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The occlusal plane inclination relative to craniofacial form: A cephalometric investigation

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THE OCCLUSAL PLANE INCLINATION
RELATIVE TO CRANIOFACIAL FORM:
A CEPHALOMETRIC INVESTIGATION

Holly Eppard D.D.S.

A THESIS

Submitted to:
The School of Dentistry
at West Virginia University
in partial fulfillment of the requirements
for the degree of

Master of Science
In
Orthodontics

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ABSTRACT

The occlusal plane inclination relative to craniofacial form: A cephalometric investigation

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Background Objectives: The occlusal plane has been given much attention throughout the orthodontic literature. Studies have shown that the occlusal plane inclination varies relative to vertical and sagittal skeletal discrepancies. The Six Elements of Orofacial Harmony does not address the occlusal plane inclination as a parameter in diagnosis and treatment planning despite its spatial influence on the position of the chin. The occlusal plane inclination is considered a critical factor in treatment planning for orthognathic surgery. The objective of this study was to systematically evaluate the inclination of the occlusal plane (Op°) relative to various skeletal and dental cephalometric parameters. **Methods:** A sample of 105 pretreatment cephalometric radiographs, in subjects with a range of skeletal and dental morphological characteristics, was appraised. Differences in the Op° and AP measurements of pogonion relative to the GALL were evaluated among the various anteroposterior, vertical, and soft tissue facial convexity groups were compared. Correlation coefficients evaluating relationships among the cephalometric measurements were calculated. A stepwise regression analysis was performed to further elucidate the variables which contribute to changes in the Op° . **Results:** The occlusal plane inclination was most significantly correlated with SN-MP $^\circ$, MP $^\circ$, Pog'GALL, Pog-GALL, Pogc'-GALL, TVL-Pog, and S-Go. The regression analysis indicated that SN-MP $^\circ$, PP $^\circ$, Element IV Md Ant, PP-Msc, PP-1, Mp-Mic, Sn'-Me', SN $^\circ$, Element IV Mx Ant and Co-Gn are good predictors of Op° . There were statistically significant differences among all vertical groups for the mean Op° . The mean Op° was found to differ among Class II and III skeletal profiles and convex and concave soft tissue facial convexities. **Conclusions:** Op° varies relative to sagittal and vertical jaw dimensions. There is a strong relationship between the occlusal plane inclination and the vertical dimension. Hyperdivergent profiles tend to have steeper occlusal plane inclinations. Hypodivergent profiles tend to have flatter occlusal plane inclinations. There is a tendency towards steeper occlusal planes in Class II skeletal subjects and a flatter occlusal plane in Class III skeletal subjects. There is a tendency towards steeper occlusal planes in subjects with convex profiles and flatter occlusal planes in patients with concave profiles. The occlusal plane inclination is highly correlated with the measurement of soft tissue pogonion to the GALL. There is a strong correlation between the occlusal plane inclination and maxillary incisor inclination. The occlusal plane inclination should be considered when diagnosis and treatment planning to maximize dental and facial esthetics.

DEDICATION

In memory of my father, **Charles Eppard**. Dad, thanks for your selfless and hardworking nature. I love you and miss you more than words can say.

To my Mother, **Judy Eppard**, for your endless support. I truly could not have made it this far without your unconditional love. Thanks for your persistence and confidence. I love you.

To my siblings, **Brad, Tracy and Jeffrey**, for always being there; and for the hard times you gave me as a kid and an adult. I love you all.

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TABLE OF CONTENTS

DEDICATION.....	iii
ACKNOWLEDGEMENTS.....	iv
TABLE OF CONTENTS.....	v
LIST OF FIGURES.....	vii
LIST OF TABLES.....	viii
CHAPTER 1: INTRODUCTION.....	1
BACKGROUND	1
STATEMENT OF THE PROBLEM.....	3
PURPOSE OF STUDY	4
HYPOTHESIS	5
DEFINITION OF TERMS	6
ASSUMPTIONS.....	9
LIMITATIONS.....	9
DELIMITATIONS	9
CHAPTER 2: REVIEW OF LITERATURE.....	10
HISTORY AND CLASSIFICATION OF MALOCCLUSIONS.....	10
THE OCCLUSAL PLANE: AN OVERVIEW.....	11
DEFINITION OF THE OCCLUSAL PLANE.....	12
THE OCCLUSAL PLANE IN CEPHALOMETRICS.....	14
THE RELATIONSHIP OF THE OCCLUSAL PLANE TO CRANIOFACIAL FORM.....	15
OCCLUSAL PLANE ALTERATION IN ORTHOGNATHIC SURGERY	17
NATURAL HEAD POSITION AND CEPHALOMETRICS.....	20
EVALUATING FACIAL ATTRACTIVENESS.....	22
THE SIX ELEMENTS OF OROFACIAL HARMONY.....	23
ELEMENT I: ARCH SHAPE AND LENGTH.....	24
ELEMENT II: AP JAW POSITIONS.....	26
ELEMENT III: BUCCOLINGUAL JAW POSITIONS	27
ELEMENT IV: SUPERIOR INFERIOR JAW RELATIONSHIPS.....	28
ELEMENT V: POGONION PROMINENCE	29
ELEMENT VI: OCCLUSION.....	29
CHAPTER 3: MATERIALS AND METHODS	31
SAMPLE DESCRIPTION	31
RESEARCH DESIGN	32
METHODOLOGY	33
CONSTRUCTION OF THE GALL AND TRUE HORIZONTAL (TH)	33
IDENTIFICATION OF THE OCCLUSAL PLANE.....	35
CEPHALOMETRIC ANALYSIS	36
LANDMARK IDENTIFICATION.....	36
SIX ELEMENTS MEASUREMENTS	37
ANGULAR MEASUREMENTS.....	41
LINEAR MEASUREMENTS.....	43
ERROR MEASUREMENTS.....	46
STATISTICAL ANALYSIS.....	46

CHAPTER 4: RESULTS	47
DESCRIPTIVE STATISTICS	47
OP° BY ANTEROPOSTERIOR SKELETAL PATTERN (ANB)	50
OP° BY SIX ELEMENTS ANTEROPOSTERIOR SKELETAL PATTERN	51
OP° BY SOFT TISSUE FACIAL CONVEXITY	52
OP° BY VERTICAL DIMENSION	53
CORRELATIONAL ANALYSIS OF Op° TO CEPHALOMETRIC VARIABLES	54
LINEAR MEASUREMENTS	55
ANGULAR MEASUREMENTS	56
SIX ELEMENTS MEASUREMENTS	58
STEPWISE REGRESSION ANALYSIS	59
POGONION PROMINENCE BY AP SKELETAL PATTERN (ANB)	60
POGONION PROMINENCE BY SIX ELEMENTS AP SKELETAL PATTERN	61
POGONION PROMINENCE BY SOFT TISSUE CONVEXITY	62
POGONION PROMINENCE BY VERTICAL PATTERN	63
 CHAPTER 5: DISCUSSION	 65
OVERVIEW	65
CRANIOFACIAL REFERENCE PLANES RELATIVE TO TRUE HORIZONTAL	66
OP° BY VERTICAL DIMENSION	68
OP° BY ANTEROPOSTERIOR SKELETAL PATTERN	69
OP° RELATIVE TO POGONION (PO°)	71
OP° PREDICTION	72
CLINICAL IMPLICATIONS	73
 CHAPTER 6: SUMMARY AND CONCLUSIONS	 75
SUMMARY	75
CONCLUSIONS	77
 CHAPTER 7: SUGGESTIONS FOR FUTURE RESEARCH	 78
 REFERENCES	 79
 ABSTRACT	 85
 APPENDIX A - IRB APPROVAL	 87
APPENDIX B	
STATISTICAL ANALYSES BY AGE AND GENDER	88
MEASUREMENT RELIABILITY COEFFICIENTS	108
PAIRWISE CORRELATION COEFFICIENTS	120
STATISTICAL ANALYSES – OCCLUSAL PLANE INCLINATION	137
STEPWISE REGRESSION ANALYSIS	139
STATISTICAL ANALYSIS – POGONION PROMINENCE MEASUREMENTS	142
 CURRICULUM VITAE	 149
 COMMITTEE APPROVAL	 150

LIST OF FIGURES

FIGURE 1.	Construction of the GALL and True Horizontal (TH)	34
FIGURE 2.	Identification of the Occlusal Plane	35
FIGURE 3.	Demonstration of the FP-Gauge™	35
FIGURE 4.	Hard and soft tissue cephalometric landmarks	36
FIGURE 5	Dental Cephalometric Landmarks.....	37
FIGURE 6	Illustration of Element II Mx.....	38
FIGURE 7.	Illustration of Element II Md.....	39
FIGURE 8.	Illustration of Element IV Mx Ant.....	40
FIGURE 9.	Illustration of Element IV Md Ant.....	40
FIGURE 10.	Illustration of Element V.....	41
FIGURE 11.	Angular Measurements.....	42
FIGURE 12.	Vertical Facial Heights.....	44
FIGURE 13.	Chin Prominence Measurement to the GALL.....	44
FIGURE 14.	Soft Tissue Chin Measurement to TVL.....	45
FIGURE 15.	Vertical Eruption	45
FIGURE 16.	Mean occlusal plane inclination (°) by anteroposterior skeletal groups....	50
FIGURE 17.	Mean occlusal plane inclination (°) by Six Elements Skeletal Pattern.....	51
FIGURE 18.	Mean occlusal plane inclination (°) by Soft Tissue Convexity.....	52
FIGURE 19.	Mean occlusal plane inclination (°) by Vertical Skeletal Pattern.....	53
FIGURE 20.	Occlusal plane inclination (°) plotted against measurements of the.....	55
	anteroposterior chin position (mm)	
FIGURE 21.	Occlusal plane inclination (°) plotted against soft tissue convexity.....	56
FIGURE 22.	Occlusal plane inclination (°) plotted against Sella-Nasion to MP.....	57
FIGURE 23.	Mean Pog'-c-GALL (mm) by Anteroposterior Skeletal Class.....	60
FIGURE 24.	Mean Pog'-c-GALL (mm) by Six Element Anteroposterior.....	61
	Skeletal Pattern	
FIGURE 25.	Mean Pog'-c-GALL (mm) by Soft Tissue Convexity.....	63
FIGURE 26.	Mean Pog'-c-GALL (mm) by Vertical Dimension.....	64

LIST OF TABLES

TABLE 1.	Six Elements Measurements.....	37
TABLE 2.	Angular Cephalometric Measurements.....	42
TABLE 3.	Linear Cephalometric Measurements.....	43
TABLE 4.	Descriptive Statistics by Gender.....	48
TABLE 5.	Descriptive Statistics by Age Group.....	48
TABLE 6.	Descriptive Statistics of Pooled Sample.....	49
TABLE 7.	Mean Op° by ANB Anteroposterior Skeletal Classification.....	50
TABLE 8.	Mean Op° by Six Elements Anteroposterior Category.....	51
TABLE 9.	Mean Op° by Soft Tissue Convexity.....	52
TABLE 10.	Mean Op° by Vertical Dimension.....	53
TABLE 11.	Correlation Coefficients related to the Occlusal Plane (Op°).....	54
TABLE 12.	Pogonion prominence by AP Skeletal Pattern (ANB).....	60
TABLE 12.	Pogonion prominence by Six Elements Anteroposterior Skeletal Pattern....	61
TABLE 13.	Pogonion prominence by Soft Tissue Convexity.....	62
TABLE 14.	Pogonion prominence by Vertical Pattern.....	63
TABLE 15.	Comparison of studies reporting craniofacial reference planes measured....	67
	Relative to true horizontal	

CHAPTER 1: INTRODUCTION

Background

The importance of the occlusal plane is underscored by the abundance of publications within the orthodontic literature. The occlusal plane is evaluated relative to craniofacial form ¹⁻³, craniofacial growth ⁴, masticatory function ^{5,6}, dental occlusion ^{7,8}, mechanotherapy ^{9,10}, and orthognathic surgery. ¹¹⁻¹⁵

It is well established that a relationship exists between the inclination of the occlusal plane and the various skeletal profiles. ^{3,4,16} Studies have shown that steeper occlusal planes are associated with Class II malocclusions whereas flatter occlusal planes are associated with Class III malocclusions. ^{4,16} The inclination of the occlusal plane also varies relative to vertical jaw discrepancies. ¹⁷ Steeper occlusal plane inclinations are reported to be associated with the hyperdivergent (long-face) individuals and flatter occlusal plane inclinations are associated with the hypo-divergent (short-face) individuals. In addition, the vertical dimension of the posterior maxilla, due to dentoalveolar compensation, has been attributed to effect the vertical and sagittal position of the mandible. ³

The variability observed in the inclination of the occlusal plane is described as a compensatory mechanism that exists to achieve a Class I dental relationship in the presence of a sagittal jaw discrepancy. ² However, if the sagittal discrepancy exceeds certain limits dentoalveolar compensation will be inadequate and a Class I relationship will not be achieved. ² Casco and Shepherd ¹⁸ evaluated 75 adult patients in an attempt to examine the skeletal variation that exists in naturally occurring optimal occlusions. He noted that as the ANB angle increased, the inclination of the occlusal plane likewise increased.

Additionally, many authors have reported on the need to alter the occlusal plane inclination in orthognathic surgery to achieve an acceptable esthetic outcome with adequate chin projection.^{11, 13, 15, 19} Arnett reported that the inclination of the maxillary occlusal plane to the true vertical line (TVL) in a sample of adult white models is $95.6 \pm 1.8^\circ$ in females and $95.0 \pm 1.4^\circ$ in males.¹⁹ Furthermore, Arnett²⁰ advocates surgical correction of the occlusal plane, within a range of $93-97^\circ$ to produce an optimal profile.

Practitioners using various virtual treatment planning software, such as Invisalign ClinCheck, OrthodCad iQ, and Ormco Insignia, have recognized the effect of various occlusal plane inclinations on the incisor inclination relative to the face.²¹ A report by Batwa et al.²² demonstrated that large alterations in the the occlusal plane inclination has an effect on smile attractiveness. Smiles with occlusal planes at 10° to true horizontal were deemed most attractive by patients.

The Andrews® Six Elements Orthodontic Philosophy™²³ attempts to overcome the shortcomings of traditional cephalometric analyses by proposing a complete analysis unique to each individual. The strength of the Andrews analysis when compared to other approaches is that the forehead serves as a fixed landmark from which to evaluate the spatial position of the jaws. A complete analysis requires an accurate description of the anteroposterior and vertical jaw positions. Andrews considers the AP position of the mandible to be optimal based on coupling of maxillary and mandibular incisors that are placed at their proper inclination, centered in basal bone, and with the maxillary central incisor facial axis point on the GALL. Andrews separates the vertical jaw position, Element IV, into anterior and posterior components within each jaw. The anterior maxilla Element IV is defined as optimal based on appropriate maxillary incisor display in repose. The posterior maxilla Element IV is considered optimal when the

anterior maxilla and mandible are optimal and there is an absence of an anterior or posterior open bite. The relationship between the anterior and posterior Element IV position of the maxilla thus establishes the inclination of the occlusal plane.

Statement of the Problem

Studies on the inclination of the occlusal plane relative to true horizontal have not evaluated the soft tissue chin prominence and maxillary incisor inclination relative to the face. The need to surgically correct the inclination of the occlusal plane to achieve optimal facial harmony suggests that there is an optimal range of occlusal plane inclinations. Does an optimal range of occlusal plane inclinations exist?

Furthermore, Andrews does not suggest an optimal inclination for the occlusal plane despite its influence on the spatial position of the chin or incisor inclination. In addition, he does not indicate an optimal AP position of the chin relative to the GALL. He does however; address the effect of varying the inclination of the occlusal plane on the incisor inclination. Based on his sample of optimally occurring natural dentitions, the average maxillary incisor inclination was 7° to the occlusal plane. An occlusal plane inclination of 7° , therefore, would have a maxillary incisor positioned 0° to the frontal plane of the head. Steepening the occlusal plane would result in a negative inclination to the maxillary central incisors. Likewise, a flattening of the occlusal plane would result in a maxillary incisor with increased positive inclination to the face.

Purpose of Study

The objectives of this study are:

1. To evaluate the relationship between the inclination of the occlusal plane and soft tissue pogonion prominence measured relative to Andrew's GALL.
2. To evaluate the relationship between the inclination of the occlusal plane and maxillary incisor inclination.
3. To evaluate the relationship between the inclination of the occlusal plane and the anteroposterior and vertical jaw dimensions.
4. To evaluate the relationship between the inclination of the occlusal plane and soft tissue facial convexity.
5. To evaluate if there is a group of cephalometric variables that explain the change in the occlusal plane inclination.

Null Hypothesis

1. The inclination of the occlusal plane does not correlate with the AP relationship of the chin relative to the GALL.
2. The inclination of the occlusal plane does not correlate with the inclination of the maxillary incisor
3. The inclination of the occlusal plane does not correlate with the AP position of the jaws.
4. The inclination of the occlusal plane does not correlate with facial soft tissue convexity.
5. The inclination of the occlusal plane does not correlate with the vertical jaw dimension.
6. There are no cephalometric variables that will explain the change in the inclination of the occlusal plane.
7. There is no significant difference in the occlusal plane inclination among the three anteroposterior groups (Class I, Class II, and Class III).
8. There is no significant difference in the occlusal plane inclination among the three vertical groups (normodivergent, hypodivergent, hyperdivergent).
9. There is no significant difference in the occlusal plane inclination among the three groups of soft tissue convexity (normal, convex, concave).

Definition of Terms

Adjusted natural head position – the clinician’s judgment of the subject’s natural head position when the patient is looking at a distant point at eye level, synonymous to natural head orientation and upright head position

Anatomical forehead – the exposed skin from trichion (hairline or where the hairline once was) to glabella

Arnett’s TVL – True Vertical Line that is placed through subnasale and perpendicular to the natural head position²⁰

Basal bone – the osseous tissue of the maxilla and mandible that does not include the alveolar process.

Centric relation – the maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective disks with the complex in the most anterior-superior position against the shapes of the articular eminencies.

Clinical forehead – the portion of the forehead that is related more with the face than the scalp. For straight foreheads, it is between trichion and glabella. For rounded or angular foreheads, it is between superion and glabella.

DALL (dentition’s anterior limit line) – a line that parallels the head’s frontal plane and passes through the maxillary incisor’s facial axis (FA) point.

Element I – the position in which a tooth is centered in basal bone with proper inclination for optimal occlusion

Element II – the anteroposterior position of the maxilla and mandible judged as optimal based on the FA point of an Element I maxillary incisor that touches the GALL and is coupled with an Element I mandibular incisor.

FA point (tooth) – the point on the facial axis of the clinical crown that is midway between the gingival and occlusal borders.

FALL (forehead's anterior limit line) – a line that parallels the head's frontal plane and passes through the FFA point.

FALL-DALL – the difference between the FALL and DALL measured in millimeters. A negative number will correspond to a DALL that is posterior to the FALL. A positive number will correspond to a DALL that is anterior to the FALL. Zero will indicate that the FALL and DALL coincide.

FFA point (forehead facial axis point) – the midpoint of the clinical forehead that is between superion and glabella for round and angular foreheads and is between trichion and glabella for straight foreheads.

GALL (goal anterior limit line) – a line that parallels the head's frontal plane and represents the optimal anterior border for the FA point of an Element I maxillary incisor. This line passes through the FFA point when the forehead inclination is 7° or less. For every degree the forehead inclination is beyond 7° , the GALL passes through a line that is 0.6 mm more anterior to the FFA point; without exceeding the glabella point.

Glabella: a point on the frontal bone that lies above nasion and between the eyebrows; the most inferior border of the clinical forehead.

Gonion: A point on the angle of the mandible formed by bisecting the angle formed by lines drawn tangent to the posterior ramus and the inferior border of the mandible.

Key I – Interarch relationships: (1) the mesiobuccal cusp of the maxillary first molar occludes in the mesio-buccal groove of the mandibular first molar; (2) the distal marginal ridge of the maxillary first molar occludes on the mesial marginal ridge of the mandibular first molar; (3) the

mesiolingual cusp of the maxillary first molar occludes in the central fossa of the mandibular first molar; (4) the buccal cusps of the maxillary premolars rest in the embrasures of the mandibular premolars; (5) the lingual cusps of the maxillary premolars rest in the fossae of the mandibular premolars; (6) the maxillary incisors overlap the mandibular incisors and the midlines of the maxillary and mandibular arch are coincident.

Natural Head Orientation – the head orientation of the subject perceived by the clinician, based on general experience, as the natural head position in a standing, relaxed body and head posture, when the subject is looking at a distant point at eye level. Same as Adjusted Natural Head position and upright head position.

Natural Head Position – a standardized and reproducible orientation of the head when the subject is focusing on a distant point at eye level.

Occlusal Plane – The occlusal plane defined by as Andrews as a line connecting the distal marginal ridge of the maxillary first premolar and the distal marginal ridge of the maxillary first molar.

Superion – the point on the angular or round forehead that, judged in profile, represents the superior boundary of the clinical forehead.

The FP Gauge™ (The Frontal-Plane Gauge™) – A measuring device developed by Dr. Timothy Tremont to accurately judge the FALL-DALL measurement.

Trichion – The superior border of an anatomical straight forehead (hairline) .

WALA ridge – a band of soft tissue immediately superior to the mucogingival junction in the mandible

Assumptions

1. The occlusal plane, as identified in this study, is an accurate representation of the line of occlusion and can be accurately identified.
2. The lateral cephalometric radiographs are taken with the mandible in centric relation.
3. The GALL, as determined by the FALL-DALL measurement and forehead inclination, represents a true vertical reference plane.
4. The FALL-DALL measurement was accurately recorded with the patient positioned in the adjusted natural head position.

Limitations

1. Geometrically a plane is a flat surface. The plane of occlusion is in reality a curved surface in three dimensions, but will be represented as a flat plane.
2. The adjusted natural head position and FALL-DALL measurement will be judged by a single operator.
3. The sample group may not provide an adequate number of patients to discern an optimal profile range because the sample is selected from a biased population of patient's with malocclusions.

Delimitations

1. The FALL-DALL measurement will be determined utilizing a novel measuring device (The FP Gauge™).
2. All landmark identification and cephalometric measurements will be completed by a single investigator.

CHAPTER 2: REVIEW OF THE LITERATURE

History and Classification of Malocclusion

The origin of orthodontics can be traced back thousands of years. Archaeological remains of ancient Egyptians revealed metal bands, proposed to be used for tooth alignment, wrapped individually around each tooth. Primitive orthodontic appliances were found in Greek and Etruscan belongings. Hippocrates (460-377 BC), in 400 BC described irregularities of the teeth. He wrote, "... others have strongly arched palates thus teeth are disposed to irregularity, crowding, one on the other." ²⁴

Pierre Fauchard, in 1723, invented the first orthodontic appliance, the bandeau; which was designed as an expansion arch. Fauchard is called the "Father of Modern Dentistry". Norman Kingsley published the first text, *Oral Deformities*, to recommend etiology, diagnosis and treatment planning in orthodontics. Kingsley also contributed to the profession with the use of occipital traction to correct incisor protrusion as well as in the treatment of cleft lip and palate. The orthodontist goals during this period of time were focused on tooth alignment and facial proportions. ²⁵

Edward H. Angle (1855-1930), the "Father of Modern Orthodontics" is considered to be one of the most influential figures within the orthodontic profession. It was he that proposed the field of orthodontics be recognized as a specialty. He founded the first post-graduate orthodontic educational program (Angle School of Orthodontia, 1900), the first orthodontic society (currently known as the American Association of Orthodontists) and the first orthodontic journal

(The American Orthodontist, 1907). He held numerous patents which include the Edgewise Appliance (1925).²⁵

One of the most notable contributions of Angle is his classification of malocclusions, published in *Dental Cosmos* in 1899. The Angle classification system relates the mesiobuccal cusp tip of the maxillary first molar to the mesiobuccal groove of the mandibular first molar. The system consists of four distinct classes: normal Class I occlusion, Class I malocclusion, Class II malocclusion and Class III malocclusion. A Class I malocclusion is defined as a normal molar relationship, whereby the mesiobuccal cusp tip of the maxillary first molars occludes in the mesiobuccal groove of the mandibular first molar, with the presence of tooth malpositions and/or rotations. A Class II malocclusion is defined as a distal position of the mandibular first molar relative to the maxillary first molar. A Class III malocclusion consists of a mesial position of the mandibular first molar relative to the maxillary first molar. Angle advocated the use of elastics to obtain a Class I occlusion and opposed extractions despite negative consequences to facial esthetics. The Angle terminology is still the most widely accepted classification system in use today.²⁶

The Occlusal Plane: An Overview

The concept of a normal occlusion stimulated a shift in orthodontic goals from simple tooth alignment to correction of the occlusion. Normal occlusion led to the idea of a line of occlusion. Angle defined the line of occlusion as a catenary curve²⁶. In the maxilla the line of occlusion passes through the central fossae of each molar and across the cingulum of the anterior teeth. In the mandible, the line of occlusion passes through the buccal cusps and incisal edges of

the dentition. The line of occlusion represents the interface of the maxillo-mandibular complex. This interface is multi-dimensional as represented by the curve of Spee and curve of Wilson within the dentition itself. The multi-dimensional nature of the plane of occlusion is also represented by its orientation within the craniofacial skeleton. To characterize dentofacial characteristics the plane of occlusion must be assessed relative to the sagittal, vertical and transverse planes. Ackerman et al ²⁷ further suggested the use of the aeronautical rotational terms pitch, roll and yaw to evaluate the spatial orientation of the occlusal plane.

The importance of the occlusal plane is underscored by the abundance of publications within the orthodontic literature. The occlusal plane is evaluated relative to craniofacial form ¹⁻³, craniofacial growth ⁴, masticatory function ^{5,6}, dental occlusion ^{7,8}, mechanotherapy ^{9,10}, orthognathic surgery ¹¹⁻¹⁵, and in prosthodontic rehabilitation ²⁸. However, the concept of a cephalometric occlusal plane has received much attention with little regard to a consistent definition or reference plane from which to measure it.

The advent of cephalometrics by Broadbent in 1931, ²⁹ enabled researchers and clinicians to assess craniofacial characteristics. Fundamental to these assessments was to relate the three-dimensional line of occlusion to the two-dimensional cephalometric radiograph.

Definition of the Occlusal Plane

Downs was the first to reference the occlusal plane in a cephalometric analysis designed to evaluate the dentoskeletal profile ¹⁶. Downs defined the occlusal plane as “a line bisecting the occlusion of the first molars and central incisors”. Downs also suggested a modified definition of the occlusal plane in cases where the incisors exhibit an obvious infra- or supra-occlusion. In

such cases the plane is identified through the buccal cusp tips of the first molar and the premolars. This definition was later adopted and referred to as the functional occlusal plane (FOP).

Abraham³⁰ defined the FOP as the central reference plane in his “Occlusal Reference System”, utilized to evaluate longitudinal craniofacial growth. Abraham stated that the FOP “located by inspection, approximates the occlusal surfaces, in functioning relation, of the maxillary and mandibular first and second deciduous molars and first permanent molars or the first and second premolars and first permanent molars”. Jenkins³¹ had previously defined the occlusal plane as “the average occlusal plane of the buccal teeth, including the canine and first permanent molar”. Ricketts³² stated a similar definition for the occlusal plane as “the overlap of buccal occlusion”.

Traditionally, either the bisected occlusal plane or the functional occlusal plane is used, arbitrarily, in various cephalometric analyses and studies evaluating craniofacial growth and form. However, some studies evaluate the maxillary or mandibular plane individually. These studies define the occlusal plane as a line connecting the mesiobuccal cusp tip of the maxillary first molar to the incisal tip within its respective arch. Wolford et al.²⁶ defines the functional occlusal plane as a line tangent to the cusp tips of the lower premolars and the buccal groove of the second molar¹¹²⁶. In addition, several studies separate the maxillary occlusal plane into anterior and posterior components due to the presence of a curve of Spee^{2, 4}.

The glossary of prosthodontic terms defines the occlusal plane as “the average plane established by the incisal and occlusal surfaces of the teeth. Generally, it is not a plane but represents the planar mean of the curvature of these surfaces”³³. Di Paolo³⁴ described an

individualized approach to identifying the occlusal plane that requires the use of the quadrilateral analysis; an evaluation of the skeletal pattern of the lower face.

The Occlusal Plane in Cephalometrics

In addition to the variability in which the occlusal plane is defined, the reference plane from which the inclination is measured in the various cephalometric analyses also varies. The two most common reference planes are the Frankfort horizontal plane and the sella-nasion plane. Frankfort horizontal is identified by a line connecting porion to orbitale.

The Downs analysis evaluates the inclination of the occlusal plane with reference to the Frankfort horizontal plane. Downs reports the inclination of the occlusal plane, in subjects he determined to exhibit an excellent clinical occlusion, to have a mean of 9.3° , with a range of 1.5° to 14° ¹⁶. His analysis also utilized the occlusal plane to evaluate incisor inclination. The lower incisor to occlusal plane angle showed a range of 3° to 20° with a mean of 14.5° ¹⁶. The Steiner analysis evaluates the FOP relative to the sella-nasion cranial base reference plane. Steiner reports the average inclination of the occlusal plane relative to sella-nasion in patients with normal occlusions is 14° ³⁵.

Ricketts noted that the vertical position of the occlusal plane has a relationship to the Xi point of the mandible posteriorly and stomion (the point of contact of the upper and lower lips) anteriorly³². The Xi point is defined by Ricketts as the “centroid of the ramus...which approximates the functional center of the mandible as well as the entrance of the mandibular nerve into the mandible”³².

The Wits appraisal is a measurement of the anteroposterior jaw discrepancy that utilizes the functional occlusal plane as the reference line³⁵. Perpendicular lines from point A and point B are projected onto the occlusal plane. A measurement is made of the distance between the intersections of each line on the occlusal plane. The Wits appraisal was developed to complement the ANB measurement of sagittal jaw discrepancy.

The Relationship of the Occlusal Plane to Craniofacial Form

It is well established that a relationship exists between the inclination of the occlusal plane and the various anteroposterior skeletal profiles.^{3, 4, 16} Studies have shown that steeper occlusal planes are associated with Class II malocclusions whereas flatter occlusal planes are associated with Class III malocclusions^{4, 16}.

Tanaka and Sato⁴ conducted a longitudinal cephalometric study evaluating the occlusal plane in skeletal Class I, II, and III subjects. The occlusal plane, measured relative to Frankfort horizontal, was identified both conventionally and also separated into anterior (OP (A)) and posterior (OP (P)) planes. The posterior occlusal plane was found to be significantly steeper in the skeletal Class II group and significantly flatter in the skeletal Class III group beginning at the age of 12 to 14 years. This relationship held constant throughout the age range of 18 to 20 years. At this age the average posterior occlusal plane inclination was $11.3^{\circ} \pm 2.7^{\circ}$ in the Class I group, $13.8^{\circ} \pm 3.3^{\circ}$ in the Class II group and $8.7 \pm 3.3^{\circ}$ in the Class III group.

These findings have been corroborated by other studies. Fushima et al.³ studied a group of 50 adult females with Class II, division I malocclusions and showed a strong correlation between the steep inclination of the posterior occlusal plane to a small, retruded and backward

rotation of the mandible. The steep inclination of the posterior occlusal plane was correlated with a short vertical height of the maxillary second molars. Therefore, the authors suggest that the vertical dimension of the posterior maxilla contributes to the development of various skeletal profiles.

The inclination of the occlusal plane also varies relative to vertical jaw discrepancies. Anwar and Fida¹⁷ grouped 185 patients into hyperdivergent (SN-MP > 36°), normodivergent (SN-MP 28-36°) and hypodivergent (SN-MP < 28°) profiles. The study showed statistically significant differences ($p < .001$) in the inclination of the occlusal plane (SN-OP) between the groups. The mean sella-nasion to occlusal plane angle for the groups was: hypodivergent ($13.85^\circ \pm 4.3$), normodivergent ($17.81^\circ \pm 9.1$) and hyperdivergent ($21.08^\circ \pm 3.6$). Therefore, steeper occlusal plane inclinations are associated with the hyperdivergent (long-face) individuals and flatter occlusal plane inclinations are associated with the hypo-divergent (short-face) individuals.

