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Loma Linda University

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LOMA LINDA UNIVERSITY
School of Dentistry
in conjunction with the
Faculty of Graduate Studies

Photos and Silhouettes in Evaluating the Need for BSSO Surgery in Adult Females

by

Jessicah L. Moretz

A thesis submitted in partial satisfaction of
the requirements for the degree of
Master of Science in Orthodontics and Dentofacial Orthopedics

September 2013

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Each person whose signature appears below certifies that this thesis in his opinion is adequate, in scope and quality, as a thesis for the degree Master of Science in Orthodontics and Dentofacial Orthopedics.

_____, Chairperson
V. Leroy Leggitt, Professor of Orthodontics & Dentofacial Orthopedics

Craig Andreiko, Assistant Professor of Orthodontics & Dentofacial Orthopedics

Roland Neufeld, Associate Professor of Orthodontics & Dentofacial Orthopedics

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ABBREVIATIONS

| | |
|------|---|
| ANB | A point-Nasion-B point (Steiner analysis) |
| BSSO | Bilateral Sagittal Split Osteotomy |
| Pog | Pogonion |
| SNA | Sella-Nasion-A point (Steiner analysis) |

ABSTRACT OF THE THESIS

Photo and Silhouettes in Evaluating the Need for BSSO Surgery in Adult Females

by

Jessicah L. Moretz

Master of Science

Graduate Program in Orthodontics and Dentofacial Orthopedics

Loma Linda University, September 2013

Dr. V. Leroy Leggitt, Chairperson

Introduction: The objective of this study was to determine the anterior/posterior position of the mandible at which an orthodontist and oral surgeon would advise bilateral sagittal split osteotomy advancement or set back when evaluating adult female photos and silhouettes.

Material & Methods: Fifty-one adult female profile photos and lateral cephalograms were collected. Subjects were selected who met three criteria: 1) ANB of 0-2, 2) balanced profile image, and 3) age greater than 18. The image and cephalometric tracing were morphed together to allow software simulation of mandibular prognathia and retrognathia in 2 mm increments. Orthodontists and oral surgeons evaluated morphed photos and silhouettes to find the profile break point at which BSSO surgery would be recommended. Both prognathic and retrognathic profile break points were evaluated. A two group repeated measures ANOVA test was used to determine a group effect.

Results: The two group repeated measures ANOVA test found a statistically significant difference between orthodontists and oral surgeons when evaluating class II and class III profiles for surgery ($P = 0.000$). There was a statistically significant difference between

photos and silhouettes when evaluating class III profiles ($P = 0.014$), but not when evaluating class II profiles ($P = 0.213$).

Conclusions: Oral surgeons and orthodontists do not recommend surgery for the same level of jaw discrepancy when they use photos and silhouettes. Oral surgeons recommended BSSO surgery at a lesser degree of retrognathia. Orthodontists recommended surgery at a lesser degree of prognathia. Photos and silhouettes were evaluated differently for patients with prognathic mandibles.

CHAPTER ONE

REVIEW OF THE LITERATURE

The past twenty-five years have brought significant advancements in the surgical management of skeletal and dental deformities. Consequently, there has been an increase in predictable surgical outcomes and patient satisfaction.¹

Orthognathic Surgery

Though surgery entails risk, in some cases surgery is essential to obtain an acceptable orthodontic outcome. When orthodontic movements will be in excess of the limits of tooth movement, the health and functional capabilities of the dentition may be at risk if surgery is not performed.² One significant benefit of surgery is that it has the potential to significantly decrease treatment times.³ There are many other benefits and risks that must be evaluated before a decision is made to proceed with surgery.¹

Profile

Essential aspects of orthodontic treatment planning are profile balance and attractiveness. Many treatment decisions, such as extraction and surgery, take profile balance into consideration. Various studies have been performed evaluating the point at which bilateral sagittal split osteotomies are recommended. According to some, mandibular retrusion up to -4.0 mm seems to be essentially unnoticeable, whereas surgery is desired if retrusion is greater than -8.0 mm.⁴ Mandibular protrusion up to +2.0

mm is essentially unnoticeable but protrusion greater than +5.0 mm was unappealing and clinicians recommended surgery.⁴ These numbers have been based on an 'ideal' sagittal position with soft tissue pogonion on or just behind a true vertical line through subnasale.⁴

Less ideal soft tissue profile outcomes have been associated with 1) larger pre-treatment SNA values, 2) larger pre treatment mandibular incisor inclination and 3) smaller final maxillary incisor inclination.⁵ If improved profile esthetics are desired, an initial ANB angle of at least six degrees has been recommended.⁶ Another study found that orthodontists identify the profile as consistently improved by surgery when the initial ANB angle was ≥ 5.5 degrees. The same study showed oral surgeons found the profile improved by surgery when the initial ANB angle was ≥ 6.5 degrees.⁷ These results suggest that patients with an initial ANB of about 6 degrees will show a perceptible improvement in profile after surgery.

It is apparent in the literature that oral surgeons and orthodontists do not fully agree on profile acceptability.^{8,9} As stated above, there was only one degree ANB difference between images orthodontists and oral surgeons found improved by orthognathic surgery.⁷ Though oral surgeons and orthodontists may not agree on the exact degree of prognathia or retrognathia at which surgery should be recommended, there is a small difference between their choices. This may signify that there is no significant clinical difference between the evaluators.¹⁰

Surgical Age

Most orthognathic surgery is done after skeletal growth is complete. Waiting until

maturity lessens the possibility of relapse due to continued growth. Various studies have found the median age of surgery to be in the early to mid twenties.^{11, 12,13} A study by Chen et al., found that 66.7% of their patients were 21-30 years of age at time of surgery.¹⁴

Evaluators Perception of Facial Attractiveness

Most studies on facial attractiveness evaluate profile images or silhouettes. This allows the researcher to mask confounding factors such as race, gender, facial blemishes and beauty. These profiles are most often rated using a visual analog scale.⁷

