

Implant Esthetics in the Predoctoral Program

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THESIS

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LIST OF ABBREVIATIONS

CODA	Commission on Dental Accreditation
IRB	Institutional Review Board
OHIP	Oral Health Impact Profile
PES	Pink Esthetic Score
PFM	Porcelain Fused to Metal
PI	Papilla Index
SES	Subjective Esthetic Score
STI	Single Tooth Implant
UIC COD	University of Illinois at Chicago College of Dentistry
WES	White Esthetic Score

SUMMARY

Implant esthetics in the maxillary esthetic zone is dictated by multiple factors, including the soft tissue structure and the prosthesis itself. The aim of this study was to assess the ability of predoctoral students to produce esthetically acceptable clinical prostheses for single tooth implants in the esthetic zone. The assessment integrated the Pink Esthetic Score (PES) and White Esthetic Score (WES) to objectively evaluate the outcome of the therapy. A secondary aim was to assess patient experience with therapy using a modified OHIP-14 format and an additional semantic scale.

Fifty-three patients were invited to participate after IRB approval was received. To be included in the study, subjects had to be over the age of 18 and had received single tooth implant prostheses placed in the maxillary esthetic zone, from first premolar to first premolar. All prostheses were delivered by predoctoral students and were in place for at least six months prior to recall. A clinical exam was performed which included two patient questionnaires, a periapical radiograph of the implant prosthesis, intraoral photographs and alginate impressions. The photographs were formatted and assessed by three board-certified Prosthodontists, two board-certified Periodontists and two fourth year dental students using the PES and WES. Statistical analyses were performed on all collected data.

Twenty-seven patients participated in the study and 27 predoctoral students were involved in restorative treatment. Ten implants were restored with custom abutments, and 17 were prefabricated abutments. Twenty-six prostheses were porcelain fused to metal and only one was all ceramic. The faculty examiners had a moderate agreement between their first and second ratings while the students had fair agreement. Both the PES and WES were in the

SUMMARY (continued)

clinically acceptable range. The OHIP-14 and semantic scale results demonstrated high patient satisfaction. There is no statistically significant correlation between the objective assessments and patient satisfaction.

Predoctoral students can provide clinically acceptable implant therapy in the esthetic zone. Patients are satisfied with the treatment provided at the dental school level as well as the quality of life and esthetic outcomes of their treatment. There was no correlation between patient satisfaction and examiner assessment using the PES and WES.

1. INTRODUCTION

1.1 Background

Implant dentistry is a common therapeutic approach for patients. It is therefore an important dental subject to be addressed at the predoctoral level (CODA). Gaining experience, both in the laboratory and clinical setting has multiple benefits to the young dental provider.[1-3] Studies have demonstrated that implant survival at the predoctoral level is high, which supports the continued practice of education in implant therapy.[2, 4] Experience levels may affect implant success and survival, and therefore earlier exposure to implant techniques may help young dental practitioners have a higher rate of success.[5-7]

The success of implant therapy does not only lie in the survival rate of the implant, but the functional and esthetic outcome of the prosthesis that the implant supports.[8-10] There have been multiple attempts to objectively assess the esthetic results of implant prostheses using grading scores.[8-10] One of the more recent objective scoring systems from Belser et al has been used in various studies and has demonstrated reproducibility.[11, 12]

Also, patient satisfaction must be considered when determining the success of an implant prosthesis.[13] It is not sufficient to limit implant studies to survival and success of the treatments. The patients' own consideration of what makes their treatment successful should be addressed.

1.2 Significance

Patient therapy with implants at the predoctoral level is gaining momentum as the expectations of students change and the national learning standards in dental schools change to address how to best practice and the needs of the patient population. This study aimed to assess the ability of predoctoral students to achieve esthetically acceptable results when treating patients with single tooth implant prostheses. In addition to implant survival, the success of the treatment also lies in how patients perceive their care at the facility. Both patient satisfaction and esthetics are subjects that have lagged in implant literature, in both quantity of studies and the patient population in predoctoral settings, and this study aimed to help define these factors at the predoctoral level.