Studies suggest that dentoalveolar compensations in incisor inclinations and occlusal plane inclinations exist to compensate for sagittal jaw discrepancies. Casco and Shepherd¹⁸ evaluated 75 adult patients in an attempt to examine the skeletal variation that exists in naturally occurring optimal occlusions. He noted that as the ANB angle increased, the inclination of the occlusal plane likewise increased. The variability observed in the inclination of the occlusal plane is described as a compensatory mechanism that exists to attain a Class I dental relationship in the presence of a sagittal jaw discrepancy.² Ishikawa et al.² performed a cephalometric analysis on forty-four adult females with either a skeletal Class I or skeletal Class III jaw relationship, and normal incisor relationships. The study demonstrated a correlation between the sagittal jaw discrepancy (SN-AB) and upper and lower incisor inclinations. The lower incisor

inclination showed the strongest relationship to the SN-AB angle; which led the authors to suggest that the lower incisor inclination is largely attributed to achieving normal incisor relationships when a jaw discrepancy exists. The study also showed a relationship between the inclination of the occlusal plane (SN-OP) and two measurements of sagittal jaw discrepancy (SN-AB and the anteroposterior dysplasia indicator (ADPI)). The authors noted that when the angle SN-AB was greater than 84° the presence of a Class I molar relationship was uncommon. Therefore, if the sagittal discrepancy exceeds certain limits this compensation will be inadequate and a Class I relationship will not be achieved.²

Occlusal Plane Alteration in Orthognathic Surgery

Single-jaw mandibular surgical correction of anteroposterior jaw discrepancies is accomplished by advancement or setback along the occlusal plane of the patient. In cases of vertical maxillary excess or vertical maxillary deficiency, the maxilla can be appropriately positioned superiorly or inferiorly. Autorotation of the mandible then establishes the post-surgical occlusal plane inclination. Although, optimal dental occlusion can be obtained with single-jaw surgery, in some instances facial esthetics and balance is not achieved.³⁶

The need to selectively alter the inclination of the occlusal plane to achieve improved facial balance in the surgical correction of dentofacial deformities is advocated^{11-15, 19, 37}.

Occlusal plane alteration requires double-jaw surgery and either clockwise or counter-clockwise rotations of the maxillo-mandibular complex. McCollum et al.³⁷ suggested increasing the occlusal plane angle in patients with a Class II deep-bite and low mandibular plane angle to achieve optimal esthetic outcomes following orthognathic surgery. The proposed method

involved posterior maxillary impaction in conjunction with a bilateral sagittal split ramus osteotomy (BSSO) to raise the posterior body of the mandible and an advancement to obtain a Class I dental relationship. The clockwise rotation of the maxillo-mandibular complex permits both optimal dental function and facial esthetics. Reyneke and Evans ¹⁴ demonstrated the esthetic advantages to a deliberate increase in the occlusal plane inclination in patients with Class I, Class II and Class III malocclusions.

Clockwise rotations are shown to remain stable long-term post-surgically. Thus, the method is also advocated for the correction of the Class II open-bite malocclusions, despite the compromise to facial esthetics. Furthermore, the increase in the occlusal plane angle in patients with an initial steep occlusal plane can also result in functional disturbances such as loss of canine and incisal guidance and the introduction of working and balancing interferences. The effects, relative to the face, of clockwise maxillomandibular jaw rotations include the following:

1. The occlusal plane inclination increases.
2. The mandibular plane inclination increases.
3. The chin rotates down and backward, thus
 - a. Decreasing chin prominence, and
 - b. Increasing lower facial height.
4. Maxillary incisor inclination decreases.
5. Mandibular incisor inclination increases.

Reyneke ¹⁵ discusses the option to vary the center of rotation to either increase or decrease the effects based on the individual circumstances and desired outcomes.

Rosen ¹³ published the results of 11 patients with severe mandibular deficiency that underwent counterclockwise surgical correction of the maxillo-mandibular complex. Counter-

clockwise rotations involve a deliberate decrease to the occlusal plane inclination. The counterclockwise rotation allowed for a greater advancement of pogonion and preservation of the posterior facial height. Several additional authors ^{11, 12, 14, 15} have discussed the need to decrease the occlusal plane inclination in patients with a high-occlusal plane facial type to achieve optimal function and esthetics. Decreasing the occlusal plane inclination facilitates the amount of mandibular chin projection that can be achieved. The effects, relative to the face, of counterclockwise maxillomandibular jaw rotations include the following:

1. The occlusal plane inclination decreases.
2. The mandibular plane inclination decreases.
3. The chin rotates upward and forward, thus
 - a. Increasing chin prominence, and
 - b. Decreasing lower facial height
4. Maxillary incisor inclination increases.
5. Mandibular incisor inclination decreases.

The stability of counter-clockwise maxillomandibular jaw rotations is controversial. Traditionally, such a movement of the distal segment of the mandible is considered unstable post-surgically. However, several authors claim stability of counter-clockwise jaw rotations ^{38, 39}. Reyneke et al. ³⁸ compared skeletal stability of patients who underwent deliberate clockwise and counter-clockwise jaw rotations with patients who underwent conventional orthognathic surgery. A total of eighty-eight patients were included and were recalled within 6-60 months post-surgery to assess stability. Skeletal stability between the groups was determined to be statistically insignificant. Chemello et al ³⁹ demonstrated skeletal stability at an average of 21

months post-surgically in group of forty-one patients who underwent either surgical increase or decrease of the occlusal plane inclination.

The surgical increase or decrease of the occlusal plane is an attempt to “normalize” the occlusal plane in low occlusal plane and high occlusal plane facial types. The overall objective is not to conform to a norm, but to maximize facial harmony.

Natural Head Position and Cephalometrics

The advent of cephalometrics enabled researchers and clinicians to assess craniofacial characteristics. Downs was the first to propose a cephalometric analysis designed to evaluate the dentoskeletal profile.¹ The Down’s analysis stimulated a plethora of cephalometric analyses to evaluate characteristics of the craniofacial skeleton and aid in orthodontic diagnosis and treatment planning. Numerous soft²⁻⁶ and hard tissue^{1, 40} cephalometric analyses⁴¹⁻⁴⁵ seek to quantify the features that constitute ideal dentofacial characteristics. These analyses, however, measured relative to internal landmarks and reference planes that were shown to be inherently unreliable for orthodontic treatment planning.⁴⁶

Downs in 1956¹ discussed the large variation (+9° to -7°) in the Frankfort horizontal plane when patients were placed in natural head position. Lundstrom and Lundstrom⁴⁷ have shown that both the sella-nasion plane and Frankfort horizontal plane exhibit a large amount of variability as measured to the horizontal plane in both natural head position and natural head orientation.⁴⁷ Furthermore, longitudinal growth studies have shown that the soft tissue profile does not directly reflect changes in the underlying hard tissue profile.^{48, 49} In addition, many came to realize that treating patients to dentoskeletal norms does not guarantee an esthetic soft

tissue outcome.⁵⁰ Therefore, the use of natural head position in cephalometric treatment planning is advocated due to the large degree of variability of intracranial reference planes.

Natural head position (NHP) was defined by Broca⁵¹ in 1862 as the position of the head when a person is standing and the “visual axis is horizontal”.⁵² Lundstrom et al⁵³ defines NHP as “the registered, mirror orientated head position in a relaxed body and head posture”. NHP contrasts natural head posture. Natural head posture is a dynamic and variable position depending upon the activity of the person, such as sitting or standing.⁵⁴

The strength in the use of natural head position is its reproducibility. Lundstrom and Lundstrom⁵⁵ evaluated the reproducibility of NHP using pretreatment lateral photographs and cephalometric radiographs. A plumb line identified the true vertical on the photograph, and is then transferred to the lateral ceph. A reproducibility of NHP between the two photographs of 2° was demonstrated. When compared to the variability of the intracranial reference planes, sella-nasion (SD. 5-5.6), basion-nasion (SD of 4.5 -5.0), and porion-orbitale (SD of 4.7-5.3) relative to the true horizontal reference line; the use of NHP to establish accurate vertical and horizontal reference lines is supported.⁵⁵

These findings are corroborated by additional studies demonstrating short-term^{64, 65} and long-term reproducibility of NHP^{56, 57}. Cooke et al.⁵⁸ showed that the method error of NHP after 1 to 2 hours was 1.9 °. At the 5-yr point⁵⁶ and 15 yr point⁵⁷ of a longitudinal study, the method error of NHP was found to be 3.04° and 2.2°, respectively. Therefore the variance of NHP, which equals the square of the method error, is 3.61 °, 9.24 °, and 4.8 ° after 1-2 hours, 5 years and 15 years, respectively. Therefore, registrations of NHP are significantly less variable than that of intracranial reference planes (25 ° – 36 °).⁵⁷

It has been noted by researchers that certain individuals will habitually assume a NHP that may be either flexed or extended. It is therefore recommended that in these instances the clinician should make the appropriate adjustments. Lundstrom and Lundstrom⁴⁷ define Natural Head Orientation (NHO) as “the head orientation of the subject perceived by the clinician, based on general experience, as the NHP in a standing, relaxed body and head posture, when the subject is looking at a distant point at eye level”. The use of NHO is shown to be valid and reproducible.⁵³

The upright head position described by Andrews²³ is an adjusted natural head position that is equivalent to Lundstrom and Lundstrom’s description of natural head orientation. For purposes of this study, the term NHP will be assumed to be the clinician’s adjusted natural head position.

Evaluating Facial Attractiveness

Facial esthetics is considered an essential goal in orthodontic treatment planning. Factors such as complexion, hair-style and color, and eye color have been attributed to influence perceptions of facial attractiveness. Despite their significance, these factors cannot be controlled. Therefore, the clinician’s focus in treatment planning for facial esthetics is to obtain optimal dento-facial harmony. This is accomplished by evaluating facial profile harmony. A study by Spyropoulos and Halazonetis⁵⁹ attempted to evaluate the relative importance of the soft tissue profile in ratings of facial attractiveness. Profile photographs of twenty female orthodontic patients were scanned, digitized and warped to conform to the average outline of the original twenty photographs. Ratings of facial attractiveness were assessed on the twenty original photographs, the twenty warped photographs, and three additional photographs that represented

the average outline, each with a different hairstyle. The authors concluded that soft tissue outline form did influence ratings of facial attractiveness. The warped images were rated higher than the non-warped images. However, the improvement in the rating was not as high as the composite images. Therefore, the authors concluded that there are factors in addition to profile form that influence perceptions of facial attractiveness.⁵⁹

Harmony can be related to the divine proportion, also called the golden ratio (1.618:1).⁶⁰ This proportion is universal concept that applies to nature as well as the human face and body.⁶⁰ One study evaluated the divine proportion and ratings of facial attractiveness in fifty females, deemed to have acceptable profiles.⁷⁰ Although none of the subjects conformed to the ideal divine proportion, subjects with higher esthetic scores did have proportions closer to the divine proportion for the vertical ratios; trichion-menton: trichion-subnasale and trichion-menton: nasion-menton.⁶¹ Although it can be argued that facial attractiveness is subjective, the significance of proportion cannot be denied.

The Six Elements of Orofacial Harmony

The Andrews® Six Elements Orthodontic Philosophy™²³ attempts to overcome the shortcomings of traditional cephalometric analyses by proposing a complete analysis unique to each individual. The Six Elements of Orofacial Harmony™ is defined by Lawrence F. Andrews as “six characteristics (within dentistry’s milieu) that are essential for optimal orofacial health and appearance”²³. The six characteristics include Element I: dental arch shape and length; Element II: anteroposterior jaw positions; Element III: buccolingual jaw positions; Element IV: superoinferior jaw positions; Element V: pogonion prominence and Element VI: dental

occlusion. Andrews established a set of objectives, goals, landmarks and referents to define the optimality of each element. The Six Elements™ allows for a comprehensive classification system representing the position of both the teeth and the jaws. Andrews suggests that each Element be “uniquely correct for each person”²³. This classification system differs from traditional analyses; in that the position of the jaws and teeth are not based on cephalometric norms.

Unique to the Six Elements is the evaluation of the lateral smiling profile. Andrews noted that a relationship exists between the forehead prominence and inclination and the AP position of the maxillary central incisor in patients with harmonious profiles. This relationship can be used to construct a frontal plane, the Goal Anterior Limit Line (GALL), to judge the optimal AP position of the jaws. A recent study confirmed that 91% of the individuals with a good to excellent facial profile fall within the GALL and FA point of the forehead.⁶² Schlosser et al.⁶³ reported on the rating of facial attractiveness using the position of the maxillary central incisors with reference to the forehead. These studies support the use of the forehead to determine the AP position of the maxilla; which is fundamental to the Six Elements classification system.

Below is a brief summary of each Element. For a comprehensive guide to the Six Elements of Orofacial Harmony, please refer to the Andrews® Foundation course syllabus²³.

Element I:

Element I concerns the shape and length of the dental arches. Teeth should be positioned with proper inclination, roots centered in basal bone and a level core line depth (curve of Spee between 0 - 2.5 mm). The dental arch shape of the mandible is determined by evaluating the bucco-lingual distance between each tooth's facial-axis (FA) point and the WALA Ridge. The

WALA ridge is the ridge of soft tissue directly superior to the mucogingival junction and is suggested to approximate the center of rotation of each tooth. The buccolingual distance between the FA point and the WALA ridge progressively decreases from posterior to anterior. The distance averages 2.2 mm at the second molar and 0.1 mm at the central incisor. A recent study by Ronay et al. has corroborated the relationship between the tooth's FA point and the WALA ridge. The shaping of arch wires to the WALA ridge not only allows the mandibular arch form to be unique for each patient, but is proposed to ensure a stable position relative to the periodontium. The maxillary arch form is then established based on the mandibular arch form.

The lateral cephalometric radiograph is essential to the evaluation of Element I. The occlusal plane must first be identified on the lateral cephalogram. The Andrews template is then utilized to determine the proper inclination of the maxillary and mandibular central incisors with the roots centered in basal bone. The template incisor inclination relative to the occlusal plane ensures an optimal inclination (7° for the maxillary incisor and -1° for the mandibular incisor) relative to the dental arch's perimeter line.

A 2" x 3" acetate overlay is placed over the maxilla and secured. The occlusal plane and outline of the maxilla is traced on the acetate overlay. The occlusal plane of the Andrews template is superimposed on the occlusal plane of the patient, and the Element I maxillary incisor is drawn once the template incisor root is centered in maxillary basal bone. A second piece of acetate paper is then placed over the body of the mandible. The occlusal plane, outline of the mandible and the Element I mandibular incisor is also traced as described for the maxilla. Measurement of the distance between the FA point of the original incisor and the Element I incisor is recorded.

An evaluation of Element I requires an analysis of the core discrepancy (crowding). Calculations must be made to determine the effects that leveling the curve of Spee, uprighting the molars, expanding the maxilla and proclining/retroclining the incisors will have on the core discrepancy. These effects are then recorded as the interim core discrepancy (ICD). For example, leveling the curve of Spee will require space within the arch and thus will ultimately decrease the space available within the arch and increase the ICD. Proclining incisors to an optimal Element I position, centered in basal bone will increase the space available within the arch and decrease the ICD. A negative ICD indicates crowding, whereas a positive ICD indicates spacing. The ICD is then utilized for treatment decisions; such as the need for space closure, extractions, interproximal reduction or an alternative compromise treatment.

Element II:

An evaluation of the anteroposterior position of the jaws is the objective of Element II. The Goal Anterior Limit Line (GALL) represents the frontal plane of the head, and is identified based on an evaluation of the forehead shape and inclination. Three forehead shapes predominate; straight, round and angular. The forehead points, trichion, superion, glabella and the foreheads facial axis point, are identified for the patient based on forehead shape. The distance between the face anterior limit line (FALL) and the dentition's anterior limit line (DALL) is evaluated clinically with the patient in the upright head position and recorded. The FALL is a line passing through the FFA point of the forehead that parallels the frontal plane of the head. The DALL is a line passing through the FA point of the maxillary incisor that parallels the frontal plane of the head. The angular measurement determined by the forehead inclination (superion and/or trichion to glabella) relative to the FALL is recorded. The FALL is equivalent

to the GALL with a forehead inclination equal to or less than $+7^\circ$. For every degree beyond $+7^\circ$, the GALL lies 0.6 mm anterior to the FALL, without exceeding glabella.

An optimal Element II maxilla requires the FA point of the maxillary central incisor to touch the GALL. The maxilla can be classified as red (prognathic) or black (retrognathic) by measuring the distance from the maxillary incisor FA point to the GALL. An optimal Element II mandible is determined relative to an optimal Element II maxilla, with the teeth in an Element I position and a Key I dental relationship. The mandible can be classified as red (prognathic) or black (retrognathic) by measuring the distance from the optimal Element I and Element II maxillary incisor to the Element I mandibular incisor.

The anteroposterior jaw classification proposed by Andrews represents the jaw discrepancy relative to optimally positioned incisors. This varies from traditional cephalometric assessments which evaluate the jaw positions based on linear measurements or angles of specific jaw landmarks; such as the A point and B point.

Element III:

Element III is an evaluation of the bucco-lingual (transverse) position of the maxilla relative to the mandible. The mandible represents the basis from which to measure the optimal bucco-lingual position of the maxilla. If a discrepancy exists, the maxilla can be orthopedically or surgically expanded to match the mandibular width. The cusp-cusp and fossa-fossa distances are measured within the maxilla and mandible with the teeth in an Element I position. The distance between FA point of the mandibular posterior teeth and WALA ridge, is used to determine the Element I tooth position. For instance, if the mandibular posterior teeth are inclined to the lingual, the amount of uprighting should be incorporated into the fossa-fossa

transverse mandibular measurements. Andrews states that the transverse measurement of FA point to FA point should be 2 to 4 mm greater in the maxillary arch than the mandibular arch.

Element IV:

The superoinferior position of each jaw is evaluated within Element IV. The measurement from glabella to subnasale (midfacial height) should equal the measurements from subnasal to menton (lower facial height) and condylion to gonion (ramus height). Andrews separates the vertical jaw position, Element IV, into anterior and posterior components within each jaw. The anterior maxilla Element IV is defined as optimal based on appropriate maxillary incisor display in repose. The FA point of the maxillary incisor should be at the same level as the inferior border of the maxillary lip in repose. The anterior mandible Element IV is defined as optimal when the distance from the FA point of the mandibular incisor to hard-tissue menton is equal to one-half the distance of the midfacial height. The posterior maxilla Element IV is considered optimal when the anterior maxilla and mandible are optimal and there is an absence of an anterior or posterior open bite. The posterior mandible Element IV is considered optimal when the ramus height equals midfacial height. The extent of deviation from optimal should be recorded.

To determine the extent that the anterior maxilla Element IV deviates from optimal, the acetate overlay should be released and moved up or down, ensuring that the occlusal plane remains parallel to the original, until the FA point of the maxillary incisor is level with the inferior border of the maxillary lip. If the acetate is moved down the distance is recorded as negative and if moved up the distance is recorded as positive.

To determine the extent that the anterior mandible Element IV deviates from optimal the difference between one-half the midfacial height and the mandibular incisor FA point to menton is recorded. If the anterior mandible is less than or greater than the midfacial height this number is recorded as a negative number or positive number, respectively. The anterior mandible Element IV can be corrected surgically.

To determine the extent of deviation from optimal for the posterior Element IV, the mandibular acetate overlay should be extended to include the condyle. The overlay should then be rotated until the amount of incisor overbite is corrected. The maxillary overlay should be released and the occlusal planes should then be superimposed. The distance of the original posterior position to the new position should be recorded.

The relationship between the anterior and posterior Element IV of the maxilla thus establishes the inclination of the occlusal plane. However, Andrews does not designate an optimal inclination for the occlusal plane.

Element V:

Element V concerns an evaluation of hard-tissue pogonion prominence. Element V is defined as optimal based on a pogonion prominence that lies on a line 90° to the occlusal plane that passes through the FA point of the Element I mandibular incisor. The amount of deviation anterior or posterior to this line is recorded as positive or negative, respectively.

Element VI:

The Six Keys to Optimal Occlusion is the basis for Element VI. When all six keys are present, with the mandible in centric relation and functional excursions include canine disclusion, Element VI is considered optimal. In 1967, Lawrence F. Andrews published The Six Keys to Normal Occlusion,⁶⁴ which he later referred to as the Six Keys to Optimal Occlusion.

Andrews studied 120 dental casts with optimal occlusions to assess if there were any universal characteristics. Within these casts variability did exist, however, the constancy of features are defined as Key; I) correct interarch relationships; II) correct crown angulation; III) correct crown inclination; IV) absence of rotations; V) tight contacts; and VI) a flat curve of Spee. The characteristics which define an optimal occlusion are now widely accepted.

Andrews' study of optimal dental casts established the basis from which he developed the fully programmed Straight Wire Orthodontic Appliance. Introduction of the preadjusted appliance in conjunction with advances in material science, such as development of nickel titanium wire, revolutionized contemporary orthodontic treatment.

CHAPTER 3: MATERIALS AND METHODS

Sample Description

Study Group:

105 patients were randomly selected from the private orthodontic practice of Dr. Timothy Tremont, White Oak, PA. Subject selection was based on the following:

Inclusion Criteria:

- Any patient 12 years of age or greater in the permanent dentition.
- A pretreatment lateral cephalometric radiograph taken prior to orthodontic treatment.

Exclusion Criteria:

- Presence of any craniofacial anomalies; eg: Cleft lip and palate.
- Absence of maxillary and/or mandibular first molars.
- Presence of an obvious transverse (right to left) cant of the maxilla which would make accurate identification of the occlusal plane difficult.
- Presence of obvious mentalis strain on the lateral cephalometric radiograph.
- Inability to visual soft-tissue profile on the lateral cephalometric radiograph.
- Any previous orthodontic treatment.

Research Design

Overview

IRB approval for the use of human research subjects was obtained prior to the start of this study (Appendix A). A lateral cephalometric radiograph was obtained for each research subject and scanned using an Epson Scan.Ink scanner (Long Beach, CA, USA) at 300 dpi. The FALL-DALL measurement was obtained from the corresponding patient record. The lateral cephalometric radiograph was digitized utilizing the Dolphin Imaging Software Version 10.5. (Chatsworth, CA, USA) Once digitized, the lateral cephalometric radiograph was printed at a 1:1 ratio on HP Premium Photo Paper (Palo Alto, CA, USA). The GALL was constructed utilizing the FALL-DALL measurement as described by Andrews.²³ (Fig. 1). The GALL represents the true frontal plane of the head from which a true horizontal was constructed via a perpendicular to the GALL. All linear measurements were measured with a Neiko Platinum Series digital LCD caliper and recorded to the nearest 0.1 mm. All angular measurements were measured with the © 1996 Lawrence F. Andrews Foundation protractor (San Diego, CA, USA) and recorded to the nearest 0.5°. The occlusal plane inclination was measured relative to the TH (Fig. 2).

The sample of 105 was divided into three anteroposterior groups (Class I, II, and III) according to the ANB angle. Class I subjects were those with an ANB angle from 0-5°. Class II subjects were those with an ANB angle > 5°. Class III subjects were those with an ANB angle < 0°.

The sample was also divided into three anteroposterior groups (Category I, II, and III) based on jaw base differences evaluated with the Six Elements measurements (Element II Mx and Element II Md). Please refer to table 1 and figures 5 and 6 for an explanation of the Six

Elements. Category I subjects were those with jaw positions (II Mx and II Md) ± 2 mm of each other. Category II subjects were those with an Element II Md positioned posteriorly > 2 mm, relative to the Element II Mx. Category III subjects were those with an Element II Md positioned anteriorly > 2 mm, relative to the Element II Mx.

The sample was divided into vertical groups based on the measure of SN-MP°. Subjects were considered normodivergent with a SN-MP° from 28 - 36°. Subjects were considered hypodivergent with a SN-MP° $< 28^\circ$ and hyperdivergent with a SN-MP° $> 36^\circ$.

Subjects were divided into groups based on soft tissue facial convexity (G'-Sn'-Pog'). Subjects were grouped as normal based on a G'-Sn'-Pog'° 165 - 175°. Subjects were grouped as convex based on a G'-Sn'-Pog'° $> 175^\circ$. Subjects were grouped as concave based on a G'-Sn'-Pog'° $< 165^\circ$.

Methodology

Construction of the GALL and True Horizontal (TH)

The patient was placed in the upright head position and the lateral smiling profile was used to clinically determine the FALL-DALL measurement. This measurement was confirmed utilizing a novel device, The FP Gauge™ (Pittsburgh, PA, USA). (Fig. 3) The FALL-DALL measurement and lateral cephalometric radiograph were obtained from the patient record. The GALL was then constructed on the lateral cephalometric radiograph as described by Andrews.²³ The angular measurement determined by the forehead inclination (superion and/or trichion to glabella) relative to the FALL was calculated. The FALL is equivalent to the GALL with a forehead inclination $+7^\circ$ or less. For every degree beyond $+7^\circ$, the GALL lies 0.6 mm anterior to the FALL, not exceeding glabella. The GALL represents a true frontal plane with the patient

in the adjusted natural head position. True horizontal (TH) was constructed from a line drawn perpendicular to the GALL.

Fig. 1: Construction of the GALL and True Horizontal (TH)

Identification of the Occlusal Plane

The occlusal plane was constructed as the functional occlusal plane. The occlusal plane is represented as a line drawn from the distal marginal ridge of the maxillary first permanent molar (MR6) to the distal marginal ridge of the maxillary first premolar (MR4), as described by Andrews.²³

Fig. 2: Identification of the Occlusal Plane

Fig. 3: Demonstration of the FP-Gauge™ to judge the FALL-DALL measurement

Cephalometric Analysis

Landmark Identification:

The lateral cephalometric radiograph was used for analysis of the cephalometric variables.

Landmark identification (Fig. 4 and Fig. 5), tracings and measurements were completed by a single investigator.

Fig. 4: Hard and Soft Tissue Cephalometric Landmarks

Fig 5: Dental Cephalometric Landmarks

Six Elements Measurements:

The cephalometric analysis included a measurement of several of Andrew's Six Elements. For an overview of these measurements please refer to table 1 below.

Table 1: Six Elements Measurements

Variable	Definition
II Mx	The antero-posterior position of the Element I maxillary central incisor relative to the GALL; measured in millimeters from the GALL to the Element I maxillary central incisor FA point. A negative value indicates that the FA point is posterior to the GALL. A positive value indicates that the FA point is anterior to the GALL.
II Md	The antero-posterior position of the Element I mandibular central incisor measured relative to an optimal Element I maxillary central incisor and Element II maxilla. A negative number indicates the measurement in millimeters of overjet. A positive number indicates the measurement in millimeters of anterior crossbite.
IV Mx Ant	The vertical position of the anterior maxilla. Measured as the vertical distance of the FA point of the Element I maxillary central incisor relative to Sts. A positive number indicates that the FA point is more inferior to Sts. A negative number indicates that the FA point is more superior to Sts.
IV Md Ant	The vertical position of the anterior mandible. Measured as the vertical distance from the FA point of the Element I mandibular central incisor to Me.
V	Pogonion Prominence. The distance between Pog to a line formed tangent to the FA pt of an Element I mandibular central incisor and perpendicular to the occlusal plane.

Element II was recorded by utilizing the © 1996 Lawrence F. Andrews Foundation tracing template, superimposed on the occlusal plane to draw a hypothetically positioned Element I maxillary and mandibular incisor. The Element II position of the maxilla was measured as a linear distance from the FA point of the Element I maxillary incisor to the GALL. A positive measurement was recorded with the FA point anterior to the GALL. A negative measurement was recorded with the FA point posterior to the GALL. (Fig. 6)

Fig. 6: Illustration of Element II Mx

The Element II position of the mandible was recorded as the AP distance of the Element I mandibular central incisor measured relative to an optimal Element I maxillary central incisor and Element II maxilla. A negative number indicates the measurement in millimeters of overjet. A positive number indicates the measurement in millimeters of anterior crossbite. (Fig. 7)

Fig. 7: Illustration of Element II Md

Element IV Max Ant is the vertical position of the anterior maxilla. It was measured as the vertical distance of the FA point of the Element I maxillary central incisor relative to Sts. A positive number indicates that the FA point is more inferior to Sts. A negative number indicates that the FA point is more superior to Sts. (Fig. 8)

Fig. 8: Illustration of Element IV Mx Ant

Element IV Md Ant is the vertical position of the anterior mandible. It was measured as the vertical distance from the FA point of the Element I mandibular central incisor to Me. (Fig. 9)

Fig. 9: Illustration of Element IV Md Ant

Element V is the pogonion prominence, and is a measure of the prominence of the hard tissue chin. It was measured as the distance between Pog to a line formed tangent to the FA pt of an Element I mandibular central incisor and perpendicular to the occlusal plane. (Fig. 10)

Fig. 10: Illustration of Element V

Angular Measurements:

The angular cephalometric measurements (Table 2) were measured utilizing © 1996 Lawrence F. Andrews Foundation protractor, and recorded to the nearest 0.5°. These measurements included the inclinations of the OP° , PP° , MP° , SN° , $U1^\circ$, and $L1^\circ$ measured relative to TH. (Fig. 11A) In addition the gonial angle (Go°), soft tissue facial convexity convexity ($G'-Sn-Pog^\circ$), $Sn-Mp^\circ$, $Op-Sn^\circ$, $U1-Op^\circ$, $L1-Op^\circ$, SNA° , SNB° and ANB° angles were measured (Fig. 11A, B). The reference planes measured relative to TH (MP° , Op° , and PP°)

were assigned a positive value for a clockwise rotation (anterior end of plane is inferior) and a negative value for an anticlockwise rotation. SN° was assigned a positive value for an anticlockwise rotation.

Table 2: Angular Cephalometric Measurements

Variable	Defintion
SNA°	The position of the maxilla relative to the cranial base. The angle formed by Sella-Nasion-Point A
SNB°	The position of the mandible relative to the cranial base. The angle of Sella-Nasion-Point B
ANB°	The relative position of the maxilla to the mandible. The difference between SNA and SNB
$G'-Sn'-Pog^\circ$	Soft tissue angle of convexity
$SN-MP^\circ$	The angular measurement of the sella-nasion to mandibular plane
SN°	The inclination of the sella to nasion plane relative to TH
$Op-Sn^\circ$	The angular measurement of the occlusal plane to the sella-nasion plane
MP°	Inclination of the mandibular plane measured relative to TH
Op°	Inclination of the occlusal plane measured relative to TH
PP°	The inclination of the palatal plane measured relative to TH
Go°	The gonial angle measured as the angle of a line tangent to the posterior ramus and the mandibular plane
$U1^\circ$	Inclination of long axis of an Element I maxillary central incisors measured relative to TH
$L1^\circ$	Inclination of long axis of an Element I mandibular central incisors measured relative to TH
$U1 - Op^\circ$	The angular measurement of the maxillary central incisor to the occlusal plane
$L1 - Op^\circ$	The angular measurement of the mandibular central incisor to the occlusal plane

Fig. 11: Angular cephalometric measurements

Linear Measurements:

The linear cephalometric measurements (Table 3) were measured using a Neiko Platinum Series digital LCD caliper and recorded to the nearest 0.1 millimeter. Soft and hard tissue vertical facial heights were recorded (Fig. 12). The anteroposterior position of the hard tissue and soft tissue chin was measured relative to Andrew's GALL (Fig. 13) and Arnett's TVL (Fig. 14,); Pog'-GALL, Pog-GALL, and Pog'c-GALL, TVL-Pog. The vertical eruption of the maxillary and mandibular first molars and maxillary and mandibular central incisors were recorded; PP-Msc, MP-Mic, PP -U1, and MP-L1 (Fig. 15).

Table 3: Linear Cephalometric Measurements

Variable	Definition
<u><i>Soft Tissue</i></u>	
G'-Me'	Soft tissue total facial height
G'-Sn'	Soft tissue upper anterior facial height
Sn'-Me'	Soft tissue lower anterior facial height
Pog-GALL	Anteroposterior position of hard tissue pogonion. The distance in millimeters of hard tissue pogonion relative to the GALL measured parallel to TH
Pog'-GALL	Anteroposterior position of soft tissue pogonion. The distance in millimeters of soft tissue pogonion relative to the GALL measured parallel to TH
Pog'c-GALL	Distance in millimeters of the corrected soft tissue pogonion to the GALL, determined by the deviation from an optimal Element V ($\text{Pog'C-GALL} = \text{Pog'-GALL} - \text{Element V}$)
Pog'-TVL	Anteroposterior position of soft tissue pogonion measured as a linear distance to Arnett's TVL
<u><i>Hard Tissue</i></u>	
N-ANS	Hard tissue upper anterior facial height
N-Me	Hard tissue total facial height
ANS-Me	Hard tissue lower anterior facial height
Co-Go	Posterior facial height as defined by Andrews
S-Go	Hard tissue posterior facial height
Co-GN	Mandibular length measured from condylion to gnathion
<u><i>Dental</i></u>	
PP-U1	Vertical height of the maxillary central incisor measured as a linear distance from the palatal plane
PP-Mic	Vertical height of maxillary first measured as a linear distance from the palatal plane
MP-L1	Vertical height of the mandibular central incisor measured as a linear distance from the mandibular plane
MP-Mic	Vertical height of the mandibular first molar measured as a linear distance from the mandibular plane

Fig. 12: Vertical Facial Heights

Fig. 13: Chin Prominence Measurement to the GALL

Fig. 14: Soft Tissue Chin Measurement to TVL

Fig. 15: Vertical Eruption

Error Measurements

All cephalometric measurements were repeated on ten subjects six weeks after the initial measurements. The reliability of landmark identification and measurements of all cephalometric variables used in this study was tested by comparing the differences between the initial measurements and repeated measurements. Coefficients of reliability and Cronbach's α were calculated between the initial and repeated measurements. (Appendix B) For all cephalometric variables, the coefficients of reliability were found to be greater than .95. For all cephalometric variables, the Cronbach's α was found to be greater than .97. This indicates reliability of all measurements.