Photos and silhouettes have been used in previous research to evaluate the profile esthetics of African Americans. The results revealed that the most attractive profiles were flatter than the norm in 39% male and 22% female silhouettes but only in 15% male and 3% female photos. Raters evaluating silhouettes more often preferred flatter than normal profiles with less lip projection. This study showed that: 1) photo preferences were closer to established norms, 2) flatter profiles were preferred over esthetic norms in silhouette, and 3) fuller profiles were preferred in only 3% of the silhouettes and 5% of the photos. Clinically, silhouette images may cause the clinician to favor flatter profiles than established norms.¹⁵

Almeida and Bittencourt conducted a study based on anterioposterior position of the mandible and the perceived need for orthognathic surgery.¹⁶ The study was conducted using a normal profile image and moving the mandible backwards in three photos and moving it forward in three photos. A rater (oral surgeon, orthodontist, artist or layperson) was then given the photos set and asked to determine which faces needed

surgery and whether they would seek treatment personally. The results revealed that surgery was recommended more often for males with a class II discrepancy. Thus, indicating male faces with a prominent chin are more socially acceptable. In contrast, females with a class III skeletal discrepancy were more often advised to have surgery by the raters. Interestingly, raters said they would recommend surgery more often when evaluating a female profile. This seems to show that greater value is placed on facial aesthetics in the female population.¹⁶

Research supports the conclusion that oral surgeons recommend BSSO surgical treatment for a greater number of profiles than orthodontists.^{16,17} This was validated in a study that used study models, pictures and radiographs for evaluation of surgical needs. Oral surgeons and orthodontists rated surgical need higher than did patients based on facial appearance alone. The same study showed that oral surgeons opted for surgery more often based on functional problems when compared to orthodontists.⁸ Juggins, et al., postulated that the variation may be due to orthodontists encountering patients with functional problems more frequently and not seeing them as handicapping.⁸ Bell, et al., found that oral surgeons and orthodontists evaluate the facial profile similarly.¹⁷ Orthodontists and oral surgeons are more likely to choose class I skeletal relationship as the most attractive profile when compared to ratings by the general public and dental students.¹⁸

Summary

According to most current literature, oral surgeons recommend surgery before orthodontists, patients, and laypersons.^{8,16,17} Still, some literature disputes these

conclusions.¹⁰ Orthognathic patients are the rater group that is most critical of profile attractiveness whereas laypersons are the most accepting of a variety of facial types. The clinician must keep each patient's needs and opinions a priority when determining surgical recommendations.

CHAPTER TWO
PHOTOS AND SILHOUETTES IN EVALUATING THE NEED
FOR BSSO SURGERY IN ADULT FEMALES

Introduction

The dental community has embraced orthognathic surgery as a reliable method of correcting skeletal facial imbalance. Malocclusion can be corrected in many cases without surgery, but an improved profile aesthetic may require surgical intervention. Consequently, it is important to know if the practitioners involved (orthodontists and oral surgeons) have similar break-points when recommending surgery based on profile photos and silhouettes.

An essential aspect of orthodontic treatment planning is profile balance and attractiveness. Various studies have been completed evaluating the point at which bilateral sagittal split osteotomy surgery is recommended. Mandibular retrusion up to -4.0 mm and protrusion up to +2.0 mm seem to be essentially unnoticeable, whereas surgery is desired if retrusion is greater than -8.0 mm and protrusion is greater than +5.0 mm.⁴ Recent research has found that an initial ANB of about 6 degrees will show a perceptible improvement in the profile after surgery.^{6,7} Various studies have found the median age of surgery to be in the early to mid twenties.^{11,12,13,14}

Photos and silhouettes have been used in previous research to evaluate the profile esthetics of African Americans. Conclusions that can be taken from this study are: 1) photo preferences were closer to established norms, 2) flatter profiles than esthetic norms

were preferred in silhouette, and 3) fuller profiles were preferred in only 3% of the silhouettes and 5% of the photos. Using silhouette images could cause clinicians to favor profiles that are flatter than the established norm¹⁵.

Almeda and Bittencourt conducted a study based on anterioposterior position of the mandible and the perceived need for orthognathic surgery. The results showed that surgery was recommended more often for males with a class II discrepancy, indicating male faces with a prominent chin were more socially acceptable. In contrast, females with a class III skeletal discrepancy were more often advised to have surgery by the evaluators. Interestingly, raters said they would recommend surgery more often when evaluating a female profile.¹⁶

Research supports the conclusion that oral surgeons recommend BSSO surgical treatment for a greater number of profiles than orthodontists.^{16,17} This was validated in a study that used study models, pictures & radiographs for evaluation. Oral surgeons and orthodontists rated surgical need higher than did patients based on facial appearance alone. The same study showed that surgeons opted for surgery more often based on functional problems when compared to orthodontists. Juggins, et al., postulated that the variation may be due to orthodontists encountering patients with functional problems more often and not seeing them as handicapping.⁸ Bell, et al., found that oral surgeons and orthodontists evaluate the facial profile similarly.¹⁷ Orthodontists and oral surgeons are more likely to choose class I skeletal relationship as the most attractive profile when compared to ratings by the general public and dental students.¹⁸

Purpose and Hypothesis

The purpose of this study was to evaluate the point at which oral surgeons and orthodontists recommend BSSO surgery when evaluating incrementally morphed mandibles in adult female silhouettes and photos. The goal was to ascertain: 1) if oral surgeons and orthodontists recommend surgery at different degrees of retrognathia and prognathia and 2) if the use of photos or silhouettes is superior when determining the need for mandibular orthognathic surgery.

The null hypothesis is that there is no difference between the point at which an orthodontist and an oral surgeon determine mandibular surgery is necessary when evaluating both adult female profiles and adult female silhouettes. The alternative hypothesis is that there is a significant difference between the point at which an orthodontist and an oral surgeon determine mandibular surgery is necessary when evaluating both adult female profiles and adult female silhouettes. The results of this study may help orthodontists and oral surgeons more accurately recommend treatment options, to enhance profile attractiveness, to their retrognathic and prognathic patients.

