

Esthetic Characteristics of Female Caucasian Beauty Pageant Winners

BY

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THESIS

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This research is dedicated to my husband Lee and my parents Susan and Brad. I am grateful for their unconditional love and support.

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LIST OF ABBREVIATIONS

AFA	Arnett Profile Angle
AFNorm	Mean Difference Between Beauty Pageant Queens' Mean and Arnett's Profile Angle
CI	Confidence Interval
Dolphin	Dolphin Image Imaging and Managing Management Solutions™ (Chatsworth, CA)
FacialAM	Beauty Pageant Queens' Mean Measurements
FC	Facial Convexity
IRB	Institutional Review Board
ILG	Interlabial Gap
LLP	Lower Lip Protrusion
LF3rd%	Lower Facial Thirds
LF%	Lower Face Percentage
MLA	Mentolabial Angle
NFr	Nasofrontal Angle
NFa	Nasofacial Angle
NLA	Nasolabial Angle
NM	Nasomental Angle
SD	Standard Deviation
SEM	Standard Error of Mean
SPSS	Statistical Package for Social Science
UIC	University of Illinois at Chicago

LIST OF ABBREVIATIONS (continued)

ULa-Ha	Upper Lip Angle
ULP	Upper Lip Protrusion
2D	Two Dimensional

LIST OF ABBREVIATIONS

A. PROFILE LANDMARK ABBREVIATIONS

A' (soft tissue A point)	Most concave point between subnasale and the anterior point of the upper lip;
B' (soft tissue B point)	Most concave point between the lower lip and the soft tissue chin;
br (bridge of nose)	Midpoint from soft tissue nasion to pronasale
C (throat point)	Innermost point between the submental area and the neck located at the intersection of lines tangent to the neck and the throat
Cn (Columella)	The most anterior point on the columella of the nose
G' (soft tissue glabella)	The most anterior point of the soft tissue forehead in the midsagittal plane
Gn' (soft tissue gnathion)	The midpoint between the most anterior and inferior points of the soft tissue chin in the midsagittal plane
LL (lower lip)	The most anterior point of the vermillion curve of the lower lip
Ls (Labi superiors)	Most superior point on the vermillion of the upper lip
Me' (soft tissue menton)	Most inferior point on the contour of the soft tissue chin
N' (soft tissue nasion)	The point of greatest concavity in the midsagittal plane between the forehead and the nose
Pg' (soft tissue pogonion)	Most anterior point on the curve of the soft tissue chin in the midsagittal plane
Prn (tip of nose)	Most anterior and superior point of the nose;
Tragus (tragus)	The pointed eminence of the external ear, projecting backwards over the meatus (http://en.wikipedia.org/wiki/Tragus_(ear))

A. PROFILE LANDMARK ABBREVIATIONS (continued)

Sn (Subnasale)	A point at which the nasal septum merges with the upper cutaneous lip in the midsagittal plane
Sts (stomion superiors)	Most inferior point on the curve of the upper lip
Sti (stomion inferioris)	Most superior point on the curve of the lower lip
UL (upper lip)	The most anterior point of the vermillion curve of the upper lip

B. FRONTAL AND SMILING LANDMARK ABBREVIATIONS

Powell and Humphreys landmarks:

Al (alare)	The most lateral point on the lateral surface of the external nose
En (inner canthal)	The most medial point of the inner corner of the eye fissures
Ex (outer canthal)	The most lateral point of the outer corner of the eye fissures
G' (soft tissue glabella)	The midpoint between the supraorbital ridges in the median sagittal plane
Go' (soft tissue gonion)	Intersection of a line tangent to the soft tissue mandibular body and a line tangent to soft tissue mandibular ramus
Hairline	Junction of hair and forehead
Lc (labial commissure)	Junction of the upper and lower lips lateral to the angle of the mouth
LLs (lower lip)	Most superior point of the lower lip
Me' (soft tissue menton)	Most inferior point of the soft tissue chin
N' (soft tissue nasion)	The midpoint of the interpupillary line
Prn (tip of nose)	Midpoint of the alare to alare line
P (pupil)	Center of the iris
Sn (subnasale)	Most inferior point of the base of the nose
ULi (upper lip)	Most inferior point of the upper lip

Arnett landmarks:

Go' (soft tissue Gonion)	The most prominent point of the soft tissue outline of the angle of the mandible
Zy (zygoma)	The most lateral prominence of the soft tissue cheek

SUMMARY

Soft tissue esthetics is a crucial component of orthodontic treatment planning. Currently, improved appearance is one of the most significant concerns of patients seeking orthodontic treatment. Few studies have been conducted to determine if previously published orthodontic soft tissue norms are in agreement with present criteria for an attractive face. Orthodontists have studied soft tissue esthetics in the past, but there is no current study that evaluates Mrs. America and Miss America facial soft tissue attributes.

The purpose of the present study is to determine if the previously published soft tissue esthetic norms are still representative of an attractive Caucasian female face. The null hypothesis tested was that there are no statistically significant mean differences for facial attractive measurements between modern day publicly acknowledged attractive faces and published norms.

A photographic study was conducted on prior and current beauty pageant title-holders. At certain Mrs. America beauty pageant competitions the following information was obtained: two-dimensional photographs of profile at repose, frontal at repose, and smiling frontal; eligibility questions, history of pageant titles; history of orthodontic treatment; and history of orthodontic retainer wear.

Based on the results of a one-sample *t*-test, there were significant mean differences between the two groups with regards to the nasolabial, nasomental, nasofacial, and nasofrontal

SUMMARY (continued)

angle, upper lip protrusion, lower facial thirds, percentage lower face percentage and interlabial gap ($p=0.000$ to 0.0024).

The results of this study indicate there are differences between current beauty pageant queens and previously published soft tissue norms; however, the majority of the variables were within 1% of the published norms. The findings of this study suggest the beauty pageant queens possess a class I soft tissue profile with a slightly decreased lower facial height. This research supports the relationship between an attractive face, a youthful appearance and a decreased lower facial height.

While the individual patient's esthetic concerns should be considered during orthodontic diagnosis and treatment planning, the results of this study provide norms and ranges of measurements derived from documented attractive faces that can as guides for orthodontist to help patients achieve their esthetic goals.

I. INTRODUCTION

A. Background

Facial attractiveness is a key factor, consciously or subconsciously, in our decisions regarding social interactions. According to Merriam-Webster's online dictionary, the definition of attractive is "having a pleasing appearance; having a feature or quality people like" (<http://www.merriam-webster.com/dictionary/attractive>). Hollywood celebrities, beauty queens, and models represent ideal esthetic goals for many people; hence, attraction. Medical professionals in various fields such as plastic surgery, oral surgery, orthodontics and prosthodontics have the ability to transform individuals' facial soft tissues to reach these esthetic goals. For medical professionals who alter soft tissue attributes knowledge of what constitutes an attractive face is essential.

Over time, scientists and philosophers have attempted to define the parameters of attractive faces; however, contrasting ideas of attractive faces still exist. Langlois and Roggman (1990) found that a composite face was more attractive than the individual component faces from which the composite face was derived. Conversely, Alley and Cunningham (1991) reported that adult faces displaying unusually juvenile facial characteristics are considered more attractive. In addition, Peck and Peck (1970) found differing opinions among lay people and orthodontists with regards to attractive faces. They found lay people preferred women possessing protrusive dentofacial patterns versus orthodontists' preference for straight dentofacial patterns. Although there are opposing opinions about attractive faces, undoubtedly if given a choice, clinicians would choose to finish treatment with an attractive result (Brody, 1994).

B. Concepts of the Study

This research project encompasses three important concepts:

1. Perceptions of a female attractive adult face;
2. Comparison of previous norms to a modern attractive adult female face; and
3. Determination of a female adult facial esthetic norm that can be used for orthodontic diagnosis and treatment planning.

II. STATEMENT OF PROBLEM

A. Previous Consideration of Facial Soft Tissue Esthetics

As early as the 1940s, soft tissue esthetics influenced orthodontic treatment planning and diagnosis. Riedel (1957) proposed incorporating the public's views of soft tissue attributes into orthodontic treatment norms. In 1970, Peck and Peck tried to decipher the bridge between patients' and providers' perception of attractive faces. They researched beauty queens, professional models, and celebrities known for their appearance (Peck and Peck, 1970). Peck and Peck choose these subjects because they understood perceptions of attractive faces should be derived from public opinion and not imposed on patients by the provider's opinion.

B. Present Consideration of Soft Tissue Esthetics

Today, orthodontists use various norms determined from groups of attractive and average faces for diagnosis and treatment planning. Different treatment norms exist for skeletal and soft tissue treatment goals. Although skeletal diagnosis and treatment planning is imperative to orthodontic treatment success, recently soft tissue considerations gained in importance to orthodontic treatment plans (Proffit, 2007; Sarver, 2000). People seeking orthodontic treatment have been motivated largely by cosmetic concerns (Czarnecki et al., 1993); therefore, treatment goals should aim at treatment of the dental problem while simultaneously improving facial attractiveness (Sarver, 2000).

At present, more adults are seeking orthodontic treatment than ever in the past (Proffit et al., 2007). Orthodontists must realize that patients seek treatment not to look average, but to look beautiful (Proffit et al., 2007). In the 80's and the 90's, Arnett, Berman, Powell, Humphreys,

and Legan (Arnett and Bergman, 1993; Powell and Humphreys, 1984; Legan and Burstone, 1980) summarized attractive soft tissue norms suitable for adults in their second decade of life, but no current study exists establishes soft tissue norms that are based on the public's perception of attractive adult faces. Moreover, there is no modern study that describes Caucasian beauty pageant winners' soft tissue attributes. The aim of this study is to fill the void and determine adult soft tissue norms for facial esthetics using recent beauty pageant winners.

The specific objectives of this research project are the following:

- Determine if the public's current perception of attractive Caucasian females is in agreement with the Arnett, Powell and Humphreys and Legan soft tissue norms.
- Create average 2 dimensional (2D) profile, frontal at repose, and smiling frontal soft tissue face composite images representative of current adult female beauty pageant winners.

C. Null Hypothesis

There is no statistically significant mean difference for female facial attractive measurements between modern day publicly acknowledged female attractive faces and published norms proposed by clinicians.

III. REVIEW OF LITERATURE

A. The History of Orthodontics and Soft Tissue Esthetics

Dating back to 1890s, Angle identified principles of occlusion. Angle, regarded as the father of modern orthodontics (Brodie, 2004), believed the most important outcome of treatment was a Class I occlusion. He explained how the mesial buccal cusp of the upper first molar shared a necessary relationship with the buccal groove of the lower first molar. Furthermore, Angle created the three classes of malocclusion currently used by dental professionals; however, this classification was based solely on the dentition. Angle suggested a properly aligned dentition would pave the way for acceptable soft tissue harmony (Proffit et al., 2007).

By the 1940s, Tweed, a student of Angle, began to emphasize facial proportions. He believed premolar extractions were an important treatment protocol to promote dental stability. Unlike Angle's belief that soft tissue balance would result from correcting the malocclusion, Tweed's philosophy employed simultaneous consideration of soft tissue and occlusal stability (Graber et al., 2005).

In the late 1940s and early 1950s, Riedel was the first to suggest incorporating the public's values for attractive faces when treatment planning and diagnosing orthodontic problems. Previous to 1950, norms were developed from the following: artists' views of beauty, beliefs regarding dental stability relating to the overlying soft tissues, Class I normal occlusion and personal beliefs for ideal proportions. The general public's view for soft tissue attractiveness was not incorporated into orthodontic treatment planning. Riedel recognized this and investigated (American Midwest) orthodontists' opinions for attractiveness using profile

photographs of Hollywood celebrities. Riedel used 30 of the 1955 Seattle Seafair queens and princesses for his sample. The ages ranged from 17 years old to 21 years old. Riedel found that Hollywood celebrities who were judged attractive by the public were considered too protrusive by the evaluating orthodontists. This contrast of opinion between public and orthodontist pointed to the need for orthodontists to understand public opinions regarding attractive faces (Riedel, 1957).

By 1970, Peck and Peck, acknowledged the importance of the public's opinion regarding soft tissue traits. They conducted a cephalometric and photographic study of publicly accepted attractive participants. The study included the following: professional models, beauty contest winners, and performing stars known for their esthetic features. The sample consisted of 49 Caucasian females and 3 Caucasian males. The mean age of the research subject was 21 years and 2 months. Frontal and profile photographs were taken on each subject. The frontal images were examined for asymmetries, while the profile photographs were evaluated using anthropologic landmarks and angular measurements. The study concluded that the public preferred more protrusive dental and soft tissue characteristics than the established cephalometric standards (Peck and Peck, 1970).

In 1992, Johnston developed a method called FacePrint that mimics evolution with a mathematical algorithm. He and Franklin performed a study using FacePrint that had participants rank their most preferred male or female facial features over a series of generations. The participants used a computer keyboard to rank phenotypes' attractiveness on a 10-point beauty scale. Ultimately, a beautiful composite face was produced and evaluated for attractiveness by Caucasian participants. The beautiful composite face was compared with

anthropometric measurements of random female faces from their local population. Their study concluded that an attractive female face is not an average face and possesses unique facial proportions such as a decreased lower facial height and an increase fullness of the lips. Their study found the highest ranked attractive face had an anterior lower facial height of an 11-year-old female according to the Farkas growth curve (Johnston and Franklin, 1992; Johnston et al., 2003).

B. Perceptions of Attraction

Perceptions of an attractive face are debatable. Some argue perceptions of attraction are subjective while some argue perceptions of attraction can be measured. Subjective believers make a case that personal feelings, culture or combinations of traits that give pleasure to the senses or mind influence perceptions (Naini et al., 2006). Additionally, subjective believers' purpose perceptions of attraction reflect individual opinion and can be influenced by society (Giddon, 1983). Giddon suggested minority groups seek to look like majority groups and patients seek to look like Hollywood celebrities and fashion models.

In contrast, some research suggests that perception of attraction is universal regardless of personal feelings. In a study by Dion et al. (1972), 60 subjects were presented with 3 facial photographs: unattractive, average and attractive. The subjects were asked a series of questions that they recorded in booklets. Personal bias was minimized and accounted for. Their study found that people judged attractive were assumed to have happier lives and more professional success. More importantly, their study suggested perceptions of attraction do not significantly differ between observers as some suggest.

A recent study of *People* magazine's most attractive Caucasian and African-American females supported common perceptions for attraction (Iglesias-Linares et al., 2011) . The study used angular and proportional photogrammetric analysis on 80 women (40 African American, 40 Caucasian) that have been judged by *People* magazine to represent beauty over the past 10 years. Although the study did not account for photographic airbrushing that may have been done by the magazine, the study supported Caucasian and African-American facial similarities of the lower soft tissue profile. Furthermore, the study suggested general parameters that describe attractive faces.

Like Dion's and Iglesias-Linares's studies, this research supports measurable traits of attractive faces. Using recently crowned beauty pageant queens allowed this research to study modern public viewpoints of soft tissue esthetics without bias from the investigator.

C. Soft Tissue Changes with Growth

Many studies have alluded to the relationships between soft tissue changes and growth. In 1959, Subtelny studied soft tissue changes in subjects from 3 months to 18 years of age. From ages 1 to 18, he found the nose grows downwards and forwards. He noted the upper and lower lip length growth slowed by age 15. Lip thickness increased from age 1 to 14. Soft tissue point A grew in thickness due to the growth of the nose. Both the soft tissue and skeletal chin were more forwardly positioned because of growth. Subtelny concluded that soft tissue does alter with time and does not always follow skeletal changes in magnitude or direction (Subtelny, 1959).

In 1991, Nanda and colleagues studied soft tissue changes in non-orthodontic patients ranged from 7 to 18 years old. Like Subtelny, they found that the upper lip length is completed by 15 years old. He also found that with age, the soft tissue thickness of the nose, upper and lower lip, and chin increased (Nanda et al., 1991).

Behrents continued the Bolton growth study to depict adult facial growth (Behrents, 1985). He evaluated over one hundred adult participants from the original longitudinal Bolton study. Behrents concluded that adults displayed a greater amount of vertical growth when compared with anteroposterior and transverse growth. He showed that the facial pattern seen in adolescence did not cease in early adulthood as once believed. He also showed continual growth of the tip of the nose and downward movement of the upper lip. Most importantly, his study demonstrated growth continues throughout life.

D. Adult Orthodontic Attractive Soft Tissue Norms

Subtelny and Nanda illustrated that the soft tissue changes with growth. Behrents demonstrated growth is a continual process. Clearly, these studies displayed the importance for a separate soft tissue norm for adolescent and adult diagnosing and treatment planning. Arnett, Bergman, Powell, Humphrey and Legan are among some of practitioners who have recognized the need for separate adult analyses and as a result summarized adult soft tissue norms.

Arnett and Bergman have created an attractive adult soft tissue norm. They outlined their philosophy to treatment planning facial esthetics in their 1993 article "Facial keys to orthodontic diagnosis and treatment planning." They defined nineteen facial traits as an adjunct to cephalometric norms. The article emphasized the importance of harmony between the face

and the occlusion (Arnett and Bergman, 1993). They published another article in 1999 elaborating on soft tissue esthetics based on facial measurements of models. The resultant “model norm” may be biased because the authors selected the models for the study (Arnett and Berman, 1993). Although Arnett and Bergman acknowledged the need for adult esthetic norms, their study lacked inclusion of public opinion regarding attractive faces.

Powell and Humphreys (1984) published a review of techniques to evaluate faces for attractiveness. They segmented the face into five different areas: forehead, nose, eyes, lip and chin. Powell and Humphreys stressed the pertinent relationship between age, skin, bone and soft tissue. In addition, they elaborated that age is the most significant contributing aspect of an attractive face (Powell and Humphreys, 1984). They outlined how the same norms cannot represent adolescence and adulthood. Like Arnett and Bergman, Powell and Humphrey elaborated on adult soft tissue norms; however, public opinion of an attractive face was not accounted.

Similar to Arnett, Bergman, Powell and Humphreys, Legan acknowledged separate soft tissue norms for adults and adolescents. He selected a study sample of 40 white adults (20 men and 20 women) between the ages of 20 and 30 and ensured that they all had Class I occlusions with acceptable vertical facial harmony. Again, the study subjects were selected by the author and lacked public views of an attractive face (Legan and Burstone, 1980).

It is important for orthodontists to realize the difference between adult soft tissue attributes and adolescent soft tissue attributes. Moreover, it is important for orthodontists to

understand the public's view of an attractive face because ultimately it is the public that is receiving orthodontic treatment.

III. MATERIALS AND METHODS

A. Design

This research compares previously and currently titled beauty pageant queens' frontal and profile soft tissue attributes with published norms.