Statistical Analysis

The statistical analysis was carried about by the statistician (E.G.) utilizing the JMP version 9.0.0 SAS Software (Cary, NC, USA). An Analysis of Variance (ANOVA) was used for comparison of the anteroposterior, vertical and soft tissue facial convexity groups. A post-hoc comparison of means with the Student's t-test and Tukey Kramer Test was used to account for differences among groups. Pairwise correlation coefficients were calculated to quantitatively evaluate the relationship among the Op° and all linear, angular and Six Elements cephalometric variables. A stepwise regression analysis was used to determine the cephalometric variables that can be used to predict Op°. A stepwise variable selection was used to identify predictive variables. The significance level was set at $p < .05$.

CHAPTER 4: RESULTS

Descriptive Statistics

The study sample (n=105) consisted of 65 female and 40 male subjects. A t-test was used to evaluate the presence of any gender differences (Table 4, appendix B). There were statistically significant differences for the variables N-ANS, N-Me, G'-Me', Co-Go, So-Go, Mp-Mic, Mp-L1, Co-Gn, Element IV Md Ant, and Element V between males and females. These linear measurements indicated differences due to larger mean values for males; indicating a larger overall size in the male group. Pog'-GALL, Pog-GALL, Pog'-TVL, Pog'c-GALL, Element II Mx, Element II Md, and were also different among the male and female groups. The male group consisted of subjects that were had larger mean values for the maxilla, mandible and pogonion measured relative to the GALL. However the mean soft tissue facial convexity, G'-Sn'-Pog', was larger in the female group.

The age distribution ranged from age 10.1 to 53.8. A t-test was used to evaluate the presence of any differences among the age groups < 18 (n = 78) and ≥ 18 (n = 27) (Table 5, appendix C). The mean age of the group < 18 was 13.2 ± 1.53 S.D. with a minimum age of 10.1 and maximum age of 17.5. The ≥ 18 group had a mean age of 33.7 ± 10.0 with a minimum age of 18.7 and maximum age of 53.8. There were statistically significant differences among the following variables when grouped by age; ANS-Me, N-Me, G'-Sn', Sn'-Me', G'-Me, Co-Go, S-Go, PP-U1, PP-Msc, MP-Mic, MP-L1 and Element II Mx. The differences in mean values between the age groups indicated larger vertical dimensions and dental eruptions in the ≥ 18 age group. The mean values for Go°, MP°, and Op° were found to be larger in the < 18 age group.

The descriptive statistics were used to determine the mean, standard deviation, minimum and maximum for each of the linear, angular and Six Elements cephalometric variables of the pooled study sample (Table 6). The mean Op° for the pooled sample was 8.83° with a S.D. of 3.5. The mean Op° for the < 18 age group was $9.42^\circ \pm 3.39$; and for the ≥ 18 age group was $7.11^\circ \pm 3.29$.

Table 4: Descriptive Statistics by Gender

	Female		Male		
Variable	Mean	S.D.	Mean	S.D.	p-Value
<u>Linear</u>					
Pog-GALL	-8.69	5.71	-12.17	5.61	0.0029*
Pog ⁱ -GALL	2.06	4.32	-0.12	5.47	0.0359*
Pog ⁱ c-GAL	0.94	4.05	-1.99	4.98	0.0025*
TVL-Pog ⁱ	-5.32	5.31	-8.34	5.78	0.0090*
N-ANS	49.69	2.93	51.41	3.89	0.0188*
ANS-Me	60.87	5.34	62.49	5.95	0.1652
N-Me	110.57	6.02	113.90	8.37	0.0318*
G ⁱ -Sn ⁱ	62.26	3.96	63.92	4.87	0.0736
Sn ⁱ -Me ⁱ	64.83	5.17	66.79	7.19	0.1367
G ⁱ -Me ⁱ	127.09	6.54	130.72	9.80	0.0425*
Co-Go	53.27	4.34	55.42	5.77	0.0469*
S-Go	71.01	5.02	73.71	7.32	0.0442*
Co-Gn	107.53	18.63	113.56	6.17	0.0258*
PP-U1	27.08	2.55	27.82	3.09	0.2065
PP-Mic	21.88	2.22	21.83	2.60	0.94
MP-L1	37.58	3.04	39.67	3.76	0.0041*
Mp-Mic	31.36	3.46	33.37	4.55	0.0196*
<u>Angular</u>					
Op°	8.63	3.24	9.15	3.90	0.4853
SNA°	80.88	3.59	81.29	3.68	0.5838
SNB°	78.62	4.74	77.91	4.79	0.4609
ANB°	2.26	3.82	3.38	3.42	0.1245
G ⁱ -Sn-Pog	166.94	7.26	163.68	6.97	0.0243*
SN-MP	32.14	6.30	30.88	7.02	0.3548
Op-Sn	18.22	4.36	18.08	5.16	0.8802
Sn	9.50	3.22	8.73	3.18	0.2311
MP°	24.23	12.77	22.39	5.76	0.7876
PP°	-1.55	3.24	-1.14	3.09	0.5199
Go°	123.67	7.10	122.08	8.41	0.3208
U1°	66.64	9.24	67.43	8.89	0.6649
L1°	65.48	8.54	63.94	9.46	0.4013
1° - Op	58.01	9.15	58.28	8.54	0.8781
1̄° - Op	74.12	8.38	73.09	9.19	0.5658
<u>Six Elements</u>					
II Mx	-3.52	3.02	-4.75	3.08	0.0493*
II Md	-3.00	3.57	-5.19	4.84	0.0157*
IV Mx Ant	-0.73	1.79	-1.18	1.91	0.2276
IV Md Ant	31.62	3.49	33.25	3.99	0.0373*
V	1.12	1.66	1.86	1.68	0.0288*

Table 5: Descriptive statistics of variables by age group

	< 18		≥ 18		
Variable	Mean	S.D.	Mean	S.D.	p-Value
<u>Linear</u>					
Pog-GALL	-10.25	5.08	-9.34	7.86	0.5757
Pog ⁱ -GALL	0.97	4.25	1.96	6.42	0.4587
Pog ⁱ c-GALL	-0.52	4.29	0.82	5.45	0.2562
TVL-Pog ⁱ	-6.69	4.96	-5.84	7.39	0.5821
N-ANS	50.04	3.47	51.24	3.13	0.1013
ANS-Me	60.29	5.22	64.95	5.32	0.0003*
N-Me	110.33	6.80	116.19	6.42	0.0002*
G ⁱ -Sn ⁱ	62.46	4.66	64.17	3.20	0.0390*
Sn ⁱ -Me ⁱ	64.31	5.60	69.24	5.94	0.0005*
G ⁱ -Me ⁱ	126.77	7.67	133.40	7.34	0.0002*
Co-Go	52.88	4.29	57.58	5.41	0.0002*
S-Go	70.43	4.93	76.69	6.87	0.0001*
Co-Gn	110.74	6.79	107.17	28.28	0.5212
PP-1	26.96	2.63	28.51	2.93	0.0199*
PP-Mic	21.22	2.20	23.72	1.76	<.0001*
MP-L1	37.73	3.18	40.25	3.65	0.0027*
Mp-Mic	31.27	3.42	34.61	4.58	0.0013*
<u>Angular</u>					
Op°	9.42	3.39	7.11	3.29	0.0031*
SNA°	81.01	3.43	81.13	4.16	0.8906
SNB°	78.46	4.77	78.04	4.75	0.6913
ANB°	2.54	3.55	3.09	4.12	0.5412
G ⁱ -Sn-Pog ^o	165.35	7.00	166.69	8.14	0.4521
SN-MP	32.17	6.39	30.17	6.99	0.1961
Op-Sn	18.59	4.70	16.94	4.38	0.1054
Sn	9.05	3.31	9.65	2.93	0.3823
MP°	24.46	11.81	20.85	5.59	0.0385*
PP°	-1.13	3.10	-2.13	3.33	0.1801
U1°	66.96	8.92	66.87	9.66	0.9663
L1°	65.15	7.94	64.15	11.34	0.6726
Go°	124.45	7.42	119.06	6.87	0.0012*
U1° - Op	57.54	8.62	59.76	9.58	0.1414
L1° - Op	74.58	7.84	71.26	10.50	0.2933
<u>Six Elements</u>					
II Mx	-4.29	3.03	-3.10	3.15	0.0954
II Md	-3.75	4.00	-4.08	4.87	0.7522
IV Mx Ant	-0.82	1.81	-1.12	1.96	0.4896
IV Md Ant	31.50	3.50	34.38	3.72	0.0011*
V	1.49	1.61	1.15	1.94	0.4188

Table 6: Descriptive Statistics of Pooled Sample				
<i>Linear</i>				
Variable	Mean	Std Dev	Minimum	Maximum
Pog-GALL	-10.02	5.89	-29.95	12.02
Pog'-GALL	1.23	4.88	-19.18	14.14
Pog'c-GALL	-0.17	4.63	-16.68	12.80
TVL-Pog'	-6.47	5.66	-30.70	7.76
N-ANS	50.35	3.41	38.81	60.69
ANS-Me	61.49	5.61	44.82	78.31
N-Me	111.84	7.15	90.80	132.83
G'-Sn'	62.90	4.38	50.11	74.99
Sn'-Me'	65.58	6.06	48.66	86.92
G'-Me'	128.47	8.09	106.31	153.14
Co-Go	54.09	5.02	40.92	70.87
S-Go	72.04	6.11	59.89	91.52
Co-Gn	111.73	6.79	93.02	128.81
PP-U1	27.36	2.78	21.10	36.35
PP-Mic	21.86	2.36	16.16	27.21
MP-L1	38.38	3.47	27.80	49.51
MP-Mic	32.13	4.01	22.60	45.78
<i>Angular</i>				
Variable	Mean	Std Dev	Minimum	Maximum
Op°	8.83	3.50	0.00	18.00
SNA°	81.04	3.61	72.00	90.50
SNB°	78.35	4.75	67.00	92.00
ANB°	2.69	3.69	-8.00	11.00
G'-Sn-Pog'°	165.70	7.29	144.00	181.50
SN-MP°	31.66	6.58	17.00	49.00
Op-Sn°	18.17	4.66	7.00	31.50
Sn°	9.20	3.21	0.00	16.00
MP°	22.58	5.49	10.00	36.00
PP°	-1.39	3.17	-9.00	7.00
Go°	123.06	7.62	103.00	142.00
L1°	64.90	8.89	43.00	90.00
U1°	66.94	9.07	51.50	95.50
L1 - Op°	73.72	8.67	54.00	95.00
U1 - Op°	58.11	8.88	42.00	89.00
<i>Six Elements</i>				
Variable	Mean	Std Dev	Minimum	Maximum
II Mx	-3.99	3.09	-11.51	1.03
II Md	-3.83	4.22	-14.87	9.50
IV Mx Ant	-0.90	1.84	-5.25	3.26
IV Md Ant	32.24	3.76	20.32	42.24
V	1.40	1.70	-3.00	6.00

Descriptive statistics were used to determine the mean, standard deviation, minimum and maximum for each of the three anteroposterior groups (Class I, II, and III) (Table 7); the three anteroposterior (Category I, II and III) Six Elements groups (Table 8), the three facial soft tissue convexity groups (normal, concave, and convex) (Table 9) and the three vertical groups (normodivergent, hypodivergent, and hyperdivergent) (Table 10) measured relative to Op°, Pog'-GALL, Pog'c-GALL and Pog'-TVL.

Op° by Anteroposterior Skeletal Pattern (ANB)

Of the pooled sample (n=105) 58% (n=61) were Class I (ANB 0-5°), 27% (n=28) were Class II (ANB >5°) and 15% (n=16) were Class III (ANB < 0°). Descriptive statistics and results of ANOVA and comparison of means (Appendix B) are summarized in Table 7.

Table 7: Op° by ANB Anteroposterior Skeletal Classification

Class I (n=61)				Class II (n=28)				Class III (n=16)				ANOVA	I-II	I-III	II-III
Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Prob>F	p-Value	p-Value	p-Value
8.61	3.63	1.5	18	10.09	3.05	4	17	7.44	3.21	0	12.5	0.0393*	0.0617	0.2243	0.0151*

p-Value determined by Student's t-test.

* statistically significant at p < .05

The mean Op° for Class I, II and III subjects was $8.61^{\circ} \pm 3.63$, $10.09^{\circ} \pm 3.05$, and $7.44^{\circ} \pm 3.21$, respectively. A comparison of means revealed that there was not a statistically significant difference among Class I and II, nor Class I and III groups. However, there was a statistically significant difference between Class II and III groups ($p = 0.0151$) for the mean Op° (Fig. 16).

Figure 16: Mean occlusal plane inclination (°) by anteroposterior skeletal groups, * = Class III statistically significant from Class II at $p < 0.05$

Op° by Six Elements Anteroposterior Skeletal Pattern

Of the pooled sample (n=105) 38% (n=40) were Category I, 32% (n=34) were Category II and 30% (n=31) were Category III. Descriptive statistics and results of ANOVA (Appendix B) and comparison of means are summarized in Table 8.

Table 8: Mean Op° by Six Elements Anteroposterior Category

Category I (n=40)				Category II (n=34)				Category III (n=31)				ANOVA	I-II	I-III	II-III
Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Prob>F	p-Value	p-Value	p-Value
8.95	3.56	1.5	17	8.43	2.91	2	14	9.11	4.04	0	18	0.7087	0.5273	0.8448	0.4344

p-Value determined by Student's t-test.

* statistically significant at $p < .05$

The mean Op° for Class I, II and III Six Elements skeletal patterns was $8.95^\circ \pm 3.56$, $8.43^\circ \pm 2.91$, and $9.11^\circ \pm 4.04$, respectively. There were no significant differences among the groups (Fig. 17).

Fig. 17: Mean occlusal plane inclination (°) by Six Elements Skeletal Pattern.
No statistically significant differences among groups

Op° by Soft Tissue Facial Convexity

Of the pooled sample (n=105) 39% (n=41) were normal (G'-Sn'-Pog'° = 165 - 175°), 48% (n=50) were convex (G'-Sn'-Pog'° >175°) and 13% (n=14) were concave (G'-Sn'-Pog'° < 165°). Descriptive statistics, results of ANOVA and comparison of means (Appendix B) are summarized in Table 9.

Table 9: Mean Op° by Soft Tissue Convexity

Normal (N) (n=41)				Convex (Cx) (n=50)				Concave (Cv) (n=14)				ANOVA	N-Cx	N-Cv	Cx-Cv
Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Prob>F	p-Value	p-Value	p-Value
8.37	3.23	2.00	15.00	9.77	3.53	0.00	18.00	6.82	3.23	1.50	12.50	0.0103*	0.0516	0.1428	0.0048*

p-Value determined by Student's t-test.

* statistically significant at p < .05

The mean Op° for normal, convex and concave groups was $8.37^\circ \pm 3.20$, $9.77^\circ \pm 3.53$, and $6.82^\circ \pm 3.23$, respectively. A comparison of means demonstrated that there was no statistically significant difference between normal and convex profiles, or between normal and concave profiles. However, there was a statistically significant difference (p = 0.0048) in the mean Op° between the concave and convex groups (Fig. 18).

Figure 18: Mean occlusal plane inclination (°) by Soft Tissue Convexity.

* = concave statistically different from convex at p < 0.05

Op° by Vertical Dimension

Of the pooled sample (n=105) 55% (n=58) were normodivergent (SN-MP 20-32°), 28% (n=29) were hypodivergent (SN-MP <20°) and 21% (n=22) were hyperdivergent (SN-MP > 32°). Descriptive statistics and results of ANOVA and comparison of means (Appendix B) are summarized in Table 10.

Table 10: Mean Op° by Vertical Dimension

Normodivergent (N) (n=58)				Hypodivergent (Ho) (n=29)				Hyperdivergent (Hr) (n=22)				ANOVA	N-Ho	N-Hr	Ho-Hr
Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Prob>F	p-Value	p-Value	p-Value
8.88	3.20	2.00	18.00	6.78	3.36	0.00	14.00	11.41	2.62	5.50	17.00	<.0001*	0.0045*	0.0019*	<.0001*

p-Value determined by Student's t-test. * statistically significant at p < .05

The mean Op° for normodivergent, hypodivergent and hyperdivergent groups was 8.88° ± 3.20, 6.78° ± 3.36, and 11.41° ± 2.62, respectively. The results of the ANOVA and comparisons of means demonstrated that there was a statistically significant difference in mean Op° among all vertical groups (Fig. 19)

Figure 19: Mean occlusal plane inclination (°) by Vertical Skeletal Pattern.

* = all groups statistically different at p < 0.05

Correlational Analysis of Op° to Cephalometric Variables

Correlation coefficients between the linear, angular and Six Elements cephalometric variables are shown in Table 11. For a comprehensive report of all pairwise correlations for all cephalometric variables, refer to Appendix B.

Table 11: Correlation Coefficients related to the Occlusal Plane (Op°)

<u>Linear</u>					
Variable	By Variable	Correlation	Lower 95%	Upper 95%	Signif Prob
Pog-GALL	Op°	-0.4114	-0.559	-0.2386	<.0001*
Pog'-GALL	Op°	-0.4578	-0.5971	-0.2917	<.0001*
Pog'c-GALL	Op°	-0.4182	-0.5646	-0.2463	<.0001*
Pog'-TVL	Op°	-0.4166	-0.5633	-0.2445	<.0001*
N-ANS	Op°	0.1127	-0.0807	0.2979	0.2523
ANS-Me	Op°	-0.0281	-0.2186	0.1645	0.776
N-Me	Op°	0.0318	-0.1609	0.2221	0.7476
G'-Sn'	Op°	0.0839	-0.1096	0.2712	0.395
Sn'-Me'	Op°	-0.0474	-0.2369	0.1456	0.6311
G'-Me'	Op°	0.01	-0.1821	0.2012	0.9197
Co-Go	Op°	-0.3231	-0.4847	-0.1401	0.0008*
S-Go	Op°	-0.3825	-0.5349	-0.2059	<.0001*
Co-Gn	Op°	-0.2566	-0.4272	-0.0683	0.0082*
PP-U1	Op°	0.1914	-0.0002	0.3695	0.0504*
PP-Msc	Op°	-0.1304	-0.3143	0.0628	0.1847
MP-L1	Op°	-0.1789	-0.3582	0.0133	0.0679
Mp-Mic	Op°	0.1442	-0.0488	0.3268	0.1422
<u>Angular</u>					
Variable	By Variable	Correlation	Lower 95%	Upper 95%	Signif Prob
SNA°	Op°	-0.0354	-0.2255	0.1573	0.7199
SNB°	Op°	-0.2355	-0.4088	-0.046	0.0156*
ANB°	Op°	0.2684	0.0809	0.4375	0.0056*
G'-Sn-Pog'°	Op°	-0.3539	-0.5109	-0.1741	0.0002*
SN-MP°	Op°	0.4798	0.3174	0.6149	<.0001*
Op-Sn°	Op°	0.7245	0.6188	0.8045	<.0001*
Sn°	Op°	-0.0046	-0.1961	0.1873	0.9631
MP°	Op°	0.5626	0.4158	0.6809	<.0001*
PP°	Op°	0.3273	0.1447	0.4883	0.0007*
Go°	Op°	0.288	0.1019	0.4546	0.0029*
L1°	Op°	-0.259	-0.4294	-0.0709	0.0076*
U1°	Op°	0.2461	0.0571	0.418	0.0114*
L1 - Op°	Op°	0.1381	-0.055	0.3212	0.1601
U1 - Op°	Op°	-0.1427	-0.3254	0.0504	0.1466
<u>Six Elements</u>					
Variable	By Variable	Correlation	Lower 95%	Upper 95%	Signif Prob
II Mx	Op°	-0.2048	-0.3815	-0.0137	0.0361*
II Md	Op°	-0.0052	-0.1966	0.1867	0.9584
IV Mx Ant	Op°	0.4288	0.2584	0.5734	<.0001*
IV Md Ant	Op°	-0.1776	-0.3571	0.0145	0.0699
V	Op°	-0.1767	-0.3563	0.0155	0.0714

Linear Measurements:

The Op° demonstrated statistically significant negative correlations for several linear cephalometric variables (Table 11).

The Op° exhibits a highly statistically significant ($p < .0001$) negative correlation with all linear measures of pogonion; Pog-GALL($r = -0.4114$), Pog'-GALL ($r = -0.4578$), Pog'c-GALL ($r = 0.4182$), TVL – Pog' ($r = -0.4166$). There is a relationship between increased posterior distances of both soft tissue and hard tissue pogonion, measured relative to Andrew's GALL and Arnett's TVL, and steeper occlusal plane inclinations (Fig. 20).

Figure 20: Occlusal plane inclination plotted against measurements of the anteroposterior chin position (mm)

The Op° exhibits a statistically significant negative correlation with measures of posterior facial height (Table 11). Co-Go ($r = -0.3231$) was statistically significant with a p-Value of 0.0008. S-Go was statistically significant with a p-Value $< .0001$. Therefore, there is a relationship between shorter posterior facial heights and steeper occlusal plane inclinations.

The Op° is significantly correlated with mandibular length (Table 11). Co-Gn ($r = -0.2566$) was statistically significant with a p-Value equal to 0.0082. This relationship indicates that shorter mandibular lengths are associated with steeper occlusal plane inclinations.

Angular Measurements:

The Op° demonstrated statistically significant positive and negative correlations for several angular cephalometric variables (Table 11).

The Op° is negatively correlated with SNB ($r = -0.2355$, $p = 0.0156$) and positively correlated with ANB ($r = 0.2684$, $p = 0.0056$). This indicates that there is a relationship between more retrusive mandibles, measured relative to the cranial base, and steeper occlusal plane inclinations.

The Op° is negatively correlated with $G'-Sn'-Pog'$ ($r = -0.3539$, $p = 0.0002$). There is an association between subjects with convex facial profiles and steeper occlusal plane inclinations. Likewise, there is an association with concave profiles and flatter occlusal plane inclinations. See Fig. 21 below. This correlational association is in agreement with the comparison of Op° means by soft tissue facial convexity, convex is statistically different from concave (Table 9, Fig. 18).

Figure 21: Occlusal plane inclination ($^\circ$) plotted against soft tissue facial convexity ($^\circ$)

There is a highly statistically significant positive correlation between the Op° and SN- MP° ($r = 0.4798$, $p < .0001$) and MP° ($r = 0.5626$, $p < .0001$), (Table 11). This demonstrates a relationship between steeper mandibular plane and occlusal plane inclinations (Fig. 22). This corresponds with the findings evaluating the comparison of Op° mean by vertical facial pattern (normodivergent, hypodivergent, hypodivergent) discussed above (Table 10, Fig. 19).

Figure 22: Occlusal plane inclination plotted against Sella-Nasion to mandibular plane ($^\circ$)

The Op° demonstrates a statistically significant positive correlation with PP° ($r = 0.3273$, $p = 0.0007$), (Table 11). Therefore, there is a relationship between a steep palatal plane (ANS down in the front) and a steeper occlusal plane inclination.

There is a statistically significant positive correlation between the Op° and Go° ($r = 0.288$, $p = 0.0029$), (Table 11). There is an association between larger gonial angles and steeper occlusal planes. Likewise, there is an association between smaller gonial angles and flatter occlusal planes. Although, statistically significant, the correlation is weak.

The Op° demonstrates statistically significant correlations with incisor inclinations (Table 11). $U1^\circ$ ($r = .2461$, $p = 0.0114$) shows a weak positive correlation with the Op° . $U1^\circ$ is a measure of the maxillary central incisor inclination relative to TH. This indicates that the larger

the $U1^\circ$, the more retroclined the incisor; and the smaller the $U1^\circ$ the more proclined the incisor. Therefore, steeper occlusal planes are associated with greater retroclination of the maxillary incisors. $L1^\circ$ ($r = -0.259$, $p = 0.0076$) is negatively correlated with Op° . $L1^\circ$ is a measure of the mandibular central incisor inclination relative to TH. This indicates that the larger the $L1^\circ$, the more retroclined the lower incisor and vice versa. Therefore, there is an association between greater proclination of the lower incisors and steeper occlusal plane inclinations.

Six Elements Measurements:

The Op° demonstrates a statistically significant negative correlation with Element II Mx ($r = -0.2048$, $p = 0.0361$) and a positive correlation with Element IV Mx Ant ($r = 0.4288$, $p < .001$). A larger measure of Element IV Mx Ant indicates a greater amount of tooth display. Therefore, there is a moderate relationship between the amount of tooth display and the occlusal plane inclination.

The Element II Mx, although a measure of jaw position, is measured as a distance from a hypothetically positioned Element I maxillary central incisor's facial axis point relative to the GALL. The positioning of the Element I incisor is completed using the occlusal plane and the weak correlation may be explained as a confounding result of the measurement itself.

Stepwise Regression Analysis

The step-wise regression analysis (Appendix B) was performed to further evaluate the relationship between cephalometric variables and Op° . Op° was held as the dependent variable and the regression analysis resulted in the following equation:

$$Op^\circ = 5.232 + 0.277 (SN-MP^\circ) + 0.615 (PP^\circ) - 0.684 (IV \text{ Md Ant}) - 0.541 (PP-Msc) + 0.487 (PP-1) + 0.279 (Mp-Mic) + 0.207 (Sn'-Me') - 0.223 (SN^\circ) + 0.215 (IV \text{ Mx Ant}) - 0.037 (Co-Gn)$$

The $R^2 = 0.78$, which indicates that 78% of the variation in Op can be explained by changes in SN-MP, PP° , IV Md Ant, PP-Msc, PP-U1, MP-Mic, $Sn'-Me'$, SN° - IV Mx Ant, and Co-Gn. As Op° increases the following variables likewise increase; SN-MP, PP-U1, Mp-Mic, $Sn'-Me'$, and IV Mx Ant. As the Op° decreases IV Md Ant, PP-Msc, SN° , Co-Gn increases.

Pogonion prominence by AP Skeletal Pattern (ANB)

Within the pooled sample (n=105) 38% (n=40) were Category I, 32% (n=34) were Category II (ANB $>5^\circ$) and 30% (n=31) were Category III (ANB $<0^\circ$). Descriptive statistics, results of the ANOVA, and comparison of means (Appendix B) for all measures of the anteroposterior position of pogonion (Pog-GALL, Pog'-GALL, Pog'c-GALL, Pog'-TVL) are summarized in Table 12.

Table 12: Pogonion Prominence by Anteroposterior (ANB) Skeletal Pattern

	Class I (n=61)		Class II (n=28)		Class III (n=16)		ANOVA	I-II	I-III	II-III
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.	Prob>F	p-Value	p-Value	p-Value
Pog'-GALL	1.79	4.05	-2.18	4.86	5.05	4.32	<.0001*	0.0001*	0.0084*	<.0001*
Pog'c-GALL	0.46	4.21	-3.47	3.99	3.17	3.89	<.0001*	<.0001*	<.0001*	0.0206*
Pog'-TVL	-5.88	4.23	-10.87	5.34	-1.00	5.45	<.0001*	<.0001*	<.0001*	0.0004*
Pog-GALL	-9.50	4.86	-14.17	4.74	-4.71	6.52	<.0001*	<.0001*	0.0012*	0.0001*

p-Value determined by Student's t-test.

* statistically significant at $p < .05$

There were statistically significant differences among all groups, Class I, II and III, for all measurements of the pogonion prominence (Pog'-GALL, Pog'c-GALL, Pog'-TVL, Pog-GALL). Figure 23 demonstrates the mean Pog'c-GALL by Skeletal Class.

Figure 23: Mean Pog'c-GALL(mm) by Anteroposterior Skeletal Class

*Stastically significant differences detected between all groups

Pogonion prominence by Six Elements AP Skeletal Pattern

Within the pooled sample (n=105) 38% (n=40) were Category I, 32% (n=34) were Category II and 30% (n=31) were Category III. Descriptive statistics, results of the ANOVA, and comparison of means (Appendix B) for all measures of the anteroposterior position of pogonion are summarized in Table 13.

Table 13: Pogonion Prominence by Six Elements Anteroposterior Skeletal Pattern

Variable	Category I (n=40)		Category II (n=34)		Category III (n=31)		ANOVA	I-II	I-III	II-III
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Prob>F	p-Value	p-Value	p-Value
Pog'GALL	1.66	3.79	-1.89	4.99	4.08	4.11	<.0001	0.0006*	0.0211*	<.0001*
Pog'c-GALL	0.34	3.77	-3.11	4.35	2.38	4.26	<.0001*	0.0005*	0.0399*	<.0001*
Pog'-TVL	-6.60	4.41	-10.07	5.36	-2.36	4.69	0.0034	0.0026*	0.0004*	<.0001*
Pog-GALL	-9.74	3.38	-12.48	7.99	-7.67	4.76	<.0001	0.0394*	0.127	0.0008*

p-Value determined by Student's t-test. * statistically significant at $p < .05$

Statistically significant differences among all Six Elements AP categories were shown for Pog'GALL, Pog'c-GALL, and Pog'-TVL. For the measure Pog-GALL there were statistically significant differences between the category I and II groups, and category II and III groups. There was not a difference among category I and III groups for Pog-GALL. Figure 24 demonstrates the mean Pog'c-GALL by Six Element AP category.

Figure 24: Mean Pog'c-GALL (mm) by Six Element Anteroposterior Skeletal Category . *Statically significant differences detected between all groups

Pogonion prominence by Soft Tissue Convexity

Within the pooled sample (n=105) the distribution of soft tissue convexity resulted in 39% (n=41) normal ($G'-Sn'-Pog'^{\circ} = 165 - 175^{\circ}$), 48% (n=50) convex ($G'-Sn'-Pog'^{\circ} > 175^{\circ}$) and 13% (n=14) concave ($G'-Sn'-Pog'^{\circ} < 165^{\circ}$). Descriptive statistics, results of the ANOVA, and comparison of means (Appendix B) for all measures of the anteroposterior position of pogonion (Pog-GALL, Pog'-GALL, Pog'c-GALL, Pog'-TVL) are summarized in Table 14.

Table 14: Pogonion Prominence by Soft Tissue Convexity

<i>Variable</i>	Normal (N) (n=41)		Convex (Cx) (n=50)		Concave (Cv) (n=14)		ANOVA	N-Cx	N-Cv	Cx-Cv
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Prob>F	p-Value	p-Value	p-Value
Pog'GALL	2.65	3.54	-1.40	4.44	6.42	4.00	<.0001*	<.0001*	0.0033*	<.0001*
Pog'c-GALL	1.17	3.44	-2.57	4.20	4.42	4.23	<.0001*	<.0001*	0.0087*	<.0001*
Pog'-TVL	-4.45	3.03	-10.50	4.25	2.00	2.68	<.0001*	<.0001*	<.0001*	<.0001*
Pog-GALL	-8.66	5.22	-12.22	5.83	-6.12	5.02	0.0003*	0.0028*	0.1376	0.0004*

p-Value determined by Student's t-test.

* statistically significant at $p < .05$

Statistically significant differences among all groups of soft tissue facial convexity were shown for Pog'-GALL, Pog'c-GALL, and Pog'-TVL. There was a statistically significant difference between the normal and convex groups, and between the convex and concave groups for Pog-GALL. There was no difference between the normal and concave for Pog-GALL.

Figure 25 demonstrates the mean Pog'c-GALL by soft tissue convexity.

Figure 25: Mean Pog'c-GALL (mm) by Soft Tissue Convexity
*Statically significant differences detected between all groups

Pogonion prominence by Vertical Pattern

Within the pooled sample (n=105) the distribution of the vertical pattern resulted in 55% (n=58) normodivergent (SN-MP 20-32°), 28% (n=29) hypodivergent (SN-MP <20°) and 21% (n=22) hyperdivergent (SN-MP > 32°). Descriptive statistics, results of the ANOVA, and comparison of means (Appendix G) for all measures of the anteroposterior position of pogonion (Pog-GALL, Pog'-GALL, Pog'c-GALL, Pog'-TVL) are summarized in Table 15.

Table 15: Pogonion Prominence by Vertical Dimension

	Normodivergent		Hypodivergent		Hyperdivergent		ANOVA	N-Ho	N-Hr	Ho-Hr
	(N)		(Ho)		(Hr)					
	(n=58)		(n=29)		(n=22)					
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.	Prob>F	p-Value	p-Value	p-Value
Pog'GALL	1.04	4.37	3.55	4.07	-1.38	5.76	0.0011*	0.0197*	0.0409*	0.0003*
Pog'c-GALL	-0.35	4.33	1.02	4.35	-1.31	5.48	0.1896	0.1982	0.4111	0.0759
Pog'-TVL	-6.95	4.41	-3.37	5.02	-9.38	7.30	0.0004*	0.0041*	0.0721	0.0001*
Pog-GALL	-9.86	5.41	-7.74	5.93	-13.40	5.66	0.0024*	0.1028	0.0142*	0.0005*

p-Value determined by Student's t-test. * statistically significant at p < .05

There are significant differences among all the vertical groups for Pog'-GALL. There are significant differences between the normodivergent and hyperdivergent; and between the hypodivergent and hyperdivergent groups for Pog'-TVL. There was no difference between the normal and hyperdivergent groups for Pog'-TVL. There were no significant differences among any of the groups for Pog'-GALL (Fig. 26). The measure of hard tissue pogonion (Pog-Gall) showed differences between the normal and hyperdivergent groups and the hypo- and hyperdivergent groups.