Materials and Methods

Fifty-one adult female subjects with balanced profiles and class I skeletal balance (ANB 0-2) were selected from the patients treated at the Graduate Orthodontic Clinic, Loma Linda University School of Dentistry. All individuals were over eighteen years of age. The sample included African American, Asian, Caucasian and Hispanic subjects. Pre-treatment profile pictures were collected and morphed backward (at B point & Pog), in 2 mm steps, until severely retrognathic CL II ANB position was acquired. The images

were further morphed until a severely prognathic mandible was created (Fig 1). Each image was labeled from 0-4 as the retrognathia or prognathia increased. Each morphed image step represents 2 mm of mandibular change. Morphing was done using Dolphin Imaging (v.11.5) software. These morphed profile photos (Fig 1) were then masked using Adobe Photoshop CS (v.5.1) to create silhouette images (Fig 2).

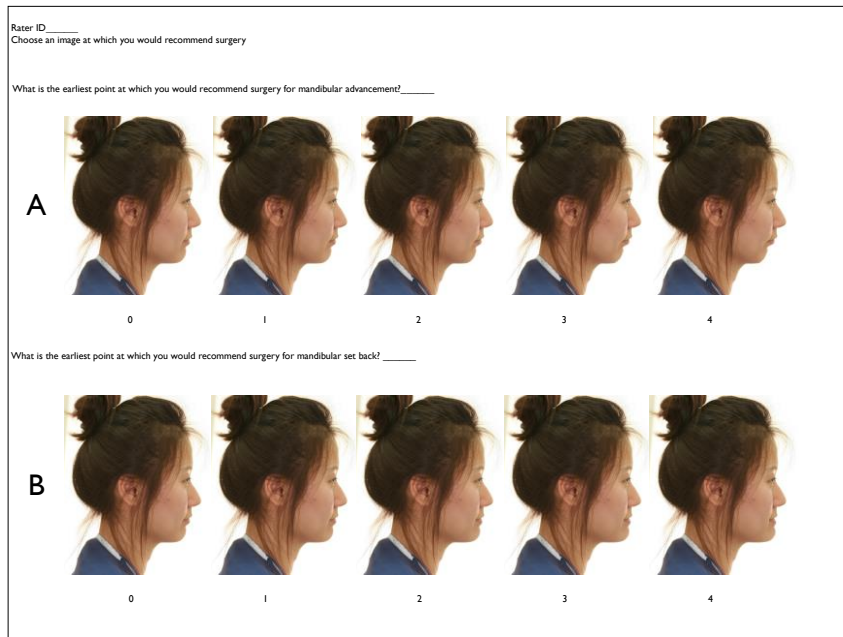


Fig 1. Modified profile photos showing the morphed mandible in 2 mm steps. Step 0 is the normal position. Row A shows the mandible morphed backward into class II. Row B shows the mandible morphed forward into class III.

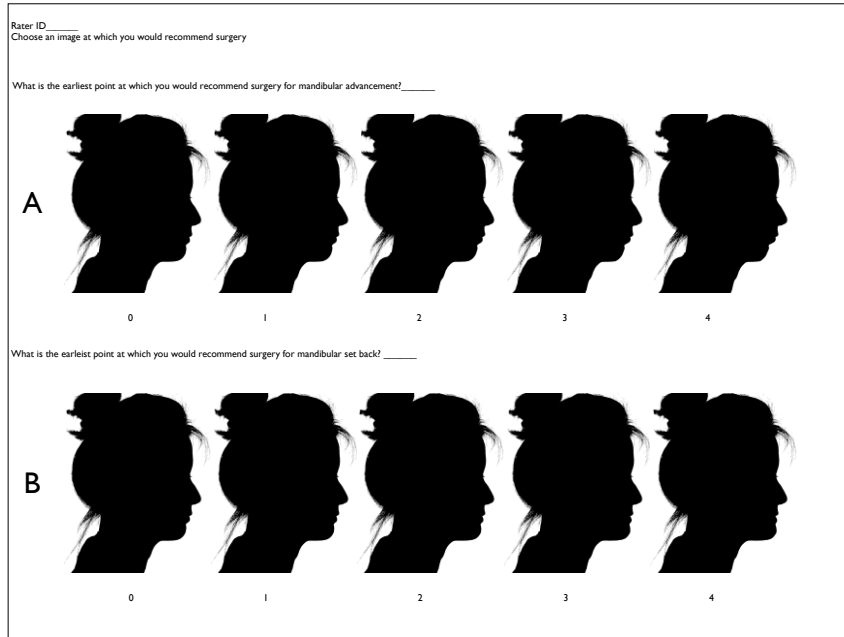


Fig 2. Modified profile silhouettes showing the morphed mandible in 2 mm steps. Step 0 is the normal position. Row A shows the mandible morphed backward into class II. Row B shows the mandible morphed forward into class III.

Three orthodontists and three oral maxillofacial surgeons evaluated the morphed photos and silhouettes. Each evaluator determined the mandibular position at which they would recommend surgical advancement or set back for each image set (Appendix A).

A questionnaire (Appendix B) collected information on each rater's age, years in practice, gender, amount of surgery in their practice, and perceived risk of surgery (rated 1-10 with 1 being no risk and 10 being life threatening). The Institutional Review Board approved this project.

Statistical Analysis

Descriptive statistics in the form of means and standard deviations were used to summarize quantitative variables. Frequencies with percentages were used to summarize

qualitative variables. A two-group repeated measures ANOVA was used to determine if there was a group effect between orthodontists and oral surgeons (within subject factor) and between photos and silhouettes. All tests of hypothesis were two-sided and considered to be significant at $\alpha = 0.05$.

Results

The mean values of mandibular retrognathia that triggered the choice of class II BSSO advancement surgery are listed in Table 1. When viewing modified silhouettes, orthodontists recommended a BSSO advancement at -5.4 mm (-2.7 image steps) (SD 0.89 image steps) and oral surgeons recommended a BSSO advancement at -4.6 mm (-2.3 image steps) (SD 0.92 image steps). When viewing modified photos, orthodontists recommended a BSSO advancement at -5.2 mm (-2.6 image steps) (SD 0.86 image steps) and oral surgeons recommended a BSSO advancement at -4.2 mm (-2.1 image steps) (SD 0.87 image steps).

