

**The Effect of the Lips and Face on Esthetic Outcomes of  
Anterior Implant Restorations**

BY

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THESIS

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This thesis is dedicated to all patients wanting esthetic outcomes of their anterior implant restorations, especially those who voluntarily participated in this study, without whom this study would not have been possible. As a dental health care provider and researcher, I vow to explore and provide the highest quality of care and research to increase patient satisfaction and quality of life.

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-ACP

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## LIST OF ABBREVIATIONS

|      |   |
|------|---|
| COD  | College of Dentistry                      |
| IRB  | Institutional Review Board                |
| PES  | Pink Esthetic Score                       |
| SPSS | Statistical Product and Service Solutions |
| UIC  | University of Illinois Chicago            |
| VAS  | Visual Analog Scale                       |
| WES  | White Esthetic Score                      |

## SUMMARY

The purpose of this research was to determine the effect of the lips and face on patient satisfaction, perceptibility, and acceptability of anterior implant restorations and to determine the effect of the lips and face on satisfaction, perceptibility and acceptability between dentists and patients. Both purposes were tested using a new modified PES/WES esthetic index.

The diagnostic tool to analyze the PES and WES was developed and verified. 51 photographs were digitally modified to represent a score of 0,1 and 2 (ideal) for selected esthetic factors in the PES and WES that were observable within the ideal photo subject's smile line. The photos consisted of three different views: only teeth, lips and facial portrait. A survey using these modified photos of a single implant anterior restoration was given to patients and dentists at University of Illinois Chicago (UIC) on an iPad (Apple Inc., California) or delivered to non UIC participants via a web-based format. Participants were asked to report their satisfaction scores using a 100mm visual analog scale, as well as state their perceptibility and acceptability of the single restoration. Data analysis was performed comparing satisfaction scores of the teeth versus the lips versus the face using a one-way ANOVA for both dentists and patients. Satisfaction scores for the lips and face in dentists versus patients were analyzed using the Independent t-test. Chi squared tests with Yates Correction and/or Fisher's Exact tests were used for perceptibility and acceptability comparisons between dentists and patients for each PES/WES factor. Statistical significance is defined as  $p \leq 0.05$ .

The survey was taken by a total of 44 participants. All participants were able to correctly identify all four of the Ishihara plates and were deemed to pass the colorblindness test. This made the final number of participants 44 for data analysis. Out of the 44 participants, 17 were dentists and 27 were patients. Analysis was performed and the effects of the lips and face on



## SUMMARY (Continued)

patient and dentist satisfaction, perceptibility and acceptability of implant restorations was determined. Patient satisfaction score was significantly different with the addition of the lips for two factors: score 1 of tooth translucency/value high and tooth color. The addition of the face affected patient satisfaction score significantly in 3 factors: score 1 of tooth translucency/value high and low and score 0 of tooth translucency/value high. The presence of the face increased the satisfaction score of the wide tooth form for dentists. The dentist satisfaction scores were influenced by the addition of the lips and the face but were significantly different in other criteria when compared to patient satisfaction scores. Patients were more tolerant of soft tissue deficiencies around the implant restoration as well as having an abnormal size/shape of the implant crown. Despite adding the face to the photo, dentists were still aware of the distal papilla deficiency and the wide tooth form. Despite adding the lips, dentists still perceived papillae changes and tooth form/surface more so than patients. 0-6% of dentists would accept a major mesial or distal papilla deficiency where less than 50% of the papilla is filled from zenith to contact point and only about half of the patients stated that they would not accept this result.

The results of this research led to several conclusions. The addition of the lips and the face influenced the satisfaction scores of patients and dentists. The presence of the face increased satisfaction scores of the tooth form for dentists. The most important parameters for patients are those for tooth color and value. Dentists appear to value tooth form more than patients. Dentists perceived papillae changes more so than patients. Lastly, dentists tend to have lower acceptability compared to patients

# 1. INTRODUCTION

## 1.1 Background

One of the most difficult areas to achieve esthetic success when using implant supported restorations is the anterior maxilla. Patient satisfaction is a very important factor in predicting the success of implant therapy in the anterior maxillary region (1). Indices have been designed to aid practitioners in objectively evaluating esthetics called the White Esthetic Score and the Pink Esthetic Score (2). Thus far, these indices have been utilized only when observing the teeth with no lips or facial portrait. A clinical study by Lindsey and Wee (3) evaluated tooth shade using two different facial backgrounds, Caucasian and African American. They investigated the impact of the color of a patient's skin and gingiva on differences in the color of the teeth. They found that when viewing the Caucasian portrait, tooth color changes in the +L direction (brighter), were much less noticed by the evaluators, which leads to the conclusion that perceptibility and acceptability thresholds for differences in tooth color are in fact affected by the facial color background.

## 1.2 Significance

All current esthetic indices, such as the White Esthetic Score (WES), the Pink Esthetic Score (PES), ICAI and the Papilla index, evaluate the teeth and gingiva without any consideration of the lips and face (2,5,7,9). The presence of the lips and face may have an influence on the esthetic evaluation of anterior implant restorations.

### **1.3 Specific Aims**

Our goal was to determine the effect of the lips and face on patient satisfaction, perceptibility, and acceptability of anterior implant restorations and to determine effect of lips and face on satisfaction, perceptibility and acceptability between dentists and patients. In this study, the satisfaction scores, perceptibility, and acceptability were examined using questionnaires of modified photographs of the WES and PES.

### **1.4 Hypotheses**

Hypotheses: (i) Framing the maxillary six anterior teeth to include the lips and facial portrait will influence patient's satisfaction level, perceptibility, and acceptability of the anterior dental esthetics. (ii) Dental professionals and patients will have different satisfaction level, perceptibility, and acceptability of the anterior dental esthetics.

## 2. REVIEW OF LITERATURE

### 2.1 Implant Esthetics

As single tooth implants become increasingly utilized due to their high survival and success rates (6, 7, 8, 9), they are deemed to be the standard of care in dentistry today (4). Now, more clinicians are concentrating on the esthetic outcomes and calibrating the esthetic evaluation of dental implants (5). Thus, several indices have been fabricated over the years, in order to standardize the evaluation of implant restorations, especially in the anterior maxilla.

Many studies regarding implant esthetics discussed maintenance of the adjacent papillae and fabrication of classification systems for this factor. Nordland et al (10) fabricated a classification system to evaluate the loss of papillary height and allow for clinicians to be more precise when describing a patient's "black triangle." The classification system used for this index was divided into 4 categories. If the interdental papilla occupied the embrasure space completely to the interproximal contact point, it was labeled as "Normal." If the interdental papilla tip extends between the interproximal contact and the coronal portion of the interproximal CEJ, it was labeled "Class I." If the interdental papilla tip extends equal or apical to the interproximal CEJ and coronal to the facial CEJ, this is "Class II." Lastly, if the interdental papilla tip is equal or apical to the facial CEJ it is deemed "Class III" (Figure 1). This system assigned numbers to the specific classes depending on the amount of papilla height loss, which ultimately aid in descriptions of cases involving restoration evaluations.

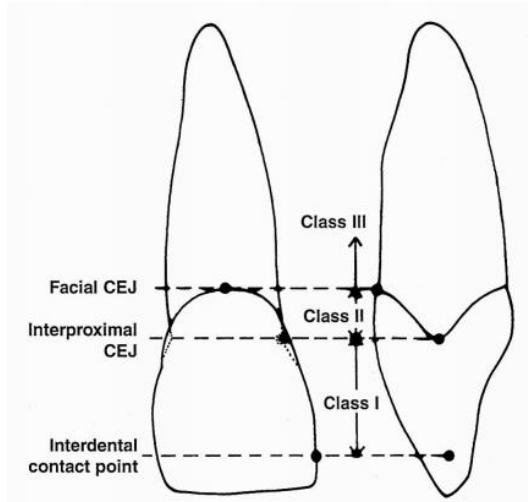


Figure 1: Papilla Height Classification System (10)

Jemt et al 1997 established the Papilla Index (Figure 2) which is a tool used to assess interproximal papillae adjacent to implant restorations and the extent of recession (11). The Index used five levels of assessment, ranged from 0-4 with 0 being complete absence of papilla and 4 being hyperplastic papilla. This study used the papilla index to evaluate 25 single tooth implants 18 months post placement of their implant restoration. Investigators found that papillae adjacent to implants regenerate after 1-3 years post implant placement without changing or manipulating the soft tissue around the restorations. They concluded that the papilla index was reliable for evaluation of soft tissue adjacent to implant restorations.

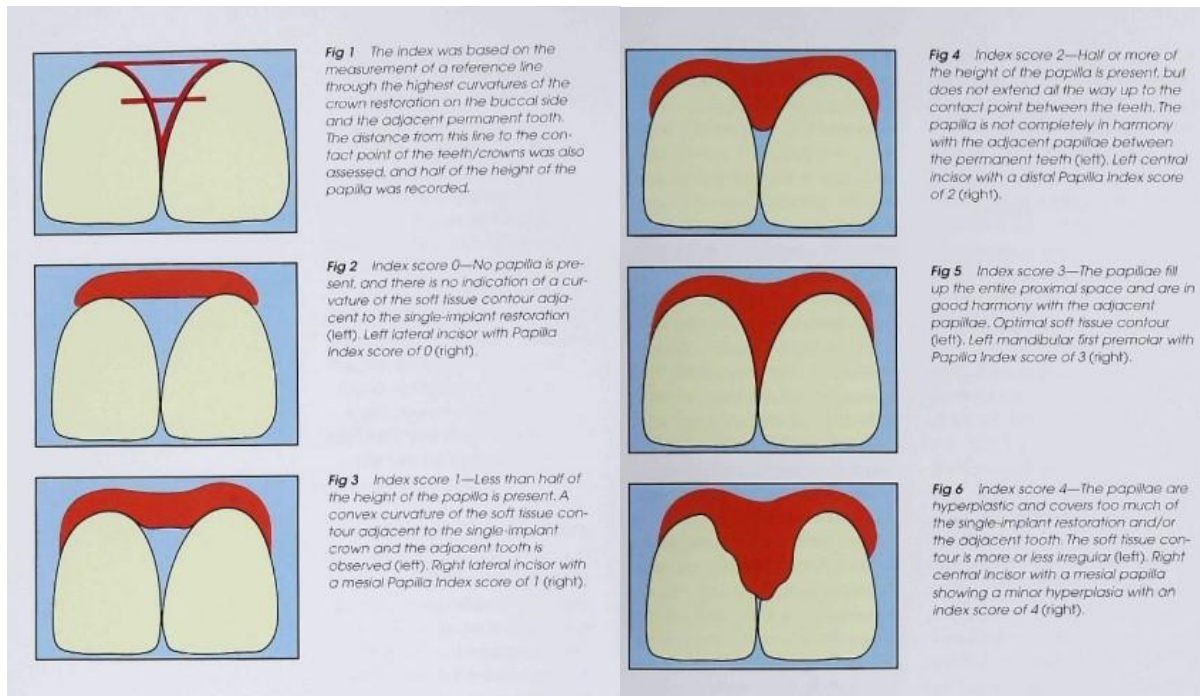


Figure 2: Papilla Index (11)

Jemt's Papilla Index was modified in Schropp et al (12) as they accepted a complete papilla fill if the papilla was the same as the adjacent teeth but not necessarily filling the entire interproximal contact area. The papilla was scored for this study as follows: a score of "0" was given if no papilla present or negative papilla; a score of "1" meant that less than half of the proximal area is filled; a score of "2" was given if at least half of the proximal area is filled with soft tissue papilla; a score of "3" was given if interproximal area entirely filled with soft tissue. They found that in this study because patients with marginal periodontitis were included, the papillae scores were not consistent and reproducible.

