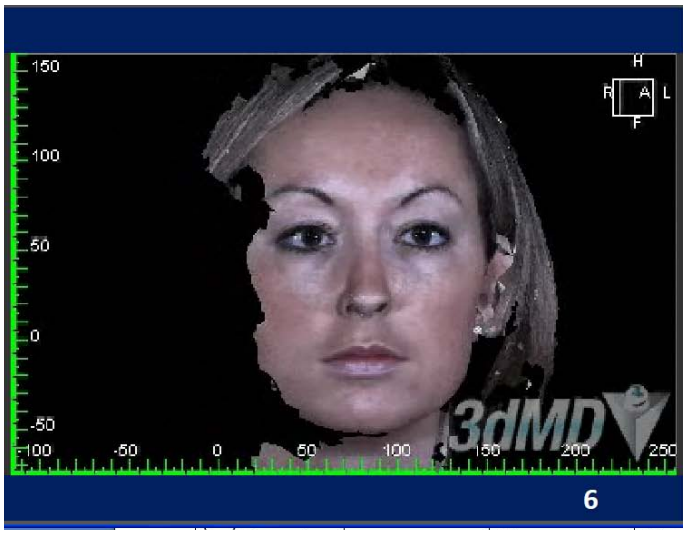


Convex	Silhouette	Facial Profile Picture	Norms for Hispanics
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-2	-2	0±1mm
Lower Lip to S line (mm)	-2	-2	0±1mm
Facial Convexity (G'-Sn-Po')	17°	17°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-4mm	-4mm	-2±2mm

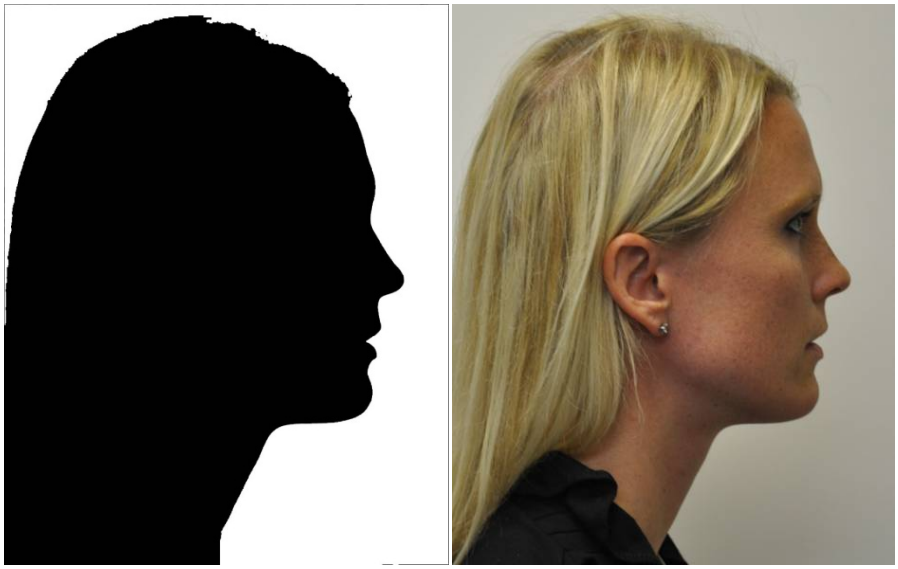
#6







Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	0	0	0±1mm
Facial Convexity (G'-Sn-Po')	15°	15°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-2mm	-2mm	-2±2mm