Figure 26: Mean Pog'-GALL (mm) by Vertical Dimension
 *No differences were detected between the groups.

CHAPTER 5: Discussion

Overview

Historically, the occlusal plane has received much interest throughout the literature, which is substantiated by numerous publications relating it to craniofacial form ¹⁻³, craniofacial growth ⁴, masticatory function ^{5,6}, dental occlusion ^{7,8}, mechanotherapy ^{9,10}, orthognathic surgery ¹¹⁻¹⁵, and prosthodontic rehabilitation ²⁸. Studies have shown that the occlusal plane varies relative to skeletal form.^{18,1, 2, 17, 65,4} These studies attribute the vertical eruption of the dentition, and ultimately the resultant occlusal plane inclination, as a mechanism by which the dentoalveolar structure adapts or compensates for vertical and sagittal jaw discrepancies. Studies evaluating the skeletal variability in normal occlusions note the varying degrees of occlusal plane inclinations that exist.^{18, 66} Some argue that there is an ideal range for the inclination of the occlusal plane, and utilize these guidelines in orthognathic surgery treatment planning.²⁰ Furthermore, some advocate “normalizing” the occlusal plane in orthognathic surgery to attain ideal facial esthetics and adequate anteroposterior projection of soft tissue pogonion in certain facial types.^{11, 12, 38} In 1964, Schudy discussed the complex interaction between anteroposterior and vertical growth.⁶⁷ He writes, “Vertical growth is trying to carry pogonion downward while anteroposterior growth is attempting to carry it forward”.⁶⁷ He presented the pogonion formula to predict the anteroposterior position of pogonion. This measure relied on condylar growth, vertical growth of the maxilla, and vertical growth of both the maxillary and mandibular first molar. Despite the relevance of the occlusal plane to facial form, Andrews does not address it as a component within the Six Elements of Orofacial Harmony. Andrews advocates that there are “six characteristics (within dentistry’s milieu) that are essential for optimal orofacial health and appearance”²³. These six characteristics do not address the need for an optimal inclination for

the occlusal plane despite its influence on the spatial position of the chin. The need to surgically correct the inclination of the occlusal plane to achieve optimal facial harmony suggests that there is an optimal range of occlusal plane inclinations. Does an optimal range of occlusal plane inclinations exist?

The objective of this study was to systematically evaluate the inclination of the occlusal plane (Op°) relative to various skeletal and dental cephalometric parameters. A sample of 105 pretreatment cephalometric radiographs, in subjects with a range of skeletal and dental morphological characteristics, was appraised. Differences in the Op° and AP measurements of pogonion relative to the GALL were evaluated among the various anteroposterior, vertical, and soft tissue facial convexity groups were compared. Correlation coefficients evaluating relationships among the cephalometric measurements were calculated. A stepwise regression analysis was performed to further elucidate the variables which contribute to changes in the Op° .

Craniofacial reference planes relative to true horizontal

The mean occlusal plane inclination measured relative to a horizontal reference plane in the pooled study sample was $8.83^\circ \pm 3.5$ with a range of $0^\circ - 18^\circ$. Our study is in agreement with other studies reporting the average occlusal plane inclinations utilizing other methods to construct true horizontal and vertical reference planes.^{52, 68} Leitao and Nanda⁶⁸ reported the functional occlusal plane to a true vertical (FOP/VER) constructed with a bubble air device, with the patient in the natural head position, to be $98.32^\circ \pm 4.61$ with a range of $85.8 - 110.2^\circ$. When corrected as a measure relative to the horizontal (as opposed to the vertical) by subtracting 90° , the mean of 8.32° and a range from -4.2 to 20.2° agrees with our mean of 8.83° , but reports a larger range of inclinations than our study. Madsen et al⁵² reported a mean functional occlusal

plane measured relative to a true horizontal, constructed utilizing a plumb line in a sample of 57 patients, to be $-11.18^{\circ} \pm 5.27$ with a range of -1.11 to -23.82 . Their study designated an anticlockwise direction as negative with the patient facing left. Therefore, the study conducted by Madsen et al reported a similar range of occlusal plane inclinations in their sample but a steeper mean inclination.

The additional reference planes PP° , SN° and MP° in our study were also in close agreement with the aforementioned studies. Table 14 displays an overview of the craniofacial reference planes measured relative to true horizontal in this study compared to the previously reported studies by Leitao and Nanda⁶⁸ and Madsen et al.⁵² The values reported in the table were corrected for variations in measurements between the studies as described above.

Table 14: Comparison of studies reporting craniofacial reference planes measured relative to true horizontal

Variable	Eppard, et al				Leitao and Nanda ⁶⁸				Madsen et al. ⁵²			
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
Op°	8.83	3.50	0.00	18.00	8.32	4.61	-4.20	20.20	11.18	5.27	-1.11	23.87
PP°	-1.39	3.17	-9.00	7.00	0.48	4.38	-10.1	15.1	0.97	5.04	-9.77	13.37
SN°	9.20	3.21	0.00	16.00	8.19	4.45	22.50	6.50	5.19	5.13	-14.86	9.88
MP°	22.58	5.49	10.00	36.00	n/a	n/a	n/a	n/a	25.54	6.84	10.49	42.77

Measurements reported for Leitao and Nanda⁶⁸ and Madsen et al⁵² studies are corrected for variations in methods of measurements to more easily visualize similarities. Please refer to references for exact measurements reported by these studies.

The similarity between these studies support the validity and reproducibility of utilizing natural head position and a true vertical / horizontal reference planes from which to judge craniofacial characteristics. Furthermore, the similarity also supports the use of the FP gauge™ and FALL-DALL measurement to construct a true vertical reference plane. Future studies comparing the accuracy of the FALL-DALL measurement utilizing the FP gauge™ is warranted. However, the outlook for it to be an accurate measurement is positive.

Op° by Vertical Dimension

The occlusal plane inclination demonstrates a significant relationship with variations in the vertical dimension. Op° exhibited a statistically significant positive correlation with SN-MP° ($r = 0.4798$, $p < .0001$). When grouped relative to facial divergence (SN-MP°) there were statistically significant differences among all groups (normodivergent, hyperdivergent, and hypodivergent) for Op°. The mean Op° for hypodivergent, normodivergent, and hyperdivergent groups was $6.78^\circ \pm 3.36$, $8.88^\circ \pm 3.20$, , and $11.41^\circ \pm 2.62$, respectively. This indicates a steepening of the occlusal plane inclination with increasing facial divergence. This is in agreement with a study conducted by Anwar and Fida¹⁷ investigating skeletal and dental factors in subjects with various vertical skeletal patterns grouped by SN-MP. Their study reported that the mean SN-OP° likewise increased with facial divergence, and reported a statistically significant difference among the groups. There are no studies that have measured the occlusal plane inclination relative to a true horizontal and related to vertical skeletal dysplasias.

Op° demonstrated a statistically significant negative correlation for measurements of posterior facial height, S-Go° ($r = -0.3825$, $p < .0001$) and Co-Go° ($r = -0.3231$, $p = 0.0008$). However, there was no correlation between the occlusal plane inclination and measurements of anterior facial height. The exception was that the Element IV Mx Ant did demonstrate a statistically significant correlation with the Op°.

Anwar and Fida¹⁷ reported similar findings. They reported a significant negative correlation of SN-OP with posterior facial height (S-Go); but no correlation was noted with respect to lower anterior facial height or total anterior facial height.

Op° also demonstrated a positive correlation with the gonial angle (Go°) ($r = 0.288$, $p = 0.0029$). This does not agree with the findings of Anwar and Fida.¹⁷ In summary, the occlusal

plane inclination is closely associated with the vertical dimension. Steeper occlusal plane inclinations are associated with hyperdivergent profiles; whereas, flatter occlusal plane inclinations are associated with hypodivergent profiles.

Op° by Anteroposterior Skeletal Pattern

The occlusal plane inclination demonstrates a relationship with anteroposterior jaw relationships. The Op° exhibited statistically significant positive correlation with ANB ($r = 0.2684$, $p = 0.0056$) and a negative correlation with SNB ($r = -0.2355$, $p = 0.0156$). The mean Op° for Class I, II and III subjects categorized by ANB was $8.61^\circ \pm 3.63$, $10.09^\circ \pm 3.05$, and $7.44^\circ \pm 3.21$, respectively. This demonstrates a trend for the occlusal plane inclination to be steeper in skeletal Class II patients and flatter in skeletal Class III patients. However, Op° was found to only be statistically different between the Class II and Class III skeletal groups.

The findings that the occlusal plane inclination varies relative to the anteroposterior dimension are in agreement with several authors. Downs in 1949¹⁶ may have been the first to note that the occlusal plane has a tendency to be steep in the skeletal Class II profile and flatter in the skeletal Class III profile. Studies evaluating the variation in skeletal patterns among subjects with normal occlusion report the same tendencies. These studies individually report that normal Class I occlusions exist within a framework of an ANB that ranges from -3 to 8° . Each of these studies reports the tendency for flat occlusal planes in those with a Class III skeletal pattern and steep occlusal planes in those with Class II skeletal patterns.

One study evaluating the dentoalveolar factors that contribute to the skeletal Class II malocclusion, report the occlusal plane (SN-OP) and lower incisor position (L1-OP) to be the most likely compensating factors.⁶⁵ Ishikawa et al.² reported that the upper incisor inclination

(SN-U1), lower incisor inclination (SN-L1) and occlusal plane inclination (SN-OP) were important factors in dentoalveolar compensation comparing skeletal Class I and III subjects. These reports of variations in the occlusal plane inclination with different skeletal profiles are consistent with the findings of our study.

It is interesting to note that when the sample was grouped based on skeletal base differences according to the Six Elements approach, there were no statistically significant differences among the groups based on the anteroposterior dimension (Table 6, Fig. 17). The Six Elements approach is analogous to the Wits Appraisal³⁵ in that the inter-jaw relationships are measured along the occlusal plane. Del Santo⁶⁹ addresses the influence the occlusal plane has on the consistency or lack of consistency between assessments made using ANB and the Wits appraisal.⁶⁹ He reported an inconsistency between ANB and Wits in subjects with a high occlusal plane. Likewise, comparison of sagittal jaw relationships utilizing the ANB and the Six Elements method would demonstrate inconsistencies. It is also interesting to note that the occlusal plane had a stronger relationship with the vertical dimension. As an angular measurement, ANB, as the difference of SNA and SNB, is influenced by the vertical dimension, and thus exhibits a relationship with the occlusal plane, whereas the Six Elements method does not. Therefore, the rotational aspects of the jaws, due to the interaction of the vertical and anteroposterior dimension cannot be overlooked when evaluating craniofacial form. This further demonstrates the need for the incorporation of an optimal occlusal plane inclination in the Six Elements method of diagnosis and treatment planning.

Op° related to pogonion (Po°)

Soft tissue and hard tissue measurements of pogonion were made relative to the GALL. No studies have evaluated the distance of pogonion relative to the GALL. In addition, Andrews does not designate an optimal measurement of soft tissue pogonion to the GALL. The interaction between vertical and anteroposterior jaw relationships suggests that there is an association between the inclination of the occlusal plane and the position of pogonion relative to the GALL. In this study, Op° demonstrated a highly statistically significant negative correlation for all measurements of pogonion (Table 9). This indicates that steeper occlusal plane inclinations are associated with more posteriorly positioned pogonions relative to the GALL and TVL. Likewise, flatter occlusal plane inclinations are associated with a more anteriorly positioned pogonion relative to the GALL and TVL.

As one would expect, the measurement of the soft tissue pogonion relative to the GALL varies with the anteroposterior dimension measured by ANB (Table 10), the Six Elements method (Table 11) and soft tissue facial convexity (Table 12). Pog'-GALL was also different among all the groups based on the vertical dimension. The mean soft tissue pogonion measured relative to the GALL when corrected for the deviation in hard tissue pogonion from ideal (Element V) for the Class I sample was $0.46 \text{ mm} \pm 4.21$, for the Category I sample was $0.34 \text{ mm} \pm 3.77$, for the normal soft tissue convexity sample was $1.17 \text{ mm} \pm 3.44$ and for the normodivergent sample was $-0.35 \text{ mm} \pm 4.33$. These groups represent those that conform more to a balanced dentofacial profile. Therefore, we can assume an optimal soft tissue pogonion measured relative to the GALL may be $\pm 1 \text{ mm}$ to the GALL. Future studies using judgments of harmonious profiles are warranted to determine the optimal range for soft tissue pogonion measured relative to the GALL.

Op° Prediction

The strongest predictor of Op°, according to the results of the regression analysis, is SN-MP°, followed in descending order by PP°, Element IV Md Ant, PP-Msc, PP-1, Mp-Mic, Sn'-Me', SN°, Element IV Mx Ant and Co-Gn. This supports the basis that the occlusal plane inclination varies relative to both skeletal and dental factors. The occlusal plane steepens with increasing facial divergence (SN-MP). As Op° increases the following variables likewise increase; PP°, PP-U1, Mp-Mic, Sn'-Me', and IV Mx Ant. As the Op° decreases IV Md Ant, PP-Msc, SN°, Co-Gn increases.

Therefore, as the profile tends towards hyperdivergence, the occlusal plane, mandibular plane and palatal planes have the tendency to rotate in an anticlockwise direction; lower anterior facial height is larger, mandibular length is smaller, and there is increased dental eruption of the mandibular molar and greater maxillary tooth display of the maxillary incisor. Likewise, as the profile tends to be more hypodivergent, the occlusal plane, mandibular plane and palatal planes have the tendency to rotate in a clockwise direction; lower anterior facial height is smaller, mandibular length is larger, and there is an increased dental eruption of the maxillary molar, decreased eruption of the mandibular molar, increased eruption of the the mandibular incisor and less maxillary incisor tooth display.

Clinical Implications

The findings of the study demonstrate statistically significant correlations with various skeletal and dental parameters; however, the correlations are at best moderate to weak. This is evidence of the large variability in craniofacial form; and suggests that each patient be examined on an individual basis. This gives support to the use of the Six Elements of Orofacial Harmony as a method of diagnosis and treatment planning. The Six Elements approach produces a diagnosis based on each Element that is unique to the individual.

The findings also demonstrate that the occlusal plane inclination is a fundamental aspect of diagnosis and treatment planning for both combined orthodontic / orthopedic and orthodontic / orthognathic surgery. A report by Batwa et al. demonstrated that altering the occlusal plane inclination has an effect on smile attractiveness. Smiles with occlusal planes at 10° to the occlusal plane were deemed most attractive. The Op° in this study was significantly correlated with the inclination of the maxillary incisor. This suggests that changes in the occlusal plane induced by orthodontic biomechanics or during orthognathic surgical procedures should be properly evaluated to produce the most esthetic outcome.

In addition to the maxillary incisor inclination, alterations in the occlusal plane can have profound effects on the anteroposterior position of pogonion. Biomechanics which cause eruption of the molars in patients with hyperdivergent profiles will result in a downward and backward movement of pogonion and can worsen profile esthetics in patients with mandibular deficiency. It was discussed previously that Class I normal occlusions can exist in a range of skeletal profiles. Therefore, a patient presenting for orthognathic surgery with a steep occlusal plane inclination and mandibular retrognathia would require a flattening of the occlusal plane inclination to obtain an adequate AP projection of pogonion, without the need for an additional

genioplasty procedure. Despite the positive impact that a counterclockwise surgical procedure may have on the final esthetic outcome, long-term stability of these types of movements have not been documented in the literature.

CHAPTER 6: SUMMARY AND CONCLUSIONS

Summary

The objective of this study was to systematically evaluate the inclination of the occlusal plane (Op°) relative to various skeletal and dental cephalometric parameters. A sample of 105 pretreatment cephalometric radiographs, in subjects with a range of skeletal and dental morphological characteristics, was appraised. Differences in the Op° and AP measurements of pogonion relative to the GALL were evaluated among the various anteroposterior, vertical, and soft tissue facial convexity groups were compared. Correlation coefficients evaluating relationships among the cephalometric measurements were calculated. A stepwise regression analysis was performed to further elucidate the variables which contribute to changes in the Op° .

The following null hypotheses were rejected:

1. The inclination of the occlusal plane does not correlate with the AP relationship of the chin relative to the GALL.
2. The inclination of the occlusal plane does not correlate with the inclination of the maxillary incisor
3. The inclination of the occlusal plane does not correlate with the AP position of the jaws.
4. The inclination of the occlusal plane does not correlate with facial soft tissue convexity.
5. The inclination of the occlusal plane does not correlate with the vertical jaw dimension.

6. There are no predictive variables to determine the occlusal plane inclination.
7. There is no significant difference in the occlusal plane inclination among the three anteroposterior groups (Class II and Class III).
8. There is no significant difference in the occlusal plane inclination among the three vertical groups (normodivergent, hypodivergent, hyperdivergent).
9. There is no significant difference in the occlusal plane inclination among the three groups of soft tissue convexity (convex and concave).

The following null hypotheses were accepted:

1. There is no significant difference in the occlusal plane inclination among the three anteroposterior groups (Class I and II, Class I and III).
2. There is no significant difference in the occlusal plane inclination among the three groups of soft tissue convexity (convex and normal, concave and normal).

Conclusions

The results of this study lead to the following conclusions:

1. There is a strong relationship between the occlusal plane inclination and the vertical dimension. Hyperdivergent profiles tend to have steeper occlusal plane inclinations. Hypodivergent profiles tend to have flatter occlusal plane inclinations
2. There is a tendency towards steeper occlusal planes in Class II skeletal subjects and a flatter occlusal plane in Class III skeletal subjects.
3. There is a tendency towards steeper occlusal planes in subjects with convex profiles and flatter occlusal planes in patients with concave profiles.
4. The occlusal plane inclination is highly correlated with the measurement of soft tissue pogonion to the GALL.
5. There is a strong correlation between the occlusal plane inclination and maxillary incisor inclination.
6. The occlusal plane inclination should be considered when diagnosis and treatment planning to maximize dental and facial esthetics.

CHAPTER 7: SUGGESTIONS FOR FUTURE RESEARCH

The present study confirmed that the occlusal plane inclination is related to craniofacial form. The question of whether an optimal occlusal plane inclination exists remains unanswered. A study should be conducted that measures the occlusal plane inclination in a sample of patients that are judged to have harmonious profiles and normal dental occlusions. From such a sample the optimal range of occlusal plane inclinations can be obtained in addition to an optimal measurement of soft tissue pogonion relative to the GALL.

This study utilized the FP Gauge to TM assess the FALL-DALL judgment to construct a frontal reference plane. The accuracy and reliability of the FP GaugeTM as a measure of the frontal plane should be investigated.

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ABSTRACT

The occlusal plane inclination relative to craniofacial form: A cephalometric investigation

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Background Objectives: The occlusal plane has been given much attention throughout the orthodontic literature. Studies have shown that the occlusal plane inclination varies relative to vertical and sagittal skeletal discrepancies. The Six Elements of Orofacial Harmony does not address the occlusal plane inclination as a parameter in diagnosis and treatment planning despite its spatial influence on the position of the chin. The occlusal plane inclination is considered a critical factor in treatment planning for orthognathic surgery. The objective of this study was to systematically evaluate the inclination of the occlusal plane (Op°) relative to various skeletal and dental cephalometric parameters. **Methods:** A sample of 105 pretreatment cephalometric radiographs, in subjects with a range of skeletal and dental morphological characteristics, was appraised. Differences in the Op° and AP measurements of pogonion relative to the GALL were evaluated among the various anteroposterior, vertical, and soft tissue facial convexity groups were compared. Correlation coefficients evaluating relationships among the cephalometric measurements were calculated. A stepwise regression analysis was performed to further elucidate the variables which contribute to changes in the Op° . **Results:** The occlusal plane inclination was most significantly correlated with SN-MP $^\circ$, MP $^\circ$, Pog'GALL, Pog-GALL, Pogc'-GALL, TVL-Pog, and S-Go. The regression analysis indicated that SN-MP $^\circ$, PP $^\circ$, Element IV Md Ant, PP-Msc, PP-1, Mp-Mic, Sn'-Me', SN $^\circ$, Element IV Mx Ant and Co-Gn are good predictors of Op° . There were statistically significant differences among all vertical groups for the mean Op° . The mean Op° was found to differ among Class II and III skeletal profiles and convex and concave soft tissue facial convexities. **Conclusions:** Op° varies relative to sagittal and vertical jaw dimensions. There is a strong relationship between the occlusal plane inclination and the vertical dimension. Hyperdivergent profiles tend to have steeper occlusal plane inclinations. Hypodivergent profiles tend to have flatter occlusal plane inclinations. There is a tendency towards steeper occlusal planes in Class II skeletal subjects and a flatter occlusal plane in Class III skeletal subjects. There is a tendency towards steeper occlusal planes in subjects with convex profiles and flatter occlusal planes in patients with concave profiles. The occlusal plane inclination is highly correlated with the measurement of soft tissue pogonion to the GALL. There is a strong correlation between the occlusal plane inclination and maxillary incisor inclination. The occlusal plane inclination should be considered when diagnosis and treatment planning to maximize dental and facial esthetics.

APPENDICES

Appendix A – IRB Exemption

IRB PROTOCOL - Details

Tracking # H-23777
PI Ngan, Peter
Title The Relationship of the Occlusal Plane to Dental and Facial Harmony
Version 1
Status Exempt
Status Date 1/27/2012 4:01:41 PM
Board Board Gold
Meeting Date
Approval Date 01/27/2012
Expiration Date

Appendix B

Statistical Analyses by Age and Gender

G = < 18 years of age

NG = ≥ 18 years of age

Oneway Analysis of ANS-Me By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Mean	Lower 95%	Upper 95%
G	78	60.2878	5.22183	0.5913	59.110	59.110	61.465
NG	27	64.9537	5.31908	1.0237	62.850	62.850	67.058

t Test

NG-

Assuming unequal variance
 Difference 4.66588 t Ratio 3.946974
 Std Err Dif 1.18214 DF 44.5667
 Upper CL Di 7.04748 Prob > |t| 0.0003 *
 Lower CL Di 2.28429 Prob > t 0.0001 *
 Confidence 0.95 Prob < t 0.9999

Oneway Analysis of N-Me By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Mean	Lower 95%	Upper 95%
G	78	110.326	6.79927	0.7699	108.79	108.79	111.86
NG	27	116.194	6.42422	1.2363	113.65	113.65	118.74

t Test

NG-

Assuming unequal variance
 Difference 5.86803 t Ratio 4.029009
 Std Err Dif 1.45645 DF 47.6529
 Upper CL Di 8.79697 Prob > |t| 0.0002 *
 Lower CL Di 2.93910 Prob > t 0.0001 *
 Confidence 0.95 Prob < t 0.9999

Oneway Analysis of G'-Sn' By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	62.4574	4.66427	0.52812	61.406	63.509
NG	27	64.1656	3.19800	0.61546	62.900	65.431

t Test

NG-

Assuming unequal variance

Difference	1.70812	t Ratio	2.106223
Std Err Dif	0.81099	DF	66.25664
Upper CL Di	3.32719	Prob > t	0.0390 *
Lower CL Di	0.08905	Prob > t	0.0195 *
Confidence	0.95	Prob < t	0.9805

Oneway Analysis of Sn'-Me' By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	64.3099	5.59669	0.6337	63.048	65.572
NG	27	69.2363	5.94287	1.1437	66.885	71.587

t Test

NG-

Assuming unequal variance

Difference	4.92642	t Ratio	3.767727
Std Err Dif	1.30753	DF	43.04459
Upper CL Di	7.56324	Prob > t	0.0005 *
Lower CL Di	2.28961	Prob > t	0.0002 *
Confidence	0.95	Prob < t	0.9998

Oneway Analysis of Co-Go By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	52.8765	4.28531	0.4852	51.910	53.843
NG	27	57.5815	5.41008	1.0412	55.441	59.722

t Test

NG-

Assuming unequal variance

Difference	4.70494	t Ratio	4.095947
Std Err Dif	1.14868	DF	37.91602
Upper CL Di	7.03050	Prob > t	0.0002 *
Lower CL Di	2.37939	Prob > t	0.0001 *
Confidence	0.95	Prob < t	0.9999

Oneway Analysis of S-Go By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	70.4273	4.92731	0.5579	69.316	71.538
NG	27	76.6944	6.87201	1.3225	73.976	79.413

t Test

NG-

Assuming unequal variance

Difference	6.26714	t Ratio	4.366183
Std Err Dif	1.43538	DF	35.6956
Upper CL Di	9.17909	Prob > t	0.0001 *
Lower CL Di	3.35519	Prob > t	<.0001 *
Confidence	0.95	Prob < t	0.9999

Oneway Analysis of PP-1 By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
G	78	26.9647	2.62621	0.29736	26.373	27.557
NG	27	28.5081	2.92729	0.56336	27.350	29.666

t Test

NG-

Assuming unequal variance

Difference	1.54340	t Ratio	2.422853
Std Err Dif	0.63702	DF	41.42027
Upper CL Di	2.82950	Prob > t	0.0199 *
Lower CL Di	0.25731	Prob > t	0.0099 *
Confidence	0.95	Prob < t	0.9901

Oneway Analysis of PP-Mic By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
G	78	21.2164	2.19858	0.24894	20.721	21.712
NG	27	23.7181	1.75845	0.33841	23.023	24.414

t Test

NG-

Assuming unequal variance

Difference	2.50174	t Ratio	5.954906
Std Err Dif	0.42011	DF	56.19502
Upper CL Di	3.34326	Prob > t	<.0001 *
Lower CL Di	1.66021	Prob > t	<.0001 *
Confidence	0.95	Prob < t	1.0000

Oneway Analysis of Mp-Mic By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
G	78	31.2669	3.42332	0.38762	30.495	32.039
NG	27	34.6126	4.58352	0.88210	32.799	36.426

t Test

NG-

Assuming unequal variance

Difference	3.34567	t Ratio	3.472392
Std Err Dif	0.96351	DF	36.5501
Upper CL Di	5.29873	Prob > t	0.0013 *
Lower CL Di	1.39261	Prob > t	0.0007 *
Confidence	0.95	Prob < t	0.9993

Oneway Analysis of Pog'-GALL By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
G	78	0.96987	4.24522	0.4807	0.0127	1.9270
NG	27	1.96407	6.42398	1.2363	-0.5772	4.5053

t Test

NG-

Assuming unequal variance

Difference	0.9942	t Ratio	0.74952
Std Err Dif	1.3265	DF	34.19111
Upper CL Di	3.6893	Prob > t	0.4587
Lower CL Di	-1.7009	Prob > t	0.2293
Confidence	0.95	Prob < t	0.7707

Oneway Analysis of MP-L1 By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	37.7256	3.17851	0.35990	37.009	38.442
NG	27	40.2515	3.65450	0.70331	38.806	41.697

t Test

NG-

Assuming unequal variance

Difference	2.52584	t Ratio	3.19709
Std Err Dif	0.79004	DF	40.46239
Upper CL Di	4.12201	Prob > t	0.0027 *
Lower CL Di	0.92967	Prob > t	0.0013 *
Confidence	0.95	Prob < t	0.9987

Oneway Analysis of I° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	65.1538	7.9394	0.8990	63.364	66.944
NG	27	64.1481	11.3407	2.1825	59.662	68.634

t Test

NG-

Assuming unequal variance

Difference	-1.0057	t Ratio	-0.42607
Std Err Dif	2.3604	DF	35.22803
Upper CL Di	3.7851	Prob > t	0.6726
Lower CL Di	-5.7965	Prob > t	0.6637
Confidence	0.95	Prob < t	0.3363

Oneway Analysis of TVL-Pog' By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	-6.6873	4.96374	0.5620	-7.806	-5.568
NG	27	-5.8378	7.38872	1.4220	-8.761	-2.915

t Test

NG-

Assuming unequal variance

Difference	0.8495	t Ratio	0.55561
Std Err Dif	1.5290	DF	34.47414
Upper CL Di	3.9553	Prob > t	0.5821
Lower CL Di	-2.2562	Prob > t	0.2910
Confidence	0.95	Prob < t	0.7090

Oneway Analysis of Pog'c-GALL By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	-0.51731	4.29309	0.4861	-1.485	0.4506
NG	27	0.81593	5.45264	1.0494	-1.341	2.9729

t Test

NG-

Assuming unequal variance

Difference	1.3332	t Ratio	1.152836
Std Err Dif	1.1565	DF	37.76827
Upper CL Di	3.6749	Prob > t	0.2562
Lower CL Di	-1.0084	Prob > t	0.1281
Confidence	0.95	Prob < t	0.8719

Oneway Analysis of 1° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	66.9603	8.92267	1.0103	64.949	68.972
NG	27	66.8704	9.66217	1.8595	63.048	70.693

t Test

NG-

Assuming unequal variance

Difference	-0.0899	t Ratio	-0.04247
Std Err Dif	2.1162	DF	42.36915
Upper CL Di	4.1797	Prob > t	0.9663
Lower CL Di	-4.3595	Prob > t	0.5168
Confidence	0.95	Prob < t	0.4832

Oneway Analysis of Pog-GALL By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	-10.251	5.08090	0.5753	-11.40	-9.105
NG	27	-9.336	7.86442	1.5135	-12.45	-6.224

t Test

NG-

Assuming unequal variance

Difference	0.9150	t Ratio	0.565082
Std Err Dif	1.6192	DF	33.8175
Upper CL Di	4.2061	Prob > t	0.5757
Lower CL Di	-2.3762	Prob > t	0.2879
Confidence	0.95	Prob < t	0.7121

Oneway Analysis of SNB° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	78.4615	4.77396	0.54054	77.385	79.538
NG	27	78.0370	4.75137	0.91440	76.157	79.917

t Test

NG-

Assuming unequal variance

Difference	-0.4245	t Ratio	-0.39963
Std Err Dif	1.0622	DF	45.47165
Upper CL Di	1.7143	Prob > t	0.6913
Lower CL Di	-2.5633	Prob > t	0.6544
Confidence	0.95	Prob < t	0.3456

Oneway Analysis of G'-Sn-Pog° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	165.353	7.00098	0.7927	163.77	166.93
NG	27	166.685	8.13604	1.5658	163.47	169.90

t Test

NG-

Assuming unequal variance

Difference	1.3326	t Ratio	0.759325
Std Err Dif	1.7550	DF	40.14547
Upper CL Di	4.8792	Prob > t	0.4521
Lower CL Di	-2.2140	Prob > t	0.2260
Confidence	0.95	Prob < t	0.7740

Oneway Analysis of SNA° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	81.0064	3.43255	0.38866	80.232	81.780
NG	27	81.1296	4.15931	0.80046	79.484	82.775

t Test

NG-

Assuming unequal variance

Difference	0.1232	t Ratio	0.138476
Std Err Dif	0.8898	DF	38.97294
Upper CL Di	1.9231	Prob > t	0.8906
Lower CL Di	-1.6767	Prob > t	0.4453
Confidence	0.95	Prob < t	0.5547

Oneway Analysis of G'-Me' By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	126.767	7.66723	0.8681	125.04	128.50
NG	27	133.402	7.34244	1.4131	130.50	136.31

t Test

NG-

Assuming unequal variance

Difference	6.63454	t Ratio	4.000496
Std Err Dif	1.65843	DF	47.06764
Upper CL Di	9.97075	Prob > t	0.0002 *
Lower CL Di	3.29834	Prob > t	0.0001 *
Confidence	0.95	Prob < t	0.9999

Oneway Analysis of ANB° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	2.54487	3.54945	0.40190	1.7446	3.3451
NG	27	3.09259	4.11853	0.79261	1.4634	4.7218

t Test

NG-G

Assuming unequal variances

Difference	0.54777	t Ratio	0.616331
Std Err Dif	0.8887	DF	40.19098
Upper CL Dif	2.3435	Prob > t	0.5412
Lower CL Dif	-1.2481	Prob > t	0.2706
Confidence	0.95	Prob < t	0.7294

Oneway Analysis of Go° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	124.449	7.41514	0.8396	122.78	126.12
NG	27	119.056	6.87293	1.3227	116.34	121.77

t Test

NG-

Assuming unequal variance

Difference	-5.3932	t Ratio	-3.44244
Std Err Dif	1.5667	DF	48.51369
Upper CL Di	-2.2440	Prob > t	0.0012 *
Lower CL Di	-8.5423	Prob > t	0.9994
Confidence	0.95	Prob < t	0.0006 *