The Implant Crown Aesthetic Index (ICAI) was developed by Meijer et al (13). This objective index evaluated implant restorations and adjacent soft tissues. The developers established 9 criteria for evaluation of an implant crown: width in a mesio-distal direction, incisal edge position, labial convex shape, translucency and color, surface texture, position of the buccal margin of the surrounding implant mucosa, position of interdental papilla, buccal plate soft tissue contour, buccal mucosa color and surface features. Each of these factors were given penalty points 1-5 with one being slight deviation and 5 being a gross deviation. Four observers, two prosthodontists and two oral surgeons were the evaluators. It was concluded that this was an objective tool for rating single implant crowns and adjacent soft tissues.

Testori et al (14) developed another scoring system for soft tissue around implant esthetics called the Implant Aesthetic Score (Figure 3). The researchers scored a total of 9 parameters including presence of mesiodistal papilla, ridge stability, soft tissue texture, color and contour. Each factor could score 0,1,2 except for the ridge stability which could only count as 0 or 1. Thus a perfect score is a 9 in this system.

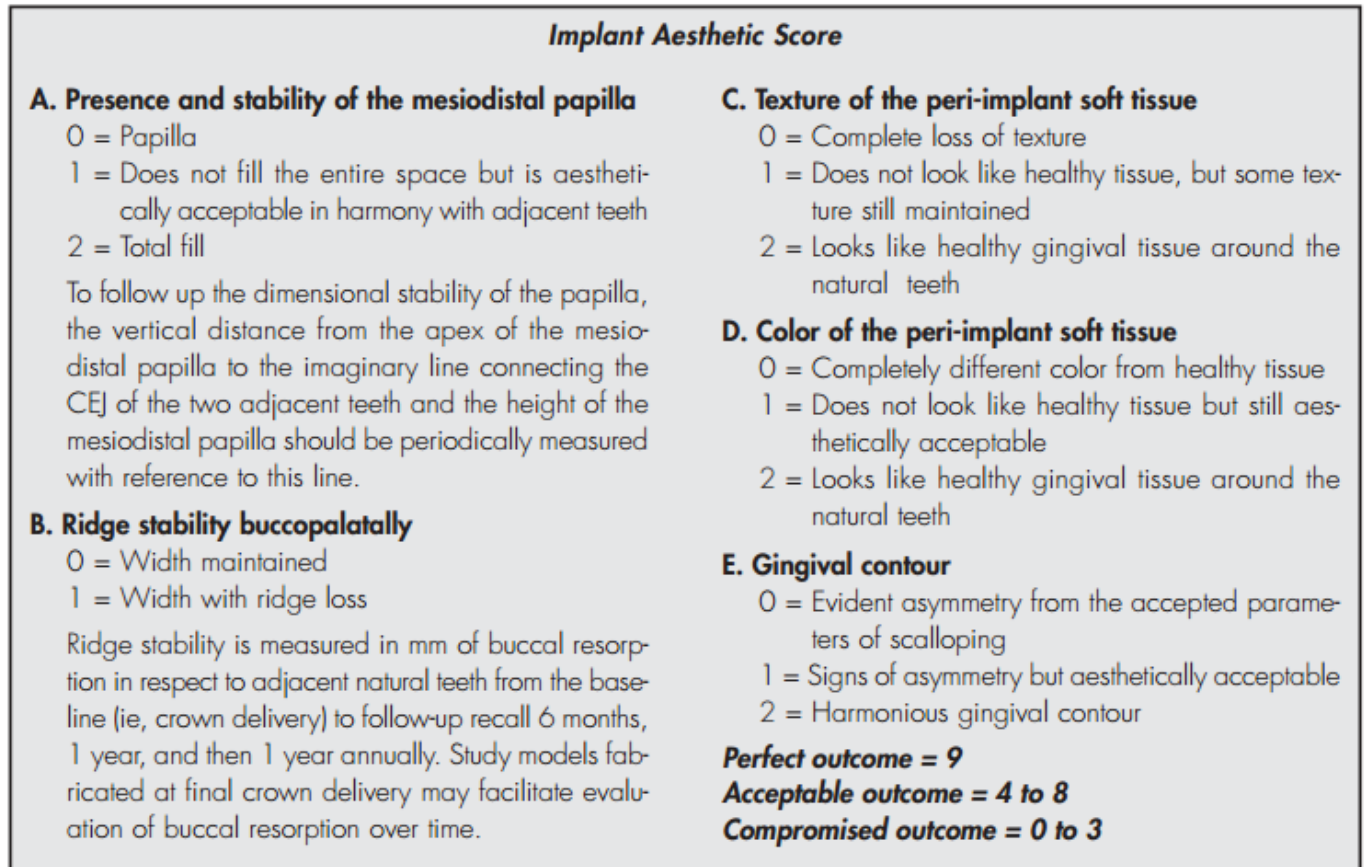
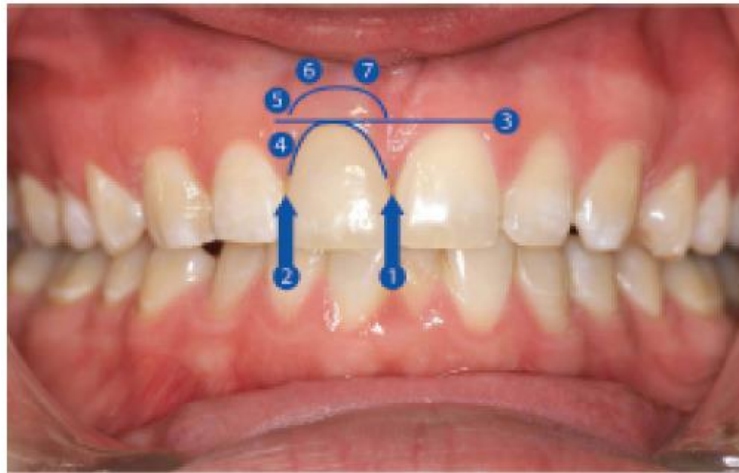


Figure 3: Implant Aesthetic Score (14)

## 2.2 Pink Esthetic Score

The Pink Esthetic Score (Figures 4 & 5) was developed by Furhauser et al (5) to provide a reproducible tool for evaluating surrounding soft tissue of implants. The PES is based on 7 variables: mesial papilla, distal papilla, soft-tissue level, soft-tissue contour, alveolar process deficiency, soft-tissue color, and texture. Each criterion was evaluated with a score of 2-1-0, with 2 being the greatest esthetic result and 0 being the worst esthetic score. Participants were of a variety of dental specialties. The study determined that this evaluation system for surrounding soft tissue in implant supported single crowns was reproducible.





- (1) Mesial papilla
- (2) Distal papilla
- (3) Level of soft tissue margin
- (4) Soft tissue contour
- (5) Alveolar process
- (6) Soft tissue color
- (7) Soft tissue texture

Figure 4: The 7 Factors of the Pink Esthetic Score (5)

| Variables                   |                                   | 0                       | 1                       | 2                     |
|-----------------------------|-----------------------------------|-------------------------|-------------------------|-----------------------|
| Mesial papilla              | Shape vs. reference tooth         | Absent                  | Incomplete              | Complete              |
| Distal papilla              | Shape vs. reference tooth         | Absent                  | Incomplete              | Complete              |
| Level of soft-tissue margin | Level vs. reference tooth         | Major discrepancy >2 mm | Minor discrepancy 1-2mm | No discrepancy < 1 mm |
| Soft-tissue contour         | Natural, matching reference tooth | Unnatural               | Fairly natural          | Natural               |
| Alveolar process            | Alveolar process deficiency       | Obvious                 | Slight                  | None                  |
| Soft-tissue color           | Color vs. reference tooth         | Obvious difference      | Moderate difference     | No difference         |
| Soft-tissue texture         | Texture vs. reference tooth       | Obvious difference      | Moderate difference     | No difference         |

Figure 5: PES Scoring Criteria (5)

Gehrke et al (15) study measured the reproducibility of the PES, all 7 factors. Used 3 general dentists, 3 oral and maxillofacial surgeons, 3 orthodontists, 3 post-graduate implant residents and 3 lay people. 30 single implant restorations were evaluated two times each with a 4 week interval and the second evaluation was done in reverse. Results showed that the soft tissue texture and color performed the worst, thus they should be given more attention when restoring implants. This study also concluded that the PES had good intra examiner agreement and was reproducible.

An implant-supported restoration should be symmetrical in dimension with the reference or contralateral tooth. The surrounding soft tissue texture, color, and height, which influences the overall crown length, all contribute to the implant crown looking natural and blending with adjacent natural teeth (16).

Lai et al (17) performed a study including evaluation of 29 single implants in 29 healthy patients. Evaluated at crown placement then at 6 month follow up by two orthodontists. They found that the esthetics of the implant crown at the follow-up were significantly improved from the delivery date according to the pink esthetic score assessment. Therefore, soft tissue changes can be expected after initial placement of single implant crowns.

### **2.3 Pink Esthetic Score and White Esthetic Score**

The Pink and White Esthetic Scores when used together, help the clinician evaluate overall implant esthetics including surrounding soft tissue, tooth form, texture, and color.

Belser UC et al (2) performed a retrospective, cross sectional study with 45 patients who had been treated with maxillary anterior implants, single tooth were evaluated using both the PES and the WES. The researchers developed a combined PES/WES in order to objectively evaluate implant supported restorations. They found that 14.7 was the mean total combined PES/WES. The mean total PES was 7.8. A mean value of 6.9 was calculated for WES. The investigators concluded that the PES/WES index was appropriate for the objective evaluation of the overall esthetic criteria for single, anterior implant restorations. Since 20% of crowns scored below the acceptable number of 6, the WES was not considered as favorable in comparison to the PES. Patients and dental professionals seem to differ in their esthetic opinions. 20 different lab

technicians used for the 45 patients, thus accounting for variety of WES- this represents more of the private practice results. Buser et al (18) performed a similar study to the previously mentioned study (2), however, they used the same technician for 20 patients and the WES score was higher 8.65. Performing studies in a university setting would be less realistic compared to the practical reality of private practice. This study simplified the original PES and felt greater value should be placed on factors 1-4 (papillae fill, level of soft tissue margin and contour) and less on 5-7 (color, texture, alveolar process), thus combined 5-7 into one and changed it to 5 total factors (Figures 6 & 7).