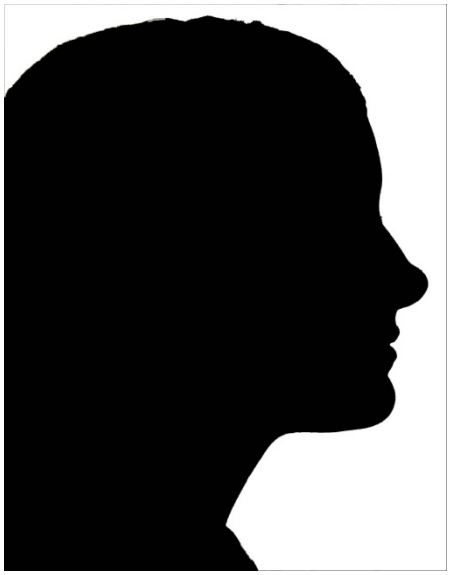
#7 

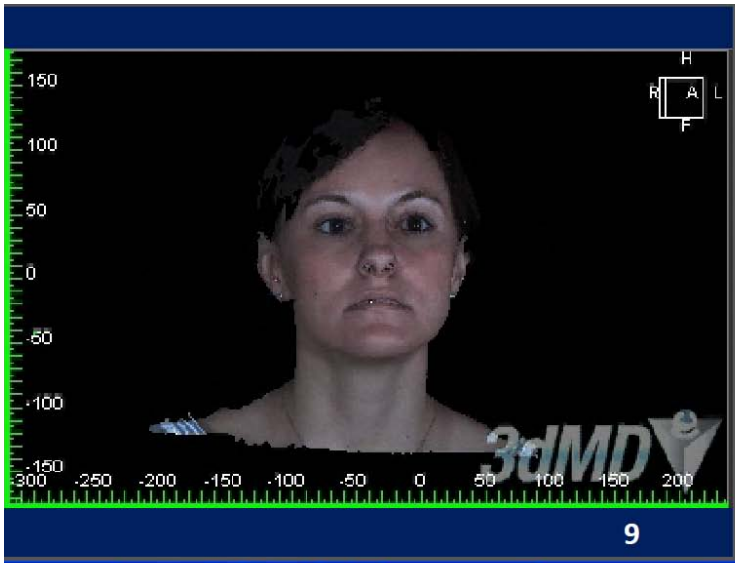
Straight	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-2	-2	0±1mm
Lower Lip to S line (mm)	-1	-1	0±1mm
Facial Convexity (G'-Sn-Po')	6°	6°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-3mm	-3mm	-2±2mm

#8  

Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-2	-2	0±1mm
Lower Lip to S line (mm)	1	1	0±1mm
Facial Convexity (G'-Sn-Po')	9°	9°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-1mm	-1mm	-2±2mm

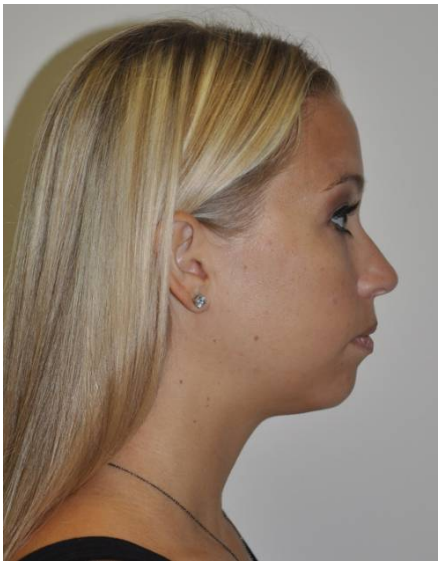
#9



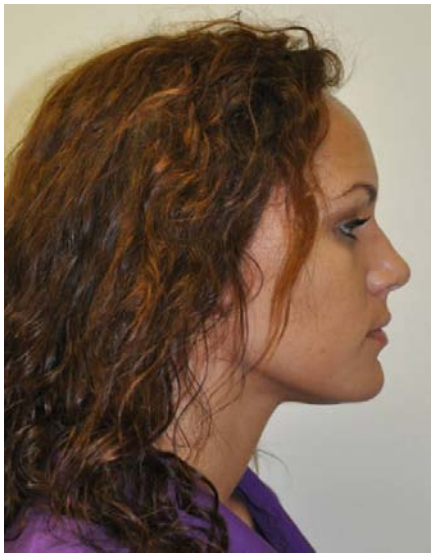


Straight-slightly Anterior Divergent	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-2	-2	0±1mm
Lower Lip to S line (mm)	2	2	0±1mm
Facial Convexity (G'-Sn-Po')	7°	7°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-4mm	-4mm	-2±2mm