Oneway Analysis of SN-MP By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	32.1731	6.39441	0.7240	30.731	33.615
NG	27	30.1667	6.98900	1.3450	27.402	32.931

t Test

NG-

Assuming unequal variance

Difference	-2.0064	t Ratio	-1.31351
Std Err Dif	1.5275	DF	42.05819
Upper CL Di	1.0761	Prob > t	0.1961
Lower CL Di	-5.0890	Prob > t	0.9019
Confidence	0.95	Prob < t	0.0981

Oneway Analysis of MP° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	24.4551	11.8138	1.3377	21.792	27.119
NG	27	20.8519	5.5881	1.0754	18.641	23.062

t Test

NG-

Assuming unequal variance

Difference	-3.6033	t Ratio	-2.09938
Std Err Dif	1.7164	DF	93.2863
Upper CL Di	-0.1951	Prob > t	0.0385 *
Lower CL Di	-7.0115	Prob > t	0.9808
Confidence	0.95	Prob < t	0.0192 *

Oneway Analysis of PP° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	-1.1346	3.09867	0.35086	-1.833	-0.4360
NG	27	-2.1296	3.32702	0.64029	-3.446	-0.8135

t Test

NG-

Assuming unequal variance

Difference	-0.9950	t Ratio	-1.36282
Std Err Dif	0.7301	DF	42.65939
Upper CL Di	0.4777	Prob > t	0.1801
Lower CL Di	-2.4678	Prob > t	0.9100
Confidence	0.95	Prob < t	0.0900

Oneway Analysis of IV Md Ant By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	31.5037	3.49771	0.39604	30.715	32.292
NG	27	34.3789	3.72241	0.71638	32.906	35.851

t Test

NG-

Assuming unequal variance

Difference	2.87517	t Ratio	3.512467
Std Err Dif	0.81856	DF	42.96595
Upper CL Di	4.52600	Prob > t	0.0011 *
Lower CL Di	1.22435	Prob > t	0.0005 *
Confidence	0.95	Prob < t	0.9995

Oneway Analysis of IV Mx Ant By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	-0.8233	1.80911	0.20484	-1.231	-0.4154
NG	27	-1.1222	1.95724	0.37667	-1.896	-0.3480

t Test

NG-

Assuming unequal variance

Difference	-0.2989	t Ratio	-0.69709
Std Err Dif	0.4288	DF	42.40026
Upper CL Di	0.5662	Prob > t	0.4896
Lower CL Di	-1.1639	Prob > t	0.7552
Confidence	0.95	Prob < t	0.2448

Oneway Analysis of V By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	1.48718	1.61361	0.18271	1.1234	1.8510
NG	27	1.14815	1.93557	0.37250	0.3825	1.9138

t Test

NG-

Assuming unequal variance

Difference	-0.3390	t Ratio	-0.81715
Std Err Dif	0.4149	DF	39.24755
Upper CL Di	0.5000	Prob > t	0.4188
Lower CL Di	-1.1781	Prob > t	0.7906
Confidence	0.95	Prob < t	0.2094

Oneway Analysis of 1° - Op By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	57.5385	8.61960	0.9760	55.595	59.482
NG	27	59.7593	9.58100	1.8439	55.969	63.549

t Test

NG-

Assuming unequal variance

Difference	2.2208	t Ratio	1.064501
Std Err Dif	2.0862	DF	41.5095
Upper CL Di	6.4325	Prob > t	0.2933
Lower CL Di	-1.9909	Prob > t	0.1466
Confidence	0.95	Prob < t	0.8534

Oneway Analysis of 1° - Op By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	74.5756	7.8374	0.8874	72.809	76.343
NG	27	71.2593	10.4976	2.0203	67.107	75.412

t Test

NG-

Assuming unequal variance

Difference	-3.3164	t Ratio	-1.50296
Std Err Dif	2.2066	DF	36.54161
Upper CL Di	1.1564	Prob > t	0.1414
Lower CL Di	-7.7892	Prob > t	0.9293
Confidence	0.95	Prob < t	0.0707

Oneway Analysis of Op-Sn By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	18.5897	4.70061	0.53224	17.530	19.650
NG	27	16.9444	4.38163	0.84325	15.211	18.678

t Test

NG-

Assuming unequal variance

Difference	-1.6453	t Ratio	-1.64997
Std Err Dif	0.9972	DF	48.25653
Upper CL Di	0.3594	Prob > t	0.1054
Lower CL Di	-3.6500	Prob > t	0.9473
Confidence	0.95	Prob < t	0.0527

Oneway Analysis of Sn By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
G	78	9.05128	3.30838	0.37460	8.3054	9.797
NG	27	9.64815	2.93131	0.56413	8.4886	10.808

t Test

NG-

Assuming unequal variance

Difference	0.5969	t Ratio	0.881402
Std Err Dif	0.6772	DF	50.65805
Upper CL Di	1.9566	Prob > t	0.3823
Lower CL Di	-0.7628	Prob > t	0.1911
Confidence	0.95	Prob < t	0.8089

Oneway Analysis of Sn'-Me' By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	64.8278	5.16513	0.6407	63.548	66.108
M	40	66.7935	7.18581	1.1362	64.495	69.092

t Test

M-
Assuming unequal variance
Difference 1.9657 t Ratio 1.506995
Std Err Dif 1.3044 DF 63.81165
Upper CL Di 4.5715 Prob > |t| 0.1367
Lower CL Di -0.6402 Prob > t 0.0684
Confidence 0.95 Prob < t 0.9316

Oneway Analysis of SN-MP By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	32.1385	6.29702	0.7810	30.578	33.699
M	40	30.8750	7.01989	1.1099	28.630	33.120

t Test

M-
Assuming unequal variance
Difference -1.2635 t Ratio -0.93093
Std Err Dif 1.3572 DF 75.85244
Upper CL Di 1.4397 Prob > |t| 0.3548
Lower CL Di -3.9667 Prob > t 0.8226
Confidence 0.95 Prob < t 0.1774

Oneway Analysis of Op° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	8.63077	3.24191	0.40211	7.8275	9.434
M	40	9.14750	3.90411	0.61729	7.8989	10.396

t Test

M-
Assuming unequal variance
Difference 0.5167 t Ratio 0.701402
Std Err Dif 0.7367 DF 71.29718
Upper CL Di 1.9856 Prob > |t| 0.4853
Lower CL Di -0.9521 Prob > t 0.2427
Confidence 0.95 Prob < t 0.7573

Oneway Analysis of N-Me By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	110.565	6.01768	0.7464	109.07	112.06
M	40	113.899	8.36744	1.3230	111.22	116.58

t Test

M-
Assuming unequal variance
Difference 3.33402 t Ratio 2.194827
Std Err Dif 1.51904 DF 63.83649
Upper CL Di 6.36879 Prob > |t| 0.0318 *
Lower CL Di 0.29925 Prob > t 0.0159 *
Confidence 0.95 Prob < t 0.9841

Oneway Analysis of G-Me By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
F	65	127.092	6.53972	0.8112	125.47	128.71
M	40	130.718	9.80380	1.5501	127.58	133.85

t Test

M-

Assuming unequal variance

Difference	3.62560	t Ratio	2.072334
Std Err Dif	1.74952	DF	60.51761
Upper CL Di	7.12455	Prob > t	0.0425 *
Lower CL Di	0.12664	Prob > t	0.0213 *
Confidence	0.95	Prob < t	0.9787

Oneway Analysis of Op° By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
G	78	9.42179	3.39008	0.38385	8.6575	10.186
NG	27	7.11111	3.29140	0.63343	5.8091	8.413

t Test

NG-

Assuming unequal variance

Difference	-2.3107	t Ratio	-3.11977
Std Err Dif	0.7407	DF	46.48493
Upper CL Di	-0.8202	Prob > t	0.0031 *
Lower CL Di	-3.8011	Prob > t	0.9984
Confidence	0.95	Prob < t	0.0016 *

Oneway Analysis of Co-Gn By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
G	78	110.743	6.7867	0.7684	109.21	112.27
NG	27	107.170	28.2761	5.4417	95.98	118.36

t Test

NG-

Assuming unequal variance

Difference	-3.572	t Ratio	-0.65
Std Err Dif	5.496	DF	27.04364
Upper CL Di	7.703	Prob > t	0.5212
Lower CL Di	-14.848	Prob > t	0.7394
Confidence	0.95	Prob < t	0.2606

Oneway Analysis of II Mx By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
G	78	-4.2918	3.02996	0.34308	-4.975	-3.609
NG	27	-3.1044	3.15118	0.60645	-4.351	-1.858

t Test

NG-

Assuming unequal variance

Difference	1.1874	t Ratio	1.704098
Std Err Dif	0.6968	DF	43.79027
Upper CL Di	2.5918	Prob > t	0.0954
Lower CL Di	-0.2171	Prob > t	0.0477 *
Confidence	0.95	Prob < t	0.9523

Oneway Analysis of Pog-GALL By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	-8.690	5.70866	0.70807	-10.10	-7.28
M	40	-12.168	5.61025	0.88706	-13.96	-10.37

t Test

M-

Assuming unequal variance

Difference	-3.4775	t Ratio	-3.06389
Std Err Dif	1.1350	DF	83.80036
Upper CL Di	-1.2204	Prob > t	0.0029 *
Lower CL Di	-5.7347	Prob > t	0.9985
Confidence	0.95	Prob < t	0.0015 *

Oneway Analysis of TVL-Pog' By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	-5.3185	5.30525	0.65803	-6.63	-4.004
M	40	-8.3382	5.78228	0.91426	-10.19	-6.489

t Test

M-

Assuming unequal variance

Difference	-3.0198	t Ratio	-2.68081
Std Err Dif	1.1264	DF	77.24139
Upper CL Di	-0.7769	Prob > t	0.0090 *
Lower CL Di	-5.2627	Prob > t	0.9955
Confidence	0.95	Prob < t	0.0045 *

Oneway Analysis of Pog'c-GALL By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	0.9398	4.04564	0.50180	-0.063	1.942
M	40	-1.9852	4.98319	0.78791	-3.579	-0.392

t Test

M-

Assuming unequal variance

Difference	-2.9251	t Ratio	-3.13134
Std Err Dif	0.9341	DF	70.03262
Upper CL Di	-1.0620	Prob > t	0.0025 *
Lower CL Di	-4.7882	Prob > t	0.9987
Confidence	0.95	Prob < t	0.0013 *

Oneway Analysis of MP-L1 By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	37.5785	3.04438	0.37761	36.824	38.333
M	40	39.6698	3.76102	0.59467	38.467	40.873

t Test

M-F

Assuming unequal variances

Difference	2.09129	t Ratio	2.968772
Std Err Dif	0.70443	DF	69.86906
Upper CL Dif	3.49627	Prob > t	0.0041 *
Lower CL Dif	0.68630	Prob > t	0.0020 *
Confidence	0.95	Prob < t	0.9980

Oneway Analysis of 1° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	66.6369	9.23740	1.1458	64.348	68.926
M	40	67.4250	8.88859	1.4054	64.582	70.268

t Test

M-

Assuming unequal variance

Difference	0.7881	t Ratio	0.434617
Std Err Dif	1.8133	DF	85.14842
Upper CL Di	4.3932	Prob > t	0.6649
Lower CL Di	-2.8171	Prob > t	0.3325
Confidence	0.95	Prob < t	0.6675

Oneway Analysis of 1° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	65.4846	8.54079	1.0594	63.368	67.601
M	40	63.9375	9.45989	1.4957	60.912	66.963

t Test

M-

Assuming unequal variance

Difference	-1.5471	t Ratio	-0.84409
Std Err Dif	1.8329	DF	76.24796
Upper CL Di	2.1032	Prob > t	0.4013
Lower CL Di	-5.1974	Prob > t	0.7994
Confidence	0.95	Prob < t	0.2006

Oneway Analysis of Go° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	123.669	7.09824	0.8804	121.91	125.43
M	40	122.075	8.40905	1.3296	119.39	124.76

t Test

M-

Assuming unequal variance

Difference	-1.5942	t Ratio	-0.99973
Std Err Dif	1.5947	DF	72.23669
Upper CL Di	1.5845	Prob > t	0.3208
Lower CL Di	-4.7730	Prob > t	0.8396
Confidence	0.95	Prob < t	0.1604

Oneway Analysis of G°-Sn-Pog° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	166.938	7.26050	0.9006	165.14	168.74
M	40	163.675	6.96746	1.1017	161.45	165.90

t Test

M-

Assuming unequal variance

Difference	-3.2635	t Ratio	-2.29353
Std Err Dif	1.4229	DF	85.32089
Upper CL Di	-0.4345	Prob > t	0.0243 *
Lower CL Di	-6.0924	Prob > t	0.9879
Confidence	0.95	Prob < t	0.0121 *

Oneway Analysis of MP° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	22.6923	5.35001	0.66359	21.367	24.018
M	40	22.3875	5.76293	0.91120	20.544	24.231

t Test

M-

Assuming unequal variance

Difference	-0.3048	t Ratio	-0.27041
Std Err Dif	1.1272	DF	77.97288
Upper CL Di	1.9393	Prob > t	0.7876
Lower CL Di	-2.5489	Prob > t	0.6062
Confidence	0.95	Prob < t	0.3938

Oneway Analysis of SNA° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	80.8846	3.59336	0.44570	79.994	81.775
M	40	81.2875	3.67578	0.58119	80.112	82.463

t Test

M-

Assuming unequal variance

Difference	0.4029	t Ratio	0.550075
Std Err Dif	0.7324	DF	81.23846
Upper CL Di	1.8601	Prob > t	0.5838
Lower CL Di	-1.0543	Prob > t	0.2919
Confidence	0.95	Prob < t	0.7081

Oneway Analysis of SNB° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	78.6231	4.73850	0.58774	77.449	79.797
M	40	77.9125	4.79301	0.75784	76.380	79.445

t Test

M-

Assuming unequal variance

Difference	-0.7106	t Ratio	-0.74092
Std Err Dif	0.9590	DF	81.95605
Upper CL Di	1.1973	Prob > t	0.4609
Lower CL Di	-2.6184	Prob > t	0.7696
Confidence	0.95	Prob < t	0.2304

Oneway Analysis of ANB° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	2.26154	3.81517	0.47321	1.3162	3.2069
M	40	3.37500	3.41518	0.53999	2.2828	4.4672

t Test

M-

Assuming unequal variance

Difference	1.1135	t Ratio	1.550791
Std Err Dif	0.7180	DF	89.67459
Upper CL Di	2.5400	Prob > t	0.1245
Lower CL Di	-0.3130	Prob > t	0.0622
Confidence	0.95	Prob < t	0.9378

Oneway Analysis of PP° By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	-1.5462	3.23642	0.40143	-2.348	-0.7442
M	40	-1.1375	3.09049	0.48865	-2.126	-0.1491

t Test

M-

Assuming unequal variance

Difference	0.4087	t Ratio	0.646201
Std Err Dif	0.6324	DF	85.63532
Upper CL Di	1.6659	Prob > t	0.5199
Lower CL Di	-0.8486	Prob > t	0.2599
Confidence	0.95	Prob < t	0.7401

Oneway Analysis of II Mx By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	-3.5188	3.02396	0.37508	-4.268	-2.769
M	40	-4.7465	3.08348	0.48754	-5.733	-3.760

t Test

M-

Assuming unequal variance

Difference	-1.2277	t Ratio	-1.99591
Std Err Dif	0.6151	DF	81.44176
Upper CL Di	-0.0039	Prob > t	0.0493 *
Lower CL Di	-2.4515	Prob > t	0.9754
Confidence	0.95	Prob < t	0.0246 *

Oneway Analysis of IV Mx Ant By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	-0.7263	1.79184	0.22225	-1.170	-0.2823
M	40	-1.1828	1.91325	0.30251	-1.795	-0.5709

t Test

M-

Assuming unequal variance

Difference	-0.4564	t Ratio	-1.21595
Std Err Dif	0.3754	DF	78.52294
Upper CL Di	0.2908	Prob > t	0.2276
Lower CL Di	-1.2037	Prob > t	0.8862
Confidence	0.95	Prob < t	0.1138

Oneway Analysis of IV Md Ant By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	31.6246	3.49460	0.43345	30.759	32.491
M	40	33.2480	3.99116	0.63106	31.972	34.524

t Test

M-

Assuming unequal variance

Difference	1.62338	t Ratio	2.120459
Std Err Dif	0.76558	DF	74.38992
Upper CL Di	3.14871	Prob > t	0.0373 *
Lower CL Di	0.09806	Prob > t	0.0187 *
Confidence	0.95	Prob < t	0.9813

Oneway Analysis of V By Gender

Means and Std Deviations

				Std Err		
Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
F	65	1.11538	1.66247	0.20620	0.7034	1.5273
M	40	1.86250	1.67557	0.26493	1.3266	2.3984

t Test

M-

Assuming unequal variance

Difference	0.74712	t Ratio	2.225405
Std Err Dif	0.33572	DF	82.18566
Upper CL Di	1.41495	Prob > t	0.0288 *
Lower CL Di	0.07928	Prob > t	0.0144 *
Confidence	0.95	Prob < t	0.9856

Oneway Analysis of 1° - Op By Gender

Means and Std Deviations

				Std Err		
Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
F	65	58.0062	9.15061	1.1350	55.739	60.274
M	40	58.2775	8.54210	1.3506	55.546	61.009

t Test

M-

Assuming unequal variance

Difference	0.2713	t Ratio	0.153807
Std Err Dif	1.7642	DF	87.07119
Upper CL Di	3.7778	Prob > t	0.8781
Lower CL Di	-3.2351	Prob > t	0.4391
Confidence	0.95	Prob < t	0.5609

Oneway Analysis of 1° - Op By Gender

Means and Std Deviations

				Std Err		
Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
F	65	74.1154	8.38235	1.0397	72.038	76.192
M	40	73.0850	9.18788	1.4527	70.147	76.023

t Test

M-

Assuming unequal variance

Difference	-1.0304	t Ratio	-0.57678
Std Err Dif	1.7865	DF	76.89133
Upper CL Di	2.5270	Prob > t	0.5658
Lower CL Di	-4.5877	Prob > t	0.7171
Confidence	0.95	Prob < t	0.2829

Oneway Analysis of Op-Sn By Gender

Means and Std Deviations

				Std Err		
Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
F	65	18.2231	4.35624	0.54032	17.144	19.302
M	40	18.0750	5.16342	0.81641	16.424	19.726

t Test

M-

Assuming unequal variance

Difference	-0.1481	t Ratio	-0.15125
Std Err Dif	0.9790	DF	72.2062
Upper CL Di	1.8035	Prob > t	0.8802
Lower CL Di	-2.0996	Prob > t	0.5599
Confidence	0.95	Prob < t	0.4401

Oneway Analysis of Sn By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
F	65	9.50000	3.21981	0.39937	8.7022	10.298
M	40	8.72500	3.18238	0.50318	7.7072	9.743

t Test

M-

Assuming unequal variance

Difference	-0.7750	t Ratio	-1.2064
Std Err Dif	0.6424	DF	83.43577
Upper CL Di	0.5026	Prob > t	0.2311
Lower CL Di	-2.0526	Prob > t	0.8845
Confidence	0.95	Prob < t	0.1155

Oneway Analysis of Co-Gn By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
F	65	110.604	6.95960	0.86323	108.88	112.33
M	40	113.556	6.16900	0.97540	111.58	115.53

t Test

M-

Assuming unequal variance

Difference	2.95169	t Ratio	2.266122
Std Err Dif	1.30253	DF	90.27097
Upper CL Di	5.53929	Prob > t	0.0258 *
Lower CL Di	0.36409	Prob > t	0.0129 *
Confidence	0.95	Prob < t	0.9871

Oneway Analysis of Mp-Mic By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
F	65	31.3643	3.46354	0.42960	30.506	32.223
M	40	33.3670	4.54618	0.71881	31.913	34.821

t Test

M-

Assuming unequal variance

Difference	2.00269	t Ratio	2.391542
Std Err Dif	0.83741	DF	66.6542
Upper CL Di	3.67432	Prob > t	0.0196 *
Lower CL Di	0.33106	Prob > t	0.0098 *
Confidence	0.95	Prob < t	0.9902

Oneway Analysis of II Md By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
F	65	-2.9962	3.57107	0.44294	-3.881	-2.111
M	40	-5.1913	4.84274	0.76570	-6.740	-3.642

t Test

M-

Assuming unequal variance

Difference	-2.1951	t Ratio	-2.48149
Std Err Dif	0.8846	DF	65.03061
Upper CL Di	-0.4285	Prob > t	0.0157 *
Lower CL Di	-3.9617	Prob > t	0.9922 *
Confidence	0.95	Prob < t	0.0078 *

Oneway Analysis of Co-Go By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
F	65	53.2686	4.33841	0.53811	52.194	54.344
M	40	55.4153	5.77419	0.91298	53.569	57.262

t Test

M-

Assuming unequal variance

Difference	2.14663	t Ratio	2.02558
Std Err Dif	1.05976	DF	65.95337
Upper CL Di	4.26255	Prob > t	0.0469 *
Lower CL Di	0.03072	Prob > t	0.0234 *
Confidence	0.95	Prob < t	0.9766

Oneway Analysis of S-Go By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
F	65	71.0102	5.02174	0.6229	69.766	72.254
M	40	73.7105	7.32147	1.1576	71.369	76.052

t Test

M-

Assuming unequal variance

Difference	2.70035	t Ratio	2.054183
Std Err Dif	1.31456	DF	61.69906
Upper CL Di	5.32837	Prob > t	0.0442 *
Lower CL Di	0.07232	Prob > t	0.0221 *
Confidence	0.95	Prob < t	0.9779

Oneway Analysis of PP-1 By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
F	65	27.0789	2.54722	0.31594	26.448	27.710
M	40	27.8210	3.09155	0.48882	26.832	28.810

t Test

M-

Assuming unequal variance

Difference	0.7421	t Ratio	1.274974
Std Err Dif	0.5820	DF	70.85629
Upper CL Di	1.9027	Prob > t	0.2065
Lower CL Di	-0.4185	Prob > t	0.1032
Confidence	0.95	Prob < t	0.8968

Oneway Analysis of Pog'-GALL By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err		
				Mean	Lower 95%	Upper 95%
F	65	2.0552	4.32275	0.53617	0.984	3.1264
M	40	-0.1227	5.47041	0.86495	-1.872	1.6268

t Test

M-

Assuming unequal variance

Difference	-2.1780	t Ratio	-2.1402
Std Err Dif	1.0177	DF	68.56199
Upper CL Di	-0.1476	Prob > t	0.0359 *
Lower CL Di	-4.2084	Prob > t	0.9821
Confidence	0.95	Prob < t	0.0179 *

Oneway Analysis of N-ANS By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	49.6920	2.92810	0.36319	48.966	50.418
M	40	51.4133	3.89183	0.61535	50.169	52.658

t Test

M-F

Assuming unequal variances

Difference	1.72125	t Ratio	2.408904
Std Err Dif	0.71454	DF	66.02163
Upper CL Di	3.14786	Prob > t	0.0188*
Lower CL Di	0.29464	Prob > t	0.0094*
Confidence	0.95	Prob < t	0.9906

Oneway Analysis of PP-Mic By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	21.8751	2.21680	0.27496	21.326	22.424
M	40	21.8348	2.59969	0.41105	21.003	22.666

t Test

M-

Assuming unequal variance

Difference	-0.0403	t Ratio	-0.08155
Std Err Dif	0.4945	DF	72.82531
Upper CL Di	0.9453	Prob > t	0.9352
Lower CL Di	-1.0260	Prob > t	0.5324
Confidence	0.95	Prob < t	0.4676

Oneway Analysis of ANS-Me By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
F	65	60.8732	5.34133	0.66251	59.550	62.197
M	40	62.4860	5.95183	0.94107	60.583	64.389

t Test

M-

Assuming unequal variance

Difference	1.6128	t Ratio	1.401334
Std Err Dif	1.1509	DF	75.87977
Upper CL Di	3.9050	Prob > t	0.1652
Lower CL Di	-0.6795	Prob > t	0.0826
Confidence	0.95	Prob < t	0.9174

Oneway Analysis of N-ANS By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
G	78	50.0386	3.47227	0.39316	49.256	50.821
NG	27	51.2407	3.13443	0.60322	50.001	52.481

t Test

NG-

Assuming unequal variance

Difference	1.2022	t Ratio	1.669575
Std Err Dif	0.7200	DF	49.74971
Upper CL Di	2.6486	Prob > t	0.1013
Lower CL Di	-0.2443	Prob > t	0.0506
Confidence	0.95	Prob < t	0.9494

Oneway Analysis of G'-Sn' By Gender

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Mean	Lower 95%	Upper 95%
F	65	62.2643	3.96366	0.49163		61.282	63.246
M	40	63.9243	4.87243	0.77040		62.366	65.483

t Test

M-

Assuming unequal variance

Difference	1.6599	t Ratio	1.816325
Std Err Dif	0.9139	DF	70.14365
Upper CL Di	3.4826	Prob > t	0.0736
Lower CL Di	-0.1627	Prob > t	0.0368 *
Confidence	0.95	Prob < t	0.9632

Oneway Analysis of II Md By AGE

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Mean	Lower 95%	Upper 95%
G	78	-3.7473	3.99975	0.45288		-4.649	-2.846
NG	27	-4.0781	4.86775	0.93680		-6.004	-2.153

t Test

NG-

Assuming unequal variance

Difference	-0.3308	t Ratio	-0.31796
Std Err Dif	1.0405	DF	38.85647
Upper CL Di	1.7741	Prob > t	0.7522
Lower CL Di	-2.4358	Prob > t	0.6239
Confidence	0.95	Prob < t	0.3761

Appendix B– Measurement Reliability Coefficient

Reliability:

Multivariate Variable= II Mx Cronbach's α

Entire set α
0.9961

Excluded α
Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9931	10	0.9699	0.9984	<.0001*

Multivariate Variable=1° Cronbach's α

Entire set α Plot Alpha
0.9989

Excluded α Plot Alpha
Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9978	10	0.9903	0.9995	<.0001*

Multivariate Variable=1° - Op Cronbach's α

Entire set α Plot Alpha
0.9987

Excluded α Plot Alpha
Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9976	10	0.9894	0.9994	<.0001*

Multivariate Variable=1°-I °
Cronbach's α

Entire set α Plot Alpha
 0.9993

Excluded α Plot Alpha
Col
 First .
 Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9987	10	0.9942	0.9997	<.0001*

Multivariate Variable=ANB°
Cronbach's α

Entire set α Plot Alpha
 0.9787

Excluded α Plot Alpha
Col
 First .
 Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9588	10	0.8307	0.9905	<.0001*

Multivariate Variable=ANS-Me
Cronbach's α

Entire set α Plot Alpha
 0.9992

Excluded α Plot Alpha
Col
 First .
 Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9986	10	0.9939	0.9997	<.0001*

Multivariate Variable=Co-Gn
Cronbach's α

α Plot Alpha

Entire set 0.9973

Excluded α Plot Alpha

Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9947	10	0.9770	0.9988	<.0001*

Multivariate Variable=Co-Go

Cronbach's α

α Plot Alpha

Entire set 0.9945

Excluded α Plot Alpha

Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%
Second	First	0.9900	10	0.9569	0.9977

Multivariate Variable=G'-Me'

Cronbach's α

α Plot Alpha

Entire set 0.9992

Excluded α Plot Alpha

Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9985	10	0.9934	0.9997	<.0001*

Multivariate Variable=G'-Sn-Pog°

Cronbach's α

α Plot Alpha

Entire set 0.9964

Multivariate Variable=II Md Cronbach's α

Entire set α Plot Alpha 0.9943

Excluded α Plot Alpha
Col
First .

Multivariate Variable=Go°

Correlations

	First	Second
First	1.0000	0.9977
Second	0.9977	1.0000

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob												
Second	First	0.9977	10	0.9897	0.9995	<.0001 *												

Cronbach's α

Entire se α -0.8 -0.6 -0.4 -0.2 0 .2 .4 .6 .8 0.9988

Excluded α -0.8 -0.6 -0.4 -0.2 0 .2 .4 .6 .8
Col
First .
Second .

Excluded α Plot Alpha
Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%
Second	First	0.9953	10	0.9793	0.9989

Multivariate Variable=G'-Sn' Cronbach's α

Entire set α Plot Alpha 0.9974

Excluded α Plot Alpha
Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9955	10	0.9805	0.9990	<.0001 *

Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9963	10	0.9836	0.9991	<.0001*

Multivariate Variable=IV Md Ant Cronbach's α

Entire set α Plot Alpha 0.9956

Excluded α Plot Alpha

Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9914	10	0.9626	0.9980	<.0001*

Multivariate Variable=IV Mx Ant Cronbach's α

Entire set α Plot Alpha 0.9873

Excluded α Plot Alpha

Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9783	10	0.9081	0.9950	<.0001*

Multivariate Variable=MP-L1 Cronbach's α

Entire set α Plot Alpha 0.9944

Excluded α Plot Alpha

Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9888	10	0.9517	0.9974	<.0001*

Multivariate Variable=Mp-Mic Cronbach's α

	α Plot Alpha
Entire set	0.9932

Excluded Col	α Plot Alpha
First	.
Second	.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9877	10	0.9468	0.9972	<.0001*

Multivariate Variable=MP° Cronbach's α

	α Plot Alpha
Entire set	0.9982

Excluded Col	α Plot Alpha
First	.
Second	.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9987	10	0.9944	0.9997	<.0001*

Multivariate Variable=N-ANS Cronbach's α

	α Plot Alpha
Entire set	0.9973

Excluded Col	α Plot Alpha
First	.
Second	.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
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Second	First	0.9949	10	0.9779	0.9988	<.0001*
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Multivariate Variable=N-Me Cronbach's α

	α Plot Alpha
Entire set	0.9994

Excluded	α Plot Alpha
Col	
First	.
Second	.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9988	10	0.9948	0.9997	<.0001*

Multivariate Variable=Op-Sn Cronbach's α

	α Plot Alpha
Entire set	0.9821

Excluded	α Plot Alpha
Col	
First	.
Second	.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9758	10	0.8975	0.9944	<.0001*

Multivariate Variable=Op° Cronbach's α

	α Plot Alpha
Entire set	0.9912

Excluded	α Plot Alpha
Col	
First	.
Second	.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9859	10	0.9394	0.9968	<.0001*

Multivariate Variable=PFH:AFH
Cronbach's α

Entire set α Plot Alpha
 0.9945

Excluded α Plot Alpha
Col
 First .
 Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9892	10	0.9531	0.9975	<.0001*

Multivariate Variable=Pog-GALL
Cronbach's α

Entire set α Plot Alpha
 0.9968

Excluded α Plot Alpha
Col
 First .
 Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9960	10	0.9825	0.9991	<.0001*

Multivariate Variable=Pog'-GALL
Cronbach's α

Entire set α Plot Alpha
 0.9948

Excluded α Plot Alpha
Col
 First .
 Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9902	10	0.9574	0.9978	<.0001*

Multivariate Variable=Pog'c-GALL
Cronbach's α

α Plot Alpha

Entire set 0.9938

Excluded Col α Plot Alpha

First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9888	10	0.9515	0.9974	<.0001*

Multivariate Variable=PP-1
Cronbach's α

Entire set 0.9959

Excluded Col α Plot Alpha

First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9924	10	0.9668	0.9983	<.0001*

Multivariate Variable=PP-Mic
Cronbach's α

Entire set 0.9922

Excluded Col α Plot Alpha

First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9848	10	0.9348	0.9965	<.0001*

Multivariate Variable=PP°
Cronbach's α

Entire set 0.9964

**Excluded
Col**

First
Second

α Plot Alpha

.
 .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9930	10	0.9698	0.9984	<.0001*

**Multivariate Variable=S-Go
Cronbach's α**

α Plot Alpha

Entire set 0.9988

**Excluded
Col**

First
Second

α Plot Alpha

.
 .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9976	10	0.9893	0.9994	<.0001*

**Multivariate Variable=SN
Cronbach's α**

α Plot Alpha

Entire set 0.9958

**Excluded
Col**

First
Second

α Plot Alpha

.
 .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9931	10	0.9698	0.9984	<.0001*

**Multivariate Variable=SN-MP
Cronbach's α**

α Plot Alpha

Entire set 0.9980

**Excluded
Col**

First

α Plot Alpha

.

Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9963	10	0.9838	0.9992	<.0001*

Multivariate Variable=Sn'-Me' Cronbach's α

Entire set α Plot Alpha 0.9994

Excluded α Plot Alpha

Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9988	10	0.9947	0.9997	<.0001*

Multivariate Variable=SNA° Cronbach's α

Entire set α Plot Alpha 0.9841

Excluded α Plot Alpha

Col
First .
Second .

Pairwise Correlations

Multivariate Variable=SNB°

Cronbach's α

Entire set α Plot Alpha 0.9896

Excluded α Plot Alpha

Col
First .
Second .