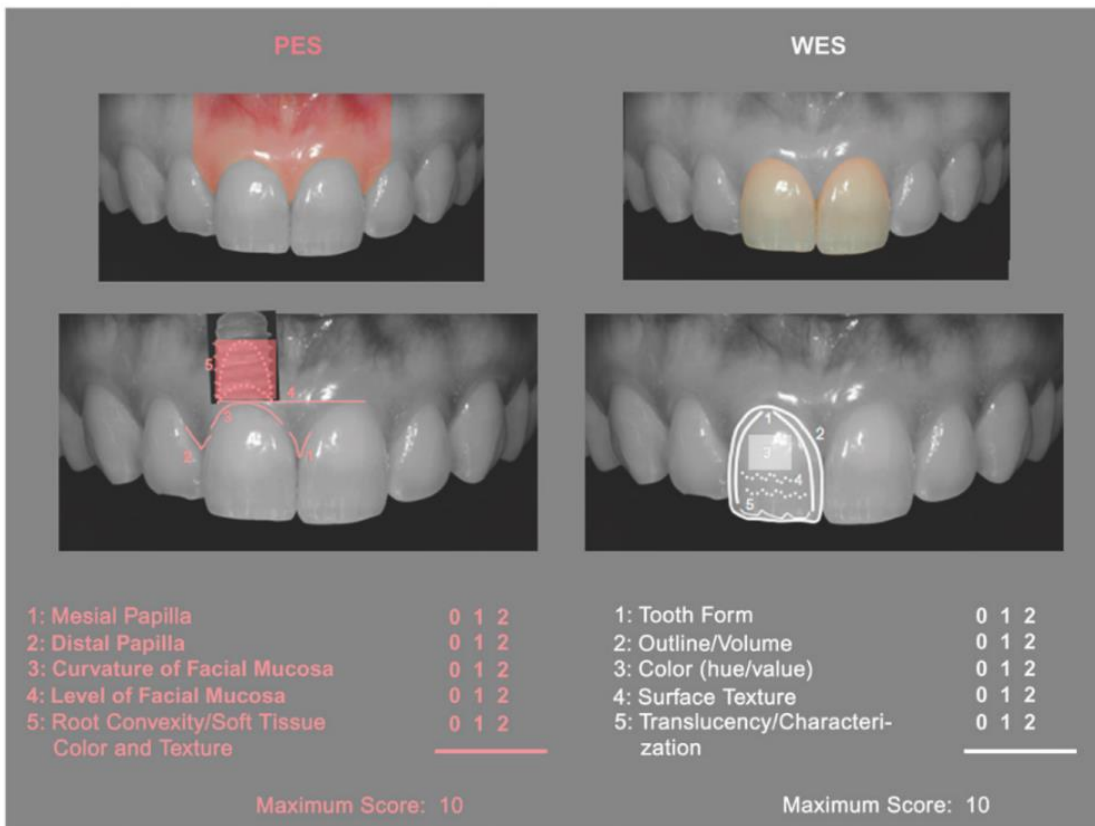


Figure 6: Combined Pink Esthetic Score and White Esthetic Score (18)

| PES  |                   |                   |                |
|--|-------------------|-------------------|----------------|
| Parameter                                    | Absent            | Incomplete        | Complete       |
| Mesial papilla                               | 0                 | 1                 | 2              |
| Distal papilla                               | 0                 | 1                 | 2              |
|  | Major Discrepancy | Minor Discrepancy | No Discrepancy |
| Curvature of facial mucosa                   | 0                 | 1                 | 2              |
| Level of facial mucosa                       | 0                 | 1                 | 2              |
| Root convexity/soft tissue color and texture | 0                 | 1                 | 2              |
| Maximum total PES score                      |                   |                   | 10             |
| WES  |                   |                   |                |
| Parameter                                    | Major Discrepancy | Minor Discrepancy | No Discrepancy |
| Tooth form                                   | 0                 | 1                 | 2              |
| Tooth volume/outline                         | 0                 | 1                 | 2              |
| Color (hue/value)                            | 0                 | 1                 | 2              |
| Surface texture                              | 0                 | 1                 | 2              |
| Translucency                                 | 0                 | 1                 | 2              |
| Maximum total WES score                      |                   |                   | 10             |

Figure 7: Scoring System for Combined PES/WES (18)

Cosyn et al (19) compared early (6-8 weeks post extraction) and conventional placement of implants. Evaluated using PES, WES and Aesthetic Score using visual analog scale. The mean PES was 9.90 and 10.40 for early and conventionally placed implants, respectively. The mean WES was 7.86 and 7.96 for early and conventionally placed implants, respectively. 25% of the cases were labeled as esthetic failures and very few were considered ideal.

Vidigal et al (20) evaluated esthetics of anterior maxillary immediately placed implants which were restored with provisional crowns on the day of surgery. The PES/WES was used to evaluate 53 immediately restored implants. Two examiners scored each restoration at two different intervals. They found that the average PES/WES was 15.5 with 12 being clinically acceptable according to Belser et al (2). The highest average PES score was for the mesial

papilla factor, while the lowest was the distal papilla factor. The highest average WES factor was surface texture, and the lowest factor was the tooth shape. The study concluded that evaluation using PES/WES showed good esthetic results for immediately loaded anterior implants. Additionally, it concluded that the PES/WES, although demonstrating ineffective interexaminer agreement, it showed robust intraexaminer agreement.

Chen et al (39) examined 306 total anterior natural teeth using the PES and WES to better understand the characteristics of natural teeth that can help determine esthetic considerations important for implant supported prostheses. This study used the classic 7 factor PES and 5 factor WES to evaluate the subjects. The mean PES score was 12.92 out of 14 and the mean WES score was 8.75 out of 10. They found age and gender affected the scores: an increase in age led to decreased PES/WES scores and females had higher scores than males.

## **2.4 Perceptibility and Acceptability**

Much of the literature regarding tooth color with implant restorations has reported the ranges of perceptibility and acceptability but does not consider the influence of the facial background (28,31). Lindsey and Wee (3) performed a study taking tooth color difference thresholds into account and tested the effect of gingival color and skin color on perceptibility and acceptability. The investigators wanted to determine if the perceptibility and acceptability thresholds for tooth color differences would be impacted by the facial color or background of the test models. The models were of different skin colors with one being African American female and the other a Caucasian male.

The researchers enlisted 10 lay people who briefly viewed several digitized photos of the two portraits which had different color changes between the two central incisors. Each participant was subjected to 1000 trials randomly, half of which were the African- American portrait and half were the Caucasian portrait. 375 of the 500 per portrait were altered in the *L* (brighter), *a* (redder) or *b* (yellower) directions of the CIELAB color space. In each of the *L*, *a*, and *b* directions, 5 color differences (1,2,3,4,5  $\Delta E$ ) were shown on 25 trials, which was determined in previous publishing to be a reasonable estimate of an individual's performance (29,30). Each subject participated in four total test meetings, where they were informed that the photo of the model's left central incisor was a crown. In two of the four meetings, the subjects were asked if they could perceive a color difference testing perceptibility and two separate meetings inquiring if the participant would accept the crown's color or color match, which tests acceptability (3).

Examiners in this study found that when viewing the Caucasian portrait, tooth color changes in the +L direction (brighter), were much less noticed by the evaluators, which leads to the conclusion that perceptibility and acceptability thresholds for differences in tooth color are in fact affected by the facial color background. Also, there was a statistical difference in the *a* (red/yellow) direction between the two portraits, lower in the African American versus the Caucasian, thus furthering the evidence that gingiva and skin color can impact perceptibility and acceptability. The researchers also concluded that skin and gingival color need to be taken into consideration for each individual restorative case. Also notable from this study was acceptability difference threshold is always greater than the perceptibility difference threshold (3).

Lindsey and Wee (21) determined perceptibility and acceptability of differences in tooth shades by using sets of teeth and gingiva generated by a computer. Subjects used signal detection

theory methods. This study used 12 dental professionals and 4 dental patients as the evaluating subjects. They were asked to respond to color differences in the three axes of CIELAB color space. Also measured the false alarm rate when subjects thought a difference existed but was not present. They found there were no differences in thresholds for acceptability versus perceptibility and no differences in performances between the dental related examiners. Regarding the false alarm rate, the subjects tended to report color differences when none existed, which should be considered when making dental prostheses' quality control guidelines.

When discussing perceptibility and acceptability of the color of the teeth and surrounding soft tissue, it is pertinent to recognize that several studies demonstrate that the perceptibility difference threshold is always smaller than the acceptability difference threshold (3). Alghazali et al (41) had participants evaluate different shades of a denture tooth and found that the mean color perceptibility threshold was significantly lower than the mean color acceptability threshold:  $1.9 \Delta E$  vs  $4.2 \Delta E$ . Waller et al (43) evaluated an implant crown in 20 different patients using lab technicians, dentists, and laypeople. They found the following results: technicians-  $\Delta E$  2.7, dentists-  $\Delta E$  3.3 and laypeople-  $\Delta E$  4.4. In all groups, they found that acceptability thresholds were higher when compared to perceptibility. Laypeople were more accepting of higher color differences of the surrounding soft tissue when compared to technicians and dentists, who seemed to be less accepting.

The differences found with the Lindsey and Wee study (21) compared to the others (3,43) could be related to the way in which the evaluations were carried out. The Lindsey and Wee study (21) did not find a difference between perceptibility and acceptability thresholds as their assessment for these thresholds were parallel in nature, while with the other studies (3,43), the assessments were sequential (perceptibility first followed by acceptability) in nature. The

sequential protocol forces the perceptibility threshold to be lower than the acceptability threshold.

## **2.5 Lips and Facial Esthetics**

Many studies have shown the influence of the height of a patient's smile or lip line on esthetic outcomes (1,2,22). If a patient has a high lip line, it can generally be anticipated that the patient will have high expectations for the tooth to mimic the natural dentition (22).

For implant therapy to be considered successful, an implant restoration should be undetectable from the adjacent natural teeth (23). When assessing an esthetic outcome of an implant crown, evaluating the lip line and smile is included (23). Patients can present with several different smile lines, which show a variety of levels of the teeth. Tjan et al (24) defined three different smile lines: high, average or low. A high smile line shows the entire tooth plus a continuous band of gingiva. An average smile line shows 75% to 100% of the tooth and papillae only. A low smile line shows less than 75% of anterior teeth.

Previous studies have shown that the perception of color differences depends on the viewing background (26, 27). Takasaki (26) and Whittle (27) described a "crispening effect" whereas if two extremely similar light stimuli are placed adjacent to one another and the background brightness value lies between the two light stimuli, their difference in brightness is perceived more strongly versus if placed on more contrasting backgrounds. Thus, increasing the importance of the background or facial portrait when viewing restorations in the smile line.



## **2.6 Patient Versus Professional Evaluation of Esthetics**

Evaluating dental esthetics can vary between patients and professionals. Factors that clinicians find unesthetic may not be equivalent to factors that patients find unesthetic. Ragain et al (32) found a significant difference in patients' proficiency of recognizing slight differences in color of composite restorations comparatively to dental professionals.