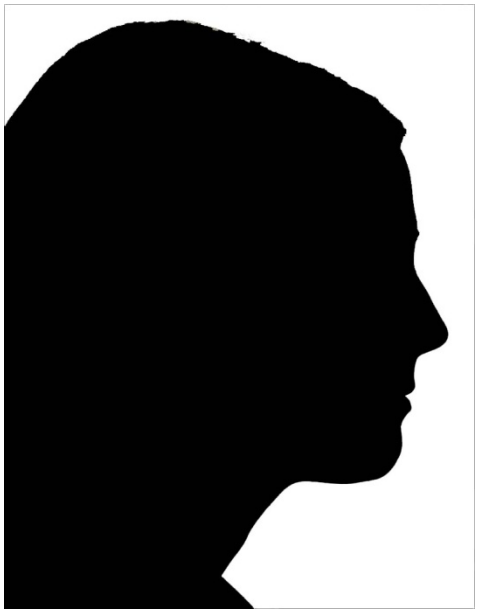
#10



Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	1	1	0±1mm
Lower Lip to S line (mm)	2	2	0±1mm
Facial Convexity (G'-Sn-Po')	17°	17°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	1mm	1mm	-2±2mm

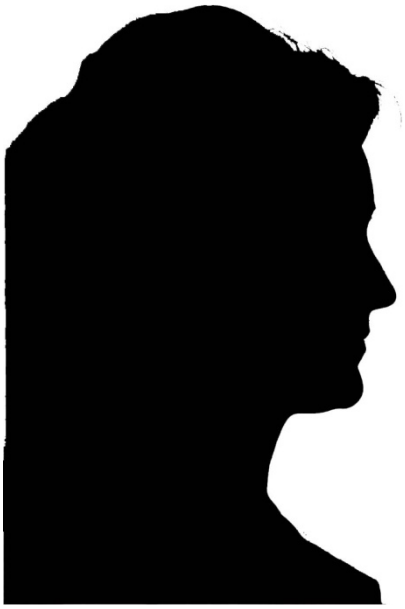
#11  

Straight	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	1	1	0±1mm
Facial Convexity (G'-Sn-Po')	9°	9°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-2mm	-2mm	-2±2mm

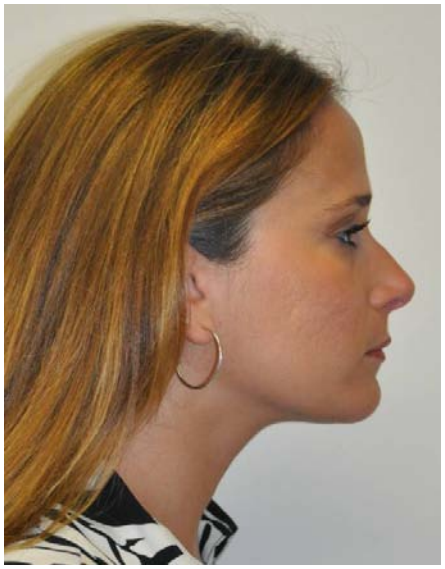
#12  

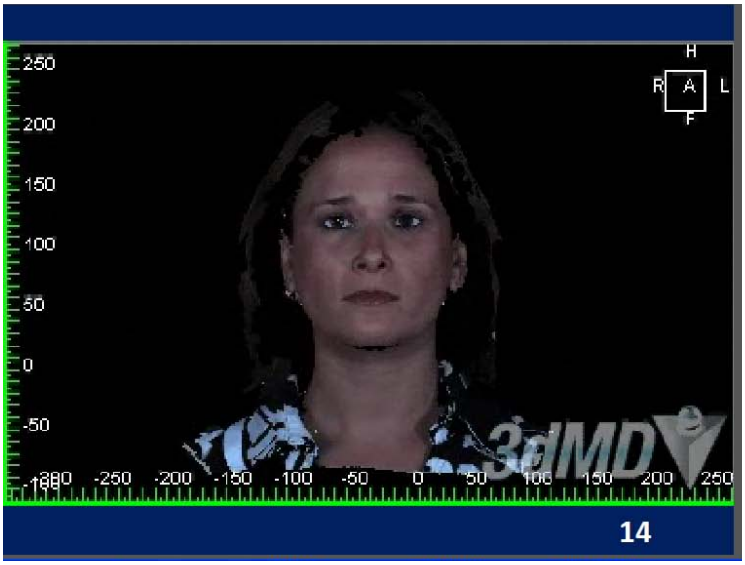
Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	1	1	0±1mm
Facial Convexity (G'-Sn-Po')	11°	11°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-3mm	-3mm	-2±2mm