The mean values of mandibular prognathia that triggered the choice of class III BSSO setback surgery are listed in Table 1. When viewing modified silhouettes, orthodontists recommended a BSSO setback at +5.8mm (+2.9 image steps) (SD 0.75 image steps) and oral surgeons recommended a BSSO setback at +6.4 mm (+3.2 image steps) (SD 0.53 image steps). When viewing modified photos, orthodontists recommended a BSSO setback at +5.6 mm (+2.8 image steps) (SD 0.79 image steps) and oral surgeons recommended a BSSO setback at +6.0 mm (+3.0 image steps) (SD 0.63 image steps).

There was a statistically significant difference between orthodontists and oral

surgeons in rating class II (P =0.000) and class III (P =0.000) silhouettes and photos (Table 2).

There was a statistically significant difference between silhouettes and photos in the rating of class III cases (P =0.014), however, there was no statistically significant difference between silhouettes and photos in the rating of class II cases (P =0.213) (Table 2).

Table 1. Mean and Standard Deviation Scores for Surgical Recommendations based on Silhouette and Photo Profile Images. Negative means indicate retrognathic mandibular images and positive means indicate prognathic images. One step corresponds to 2 mm.

| Profile Class | Group | Method | Mean Image Steps | SD | Conversion (mm) |
|---------------|---------------|------------|------------------|------|-----------------|
| Class II | Orthodontists | Silhouette | -2.7 | 0.89 | -5.4 |
| Class II | Orthodontists | Photo | -2.6 | 0.86 | -5.2 |
| Class II | Oral Surgeon | Silhouette | -2.3 | 0.92 | -4.6 |
| Class II | Oral Surgeon | Photo | -2.1 | 0.87 | -4.2 |
| Class III | Orthodontists | Silhouette | 2.9 | 0.75 | 5.8 |
| Class III | Orthodontists | Photo | 2.8 | 0.79 | 5.6 |
| Class III | Oral Surgeons | Silhouette | 3.2 | 0.53 | 6.4 |
| Class III | Oral Surgeons | Photo | 3.0 | 0.63 | 6.0 |

Table 2. Summary of Repeated Measures ANOVA Results.

| Profile Class | Group | P Value |
|---------------|---------------------------------|---------|
| Class II | Orthodontists vs. Oral Surgeons | 0.000* |
| Class II | Silhouettes vs. Photos | 0.213 |
| Class III | Orthodontists vs. Oral Surgeons | 0.000* |
| Class III | Silhouettes vs. Photos | 0.014* |

*Significant at $\alpha= 0.05$

Rater demographic data was collected via the questionnaire (Appendix B) and reported in Table 3. All raters were male. All orthodontic raters were less than 60 years of age. The oral surgeons were different age ranges with one being less than 50, one less than 60, and one less than 70 years old. The orthodontic raters had been in practice for different time periods: 1) 16-20 years, 2) 21-25 years, 3) >30 years. Two oral surgeons had been in practice for 11-15 years and one for more than 30 years. The orthodontists' experience with surgical cases ranged from: 1) 0-20 cases to 2) 21-50 to 3) more than 100 cases. One oral surgeon had completed more than 100 cases and the other two had completed more than 300 cases.

The average orthodontist perceived the risk associated with surgery to be 3.3. The average oral surgeon rated the risk associated with surgery to be 2.3. These were based on a scale of 1 being no risk and 10 being life threatening.

Table 3. Demographic Data. The column data is listed in ascending order within each rater group so that age, years in practice, surgical experience and perceived risk associated with surgery cannot be associated with an individual rater.

| Rater | Age | Years in Practice | Surgical Experience | Risk of Surgery* |
|--------------|-------|-------------------|---------------------|------------------|
| Orthodontist | 50-60 | 16-20 | 0-20 | 2 |
| Orthodontist | 50-60 | 21-25 | 21-50 | 3 |
| Orthodontist | 50-60 | >30 | >100 | 5 |
| Oral Surgeon | 40-50 | 11-15 | >100 | 2 |
| Oral Surgeon | 50-60 | 11-15 | >300 | 2 |
| Oral Surgeon | 60-70 | >30 | >300 | 3 |

* Average risk associated with surgery: Orthodontists (3.3), Oral Surgeons (2.2).

Discussion

Skeletal class II or class III malocclusions can be difficult to correct with orthodontics alone. Orthognathic surgery has become a reliable and improved treatment option that the clinician can use to correct these skeletal imbalances. It is important to know if orthodontists or oral surgeons are more prone to recommend BSSO surgery. In addition, it is important to know if photos or silhouettes influence the clinician differently.

The decision to evaluate female subjects was based on the fact that surgery is most often performed on adult females.¹² In addition, raters have recommended surgery more often “on themselves” when they were looking at female images.¹⁶

Oral surgeons and orthodontists rated surgery for class II and class III profile disharmony at statistically different mandibular positions. This finding is consistent with current literature.^{8,16,17} Oral surgeons recommended surgery for class II profile disharmony at a less retrognathic profile image (-4.2 mm photo/ -4.6 mm silhouette) than orthodontists (-5.2 mm photo/ -5.4 mm silhouette) resulting in 1.0 mm and 0.8 mm differences respectively (Table 1). This supports the conclusion that oral surgeons are more prone to recommend surgery (based on profile images) than orthodontists.^{8,16,17} This suggests that orthodontists allow more Class II disharmony in their range of profile acceptability.

Conversely, orthodontists were more prone to recommend surgery for class III profiles at a lesser degree of prognathia (0.4 mm less for photos/ 0.6 mm less for silhouettes) (Table 1). This is not in agreement with the previously referenced literature that concluded that oral surgeons would recommend surgery more often than orthodontists.^{8,16,17} Another study found that raters were more prone to recommend

surgery for class III profiles when evaluating female profiles.¹⁶ This may explain why orthodontists were more likely to recommend surgery for females, but does not explain why oral surgeons recommended surgery in slightly more prognathic profiles. This conclusion suggests oral surgeons allow more class III disharmony in their range of profile acceptability. These unexpected findings may be due to a small rater size.