Douglas et al (33) performed a study to determine the perceptibility and acceptability of shade discrepancy in a clinical scenario. A test denture with 10 interchangeable left central incisors which were a variety of shades different than the right central incisor. It was worn by one subject, with each of the 10 different shaded teeth being shown to 28 dentists. The researchers used a spectroradiometer to establish the CIELAB coordinates and color difference ( $\Delta E$ ) between the two centrals. The dentists were asked if they could see the shade difference and if they did, were then asked if the mismatch was acceptable. The difference in color at which 50% of the dentists were able to recognize a difference was 2.6  $\Delta E$  units and the color difference at which 50% of the dentists deemed the mismatch unacceptable and would remake the restoration was 5.5  $\Delta E$ . Thus, the tolerances for perceptibility were significantly lower than the tolerances for acceptability for shade mismatch. Dentists could see the shade mismatch at 2.6  $\Delta E$ , but were accepting of the difference up to 5.5  $\Delta E$ .

Chang et al (16) compared evaluation of single implant esthetics between the patients with the implant crowns and prosthodontists. They found that clinician's overall satisfaction was heavily influenced by the overall shape of the crown and the appearance of the surrounding soft tissue. This study also concluded that factors that clinicians may consider significant for esthetic outcomes may not be important to patient's notion of satisfaction.

Chang et al (34) compared the VAS scoring of patients evaluating an implant supported crown compared to the contralateral natural tooth. Some of the differences between the implant crowns and contralateral tooth were that the implant crown was longer, less facial-lingual width, facial mucosa was thicker, less distal papilla height and tended to bleed more upon probing. They found that patients' satisfaction with the appearance of their single implant crowns had a median value of 96% with a range of 70 to 100%. This demonstrated that differences in crown height/form as well as soft tissue differences between a single, implant-supported crown and the contralateral natural tooth may not be critical for patients in their assessment of the esthetic outcome of implant restorations.

Dunn et al (35) showed that when evaluating patient's perception of dental attractiveness, tooth color was the most important factor. The symmetry and height of the lip line influenced the least in predicting patients perceived dental attractiveness.

### 3. METHODOLOGY

#### 3.1 Study Design

A survey comprising of 51 digitally modified photos of one anterior implant supported restoration positioned with lips retracted, lips in smile line and facial portrait were given to participants on an iPad or available in a web-based format (Figure 8). Participants were a group of dentists and patients. The photographs were modified digitally to varying scores for certain criteria of the PES and WES chosen based on viewability with lips and face inclusion in the photos. Patients were asked three questions for each photograph including their satisfaction level with each photograph's restoration, perceptibility and acceptability. Satisfaction was determined using a 100mm visual analog scale. All data from the iPads and the web-based page were gathered and calculated. Significant differences, defined by  $p < 0.05$ , were calculated for satisfaction level, perceptibility, and acceptability of each WES/PES factor as well as between dentists and non-dentists. The experimental protocol was approved by the University of Illinois Chicago Institutional Review Board office (IRB #2012-0396).

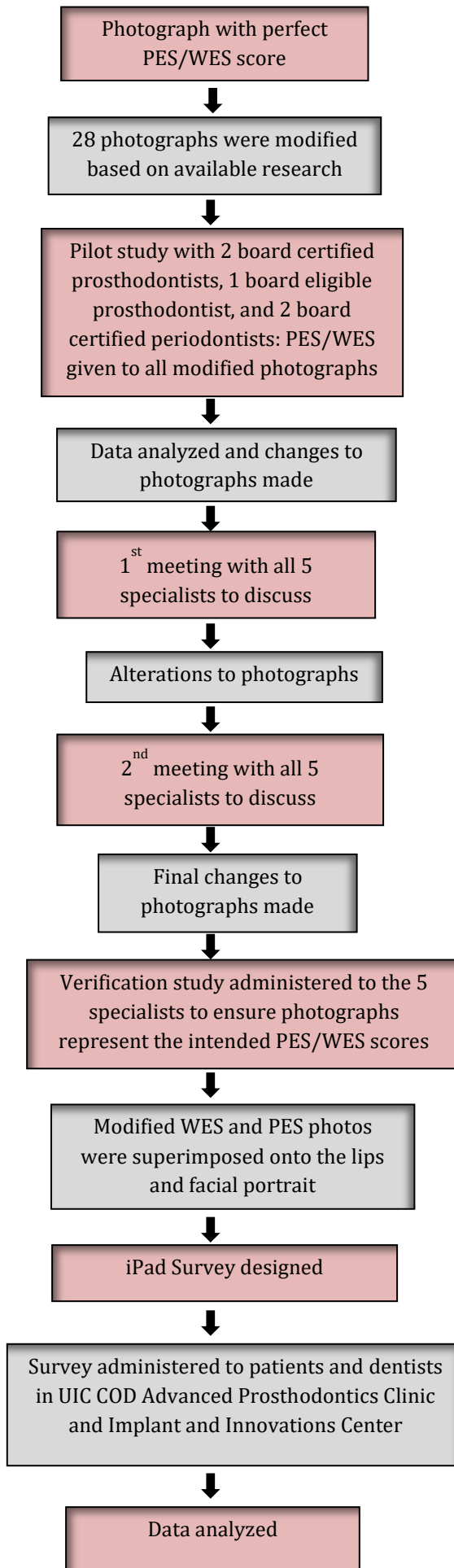


Figure 8: Research Design Flow Chart

## **3.2 Materials and Methods**

### **3.2.1 Preparation of Photographs**

Twenty-nine photographs of the maxillary anterior teeth 6-11 were initially used in this study to establish the validity of the alterations made to each PES and WES factor (Figure 9). A photograph of one patient with an ideal PES and WES score was used as the basis for the changes. The subject's photo was intended to represent a patient who had an implant restoration completed at tooth site 8. The remainder of the 28 photos were digitally modified to represent esthetic results of such a restoration established in similar studies prior (36,37). A biomedical illustrator completed the alterations based on instructions from the authors. Each of the 28 photos had one PES/WES criterion adjusted to represent the scoring system of 0 and 1 (Figures 3 & 4). The degree of each modification was based on previous studies established thresholds (37). The criteria that did not have previous thresholds were modified by the authors and verified in a pilot study consisting of a group of 5 prosthodontists and periodontists. A more objective scoring system was established after the pilot study was verified (Figure 2). The 7 original esthetic factors in the PES were used in this study, however the 5 original esthetic factors of the WES were modified. Tooth form was divided into two different sections representing if a tooth appears too wide or too narrow. The tooth color factor originally included hue and value. In this study, tooth color involved hue and chroma. Lastly, the translucency factor was divided into two different sections representing when a restoration has too much translucency, low value, and when a restoration has too little translucency appearing opaque or a high value.

The modifications of all photographs were completed using a software program (Adobe Photoshop 5.0.2; Adobe Systems Inc, San Jose, CA). This was performed by an independent biomedical illustrator. Several meetings were held between the illustrator and the research team to be sure the modifications were appropriate for the purpose of the study. All photographs were maintained in a 1:1 size ratio in order to stimulate real life viewing of an anterior implant supported restoration to the survey participants.

After the pilot study was performed to verify the intended PES/WES scores, the modified PES and WES photographs were then superimposed on the original photographed model's lips and facial portrait by the illustrator. The same was completed for the ideal photo (Figure 10). Due to the subject's smile line, it was determined that not all of the PES/WES factors were able to be evaluated with the addition of the lips and face. The following factors were used for this study as they could be viewed in patient's smile line: 2 PES factors- mesial papilla and distal papilla; 6 WES factors- tooth form wide and narrow, color, surface, translucency/value high and low. (Outlined in yellow in Figure 9). Thus, a total of 8 esthetic factors were evaluated with lips retracted, lips in place and facial portrait.



### **Mesial Papilla**

**1**

**0**

Score 1 – 50%-75% papilla fill as measured from the zenith to the contact point .

Score 0 – Less than 50% papilla fill.



### **Distal Papilla**

**1**

**0**

Score 1 – 50%-75% papilla fill as measured from the zenith to the contact point.

Score 0 – Less than 50% papilla fill.



### **Level of soft tissue margin**

**1**

**0**

Score 1 – Discrepancy of 1-2 mm.

Score 0 – Discrepancy greater than 2 mm or if abutment is visible.



### **Soft tissue contour**

**1**

**0**

Score 1 – Zenith flat, wide and located middle to long axis of tooth rather than slight distal to the long axis.

Score 0 – Zenith located mesial to the long axis.



### **Alveolar process**

**1**

**0**

Score 1 – Horizontal buccal defect 1-2mm and consistent with normal bone resorption after extraction and implant placement.

Score 0 – Defect greater than 2mm.



### Soft tissue color

1

0

Score 1 – Grey discoloration limited to the gingival margin area.

Score 0 – Discoloration extending apically to the mucosa.



### Soft tissue texture

1

0

Score 1 – Slight scarring or hyperplastic tissue consistent with normal flap elevation.

Score 0 – White or red fibrotic tissue consistent with extensive periodontal procedures.



### Tooth Form - Wide

1

0

Score 1 – Line angles are located too far to the periphery.

Score 0 – Line angles are incorrect and incisal edge is too straight.



### Tooth Form - Narrow

1

0

Score 1 – Line angles are located too proximally.

Score 0 – Line angles are incorrect and incisal edge is too rounded.



### Tooth outline/volume

1

0

Score 1 – Tooth volume required to eliminate black triangles if there was only a 50-75% papilla fill.

Score 0 – Volume required to eliminate black triangles if there was less than 50% papilla fill.