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
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Second	First	0.9802	10	0.9159	0.9955	<.0001*
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Multivariate Variable=TVL-Pog'

Cronbach's α

	α Plot Alpha
Entire set	0.9935

Excluded Col

	α Plot Alpha
First	.
Second	.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9889	10	0.9521	0.9975	<.0001*

Multivariate Variable=V

Cronbach's α

	α Plot Alpha
Entire set	0.9796

Excluded Col

	α Plot Alpha
First	.
Second	.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9603	10	0.8364	0.9908	<.0001*

Multivariate Variable= $\bar{I}^\circ$

Cronbach's α

	α Plot Alpha
Entire set	0.9980

Excluded Col

	α Plot Alpha
First	.
Second	.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9963	10	0.9836	0.9991	<.0001*

Multivariate Variable= $\bar{I}^\circ$ - Op Cronbach's α

Entire set α Plot Alpha 0.9988

Excluded Col α Plot Alpha

First
Second

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Second	First	0.9975	10	0.9892	0.9994	<.0001*

Pairwise Correlation Coefficients for all measurements

Pairwise Correlations

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob
Go $^\circ$	ANS-Me	0.1913	105	-0.0004	0.3694	0.0506
Go $^\circ$	Co-Gn	0.1245	105	-0.0688	0.3088	0.2058
Go $^\circ$	Co-Go	-0.4256	105	-0.5707	-0.2547	<.0001*
Go $^\circ$	G'-Me'	0.0657	105	-0.1275	0.2542	0.5053
Go $^\circ$	G'-Sn'	-0.0609	105	-0.2496	0.1323	0.5373
Go $^\circ$	L1 $^\circ$	0.0808	105	-0.1126	0.2683	0.4124
Go $^\circ$	MP-L1	-0.0583	105	-0.2472	0.1349	0.5547
Go $^\circ$	Mp-Mic	-0.0508	105	-0.2401	0.1423	0.607
Go $^\circ$	N-ANS	-0.1579	105	-0.3393	0.0348	0.1077
Go $^\circ$	N-Me	0.0746	105	-0.1188	0.2625	0.4494
Go $^\circ$	Op $^\circ$	0.288	105	0.1019	0.4546	0.0029*
Go $^\circ$	PFH:AFH	-0.4578	105	-0.597	-0.2917	<.0001*
Go $^\circ$	Pog'c-GALL	0.156	105	-0.0368	0.3376	0.112
Go $^\circ$	Pog'-GALL	0.053	105	-0.14	0.2422	0.591
Go $^\circ$	Pog-GALL	-0.0144	105	-0.2055	0.1778	0.8842
Go $^\circ$	PP-Mic	-0.0172	105	-0.2082	0.175	0.8615

Go°	PP-U1	0.0479	105	-0.1451	0.2373	0.6278
Go°	S-Go	-0.3556	105	-0.5123	-0.1759	0.0002*
Go°	Sn'-Me'	0.1319	105	-0.0614	0.3156	0.18
Go°	TVL-Pog'	0.0983	105	-0.0952	0.2846	0.3187
Go°	U1°	-0.1872	105	-0.3657	0.0046	0.0558
II Mx	Go°	-0.1954	105	-0.3731	-0.0039	0.0457*
II Mx	ANB°	0.4552	105	0.2887	0.595	<.0001*
II Mx	ANS-Me	0.1376	105	-0.0555	0.3208	0.1616
II Mx	Co-Gn	-0.2169	105	-0.3923	-0.0263	0.0263*
II Mx	Co-Go	-0.0739	105	-0.2619	0.1194	0.4536
II Mx	G'-Me'	-0.0952	105	-0.2818	0.0982	0.3339
II Mx	G'-Sn'	-0.3012	105	-0.466	-0.1163	0.0018*
II Mx	G'-Sn-Pog'°	-0.4045	105	-0.5533	-0.2307	<.0001*
II Mx	L1 - Op°	-0.4529	105	-0.5931	-0.2861	<.0001*
II Mx	L1°	-0.3611	105	-0.5169	-0.182	0.0002*
II Mx	MP°	-0.1079	105	-0.2935	0.0856	0.2734
II Mx	MP-L1	0.0697	105	-0.1236	0.2579	0.4798
II Mx	Mp-Mic	0.0849	105	-0.1086	0.2721	0.3893
II Mx	N-ANS	-0.1248	105	-0.3091	0.0685	0.2045
II Mx	N-Me	0.0483	105	-0.1447	0.2377	0.6248
II Mx	Op°	-0.2048	105	-0.3815	-0.0137	0.0361*
II Mx	Op-Sn°	0.1796	105	-0.0125	0.3589	0.0668
II Mx	PFH:AFH	-0.0238	105	-0.2145	0.1686	0.8094
II Mx	Pog'c-GALL	0.1095	105	-0.0839	0.295	0.2661
II Mx	Pog'-GALL	0.0209	105	-0.1714	0.2117	0.8322
II Mx	Pog-GALL	0.1368	105	-0.0564	0.32	0.1642
II Mx	PP°	-0.4311	105	-0.5753	-0.261	<.0001*
II Mx	PP-Mic	0.1224	105	-0.0709	0.3069	0.2136
II Mx	PP-U1	0.3515	105	0.1714	0.5089	0.0002*
II Mx	S-Go	-0.0787	105	-0.2664	0.1147	0.4248
II Mx	Sn°	0.4864	105	0.325	0.6202	<.0001*
II Mx	SNA°	0.0794	105	-0.114	0.267	0.4206
II Mx	SNB°	-0.2934	105	-0.4593	-0.1078	0.0024*
II Mx	Sn'-Me'	0.0908	105	-0.1026	0.2777	0.3568
II Mx	SN-MP°	0.1524	105	-0.0405	0.3343	0.1207
II Mx	TVL-Pog'	-0.2681	105	-0.4373	-0.0805	0.0057
II Mx	U1 - Op°	0.1489	105	-0.0441	0.3311	0.1296
II Mx	U1°	0.0668	105	-0.1265	0.2552	0.4986
ANB°	Go°	-0.1759	105	-0.3555	0.0164	0.0728
ANB°	ANS-Me	0.1341	105	-0.0591	0.3176	0.1726
ANB°	Co-Gn	-0.2969	105	-0.4623	-0.1116	0.0021*
ANB°	Co-Go	-0.0138	105	-0.2049	0.1784	0.8892
ANB°	G'-Me'	0.1592	105	-0.0335	0.3404	0.1049

ANB°	G'-Sn'	0.071	105	-0.1224	0.2591	0.4718
ANB°	G'-Sn-Pog'°	-0.6751	105	-0.7675	-0.5553	<.0001*
ANB°	L1°	-0.4846	105	-0.6188	-0.3229	<.0001*
ANB°	MP°	0.1318	105	-0.0614	0.3155	0.1802
ANB°	MP-L1	0.2295	105	0.0395	0.4034	0.0185*
ANB°	Mp-Mic	0.278	105	0.0912	0.4459	0.0041*
ANB°	N-ANS	0.2068	105	0.0157	0.3832	0.0343*
ANB°	N-Me	0.2038	105	0.0126	0.3806	0.037*
ANB°	Op°	0.2684	105	0.0809	0.4375	0.0056*
ANB°	PFH:AFH	-0.1853	105	-0.364	0.0066	0.0585
ANB°	Pog'c-GALL	-0.5346	105	-0.6587	-0.3821	<.0001*
ANB°	Pog'-GALL	-0.5726	105	-0.6887	-0.428	<.0001*
ANB°	Pog-GALL	-0.618	105	-0.7239	-0.4837	<.0001*
ANB°	PP-Mic	0.1246	105	-0.0687	0.3089	0.2052
ANB°	PP-U1	0.4722	105	0.3085	0.6088	<.0001*
ANB°	S-Go	-0.0339	105	-0.2241	0.1588	0.7315
ANB°	SNA°	0.1547	105	-0.0381	0.3364	0.1152
ANB°	SNB°	-0.6596	105	-0.7558	-0.5357	<.0001*
ANB°	Sn'-Me'	0.1612	105	-0.0314	0.3423	0.1003
ANB°	TVL-Pog'	-0.6658	105	-0.7604	-0.5434	<.0001*
ANB°	U1°	0.3639	105	0.1852	0.5194	0.0001*
ANS-Me	N-ANS	0.2105	105	0.0197	0.3866	0.0311*
ANS-Me	Op°	-0.0281	105	-0.2186	0.1645	0.776
ANS-Me	Pog'c-GALL	-0.007	105	-0.1984	0.1849	0.9435
ANS-Me	Pog'-GALL	-0.0828	105	-0.2702	0.1106	0.4009
ANS-Me	Pog-GALL	-0.2565	105	-0.4272	-0.0682	0.0083*
ANS-Me	TVL-Pog'	-0.0691	105	-0.2573	0.1242	0.4838
Co-Gn	ANS-Me	0.5219	105	0.367	0.6487	<.0001*
Co-Gn	Co-Go	0.6436	105	0.5156	0.7436	<.0001*
Co-Gn	G'-Me'	0.5916	105	0.451	0.7035	<.0001*
Co-Gn	G'-Sn'	0.3813	105	0.2046	0.534	<.0001*
Co-Gn	N-ANS	0.2615	105	0.0735	0.4315	0.0071*
Co-Gn	N-Me	0.534	105	0.3813	0.6583	<.0001*
Co-Gn	Op°	-0.2566	105	-0.4272	-0.0683	0.0082*
Co-Gn	Pog'c-GALL	0.3167	105	0.1331	0.4793	0.001*
Co-Gn	Pog'-GALL	0.3822	105	0.2056	0.5347	<.0001*
Co-Gn	Pog-GALL	0.104	105	-0.0895	0.2899	0.2912
Co-Gn	S-Go	0.5629	105	0.4162	0.6811	<.0001*
Co-Gn	Sn'-Me'	0.5142	105	0.3578	0.6426	<.0001*
Co-Gn	TVL-Pog'	0.4016	105	0.2275	0.5509	<.0001*
Co-Go	ANS-Me	0.3108	105	0.1267	0.4742	0.0013*
Co-Go	G'-Me'	0.4934	105	0.3332	0.6258	<.0001*
Co-Go	G'-Sn'	0.4678	105	0.3033	0.6052	<.0001*

Co-Go	N-ANS	0.4263	105	0.2555	0.5713	<.0001*
Co-Go	N-Me	0.4471	105	0.2794	0.5884	<.0001*
Co-Go	Op°	-0.3231	105	-0.4847	-0.1401	0.0008*
Co-Go	Pog'c-GALL	-0.0449	105	-0.2346	0.148	0.6491
Co-Go	Pog'-GALL	0.0557	105	-0.1374	0.2448	0.5724
Co-Go	Pog-GALL	-0.0344	105	-0.2246	0.1583	0.7273
Co-Go	Sn'-Me'	0.3205	105	0.1372	0.4825	0.0009*
Co-Go	TVL-Pog'	0.0582	105	-0.135	0.2471	0.5554
G'-Me'	ANS-Me	0.7904	105	0.7057	0.8529	<.0001*
G'-Me'	G'-Sn'	0.6766	105	0.5572	0.7686	<.0001*
G'-Me'	N-ANS	0.5404	105	0.3891	0.6634	<.0001*
G'-Me'	N-Me	0.8776	105	0.8247	0.9153	<.0001*
G'-Me'	Op°	0.01	105	-0.1821	0.2012	0.9197
G'-Me'	Pog'c-GALL	-0.0931	105	-0.2798	0.1004	0.345
G'-Me'	Pog'-GALL	-0.1452	105	-0.3277	0.0478	0.1396
G'-Me'	Pog-GALL	-0.3576	105	-0.514	-0.1781	0.0002*
G'-Me'	Sn'-Me'	0.8461	105	0.7811	0.893	<.0001*
G'-Me'	TVL-Pog'	-0.1158	105	-0.3008	0.0776	0.2394
G'-Sn'	ANS-Me	0.2195	105	0.029	0.3945	0.0245*
G'-Sn'	N-ANS	0.6926	105	0.5777	0.7807	<.0001*
G'-Sn'	N-Me	0.5027	105	0.3442	0.6333	<.0001*
G'-Sn'	Op°	0.0839	105	-0.1096	0.2712	0.395
G'-Sn'	Pog'c-GALL	-0.2241	105	-0.3987	-0.0339	0.0215*
G'-Sn'	Pog'-GALL	-0.1907	105	-0.3689	0.001	0.0514
G'-Sn'	Pog-GALL	-0.2552	105	-0.426	-0.0668	0.0086*
G'-Sn'	TVL-Pog'	-0.1469	105	-0.3293	0.046	0.1347
G'-Sn-Pog'°	Go°	0.1311	105	-0.0621	0.3148	0.1826
G'-Sn-Pog'°	ANS-Me	0.0549	105	-0.1382	0.244	0.5782
G'-Sn-Pog'°	Co-Gn	0.3996	105	0.2252	0.5492	<.0001*
G'-Sn-Pog'°	Co-Go	0.0865	105	-0.1069	0.2736	0.3803
G'-Sn-Pog'°	G'-Me'	0.0066	105	-0.1853	0.198	0.9465
G'-Sn-Pog'°	G'-Sn'	-0.0988	105	-0.2851	0.0947	0.316
G'-Sn-Pog'°	L1°	0.5301	105	0.3767	0.6552	<.0001*
G'-Sn-Pog'°	MP-L1	-0.0688	105	-0.257	0.1245	0.4858
G'-Sn-Pog'°	Mp-Mic	-0.1981	105	-0.3755	-0.0067	0.0428*
G'-Sn-Pog'°	N-ANS	-0.3109	105	-0.4743	-0.1268	0.0012*
G'-Sn-Pog'°	N-Me	-0.1054	105	-0.2912	0.088	0.2846
G'-Sn-Pog'°	Op°	-0.3539	105	-0.5109	-0.1741	0.0002*
G'-Sn-Pog'°	PFH:AFH	0.2008	105	0.0095	0.3779	0.04*
G'-Sn-Pog'°	Pog'c-GALL	0.6383	105	0.5089	0.7395	<.0001*
G'-Sn-Pog'°	Pog'-GALL	0.691	105	0.5756	0.7795	<.0001*
G'-Sn-Pog'°	Pog-GALL	0.4757	105	0.3126	0.6116	<.0001*
G'-Sn-Pog'°	PP-Mic	0.0907	105	-0.1028	0.2775	0.3576

G'-Sn-Pog [°]	PP-U1	-0.2826	105	-0.4499	-0.0961	0.0035*
G'-Sn-Pog [°]	S-Go	0.1824	105	-0.0096	0.3615	0.0625
G'-Sn-Pog [°]	Sn'-Me'	0.0804	105	-0.113	0.2679	0.415
G'-Sn-Pog [°]	TVL-Pog'	0.8854	105	0.8355	0.9208	<.0001*
G'-Sn-Pog [°]	U1°	-0.1775	105	-0.357	0.0147	0.0701
II Md	Go°	0.2334	105	0.0437	0.4069	0.0166*
II Md	II Mx	0.1357	105	-0.0575	0.319	0.1676
II Md	ANB°	-0.4577	105	-0.597	-0.2917	<.0001*
II Md	ANS-Me	-0.054	105	-0.2432	0.1391	0.5842
II Md	Co-Gn	0.1837	105	-0.0083	0.3626	0.0607
II Md	Co-Go	-0.2374	105	-0.4104	-0.0479	0.0148*
II Md	G'-Me'	-0.2384	105	-0.4113	-0.049	0.0143*
II Md	G'-Sn'	-0.255	105	-0.4258	-0.0666	0.0087*
II Md	G'-Sn-Pog [°]	0.3676	105	0.1893	0.5225	0.0001*
II Md	L1 - Op°	0.3791	105	0.2021	0.5321	<.0001*
II Md	L1°	0.3717	105	0.1939	0.5259	<.0001*
II Md	MP°	0.0793	105	-0.1141	0.2669	0.4213
II Md	MP-L1	-0.2846	105	-0.4517	-0.0983	0.0033*
II Md	Mp-Mic	-0.2086	105	-0.3849	-0.0176	0.0327*
II Md	N-ANS	-0.2157	105	-0.3912	-0.0251	0.0271*
II Md	N-Me	-0.1453	105	-0.3278	0.0477	0.1391
II Md	Op°	-0.0052	105	-0.1966	0.1867	0.9584
II Md	Op-Sn°	-0.0566	105	-0.2456	0.1365	0.5661
II Md	PFH:AFH	-0.0218	105	-0.2126	0.1706	0.8252
II Md	Pog'c-GALL	0.705	105	0.5936	0.7899	<.0001*
II Md	Pog'-GALL	0.6886	105	0.5725	0.7776	<.0001*
II Md	Pog-GALL	0.5949	105	0.4552	0.7061	<.0001*
II Md	PP°	0.1612	105	-0.0315	0.3423	0.1005
II Md	PP-Mic	-0.0739	105	-0.2618	0.1195	0.4539
II Md	PP-U1	-0.2999	105	-0.4649	-0.1149	0.0019*
II Md	S-Go	-0.1922	105	-0.3702	-0.0005	0.0495*
II Md	Sn°	-0.0501	105	-0.2394	0.143	0.612
II Md	SNA°	0.1405	105	-0.0526	0.3235	0.1528
II Md	SNB°	0.4627	105	0.2974	0.6011	<.0001*
II Md	Sn'-Me'	-0.1339	105	-0.3174	0.0593	0.1732
II Md	SN-MP°	0.0443	105	-0.1486	0.234	0.6537
II Md	TVL-Pog'	0.5396	105	0.3881	0.6627	<.0001*
II Md	U1 - Op°	-0.2192	105	-0.3943	-0.0287	0.0247*
II Md	U1°	-0.2166	105	-0.392	-0.0261	0.0264*
IV Md Ant	Go°	0.105	105	-0.0885	0.2908	0.2865
IV Md Ant	II Mx	0.0977	105	-0.0958	0.284	0.3214
IV Md Ant	ANB°	0.0687	105	-0.1246	0.257	0.486
IV Md Ant	ANS-Me	0.9053	105	0.8635	0.9348	<.0001*

IV Md Ant	Co-Gn	0.6016	105	0.4633	0.7112	<.0001*
IV Md Ant	Co-Go	0.4157	105	0.2434	0.5625	<.0001*
IV Md Ant	G'-Me'	0.8052	105	0.7255	0.8636	<.0001*
IV Md Ant	G'-Sn'	0.3369	105	0.1553	0.4965	0.0004*
IV Md Ant	G'-Sn-Pog'°	0.0842	105	-0.1092	0.2715	0.3932
IV Md Ant	II Md	-0.0312	105	-0.2216	0.1614	0.7519
IV Md Ant	IV Mx Ant	-0.0508	105	-0.2401	0.1423	0.6071
IV Md Ant	L1 - Op°	-0.2683	105	-0.4375	-0.0808	0.0057*
IV Md Ant	L1°	-0.1917	105	-0.3698	0	0.0501
IV Md Ant	MP°	0.3418	105	0.1607	0.5007	0.0004*
IV Md Ant	MP-L1	0.7973	105	0.7148	0.8579	<.0001*
IV Md Ant	Mp-Mic	0.7917	105	0.7073	0.8538	<.0001*
IV Md Ant	N-ANS	0.3453	105	0.1645	0.5036	0.0003*
IV Md Ant	N-Me	0.8746	105	0.8204	0.9132	<.0001*
IV Md Ant	Op°	-0.1776	105	-0.3571	0.0145	0.0699
IV Md Ant	Op-Sn°	-0.0861	105	-0.2733	0.1073	0.3824
IV Md Ant	PFH:AFH	-0.107	105	-0.2927	0.0864	0.2773
IV Md Ant	Pog'c-GALL	0.0547	105	-0.1384	0.2438	0.5797
IV Md Ant	Pog'-GALL	-0.0196	105	-0.2105	0.1727	0.8429
IV Md Ant	Pog-GALL	-0.2095	105	-0.3857	-0.0186	0.032*
IV Md Ant	PP°	-0.0849	105	-0.2721	0.1086	0.3893
IV Md Ant	PP-Mic	0.6225	105	0.4892	0.7274	<.0001*
IV Md Ant	PP-U1	0.4722	105	0.3084	0.6088	<.0001*
IV Md Ant	S-Go	0.516	105	0.3599	0.6439	<.0001*
IV Md Ant	Sn°	0.0325	105	-0.1602	0.2228	0.7421
IV Md Ant	SNA°	-0.0052	105	-0.1966	0.1867	0.9583
IV Md Ant	SNB°	-0.0574	105	-0.2463	0.1358	0.5611
IV Md Ant	Sn'-Me'	0.8317	105	0.7614	0.8827	<.0001*
IV Md Ant	SN-MP°	0.3007	105	0.1157	0.4655	0.0018*
IV Md Ant	TVL-Pog'	-0.0252	105	-0.2158	0.1673	0.7986
IV Md Ant	U1 - Op°	-0.004	105	-0.1955	0.1878	0.9677
IV Md Ant	U1°	-0.0724	105	-0.2605	0.1209	0.4627
IV Mx Ant	Go°	0.1813	105	-0.0107	0.3604	0.0642
IV Mx Ant	II Mx	-0.0392	105	-0.2291	0.1537	0.6916
IV Mx Ant	ANB°	0.0354	105	-0.1574	0.2255	0.7203
IV Mx Ant	ANS-Me	0.1288	105	-0.0644	0.3128	0.1903
IV Mx Ant	Co-Gn	-0.1177	105	-0.3025	0.0757	0.232
IV Mx Ant	Co-Go	-0.2417	105	-0.4142	-0.0525	0.013*
IV Mx Ant	G'-Me'	-0.084	105	-0.2713	0.1094	0.3943
IV Mx Ant	G'-Sn'	-0.2627	105	-0.4326	-0.0748	0.0068*
IV Mx Ant	G'-Sn-Pog'°	-0.0591	105	-0.248	0.1341	0.5491
IV Mx Ant	II Md	0.0634	105	-0.1298	0.252	0.5205
IV Mx Ant	L1 - Op°	0.0578	105	-0.1354	0.2467	0.5583

IV Mx Ant	L1°	-0.1125	105	-0.2977	0.0809	0.2532
IV Mx Ant	MP°	0.3326	105	0.1506	0.4929	0.0005*
IV Mx Ant	MP-L1	-0.0449	105	-0.2346	0.148	0.649
IV Mx Ant	Mp-Mic	0.017	105	-0.1752	0.208	0.8631
IV Mx Ant	N-ANS	-0.1191	105	-0.3038	0.0743	0.2263
IV Mx Ant	N-Me	0.0441	105	-0.1488	0.2338	0.6547
IV Mx Ant	Op°	0.4288	105	0.2584	0.5734	<.0001*
IV Mx Ant	Op-Sn°	0.3822	105	0.2056	0.5347	<.0001*
IV Mx Ant	PFH:AFH	-0.2931	105	-0.459	-0.1074	0.0024*
IV Mx Ant	Pog'c-GALL	-0.1566	105	-0.3381	0.0362	0.1107
IV Mx Ant	Pog'-GALL	-0.1868	105	-0.3654	0.0051	0.0564
IV Mx Ant	Pog-GALL	-0.1817	105	-0.3608	0.0103	0.0635
IV Mx Ant	PP°	-0.0369	105	-0.2269	0.1559	0.709
IV Mx Ant	PP-Mic	0.0873	105	-0.1061	0.2744	0.3759
IV Mx Ant	PP-U1	0.2878	105	0.1018	0.4544	0.0029*
IV Mx Ant	S-Go	-0.3191	105	-0.4813	-0.1357	0.0009*
IV Mx Ant	Sn°	0.1096	105	-0.0838	0.2951	0.2657
IV Mx Ant	SNA°	-0.1772	105	-0.3568	0.0149	0.0705
IV Mx Ant	SNB°	-0.1623	105	-0.3433	0.0303	0.0981
IV Mx Ant	Sn'-Me'	0.078	105	-0.1154	0.2657	0.4292
IV Mx Ant	SN-MP°	0.3569	105	0.1774	0.5135	0.0002*
IV Mx Ant	TVL-Pog'	-0.0888	105	-0.2757	0.1047	0.3679
IV Mx Ant	U1 - Op°	-0.1828	105	-0.3618	0.0092	0.062
IV Mx Ant	U1°	-0.0136	105	-0.2047	0.1786	0.8907
L1 - Op°	Go°	0.1991	105	0.0078	0.3764	0.0417*
L1 - Op°	ANB°	-0.3886	105	-0.54	-0.2127	<.0001*
L1 - Op°	ANS-Me	-0.284	105	-0.4511	-0.0977	0.0033*
L1 - Op°	Co-Gn	0.1317	105	-0.0615	0.3154	0.1804
L1 - Op°	Co-Go	-0.1298	105	-0.3137	0.0634	0.1869
L1 - Op°	G'-Me'	-0.2016	105	-0.3787	-0.0104	0.0391*
L1 - Op°	G'-Sn'	0.0063	105	-0.1856	0.1977	0.9493
L1 - Op°	G'-Sn-Pog'°	0.4007	105	0.2264	0.5501	<.0001*
L1 - Op°	L1°	0.9208	105	0.8855	0.9456	<.0001*
L1 - Op°	MP°	-0.0512	105	-0.2405	0.1419	0.604
L1 - Op°	MP-L1	-0.1433	105	-0.326	0.0498	0.1448
L1 - Op°	Mp-Mic	-0.3893	105	-0.5406	-0.2136	<.0001*
L1 - Op°	N-ANS	-0.064	105	-0.2526	0.1293	0.5167
L1 - Op°	N-Me	-0.2532	105	-0.4243	-0.0647	0.0092*
L1 - Op°	Op°	0.1381	105	-0.055	0.3212	0.1601
L1 - Op°	PFH:AFH	0.1197	105	-0.0736	0.3044	0.2238
L1 - Op°	Pog'c-GALL	0.2668	105	0.0792	0.4362	0.0059*
L1 - Op°	Pog'-GALL	0.4088	105	0.2356	0.5568	<.0001*
L1 - Op°	Pog-GALL	0.2832	105	0.0967	0.4504	0.0034*

L1 - Op°	PP°	0.2583	105	0.0701	0.4287	0.0078*
L1 - Op°	PP-Mic	-0.2545	105	-0.4254	-0.0661	0.0088*
L1 - Op°	PP-U1	-0.3606	105	-0.5166	-0.1815	0.0002*
L1 - Op°	S-Go	-0.0509	105	-0.2402	0.1422	0.6064
L1 - Op°	SNA°	0.0625	105	-0.1307	0.2512	0.5264
L1 - Op°	SNB°	0.3496	105	0.1693	0.5073	0.0003*
L1 - Op°	Sn'-Me'	-0.2739	105	-0.4423	-0.0868	0.0047*
L1 - Op°	SN-MP°	-0.1969	105	-0.3745	-0.0055	0.044*
L1 - Op°	TVL-Pog'	0.473	105	0.3094	0.6094	<.0001*
L1 - Op°	U1 - Op°	0.1474	105	-0.0456	0.3297	0.1335
L1 - Op°	U1°	0.1976	105	0.0062	0.3751	0.0433*
L1°	ANS-Me	-0.2659	105	-0.4354	-0.0783	0.0061*
L1°	Co-Gn	0.2295	105	0.0396	0.4034	0.0185*
L1°	Co-Go	0.0006	105	-0.1911	0.1923	0.9951
L1°	G'-Me'	-0.2006	105	-0.3777	-0.0092	0.0402*
L1°	G'-Sn'	-0.0269	105	-0.2174	0.1656	0.7854
L1°	MP-L1	-0.0693	105	-0.2576	0.124	0.4823
L1°	Mp-Mic	-0.4364	105	-0.5796	-0.2671	<.0001*
L1°	N-ANS	-0.1068	105	-0.2925	0.0867	0.2783
L1°	N-Me	-0.2594	105	-0.4297	-0.0713	0.0075*
L1°	Op°	-0.259	105	-0.4294	-0.0709	0.0076*
L1°	PFH:AFH	0.2927	105	0.1071	0.4587	0.0024*
L1°	Pog'c-GALL	0.4248	105	0.2538	0.5701	<.0001*
L1°	Pog'-GALL	0.5789	105	0.4356	0.6936	<.0001*
L1°	Pog-GALL	0.4381	105	0.2691	0.581	<.0001*
L1°	PP-Mic	-0.1968	105	-0.3744	-0.0054	0.0441*
L1°	PP-U1	-0.427	105	-0.5719	-0.2564	<.0001*
L1°	S-Go	0.101	105	-0.0925	0.2871	0.3054
L1°	Sn'-Me'	-0.2485	105	-0.4201	-0.0596	0.0106*
L1°	TVL-Pog'	0.6253	105	0.4927	0.7295	<.0001*
L1°	U1°	0.0958	105	-0.0976	0.2823	0.3309
MP°	Go°	0.694	105	0.5795	0.7817	<.0001*
MP°	ANS-Me	0.4418	105	0.2733	0.584	<.0001*
MP°	Co-Gn	0.0266	105	-0.1659	0.2171	0.7878
MP°	Co-Go	-0.4059	105	-0.5544	-0.2323	<.0001*
MP°	G'-Me'	0.3021	105	0.1172	0.4667	0.0017*
MP°	G'-Sn'	0.0655	105	-0.1278	0.254	0.5068
MP°	G'-Sn-Pog'°	-0.1352	105	-0.3186	0.0579	0.169
MP°	L1°	-0.2714	105	-0.4402	-0.0841	0.0051*
MP°	MP-L1	0.1374	105	-0.0557	0.3206	0.1622
MP°	Mp-Mic	0.336	105	0.1543	0.4957	0.0005*
MP°	N-ANS	0.1159	105	-0.0775	0.3009	0.2389
MP°	N-Me	0.4017	105	0.2275	0.5509	<.0001*

MP°	Op°	0.5626	105	0.4158	0.6809	<.0001*
MP°	PFH:AFH	-0.7107	105	-0.7942	-0.6008	<.0001*
MP°	Pog'c-GALL	-0.1617	105	-0.3427	0.031	0.0994
MP°	Pog'-GALL	-0.3327	105	-0.4929	-0.1506	0.0005*
MP°	Pog-GALL	-0.3797	105	-0.5326	-0.2028	<.0001*
MP°	PP-Mic	0.2046	105	0.0134	0.3813	0.0363*
MP°	PP-U1	0.3655	105	0.1869	0.5207	0.0001*
MP°	S-Go	-0.3905	105	-0.5416	-0.2149	<.0001*
MP°	Sn'-Me'	0.3561	105	0.1765	0.5128	0.0002*
MP°	TVL-Pog'	-0.2646	105	-0.4342	-0.0768	0.0064
MP°	U1°	-0.0186	105	-0.2095	0.1737	0.8505
MP-L1	ANS-Me	0.7696	105	0.6779	0.8377	<.0001*
MP-L1	Co-Gn	0.4746	105	0.3113	0.6108	<.0001*
MP-L1	Co-Go	0.4784	105	0.3156	0.6137	<.0001*
MP-L1	G'-Me'	0.6879	105	0.5716	0.7771	<.0001*
MP-L1	G'-Sn'	0.3106	105	0.1264	0.474	0.0013*
MP-L1	Mp-Mic	0.6987	105	0.5855	0.7852	<.0001*
MP-L1	N-ANS	0.3735	105	0.1959	0.5275	<.0001*
MP-L1	N-Me	0.7816	105	0.6939	0.8465	<.0001*
MP-L1	Op°	-0.1789	105	-0.3582	0.0133	0.0679
MP-L1	PFH:AFH	0.0929	105	-0.1006	0.2795	0.3461
MP-L1	Pog'c-GALL	-0.1598	105	-0.3411	0.0328	0.1034
MP-L1	Pog'-GALL	-0.1301	105	-0.3139	0.0632	0.1859
MP-L1	Pog-GALL	-0.2736	105	-0.4421	-0.0865	0.0047*
MP-L1	PP-Mic	0.5486	105	0.3989	0.6698	<.0001*
MP-L1	PP-U1	0.5338	105	0.3811	0.6581	<.0001*
MP-L1	S-Go	0.597	105	0.4577	0.7077	<.0001*
MP-L1	Sn'-Me'	0.6941	105	0.5795	0.7818	<.0001*
MP-L1	TVL-Pog'	-0.1425	105	-0.3253	0.0506	0.147
Mp-Mic	ANS-Me	0.8041	105	0.724	0.8628	<.0001*
Mp-Mic	Co-Gn	0.3818	105	0.2051	0.5343	<.0001*
Mp-Mic	Co-Go	0.4154	105	0.2431	0.5623	<.0001*
Mp-Mic	G'-Me'	0.7492	105	0.651	0.8227	<.0001*
Mp-Mic	G'-Sn'	0.403	105	0.2291	0.5521	<.0001*
Mp-Mic	N-ANS	0.4007	105	0.2265	0.5502	<.0001*
Mp-Mic	N-Me	0.8217	105	0.7478	0.8755	<.0001*
Mp-Mic	Op°	0.1442	105	-0.0488	0.3268	0.1422
Mp-Mic	PFH:AFH	-0.0705	105	-0.2587	0.1228	0.4749
Mp-Mic	Pog'c-GALL	-0.2255	105	-0.3999	-0.0354	0.0207*
Mp-Mic	Pog'-GALL	-0.3136	105	-0.4767	-0.1298	0.0011*
Mp-Mic	Pog-GALL	-0.4258	105	-0.5708	-0.2549	<.0001*
Mp-Mic	PP-Mic	0.5258	105	0.3715	0.6518	<.0001*
Mp-Mic	PP-U1	0.5452	105	0.3948	0.6672	<.0001*