The initial research protocol was submitted to University of Illinois at Chicago (UIC) Institutional Review Board (IRB) asking for expedited approval on October 25, 2010. After supplying additional information, expedited approval was granted from IRB on December 6, 2010 (Appendix A), Research Protocol Number: 2010-0927).

B. Beauty Pageant Queen Judging Criteria

According to pageant documents and interviews with pageant judges, judging criteria for pageant queens are based on: beauty, poise, intelligence, personal interview, physical fitness, evening gown, on stage question and costume competition. Pageant judges stated that beauty and attraction were more than 80% of the judging criteria (<http://mrsminnesota-america.com/judging.html>). The pageant judges consisted of prior pageant queens, celebrities and medical professionals.

C. Recruitment of Subjects

Following UIC IRB approval, the principal investigator (PI) contacted pageant directors and received pageant director approval to attend beauty pageants. On the interview day of the Mrs. Georgia America, Mrs. Missouri America, Mrs. Wisconsin America, and Mrs. Iowa America beauty pageants, the Mrs. America subjects were recruited with "Verbal recruitment to

participate in research” (Appendix C). Before participation, subjects were asked to sign an informed consent (Appendix B). For participation in the study, an eligibility questionnaire (Appendix D) and a photographic questionnaire (Appendix E) were completed by each subject. Subjects were asked to state their age, previous pageant participation and titles, confirmation of ethnicity and gender, and history of orthodontic treatment and post treatment retainers.

D. Inclusion Criteria for Beauty Pageant Winners’ Soft Tissue Composite

The inclusion criteria for participation in this study are as follows:

1. Caucasian female; and
2. Beauty pageant winner within the past five years.

E. Photographic Set Up

On the interview day of the Mrs. Georgia America, Mrs. Missouri America, Mrs. Wisconsin America, and Mrs. Iowa America beauty pageants, the PI obtained 2D photos with a Sony Alpha Nex-5 digital SLR camera (Sony, New York, New York) with an 18-55mm zoom lens, locked at 55mm. The photography was non-invasive and exposed the participants to minimal risk. The images collected consisted of profile with lips at repose, frontal photographs with lips at repose, and Stage two smiling frontal photographs (Peck et al., 1992). Peck and Peck defined three stages in the genesis of a full smile. They describe Stage zero as the initial rest position when the individual is at repose. They explain Stage one as the slight movement of the upper lip with the initial presentation of nasolabial fold. Stage two is explained as the maximum movement of the upper lip and maximum appearance of the nasolabial fold using four facial muscles: levator labii superioris, zygomaticus major and superior fibers of the buccinators (Peck et al., 1992).

Participants sat in a chair, placed their feet on a line in front of a black felt background five feet from the camera (Figure 1). To ensure natural head position, the participants were asked to look off to the horizon at a white sign behind the PI taking the photographs. For the profile and frontal photograph at repose, participants were asked to lick their lips gently, and then relax (Arnett and Bergman, 1993). For the stage two smiling frontal photograph, participants were asked to smile fully until their lips encountered resistance at the nasolabial fold (Peck et al., 1992).

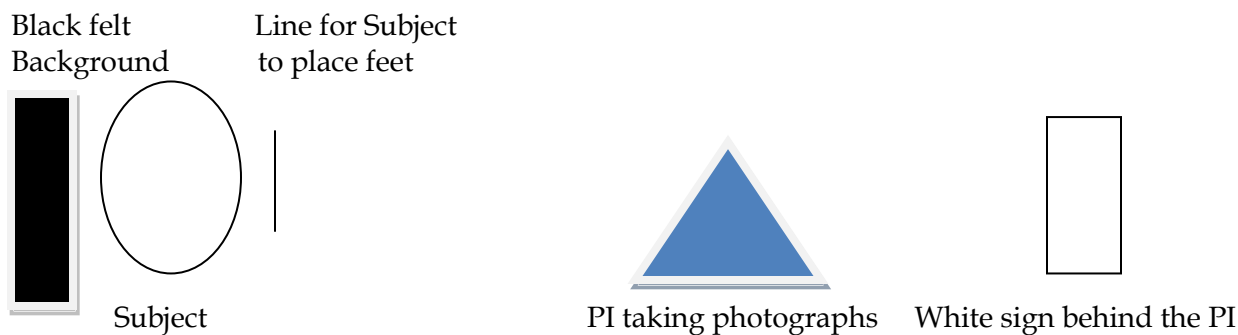


Figure 1. The photographic set up.

F. Photographic Layout Specifications

The layout of the photographic equipment used for data collection:

Height of top of camera lens	53"
Height of subject's eye	54"
Distance between camera lens and subject	60"

G. Camera Setup System

The specifications for the camera setup are as follows:

Camera body	Sony Alpha Nex-5 digital SLR camera 14.2 mega pixels
Lens	<i>Optical</i> Steady shot 3.5-5.6/18-55mm zoom lens, locked at 55mm
Tripod	Velbon Victory 150
Lens focal length	55mm
Camera setting	Intelligent Auto
Aperture	F5.6
Shutter Speed	1/100s

H. Subject Positioning

Due to the stressful nature of the interview day on the pageant women and the special hair, make-up and attire the pageant women were dressed in, the pageant director requested that the PI not tie the women's hair back. With the camera in place, the PI helped position the subjects in the proper profile position:

1. Necessary landmarks are visible;
2. Have subjects place hair behind ears or hold hair in hand closest to the black felt background to ensure glabella and tragus are clearly visible;
3. No shadows are visible; and
4. Have subjects lick their lips and then relax to ensure subjects at repose.

The subject positioning for the frontal with lips at repose photograph as follows:

1. Adjust vertical height of chair;
2. Place subjects feet on floor marker;

3. Have subject look at PI and off to the horizon at white poster behind PI;
4. Facial features are clearly visible; and
5. Have subjects lick their lips and then relax to ensure subjects at repose.

The subject positioning for the smiling frontal photograph as follows:

1. Adjust vertical height of chair;
2. Place subjects feet on floor marker;
3. Have subject look at PI and off to the horizon at white poster behind PI;
4. Facial features clearly visible; and
5. Have patients smile fully.

I. Profile Image Upload and Calibration

To ensure resolution standardization, the 2D photographs were uploaded to Adobe Photoshop CS, version 7.0 and calibrated to 300 pixels per inch (Adobe, San Jose, CA). Next, the profile photos were captured in Dolphin Solutions™ version 11.5 Premium (Dolphin, Chatsworth, CA) in the lateral x-ray view function. They were oriented to the Frankfort horizontal plane and further calibrated using the digitizing landmark function in Dolphin for linear and angular measurements (<http://www.dolphinimaging.com>).

The digitizing landmark function in Dolphin is similar to using the “Moorrees Mesh diagram for proportionate evaluation” (Moorrees et al., 1976). This Dolphin function sets a fixed distance that scales each image to ensure consistent proportion of the images in the sample.

J. Profile Photographic Analysis

The landmarks for the profile photographs are as follows (Bergman, 1999; Peck and Peck, 1970; Arnett and Bergman, 1993; Legan and Burstone, 1980) (Figure 2):

1. Soft tissue glabella (G'): the most anterior point of the soft tissue forehead in the midsagittal plane;
2. Soft tissue nasion (N'): the point of greatest concavity in the midsagittal plane between the forehead and the nose;
3. Tragus: the pointed eminence of the external ear, projecting backwards over the meatus ([http://en.wikipedia.org/wiki/Tragus_\(ear\)](http://en.wikipedia.org/wiki/Tragus_(ear)));
4. Columella (Cm): the most anterior point on the columella of the nose;
5. Bridge of nose: mid-point from soft tissue nasion to tip of nose;
6. Tip of nose (Prn): most anterior and superior point of the nose;
7. Subnasale (Sn): a point at which the nasal septum merges with the upper cutaneous lip in the midsagittal plane;
8. Soft tissue A point (A'): most concave point between subnasale and the anterior point of the upper lip;
9. Labi superiors (Ls): most superior point on the vermillion of the upper lip;
10. Upper lip (UL): the most anterior point of the vermillion curve of the upper lip;
11. Lower lip (LL): the most anterior point of the vermillion curve of the lower lip;
12. Stomion superiors (Sts): most inferior point on the vermillion of the upper lip;
13. Labi inferiors (Li): most inferior point of the vermillion of the lower lip;

14. Stomion inferioris (Sti): most superior point on the vermillion of the lower lip;
15. Soft tissue B point (B'): most concave point between the lower lip and the soft tissue chin;
16. Soft tissue pogonion (Pg'): most anterior point on the curve of the soft tissue chin in the midsagittal plane;
17. Soft tissue gnathion (Gn'): The midpoint between the soft tissue pogonion and soft tissue menton;
18. Soft tissue menton (Me'): most inferior point on the contour of the soft tissue chin; and
19. Throat point (C): innermost point between the submental area and the neck located at the intersection of lines tangent to the neck and the throat.

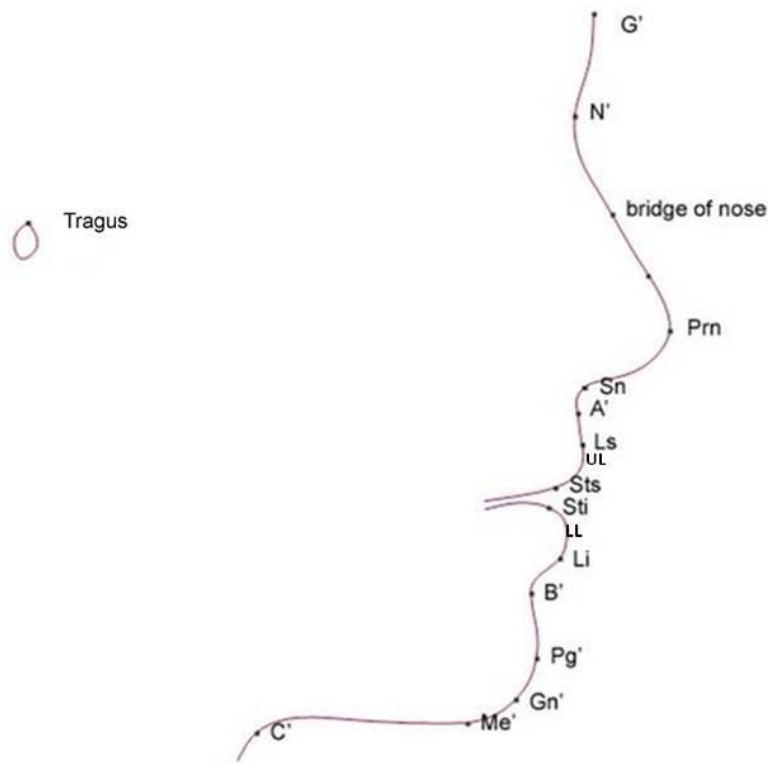


Figure 2. Profile composite of landmarks.

After landmark identification, angular and linear measurements were obtained from Dolphin and exported to Microsoft Excel (Redmond, WA). The measurements were tested for intra and inter reliability using the Statistical Package for Social Sciences (SPSS), version 19, software for Windows (Chicago, IL).

After determination of high intra and inter reliability, the PI digitized the profile photographic sample. Angular and linear measurements were calculated on the profile photographs using Dolphin (Chatsworth, CA). The degree of variation between the soft tissue measurements of the study subjects were compared with Arnett, Bergman, Powell, Humphreys and Legan published soft tissue norms (Arnett and Bergman, 1993; Powell and Humphrey, 1984; Legan and Burstone, 1980). The published norms for comparison are as follows:

Legan Analysis:

1. Angle of Facial Convexity (intersection of $G'-Sn$ and $Sn-Pg'$) ($^{\circ}$);
2. Nasolabial Angle ($Col-Sn-UL$) ($^{\circ}$);
3. Interlabial Gap ($Sts-Sti$) (mm);
4. Upper Lip Protrusion ($UL-SnPg'$) (mm);
5. Lower Lip Protrusion ($LL-SnPg'$) (mm); and
6. Lower facial thirds ($Sn-Sts: Sti-Me'$) (%).

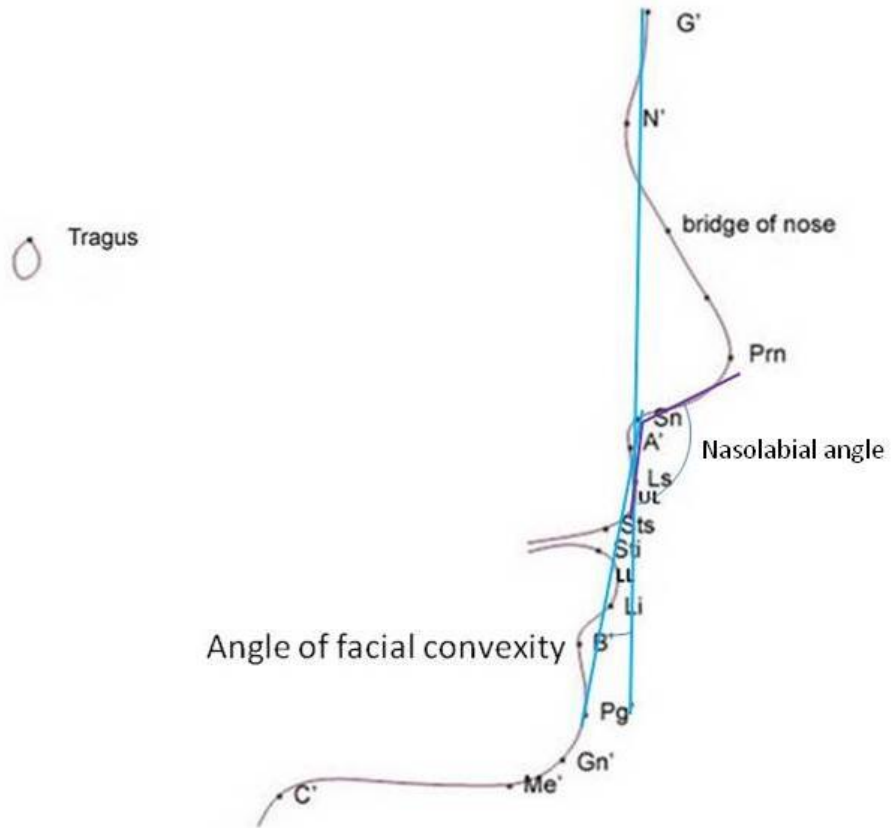


Figure 3. Legan angular soft tissue analysis.

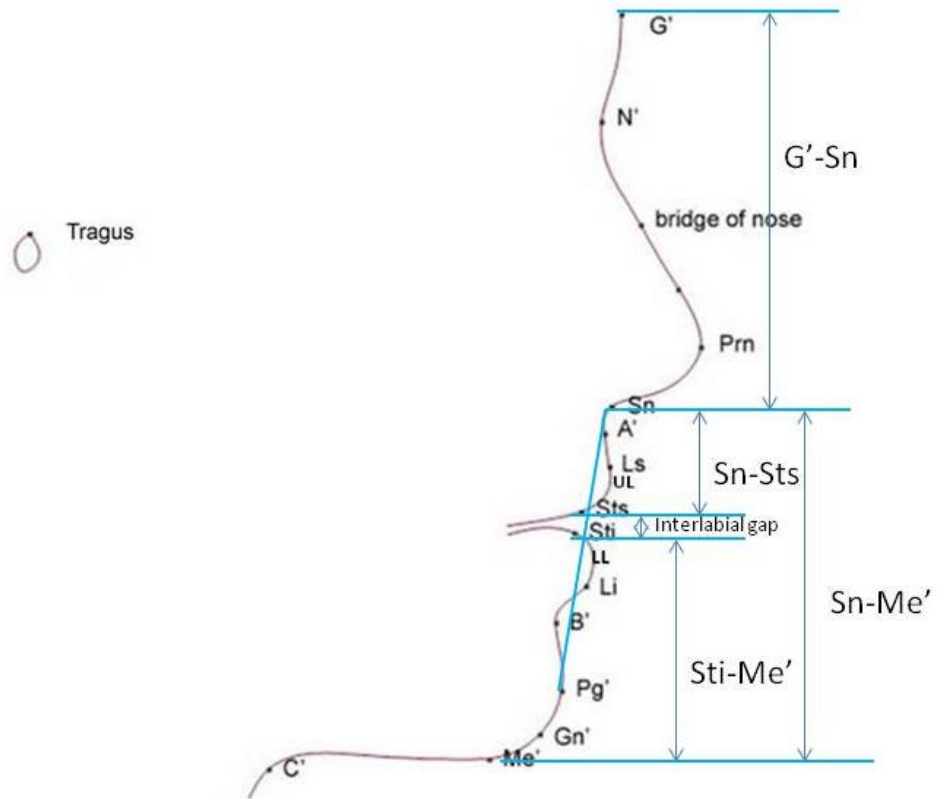


Figure 4. Legan linear and proportional soft tissue analysis.

Arnett and Bergman Analysis:

1. Profile Angle ($G'-Sn-Pg'$) (larger angle) ($^{\circ}$).

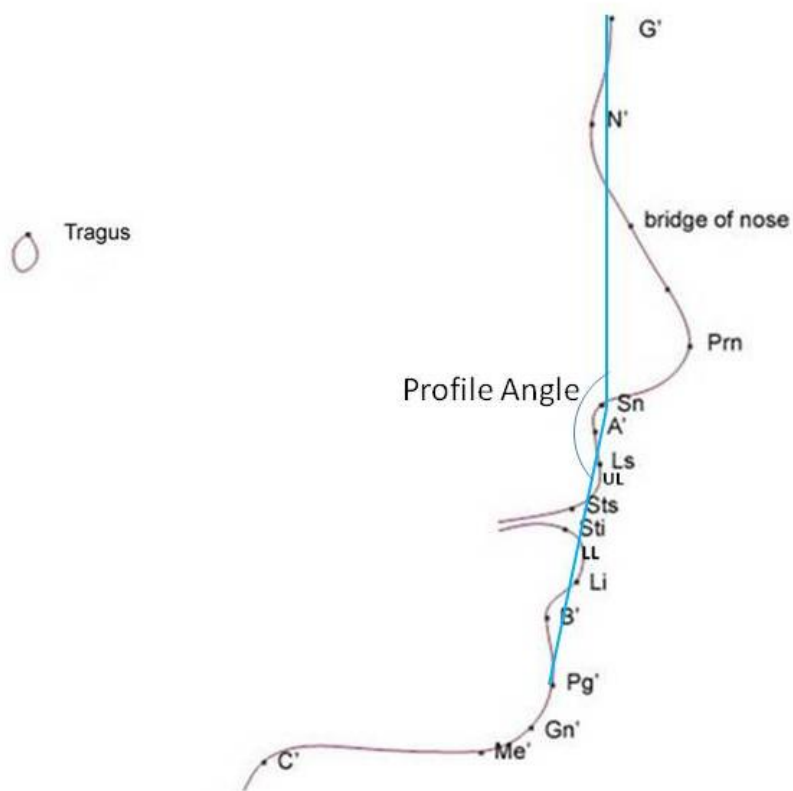


Figure 5. Arnett and Bergman soft tissue analysis.