Figure 9: Standardized set of 29 photographs, photos outlined in yellow used for this study

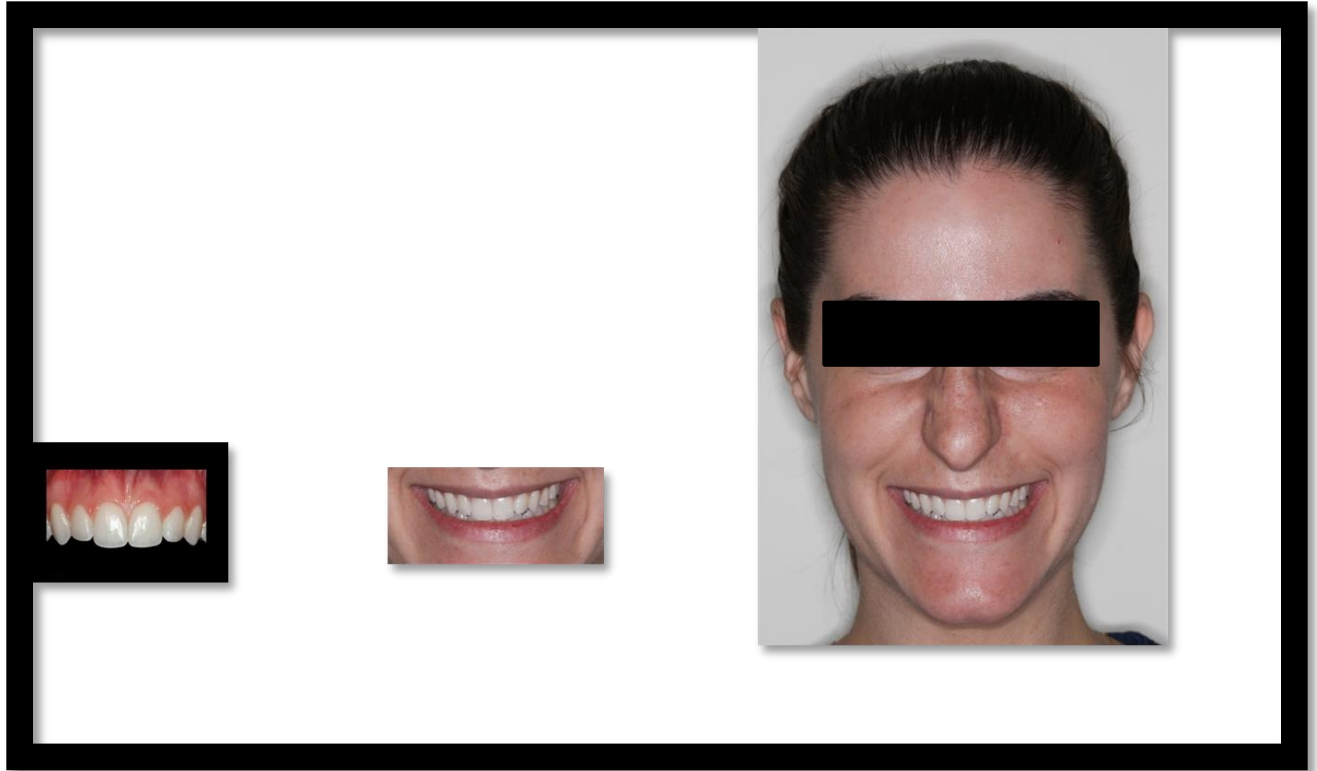


Figure 10: Perfect Photo of Teeth, Lips, and Face (Score of 2 in every factor in the PES & WES)

### 3.2.2 Pilot Study

The pilot study was performed to determine whether the modified photographs depicted the intended criteria scores. The amount of modification of the photos was increased or decreased depending on the scores obtained during this pilot.

The team selected to view the 28 modified photographs consisted of 2 board certified prosthodontists, 2 board certified periodontists and 1 board eligible prosthodontist at University of Illinois Chicago, College of Dentistry. The specialists were given the 29 total photographs and were asked to give a PES and WES for each one. The results were collected and if 4 or 5 of the specialists agreed on the criteria, the photograph remained the same and no alterations were made.

However, if only 3 or less specialists agreed on a certain criterion, it was discussed as a group as to the degree that the change should be made during a meeting with all specialists and the researchers. The modifications to the photos were agreed upon and relayed to the illustrator. The photos that required changes were made and a second meeting was arranged with all specialists and researchers. At this meeting, all photographs were confirmed to be accurate representations of all PES and WES factors.

### **3.2.3 Study Population**

The inclusion criteria for this study included that subjects must be 18 years or older to provide informed consent and must understand English. The exclusion criteria were subjects with known colorblindness, inability to pass a colorblind test or unwillingness to participate on the colorblind test. Colorblind individuals were identified in this study by issuing an Ishihara test at the beginning of the survey, which included 4 different Ishihara plates. Subjects were required to identify all 4 numbers in the plates correctly to be included in the data analysis. All participants were required to answer demographic data questions. This included: year of birth, gender, education level, income level, ethnicity, occupation, and prior implant treatment. Income level categories were based on the federally marked poverty level in 2013 of \$11,170 for a family of 1.

The survey was distributed in two different forms: in-person vs online. The in-person participants were dentists and patients receiving care at the UIC COD in the Advanced Prosthodontics Clinic and the Implant and Innovations Center in Chicago, IL. The online participants were those who took the survey online with their own computer. The online survey was available to the general public and was not exclusive to dental patients. The survey link was

sent out through word of mouth and social media (Facebook Inc, Menlo Park, CA). The website link for the survey was available for a period of 6 months. A mobile version was not available as this would not allow for participants to view the images in real life size.

### **3.2.4 Survey**

The survey for this study was accessed worldwide through an iPad or a home computer at the web address “uicestheticsmile.com.” An independent computer programmer was hired to make the iPad survey and the web-based survey via directions from the research team. An independent company (Netfirms Inc, Toronto, Canada) hosted the website and the data was stored online where it was easily accessible for the research team to gather. Participants were required to complete the entire survey for the data set to be stored.

The first page of the survey describes the purpose of the study and requires the participant to fill out a consent form (Figures 11,12). If the participant agreed to give consent, they were advanced to the color blindness evaluations. Four Ishihara plates were shown one at a time and the participants were asked to choose the number they see (Figure 13). The next page was an instruction sheet describing how to complete the survey. Each photograph slide was available for viewing no more than 30 seconds. After the 30 seconds, the photo would disappear, and the participant would still be able to complete the questionnaire. A timer was located on top of the screen to let the participants know how much time they had to view the photo. A pause button could be selected if the participant needed a break. This would cause the screen to turn to a solid 18% gray while on pause. Once the survey was resumed, the photo timer continued. To mimic a real-life dental scenario, the participants were asked not to zoom in to any of the photos.

This would ensure that the central incisor measure 10.5mm consistent with the life-size simulation. The last instruction for participants was explaining how to use the Visual Analog Scale to represent their satisfaction score with each photo. Once instructions were completed, the survey began.