No statistically significant differences were found between photos and silhouettes for class II surgery ($P= 0.213$). These results indicate that orthodontists and oral surgeons do not rate one form of imagery (photo or silhouette) different than the other when evaluating class II profile disharmony.

Evaluators rated surgery differently when evaluating class III photos compared to class III silhouettes (average 0.4 mm difference) (Table 1, Table 2). Surgery was advised at a lesser degree of prognathia in photos. Restated, photos are more appealing when less prognathic. This finding is not consistent with previous literature in which silhouettes were more appealing when less prognathic.¹⁵ It is possible that seeing the photo with more defining characteristics (such as hair color, skin color, and overall facial esthetics) caused the evaluator to recommend surgery at a lesser degree of prognathia. The previous study was carried out solely on African American male and female individuals. This study used a mix of female ethnicities.

Orthodontists on average recommended surgery for class II photos and silhouettes at -5.3 mm and oral surgeons recommended surgery for class II photos and silhouettes on average at -4.4 mm. This is in agreement with previous research that found that mandibular retrusion up to -4.0 mm was essentially unnoticeable and surgery was needed at -8.0 mm.⁴

Orthodontists on average recommended surgery for class III photos and silhouettes at +5.7 mm. Oral surgeons recommended surgery for prognathic mandibles (class III) photos and silhouettes at an average of +6.2 mm. Previous studies show that protrusion up to +2.0 mm was essentially unnoticeable and that surgery was recommended by clinicians at > +5.0 mm.⁴ The data from this study was consistent with these results.

To be considered clinically significant, research must meet three criteria: 1) the difference between the control and clinical group is of interest to someone (clinicians or patients), 2) the change occurred in an important outcome and 3) the change reached statistical significance.¹⁹ Differences between surgical recommendations by oral surgeons and orthodontists can have negative consequences for the patient's treatment plan and surgical esthetic outcome. Statistically significant differences were also found between the raters. However, the claim that a difference of 1.0 mm in surgical prediction is of interest to the patient and clinician is questionable.

Though statistical significance was found in this study, clinical significance may be doubtful. As previously discussed, the largest millimeter difference between orthodontists and oral surgeons, when recommending BSSO advancement or set back, was 1.0 mm. The millimeter difference between photos and silhouettes was 0.4 mm. Such small differences are very difficult to visually perceive when comparing photo or silhouette profiles. The difference between photos and silhouettes and orthodontists and oral surgeons seem so small as to signify no clinical difference in patient surgical recommendations and results.¹⁹

Overall, oral surgeons and orthodontists did not perceive surgery to be highly risky. In general, oral surgeons and orthodontists rated the risk of surgery to be the same (their risk ratings of 2.3 and 3.3 were similar). Thus, orthodontist and oral surgeons view orthognathic surgery as a relatively safe tool to balance and correct occlusion and facial disharmony.

Conclusions

1. Orthodontists and oral surgeons did not recommend BSSO surgery for class II adult female patients and class III adult female patients at the same level of retrognathia and prognathia when evaluating profile silhouettes and photos.
2. Oral surgeons recommended BSSO advancement surgery for adult female patients at less retrognathia than orthodontists (-0.9 mm less)(for class II profiles).
3. Orthodontists recommended BSSO set back surgery for adult female patients at less prognathia than oral surgeons (+0.5 mm less)(for class III profiles).
4. A statistically significant difference was found between photos and silhouettes when assessing the point of BSSO surgical recommendation for class III adult female profiles. Surgery was recommended at less prognathia when evaluating photos (+0.4 mm less).
5. Orthodontists and oral surgeons perceive the overall risk of surgery to be similar.
6. Although statistically significant differences were reported, this paper supports the idea that orthodontists and oral surgeons make similar clinical decisions (within 1.0 mm).

CHAPTER THREE

EXTENDED DISCUSSION

Future studies could evaluate both male and female subjects, to determining if photos and silhouettes cause different recommendations for BSSO surgery. In addition, keeping the sample confined to one ethnicity may reveal very practical information concerning specific surgical treatment recommendations. This study could also be extended to evaluate frontal facial photos. Another research option would be to evaluate photos and silhouettes for LeFort surgery or two-jaw surgery.

Several limitations were present in this study. The sample only included female subjects, which narrowed the scope of the study. Specific races were not taken into account. The number of raters was relatively small. All of these could have been confounding variables in the results.

More images could have been included in each class II and class III group showing additional degrees of prognathia and retrognathia. This would have given the rater more break point options. The study did not specify if the rater chose image 4 to be the break point for surgery or if that was simply the most retrognathic or prognathic image available. Some raters may have picked an image greater than 4 if it had been provided.

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APPENDIX A

RAW DATA

| | Rater One (Orthodontist) | | | |
|----|--------------------------|-------|------------|-------|
| | Class II | | Class III | |
| | Silhouette | Photo | Silhouette | Photo |
| 1 | 3 | 3 | 4 | 3 |
| 2 | 4 | 4 | 2 | 3 |
| 3 | 4 | 4 | 2 | 2 |
| 4 | 4 | 4 | 2 | 2 |
| 5 | 4 | 4 | 3 | 2 |
| 6 | 3 | 3 | 4 | 1 |
| 7 | 2 | 3 | 4 | 3 |
| 8 | 4 | 4 | 2 | 3 |
| 9 | 3 | 4 | 3 | 3 |
| 10 | 3 | 2 | 3 | 4 |
| 11 | 1 | 2 | 4 | 4 |
| 12 | 4 | 4 | 3 | 3 |
| 13 | 4 | 4 | 2 | 2 |
| 14 | 0 | 0 | 4 | 4 |
| 15 | 3 | 3 | 2 | 3 |
| 16 | 2 | 2 | 4 | 4 |
| 17 | 2 | 3 | 3 | 3 |
| 18 | 3 | 4 | 2 | 2 |
| 19 | 1 | 2 | 4 | 4 |
| 20 | 3 | 4 | 2 | 3 |
| 21 | 4 | 3 | 4 | 3 |
| 22 | 4 | 4 | 1 | 1 |
| 23 | 2 | 2 | 3 | 2 |
| 24 | 4 | 4 | 2 | 2 |
| 25 | 4 | 4 | 3 | 2 |
| 26 | 3 | 4 | 3 | 2 |
| 27 | 3 | 3 | 3 | 4 |
| 28 | 3 | 4 | 3 | 2 |
| 29 | 2 | 2 | 4 | 4 |
| 30 | 4 | 4 | 2 | 2 |
| 31 | 3 | 4 | 2 | 3 |