Powell and Humphreys Analysis:

1. Nasofrontal angle ($G'-N'-Prn$) ($^{\circ}$): Angle formed by a line connecting soft tissue glabella and soft tissue nasion intersecting with a line tangent to the nasal dorsum;
2. Nasomental angle ($N'-Prn-Pg'$) ($^{\circ}$): An angle formed by nasal dorsal line ($N'-Prn$) and nasomental line (a line from the nasal tip to the soft tissue pogonion); and
3. Nasofacial angle ($N'-Prn-Pg'-G'$) ($^{\circ}$): The angle is created by a line connecting the soft tissue glabella and soft tissue pogonion intersected by the dorsal plane of the nose ($N-Prn$).

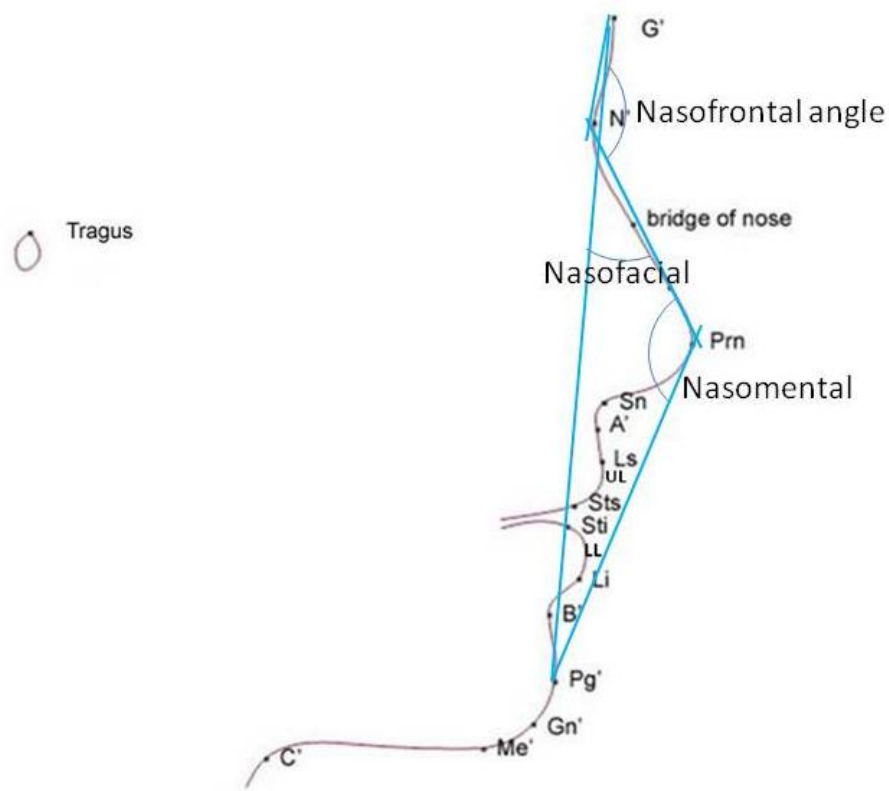


Figure 6. Powell and Humphreys soft tissue analysis.

Additional Analysis:

1. Upper lip angle ($Pg'-N':Pg'-UL$) ($^{\circ}$);
2. Mentolabial angle ($Li-B'-Pg'$) ($^{\circ}$);
3. Lower face percentage ($Sn-Me':G'-Me'$) (%).

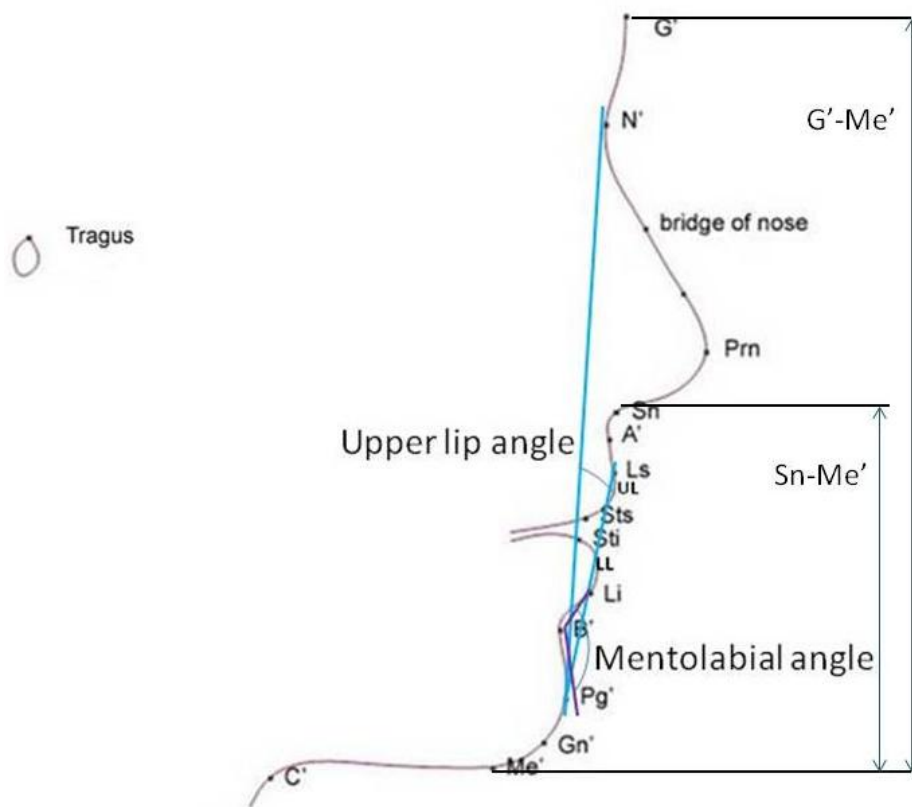


Figure 7. Additional soft tissue analysis.

K. Creation of Profile Traced Image Composite

After digitization of the twenty-seven profile photographs in Dolphin, an average tracing composite of the profile photographs was completed as follows: (Figures 8-10)

1. The PI selected the tracing superimpositions function from the left hand side of the home screen (Figure 8);
2. The PI selected digitized lateral ceph from the image/record chooser function (Figure 9);
3. The PI selected each of the twenty-seven photographic traced images (Figure 9);
4. The PI selected “choose alignment” while in superimposition screen (Figure 9);
5. The PI selected porion from drop down “align at” box (Figure 9);
6. The PI selected soft tissue nasion from drop down “in the direction of” box (Figure 9); and
7. The PI registered the tracings at porion in the direction of soft tissue nasion for alignment (Figure 10).

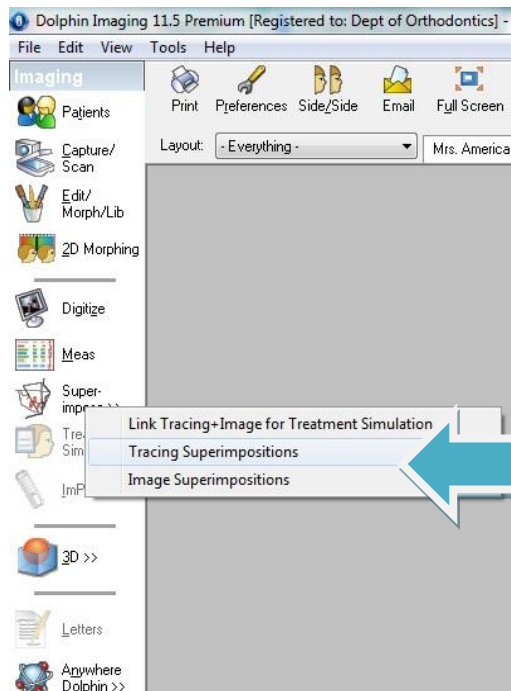


Figure 8. Selection of tracing superimposition in Dolphin.

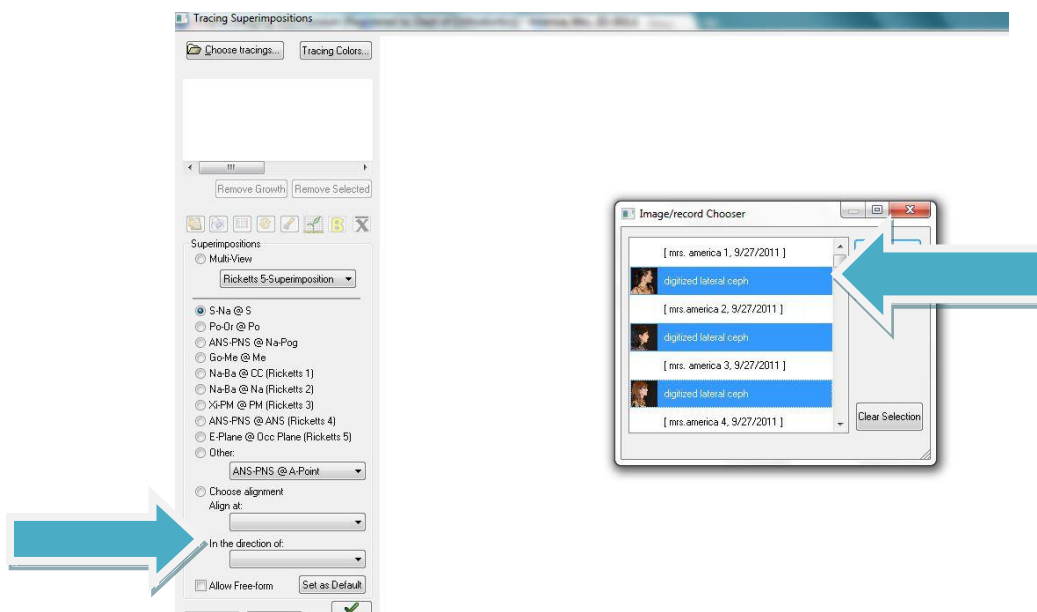


Figure 9. Selection of digitized lateral ceph and alignment.

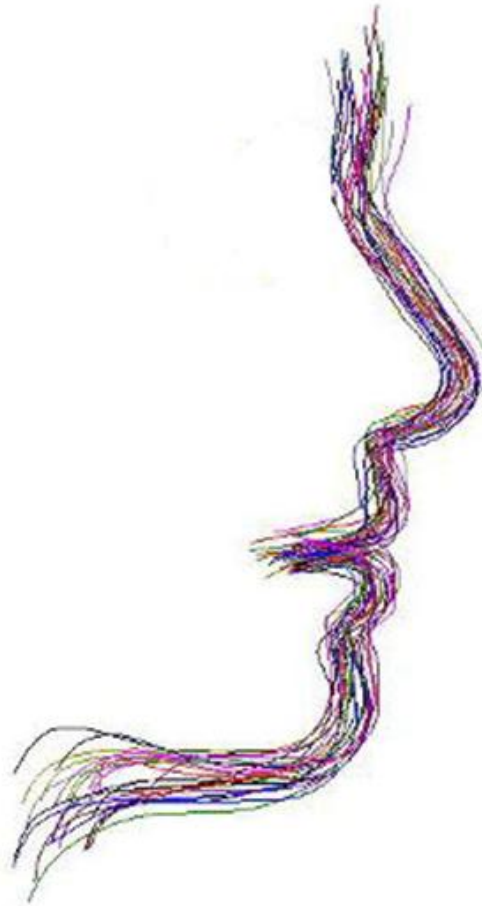


Figure 10. Profile superimpositions-register at porion in the direction of soft tissue nasion.

The software's averaging function, depicted below as an X with a line above it (Figure 11) calculated the average of each landmark and measurement to establish 1 composite tracing of all 27 photographic tracings.

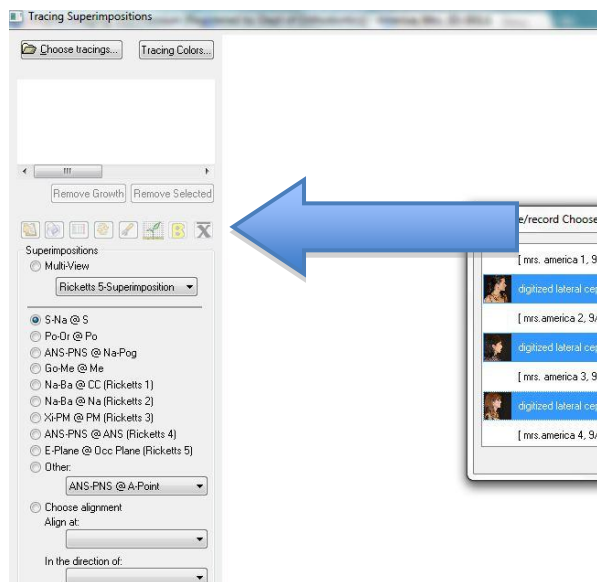


Figure 11. Dolphin averaging function.

L. Creation of Frontal at Rest and Smiling Frontal Photographic Composites

For this research project, Jpsychomorph was used to create the frontal at rest and smiling frontal photographic composite images (Scotland, UK). An average image of the frontal at rest and smiling frontal photographs was completed as follows

(<http://www.faceresearch.org/tech/protomethods>):

1. The PI uploaded the photographs and save as .jpg files;
2. The PI manually digitize facial landmarks: In the transform window, use the Tiddeman et al. method of “prototyping and transformation of skin textures.” Delineate 179 “key facial points on the contours of the major facial features (nose, eyes, mouth) and facial borders” on 27 frontal at repose and 27 smiling frontal photographs (Tiddeman et al., 2005);

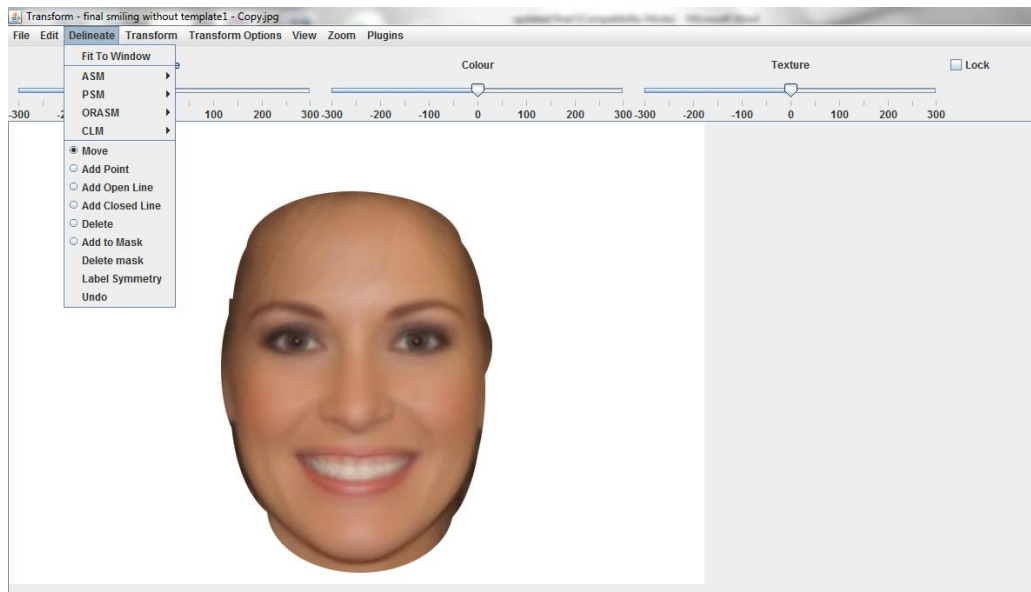


Figure 12. Selection of Delineate function in the transform window.

3. The PI saved the landmarked photographs as a template file format (.tem);
4. The PI paired the 27 frontal at repose and 27 smiling frontal photographs (.jpg) with their respective template (.tem) in a text file (.txt);

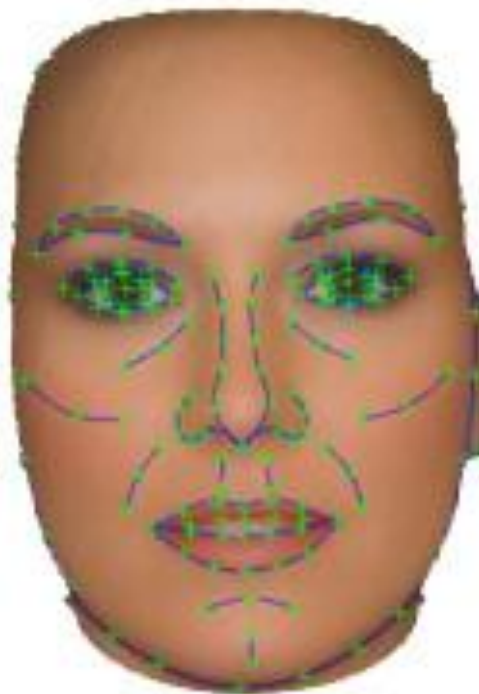


Figure 13. Text file (.txt): Frontal at repose photograph (.jpg) and template (.tem).

5. In the Psychomorph window, the PI selected “average” from the drop down box and “full Procrustes” for shape normalization for each of the paired files, frontal and smiling frontal;

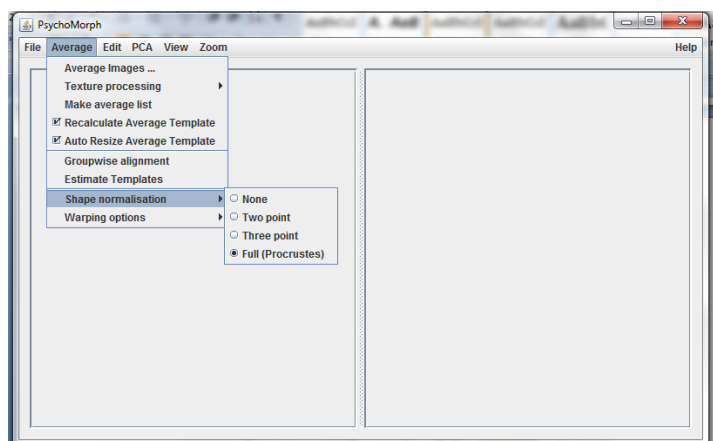


Figure 14. Shape normalization.

6. After normalization, the software averaged each landmark from the paired files, respectively;
7. The average points from the twenty-seven photographs made an average frontal and smiling frontal face shape; and
8. Finally, the color of 27 frontal and 27 smiling frontal faces were averaged into their respective composite face.

M. Frontal at Repose Photographic Analysis

After software processing to establish the frontal at repose and smiling frontal composite, the respective composite images were captured in Dolphin using the frontal x-ray view. Each composite image was printed at a 1:1 ratio. The PI hand traced 14 points on 2 frontal at repose and 2 smiling frontal composite images 2 times 2 weeks apart.