Mp-Mic	S-Go	0.5054	105	0.3474	0.6355	<.0001*
Mp-Mic	Sn'-Me'	0.7091	105	0.5988	0.793	<.0001*
Mp-Mic	TVL-Pog'	-0.3241	105	-0.4856	-0.1412	0.0007*
N-ANS	Op°	0.1127	105	-0.0807	0.2979	0.2523
N-ANS	Pog'c-GALL	-0.3014	105	-0.4661	-0.1164	0.0018*
N-ANS	Pog'-GALL	-0.2885	105	-0.455	-0.1025	0.0028*
N-ANS	Pog-GALL	-0.3155	105	-0.4782	-0.1318	0.001*
N-ANS	TVL-Pog'	-0.3411	105	-0.5001	-0.1599	0.0004*
N-Me	ANS-Me	0.8845	105	0.8342	0.9201	<.0001*
N-Me	N-ANS	0.6424	105	0.514	0.7426	<.0001*
N-Me	Op°	0.0318	105	-0.1609	0.2221	0.7476
N-Me	Pog'c-GALL	-0.1493	105	-0.3315	0.0436	0.1284
N-Me	Pog'-GALL	-0.2026	105	-0.3796	-0.0114	0.0382*
N-Me	Pog-GALL	-0.3517	105	-0.509	-0.1716	0.0002*
N-Me	TVL-Pog'	-0.217	105	-0.3923	-0.0264	0.0262*
Op-Sn°	Go°	0.1435	105	-0.0495	0.3262	0.1441
Op-Sn°	ANB°	0.4295	105	0.2592	0.5739	<.0001*
Op-Sn°	ANS-Me	0.0723	105	-0.1211	0.2603	0.4637
Op-Sn°	Co-Gn	-0.4455	105	-0.587	-0.2775	<.0001*
Op-Sn°	Co-Go	-0.3513	105	-0.5087	-0.1711	0.0002*
Op-Sn°	G'-Me'	0.0278	105	-0.1647	0.2183	0.7781
Op-Sn°	G'-Sn'	0.007	105	-0.1849	0.1984	0.9437
Op-Sn°	G'-Sn-Pog'°	-0.517	105	-0.6448	-0.3611	<.0001*
Op-Sn°	L1 - Op°	-0.1008	105	-0.287	0.0926	0.3061
Op-Sn°	L1°	-0.3836	105	-0.5358	-0.2071	<.0001*
Op-Sn°	MP°	0.4368	105	0.2676	0.58	<.0001*
Op-Sn°	MP-L1	-0.0606	105	-0.2494	0.1326	0.5389
Op-Sn°	Mp-Mic	0.154	105	-0.0389	0.3357	0.1169
Op-Sn°	N-ANS	0.2437	105	0.0546	0.4159	0.0122*
Op-Sn°	N-Me	0.173	105	-0.0193	0.3529	0.0776
Op-Sn°	Op°	0.7245	105	0.6188	0.8045	<.0001*
Op-Sn°	PFH:AFH	-0.5586	105	-0.6777	-0.4109	<.0001*
Op-Sn°	Pog'c-GALL	-0.3982	105	-0.548	-0.2236	<.0001*
Op-Sn°	Pog'-GALL	-0.4637	105	-0.6019	-0.2986	<.0001*
Op-Sn°	Pog-GALL	-0.3747	105	-0.5284	-0.1972	<.0001*
Op-Sn°	PP°	-0.1046	105	-0.2904	0.0889	0.2884
Op-Sn°	PP-Mic	-0.1293	105	-0.3132	0.0639	0.1886
Op-Sn°	PP-U1	0.3612	105	0.1821	0.5171	0.0002*
Op-Sn°	S-Go	-0.4599	105	-0.5988	-0.2942	<.0001*
Op-Sn°	SNA°	-0.5185	105	-0.646	-0.3629	<.0001*
Op-Sn°	SNB°	-0.7283	105	-0.8073	-0.6237	<.0001*
Op-Sn°	Sn'-Me'	0.0321	105	-0.1605	0.2224	0.7449
Op-Sn°	SN-MP°	0.7012	105	0.5887	0.7871	<.0001*

Op-Sn°	TVL-Pog'	-0.5214	105	-0.6483	-0.3663	<.0001*
Op-Sn°	U1 - Op°	-0.0591	105	-0.248	0.134	0.549
Op-Sn°	U1°	0.2216	105	0.0313	0.3964	0.0231*
PFH:AFH	ANS-Me	-0.2135	105	-0.3892	-0.0227	0.0288*
PFH:AFH	Co-Gn	0.1357	105	-0.0575	0.3191	0.1675
PFH:AFH	Co-Go	0.4864	105	0.3251	0.6203	<.0001*
PFH:AFH	G'-Me'	-0.2434	105	-0.4157	-0.0543	0.0124*
PFH:AFH	G'-Sn'	-0.0782	105	-0.2659	0.1152	0.4277
PFH:AFH	N-ANS	-0.0725	105	-0.2606	0.1208	0.4622
PFH:AFH	N-Me	-0.202	105	-0.379	-0.0107	0.0388*
PFH:AFH	Op°	-0.447	105	-0.5882	-0.2792	<.0001*
PFH:AFH	Pog'c-GALL	0.116	105	-0.0774	0.301	0.2387
PFH:AFH	Pog'-GALL	0.2596	105	0.0715	0.4298	0.0075*
PFH:AFH	Pog-GALL	0.2756	105	0.0887	0.4439	0.0044*
PFH:AFH	S-Go	0.6758	105	0.5562	0.768	<.0001*
PFH:AFH	Sn'-Me'	-0.2685	105	-0.4377	-0.081	0.0056*
PFH:AFH	TVL-Pog'	0.2332	105	0.0435	0.4067	0.0166*
Pog'c-GALL	Op°	-0.4182	105	-0.5646	-0.2463	<.0001*
Pog'c-GALL	Pog'-GALL	0.9376	105	0.9093	0.9572	<.0001*
Pog'c-GALL	Pog-GALL	0.6731	105	0.5528	0.766	<.0001*
Pog'c-GALL	TVL-Pog'	0.8158	105	0.7398	0.8712	<.0001*
Pog'-GALL	Op°	-0.4578	105	-0.5971	-0.2917	<.0001*
Pog-GALL	Op°	-0.4114	105	-0.559	-0.2386	<.0001*
Pog-GALL	Pog'-GALL	0.7329	105	0.6298	0.8107	<.0001*
PP°	Go°	-0.0227	105	-0.2135	0.1697	0.8179
PP°	ANB°	-0.1561	105	-0.3377	0.0367	0.1118
PP°	ANS-Me	-0.2632	105	-0.4331	-0.0754	0.0067
PP°	Co-Gn	0.2026	105	0.0114	0.3795	0.0382*
PP°	Co-Go	0.1177	105	-0.0756	0.3026	0.2316
PP°	G'-Me'	0.0206	105	-0.1717	0.2115	0.8345
PP°	G'-Sn'	0.3841	105	0.2077	0.5363	<.0001*
PP°	G'-Sn-Pog'°	0.0506	105	-0.1424	0.2399	0.6082
PP°	L1°	0.1231	105	-0.0703	0.3075	0.2111
PP°	MP°	0.0713	105	-0.122	0.2595	0.4696
PP°	MP-L1	-0.161	105	-0.3421	0.0316	0.1008
PP°	Mp-Mic	0.0276	105	-0.1649	0.2182	0.7795
PP°	N-ANS	0.3055	105	0.1209	0.4697	0.0015*
PP°	N-Me	-0.0606	105	-0.2493	0.1327	0.5395
PP°	Op°	0.3273	105	0.1447	0.4883	0.0007*
PP°	PFH:AFH	0.0974	105	-0.0961	0.2838	0.3229
PP°	Pog'c-GALL	-0.0685	105	-0.2568	0.1248	0.4873
PP°	Pog'-GALL	-0.0262	105	-0.2168	0.1663	0.7906
PP°	Pog-GALL	-0.032	105	-0.2223	0.1606	0.7457

PP°	PP-Mic	-0.0026	105	-0.1941	0.1892	0.9793
PP°	PP-U1	-0.4525	105	-0.5928	-0.2856	<.0001*
PP°	S-Go	0.0938	105	-0.0997	0.2804	0.3412
PP°	SNA°	0.2907	105	0.1049	0.4569	0.0026*
PP°	SNB°	0.3425	105	0.1614	0.5012	0.0003*
PP°	Sn'-Me'	-0.2505	105	-0.4219	-0.0617	0.01*
PP°	SN-MP°	-0.1928	105	-0.3708	-0.0012	0.0487*
PP°	TVL-Pog'	0.0398	105	-0.153	0.2297	0.6869
PP°	U1°	0.141	105	-0.0521	0.3239	0.1514
PP-Mic	ANS-Me	0.7142	105	0.6054	0.7968	<.0001*
PP-Mic	Co-Gn	0.4522	105	0.2852	0.5925	<.0001*
PP-Mic	Co-Go	0.3449	105	0.1641	0.5033	0.0003*
PP-Mic	G'-Me'	0.6424	105	0.514	0.7426	<.0001*
PP-Mic	G'-Sn'	0.2221	105	0.0318	0.3969	0.0228*
PP-Mic	N-ANS	0.1575	105	-0.0352	0.3389	0.1086
PP-Mic	N-Me	0.6351	105	0.5048	0.737	<.0001*
PP-Mic	Op°	-0.1304	105	-0.3143	0.0628	0.1847
PP-Mic	PFH:AFH	-0.0532	105	-0.2424	0.1399	0.5896
PP-Mic	Pog'c-GALL	0.0029	105	-0.1889	0.1945	0.9765
PP-Mic	Pog'-GALL	-0.0446	105	-0.2342	0.1484	0.6517
PP-Mic	Pog-GALL	-0.1756	105	-0.3553	0.0166	0.0732
PP-Mic	PP-U1	0.5577	105	0.4098	0.677	<.0001*
PP-Mic	S-Go	0.4413	105	0.2727	0.5836	<.0001*
PP-Mic	Sn'-Me'	0.6974	105	0.5838	0.7842	<.0001*
PP-Mic	TVL-Pog'	-0.0037	105	-0.1952	0.1881	0.9704
PP-U1	ANS-Me	0.7108	105	0.601	0.7943	<.0001*
PP-U1	Co-Gn	0.089	105	-0.1045	0.2759	0.3667
PP-U1	Co-Go	0.1	105	-0.0934	0.2862	0.31
PP-U1	G'-Me'	0.5038	105	0.3455	0.6342	<.0001*
PP-U1	G'-Sn'	0.0323	105	-0.1603	0.2226	0.7434
PP-U1	N-ANS	0.0329	105	-0.1598	0.2231	0.7392
PP-U1	N-Me	0.5729	105	0.4283	0.689	<.0001*
PP-U1	Op°	0.1914	105	-0.0002	0.3695	0.0504*
PP-U1	PFH:AFH	-0.3496	105	-0.5073	-0.1693	0.0003*
PP-U1	Pog'c-GALL	-0.2875	105	-0.4542	-0.1015	0.0029*
PP-U1	Pog'-GALL	-0.3454	105	-0.5037	-0.1646	0.0003*
PP-U1	Pog-GALL	-0.3932	105	-0.5439	-0.218	<.0001*
PP-U1	S-Go	0.082	105	-0.1114	0.2694	0.4056
PP-U1	Sn'-Me'	0.6496	105	0.5231	0.7481	<.0001*
PP-U1	TVL-Pog'	-0.3749	105	-0.5285	-0.1974	<.0001*
S-Go	ANS-Me	0.4139	105	0.2414	0.5611	<.0001*
S-Go	Co-Go	0.795	105	0.7118	0.8562	<.0001*
S-Go	G'-Me'	0.5474	105	0.3974	0.6689	<.0001*

S-Go	G'-Sn'	0.4411	105	0.2724	0.5834	<.0001*
S-Go	N-ANS	0.3397	105	0.1584	0.4989	0.0004*
S-Go	N-Me	0.4867	105	0.3254	0.6205	<.0001*
S-Go	Op°	-0.3825	105	-0.5349	-0.2059	<.0001*
S-Go	Pog'c-GALL	0.0432	105	-0.1497	0.233	0.6616
S-Go	Pog'-GALL	0.1264	105	-0.0669	0.3105	0.1988
S-Go	Pog-GALL	-0.0271	105	-0.2176	0.1654	0.7838
S-Go	Sn'-Me'	0.412	105	0.2392	0.5595	<.0001*
S-Go	TVL-Pog'	0.122	105	-0.0713	0.3065	0.215
Sn°	Go°	-0.0886	105	-0.2755	0.1049	0.369
Sn°	ANB°	0.3243	105	0.1415	0.4858	0.0007*
Sn°	ANS-Me	0.1031	105	-0.0904	0.289	0.2955
Sn°	Co-Gn	-0.4051	105	-0.5538	-0.2314	<.0001*
Sn°	Co-Go	-0.1942	105	-0.372	-0.0026	0.0471*
Sn°	G'-Me'	-0.0043	105	-0.1958	0.1875	0.9653
Sn°	G'-Sn'	-0.0979	105	-0.2842	0.0956	0.3206
Sn°	G'-Sn-Pog'°	-0.3815	105	-0.5341	-0.2048	<.0001*
Sn°	L1 - Op°	-0.2967	105	-0.4621	-0.1114	0.0021*
Sn°	L1°	-0.2875	105	-0.4542	-0.1015	0.0029*
Sn°	MP°	0.0286	105	-0.164	0.219	0.7723
Sn°	MP-L1	0.0611	105	-0.1321	0.2499	0.5357
Sn°	Mp-Mic	0.0541	105	-0.139	0.2432	0.5839
Sn°	N-ANS	0.2216	105	0.0313	0.3965	0.0231*
Sn°	N-Me	0.1866	105	-0.0053	0.3652	0.0567
Sn°	Op°	-0.0046	105	-0.1961	0.1873	0.9631
Sn°	Op-Sn°	0.6731	105	0.5528	0.766	<.0001*
Sn°	PFH:AFH	-0.3393	105	-0.4985	-0.1579	0.0004*
Sn°	Pog'c-GALL	-0.1023	105	-0.2883	0.0912	0.2993
Sn°	Pog'-GALL	-0.1676	105	-0.3481	0.0249	0.0875
Sn°	Pog-GALL	-0.0633	105	-0.2519	0.1299	0.5212
Sn°	PP°	-0.4935	105	-0.6259	-0.3333	<.0001*
Sn°	PP-Mic	-0.0735	105	-0.2615	0.1198	0.456
Sn°	PP-U1	0.2803	105	0.0937	0.4479	0.0038*
Sn°	S-Go	-0.292	105	-0.458	-0.1063	0.0025*
Sn°	SNA°	-0.7266	105	-0.806	-0.6215	<.0001*
Sn°	SNB°	-0.8049	105	-0.8634	-0.7251	<.0001*
Sn°	Sn'-Me'	0.0651	105	-0.1282	0.2536	0.5094
Sn°	SN-MP°	0.5051	105	0.347	0.6352	<.0001*
Sn°	TVL-Pog'	-0.304	105	-0.4684	-0.1193	0.0016*
Sn°	U1 - Op°	0.0211	105	-0.1713	0.2119	0.831
Sn°	U1°	0.0189	105	-0.1734	0.2098	0.8484
SNA°	Go°	0.0074	105	-0.1845	0.1988	0.9401
SNA°	ANS-Me	-0.04	105	-0.2299	0.1529	0.6857

SNA°	Co-Gn	0.2935	105	0.1079	0.4593	0.0024*
SNA°	Co-Go	0.1457	105	-0.0472	0.3282	0.1379
SNA°	G'-Me'	-0.0195	105	-0.2104	0.1728	0.8434
SNA°	G'-Sn'	-0.0605	105	-0.2493	0.1327	0.5395
SNA°	G'-Sn-Pog'°	0.1104	105	-0.083	0.2958	0.2623
SNA°	L1°	0.0749	105	-0.1185	0.2628	0.4476
SNA°	MP°	-0.079	105	-0.2666	0.1144	0.4231
SNA°	MP-L1	-0.016	105	-0.207	0.1762	0.8715
SNA°	Mp-Mic	0.0125	105	-0.1796	0.2037	0.8989
SNA°	N-ANS	-0.303	105	-0.4675	-0.1182	0.0017*
SNA°	N-Me	-0.1759	105	-0.3556	0.0163	0.0726
SNA°	Op°	-0.0354	105	-0.2255	0.1573	0.7199
SNA°	PFH:AFH	0.3061	105	0.1215	0.4701	0.0015*
SNA°	Pog'c-GALL	0.1939	105	0.0024	0.3718	0.0474*
SNA°	Pog'-GALL	0.2173	105	0.0267	0.3926	0.026*
SNA°	Pog-GALL	0.0472	105	-0.1458	0.2367	0.6327
SNA°	PP-Mic	0.1143	105	-0.0791	0.2994	0.2455
SNA°	PP-U1	-0.0802	105	-0.2678	0.1132	0.4159
SNA°	S-Go	0.2578	105	0.0696	0.4283	0.0079*
SNA°	Sn'-Me'	0.0178	105	-0.1745	0.2087	0.8573
SNA°	TVL-Pog'	0.1556	105	-0.0372	0.3372	0.113
SNA°	U1°	0.0995	105	-0.0939	0.2858	0.3124
SNB°	Go°	0.1423	105	-0.0507	0.3251	0.1475
SNB°	ANS-Me	-0.1346	105	-0.3181	0.0585	0.1709
SNB°	Co-Gn	0.454	105	0.2874	0.594	<.0001*
SNB°	Co-Go	0.1216	105	-0.0718	0.3061	0.2167
SNB°	G'-Me'	-0.1386	105	-0.3217	0.0546	0.1587
SNB°	G'-Sn'	-0.1012	105	-0.2873	0.0922	0.3042
SNB°	G'-Sn-Pog'°	0.6087	105	0.4722	0.7168	<.0001*
SNB°	L1°	0.4337	105	0.2639	0.5773	<.0001*
SNB°	MP°	-0.1625	105	-0.3435	0.0301	0.0976
SNB°	MP-L1	-0.1905	105	-0.3687	0.0012	0.0516
SNB°	Mp-Mic	-0.2065	105	-0.3831	-0.0155	0.0345*
SNB°	N-ANS	-0.3912	105	-0.5422	-0.2157	<.0001*
SNB°	N-Me	-0.2923	105	-0.4583	-0.1066	0.0025*
SNB°	Op°	-0.2355	105	-0.4088	-0.046	0.0156*
SNB°	PFH:AFH	0.3768	105	0.1996	0.5302	<.0001*
SNB°	Pog'c-GALL	0.5631	105	0.4163	0.6812	<.0001*
SNB°	Pog'-GALL	0.6104	105	0.4742	0.7181	<.0001*
SNB°	Pog-GALL	0.5163	105	0.3603	0.6442	<.0001*
SNB°	PP-Mic	-0.0099	105	-0.2012	0.1821	0.9201
SNB°	PP-U1	-0.4281	105	-0.5728	-0.2576	<.0001*
SNB°	S-Go	0.2225	105	0.0322	0.3972	0.0225*

SNB°	SNA°	0.6405	105	0.5117	0.7412	<.0001*
SNB°	Sn'-Me'	-0.1118	105	-0.2971	0.0816	0.2561
SNB°	TVL-Pog'	0.6358	105	0.5058	0.7376	<.0001*
SNB°	U1°	-0.2072	105	-0.3836	-0.0162	0.034*
Sn'-Me'	ANS-Me	0.897	105	0.8518	0.929	<.0001*
Sn'-Me'	G'-Sn'	0.18	105	-0.0121	0.3593	0.0661
Sn'-Me'	N-ANS	0.2206	105	0.0302	0.3955	0.0237*
Sn'-Me'	N-Me	0.8085	105	0.73	0.866	<.0001*
Sn'-Me'	Op°	-0.0474	105	-0.2369	0.1456	0.6311
Sn'-Me'	Pog'c-GALL	0.0379	105	-0.1549	0.2279	0.7013
Sn'-Me'	Pog'-GALL	-0.0559	105	-0.2449	0.1372	0.5711
Sn'-Me'	Pog-GALL	-0.293	105	-0.4589	-0.1073	0.0024*
Sn'-Me'	TVL-Pog'	-0.0483	105	-0.2378	0.1447	0.6244
SN-MP°	Go°	0.5389	105	0.3873	0.6622	<.0001*
SN-MP°	ANB°	0.2615	105	0.0735	0.4315	0.0071
SN-MP°	ANS-Me	0.4106	105	0.2377	0.5584	<.0001*
SN-MP°	Co-Gn	-0.1911	105	-0.3692	0.0006	0.0508*
SN-MP°	Co-Go	-0.4461	105	-0.5875	-0.2782	<.0001*
SN-MP°	G'-Me'	0.2306	105	0.0407	0.4044	0.018*
SN-MP°	G'-Sn'	-0.0139	105	-0.2051	0.1782	0.8878
SN-MP°	G'-Sn-Pog'°	-0.3132	105	-0.4763	-0.1293	0.0011*
SN-MP°	L1°	-0.381	105	-0.5337	-0.2042	<.0001*
SN-MP°	MP°	0.8513	105	0.7883	0.8967	<.0001*
SN-MP°	MP-L1	0.1328	105	-0.0604	0.3164	0.177
SN-MP°	Mp-Mic	0.2926	105	0.1069	0.4586	0.0025*
SN-MP°	N-ANS	0.1966	105	0.0051	0.3741	0.0445*
SN-MP°	N-Me	0.4158	105	0.2435	0.5626	<.0001*
SN-MP°	Op°	0.4798	105	0.3174	0.6149	<.0001*
SN-MP°	PFH:AFH	-0.7658	105	-0.835	-0.673	<.0001*
SN-MP°	Pog'c-GALL	-0.1961	105	-0.3737	-0.0046	0.045*
SN-MP°	Pog'-GALL	-0.3742	105	-0.528	-0.1967	<.0001*
SN-MP°	Pog-GALL	-0.3486	105	-0.5065	-0.1682	0.0003*
SN-MP°	PP-Mic	0.1107	105	-0.0828	0.2961	0.2611
SN-MP°	PP-U1	0.4351	105	0.2656	0.5785	<.0001*
SN-MP°	S-Go	-0.4895	105	-0.6227	-0.3287	<.0001*
SN-MP°	SNA°	-0.4349	105	-0.5783	-0.2653	<.0001*
SN-MP°	SNB°	-0.534	105	-0.6583	-0.3814	<.0001*
SN-MP°	Sn'-Me'	0.3181	105	0.1347	0.4805	0.0009*
SN-MP°	TVL-Pog'	-0.38	105	-0.5329	-0.2031	<.0001*
SN-MP°	U1°	-0.0445	105	-0.2342	0.1484	0.6521
TVL-Pog'	Op°	-0.4166	105	-0.5633	-0.2445	<.0001*
TVL-Pog'	Pog'-GALL	0.8862	105	0.8367	0.9214	<.0001*
TVL-Pog'	Pog-GALL	0.6091	105	0.4727	0.7171	<.0001*

U1 - Op°	Go°	-0.3046	105	-0.4689	-0.12	0.0016*
U1 - Op°	ANB°	0.2659	105	0.0782	0.4354	0.0061*
U1 - Op°	ANS-Me	-0.0184	105	-0.2093	0.1739	0.8523
U1 - Op°	Co-Gn	-0.0467	105	-0.2362	0.1463	0.6363
U1 - Op°	Co-Go	0.164	105	-0.0286	0.3448	0.0946
U1 - Op°	G'-Me'	0.106	105	-0.0874	0.2918	0.2817
U1 - Op°	G'-Sn'	0.2435	105	0.0543	0.4157	0.0123*
U1 - Op°	G'-Sn-Pog'°	-0.0418	105	-0.2316	0.1511	0.672
U1 - Op°	L1°	0.1999	105	0.0086	0.3771	0.0409*
U1 - Op°	MP°	-0.2407	105	-0.4133	-0.0514	0.0134*
U1 - Op°	MP-L1	0.1122	105	-0.0812	0.2975	0.2545
U1 - Op°	Mp-Mic	0.0261	105	-0.1664	0.2167	0.7916
U1 - Op°	N-ANS	0.1254	105	-0.0679	0.3096	0.2024
U1 - Op°	N-Me	0.0454	105	-0.1475	0.2351	0.6454
U1 - Op°	Op°	-0.1427	105	-0.3254	0.0504	0.1466
U1 - Op°	PFH:AFH	0.1246	105	-0.0687	0.3089	0.2052
U1 - Op°	Pog'c-GALL	-0.1346	105	-0.3181	0.0586	0.1709
U1 - Op°	Pog'-GALL	-0.0399	105	-0.2298	0.153	0.6864
U1 - Op°	Pog-GALL	-0.0529	105	-0.2421	0.1402	0.5922
U1 - Op°	PP°	0.0151	105	-0.1771	0.2061	0.8788
U1 - Op°	PP-Mic	0.0143	105	-0.1778	0.2054	0.8847
U1 - Op°	PP-U1	0.1821	105	-0.0099	0.3612	0.0629
U1 - Op°	S-Go	0.1958	105	0.0042	0.3734	0.0454*
U1 - Op°	SNA°	0.1156	105	-0.0778	0.3006	0.2403
U1 - Op°	SNB°	-0.1188	105	-0.3035	0.0746	0.2276
U1 - Op°	Sn'-Me'	-0.0346	105	-0.2248	0.1581	0.7261
U1 - Op°	SN-MP°	-0.2345	105	-0.4078	-0.0448	0.0161*
U1 - Op°	TVL-Pog'	-0.0306	105	-0.2209	0.162	0.7568
U1 - Op°	U1°	0.9242	105	0.8903	0.948	<.0001*
U1°	ANS-Me	-0.0289	105	-0.2193	0.1637	0.7702
U1°	Co-Gn	-0.1447	105	-0.3273	0.0483	0.1408
U1°	Co-Go	0.0359	105	-0.1568	0.226	0.7159
U1°	G'-Me'	0.1077	105	-0.0858	0.2933	0.2743
U1°	G'-Sn'	0.2708	105	0.0834	0.4396	0.0052*
U1°	MP-L1	0.0409	105	-0.152	0.2307	0.679
U1°	Mp-Mic	0.0812	105	-0.1122	0.2687	0.4103
U1°	N-ANS	0.1663	105	-0.0262	0.3469	0.09
U1°	N-Me	0.0568	105	-0.1364	0.2457	0.5653
U1°	Op°	0.2461	105	0.0571	0.418	0.0114*
U1°	PFH:AFH	-0.0504	105	-0.2397	0.1427	0.6098
U1°	Pog'c-GALL	-0.2932	105	-0.459	-0.1075	0.0024*
U1°	Pog'-GALL	-0.2157	105	-0.3912	-0.025	0.0271*
U1°	Pog-GALL	-0.2105	105	-0.3866	-0.0196	0.0311*

U1°	PP-Mic	-0.0363	105	-0.2264	0.1565	0.7132
U1°	PP-U1	0.2522	105	0.0636	0.4234	0.0094*
U1°	S-Go	0.0441	105	-0.1488	0.2338	0.6548
U1°	Sn'-Me'	-0.0522	105	-0.2414	0.1409	0.5972
U1°	TVL-Pog'	-0.1907	105	-0.3688	0.001	0.0514
V	Go°	-0.2725	105	-0.4411	-0.0853	0.0049*
V	II Mx	-0.2381	105	-0.411	-0.0487	0.0144*
V	ANB°	-0.1898	105	-0.3681	0.0019	0.0525*
V	ANS-Me	-0.219	105	-0.3941	-0.0285	0.0248*
V	Co-Gn	0.2358	105	0.0462	0.409	0.0155*
V	Co-Go	0.2825	105	0.096	0.4498	0.0035*
V	G'-Me'	-0.1637	105	-0.3445	0.0289	0.0952
V	G'-Sn'	0.0625	105	-0.1308	0.2511	0.5267
V	G'-Sn-Pog'°	0.2474	105	0.0585	0.4192	0.0109*
V	II Md	0.0588	105	-0.1344	0.2477	0.5512
V	IV Md Ant	-0.2052	105	-0.3818	-0.0141	0.0357*
V	IV Mx Ant	-0.1104	105	-0.2958	0.0831	0.2624
V	L1 - Op°	0.4483	105	0.2807	0.5893	<.0001*
V	L1°	0.5067	105	0.349	0.6366	<.0001*
V	MP°	-0.5158	105	-0.6438	-0.3597	<.0001*
V	MP-L1	0.0615	105	-0.1317	0.2502	0.5331
V	Mp-Mic	-0.2872	105	-0.4539	-0.1011	0.003*
V	N-ANS	-0.0083	105	-0.1996	0.1837	0.9333
V	N-Me	-0.1756	105	-0.3553	0.0166	0.0731
V	Op°	-0.1767	105	-0.3563	0.0155	0.0714
V	Op-Sn°	-0.2483	105	-0.4199	-0.0594	0.0107*
V	PFH:AFH	0.4301	105	0.2599	0.5744	<.0001*
V	Pog'c-GALL	-0.0291	105	-0.2195	0.1635	0.7684
V	Pog'-GALL	0.3203	105	0.1371	0.4824	0.0009*
V	Pog-GALL	0.2731	105	0.0859	0.4416	0.0048*
V	PP°	0.1113	105	-0.0821	0.2966	0.2583
V	PP-Mic	-0.136	105	-0.3194	0.0571	0.1664
V	PP-U1	-0.2094	105	-0.3856	-0.0185	0.032*
V	S-Go	0.2456	105	0.0566	0.4176	0.0116*
V	Sn°	-0.2032	105	-0.3801	-0.012	0.0376*
V	SNA°	0.0962	105	-0.0973	0.2826	0.329
V	SNB°	0.2207	105	0.0303	0.3956	0.0237*
V	Sn'-Me'	-0.2639	105	-0.4336	-0.076	0.0065*
V	SN-MP°	-0.5415	105	-0.6642	-0.3904	<.0001*
V	TVL-Pog'	0.3251	105	0.1423	0.4864	0.0007*
V	U1 - Op°	0.2521	105	0.0635	0.4233	0.0095*
V	U1°	0.1787	105	-0.0134	0.3581	0.0681

Statistical Analyses - Occlusal Plane Inclination

Oneway Anova

Summary of Fit

Rsquare	0.21106
Adj Rsquare	0.195691
Root Mean Square Error	3.138728
Mean of Response	8.827619
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Vertical	2	268.8253	134.413	13.6437	<.0001 *
Error	102	1004.8646	9.852		
C. Total	104	1273.6899			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
hyper	22	11.4091	0.66918	10.082	12.736
hypo	29	6.7759	0.58285	5.620	7.932
norm	54	8.8778	0.42713	8.031	9.725

Std Error uses a pooled estimate of error varianc

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
hyper	22	11.4091	2.62151	0.55891	10.247	12.571
hypo	29	6.7759	3.36098	0.62412	5.497	8.054
norm	54	8.8778	3.20452	0.43608	8.003	9.752

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	hyper	normo	hypo
hyper	-1.8771	0.9567	2.8730
normo	0.9567	-1.1981	0.6686
hypo	2.8730	0.6686	-1.6349

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
hyper A	11.409091
norm B	8.877778
hypo C	6.775862

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
hyper	hypo	4.633229	0.8874184	2.873039	6.393419	<.0001 *
hyper	normo	2.531313	0.7938753	0.956665	4.105961	0.0019 *
norm	hypo	2.101916	0.7225982	0.668646	3.535186	0.0045 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	hyper	normo	hypo
hyper	-2.2509	0.6431	2.5226
normo	0.6431	-1.4367	0.3833
hypo	2.5226	0.3833	-1.9605

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
hyper A	11.409091
norm B	8.877778
hypo C	6.775862

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
hyper	hypo	4.633229	0.8874184	2.522565	6.743893	<.0001 *
hyper	normo	2.531313	0.7938753	0.643135	4.419491	0.0054 *
norm	hypo	2.101916	0.7225982	0.383266	3.820566	0.0123 *

Oneway Anova

Summary of Fit

Rsquare	0.085818
Adj Rsquare	0.067893
Root Mean Square Error	3.378688
Mean of Response	8.827619
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Convexity	2	109.3053	54.6527	4.7876	0.0103 *
Error	102	1164.3846	11.4155		
C. Total	104	1273.6899			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
concav	14	6.82143	0.90299	5.0303	8.613
convex	50	9.76800	0.47782	8.8202	10.716
normal	41	8.36585	0.52766	7.3192	9.412