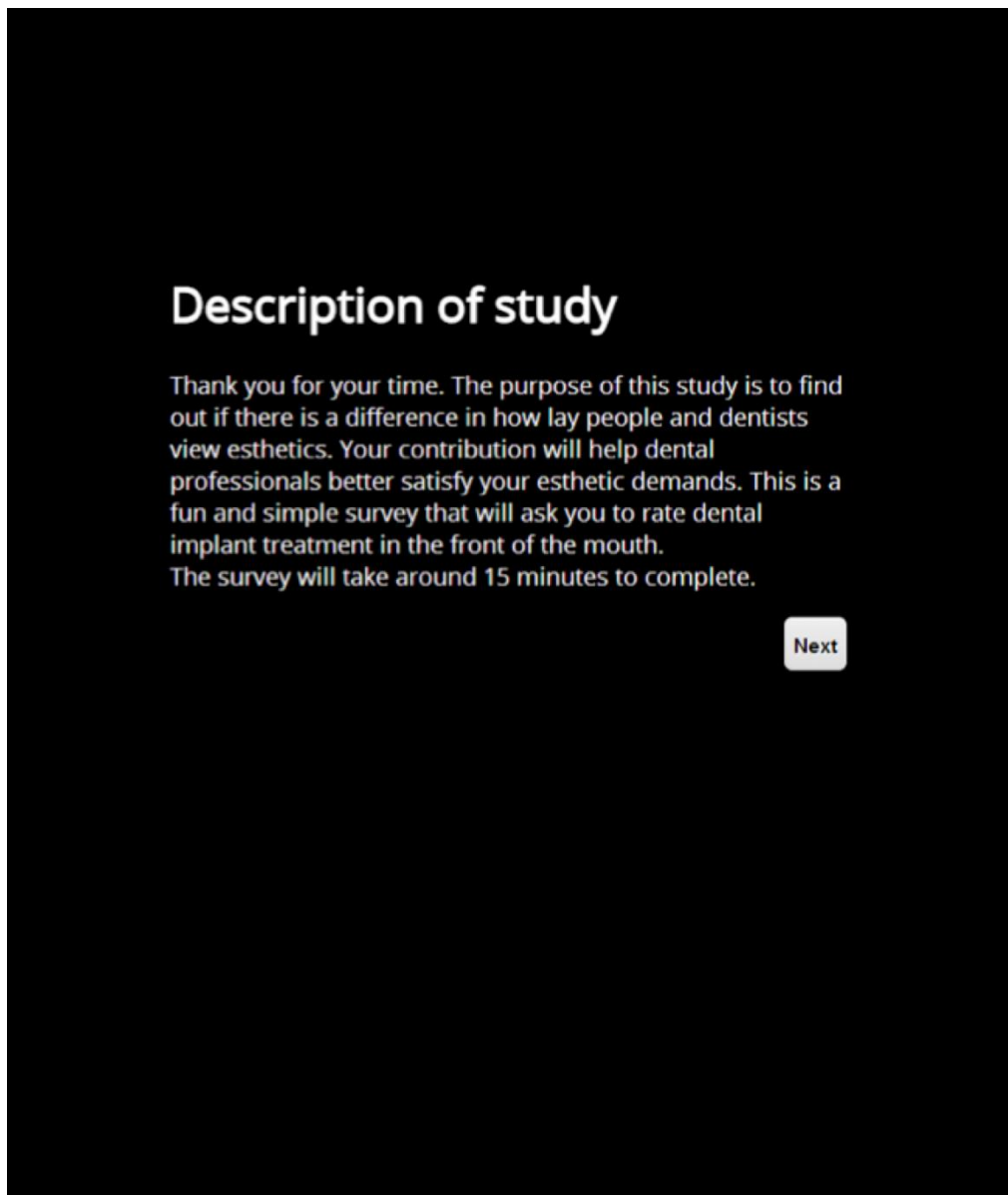


Figure 11: Screen 1 of survey showing Description of Study

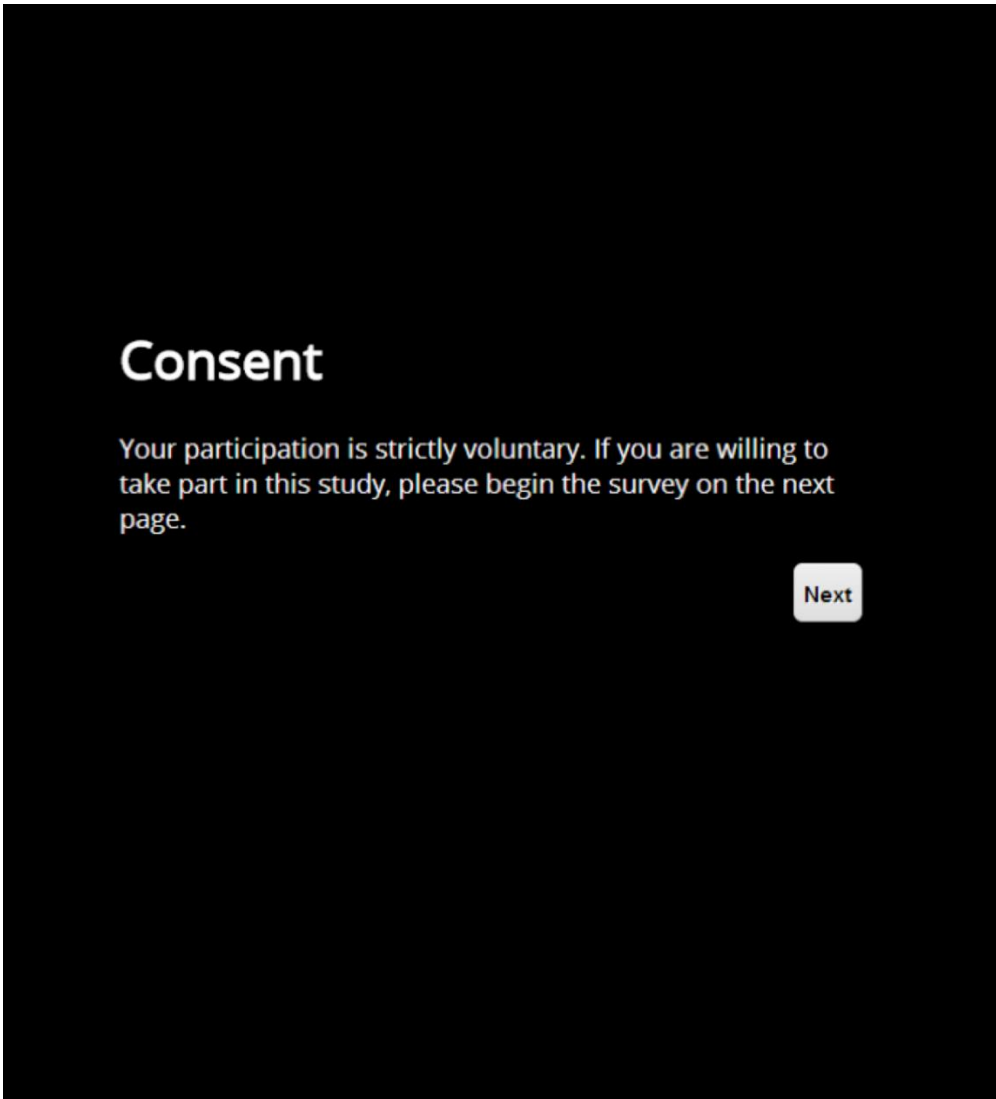


Figure 12: Screen 2 of survey showing consent form

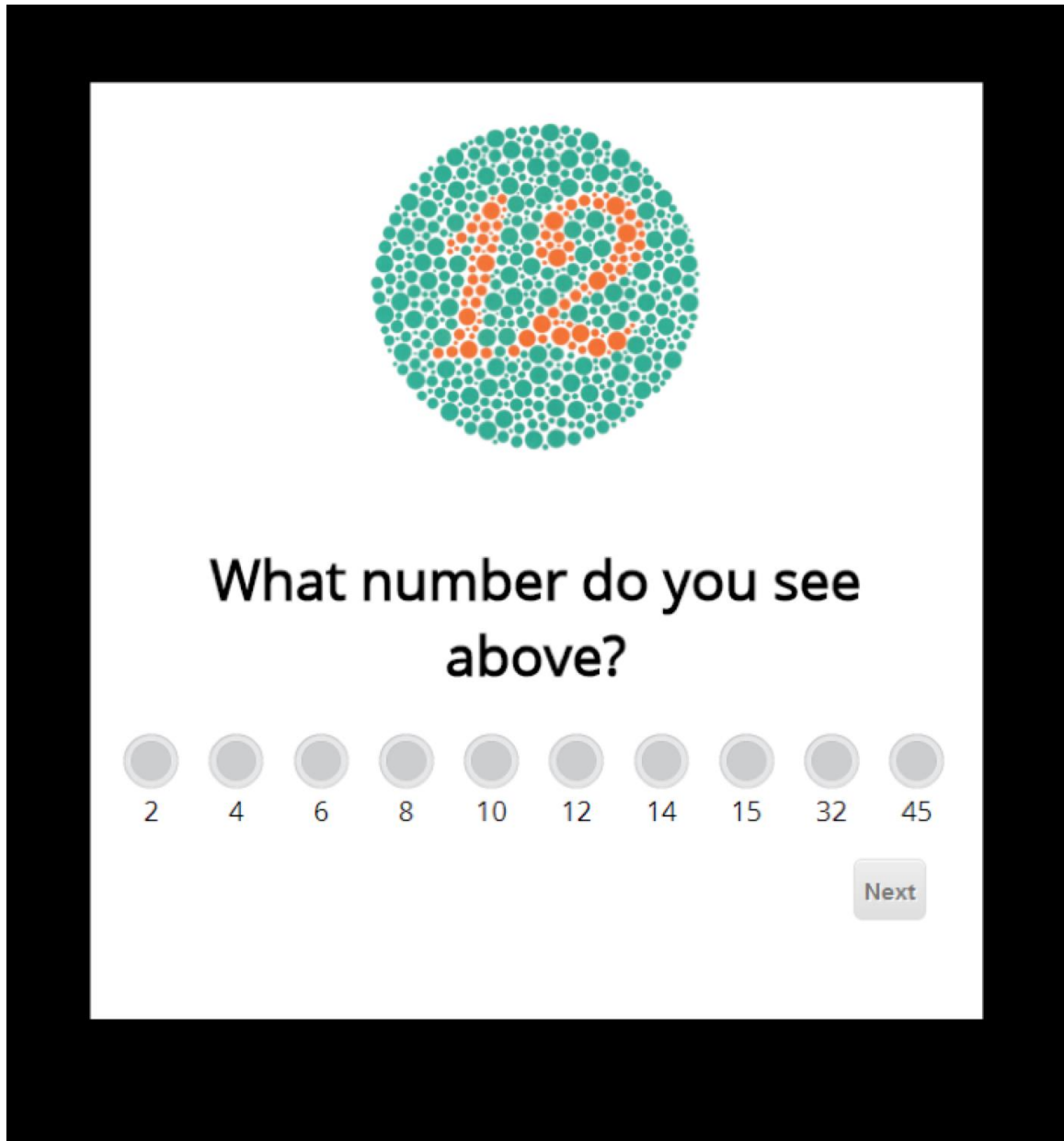



Figure 13: Screen 3 of survey showing one of four Ishihara plates

Each slide with a photograph consisted of three questions (Figures 14,15,16). The first question was “how satisfied would you be with the esthetic outcome of the front teeth and gums if this was your mouth?” Participants would slide the VAS scale representing their satisfaction level with 0 being unsatisfied and 100 being very satisfied. The second question asked the

participants “do you see a difference between the treated area and the rest of the teeth?” This yes or no question evaluated participants perceptibility. The third question asked the participants “would you accept these results if these were your teeth?” This yes or no question evaluated participants acceptability. The questions were set up this way so as not to lead the participant to a specific tooth, just the anterior area in general. Participants were unable to go back to change answers. All photographs were randomized for each participant and demographic questions were placed throughout the survey to reduce participant fatigue (Figure 17). To decrease participant’s eye fatigue, a solid 18% gray screen was present for one second between each photo.



Seconds remaining: 19 Pause



How satisfied would you be with the esthetic outcome of the FRONT TEETH and GUMS if this was your mouth?

very unsatisfied 0 100 very satisfied


Do you see any difference between the treated area and the rest of the teeth? Yes No

Would you accept these results if these were your teeth? Yes No

Next

Figure 14: Screen of survey showing a question with retracted lips

Seconds remaining: 20 Pause



How satisfied would you be with the esthetic outcome of the FRONT TEETH and GUMS if this was your mouth?

very unsatisfied 0 100 very satisfied

Do you see any difference between the treated area and the rest of the teeth?  Yes  No

Would you accept these results if these were your teeth?  Yes  No

Next

Figure 15: Screen of survey showing a question page with lips present

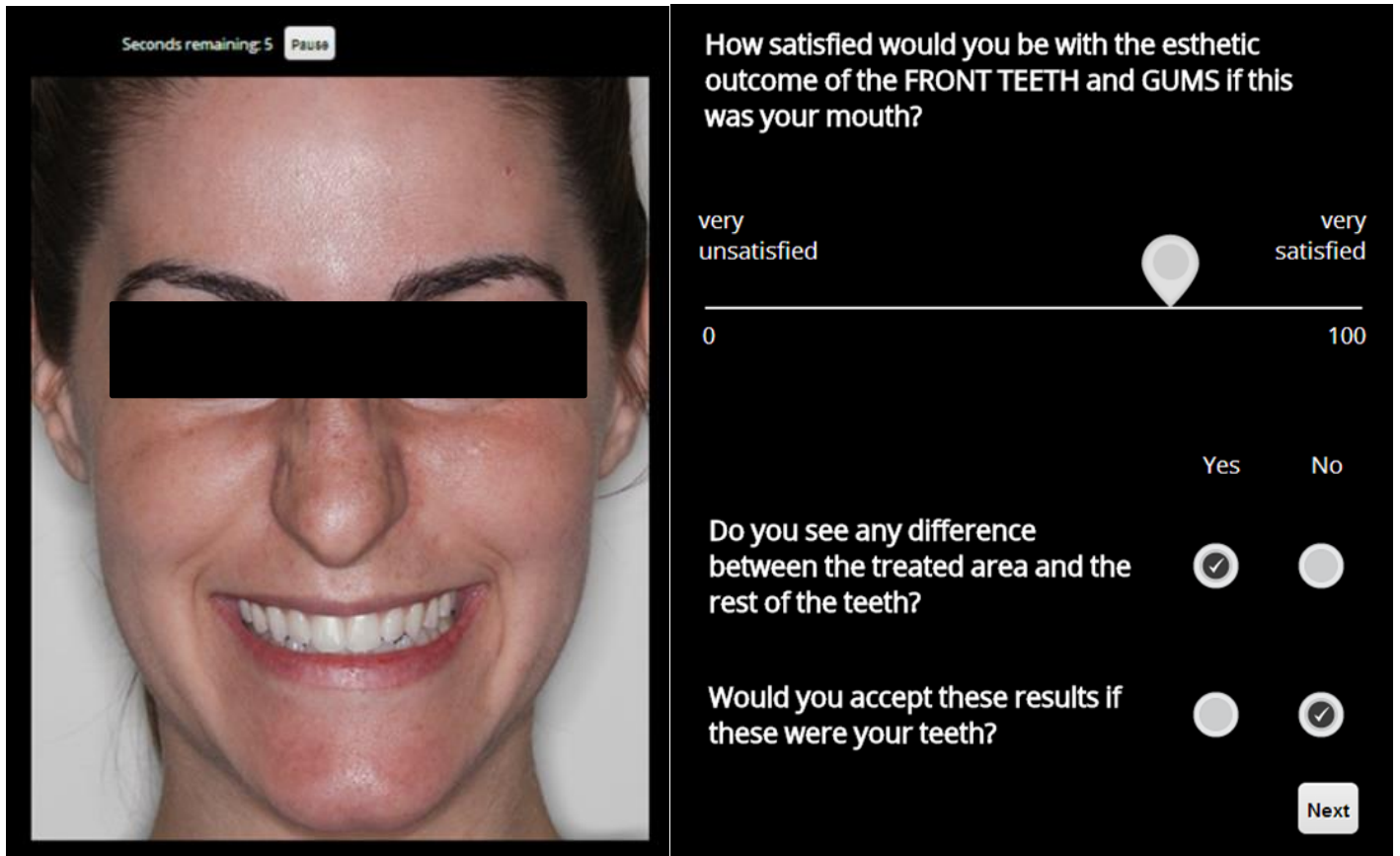


Figure 16: Screen of survey showing a question page with facial portrait present

## Ethnicity:

- American Indian or Alaska Native (*origins in any of the original peoples of North, Central and South America*)
- Asian (*origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand and Vietnam.*)
- Black or African American (*origins in any of the Black racial groups of Africa - includes Caribbean Islanders and other of African origin.*)
- Native Hawaiian or Other Pacific Islander (*origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.*)
- White (*origins in any of the original peoples of Europe, the Middle East, or North Africa.*)

Next

Figure 17: Screen showing example of demographic question

### **3.3 Statistical Analysis**

All data was extracted and exported to a spreadsheet for cleaning (Microsoft Excel, Redmond, Washington). Descriptive analyses were completed for the demographic data using statistical software (SPSS v.20, Armonk, NY).