#13

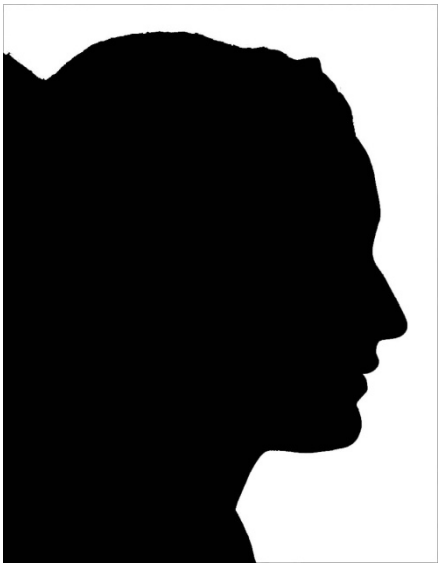
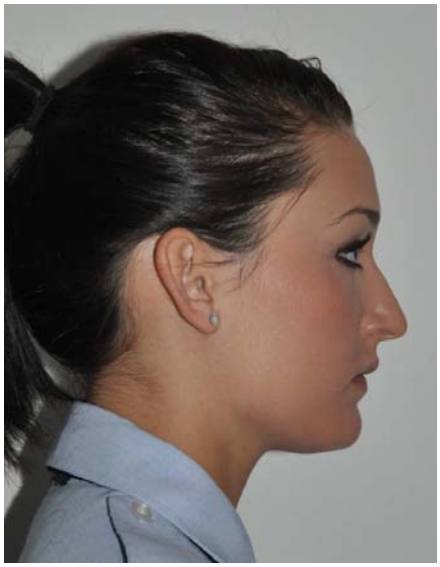


Straight: posterior divergent	Silhouette	Facial Profile Picture	Norms for Hispanics
Facial 1/3	1:1.1:1	1:1.1:1	1:1
Upper Lip to S line (mm)	-2	-2	0±1mm
Lower Lip to S line (mm)	-2	-2	0±1mm
Facial Convexity (G'-Sn-Po')	10°	10°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-5mm	-5mm	-2±2mm

#14  



Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	2	2	0±1mm
Facial Convexity (G'-Sn-Po')	14°	14°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-3mm	-3mm	-2±2mm

#15  

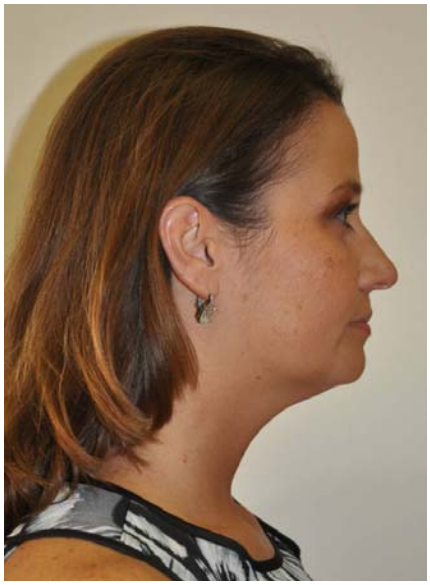
Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1.2	1:1:1.2	1:1
Upper Lip to S line (mm)	-2	-2	0±1mm
Lower Lip to S line (mm)	2	2	0±1mm
Facial Convexity (G'-Sn-Po')	11°	11°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-4mm	-4mm	-2±2mm