The frontal at repose photographic landmarks are depicted in figure 15 (Arnett and Bergman, 1993):

1. Soft tissue glabella (G'): the midpoint between the supraorbital ridges in the median sagittal plane;
2. Soft tissue nasion (N'): the midpoint of the interpupillary line;
3. Tip of nose (Prn): midpoint of the inter alare line;
4. Subnasale (Sn): the midpoint at most inferior point of the base of the nose;
5. Upper lip (ULi): most inferior point of the upper lip;
6. Lower lip (LLs): most superior point of the lower lip;
7. Soft tissue menton (Me'): most inferior point of the soft tissue chin;
8. Alare (Al): the most lateral point on the lateral surface of the external nose;

9. Labial comissure (Lc): junction of the upper and lower lips lateral to the angle of the mouth;
10. Zygoma (Zy): the most lateral prominence of the soft tissue cheek;
11. Soft tissue Gonion (Go'): intersection of a line tangent to the soft tissue mandibular body and a line tangent to soft tissue mandibular ramus;
12. Outer canthal (Ex): the most lateral point of the outer corner of the eye fissures;
13. Inner canthal (En): the most medial point of the inner corner of the eye fissures;
and
14. Pupil (P): center of the iris.

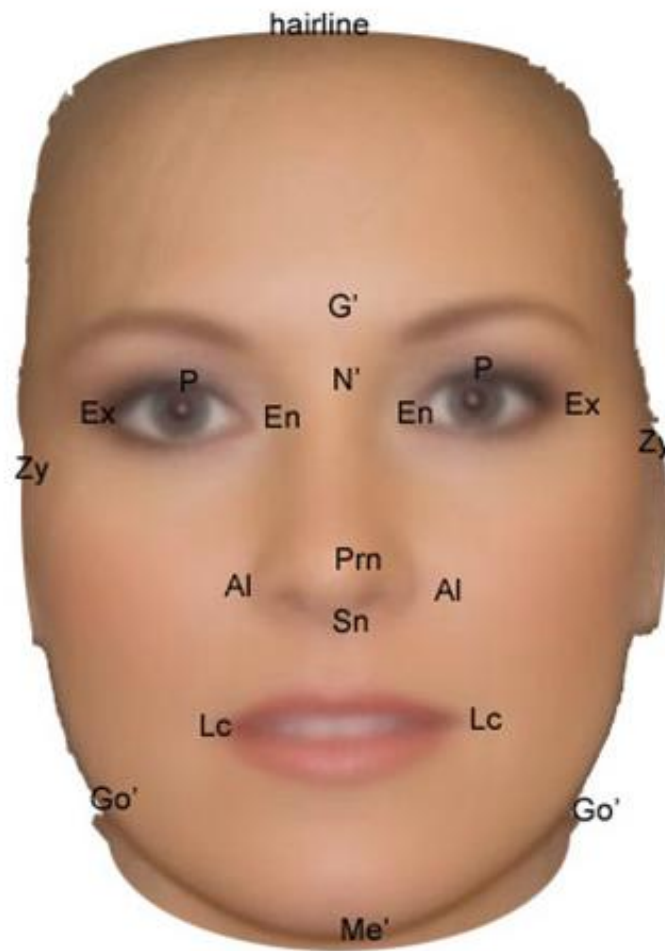


Figure 15. Frontal at repose photographic landmarks.

After the landmarks were digitized twice, the averages were taken. The measurements for comparison are as follows (Figure 15):

Powell and Humphreys measurements:

1. Inter inner canthal (En) distance compared to inter outer canthal (Ex) distance;
2. Basic facial shape-round, oval, square, or diamond/pear (Figure 16);
3. Eye variation-round, small or ptotic (Figure 17);
4. Comparison of inter medial limbus distance to inter commissure distance;

5. The ratio of subnasle to upper lip inferioris distance versus lower lip superioris to soft tissue menton distance (Sn-ULi: LLs-Me');

Arnett's published measurements:

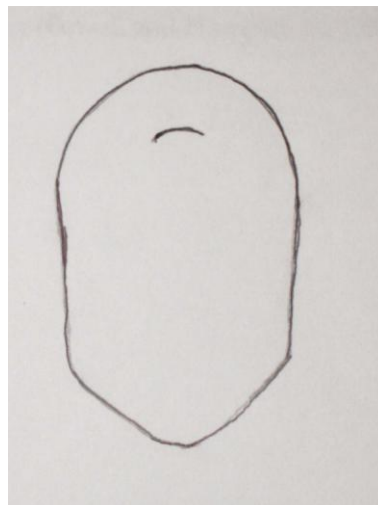
1. Facial width- soft tissue Zy-Zy: Go'-Go'; and

Additional measurement:

1. Upper facial height to lower facial height (G'-Sn: Sn-Me').



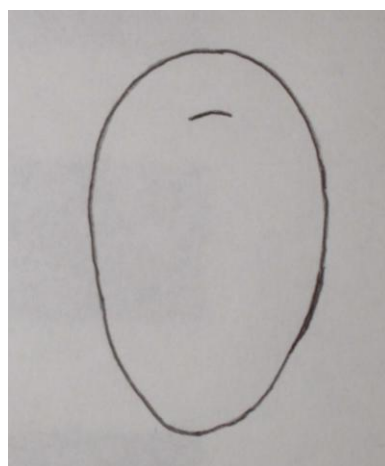
Square



Diamond/Pear

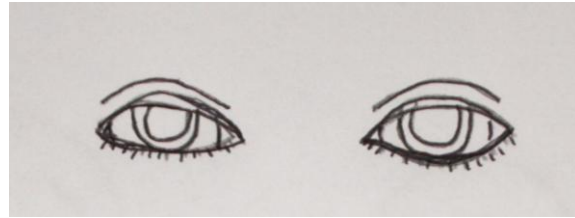


Round



Oval

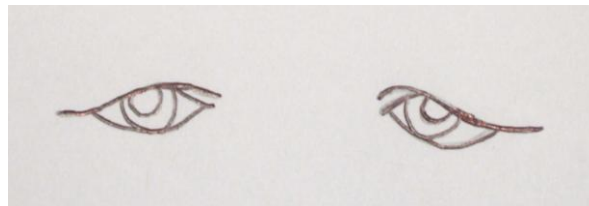
Figure 16. Basic facial shape-round, oval, square, or diamond/pear (after Powell and Humphreys, 1980).



Round



Small



Ptotic

Figure 17. Eye variation- round, small or ptotic (after Powell and Humphreys, 1980).

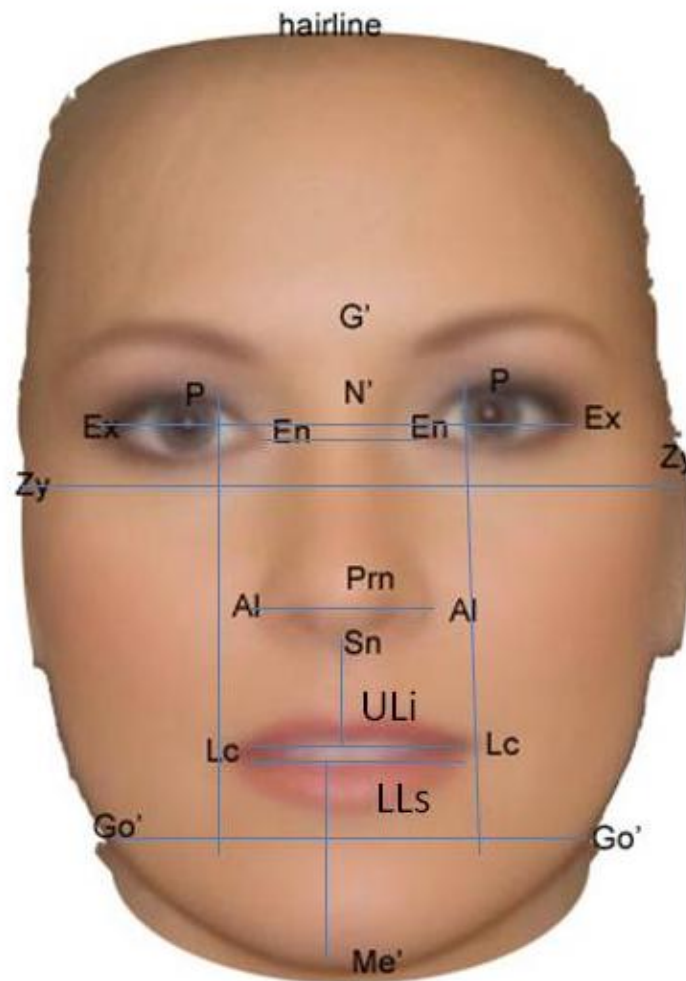


Figure 18. Frontal at repose photographic analysis.

For the smiling frontal photographic analysis, the landmarks were digitized twice and the averages were taken. The smiling frontal photographic analysis consisted of variables in Figure 18 compared to variables in Figure 19. The ratios that were used for comparison are as follows:

1. Gingiva display -The linear measurement from the upper lip inferioris to the most inferior point of the gingival margin;

2. Inter labial commissure (Lc) distance at repose compared with the inter labial commissure (Lc) distance at smiling;
3. Nasion (N') to subnasale (Sn) at repose compared to nasion (N') to subnasale (Sn) at smiling;
4. Inter-outer canthal (Ex) width at repose compared with inter-outer canthal (Ex) width at smiling;
5. Nasion (N') to upper lip inferiors (ULi) at repose compared to nasion (N') to upper lip inferiors (ULi) at smiling;
6. Inter inner canthal (En) at repose compared with the inter inner canthal (En) at smiling; and
7. Inter alare (Al) width at repose compared to inter alare (Al) width at smiling.

An additional measurement was completed only on the smiling analysis: Subnasale (Sn) to Upper lip inferiors: inter alare line to labial commissure (Sn-ULi: Al-Lc).

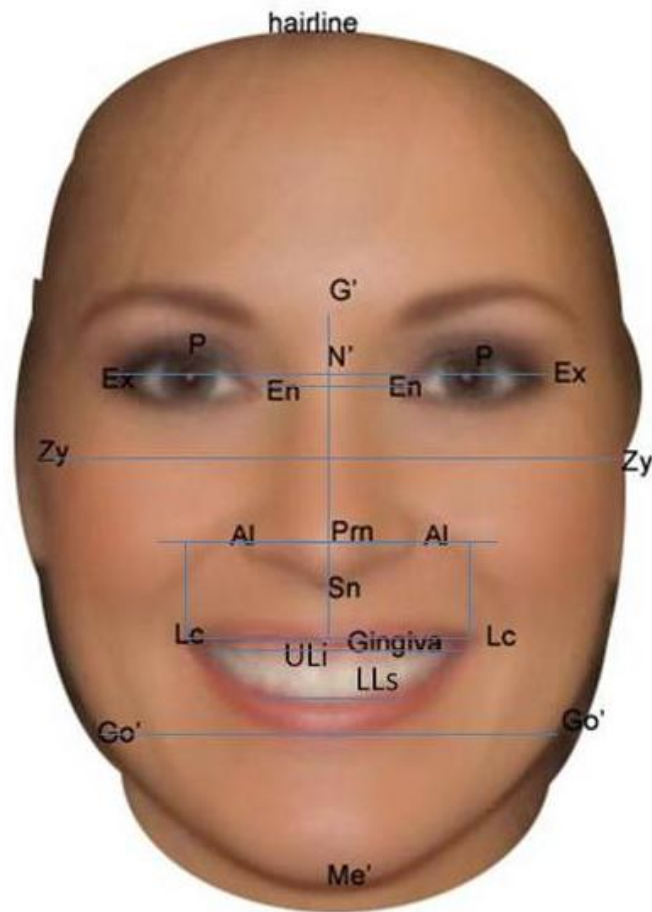


Figure 19. Smiling frontal photograph analysis

N. Statistical Analysis

After collection of the data from the profile photographs, the data were tabulated using Microsoft Excel and analyzed using the statistical software, SPSS. A one-sample *t*-test was performed to evaluate significant mean differences between the beauty pageant queens' soft tissue measurements and published norms.

IV. RESULTS

A. Study Sample Distribution

This study evaluated twenty-seven beauty pageant winners. The beauty pageant queens won various pageants within the past five years: Mrs. Iowa, Mrs. Georgia, Mrs. Alabama, Miss North Central Georgia, Miss Georgia USA, Mrs. Savannah Georgia, Miss Illinois, 2 Mrs. Kansas, Mrs. Missouri, Miss Cupid, Miss Heartland, Mrs. America, Mrs. DC Galaxy, Mrs. Mid Missouri, Mrs. Marshfield, Mrs. Wisconsin, Mrs. Minnesota, Mrs. Elk River, Mrs. Des Moines Iowa, Mrs. Wisconsin, Mrs. Illinois America, 2 Mrs. Minnesota United States, 2 Mrs. Iowa America, and Mrs. Iowa America International. The ages ranged from 20-47 years old. The mean age was 34.96 years old (Figure 20). Fifteen of the 27 women had orthodontic treatment in adolescence, and 1 woman had Invisalign as an adult. Three women reported having teeth extracted for orthodontic treatment. Per IRB, the participants must remain de-identified and it is not possible to list the years of the individual's pageant queen titles.

The Kolmogorov-Smirnov and Shapiro Wilk test showed that all the variables in the study have approximately normal distribution. A one-sample *t*-test was used to compare the sample to a hypothesized mean. The data was analyzed using the SPSS software (v.19.0), (Chicago, IL).

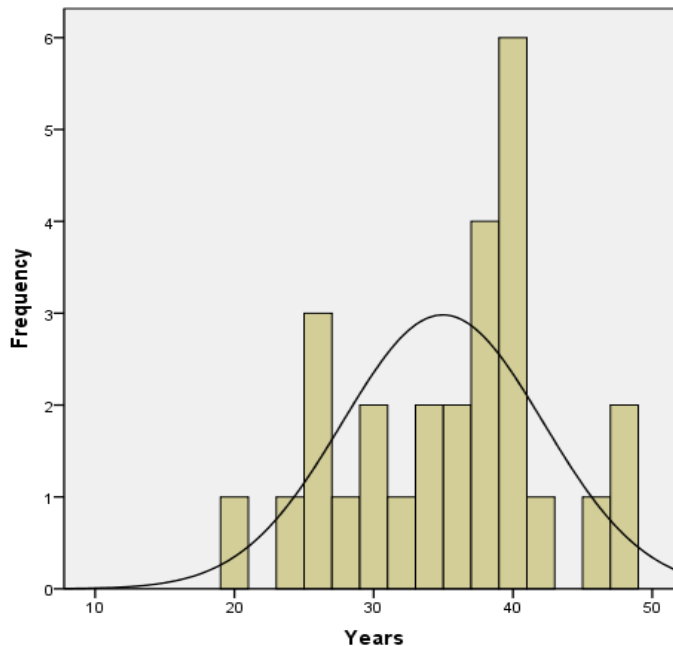


Figure 20. Pageant queens age distribution in years.

B. Inter and Intra Reliability Testing

After calibration and scaling, the PI tested intra reliability by tracings 10 subjects' photographs in Dolphin (Chatsworth, CA) with 19 different landmarks at 2 time periods, 2 weeks apart. A paired samples correlation showed a coefficient of correlation range between 0.982 and 1.00, indicating a high range of correlation thus providing good support for intra-operator reliability. To measure inter-operator reliability, the PI and a UIC orthodontic faculty member each traced the same 10 photographs with 19 different landmarks separately. A paired samples correlations showed coefficient of correlation range from 0.810 to 0.970, indicating good inter reliability between the PI and UIC faculty.

C. Profile Photographic Composite and Results

Twenty-seven Caucasian adult beauty pageant queen winners' soft tissue attributes were evaluated for this study. The profile tracing photographic composite and (+/-) 1 standard deviation was averaged in Dolphin and depicted below.

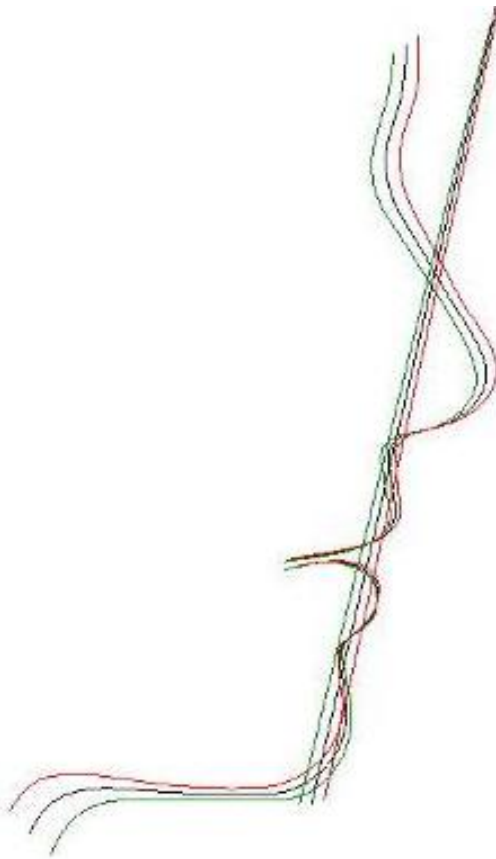


Figure 21. Profile tracing photographic composite in relation to subnasale-soft tissue pogonion line: (-1) standard deviation (green), average composite (black), (+1) standard deviation (red).

Tables I and II show the descriptive statistics and the results of the one-sample *t*-test comparison of the published mean norms for profile soft tissue measurements compared with the beauty pageant queens' norms for profile soft tissue measurements.