1. A one-way ANOVA was used to compare the mean satisfaction scores of the teeth, the lips and the face of all survey participants.
2. An independent t-test was used to compare the satisfaction scores of dentists versus patients for each PES/WES factor with the lips and face present.
3. Chi-squared tests with Yates Correction and/or Fisher's Exact tests were used for perceptibility and acceptability comparisons between dentists and patients for each PES/WES factor.
4. Statistical significance is defined as  $p < 0.05$ .

## 4. RESULTS

The survey was taken by a total of 44 participants. No participants were excluded as they were all able to correctly identify all four of the Ishihara plates and deemed to pass the colorblindness test. This made the final number of participants 44 for data analysis. Out of the 44 participants, 17 were dentists and 27 were patients.

### 4.1 Demographic Data

The demographic data for age, gender, education, ethnicity, income, dental professional status, prior implant treatment information is listed in Tables I-VII, respectively.

**Table I**

#### **AGE**

|       | Frequency | Percent |
|-------|-----------|---------|
| 18-29 | 14        | 31.8    |
| 30-50 | 14        | 31.8    |
| 50+   | 16        | 36.4    |
| Total | 44        | 100     |

**Table II**

**GENDER**

|        | Frequency | Percent |
|--------|-----------|---------|
| Male   | 17        | 38.6    |
| Female | 27        | 61.4    |
| Total  | 44        | 100     |

**Table III**

**ETHNICITY**

|                                  | Frequency | Percent |
|----------------------------------|-----------|---------|
| American Indian or Alaska Native | 2         | 4.5     |
| Asian                            | 16        | 36.4    |
| Black or African American        | 3         | 6.8     |
| Native Hawaiian/Pacific Islander | 0         | 0.0     |
| White                            | 23        | 52.3    |
| Total                            | 44        | 100     |

**Table IV**

**EDUCATION**

|                       | Frequency | Percent |
|-----------------------|-----------|---------|
| Less than High School | 1         | 2.3     |
| High School           | 13        | 29.6    |
| Bachelor's Degree     | 10        | 22.7    |
| Master's Degree       | 6         | 13.6    |
| Doctorate             | 14        | 31.8    |
| Total                 | 44        | 100     |

**Table V**

**INCOME**

|                 | Frequency | Percent |
|-----------------|-----------|---------|
| < \$5,499       | 9         | 20.5    |
| \$5,500-10,999  | 2         | 4.5     |
| \$11,000-21,999 | 4         | 9.1     |
| \$22,000-44,999 | 7         | 15.9    |
| \$45,000-89,999 | 14        | 31.8    |
| > \$90,000      | 8         | 18.2    |
| Total           | 44        | 100     |



**Table VI**

**OCCUPATION**

|                      | Frequency | Percent |
|----------------------|-----------|---------|
| Dental Professionals | 17        | 38.6    |
| Other                | 27        | 61.4    |
| Total                | 44        | 100     |

**Table VII**

**PRIOR IMPLANT TREATMENT**

|       | Frequency | Percent |
|-------|-----------|---------|
| Yes   | 10        | 22.7    |
| No    | 34        | 77.3    |
| Total | 44        | 100     |

**4.2 Satisfaction Score Results**

There was a statistically significant ( $p < 0.05$ ) difference in patient satisfaction scores among the teeth, the lips and the face in 3 criteria (see Table VIII)

**Table VIII**

**DIFFERENCE IN PATIENT SATISFACTION SCORES**

|                                  |               |          |
|----------------------------------|---------------|----------|
| Tooth color (hue and chroma)-1   | Lips vs Teeth | p= 0.011 |
| Tooth translucency/value- high-1 | Lips vs Teeth | p=0.041  |
|                                  | Face vs Teeth | p=0.043  |
| Tooth translucency/value- high-0 | Face vs Teeth | p= 0.008 |
| Tooth translucency/value- low-1  | Face vs Teeth | p=0.007  |

There was a statistically significant ( $p < 0.05$ ) difference in dentist satisfaction scores among the teeth, the lips and the face in 3 criteria (see Table IX).

**Table IX**

**DIFFERENCE IN DENTIST SATISFACTION SCORES**

|                                  |               |          |
|----------------------------------|---------------|----------|
| Tooth form- wide- score 1        | Lips vs Teeth | p= 0.003 |
| Tooth form- wide- score 0        | Lips vs Teeth | p=0.011  |
|                                  | Face vs Teeth | p=0.035  |
| Tooth translucency/value- high-0 | Lips vs Teeth | p=0.040  |
| Tooth translucency/value- low-1  | Lips vs Teeth | p=0.014  |
|                                  | Face vs Teeth | p=0.006  |

There was a statistically significant ( $p \leq 0.05$ ) difference in satisfaction scores of the lips between dentists and patients in 6 criteria (see Table X).

**TABLE X**  
**DIFFERENCE IN SATISFACTION SCORES OF THE LIPS BETWEEN DENTISTS**  
**AND PATIENTS**

| Variable                                | Dentist | Patients |         |
|---|---------|----------|---------|
| Mesial papilla- score 0                 | 28      | 47       | p=0.028 |
| Distal papilla – score 0                | 29      | 49       | p=0.033 |
| Tooth form- wide- score 0               | 25      | 52       | p=0.006 |
| Tooth form - narrow– score 0            | 48      | 68       | p=0.001 |
| Tooth surface – score 0                 | 56      | 76       | p=0.014 |
| Tooth translucency/value – low– score 0 | 32      | 51       | p=0.035 |

There was a statistically significant ( $p \leq 0.05$ ) difference in satisfaction scores of the face between dentists and patients in 2 criteria (see Table XI).

**TABLE XI**  
**DIFFERENCE IN SATISFACTION SCORES OF THE FACE BETWEEN DENTISTS**  
**AND PATIENTS**

| Variable                                 | Dentist | Patients |         |
|--|---------|----------|---------|
| Distal papilla- score 1                  | 35      | 59       | p=0.014 |
| Distal papilla- score 0                  | 27      | 52       | p=0.002 |
| Tooth form- wide – score 0               | 29      | 59       | p=0.002 |
| Tooth translucency/value – high– score 0 | 49      | 77       | p=0.001 |

#### **4.3 Perceptibility Results**

There was a statistically significant ( $p \leq 0.05$ ) difference in perceptibility between dentists and patients in 6 criteria with the lips (see Table XII).

**Table XII:**

**DIFFERENCE IN PERCEPTIBILITY BETWEEN DENTISTS AND PATIENTS WITH THE LIPS**

| <b>Variable</b>                                | <b>Dentist</b> | <b>Patients</b> |
|--|----------------|-----------------|
| <b>Mesial papilla– score 1</b>                 | <b>100%</b>    | <b>56%</b>      |
| <b>Distal papilla– score 1</b>                 | <b>100%</b>    | <b>59%</b>      |
| <b>Distal papilla– -score 0</b>                | <b>100%</b>    | <b>74%</b>      |
| <b>Tooth form – wide – score 1</b>             | <b>94%</b>     | <b>48%</b>      |
| <b>Tooth form – wide – score 0</b>             | <b>100%</b>    | <b>67%</b>      |
| <b>Tooth form – narrow – score 1</b>           | <b>71%</b>     | <b>26%</b>      |
| <b>Tooth form – narrow – score 0</b>           | <b>94%</b>     | <b>37%</b>      |
| <b>Tooth surface – score 1</b>                 | <b>65%</b>     | <b>19%</b>      |
| <b>Tooth surface – score 0</b>                 | <b>82%</b>     | <b>37%</b>      |
| <b>Tooth translucency/value- high- score 1</b> | <b>65%</b>     | <b>26%</b>      |
| <b>Tooth translucency/value- high- score 0</b> | <b>77%</b>     | <b>41%</b>      |
| <b>Perfect Lips</b>                            | <b>59%</b>     | <b>15%</b>      |

There was a statistically significant ( $p \leq 0.05$ ) difference in perceptibility between dentists and patients in 7 criteria with the face (see Table XIII).

**TABLE XIII****DIFFERENCE IN PERCEPTIBILITY BETWEEN DENTISTS AND PATIENTS WITH THE FACE**

| <b>Variable</b>                                  | <b>Dentists</b> | <b>Patients</b> |
|--|-----------------|-----------------|
| <b>Mesial papilla– score 1</b>                   | <b>100%</b>     | <b>52%</b>      |
| <b>Mesial papilla– score 0</b>                   | <b>100%</b>     | <b>67%</b>      |
| <b>Distal papilla– score 1</b>                   | <b>100%</b>     | <b>63%</b>      |
| <b>Distal papilla– -score 0</b>                  | <b>100%</b>     | <b>63%</b>      |
| <b>Tooth form – wide – score 1</b>               | <b>88%</b>      | <b>41%</b>      |
| <b>Tooth form – wide – score 0</b>               | <b>94%</b>      | <b>56%</b>      |
| <b>Tooth form – narrow – score 1</b>             | <b>77%</b>      | <b>33%</b>      |
| <b>Tooth form – narrow – score 0</b>             | <b>94%</b>      | <b>52%</b>      |
| <b>Tooth surface – score 1</b>                   | <b>53%</b>      | <b>15%</b>      |
| <b>Tooth surface – score 0</b>                   | <b>82%</b>      | <b>30%</b>      |
| <b>Tooth translucency/value – high – score 0</b> | <b>88%</b>      | <b>33%</b>      |
| <b>Tooth translucency/value – low – score 0</b>  | <b>71%</b>      | <b>22%</b>      |
| <b>Perfect Face</b>                              | <b>65%</b>      | <b>11%</b>      |

#### 4.4 Acceptability Results

There was a statistically significant ( $p \leq 0.05$ ) difference in acceptability between dentists and patients in 4 criteria with the lips (see Table XIV).

**TABLE XIV**  
**DIFFERENCE IN ACCEPTABILITY BETWEEN DENTISTS AND PATIENTS WITH THE LIPS**

| Variable                                       | Dentist    | Patients   |
|--|------------|------------|
| <b>Distal papilla – score 0</b>                | <b>12%</b> | <b>52%</b> |
| <b>Tooth form - wide– score 0</b>              | <b>6%</b>  | <b>48%</b> |
| <b>Tooth surface- score 0</b>                  | <b>41%</b> | <b>82%</b> |
| <b>Tooth translucency/value – low– score 0</b> | <b>6%</b>  | <b>44%</b> |

There was a statistically significant ( $p \leq 0.05$ ) difference in acceptability between dentists and patients in 5 criteria with the face (see Table XV).