#16 

Straight	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	0	0	0±1mm
Lower Lip to S line (mm)	1	1	0±1mm
Facial Convexity (G'-Sn-Po')	10°	10°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	0mm	0mm	-2±2mm

#17 

Convex	Silhouette	Facial Profile Picture	Norms for Hispanics
Facial 1/3	1:1.3:1	1:1.3:1	1:1
Upper Lip to S line (mm)	0	0	0±1mm
Lower Lip to S line (mm)	0	0	0±1mm
Facial Convexity (G'-Sn-Po')	15°	15°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-1mm	-1mm	-2±2mm

#18  

Straight	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:0.9	1:1:0.9	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	0	0	0±1mm
Facial Convexity (G'-Sn-Po')	8°	8°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-3mm	-3mm	-2±2mm

#19  

Straight	Silhouette	Facial Profile Picture	Norms for Hispanics
Facial 1/3	1:1.1:1	1:1.1:1	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	0	0	0±1mm
Facial Convexity (G'-Sn-Po')	5°	5°	11°+4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-2mm	-2mm	-2±2mm

#20  

Straight	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	0	0	0±1mm
Facial Convexity (G'-Sn-Po')	5°	5°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-2mm	-2mm	-2±2mm

#21

Straight	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	0	0	0±1mm
Lower Lip to S line (mm)	0	0	0±1mm
Facial Convexity (G'-Sn-Po')	5°	5°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-2mm	-2mm	-2±2mm

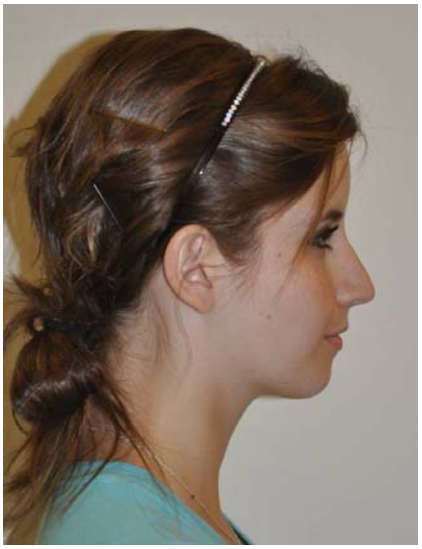
#22

Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	1	1	0±1mm
Facial Convexity (G'-Sn-Po')	20°	20°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	0mm	0mm	-2±2mm

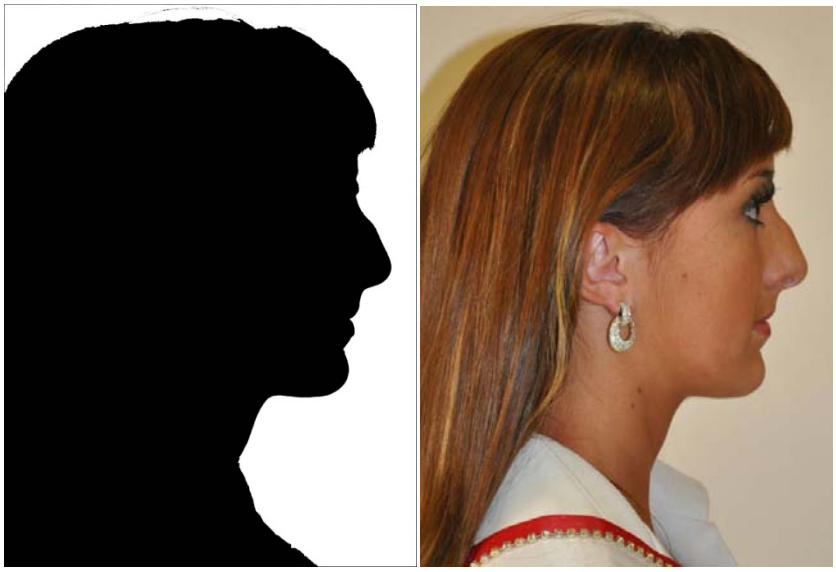
#23  

Convex	Silhouette	Facial Profile Picture	Norms for Hispanics
Facial 1/3	1:1.2:1	1:1.2:1	1:1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	1	1	0±1mm
Facial Convexity (G'-Sn-Po')	15°	15°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-2mm	-2mm	-2±2mm