TABLE I

DESCRIPTIVE STATISTICS OF THE BEAUTY PAGEANT QUEENS'

Soft Tissue Lateral Measurements	N	Mean Norm	Sample Mean	(±) SD
Legan Analysis				
Facial Convexity (intersection of G'-Sn and Sn-Pg') (°)	27	12.00	11.64	5.623
Nasolabial Angle (Col-Sn-UL) (°)	27	102.00	109.21	10.341
Interlabial Gap (Sts-Sti) (mm)	27	3.30	4.044	2.313
Upper Lip Protrusion (UL-SnPg') (mm)	27	3.00	2.050	2.062
Lower Lip Protrusion (LL-SnPg') (mm)	27	2.00	1.44	2.3113
Lower facial thirds (Sn-Sts:Sti-Me') (%)	27	33.30	28.12	2.543
Arnett and Bergman Analysis				
Profile Angle (G'-Sn-Pg') (°)	27	170.00	168.77	5.740
Powell and Humphreys Analysis				
Nasofrontal angle (N'-nasal dorsum) (°)	27	122.50	135.64	7.076
Nasomental angle (nasal dorsal line-nasomental line) (°)	27	126.00	121.47	5.976
Nasofacial angle (G'-Pg'-dorsal plane of the nose) (°)	27	35.00	37.50	4.486
Additional Analysis				
Upper lip angle (Pg'-UL:PG'-N') (°)	27	10.00	10.34	3.541
Mentolabial angle (LL-B'-Pg') (°)	27	126.00	128.19	13.900
Lower face percentage (Sn-Me':G'-Me') (%)	27	54.00	51.17	2.063

TABLE II

ONE-SAMPLE *t*-TEST RESULTS OF THE PUBLISHED MEAN NORMS COMPARED TO BEAUTY PAGEANT QUEENS' MEAN NORMS

Profile Soft Tissue Measurements	N	Mean Difference	t	df	p-value*	95% CI
Legan						
Facial convexity(°)	27	-0.36	-0.329	26	0.745	-2.580 to 1.869
Nasolabial angle (°)	27	7.21	73.625	26	0.001*	3.124 to 11.306
Interlabial gap(mm)	27	0.74	2.976	26	0.006*	0.230 to 1.259
Upper lip protrusion(mm)	27	-0.95	-2.398	26	0.024*	-1.768 to -0.135
Lower lip protrusion (mm)	27	-0.56	-1.265	26	0.217	-1.478 to 0.352
Lower facial thirds(%)	27	-5.18	-10.581	26	0.000*	-6.184 to -4.172
Arnett and Bergman						
Profile angle(°)	27	-1.23	-1.117	26	0.274	-3.504 to 1.037
Powell and Humphreys						
Nasofrontal angle(°)	27	13.14	9.652	26	0.000*	10.345 to 15.944
Nasomental angle(°)	27	-4.54	-3.948	26	0.001*	-6.905 to -2.177
Nasofacial angle(°)	27	2.50	2.896	26	0.008*	0.725 to 4.275
Additional						
Upper lip angle(°)	27	0.34	0.505	26	0.618	-1.056 to 1.745
Mentolabial angle(°)	27	2.19	0.820	26	0.420	-3.306 to 7.691
Lower face percentage(%)	27	-2.84	-7.146	26	0.000*	-3.653 to -2.021

(*) statistically significant at $p \leq 0.05$.

The charts below display the comparison of the beauty pageant queens' means and Legan's published norms (Figure 22 (a) and (b)).

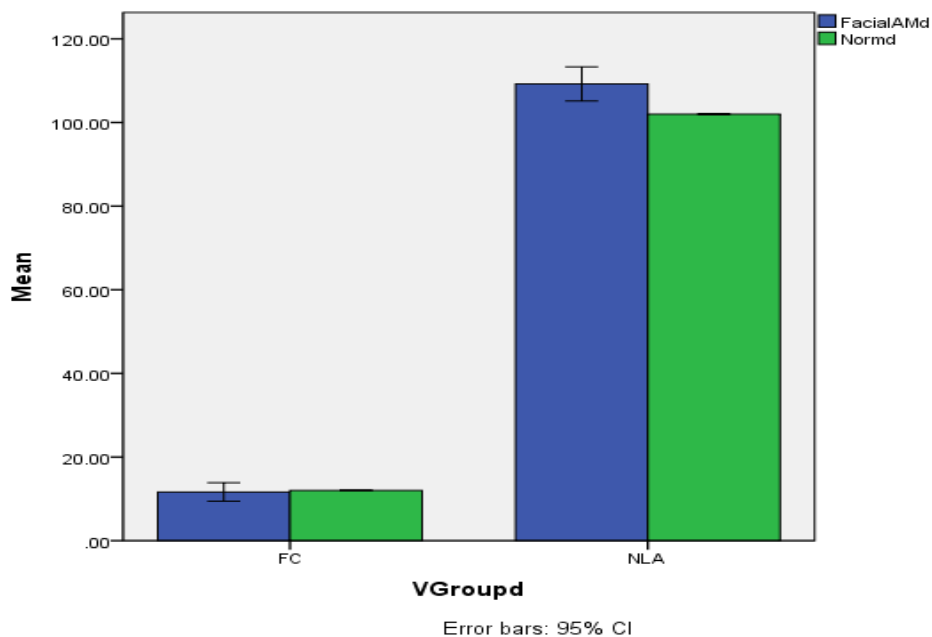


Figure 22. (a) Facial attractive measurements of beauty pageant queens' compared with Legan published norms (^o).

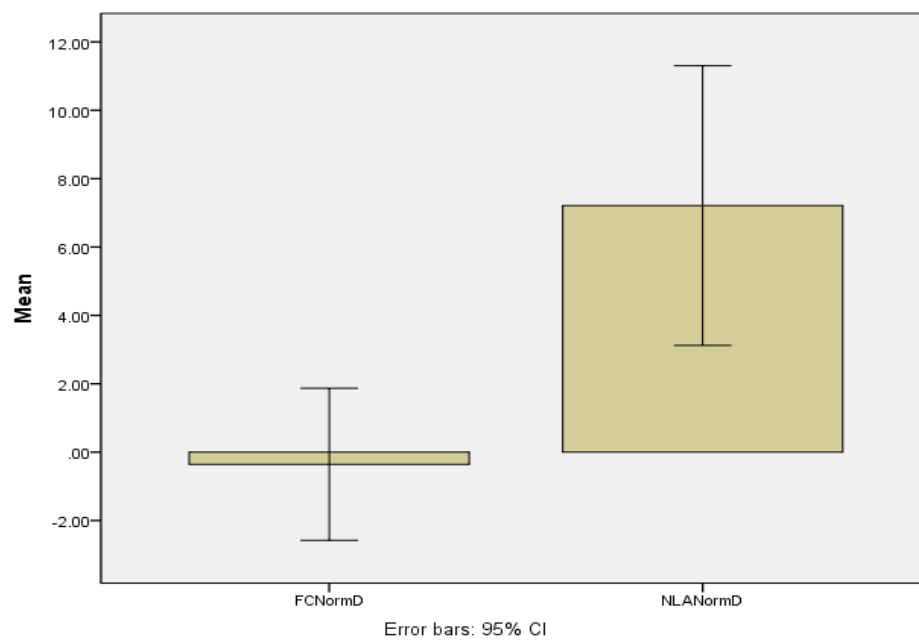


Figure 22. (b) Mean differences between the beauty queens' measurements and Legan published norms (^o).

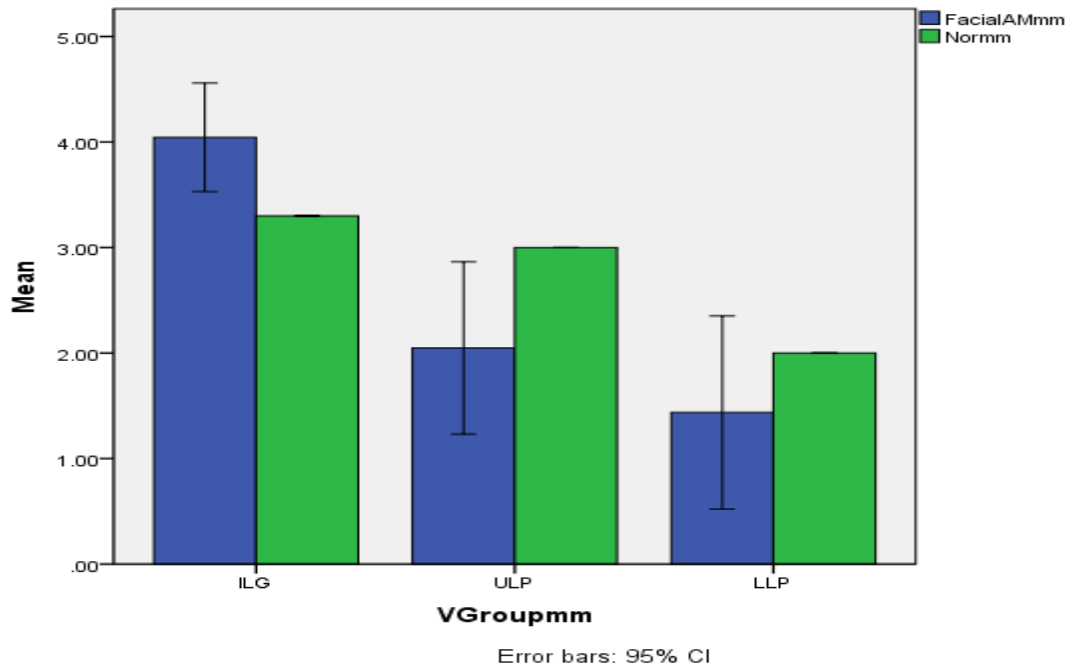


Figure 23. (a) Facial attractive measurements of beauty pageant queens' compared with Legan published norms (mms).

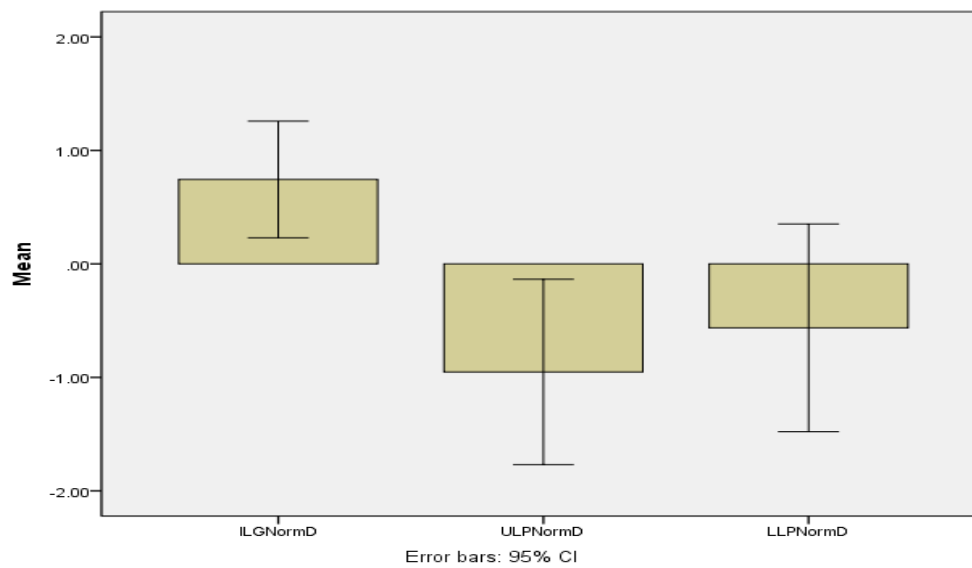


Figure 23. (b) Mean differences between the beauty queens' measurements and Legan published norms (mms).

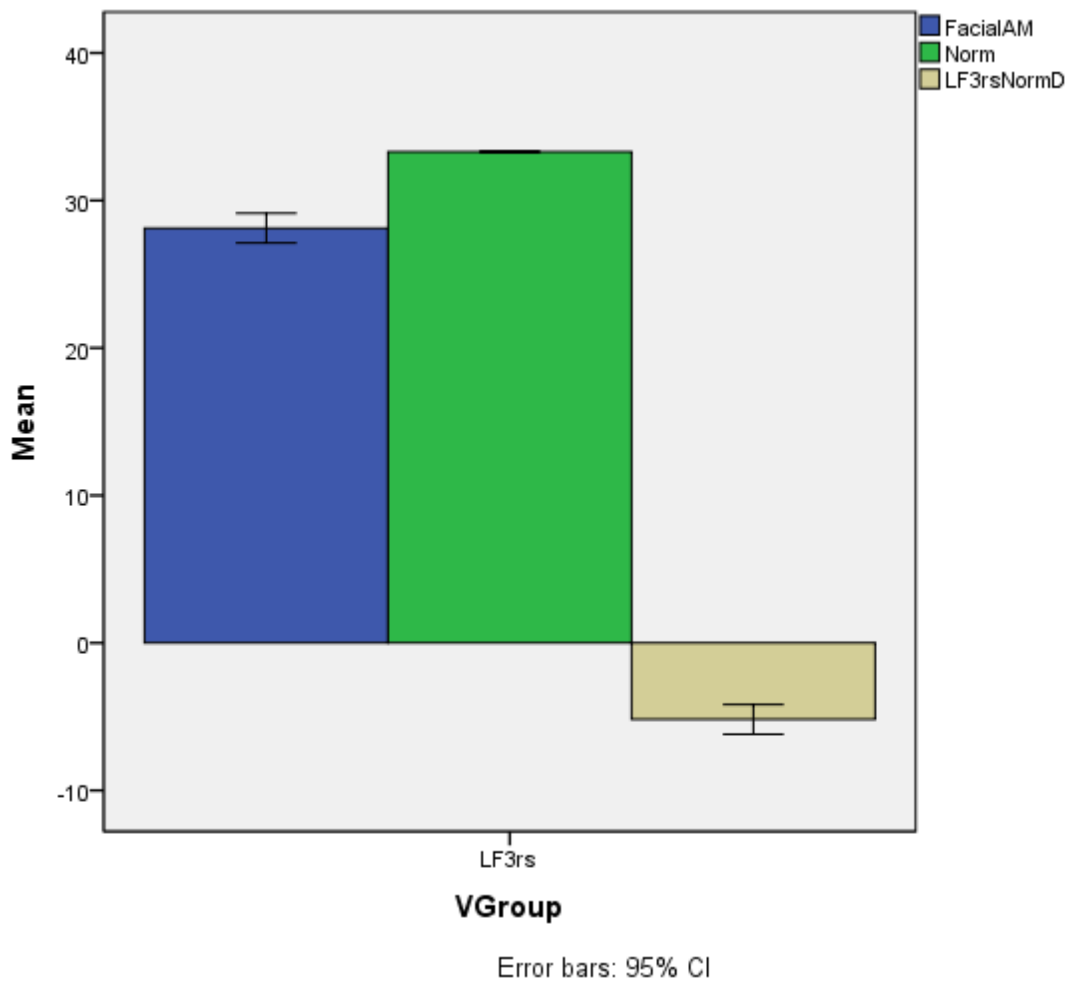


Figure 24. Facial attractive measurements of beauty pageant queens' compared with Legan published norms and the mean differences between the study sample and Legan published norms (%).

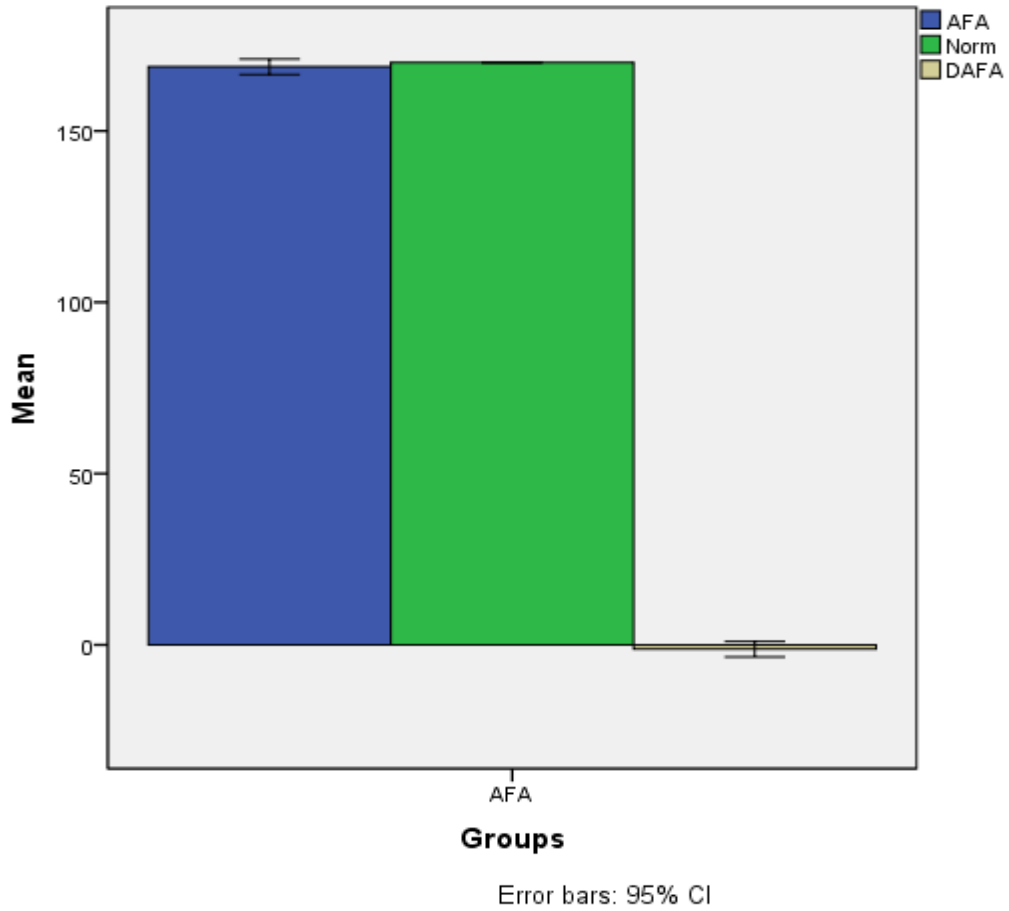


Figure 25. Facial attractive measurements of beauty pageant queens' compared with Arnett and Bergman published norm and the mean difference.

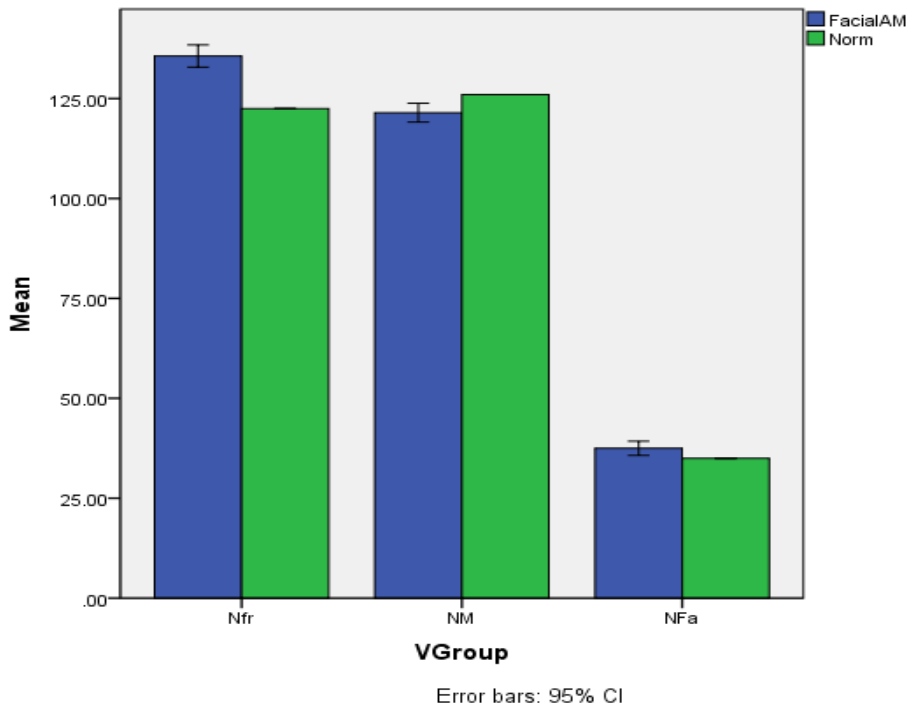


Figure 26. Facial attractive measurements of beauty pageant queens' compared with Powell and Humphreys published norms.