1.3 Specific Aims

Implant esthetics in the anterior region of the maxilla is dictated by multiple factors, including the soft tissue structure and the prosthesis itself. To objectively assess these outcomes, various measurements have recently been published, including the Pink Esthetic Score (PES) and White Esthetic Score (WES). With implant therapy becoming increasingly popular and practiced, dental schools have bolstered the curriculum to implement implant training. The aim of this study was to assess the ability of predoctoral students to produce esthetically acceptable clinical prostheses for single tooth implants in the esthetic zone. The assessment integrated the PES and WES outline to objectively evaluate the outcome of the therapy.

From this assessment, we hoped to gain better insight into the ability of a predoctoral education program to provide implant therapy through clinician assessed outcomes. Anterior implants in the esthetic zone have a multitude of factors that help define a clinical success or failure. If certain areas of the esthetic assessment have strength or weakness, the results would give positive feedback to faculty when considering the effectiveness of the predoctoral implant curriculum and its need for modifications.

The aim of this study was to use the objective esthetic index of the PES/WES system to assess the ability of predoctoral students to deliver esthetically pleasing anterior, maxillary single tooth implant prostheses based on the clinician's perspective.

A secondary aim was to assess patient experience with therapy using a modified OHIP-14 format and an additional semantic scale. These two methods of assessment evaluated patient perceived oral health quality of life and satisfaction with therapy, respectively.

1.4 Hypotheses

1. Predoctoral students provide esthetic single tooth implant (STI) prostheses in the maxillary esthetic zone based on PES and WES assessments made by specialists and dental students.
2. Patients are satisfied with the single implant supported prostheses received in the maxillary esthetic zone when treated at the predoctoral level as determined by using the modified OHIP-14 and semantic scale assessments.

2. REVIEW OF LITERATURE

2.1 Predoctoral Implant Training

Implant education has been continually changing with the advances in science and technology and trends indicate the ongoing integration of all aspects of therapy with implants in the predoctoral learning environment.[2] In 2002, a survey study of North American dental schools showed that at least 84% of the respondents did have an implant dentistry course as part of the required curriculum.[3] Two years later, another survey of deans at North American dental schools revealed that 97% of responding schools had didactic training required in implant therapy, 86% had clinical experience as well. Only 13% made this clinical experience a requirement in the curriculum.[14] Similar results were seen from a European study that assessed implant education at the predoctoral level.[15] The European study revealed that 80% of the responding schools required a course in implant dentistry and that, within that group, 87% of those courses had a prosthodontist involved in the training. Although there was a high level of exposure to the subject of implant dentistry, only 37% of those schools also offered laboratory education and a total of 63% were not restoring implants at the predoctoral level. Sixty-eight percent required that the predoctoral students be present during the time of implant surgery.

The clinical experience received in implant training may be beneficial by increasing clinician awareness of the treatment possibilities for their patients. A significant increase in general dentist implant therapy at the private practice level may exist if the dentist received clinical training at the predoctoral level.[16] If there was no clinical predoctoral training noted,

there were fewer general dentists participating in implant therapy, even if they had didactic training experience.[16, 17]

The trend of increasing practitioners participating in implant therapy was also reinforced by a 2002 study from Atchison et al.[18] A questionnaire was sent out to former dental students, requesting information on gender, further training and types of procedures the individuals tended to refer out versus maintain in office. The study noted that those individuals that have General Practice residency training were more likely to place implants themselves versus general dentists who had not received any additional training. With increasing exposure to implant therapy, a student or resident will more likely use that knowledge and experience at the private practice level.

Considering the increased importance of implant therapy for patient, predoctoral programs are incorporating increased didactic training to instruct students in both the surgical and restorative aspects of implant therapy. The Commission on Dental Accreditation (CODA) is requiring, beginning in 2013, that all dental schools must implement implant programs that, as a minimum, provide students with competency in implant prosthodontic therapy (CODA).