**TABLE XV****DIFFERENCE IN ACCEPTABILITY BETWEEN DENTISTS AND PATIENTS WITH THE FACE**

| <b>Variable</b>                                 | <b>Dentist</b> | <b>Patients</b> |
|---|----------------|-----------------|
| <b>Mesial papilla- score 0</b>                  | <b>0%</b>      | <b>44%</b>      |
| <b>Distal papilla – score 0</b>                 | <b>6%</b>      | <b>52%</b>      |
| <b>Tooth form- wide – score 0</b>               | <b>6%</b>      | <b>44%</b>      |
| <b>Tooth form- narrow- score 0</b>              | <b>35%</b>     | <b>74%</b>      |
| <b>Tooth translucency/value – high– score 0</b> | <b>29%</b>     | <b>82%</b>      |



## 5. DISCUSSION

### 5.1 Discussion

In this study, the changes made to the PES/WES scoring system, called the USI or UIC-SIU Index, were found to allow for better prediction of patient satisfaction and acceptability of anterior implant restorations (38). By using this esthetic tool, the authors were able to evaluate the influence of the lips and the face on the different factors that can affect a single implant restoration and determine if there was a difference between dentists and patients.

Patient satisfaction scores- The question is do the lips and face influence patients satisfaction with implant restorations. Based on this study, patient satisfaction score was significantly different with the addition of the lips for two factors: score 1 of tooth translucency/value high and score 1 of tooth color. The addition of the face affected patient satisfaction score significantly in 3 factors: score 1 of tooth translucency/value high, score 0 of tooth translucency/value high and score 1 of tooth translucency/value low. These results for patient satisfaction score suggest that when the teeth are viewed alone, the 1 score for the tooth color and high translucency or opaque coloration are affected when adding the lips and face. All of the criteria that patients revealed significant differences, involved tooth color criteria, which can be supported by findings in another study evaluating patient's perception of dental attractiveness (35) where the researchers confirmed that patients found tooth color to be the most important factor of dental attractiveness.

Dentist satisfaction scores- The dentist satisfaction scores were influenced by the addition of the lips and the face but were significantly different in other criteria when compared to patient satisfaction scores. Dentist satisfaction scores were significantly different with the addition of the

lips for 4 factors: score 0 of tooth translucency/value high, score 1 of tooth form wide, score 0 of tooth form wide and score 1 of tooth translucency/value low. The addition of the face affected dentist satisfaction in 2 factors: score 0 of tooth form wide and score 1 of tooth translucency/value low. The presence of the face increased the satisfaction score of the wide tooth form for dentists. Dentists' satisfaction score differences included color changes similar to patients' scores but in addition to color, tooth form.

Satisfaction scores of lips between dentists and patients- The satisfaction score of the addition of the lips resulted in significant differences in the score 0 of 6 factors between dentists and patients: mesial papilla, distal papilla, tooth form wide, tooth form narrow, tooth surface and tooth translucency/value low. This suggests that patients are more tolerant of soft tissue deficiencies surrounding implant restorations, which can be supported by Kourkata et al (40) that found patient esthetic satisfaction to be high, despite a less than ideal fill of the papillae. Also, the results showed that patients are more tolerant of abnormal size/shape of the implant crown in comparison to dentists' evaluations, which was concluded in Chang et al (34) where researchers found that differences in crown height/form as well as soft tissue differences may not be important for patients' appreciation of esthetic outcome of implant restoration. Dentists seem to notice changes in papilla and tooth form more so than the patients who were evaluating.

Satisfaction scores of the face between dentists and patients- The satisfaction score of the addition of the face resulted in significant differences in 4 criteria between dentists and patients: distal papilla score 1, distal papilla score 0, tooth form wide score 0 and tooth translucency/value high score 0. This suggests that despite adding the face to the photo, dentists were still aware of the distal papilla deficiency and the wide tooth form. Chang et al (16) found that clinician's overall satisfaction was heavily influenced by the form of the crown and the surrounding soft

tissue appearance, thus it seems that this tends to be an evaluating criterion that dentists are increasingly aware of when compared to patients.

Perceptibility with the lips between dentists and patients- The perceptibility between dentists and patients differed in several criteria with addition of the lips and the perfect photo as well. Both 0 and 1 scores for distal papilla, tooth form wide, tooth form narrow, tooth surface and tooth translucency/value high. Score 1 of mesial papilla had a significant difference. These results suggest that despite adding the lips, dentists still perceived papillae changes and tooth form/surface more so than patients. Notice that 100% of the dentists taking the survey were able to perceive the changes in papillae and wide tooth form. Almost all dentists were able to perceive the 1 score of the wide tooth form and 0 score of the narrow tooth form with 94% each. Note that the 59 % of dentists perceived a difference in the “perfect” photo adding to a false positive consideration that when people take a survey and know that something will be different, they think there is a difference when there is not, which was also found by the Lindsey and Wee study (3).

Perceptibility with the face between dentists and patients- The perceptibility between dentists and patients differed in several criteria with the addition of the face and the perfect photo as well. Both 0 and 1 scores for mesial papilla, distal papilla, tooth form wide, tooth form narrow, tooth surface and tooth translucency/value high were significantly different between dentists and patients. Score 0 of tooth translucency/value low and the “perfect” face photo were also found to be perceived differently between patients and dentists. These results suggest that despite the addition of the face, dentists still perceive changes in papillae deficiencies as can be seen by the results of 100% of dentists responded that they saw a difference in the treated area. Dentists were able to perceive tooth form, surface, and value more so than patients despite the

addition of the face. Line angles and incisal edge changes are valued more by dentists in comparison to patients. Also, similarly to the perceptibility section with the lips, the “perfect” face photo was perceived by 65% of dentists to have a difference in the treatment area. High false alarm rate is present. Notice that patients were not as perceptive to value changes in the +L direction when viewing the facial portrait. Only 33% perceived when the implant crown shade was increased which is what Lindsey and Wee (3) study confirmed as well.

Acceptability with the lips between dentists and patients- The acceptability with the presence of the lips between dentists and patients differed significantly in 4 criteria of score 0: distal papilla, tooth form wide, tooth surface and tooth translucency/value low. 52% of patients would accept a less than 50% fill of papilla adjacent to an implant crown, whereas only 12% of dentists would accept this result. Kourkata et al (40) found that even when the final crown resulted in a less than ideal papilla fill, patient esthetic satisfaction was high. Tymstra et al (42) had patients evaluate their own implant therapy along with clinicians. The final implant crowns demonstrated a complete papilla fill in 70% of the patients. All 10 patients involved in the study rated their esthetic outcome of their crown and surrounding soft tissue as acceptable. Clinicians evaluated the results using the Implant Crown Aesthetic Index and found six to be acceptable and four unacceptable. This supports the conclusion that patients may not value complete papilla fill comparatively to dentists. Only 6% of dentists would accept the 0 score of tooth form and low value whereas close to 50% of patients would be accepting of this, which is supported by previous studies (16,34).

Acceptability with the face between dentists and patients- the acceptability with the presence of the face between dentists and patients differed significantly in 5 criteria of score 0: mesial papilla, distal papilla, tooth form wide, tooth form narrow and tooth translucency/value

high. Similarly, to the lips photos, 0-6% of dentists would accept a major mesial or distal papilla deficiency where less than 50% of the papilla is filled from zenith to contact point. Only about half of the patients stated that they would not accept this result supported by previous study (40). Another point to consider is that acceptability of the tooth translucency high score 0 (+L of above 7.0) by patients was 82%, which suggests less sensitivity to changes in brightness due to the model's lighter complexion leading to a higher acceptability percentage. Only 29% of dentists accepted this which may imply that patients are less bothered by an opaque crown compared to the adjacent natural tooth. 33% of patients perceived a difference with the face, high translucency score 0 and 82% of the patients stated they would accept this result. May suggest that patients do not mind having a crown that is too light if it is white, even if whiter than the surrounding teeth.

Overall, dentists were much better at perceiving changes in soft tissue and tooth form even with the addition of the lips and face. Patients were not bothered by these factors as much and appeared to be more concerned with color and value of the implant crown.

## **5.1 Limitations of the study**

Several limitations of this study were observed. One of the largest issues was the sample size (n=44, 17 dentists and 27 patients). Small sample sizes can lead to difficulty in detecting statistical differences in research questions. As we did not perform the Bonferroni corrections, there may be a tendency for type I errors to occur in interpreting the statistical findings.

Acquiring more participants for the survey would increase the N for the study, thus allowing for better data analysis. The difference in numbers of dentists and patients could lead to statistical

differences. 39% of the participants were dentists and 61% were patients. It would have been ideal to have closer to a 50/50 ratio of dentists to patients.

Another limitation of this study was that participants taking the survey on the iPad at UIC COD were in a controlled environment versus those taking the survey on a computer were in an uncontrolled environment. This may have resulted in different viewing parameters (dimensions and color) of the photos which can lead to different viewability of the changes in the PES/WES criteria.

Due to the 8 criteria of the PES/WES used in this study plus the lips and face pictures for evaluation, this resulted in several photos for participants to evaluate. Although demographic information was strategically placed throughout the survey, due to the large number of photos to evaluate, this can lead to fatigue for the participant.

When the participants viewed each photo, they were only given 30 seconds to decide. This may force the survey taker to make a decision before they are sure, which increases false position (stating there is a difference when there is not.)

Lastly, because only one esthetic factor was changed in each photograph, the authors were unable to test for any interaction between the esthetic factors. For example, if a photo had a papilla alteration as well as a tooth form change together in one photo, if this would alter the satisfaction scores.

## 5.2 **Future Research**

Future research should include using a “perfect” photo with a high smile line to show all criteria of the pink and white esthetic score/UIC-SIU Index as this study was only able to use the mesial and distal papilla factors in the PES. Another change in the methods that may result in more information regarding the effect of skin complexion and the esthetic criteria is by using a darker complected face/smile. Previous studies found that when viewing a Caucasian portrait, tooth color changes in the +L direction (brighter), were much less noticed by the evaluators (3). This may have a different effect on color perceptions and ultimately affect the satisfaction scores when compared to this study. Lastly, the study may prove to be more acceptable or more valuable if the standardized global scale of the PES/WES is used versus the new UIC-Siu Index as this is less known worldwide at this time.

## **6. CONCLUSION**

The results of this study enabled authors to make the following conclusions:

1. The addition of the lips and the face influenced the satisfaction scores of patients and dentists.
2. The presence of the face increased satisfaction scores of the tooth form for dentists.
3. The most important parameters for patients are those for tooth color and value.
4. Dentists appear to value tooth form more than patients.
5. Dentists perceived papillae changes more so than patients.
6. Dentists tend to have lower acceptability compared to patients



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### ABSTRACT POSTER

PRESENTATIONS: Master Thesis: "The Effect of the Lips and Face on Esthetic Outcomes of  
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