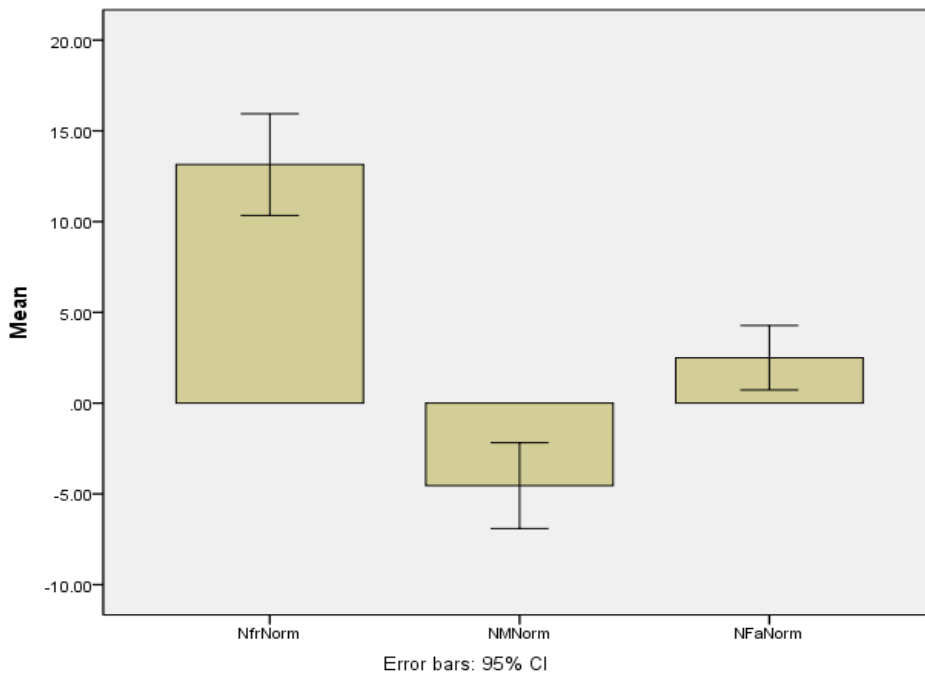


Figure 27. Mean differences between beauty pageant queens' measurements and Powell and Humphreys published norms.

The chart below displays the comparison of the beauty pageant queens' mean and the additional published norm (Figure 28).

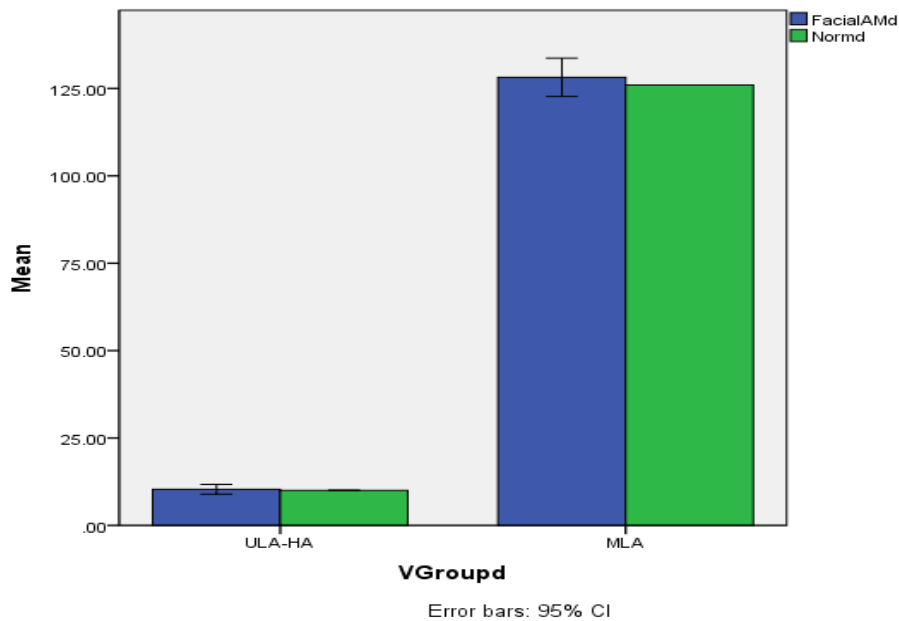


Figure 28. (a) Facial attractive measurements of beauty pageant queens' compared to additional published norms ($^{\circ}$).

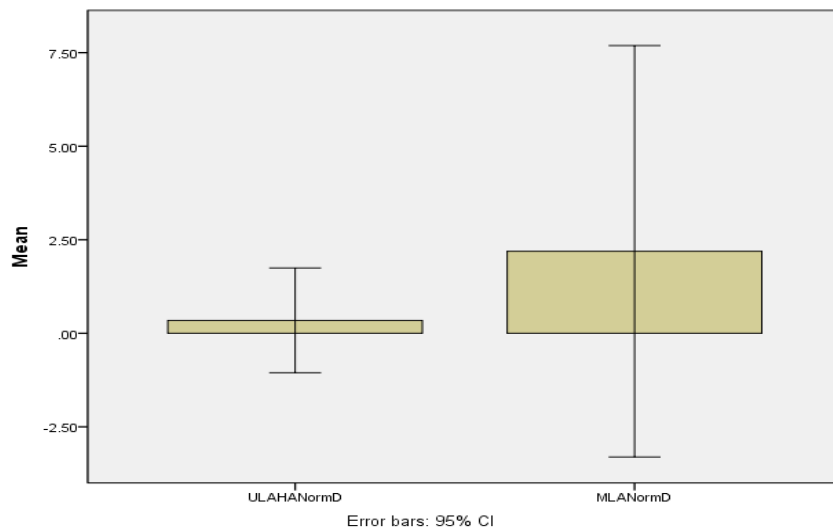


Figure 28. (b) Mean differences between beauty pageant queens' measurements and additional published norms ($^{\circ}$).

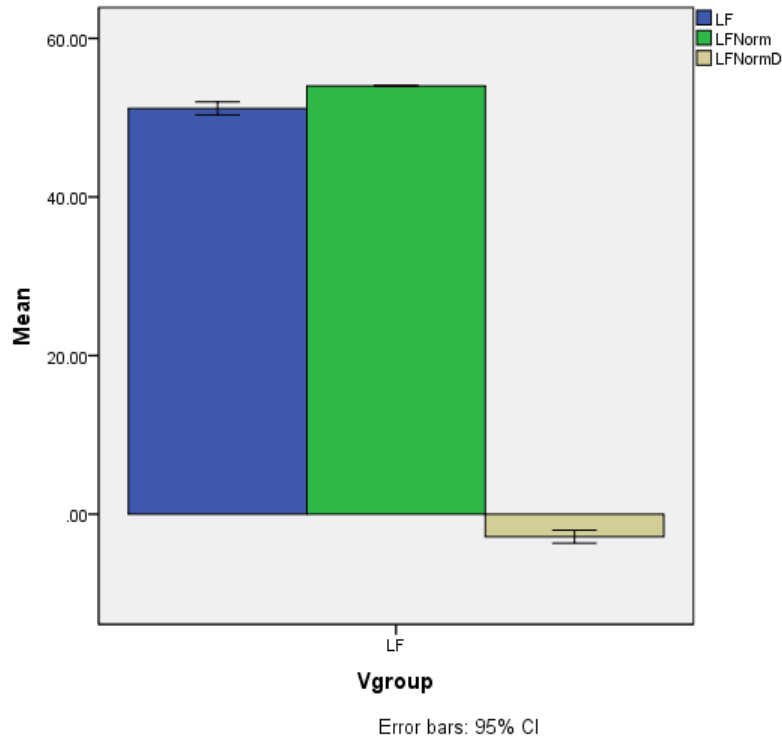


Figure 28. (c) Facial attractive measurements of beauty pageant queens' compared with additional published norm and the mean difference (%).

The study sample means were compared with the Legan, Arnett, Bergman, Powell, Humphreys and additional published norms. For Arnett's profile angle, Powell and Humphreys's nasomental, nasofacial, and nasofrontal angle, the midpoint of the published ranges was used as the mean for statistical testing in this study.

A one-sample *t*-test indicated that 8 variables out of 13 variables in the study showed statistically significant mean differences from the published norms with *p*-values ranging from 0.000 to 0.0024. Based on the results, the study rejects the null hypothesis that the means are approximately the same for the following variables respectively:

Powell and Humphreys measurements: Nasolabial, Nasomental, Nasofacial and Nasofrontal angles;

Legan measurements: Upper lip protrusion, Lower facial thirds and Interlabial gap; and

Additional measurements: Lower face percentage.

The beauty pageant queens' nasofrontal angle, nasofacial angle, nasolabial angle, upper lip protrusion, lower facial thirds and lower face percentage was significantly greater than the published norms. The beauty pageant queens' nasomental angle and interlabial gap was significantly less than the published norm.

The results show that 5 out of 13 variables in the study show no statistically significant mean differences for the angle of facial convexity, profile angle, upper lip angle, mental labial angle, and lower lip protrusion, p-values >0.05 .

D. Frontal at Repose Photographic Composite and Results

The frontal at repose composite can be seen in Figure 29.



Figure 29. Frontal at repose photographic composite.

Due to the software's inability to extrapolate the raw data, it was not possible to test the frontal at repose and smiling frontal composite norms for statistical significance. However, measurements were made from both composite faces, which should represent norms for the beauty pageant queens' in the frontal at repose and smiling frontal position.

Various measurements were calculated by the PI and repeated twice. The findings below are comparisons of previously published norms with the study sample measurements.

Powell and Humphreys reported the ideal inner canthal and outer canthal distances: 35.00 mm, 9.80 mm respectively. The PI calculated a ratio of inner canthal to outer canthal from the published norms equaled 0.36. The sample frontal composite inner canthal to outer canthal ratio equaled 0.38. The study sample showed a slightly larger inner to outer canthal distance ratio than the norm.

For attractive female faces, the bi-zygomatic width reported by Arnett, Bergman and Farkas is 128.80 mm. For attractive female faces, the bi-gonial width according to the same clinicians is 94.50 mm. The bi-zygomatic : bi-gonial ratio for an attractive female face is 1.36. The study sample frontal at repose composite showed bi-zygomatic : bi-gonial facial width equaled to 1.29. The study sample showed close approximation with the Arnett, Bergman and Farkas attractive female face bi-zygomatic : bi-gonial norm (Arnett and Bergman, 1993; Farkas, 1987).

Based on the Powell and Humphreys facial and eye classification, the composite frontal photographic image matched the diamond/pear face and round eye classification (Powell and Humphreys, 1984).

Furthermore the study sample lip length on the frontal photographic composite was compared to the Powell and Humphreys norm for lip length. Powell and Humphreys described a ratio for the lower to upper lip length of 2.30. The study sample showed a ratio for the lower to upper lip length equaled to 2.17. This suggests the beauty pageant queens' norm has a shorter upper lip compared with the published norm.

Powell and Humphreys suggested the distance for the inter labial commissures should equal the distance for the inter medial limbus of the eyes (Powell and Humphreys, 1984). A greater inter labial commissure distance as compared with the inter medial limbus distance was found in our samples.

Table III shows published norms compared to the beauty pageant queens' frontal at repose soft tissue norm.

TABLE III

BEAUTY QUEENS' FRONTAL SOFT TISSUE ANALYSIS

Measurements	N	Published Norm	Beauty pageant queens' norm
Powell and Humphrey Published Norm			
Inner canthal (En): Outer canthal (Ex) ratio (mm)	27	0.36	0.38
Basic facial shape	27	Round, oval, square or diamond/pear	Diamond/pear
Eye variation	27	Round, small, ptotic	Round
Inter medial limbus: inter labial commissures	27	1.00	0.925
Lip ratio- (Sn-ULi, LLS-Me') (mm)	27	2.30	2.17
Upper facial height to lower facial height (G'-Sn: Sn-Me')	27	1.00	1.11
Arnett' and Bergman's Published Norm			
Facial width- Zy-Zy: Go'-Go' (mm)	27	1.36	1.29

E. **Smiling Frontal Photographic Composite and Results**

The smiling composite can be seen in Figure 30.

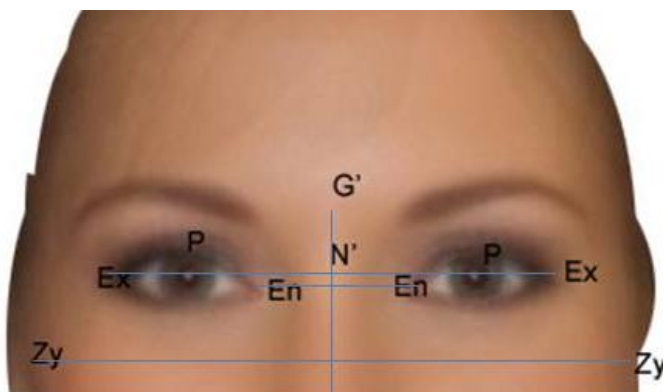


Figure 30. Smiling frontal photographic composite.

On the smiling frontal composite image, various measurements were made by the PI and repeated twice. Additionally, ratios were calculated between the frontal at repose composite image and the smiling frontal composite image.

To ensure the image magnification was consistent between the two (frontal at repose and smiling frontal) composites, the PI measured the inter-inner canthal distances on both composites. These distances were compared and found to be equal.

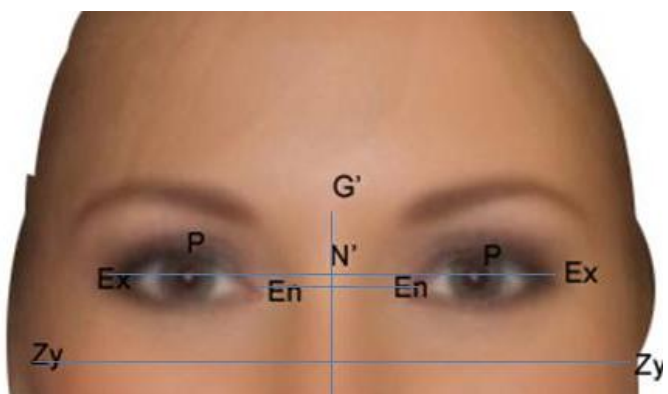
Soft tissue nasion was determined on the frontal composite. Soft tissue nasion was then transferred to the smiling composite. It was determined that soft tissue nasion on the frontal at repose composite and smiling frontal composite were equal (Figure 31).



En-En: 25mm

N'-midpoint of En-En=5mm

Frontal at repose inter inner canthal distance-soft tissue nasion



En-En: 25mm

N'-midpoint of En-En=5mm

Smiling frontal inter inner canthal distance- soft tissue nasion

Figure 31. Landmarked and equidistant soft tissue nasion.

The distances when lips were at rest and when smiling were obtained and their values and ratios were reported as follows:

1. (N'-ULi)repose: (N'-ULi)smiling: 53.00 mm: 50.00 mm, 1.06;
2. (N'-Sn)repose: (N'-Sn)smiling: 37.00 mm: 40.50 mm, 0.91;
3. (Ex-Ex)repose: (Ex-Ex)smiling 71.00mm: 75.00mm, 0.95;
4. (Al-Al)repose: (Al-Al)smiling 27.00mm: 30.00mm, 0.90; and
5. (Lc-Lc)repose: (Lc-Lc)smiling 40.00mm: 52.00mm, 0.77.

The frontal at repose composite showed 0 mm of gingiva, whereas the smiling composite showed 2.25 mm of gingiva.

Table IV shows the beauty pageant queens' frontal-smiling soft tissue norm.

TABLE IV

BEAUTY PAGEANT QUEENS' SOFT TISSUE FRONTAL-SMILING ANALYSIS

Measurements	N	Beauty pageant queens' norm
Gingiva display (mm)	27	2.25
Inter labial commissure (Lc) at repose: Inter labial commissure (Lc) at smiling	27	0.77
Nasion (N') to subnasale (Sn) at repose: Nasion (N') to subnasale (Sn) at smiling	27	0.91
Inter outer canthal (Ex) width at repose: Inter outer canthal (Ex) width at smiling	27	0.95
Nasion (N') to upper lip inferiors (ULi) at repose: nasion (N') to upper lip inferiors (ULi) at smiling	27	1.06
Inter inner canthal (En) at repose: Inter inner canthal (En) at smiling	27	1.00
Inter alare (Al) width at repose: Inter alare (Al) width at smiling	27	0.90
Subnasale (Sn) to Upper lip inferiors: Alare to labial commissure	27	0.77

V. DISCUSSION

This project is one of few research attempts to objectively study attributes of female facial esthetics. To circumvent the criticism of personal bias or preferences, we used beauty pageant queens that have already been publicly judged attractive.

Also, this study was designed to determine whether previously created soft tissue norms correspond to present day Caucasian females who are publicly judged as attractive. Composite profile, frontal at repose and smiling frontal images of the pageant queens were created and means and standard deviations were generated for future use in orthodontic diagnosis and treatment planning.

A. Selection of Subjects for Beauty Pageant Winners' Soft Tissue Composites

In Bishara's 1998 article, he encouraged orthodontists to treat an adolescent to a different norm than an adult because of the affects of growth on a child's developing soft tissue (Bishara et al., 1998). It is important to re-emphasize that the sample in this research is Caucasian female adult beauty pageant winners from the past five years. The reason this group of women was chosen is because the women have been judged attractive. However, any extrapolation of our findings to younger, adolescent females is not suggested.

B. Analysis of Results

1. Profile Composite

The purpose of this study was to evaluate the shape of beauty pageant queens' face, assess their esthetic characteristics, and review if norms for attraction have changed over time. This 2011 study sample was compared to norms for attraction published at different time points: Legan norms published in 1980, Powell and Humphreys norms published in 1984 and Arnett and Bergman norms published in 1993. In this 2011 study, the beauty pageant queens' norm was more closely in agreement with Arnett and Bergman's 1993 norm. It can be inferred from the findings that the study sample in this research most closely resembles the models used by Arnett and Bergman, which was the most current published norm used for comparison.