Students recognize the importance of implant therapy even before they have begun training.[1, 19] Students not only need to learn about implants but they also expect to gain this knowledge base while in school. Students gain confidence and comfort with implant therapy as they become better acquainted with the techniques involved.[1]

The success rate of implants at the predoctoral level must also be addressed. An early study from Creighton University demonstrated a surgical success rate of 91% and 87% at three

and five year follow-ups, respectively.[2] A more recent study demonstrated that, over a three year span, implants for both mandibular overdentures and single tooth prostheses had a 99% survival rate in the predoctoral setting.[4] Prosthetic therapy involving implants has also been successful at the predoctoral level. Aragon, in 2010, demonstrated that mandibular implant-supported overdentures were fabricated to the same level of success as conventional dentures at the predoctoral level, when assessed by both patients and prosthodontists.[20] The success of implant integration and prosthesis success observed at advanced levels of expertise is being replicated at the predoctoral level.

2.2 Improvement with training

Survival rates of implants at the predoctoral level are extremely high, but often those implants are not placed by the predoctoral students.[4] The predoctoral students often work in conjunction with the specialty students at the surgical placement stage, as occurs at the University of Illinois at Chicago College of Dentistry. The level of surgical experience, specifically with implant placement may influence implant survival and success rates.

Preiskel et al (1995) assessed the treatment outcome of implant therapy between two groups with different levels of implant experience.[7] Group A were experienced oral and maxillofacial surgeons who were just beginning their training in implant therapy, whereas Group B were both periodontists and an oral maxillofacial surgeon who had a minimum of two years' experience with implant therapy. Integration of the implants between the two groups was similar, but a difference existed in the success of the prostheses following restoration. Longer cantilever designs from Group A resulted in overdenture bar fractures. The authors

suggested that this may have been due to a more conservative approach of the second group, having had the previous experience to know the type of designs and methods that work best. The study concluded that the overall outcome of implant therapy improves with an increase in experience.

Inexperienced surgeons, defined by having placed less than 50 implants, reportedly had a failure rate twice as high as those surgeons who had placed greater than 50 implants.[21] Implants placed through the first nine patients had the greatest difference in survival compared to groups beyond that. In the first nine patients, inexperienced surgeons had a failure rate of 5.9% compared to only 2.4% for the experienced group. Knowing that a learning curve may exist that affects implant therapy outcomes, beginning the education and experience of providers in the dental school setting may help to reduce the discrepancy between less experienced dental graduates versus those with more expertise.

Another study compared implant therapy results between a specialty clinic and a general practice clinic.[5] The general practice individuals had completed a training course in basic implant treatment, including lectures, hands-on training and guided patient treatment. The course was followed by planning, treatment and follow-up of single tooth implant patients at their own offices. A total of 38 patients were treated with single tooth implants and subsequent prostheses. All implants were placed in the maxilla, anterior to the sinus, and did not require any additional surgical intervention. There were no differences observed between the two groups, and each had a 100% rate of implant survival. Only one prosthesis failed due to

trauma. Results suggested that general practitioners can successfully place and restore single tooth implants, when the procedures have limited complexity.

A study from the University of Illinois at Chicago College of Dentistry assessed the survival rate of implants placed in the postgraduate Prosthodontic clinic.[6] A total of 306 implants were included in the study, placed over a 34-month period, and the majority had been in service for at least three years. Only seven implants failed (2.3%). All failed within six months of placement. The study also assessed if there were any differences noted between the residents year in training at the time of implant placement. No statistically significant difference was noted between level of training.

2.3 Pink & White Esthetic Score

Although implants have reportedly high survival rates, other considerations define successful dental therapy. Esthetics is an important factor in successful dental treatment. Assessing implant esthetics, a potentially subjective measurement, has been attempted repeatedly over recent years.[8-12, 22-26]

Esthetic assessments have been conducted for many years in an attempt to establish certain criteria that result in the most favorable outcomes without the extra consideration of implant therapy.[27, 28] Kokich's study demonstrated that esthetic discrepancies are different between various dental specialties and laypeople. Laypeople had a more forgiving assessment of what constitutes a favorable outcome.[27] Erum and colleagues noted that laypeople did not necessarily have similar preferences in esthetic displays, which reinforced the need to identify a patient's specific expectations.[28]

Early attempts to compare esthetics between natural teeth and single tooth implants were performed by Chang and colleagues in 1999.[29] At this early stage, they attempted to gather information to compare both soft and hard tissue outcomes in a non-quantitative format, making objective assessments impossible. Patient satisfaction was also assessed, using a visual analog scale, but a small sample size and lack of standardization decreased the study's clinical relevance.