| | | | | |
|----|--------------------------|-------|------------|-------|
| 32 | 4 | 3 | 2 | 2 |
| 33 | 1 | 2 | 4 | 4 |
| 34 | 3 | 3 | 2 | 2 |
| 35 | 4 | 4 | 3 | 3 |
| 36 | 4 | 3 | 2 | 2 |
| 37 | 4 | 3 | 3 | 2 |
| 38 | 4 | 4 | 2 | 2 |
| 39 | 3 | 3 | 3 | 3 |
| 40 | 4 | 4 | 3 | 4 |
| 41 | 4 | 4 | 3 | 3 |
| 42 | 3 | 3 | 3 | 2 |
| 43 | 4 | 4 | 1 | 1 |
| 44 | 4 | 3 | 3 | 2 |
| 45 | 3 | 3 | 4 | 3 |
| 46 | 3 | 3 | 3 | 3 |
| 47 | 3 | 2 | 3 | 3 |
| 48 | 3 | 4 | 4 | 3 |
| 49 | 2 | 2 | 4 | 3 |
| 50 | 2 | 2 | 4 | 4 |
| 51 | 3 | 3 | 4 | 4 |
| | Rater Two (Orthodontist) | | | |
| | Class II | | Class III | |
| | Silhouette | Photo | Silhouette | Photo |
| 1 | 0 | 2 | 4 | 4 |
| 2 | 3 | 2 | 3 | 3 |
| 3 | 3 | 3 | 2 | 3 |
| 4 | 3 | 2 | 3 | 2 |
| 5 | 2 | 3 | 2 | 3 |
| 6 | 3 | 3 | 2 | 2 |
| 7 | 2 | 3 | 4 | 3 |
| 8 | 3 | 1 | 3 | 2 |
| 9 | 3 | 4 | 3 | 2 |
| 10 | 2 | 1 | 4 | 3 |
| 11 | 0 | 1 | 4 | 4 |
| 12 | 3 | 2 | 3 | 3 |
| 13 | 4 | 4 | 1 | 3 |
| 14 | 3 | 0 | 4 | 4 |
| 15 | 3 | 3 | 3 | 3 |
| 16 | 0 | 0 | 4 | 4 |
| 17 | 1 | 2 | 4 | 3 |
| 18 | 3 | 2 | 3 | 3 |

| | | | | |
|----|----------------------------|-------|------------|-------|
| 19 | 0 | 1 | 4 | 4 |
| 20 | 2 | 2 | 3 | 3 |
| 21 | 1 | 2 | 3 | 4 |
| 22 | 4 | 3 | 1 | 1 |
| 23 | 3 | 3 | 4 | 3 |
| 24 | 3 | 4 | 2 | 3 |
| 25 | 2 | 3 | 2 | 2 |
| 26 | 3 | 2 | 3 | 3 |
| 27 | 3 | 1 | 4 | 2 |
| 28 | 3 | 2 | 4 | 3 |
| 29 | 1 | 1 | 4 | 4 |
| 30 | 3 | 1 | 2 | 2 |
| 31 | 2 | 4 | 2 | 3 |
| 32 | 4 | 2 | 4 | 2 |
| 33 | 1 | 0 | 4 | 4 |
| 34 | 3 | 3 | 3 | 2 |
| 35 | 3 | 3 | 3 | 3 |
| 36 | 3 | 2 | 3 | 2 |
| 37 | 3 | 2 | 3 | 3 |
| 38 | 2 | 2 | 3 | 3 |
| 39 | 2 | 3 | 3 | 4 |
| 40 | 4 | 2 | 4 | 2 |
| 41 | 2 | 3 | 3 | 4 |
| 42 | 3 | 2 | 3 | 3 |
| 43 | 2 | 4 | 2 | 2 |
| 44 | 3 | 4 | 2 | 1 |
| 45 | 1 | 2 | 4 | 3 |
| 46 | 2 | 3 | 4 | 3 |
| 47 | 1 | 2 | 4 | 4 |
| 48 | 1 | 1 | 4 | 3 |
| 49 | 1 | 2 | 4 | 4 |
| 50 | 2 | 1 | 4 | 4 |
| 51 | 2 | 1 | 4 | 4 |
| | Rater Three (Orthodontist) | | | |
| | Class II | | Class III | |
| | Silhouette | Photo | Silhouette | Photo |
| 1 | 2 | 2 | 4 | 4 |
| 2 | 4 | 4 | 1 | 1 |
| 3 | 3 | 3 | 2 | 3 |
| 4 | 4 | 3 | 2 | 3 |
| 5 | 2 | 2 | 2 | 2 |