Interestingly, the findings for the beauty pageant queens' nasofrontal and nasofacial angle means were significantly greater than the published norm. An increased nasofrontal angle suggests a smaller nose or retrusive forehead; however a smaller nose is unlikely because our sample also had an increased nasofacial angle. Taking these findings together, this suggests a flattened (retrusive) forehead.

The beauty pageant queens' significantly decreased nasomental angle suggests a larger nose, a retrusive chin or a more deeply set soft tissue nasion. However, the significantly increased nasofacial angle, the nonsignificant angle of facial convexity and profile angle suggest soft tissue chin and nose measurements in agreement with the published norms. Compiling these measurements together suggests a more deeply set soft tissue nasion.

The beauty pageant queens' significantly greater mean nasolabial angle suggests a retruded upper lip or tipped up nose. Their significantly decreased upper lip protrusion substantiates the retruded position of the upper lip. A retrusive upper lip may suggest a degree of maxillary hypoplasia, retruded upper incisors, or the effects of soft tissue aging. It is not believed that this study sample has a vertical maxillary deficiency because of the normal gingival display. If the maxilla were vertically deficient there would be a tendency to show less of the maxillary incisors with the lips relaxed. It is possible that the beauty pageant queens have retruded incisors, but since no clinical exam was performed we have no way of knowing this. The fact that our study sample had less upper lip protrusion than the Legan published norm corroborated Behrents's (1985) results suggesting the influences of aging on the beauty pageant queens' upper lip.

One might expect a decreased interlabial gap and decreased incisor display when the lips are relaxed if age was a major contributing factor; however, that is not the case. This sample displays an increased interlabial gap implying the beauty pageant queens' norm displays more incisors at repose. This may suggest vertical maxillary excess and/or a short upper lip.

The lower lip protrusion did not show significance differences from the Legan published norm. It can be interpreted that the upper lip for this sample is more retrusive than the lower lip. The nonsignificant difference in the lower lip may suggest well positioned lower incisors. Additionally, this suggests the lower lip may not be affected to the same degree as the upper lip by soft tissue aging.

It is likely that the soft tissue chin is in agreement with published norms. The nonsignificant differences of the angle of facial convexity, profile angle and mentolabial indirectly suggests a soft tissue chin position in agreement with the published norms. In addition, although the mentolabial angle did not show significance, the large standard deviation suggests a wide range of variation.

One of the most important findings in this study was the variation in facial heights. The study results showed significant differences between the sample norm in the lower facial thirds and lower face percentage. Our samples have a decreased stomion inferioris to soft tissue menton compared with the publish norm. These findings are consistent in both our profile and frontal facial analysis.

2. **Frontal at Repose and Smiling Frontal Composite**

Some of this work evaluated soft tissue changes between repose and smiling. This study was in agreement with Peck et al., "The gingival smile line" (Peck et al., 1992). The comparison of the frontal at repose and smiling frontal composite depicted a more downward pointing nose position for the smiling frontal composite. This composite also showed a more elevated lip. The lips also appeared to widen between the frontal at repose composite and the smiling frontal composite. Moreover, the eyes squinted from repose to smiling.

3. **Smiling Frontal Composite**

Smiling facial esthetics was also assessed by this study. Perceptions for an attractive smile were compared between the beauty pageant queens' smile and the esthetic smile described by Kokich Jr et al. (1999). Kokich Jr et al., suggested that orthodontists, lay

people and general dentists have differing opinions regarding smile esthetics. According to Kokick Jr et al., orthodontists prefer 2mm or less gingival exposure when smiling (Kokich Jr et al., 1999). It was interesting to see the beauty pageant queens' smiling composite displayed more gingiva than some orthodontists may prefer.

C. Significance of Current Study

With orthodontics experiencing a paradigm shift into a simultaneous consideration of hard and soft tissue for diagnosis and treatment planning, there is a growing need for information regarding the soft tissue attributes of attractive faces (Sarver, 2000). Proffit stated that a key reason people seek orthodontic treatment is to overcome psychosocial difficulties relating to facial and dental appearances (Proffit, 2007). Because more patients are seeking orthodontic treatment for cosmetic concerns, orthodontists' knowledge concerning soft tissue attributes as well as public perceptions for an attractive face becomes pertinent (Czarnecki et al., 1993). Furthermore norms and ranges obtained from these attractive faces can act as a guide for orthodontists to help patients' achieve their esthetic goals.

Proffit stated in 1989 that five percent of orthodontic patients were adults. In 1996, the percentage changes to twenty five percent (Proffit, 2007). This increase in adult orthodontic treatment illustrates the need for adult soft tissue norms. Sarver commented that the profession of orthodontics is experiencing notable change away from treatment goals of solely improving the dental occlusion towards a greater focus on improving facial esthetics (Sarver, 2007). It is for these reasons that this study describes adult female beauty pageant queens' soft tissue attributes.

This study was not in agreement with Riedel's and Peck and Peck's findings for a more protrusive facial pattern (Riedel, 1957; Peck and Peck 1970). According to Legan, Burstone, Arnett and Bergman, this sample is in agreement for a Class I soft tissue profile.

This study does support Johnston and Franklin's finding that a beautiful female face composite displays a decreased lower facial height (Johnston and Franklin, 1992). A decreased lower face reflects characteristics of a more youthful face and is therefore found to be more attractive. Additionally, this research supports Alley and Cunningham's beliefs that adult faces displaying unusually juvenile facial characteristics are considered more attractive (Alley and Cunningham, 1991). The slightly increased gingival display of the pageant queens' also may contribute to their more youthful appearance.

D. Strengths of Current Study

This study is unique because most of the previous studies described soft tissue esthetic characteristics based on a combination of models, Seafair Princesses, Hollywood celebrities, or pageant queens. This research exclusively evaluated Mrs. America and Miss America soft tissue attributes. Furthermore, a majority of the previous studies did not simultaneously include profile, frontal at repose and smiling photographs. Using a combination of photographs more accurately describes the pageant queens' soft tissue esthetics.

Another strength of the study is the more current data collection of the reigning and past beauty queens. The distinctive component in this research is that the sample has been prejudged as attractive. This allowed for the PI to obtain unbiased photographs. Furthermore,

by the PI attending the beauty pageants and obtaining the photographs, consistency regarding image positioning and capture was reinforced; hence, reducing photographic error.

The age of the sample size is also a distinguishing component to this research. Riedel, Peck, Peck, Arnett, Bergman, Powell, Humphreys and Legan studied females in their early twenties (Riedel, 1957; Peck and Peck, 1970; Arnett and Bergman, 1993; Powell and Humphreys, 1984; Legan and Burstone, 1980). Our study sample consisted of more females in their middle to late thirties. This is one of the few studies to evaluate attractive adult Caucasian females in their thirties.

Furthermore, examining multiple published norms was beneficial to the study. This provided comparison of the current beauty pageant queens' soft tissue and published norms from different eras encompassing the last thirty years.

E. Limitations of Current Study

Due to the nature of participant recruitment, it was difficult to standardize the age range. This research sample had 6 women between the ages of 20-28 and 21 women between the ages of 30-47. However, it was assumed that most of the women's skeletal growth was complete. In further studies, it would be interesting to evaluate each decade's soft tissue attributes separately to see if significant differences exist as a result of age.

Hair color and make up influences were not accounted for in this research. Fourteen women had blonde hair, 12 women had brunette hair, and 1 woman had red hair. One pageant queen had freckles and another pageant queen had a mole on her face. Future studies could

evaluate the pageant queens before the pageant competition when the women could have their hair tied back and make-up free faces.

Plastic surgery treatment was not acknowledged in this study. The eligibility and photographic questionnaires did not address if any subjects had plastic surgery enhancements on their face. For this reason, women may have had adjunctive treatment to alter their natural facial attributes. However, since the study aimed to evaluate current concepts of attractive faces, if plastic surgery were performed it did not affect the ultimate goals of the study.

The PI had to verbally ask the pageant queens to state their titles because the eligibility questionnaire did not state that directly. In future studies, the eligibility questionnaire should ask which pageant title was won. Moreover, this study included Mrs. America and Miss America winners. In future studies, it would be interesting to see if there are differences between Mrs. America's and Miss America's soft tissue attributes; hence, separately evaluating each respective queen's soft tissue characteristics.

Besides additional survey questions, a clinical exam would have been beneficial to the study. Unfortunately, neither was feasible. Occlusal relationships were not measured in this study. Therefore, it is likely this research may include samples with malocclusion. The beauty pageant queens had their make-up prepared for a successful pageant interview day and clinical exams would have added stress to the competing women, possibly resulting in less subject recruitment.

Although previously published studies by Arnett and Legan used a similar sample size to this study, increasing the sample size in future studies would increase its statistical power.

It is possible that there are inconsistencies for obtaining a reproducible position of lips at repose. The PI tried to minimize the error of lip positioning at repose by helping each subject practice before the photographs were obtained. The PI asked the subjects to lick their lips and then relax. Subjects also have the ability to alter their smile. It is possible to enlarge a smile and display more gum. If a subject was not fully smiling, this could create an error in the true amount of gum display upon smiling. Again, the PI practiced with the subjects to smile fully. The PI told the subjects to smile like they just won the lottery. Furthermore, the PI elicited a full smile based on Peck and Peck's definition (Peck et al., 1992).

Photograph capture may have contributed to measurement error. The PI tried to reproduce a consistent photographic set up at each pageant; however, the PI did attend various pageants with various types of lighting that may have affected the image quality. If all of the photographs were taken at one time period with one photographic set up, lighting inconsistencies would have been minimized.

In future studies, the photographs should be captured with a portrait lens. A standard portrait lens has longer focal length. For example, it would have been more ideal to use a 100 mm focal lens or longer to maintain natural proportions (Fernandez-Riveiro et al., 2003). Although a portrait lens was not used, intra and inter reliability tests confirmed reliable landmark identification. Furthermore, landmark identification is not related to optical

distortions. Moreover, the same camera lens was used for each photograph in this research to maintain photographic consistency.

F. Future Studies

While the current study did evaluate beauty queens' soft tissue attributes, it used two-dimensional photographs. A future study could evaluate the beauty queens' using stereophotogrammetry or surface scanning. Although this technique would only provide surface data, any information regarding attractive faces could act as a starting point to establishing three dimensional soft tissue norms for orthodontic diagnosis and treatment planning. Currently, there are no three dimensional norms that describe attractive faces during growth, maturity or aging.

Another study could use video to capture the beauty queens' stages in the genesis of their full smile. These data could be compared with the Peck and Peck's study that describes three stages for a complete smile (Peck and Peck, 1992). Combined with Peck and Peck's research, a description of the beauty pageant queens' stages for a smile could act as guide for orthodontists to obtain more accurate smiling frontal photographs.

An additional study, designed along the parameters of the current study, could directly evaluate the sagittal chin position. This study indirectly evaluated chin position in relation to soft tissue glabella and subnasale. A future study could evaluate chin position in regards to a line tangent to subnasale, a line tangent to soft tissue nasion and a line tangent to soft tissue glabella. Evaluation of the relationship between the beauty pageant queens' chin and various

tangent lines could provide a more accurate way to access chin position. It is likely that the beauty pageant queens' chin would be in closer alignment with the soft tissue nasion line.

A future study, also designed along the parameters of the current study, could evaluate a larger sample of beauty queens. The study would be expanded to include and evaluate differences between African- American and Caucasian beauty pageant winners' soft tissue attributes. In doing so, a comparison between races may show agreement with previous research for a blending of attractive soft tissue characteristics, regardless of race.

G. Clinical Significance

The findings of this study suggest the beauty pageant queens possess a Class I soft tissue profile with a slightly decreased lower facial height. The majority of the variables were within 1% of the published norms.

Our research supports the relationship between attraction, a youthful appearance and a decreased lower face. This implies that when treating to what is considered attractive, if a patient has a slightly decreased to acceptable lower face height, molar extrusion mechanics should be minimized and in some cases avoided. For example, in a skeletal Class II division I vertical grower, caution is advised when using a cervical pull head gear as to not extrude the molars resulting in an increased lower facial height.

To further maintain the youthful appearance of the smile, treatment of adolescent individuals should be critically evaluated in regards to upper lip position, gingival and incisor display at rest and smiling. The majority of adolescent individuals show an increased gingival

smile and incisor display which decreases with age. The downward and backward movement of the upper lip contributes to the decreased gingival and incisor display and aging smile.

In addition, to preserve a youthful smile, the gingival display should be used as a crucial orthodontic and orthognathic diagnostic measurement. Initial diagnosis and treatment planning must assess the patient's skeletal, dental, soft tissue, and age. For example, when treatment planning for a maxillary impaction, aim for at least 2mm of gingival display upon smiling to maintain the youthfulness of the patient's smile. Most importantly, always consider the fourth dimension of time with respect to aging of the attractive female face.

VI. CONCLUSION

One of the aims of this research was to evaluate and compare previous soft tissue norms with documented Caucasian adult female attractive faces. This research rejects the null hypothesis and suggests that there are statistically significant mean differences for facial attractiveness measurements between modern day publicly acknowledged attractive faces and published norms. After sample collection and evaluation, it is apparent that women who are judged attractive show significant differences from the norms obtained by Arnett, Bergman, Powell, Humphreys and Legan. Most significantly, this research indicated that the beauty pageant queens have a decreased lower facial height. The women in this sample have won various beauty pageants and represented a norm of attractive females selected by judges from society at large.

Standardized 2D profile, frontal at repose and smiling frontal photographs were taken in natural head position. Previous research study samples included Hollywood celebrities, beauty pageant winners, professional models and women judged to be attractive by the authors (Peck and Peck, 1970; Powell and Humphreys, 1984; Arnett and Bergman, 1993, 1999). This study used photographs of adult beauty pageant winners and this research objectively addressed current soft tissue attributes of adult attractive faces.

While orthodontists' personal biases influence patient treatment recommendations, patients' esthetic concerns should be accounted for while planning treatment. Patients seek orthodontic treatment mainly for cosmetic concerns. They also seek treatment for psychosocial reasons to improve self-confidence (Linn, 1966). Understanding current soft tissue esthetics is

crucial for clinicians to help patients achieve their esthetic desires. This study outlines female soft tissue esthetic norms that can be used to treat female adults to better than just average norms.

CITED LITERATURE

- Alley T.R., Cunningham M.R.: Averaged faces are attractive, but very attractive faces are not average. Psychol Sci. 2;123-125:1991.
- Arnett G.W., Bergman, R.T: Facial keys to orthodontic diagnosis and treatment planning. Part I and II. Am J Orthod Dentofacial Orthop. 104;299-312:1993.
- Arnett G.W., Jelic J.S., Kim J, Cummings D.R., Beress A, Worley C.M. Jr, Chung B, Bergman R.: Soft tissue cephalometric analysis: diagnosis and treatment planning of dentofacial deformity. Am J Orthod Dentofacial Orthop. 116;239-253:1999.
- Behrents R: Growth in the Aging Craniofacial Skeleton. Craniofacial Growth Series. Ann Arbor, Mich: Center for Human Growth and Development, The University of Michigan, 1985.
- Bergman R.T.: Cephalometric soft tissue facial analysis. Am J Orthod Dentofacial Orthop. 116;373-389:1999.
- Bhatia S.N., Leighton B.C.: A Manual of Facial Growth. Oxford, Oxford University Press, 1993.
- Bishara SE, Jakobsen JR, Hession TJ, Treder JE.: Soft tissue profile changes from 5 to 45 years of age. Am J Orthod Dentofacial Orthop. 114;698-706:1998.
- Brody, Jane.: Ideals of beauty are seen as innate. The New York Times. March 21, 1994.
- Czarnecki S.T., Nanda R.S., Currier G.F.: Perceptions of a balanced facial profile. Am J Orthod Dentofacial Orthop. 104;180-187:1993.
- Dolphin Image and Managing Solutions. (2011). Imaging tips. Retrieved on June 3, 2011, from:
<http://www.dolphinimaging.com/newsletter/december07/imagingtip.html>.
- Dion, K, Berscheid, E, Walster, E.: What is beautiful is good. J Pers Soc Psychol. 24;285-290:1972.
- Facereserach. (January 17, 2007). Protomethods. Retrieved on September 10, 2011, from:
<http://www.faceresearch.org/tech/protomethods>.
- Farkas L.G.: Anthropometry of the head and face in medicine. New York, Elsevier North Holland Inc, 1981.
- Farkas L.G., Munro, I.: Anthropometric Facial Proportions in Medicine. Springfield, Illinois, Charles C. Thomas, 1987.

- Farkas L.G., Kolar J.C.: Anthropometrics and art in the aesthetics of women's faces. Clin Plast Surg. 14;599-615:1987.
- Farkas L.G., Bryson W, Klotz J.: Is photogrammetry of the face reliable? Plast Reconstr Surg. 66;346-355:1980.
- Fernandez-Riveiro P, Smyth-Chamosa E, Suarez-Quintanilla, Suarez-Quintanilla M.: Angular photogrammetric analysis of the soft tissue facial profile. Eur J Orthod. 25;393-399:2003.
- Graber T.M., Vanarsdall R, Vig K.: Orthodontics Current Principles and Techniques. 4th ed. St. Louis, Mosby Inc, 2007.
- Holdaway R.A.: A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part I. Am J Orthod Dentofacial Orthop. 4;1-28:983.
- Iglesias-Linares A, Yáñez-Vico R.M., Moreno-Manteca B, Moreno-Fernández A.M., Mendoza-Mendoza A, Solano-Reina E.: Common standards in facial esthetics: craniofacial analysis of most attractive black and white subjects according to People magazine during the previous 10 years. J Oral Maxillofac Surg. 69;216-224:2011.
- Johnston VS, Franklin, M.: Is beauty in the eye of the beholder? Ethol Sociobiol. 14;183-199:1992.
- Johnston, VS, Solomon, CJ, Gibson SJ, Pallares-Bejarano, A.: Human facial beauty current theories and methodologies. Arch Facial Plast Surg. 5; 371-377:2003.
- Kokich V.O. Jr., Kiyak H.A., Shapiro P.A.: Comparing the perception of dentists and lay people to altered dental esthetics. Journal of Esthet Dent. 11;311-324:1999.
- Langlois, J.H., Roggman, L.: Attractive faces are only average. Psychol Sci. 1;115-121:1990.
- Lectures of Dr. Allan G. Brodie. The Dentofacial Complex. Chicago, UIC College of Dentistry Press, 2004.
- Legan H.L., Burstone C.J.: Soft tissue cephalometric analysis for orthognathic surgery. J Oral Surg. 38;744-751:1980.
- Linn E. L.: Social meanings of dental appearance. J Health Hum Behav. 7;289-295:1966.
- Merriam-Webster. (2011). Attractive. Retrieved on June 3, 2011, from: <http://www.merriam-webster.com/dictionary/attractive>.