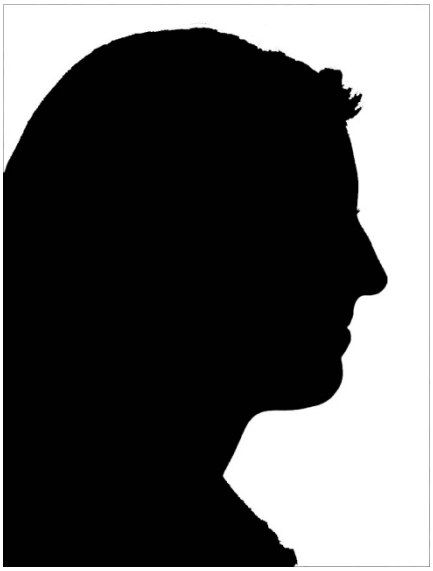
#24



Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1.3:1	1:1.3:1	1:1:1
Upper Lip to S line (mm)	-2	-2	0±1mm
Lower Lip to S line (mm)	-1	-1	0±1mm
Facial Convexity (G'-Sn-Po')	14°	14°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-3mm	-3mm	-2±2mm

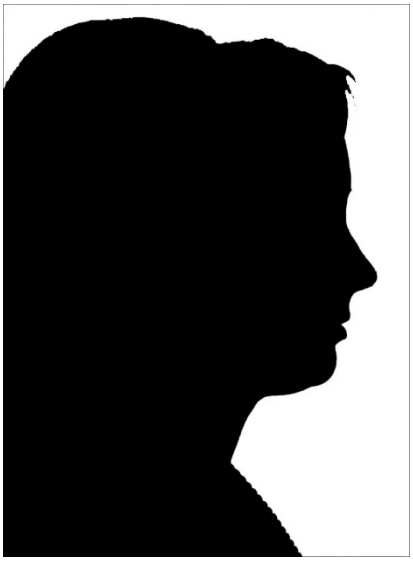
#25 

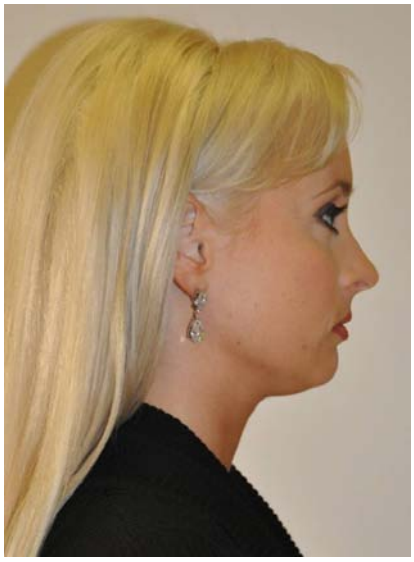
Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1.1:1	1:1.1:1	1:1
Upper Lip to S line (mm)	-3	-3	0±1mm
Lower Lip to S line (mm)	-3	-3	0±1mm
Facial Convexity (G'-Sn-Po')	13°	13°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-5mm	-5mm	-2±2mm