| | | | | |
|----|---|---|---|---|
| 6 | 3 | 4 | 1 | 0 |
| 7 | 2 | 3 | 3 | 2 |
| 8 | 2 | 3 | 3 | 2 |
| 9 | 3 | 3 | 2 | 2 |
| 10 | 2 | 1 | 3 | 4 |
| 11 | 1 | 1 | 4 | 4 |
| 12 | 4 | 4 | 4 | 3 |
| 13 | 4 | 4 | 1 | 2 |
| 14 | 0 | 0 | 4 | 4 |
| 15 | 2 | 2 | 3 | 4 |
| 16 | 1 | 0 | 3 | 4 |
| 17 | 3 | 3 | 2 | 2 |
| 18 | 3 | 3 | 2 | 3 |
| 19 | 0 | 2 | 4 | 4 |
| 20 | 3 | 2 | 1 | 2 |
| 21 | 2 | 1 | 3 | 2 |
| 22 | 4 | 3 | 2 | 1 |
| 23 | 3 | 2 | 2 | 2 |
| 24 | 4 | 3 | 2 | 2 |
| 25 | 3 | 3 | 2 | 2 |
| 26 | 4 | 3 | 4 | 3 |
| 27 | 2 | 2 | 2 | 3 |
| 28 | 4 | 3 | 2 | 2 |
| 29 | 2 | 1 | 3 | 4 |
| 30 | 3 | 3 | 2 | 2 |
| 31 | 3 | 4 | 3 | 3 |
| 32 | 4 | 2 | 2 | 1 |
| 33 | 1 | 0 | 4 | 4 |
| 34 | 3 | 3 | 2 | 1 |
| 35 | 3 | 3 | 3 | 3 |
| 36 | 3 | 2 | 3 | 2 |
| 37 | 3 | 3 | 3 | 3 |
| 38 | 4 | 4 | 2 | 2 |
| 39 | 2 | 3 | 2 | 2 |
| 40 | 4 | 4 | 3 | 2 |
| 41 | 3 | 3 | 2 | 3 |
| 42 | 3 | 4 | 3 | 2 |
| 43 | 4 | 3 | 1 | 2 |
| 44 | 3 | 3 | 3 | 1 |
| 45 | 3 | 3 | 4 | 3 |
| 46 | 1 | 2 | 3 | 4 |

| | | | | |
|----|----------------------|-------|------------|-------|
| 47 | 3 | 3 | 3 | 3 |
| 48 | 3 | 2 | 4 | 4 |
| 49 | 2 | 2 | 3 | 2 |
| 50 | 3 | 2 | 4 | 3 |
| 51 | 3 | 2 | 3 | 4 |
| | Rater Four (Surgeon) | | | |
| | Class II | | Class III | |
| | Silhouette | Photo | Silhouette | Photo |
| 1 | 2 | 2 | 4 | 3 |
| 2 | 3 | 2 | 4 | 4 |
| 3 | 2 | 2 | 4 | 4 |
| 4 | 4 | 1 | 4 | 3 |
| 5 | 0 | 1 | 4 | 4 |
| 6 | 2 | 2 | 4 | 3 |
| 7 | 2 | 2 | 4 | 3 |
| 8 | 1 | 1 | 3 | 4 |
| 9 | 3 | 2 | 3 | 2 |
| 10 | 1 | 0 | 4 | 4 |
| 11 | 0 | 0 | 3 | 4 |
| 12 | 2 | 2 | 4 | 4 |
| 13 | 2 | 3 | 4 | 4 |
| 14 | 0 | 0 | 4 | 4 |
| 15 | 2 | 2 | 4 | 4 |
| 16 | 0 | 0 | 4 | 4 |
| 17 | 2 | 1 | 4 | 3 |
| 18 | 4 | 3 | 4 | 3 |
| 19 | 0 | 1 | 4 | 4 |
| 20 | 1 | 1 | 4 | 3 |
| 21 | 2 | 2 | 4 | 3 |
| 22 | 3 | 2 | 4 | 4 |
| 23 | 3 | 1 | 4 | 3 |
| 24 | 3 | 3 | 3 | 4 |
| 25 | 2 | 2 | 4 | 3 |
| 26 | 3 | 2 | 4 | 4 |
| 27 | 1 | 1 | 3 | 4 |
| 28 | 1 | 1 | 4 | 4 |
| 29 | 0 | 1 | 4 | 4 |
| 30 | 2 | 3 | 4 | 3 |
| 31 | 2 | 2 | 4 | 4 |
| 32 | 4 | 3 | 4 | 4 |
| 33 | 0 | 0 | 4 | 3 |

| | | | | |
|----|----------------------|-------|------------|-------|
| 34 | 2 | 1 | 4 | 4 |
| 35 | 3 | 1 | 4 | 4 |
| 36 | 1 | 2 | 4 | 3 |
| 37 | 2 | 3 | 4 | 4 |
| 38 | 1 | 2 | 4 | 3 |
| 39 | 1 | 2 | 4 | 4 |
| 40 | 3 | 3 | 3 | 3 |
| 41 | 2 | 2 | 4 | 3 |
| 42 | 2 | 2 | 4 | 4 |
| 43 | 1 | 3 | 4 | 3 |
| 44 | 4 | 3 | 4 | 3 |
| 45 | 2 | 2 | 4 | 4 |
| 46 | 2 | 2 | 4 | 4 |
| 47 | 2 | 1 | 4 | 2 |
| 48 | 1 | 1 | 4 | 4 |
| 49 | 1 | 1 | 4 | 3 |
| 50 | 2 | 1 | 4 | 4 |
| 51 | 1 | 1 | 4 | 4 |
| | Rater Five (Surgeon) | | | |
| | Class II | | Class III | |
| | Silhouette | Photo | Silhouette | Photo |
| 1 | 3 | 3 | 2 | 3 |
| 2 | 3 | 4 | 0 | 2 |
| 3 | 1 | 3 | 2 | 3 |
| 4 | 0 | 2 | 3 | 3 |
| 5 | 4 | 4 | 2 | 2 |
| 6 | 3 | 0 | 0 | 0 |
| 7 | 4 | 3 | 1 | 1 |
| 8 | 4 | 0 | 3 | 3 |
| 9 | 4 | 3 | 1 | 2 |
| 10 | 1 | 2 | 1 | 1 |
| 11 | 3 | 1 | 3 | 3 |
| 12 | 3 | 4 | 3 | 3 |
| 13 | 4 | 4 | 1 | 3 |
| 14 | 2 | 1 | 4 | 4 |
| 15 | 4 | 2 | 2 | 3 |
| 16 | 3 | 2 | 2 | 3 |
| 17 | 3 | 3 | 2 | 2 |
| 18 | 4 | 4 | 2 | 1 |
| 19 | 0 | 1 | 3 | 4 |
| 20 | 3 | 4 | 1 | 2 |