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
concav	14	6.82143	3.23209	0.86381	4.9553	8.688
convex	50	9.76800	3.52851	0.49901	8.7652	10.771
normal	41	8.36585	3.23463	0.50516	7.3449	9.387

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	convex	normal	concave
convex	-1.3403	-0.0098	0.9202
normal	-0.0098	-1.4801	-0.5300
concave	0.9202	-0.5300	-2.5300

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
convex A	9.7680000
normal A B	8.3658537
concav B	6.8214286

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
convex	concav	2.946571	1.021619	0.920194	4.972949	0.0048 *
normal	concav	1.544425	1.045860	-0.530033	3.618883	0.1428
convex	normal	1.402146	0.711856	-0.009816	2.814109	0.0516

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	convex	normal	concave
convex	-1.6072	-0.2910	0.5167
normal	-0.2910	-1.7749	-0.9431
concave	0.5167	-0.9431	-3.0373

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
convex A	9.7680000
normal A B	8.3658537
concav B	6.8214286

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
convex	concav	2.946571	1.021619	0.516720	5.376423	0.0132 *
normal	concav	1.544425	1.045860	-0.943081	4.031931	0.3063
convex	normal	1.402146	0.711856	-0.290953	3.095246	0.1250

Oneway Analysis of Op° By Category

Oneway Anova

Summary of Fit

Rsquare	0.006728
Adj Rsquare	-0.01275
Root Mean Square Error	3.52181
Mean of Response	8.827619
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Category	2	8.5691	4.2846	0.3454	0.7087
Error	102	1265.1208	12.4031		
C. Total	104	1273.6899			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	40	8.94750	0.55685	7.8430	10.052
II	34	8.42647	0.60399	7.2285	9.624
III	31	9.11290	0.63254	7.8583	10.368

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
I	40	8.94750	3.56335	0.56341	7.8079	10.087
II	34	8.42647	2.91322	0.49961	7.4100	9.443
III	31	9.11290	4.04085	0.72576	7.6307	10.595

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	III	I	II
III	-1.7743	-1.5061	-1.0483
I	-1.5061	-1.5620	-1.1084
II	-1.0483	-1.1084	-1.6942

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	9.1129032
I A	8.9475000
II A	8.4264706

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
I	II	0.6864326	0.8745855	-1.04830	2.421169	0.4344
I	III	0.5210294	0.8215090	-1.10843	2.150489	0.5273
III	I	0.1654032	0.8427218	-1.50613	1.836938	0.8448

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	III	I	II
III	-2.1276	-1.8390	-1.3937
I	-1.8390	-1.8730	-1.4329
II	-1.3937	-1.4329	-2.0316

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	9.1129032
I A	8.9475000
II A	8.4264706

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
I	II	0.6864326	0.8745855	-1.39371	2.766574	0.7132
I	III	0.5210294	0.8215090	-1.43287	2.474932	0.8016
III	I	0.1654032	0.8427218	-1.83895	2.169759	0.9790

Oneway Analysis of Op° By Skeletal CLASS

Oneway Anova

Summary of Fit

Rsquare	0.061472
Adj Rsquare	0.043069
Root Mean Square Error	3.423382
Mean of Response	8.827619
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Skeletal CLAS	2	78.2961	39.1481	3.3404	0.0393 *
Error	102	1195.3938	11.7195		
C. Total	104	1273.6899			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	61	8.6131	0.43832	7.7437	9.483
II	28	10.0893	0.64696	8.8060	11.373
III	16	7.4375	0.85585	5.7399	9.135

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
I	61	8.6131	3.62843	0.46457	7.6838	9.542
II	28	10.0893	3.04611	0.57566	8.9081	11.270
III	16	7.4375	3.21390	0.80348	5.7249	9.150

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	II	I	III
II	-1.8148	-0.0739	0.5238
I	-0.0739	-1.2295	-0.7316
III	0.5238	-0.7316	-2.4007

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
II A	10.089286
I A B	8.613115
III B	7.437500

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
II	III	2.651786	1.072859	0.523775	4.779797	0.0151 *
II	I	1.476171	0.781460	-0.073850	3.026192	0.0617
I	III	1.175615	0.961559	-0.731633	3.082862	0.2243

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	II	I	III
II	-2.1761	-0.3825	0.1001
I	-0.3825	-1.4743	-1.1114
III	0.1001	-1.1114	-2.8787

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
II A	10.089286
I A B	8.613115
III B	7.437500

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
II	III	2.651786	1.072859	0.10006	5.203508	0.0397 *
II	I	1.476171	0.781460	-0.38248	3.334819	0.1471
I	III	1.175615	0.961559	-1.11139	3.462616	0.4426

Stepwise Regression Analysis

Stepwise Fit for Op° Stepwise Regression Control

Prob to 0.05
Enter
Prob to 0.05
Leave
Direction: Mixed

Current Estimates

Entere d	Parameter	Estimate	"F Ratio"	"Prob>F"
X	Intercept	5.23289944	0.000	1
	PFH:AFH	0	0.378	0.5403
	N-ANS	0	0.026	0.87262
	ANS-Me	0	1.897	0.17173
	G'-Sn'	0	0.881	0.35033
X	Sn'-Me'	0.2078999	9.918	0.00219
	Co-Go	0	0.028	0.86717
	S-Go	0	1.646	0.20272
X	PP-1	0.48704104	17.608	6.15e-5
X	PP-Mic	-0.5411415	19.868	2.29e-5
X	Mp-Mic	0.27989329	10.947	0.00133
	MP-L1	0	0.003	0.95966
	Pog'-GALL	0	0.070	0.79188
	Pog-GALL	0	0.154	0.69582
	Pog'-TVL	0	0.440	0.50858
	Pog'c-GALL	0	1.097	0.29755
	1°	0	0.673	0.41424
	I°	0	0.928	0.33787
	1°-I°	0	1.131	0.29028
	Go°	0	0.377	0.54058
	G'-Sn-	0	0.747	0.3897
	Pog'°			
	MP°	0	2.535	0.11476
	SNA°	0	0.034	0.85321
	SNB°	0	0.685	0.41
X	SN-MP	0.27761029	57.183	2.6e-11
X	PP°	0.61557339	50.358	2.4e-10
	II Mx	0	0.514	0.47518

Entere d	Parameter	Estimate	"F Ratio"	"Prob>F"
	II Md	0	3.228	0.07562
X	IV Mx Ant	0.21578033	4.069	0.04653
X	IV Md Ant	-0.6848812	40.189	7.95e-9
X	Sn	-0.2232288	9.109	0.00327
X	Co-Gn	-0.03727	4.031	0.04754

Step History

Step	Parameter	Action	"Sig Prob"	RSquare
1	SN-MP	Entere d	0.0000	0.2302
2	PP°	Entere d	0.0000	0.4133
3	IV Md Ant	Entere d	0.0000	0.5191
4	Mp-Mic	Entere d	0.0000	0.6399
5	PP-1	Entere d	0.0002	0.6868
6	Sn	Entere d	0.0030	0.7138
7	PP-Mic	Entere d	0.0032	0.7384
8	Sn'-Me'	Entere d	0.0067	0.7578
9	IV Mx Ant	Entere d	0.0226	0.7707
10	Co-Gn	Entere d	0.0475	0.7802

Response Op°

Summary of Fit

RSquare	0.780168
RSquare Adj	0.756781
Root Mean Square Error	1.725892
Mean of Response	8.827619
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	10	993.6918	99.3692	33.3599

Source	DF	Sum of Squares	Mean Square	F Ratio
Error	94	279.9981	2.9787	Prob > F
C.	104	1273.6899		<.0001*
Total				

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob> t
Intercep t	5.2328994	2.574106	2.03	0.0449*
Sn'-Me'	0.2078999	0.066015	3.15	0.0022*
PP-1	0.487041	0.116068	4.20	<.0001*
PP-Mic	-0.541141	0.121405	-4.46	<.0001*
Mp-Mic	0.2798933	0.084594	3.31	0.0013*
SN-MP	0.2776103	0.036712	7.56	<.0001*
PP°	0.6155734	0.086746	7.10	<.0001*
IV Mx	0.2157803	0.106973	2.02	0.0465*
Ant				
IV Md	-0.684881	0.108034	-6.34	<.0001*
Ant				
Sn	-0.223229	0.073964	-3.02	0.0033*
Co-Gn	-0.03727	0.018563	-2.01	0.0475*

Sorted Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob> t
SN-MP	0.2776103	0.036712	7.56	<.0001*
PP°	0.6155734	0.086746	7.10	<.0001*
IV Md	-0.684881	0.108034	-6.34	<.0001*
Ant				
PP-Mic	-0.541141	0.121405	-4.46	<.0001*
PP-1	0.487041	0.116068	4.20	<.0001*
Mp-Mic	0.2798933	0.084594	3.31	0.0013*
Sn'-Me'	0.2078999	0.066015	3.15	0.0022*
Sn	-0.223229	0.073964	-3.02	0.0033*
IV Mx	0.2157803	0.106973	2.02	0.0465*
Ant				
Co-Gn	-0.03727	0.018563	-2.01	0.0475*

Statistical Analyses: Pogonion Prominence Measurements

Oneway Anova

Summary of Fit	
Rsquare	0.23776
Adj Rsquare	0.222814
Root Mean Square Error	4.305391
Mean of Response	1.225524
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Category	2	589.7550	294.878	15.9080	<.0001 *
Error	102	1890.7122	18.536		
C. Total	104	2480.4672			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	40	1.6633	0.68074	0.313	3.013
II	34	-1.8897	0.73837	-3.354	-0.425
III	31	4.0774	0.77327	2.544	5.611

Std Error uses a pooled estimate of error variance.

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
I	40	1.6633	3.78932	0.59914	0.451	2.875
II	34	-1.8897	4.99347	0.85637	-3.632	-0.147
III	31	4.0774	4.11448	0.73898	2.568	5.587

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	III	I	II
III	-2.1691	0.3707	3.8464
I	0.3707	-1.9095	1.5610
II	3.8464	1.5610	-2.0712

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	4.077419
I B	1.663250
II C	-1.889706

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	5.967125	1.069175	3.846421	8.087830	<.0001 *
I	II	3.552956	1.004290	1.560952	5.544960	0.0006 *
III	I	2.414169	1.030222	0.370728	4.457610	0.0211 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	III	I	II
III	-2.6010	-0.0361	3.4242
I	-0.0361	-2.2898	1.1643
II	3.4242	1.1643	-2.4836

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	4.077419
I A	1.663250
II B	-1.889706

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	5.967125	1.069175	3.42416	8.510086	<.0001 *
I	II	3.552956	1.004290	1.16432	5.941590	0.0017 *
III	I	2.414169	1.030222	-0.03614	4.864482	0.0544

Oneway Anova

Summary of Fit	
Rsquare	0.232808
Adj Rsquare	0.217765
Root Mean Square Error	4.319354
Mean of Response	1.225524
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Skeletal CLAS	2	577.4718	288.736	15.4762	<.0001 *
Error	102	1902.9954	18.657		
C. Total	104	2480.4672			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	61	1.7859	0.5530	0.689	2.883
II	28	-2.1793	0.8163	-3.798	-0.560
III	16	5.0475	1.0798	2.906	7.189

Std Error uses a pooled estimate of error variance.

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
I	61	1.7859	4.05327	0.5190	0.748	2.824
II	28	-2.1793	4.85685	0.9179	-4.063	-0.296
III	16	5.0475	4.32323	1.0808	2.744	7.351

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	III	I	II
III	-3.0290	0.8552	4.5418
I	0.8552	-1.5513	2.0095
II	4.5418	2.0095	-2.2897

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	5.047500
I B	1.785902
II C	-2.179286

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	7.226786	1.353649	4.541829	9.911742	<.0001 *
I	II	3.965187	0.985984	2.009493	5.920882	0.0001 *
III	I	3.261598	1.213219	0.855184	5.668013	0.0084 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	III	I	II
III	-3.6322	0.3760	4.0072
I	0.3760	-1.8602	1.6201
II	4.0072	1.6201	-2.7457

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	5.047500
I B	1.785902
II C	-2.179286

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	7.226786	1.353649	4.007224	10.44635	<.0001 *
I	II	3.965187	0.985984	1.620092	6.31028	0.0003 *
III	I	3.261598	1.213219	0.376040	6.14716	0.0226 *

Fit Y by X Group

Oneway Analysis of TVL-Pog' By Convexity*

Oneway Anova

Summary of Fit

Rsquare	0.595166
Adj Rsquare	0.587228
Root Mean Square Error	3.636061
Mean of Response	-6.46886
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Convexity	2	1982.5463	991.273	74.9775	<.0001 *
Error	102	1348.5356	13.221		
C. Total	104	3331.0819			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
concav	14	2.000	0.97178	0.07248	3.928
convex	50	-10.497	0.51422	-11.52	-9.477
normal	41	-4.449	0.56786	-5.58	-3.322

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
concav	14	2.000	2.68451	0.71747	0.45	3.550
convex	50	-10.497	4.25328	0.60150	-11.71	-9.288
normal	41	-4.449	3.03488	0.47397	-5.41	-3.491

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	concave	normal	convex
concave	-2.726	4.216	10.316
normal	4.216	-1.593	4.528
convex	10.316	4.528	-1.442

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
concav A	2.00000
normal B	-4.44878
convex C	-10.49660

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
concav	convex	12.49660	1.099441	10.31586	14.67734	<.0001 *
concav	normal	6.44878	1.125529	4.21630	8.68126	<.0001 *
normal	convex	6.04782	0.766081	4.52830	7.56734	<.0001 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	concave	normal	convex
concave	-3.2687	3.7718	9.8817
normal	3.7718	-1.9101	4.2257
convex	9.8817	4.2257	-1.7296

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
concav A	2.00000
normal B	-4.44878
convex C	-10.49660

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
concav	convex	12.49660	1.099441	9.881654	15.11155	<.0001 *
concav	normal	6.44878	1.125529	3.771788	9.12577	<.0001 *
normal	convex	6.04782	0.766081	4.225748	7.86989	<.0001 *

Oneway Analysis of TVL-Pog' By Skeletal CLAS

Oneway Anova

Summary of Fit

Rsquare	0.313088
Adj Rsquare	0.299619
Root Mean Square Error	4.736344
Mean of Response	-6.46886
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Skeletal CLAS	2	1042.9203	521.460	23.2453	<.0001 *
Error	102	2288.1616	22.433		
C. Total	104	3331.0819			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	61	-5.882	0.6064	-7.08	-4.679
II	28	-10.874	0.8951	-12.65	-9.098
III	16	-0.999	1.1841	-3.35	1.349

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
I	61	-5.882	4.23046	0.5417	-6.97	-4.798
II	28	-10.874	5.33735	1.0087	-12.94	-8.804
III	16	-0.999	5.44793	1.3620	-3.90	1.904

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	I	II	III
III	-3.3215	2.2435	6.9300
I	2.2435	-1.7011	2.8474
II	6.9300	2.8474	-2.5108

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	-0.99938
I B	-5.88164
II C	-10.87357

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	9.874196	1.484330	6.930034	12.81836	<.0001 *
I	II	4.991932	1.081171	2.847435	7.13643	<.0001 *
III	I	4.882264	1.330343	2.243535	7.52099	0.0004 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	I	II	III
III	-3.9828	1.7181	6.3438
I	1.7181	-2.0398	2.4204
II	6.3438	2.4204	-3.0107

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	-0.99938
I B	-5.88164
II C	-10.87357

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	9.874196	1.484330	6.343818	13.40457	<.0001 *
I	II	4.991932	1.081171	2.420441	7.56342	<.0001 *
III	I	4.882264	1.330343	1.718134	8.04639	0.0011 *

Oneway Analysis of TVL-Pog' By Vertical

Oneway Anova

Summary of Fit

Rsquare	0.14315
Adj Rsquare	0.126349
Root Mean Square Error	5.289869
Mean of Response	-6.46886
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Vertical	2	476.8445	238.422	8.5203	0.0004 *
Error	102	2854.2374	27.983		
C. Total	104	3331.0819			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
hyper	22	-9.3786	1.1278	-11.62	-7.142
hypo	29	-3.3714	0.9823	-5.32	-1.423
norm	54	-6.9469	0.7199	-8.37	-5.519

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
hyper	22	-9.3786	7.29711	1.5557	-12.61	-6.143
hypo	29	-3.3714	5.02207	0.9326	-5.28	-1.461
norm	54	-6.9469	4.40805	0.5999	-8.15	-5.744

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD	hypo	normo	hyper
hypo	-2.7554	1.1599	3.0407
normo	1.1599	-2.0193	-0.2221
hyper	3.0407	-0.2221	-3.1636

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
hypo A	-3.371379
norm B	-6.946852
hyper B	-9.378636

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
hypo	hyper	6.007257	1.495615	3.04071	8.973802	0.0001 *
hypo	normo	3.575473	1.217834	1.15990	5.991041	0.0041 *
norm	hyper	2.431785	1.337961	-0.22206	5.085624	0.0721

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD	hypo	normo	hyper
hypo	-3.3041	0.6789	2.4500
normo	0.6789	-2.4213	-0.7505
hyper	2.4500	-0.7505	-3.7935

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
hypo A	-3.371379
norm B	-6.946852
hyper B	-9.378636

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
hypo	hyper	6.007257	1.495615	2.45004	9.564474	0.0003 *
hypo	normo	3.575473	1.217834	0.67894	6.472007	0.0114 *
norm	hyper	2.431785	1.337961	-0.75046	5.614033	0.1690

Oneway Analysis of TVL-Pog' By Category

Oneway Anova

Summary of Fit

Rsquare	0.289723
Adj Rsquare	0.275796
Root Mean Square Error	4.816221
Mean of Response	-6.46886
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Category	2	965.0917	482.546	20.8030	<.0001 *
Error	102	2365.9902	23.196		
C. Total	104	3331.0819			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	40	-6.599	0.78151	-8.11	-5.088
II	34	-10.066	0.82598	-11.70	-8.428
III	31	-2.356	0.86502	-4.07	-0.640

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
I	40	-6.599	4.40707	0.69682	-8.01	-5.189
II	34	-10.066	5.36405	0.91993	-11.94	-8.195
III	31	-2.356	4.68691	0.84179	-4.07	-0.637

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD	III	I	II
III	-2.4265	1.9571	5.3380
I	1.9571	-2.1361	1.2391
II	5.3380	1.2391	-2.3169

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	-2.35581
I B	-6.59875
II C	-10.06618

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	7.710370	1.196032	5.338046	10.08269	<.0001 *
III	I	4.242944	1.152457	1.957051	6.52884	0.0004 *
I	II	3.467426	1.123448	1.239074	5.69578	0.0026 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD	III	I	II
III	-2.9096	1.5019	4.8657
I	1.5019	-2.5614	0.7954
II	4.8657	0.7954	-2.7783

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	-2.35581
I B	-6.59875
II C	-10.06618

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	7.710370	1.196032	4.865690	10.55505	<.0001 *
III	I	4.242944	1.152457	1.501904	6.98398	0.0011 *
I	II	3.467426	1.123448	0.795384	6.13947	0.0073 *

Oneway Analysis of Pog'c-GALL By Vertical

Oneway Anova

Summary of Fit

Rsquare	0.032079
Adj Rsquare	0.0131
Root Mean Square Error	4.597906
Mean of Response	-0.17448
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Vertical	2	71.4653	35.7327	1.6902	0.1896
Error	102	2156.3559	21.1407		
C. Total	104	2227.8212			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
hyper	22	-1.3118	0.98028	-3.256	0.6326
hypo	29	1.0190	0.85381	-0.675	2.7125
norm	54	-0.3520	0.62570	-1.593	0.8890

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
hyper	22	-1.3118	5.48409	1.1692	-3.743	1.1197
hypo	29	1.0190	4.35143	0.8080	-0.636	2.6742
norm	54	-0.3520	4.33197	0.5895	-1.534	0.8304

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	hypo	normo	hyper
hypo	-2.3950	-0.7286	-0.2477
normo	-0.7286	-1.7551	-1.3469
hyper	-0.2477	-1.3469	-2.7498

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
hypo A	1.018966
norm A	-0.352037
hyper A	-1.311818

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
hypo	hyper	2.330784	1.299975	-0.24771	4.909277	0.0759
hypo	normo	1.371003	1.058530	-0.72859	3.470592	0.1982
norm	hyper	0.959781	1.162944	-1.34691	3.266475	0.4111

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	hypo	normo	hyper
hypo	-2.8719	-1.1466	-0.7611
normo	-1.1466	-2.1046	-1.8062
hyper	-0.7611	-1.8062	-3.2973

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
hypo A	1.018966
norm A	-0.352037
hyper A	-1.311818

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
hypo	hyper	2.330784	1.299975	-0.76112	5.422684	0.1771
hypo	normo	1.371003	1.058530	-1.14664	3.888644	0.4011
norm	hyper	0.959781	1.162944	-1.80620	3.725763	0.6882

Oneway Analysis of Pog'c-GALL By Category

Oneway Anova

Summary of Fit

Rsquare	0.227335
Adj Rsquare	0.212185
Root Mean Square Error	4.10805
Mean of Response	-0.17448
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Category	2	506.4618	253.231	15.0053	<.0001 *
Error	102	1721.3594	16.876		
C. Total	104	2227.8212			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	40	0.3382	0.64954	-0.950	1.627
II	34	-3.1103	0.70452	-4.508	-1.713
III	31	2.3839	0.73783	0.920	3.847

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
I	40	0.3382	3.76937	0.59599	-0.867	1.544
II	34	-3.1103	4.34590	0.74532	-4.627	-1.594
III	31	2.3839	4.25823	0.76480	0.822	3.946

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	III	I	II
III	-2.0697	0.0958	3.4707
I	0.0958	-1.8220	1.5478
II	3.4707	1.5478	-1.9763

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	2.383871
I B	0.338250
II C	-3.110294

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	5.494165	1.020169	3.470665	7.517665	<.0001 *
I	II	3.448544	0.958257	1.547845	5.349243	0.0005 *
III	I	2.045621	0.983001	0.095843	3.995399	0.0399 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	III	I	II
III	-2.4818	-0.2924	3.0678
I	-0.2924	-2.1848	1.1694
II	3.0678	1.1694	-2.3697

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	2.383871
I A	0.338250
II B	-3.110294

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	5.494165	1.020169	3.06776	7.920567	<.0001 *
I	II	3.448544	0.958257	1.16940	5.727693	0.0014 *
III	I	2.045621	0.983001	-0.29238	4.383622	0.0989

Fit Y by X Group

Oneway Analysis of Pog'c-GALL By Convexity°

Oneway Anova

Summary of Fit

Rsquare	0.294452
Adj Rsquare	0.280618
Root Mean Square Error	3.925576
Mean of Response	-0.17448
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Convexity	2	655.9865	327.993	21.2842	<.0001 *
Error	102	1571.8347	15.410		
C. Total	104	2227.8212			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
concav	14	4.4236	1.0492	2.343	6.505
conve	50	-2.5652	0.5552	-3.666	-1.464
normal	41	1.1710	0.6131	-0.045	2.387

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
concav	14	4.4236	4.23180	1.1310	1.980	6.867
conve	50	-2.5652	4.20313	0.5944	-3.760	-1.371
normal	41	1.1710	3.44013	0.5373	0.085	2.257

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	concave	normal	convex
concave	-2.9430	0.8424	4.6344
normal	0.8424	-1.7197	2.0957
convex	4.6344	2.0957	-1.5573

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
concav	4.423571
normal	1.170976
convex	-2.565200

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
concav	convex	6.988771	1.186983	4.634397	9.343146	<.0001 *
normal	convex	3.736176	0.827079	2.095668	5.376683	<.0001 *
concav	normal	3.252596	1.215147	0.842358	5.662834	0.0087 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	concave	normal	convex
concave	-3.5289	0.3625	4.1656
normal	0.3625	-2.0621	1.7690
convex	4.1656	1.7690	-1.8673

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
concav	4.423571
normal	1.170976
convex	-2.565200

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
concav	convex	6.988771	1.186983	4.165615	9.811928	<.0001 *
normal	convex	3.736176	0.827079	1.769024	5.703327	<.0001 *
concav	normal	3.252596	1.215147	0.362453	6.142739	0.0234 *

Oneway Analysis of Pog'c-GALL By Skeletal CLASS

Oneway Anova

Summary of Fit

Rsquare	0.227492
Adj Rsquare	0.212345
Root Mean Square Error	4.107632
Mean of Response	-0.17448
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Skeletal CLAS	2	506.8114	253.406	15.0187	<.0001 *
Error	102	1721.0098	16.873		
C. Total	104	2227.8212			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	61	0.4580	0.5259	-0.585	1.501
II	28	-3.4650	0.7763	-5.005	-1.925
III	16	3.1725	1.0269	1.136	5.209

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
I	61	0.4580	4.21329	0.53946	-0.621	1.537
II	28	-3.4650	3.98594	0.75327	-5.011	-1.919
III	16	3.1725	3.88960	0.97240	1.100	5.245

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	III	I	II
III	-2.8806	0.4260	4.0842
I	0.4260	-1.4753	2.0632
II	4.0842	2.0632	-2.1775

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III	3.172500
I	0.458033
II	-3.465000

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	6.637500	1.287297	4.084152	9.190848	<.0001 *
I	II	3.923033	0.937654	2.063200	5.782865	<.0001 *
III	I	2.714467	1.153751	0.426008	5.002927	0.0206 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	III	I	II
III	-3.4541	-0.0296	3.5758
I	-0.0296	-1.7690	1.6929
II	3.5758	1.6929	-2.6111

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III	3.172500
I	0.458033
II	-3.465000

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	6.637500	1.287297	3.57575	9.699249	<.0001 *
I	II	3.923033	0.937654	1.69289	6.153179	0.0002 *
III	I	2.714467	1.153751	-0.02965	5.458584	0.0532 *

Fit Y by X Group

Oneway Analysis of Pog-GALL By Convexity*

Oneway Anova

Summary of Fit

Rsquare	0.146662
Adj Rsquare	0.12993
Root Mean Square Error	5.497609
Mean of Response	-10.0152
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Convexity	2	529.8412	264.921	8.7653	0.0003 *
Error	102	3082.8180	30.224		
C. Total	104	3612.6592			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
concav	14	-6.116	1.4693	-9.03	-3.20
convex	50	-12.216	0.7775	-13.76	-10.67
normal	41	-8.663	0.8586	-10.37	-6.96

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
concav	14	-6.116	5.02240	1.3423	-9.02	-3.22
convex	50	-12.216	5.82710	0.8241	-13.87	-10.56
normal	41	-8.663	5.22279	0.8157	-10.31	-7.01

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	concave	normal	convex
concave			
normal	-4.1215		
convex	-0.8287	-2.4084	

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
concav A	-6.11643
normal A	-8.66317
convex B	-12.21560

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
concav	convex	6.099171	1.662321	2.80197	9.396377	0.0004 *
normal	convex	3.552429	1.158291	1.25496	5.849894	0.0028 *
concav	normal	2.546742	1.701764	-0.82870	5.922182	0.1376

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	concave	normal	convex
concave			
normal	-4.9421		
convex	-1.5008	-2.8879	

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
concav A	-6.11643
normal A	-8.66317
convex B	-12.21560

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
concav	convex	6.099171	1.662321	2.14546	10.05289	0.0011 *
normal	convex	3.552429	1.158291	0.79751	6.30734	0.0077 *
concav	normal	2.546742	1.701764	-1.50079	6.59427	0.2968

Oneway Analysis of Pog-GALL By Skeletal CLASS

Oneway Anova

Summary of Fit

Rsquare	0.262827
Adj Rsquare	0.248373
Root Mean Square Error	5.109732
Mean of Response	-10.0152
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Skeletal CLAS	2	949.5045	474.752	18.1832	<.0001 *
Error	102	2663.1548	26.109		
C. Total	104	3612.6592			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	61	-9.500	0.6542	-10.80	-8.20
II	28	-14.169	0.9656	-16.08	-12.25
III	16	-4.711	1.2774	-7.24	-2.18

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Mean	Lower 95%	Upper 95%
I	61	-9.500	4.86464	0.6229	-10.75	-8.25
II	28	-14.169	4.73710	0.8952	-16.01	-12.33
III	16	-4.711	6.51863	1.6297	-8.18	-1.24

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	III	I	II
III			
I	-3.5833		
II	1.9426	-1.8352	

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	-4.71063
I B	-9.50000
II C	-14.16893

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	9.458304	1.601347	6.282039	12.63457	<.0001 *
III	I	4.789375	1.435220	1.942622	7.63613	0.0012 *
I	II	4.668929	1.166405	2.355371	6.98249	0.0001 *

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	III	I	II
III			
I	-4.2968		
II	1.3758	-2.2006	

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	-4.71063
I B	-9.50000
II C	-14.16893

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	9.458304	1.601347	5.649610	13.26700	<.0001 *
III	I	4.789375	1.435220	1.375802	8.20295	0.0034 *
I	II	4.668929	1.166405	1.894716	7.44314	0.0003 *

Oneway Analysis of Pog-GALL By Vertical

Oneway Anova

Summary of Fit

Rsquare	0.111856
Adj Rsquare	0.094441
Root Mean Square Error	5.608609
Mean of Response	-10.0152
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Vertical	2	404.0967	202.048	6.4231	0.0024 *
Error	102	3208.5625	31.456		
C. Total	104	3612.6592			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
hyper	22	-13.400	1.1958	-15.77	-11.03
hypo	29	-7.735	1.0415	-9.80	-5.67
norm	54	-9.861	0.7632	-11.37	-8.35

Std Error uses a pooled estimate of error varianc

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
hyper	22	-13.400	5.66124	1.2070	-15.91	-10.89
hypo	29	-7.735	5.92601	1.1004	-9.99	-5.48
norm	54	-9.861	5.41178	0.7364	-11.34	-8.38

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	hypo	normo	hyper
hypo	-2.9215	-0.4355	2.5195
normo	-0.4355	-2.1409	0.7255
hyper	2.5195	0.7255	-3.3542

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
hypo A	-7.73517
norm A	-9.86074
hyper B	-13.40000

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
hypo	hyper	5.664828	1.585732	2.51953	8.810120	0.0005 *
norm	hyper	3.539259	1.418580	0.72551	6.353005	0.0142 *
hypo	normo	2.125568	1.291214	-0.43555	4.686686	0.1028

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	hypo	normo	hyper
hypo	-3.5032	-0.9455	1.8933
normo	-0.9455	-2.5672	0.1653
hyper	1.8933	0.1653	-4.0221

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
hypo A	-7.73517
norm A	-9.86074
hyper B	-13.40000

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
hypo	hyper	5.664828	1.585732	1.89327	9.436383	0.0016 *
norm	hyper	3.539259	1.418580	0.16526	6.913254	0.0375 *
hypo	normo	2.125568	1.291214	-0.94550	5.196633	0.2312

Oneway Analysis of Pog-GALL By Category

Oneway Anova

Summary of Fit

Rsquare	0.105315
Adj Rsquare	0.087772
Root Mean Square Error	5.629223
Mean of Response	-10.0152
Observations (or Sum Wgts)	105

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Categor	2	380.4673	190.234	6.0033	0.0034 *
Error	102	3232.1919	31.688		
C. Total	104	3612.6592			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	40	-9.740	0.8901	-11.51	-7.97
II	34	-12.480	0.9654	-14.39	-10.57
III	31	-7.667	1.0110	-9.67	-5.66

Std Error uses a pooled estimate of error varianc

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err	Lower 95%	Upper 95%
I	40	-9.740	3.37864	0.5342	-10.82	-8.659
II	34	-12.480	7.99049	1.3704	-15.27	-9.692
III	31	-7.667	4.76102	0.8551	-9.41	-5.921

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.98350	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	III	I	II
III	-2.8360	-0.5994	2.0398
I	-0.5994	-2.4967	0.1357
II	2.0398	0.1357	-2.7080

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	-7.66742
I A	-9.73975
II B	-12.48000

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	4.812581	1.397928	2.03980	7.585365	0.0008 *
I	II	2.740250	1.313091	0.13574	5.344760	0.0394 *
III	I	2.072331	1.346998	-0.59943	4.744094	0.1270

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.37843	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

	III	I	II
III	-3.4007	-1.1314	1.4877
I	-1.1314	-2.9938	-0.3828
II	1.4877	-0.3828	-3.2472

Positive values show pairs of means that are significantly different

Connecting Letters Report

Level	Mean
III A	-7.66742
I A B	-9.73975
II B	-12.48000

Levels not connected by same letter are significantly different

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
III	II	4.812581	1.397928	1.48770	8.137457	0.0024 *
I	II	2.740250	1.313091	-0.38285	5.863347	0.0976
III	I	2.072331	1.346998	-1.13141	5.276072	0.2774

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The Occlusal Plane Inclination Relative to Craniofacial Form: A Cephalometric Investigation

Holly R. Eppard, D.D.S.

Thesis Submitted to the
School of Dentistry at West Virginia University
In partial fulfillment of the requirements
For the degree of Master of Science

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