#26  

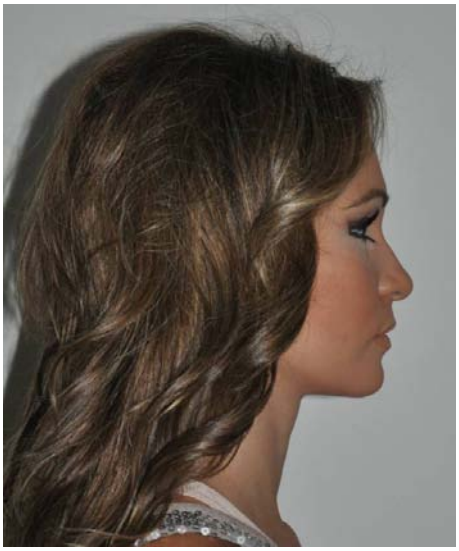
Convex	Silhouette	Facial Profile Picture	Norms for Hispanics
Facial 1/3	1:1:1.1	1:1:1.1	1:1:1
Upper Lip to S line (mm)	-3	-3	0±1mm
Lower Lip to S line (mm)	-2	-2	0±1mm
Facial Convexity (G'-Sn-Po')	10°	10°	11°±4
ULL:LLL (ratio)	1:2.3	1:2.3	1:2
Rickett's E-line	-4mm	-4mm	-2±2mm

#27





Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	-2	-2	0±1mm
Lower Lip to S line (mm)	0	0	0±1mm
Facial Convexity (G'-Sn-Po')	14°	14°	11°+4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-1mm	-1mm	-2±2mm

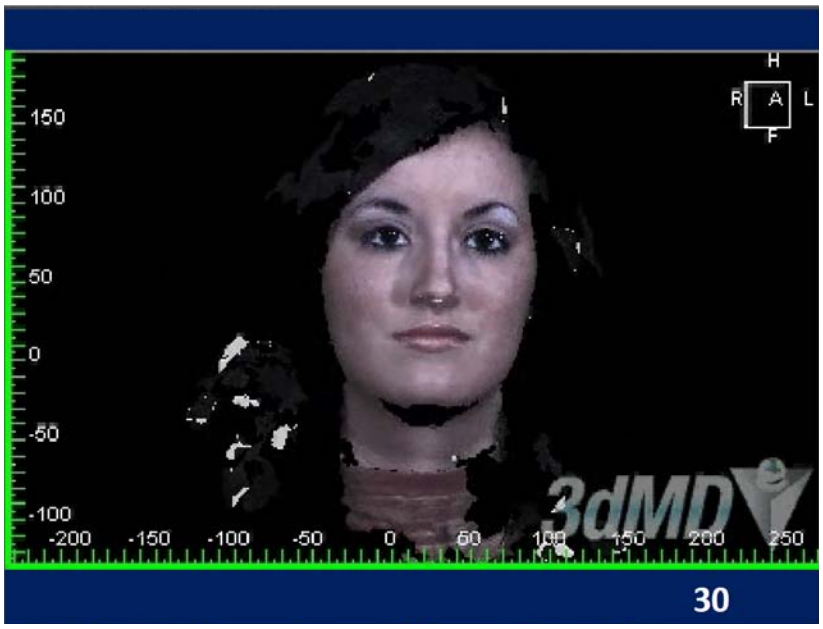
#28  

Convex	Silhouette	Facial Profile Picture	Norms for Hispanics
Facial 1/3	1:1	1:1	1:1
Upper Lip to S line (mm)	-1	-1	0±1mm
Lower Lip to S line (mm)	0	0	0±1mm
Facial Convexity (G'-Sn-Po')	9°	10°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-1mm	-1mm	-2±2mm

#29 

Convex	Silhouette	Facial Profile Picture	Norms for Caucasians
Facial 1/3	1:1:1	1:1:1	1:1:1
Upper Lip to S line (mm)	1	1	0±1mm
Lower Lip to S line (mm)	1	1	0±1mm
Facial Convexity (G'-Sn-Po')	9°	9°	11°±4
ULL:LLL (ratio)	1:1.8	1:1.8	1:2
Rickett's E-line	-1mm	-1mm	-2±2mm

#30



Straight	Silhouette	Facial Profile Picture	Norms for Hispanics
Facial 1/3	1:1:0.8	1:1:0.8	1:1:1
Upper Lip to S line (mm)	-2	-2	0±1mm
Lower Lip to S line (mm)	-1	-1	0±1mm
Facial Convexity (G'-Sn-Po')	5°	5°	11°±4
ULL:LLL (ratio)	1:2	1:2	1:2
Rickett's E-line	-3mm	-3mm	-2±2mm

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