| | | | | |
|----|---------------------|-------|------------|-------|
| 21 | 4 | 1 | 3 | 2 |
| 22 | 4 | 4 | 2 | 1 |
| 23 | 2 | 2 | 2 | 2 |
| 24 | 4 | 4 | 2 | 2 |
| 25 | 4 | 1 | 2 | 2 |
| 26 | 4 | 4 | 3 | 4 |
| 27 | 3 | 4 | 2 | 2 |
| 28 | 3 | 4 | 2 | 0 |
| 29 | 1 | 2 | 3 | 3 |
| 30 | 3 | 3 | 2 | 4 |
| 31 | 4 | 3 | 1 | 3 |
| 32 | 4 | 4 | 2 | 1 |
| 33 | 2 | 2 | 4 | 3 |
| 34 | 3 | 2 | 2 | 2 |
| 35 | 4 | 3 | 2 | 3 |
| 36 | 2 | 3 | 3 | 2 |
| 37 | 4 | 4 | 2 | 2 |
| 38 | 4 | 3 | 1 | 2 |
| 39 | 4 | 1 | 2 | 3 |
| 40 | 4 | 4 | 1 | 3 |
| 41 | 2 | 1 | 1 | 2 |
| 42 | 3 | 4 | 1 | 3 |
| 43 | 4 | 3 | 2 | 1 |
| 44 | 4 | 4 | 3 | 1 |
| 45 | 2 | 1 | 2 | 2 |
| 46 | 2 | 3 | 2 | 3 |
| 47 | 4 | 2 | 2 | 2 |
| 48 | 2 | 2 | 2 | 3 |
| 49 | 1 | 1 | 1 | 3 |
| 50 | 1 | 2 | 2 | 3 |
| 51 | 4 | 4 | 3 | 2 |
| | Rater Six (Surgeon) | | | |
| | Class II | | Class III | |
| | Silhouette | Photo | Silhouette | Photo |
| 1 | 1 | 1 | 3 | 3 |
| 2 | 0 | 0 | 0 | 0 |
| 3 | 1 | 1 | 3 | 3 |
| 4 | 1 | 2 | 2 | 2 |
| 5 | 1 | 1 | 2 | 1 |
| 6 | 2 | 1 | 1 | 1 |
| 7 | 1 | 2 | 3 | 2 |

| | | | | |
|----|---|---|---|---|
| 8 | 1 | 1 | 2 | 2 |
| 9 | 1 | 2 | 2 | 2 |
| 10 | 0 | 1 | 3 | 2 |
| 11 | 0 | 0 | 4 | 4 |
| 12 | 1 | 2 | 2 | 3 |
| 13 | 2 | 1 | 1 | 3 |
| 14 | 0 | 0 | 4 | 4 |
| 15 | 0 | 1 | 3 | 3 |
| 16 | 0 | 0 | 4 | 4 |
| 17 | 0 | 2 | 2 | 2 |
| 18 | 2 | 3 | 2 | 2 |
| 19 | 0 | 0 | 4 | 4 |
| 20 | 2 | 2 | 2 | 2 |
| 21 | 1 | 1 | 2 | 2 |
| 22 | 2 | 3 | 0 | 1 |
| 23 | 0 | 1 | 3 | 2 |
| 24 | 3 | 2 | 2 | 1 |
| 25 | 1 | 2 | 3 | 2 |
| 26 | 1 | 2 | 2 | 2 |
| 27 | 0 | 0 | 4 | 4 |
| 28 | 0 | 1 | 2 | 2 |
| 29 | 0 | 0 | 4 | 4 |
| 30 | 2 | 2 | 1 | 2 |
| 31 | 1 | 1 | 2 | 2 |
| 32 | 2 | 2 | 1 | 2 |
| 33 | 0 | 0 | 4 | 4 |
| 34 | 2 | 2 | 2 | 2 |
| 35 | 1 | 1 | 2 | 2 |
| 36 | 1 | 2 | 2 | 3 |
| 37 | 2 | 2 | 2 | 2 |
| 38 | 1 | 1 | 2 | 2 |
| 39 | 1 | 1 | 2 | 3 |
| 40 | 1 | 1 | 2 | 2 |
| 41 | 1 | 1 | 2 | 2 |
| 42 | 1 | 1 | 2 | 2 |
| 43 | 2 | 2 | 1 | 1 |
| 44 | 1 | 2 | 1 | 2 |
| 45 | 0 | 1 | 3 | 4 |
| 46 | 0 | 1 | 3 | 3 |
| 47 | 0 | 0 | 4 | 2 |
| 48 | 0 | 1 | 3 | 3 |

| | | | | |
|----|---|---|---|---|
| 49 | 0 | 1 | 2 | 4 |
| 50 | 0 | 0 | 4 | 4 |
| 51 | 0 | 0 | 3 | 3 |

APPENDIX B
QUESTIONNAIRE

Questionnaire

Orthodontic Research

page 1 of 1

Evaluators Name#:

What is your gender?

- a) male
- b) female

What is your age?

- a) <30 yrs c) <50 yrs e) <70 yrs
- b) <40 yrs d) <60 yrs f) >70 yrs

How many years have you been practicing your specialty?

- a) 0-5 yrs e) 11-15 yrs g) >30 yrs
- b) 6-10 yrs d) 16-20 yrs f) 26-30 yrs

How many BSSO surgical orthognathic cases have you:

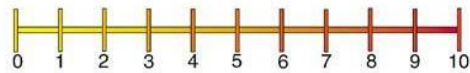
-set up and finished (ortho)?

- a) 0-20 e) 51-75 i) >2000 k) >4000
- b) 21-50 d) 76-100 f) >300 h) >1000 j) >3000 l) >5000

-performed surgery on (omfs)?

- a) 0-20 e) 51-75 i) >2000 k) >4000
- b) 21-50 d) 76-100 f) >300 h) >1000 j) >3000 l) >5000

How risky do you perceive surgery to be?



0 no risk

10-life threatening
with high sequelae

- a) 1 c) 3 e) 5 g) 7 i) 9
- b) 2 d) 4 f) 6 h) 8 j) 10