Moorrees C.F.A., Van Venrooii M.E., Lebret L.E.M., Glatky C.B., Kent R.L., Reed R.B.: New norms for the mesh diagram analysis. Am J Orthod Dentofacial Orthop. 69;57-71:1976.

Mrs. Minnesota-America. Judging. Retrieved on September 10, 2011, from <http://mrsminnesota-america.com/judging.html>.

Nanda R.S., Meng H., Kapilla, S., Goorhuis J.: Growth changes in the soft tissue facial profile. Angle Orthod. 60;177-190:1990.

Peck H, Peck S: A concept of facial esthetics. Angle Orthod. 40;284-318:1970.

Peck, H, Peck, L, Kataja, M.: The gingival smile line. Angle Orthod. 62;91- 100:1992.

Powell N, Humphreys B.: Proportions of the Aesthetic Face. New York, Thieme-Stratton Inc., 1984.

Proffit, W.R.: Contemporary Orthodontic Appliances. In: Contemporary Orthodontics. W.R. Proffit, H.W. Fields, and D.M. Sarver (eds.), Philadelphia, Mosby, 2007.

Riedel R.: An analysis of dentofacial relationships. Am J Orthod. 4;103-119:1957.

Sarver, D.M.: Orthodontics about face: the re-emergence of the esthetic paradigm. Am J Orthod Dentofacial Orthop. 117;575-576:2000.

Subtelny J.D.: A longitudinal study of soft tissue facial structures and their profile characteristics, defined in relation to the underlying skeletal structures. Am J Orthod Dentofacial Orthop. 45;481-507:1959.

Spring I.N., Zernial O, Wiltfang J, Warnke P.H., Terheyden H, Wolfart S.: Facial aesthetics part I- the significance of the triangle of yarbus. Mund Kiefer Gesichtschir. 11;145-151:2007.

Tiddeman B, Burt D.M, Perrett D.: Computer graphics in facial perception research. IEEE Comp Graphics Ap. 21;42-50:2001.

Tiddeman B, Stirrat, Perrett D.: Towards realism in facial transformation: results of a wavelet MRF method. Computer Graphics Forum, Eurographics conference Issue 24;1-5:2005.

Torlakovic, L, Faerovig, E.: Age-related changes of the soft tissue profile from the second to the fourth decades of life. Angle Orthod. 81;50-57:2011.

Wikipedia. (2011, January). Tragus. Retrieved on October 5, 2011, from: [http://en.wikipedia.org/wiki/Tragus_\(ear\)](http://en.wikipedia.org/wiki/Tragus_(ear)).

APPENDICES

APPENDIX A
UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

**Approval Notice
Initial Review (Response to Modifications)**

December 9, 2010

Jessica Hylan-Cohen, BS, DMD
Orthodontics
801 S. Paulina St., Room 13
Orthodontics
Chicago, IL
Phone: (312) 933-5414 / Fax: (773) 289-9210

RE: Protocol # 2010-0927
“Esthetic characteristics of female Caucasian models and beauty pageant participants”

Dear Dr. Hylan-Cohen:

Your Initial Review (Response to Modifications) was reviewed and approved by the Expedited review process on December 6, 2010. You may now begin your research

Please note the following information about your approved research protocol:

Protocol Approval Period: December 6, 2010 - December 5, 2011
Approved Subject Enrollment #: 120
Additional Determinations for Research Involving Minors: The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk. Therefore, in accordance with 45CFR46.408, the IRB determined that only one parent's/legal guardian's permission/signature is needed. Wards of the State may not be enrolled unless the IRB grants specific approval and assures inclusion of additional protections in the research required under 45CFR46.409. If you wish to enroll Wards of the State contact OPRS and refer to the tip sheet.
Performance Sites: UIC, Miss America pageant sites and fashion shows
Sponsor: None
PAF#: - Not Applicable
Research Protocol(s):

- a) Esthetic characteristics of female Caucasian beauty pageant participants and professional

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b.) models; Version 3

Recruitment Material(s):

- a) Eligibility Screening; Version 1.1; 11/08/2010
- b) Adult Photographs Verbal Recruitment; Version 2.1; 11/11/2010
- c) Child Photographs Verbal Recruitment; Version 2.1; 11/11/2010
- d) Photographic Questionnaire; Version 1

Informed Consent(s):

- a) Consent Form; Version 3.1; 11/30/2010
- b) Waiver of Informed Consent 45 CFR 46.116(d) for existing data

Assent(s):

- a) Assent to Participate; Version 3.1; 11/30/2010

Parental Permission(s):

- a) Parent Permission Form; Version 2.1; 11/30/2010

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category:

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
10/25/2010	Initial Review	Expedited	10/27/2010	Modifications Required
11/16/2010	Response To Modifications	Expedited	11/18/2010	Modifications Required
12/01/2010	Response To Modifications	Expedited	12/06/2010	Approved

Please remember to:

→ Use your **research protocol number** (2010-0927) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,
"UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

APPENDIX A (continued)

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-9299. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Marissa Benni-Weis, M.S.
IRB Coordinator, IRB # 2
Office for the Protection of Research

Subjects

Enclosure(s):

- 1. UIC Investigator Responsibilities, Protection of Human Research Subjects**
- 2. Informed Consent Document(s):**
 - a) Consent Form; Version 3.1; 11/30/2010
- 3. Assent Document(s):**
 - a) Assent to Participate; Version 3.1; 11/30/2010
- 4. Parental Permission(s):**
 - a) Parent Permission Form; Version 2.1; 11/30/2010
- 5. Recruiting Material(s):**
 - a) Eligibility Screening; Version 1.1; 11/08/2010
 - b) Adult Photographs Verbal Recruitment; Version 2.1; 11/11/2010
 - c) Child Photographs Verbal Recruitment; Version 2.1; 11/11/2010
 - d) Photographic Questionnaire; Version 1

cc: Carlotta A. Evans, Orthodontics, M/C 841
Tzong-Guang Tsay, Orthodontics, M/C 841

APPENDIX B

Leave box empty - For office use only

**University of Illinois at Chicago
Consent for Participation in Research
“Esthetic characteristics of female Caucasian models and beauty pageant
participants”**

You are being asked to participate in a research study. Researchers are required to provide a consent form such as this one to tell you about the research, to explain that taking part is voluntary, to describe the risks and benefits of participation, and to help you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Principal Investigator Name and Title: Dr. Jessica A. Hylan-Cohen, orthodontic resident
Department and Institution: University of Illinois at Chicago
Address and Contact Information: 801 South Paulina Chicago Illinois Rm. 131 60612

Why am I being asked?

You are being asked to be a subject in a research study about **beautiful Caucasian female faces conducted by Dr. Jessica A. Hylan-Cohen, Resident, Department of Orthodontics, University of Illinois at Chicago.**

You have been asked to participate in the research because you **are a beauty pageant participant or professional model.** We ask that you read this form and ask any questions you may have before agreeing to be in the research.

Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future dealings with the University of Illinois. Your decision to

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participate will not affect current or future dealings with the pageant or any additional institutions related to the study that the subject may be concerned about. **If you decide to participate, you are free to withdraw at any time without affecting that relationship.**

What is the purpose of this research?

The aim of this study is to characteristics of beautiful faces. Additionally, this research seeks to create an averaged 2 dimensional(2D) and 3 dimensional (3D) beautiful face model that can be used as a treatment guide for orthodontists.

This research is being done because:

No current study exists to determine the public's perception of an attractive face reflective of soft tissue. In order for orthodontists to provide patients with pleasing cosmetic outcomes, we must understand patients' dental and soft tissue treatment goals. In orthodontic treatment, cases of craniofacial abnormalities, syndromes or other conditions, esthetics must be incorporated into treatment planning.

What procedures are involved?

Since you are eligible and if you agree to be in this research, we would ask you to do the following things:

Complete a simple questionnaire that is not medically related and sit for a few photographs.

The survey and photographs should be around 10-15 minutes. This is the total length of time for participation in the study.

Approximately 40 females (12-18 years old), 40 females (19-29 years old) and 40 females (29+) will be used for the study.

What are the potential risks and discomforts?

This research presents minimal risks since photographs provide no harm and all data will be de-identified. The greatest risks in this research are privacy issues. However, because personal information will be collected and de-identified, the risks of privacy issues are minimal. All of the records will be locked in storage cabinets and only the private investigator, Dr. Jessica Hylan-Cohen will have the key.

APPENDIX B (continued)

With regards to the photographs taken, once all the photographs have been acquired, they will be averaged to form a composite 2D and 3D beautiful face. Since this composite is an amalgamation of many different faces, no one face will be identifiable in the composite. This also helps protect privacy after the data is collected.

What about privacy and confidentiality?

The people who will know that you are a research subject are members of the research team and others present at the pageant that see Dr. Jessica Hylan-Cohen photographing you or you completing the survey. The survey information does not require your name and therefore cannot be linked to you. The photographs are going to be averaged together to form one composite image. The averaged image will ensure that identify of each subject will not be detectable. No information about you, or provided by you during the research, will be disclosed to others without your written permission, except:

- if necessary to protect your rights or welfare (for example, when the UIC Institutional Review Board monitors the research or consent process); or
- if required by law.

When the results of the research are published or discussed in conferences, no information will be included that would reveal your identity. If photographs of you will be used for educational purposes, your identity will be protected or disguised by the composite image. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law.

The 2D and 3D beautiful face model may be provided to health facilities. The beautiful face model will be a tool for orthodontists to provide better treatment.

The 2D and 3D soft tissue esthetic face model may also be used to enhance or communicate treatment preferences for patients.

Note: because the 2D and 3D beautiful face model consists of many faces, identifying any one individual from the composite will not be possible.

What are the costs for participating in this research?

There are no costs to you for participating in this research.

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Will I be reimbursed for any of my expenses or paid for my participation in this research?

There is no compensation for participating in the research.

Can I withdraw or be removed from the study?

If you decide to participate, you are free to withdraw your consent and discontinue participation at any time. Please note that you may skip or decline to answer some questions. Your participation in this research is voluntary. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

Who should I contact if I have questions?

The researcher conducting this study is **Dr. Jessica A. Hylan-Cohen**. You may ask any questions you have now. If you have questions later, you may contact the researcher at:

Jessica A. Hylan-Cohen
Resident
Department of Orthodontics
University Of Illinois at Chicago
Address: 801 S Paulina Street, Rm. 131, Chicago, Illinois 60612
Phone: (773) 234.5377
Email address: jhylan3@uic.edu

Questions may also be directed to the faculty sponsor:

Dr. T. Peter Tsay
Professor of Orthodontics
Associate Director of Postgraduate Program
Director of Clinical Research
Department of Orthodontics
University Of Illinois at Chicago
Address: 801 S Paulina Street, Rm. 131, Chicago, Illinois 60612
E-mail Address: ttsay2@yahoo.com

What are my rights as a research subject?

If you feel you have not been treated according to the descriptions in this form, or if you have any questions about your rights as a research subject, including questions, concerns, complaints, or to offer input, you may call the Office for the Protection of Research Subjects (OPRS) at 312-996-1711 or 1-866-789-6215 (toll-free) or e-mail OPRS at uicirb@uic.edu.

APPENDIX B (continued)

Remember:

Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University. If you decide to participate, you are free to withdraw at any time without affecting that relationship.

You will be given a copy of this form for your information and to keep for your records.

Signature of Subject or Legally Authorized Representative

I have read (or someone has read to me) the above information. I have been given an opportunity to ask questions and my questions have been answered to my satisfaction. I agree to participate in this research. I will be given a copy of this signed and dated form.

Signature

Date

Printed Name

Signature of Person Obtaining Consent

Date (must be same as subject's)

Printed Name of Person Obtaining Consent

APPENDIX C

University of Illinois at Chicago

VERBAL RECRUITMENT TO PARTICIPATE IN RESEARCH
Esthetic characteristics of female Caucasian models and beauty
pageant participants -*Adult Photographs*

My name is Dr. Jessica A. Hylan-Cohen. I am a resident of the Department of Orthodontics at the University of Illinois at Chicago. Currently I am researching facial structure in beautiful Caucasian females.

The aim of this study is to determine how female faces have changed with time. Additionally, this research seeks to create an averaged 2 dimensional(2D) and 3 dimensional (3D) soft tissue face model.

This research is being done because:

No current study exists to determine the public's perception of an attractive face reflective of soft tissue. In order for orthodontists to provide patients with pleasing cosmetic outcomes, we must understand patients' dental and soft tissue treatment goals. In orthodontic treatment, cases of craniofacial abnormalities, syndromes or other conditions, esthetics must be incorporated into treatment planning.

The research will be done through computer software measuring points and angles on photographs.

Participants will have front, side, and $\frac{3}{4}$ view photographs taken. Participants will be asked to complete a brief questionnaire. This will take approximately 10 minutes of your time.

You have been asked to participate in this research **because you are a pageant participant or professional model** and may be eligible to participate.

Would you like to participate in the study?

If yes:

- 1) Answer questions
- 2) Obtain and explain the informed consent

If adult would like to participate:

- 1) Collect signature and provide copy of consent to subject

APPENDIX E

**Esthetic characteristics of female Caucasian models and beauty
pageant contestants****Photographic Questionnaire**

WHAT IS YOUR AGE (IN YEARS AND MONTHS): _____ YEARS ____ MONTHS

HAVE YOU HAD BRACES BEFORE? YES NO

IF SO, AT WHAT AGE? _____

EXTRACTED TEETH YES NO

RETAINERS YES NO

APPENDIX F
PROFILE PHOTOGRAPH MEASUREMENTS

Subject	Years	Months	FC	NLA	AFA	NM	Nfa	Nfr	ULA-Ha	MLA
1	37	7	6.6	90.2	173.4	122.2	36.2	143.4	11.1	137.9
2	25	11	13.2	121.2	167.8	123.9	36.2	136.3	10.1	121.3
3	40	3	5.5	108	179.7	129.6	34.2	137.8	8.8	115.9
4	35	5	9.2	97.2	172.9	127.1	36.2	135.7	12.8	131
5	28	3	14.6	115.7	165.4	118.1	37	139.5	9.5	117.4
6	31	0	12.3	116.5	167.7	123.6	36.4	139.7	10.1	129.9
7	26	7	4.9	96.6	174.8	122.9	38.6	130.2	10.4	131.9
8	40	4	11.2	117.8	164.8	119.6	39.7	124.7	11.1	145.1
9	39	0	2.6	94.5	177.3	132	30.9	138.4	6.9	136.6
10	38	5	9.6	108.7	170.7	129.3	31.8	138.3	8.3	127.4
11	40	5	14.5	108.6	163.9	124.1	36.4	139.1	15.4	103.5
12	39	0	2.3	92.4	177.7	127.3	30.8	131.7	8.8	141.4
13	41	11	13.4	106.7	165.8	121.5	37.6	133.1	11.7	136
14	25	4	11.8	119.7	168.3	122.7	31.7	154.9	3.9	134
15	33	5	8.7	109	169.6	125	37.6	136.6	8.4	91.4
16	47	5	15	104.8	165	119.2	42.4	124.7	18.8	156.2
17	20	3	17.5	126.7	163.8	116	39.9	138.8	7.8	136.8
18	23	7	17.9	95.9	164.9	114	41	131.7	15.5	128.6
19	45	0	15.9	119	165.5	109.3	48.8	122.7	11.9	115.4
20	35	1	14.3	115	166.8	122.3	34.5	138.2	8.5	150.2
21	30	5	14	106.1	166.9	113.2	40.9	130.6	10	131.6
22	47	9	6	107.7	173.4	123.9	35.1	132.9	7	119.2
23	38	5	8.8	98.6	172.3	116.8	44.3	126.4	12.2	133.5
24	34	9	2.8	111.8	178.3	131.2	31	138.8	1.8	125.1
25	38	1	16.9	114.8	163.1	117.6	39.1	142.3	10.7	130.6
26	30	1	24.4	119.5	157.6	114.8	39.4	146.1	14.6	109.9
27	40	2	20.5	126.1	159.3	112.2	44.8	129.8	13.2	123.4
Norm			12	102	165	126	35	122.5	10	126

APPENDIX F
PROFILE PHOTOGRAPH MEASUREMENTS (continued)

Subject	ULP (mm)	LLP (mm)	ILG (mm)
1	5	0.5	3.6
2	1.2	-0.6	4.2
3	2.4	-0.3	3.1
4	5.5	4.4	2.8
5	0	1.1	2.3
6	1.5	0.3	3.7
7	3.9	3.4	5.6
8	-0.1	3.1	6.7
9	2.9	-1.4	4.8
10	1.1	1.4	5.6
11	4.3	2.9	4
12	3.5	0.4	2.1
13	2.1	3.2	6.2
14	-1.7	-4	3.9
15	2.3	-1.5	4.3
16	5.9	7	1.9
17	-1.2	0.1	4.3
18	4.5	3.4	3.2
19	1.4	4.2	2.1
20	-0.2	0.3	3.2
21	1	2.8	5.2
22	1.2	-0.3	4.5
23	4.6	3.9	5.6
24	-0.7	-0.2	3.6
25	1.1	2.8	4.5
26	1.8	1.3	5.3
27	2	0.6	2.9
Norm	3	2	3.3

APPENDIX F
PROFILE PHOTOGRAPH MEASUREMENTS (continued)

Subject	LF3rs %	LF %
1	29.8	47.6
2	30.1	50.4
3	30.2	48
4	28.9	50.3
5	31.1	48.3
6	29.6	50.4
7	31.9	51.3
8	28.9	52.5
9	29.8	51.2
10	26.6	50.5
11	30.1	54
12	28.9	54.8
13	28.9	53.5
14	27	47.2
15	24.9	52.1
16	30.5	53
17	26.3	51.3
18	25.6	52.1
19	30.4	52.4
20	26.6	48.3
21	23.3	50.8
22	22.6	51
23	25.3	52
24	27.1	49.8
25	31	51
26	24.5	52.9
27	29.4	54.7
Norm	33.3	54

VITA

NAME: Jessica A. Hylan-Cohen

EDUCATION: BS, University of Wisconsin-Madison 2003
DMD, Case Western Reserve University 2009
M.S., Oral Sciences, University of Illinois at Chicago,
Chicago, Illinois, 2012
Certificate, Orthodontics, University of Illinois at Chicago,
Chicago, Illinois, 2012

PROFESSIONAL MEMBERSHIPS: Chicago Dental Society
American Dental Association
American Association of Orthodontists
Illinois Society of Orthodontists

AWARDS: ADA Dental Student Scholarship
The Ohio Section of the American College of Dentists
Case School of Dental Medicine Academic Commendation
Case School of Dental Medicine Scholarship
Omnicron Kappa Upsilon Merit Scholarship