From this early attempt at esthetic implant assessment, more studies have examples on esthetic analyses.[9-12, 22, 24, 25, 30]

In 2005, Meijer et al published another model for objective assessment of implant prostheses.[10] The Implant Crown Aesthetic Index had nine factors that assess both the soft and hard tissue of the single tooth implant prosthesis. These factors included the mesiodistal crown dimension, the incisal edge position, labial crown convexity, crown color and translucency, crown surface texture, position of the labial margin of the periimplant mucosa, position of the mucosa in the proximal embrasures and contour of the labial surface of the mucosa. Meijer et al recruited two oral and maxillofacial surgeons and two prosthodontists. Each observer rated 24 single tooth implant prostheses twice; their inter- and intra-rater repeatability was assessed. The study found that prosthodontists were better at repeatability of scoring in comparison to the surgeons and that only the prosthodontists had good agreement between the two observers. Although the authors suggest that the Implant Crown Aesthetic Index was a useful tool for objective assessment of single tooth implant prostheses, the lack of reproducibility of two out of the four observers suggested that further modification was needed to create reliable clinical measurement.

Furhauser and colleagues (2005) presented the Pink Esthetic Score (PES) that assessed seven aspects of the gingival architecture surrounding an anterior single tooth implant.[9, 10] The seven variables of the PES included the mesial papilla, distal papilla, soft-tissue level, soft-tissue contour, alveolar process deficiency, soft-tissue color and soft-tissue texture.[9] The authors used a scoring system of 0-1-2, with 0 being the lowest value. The best PES score achievable was 14. The authors had twenty observers, with five prosthodontists, five oral surgeons, five orthodontists and five dental students. These observers assessed a total of 30 single-tooth implant restorations in comparison to the natural reference tooth two times, at a four week interval. Overall, the study found that the scoring assessments were repeatable, especially for restorations that were rated as having either very poor or very esthetic restoration outcomes. Also, orthodontists were found to give the lowest score values, while prosthodontists rated the prostheses most favorably. The authors stated that their PES system was reproducible and a good tool for esthetic, objective assessment of peri-implant soft tissue around a single tooth implant prosthesis.

Gehrke et al, in 2008, further assessed the ability of the Pink Esthetic Score to objectively score the esthetics of single tooth implant prostheses in a reproducible manner.[30] Using the same format as the Furhauser et al study, they had 15 examiners assess 30 implant-supported single restorations twice at an interval of 4 weeks.[9, 30] They used three general dentists, three oral maxillofacial surgeons, three orthodontists, three postgraduate students in implant dentistry and three lay people. Their results demonstrated that there was a 70.5% agreement between the first and second rating for all occupational groups, though the greatest agreement was obtained by orthodontists, at 73.5%, and the least by lay people, at 65.9%. Like

Furhauser and colleagues' original study, orthodontists assigned the lowest ratings.[9, 30] The lay people and the postgraduate students assigned the highest ratings. The prostheses that were either very poor or very esthetic had the smallest deviation between scores.

The Pink Esthetic Score, introduced by Furhauser et al in 2005, became an assessment used in various other studies that attempted to affirm its repeatability and application to other aspects of single tooth implant prostheses.[9] In 2008, Lai et al used the PES, as outlined by Furhauser and colleagues, to assess the soft tissue esthetics of single tooth implant prostheses as a function of time.[25] The single tooth implant prostheses and surrounding soft tissues were assessed at the time of crown placement and then six months post-loading. There were a total of 29 patients and the assessments were made by two orthodontists. The observers showed no statistically significant differences between their scores and they found that multiple factors improved over the six month period. The mesial and distal papilla, level of the soft-tissue margin, soft-tissue contour, color and texture all increased significantly at the time of follow up. Therefore, when determining the timeline of recall for our patient population, a minimum of six months was identified to allow for any soft tissue changes to occur following delivery. It also appeared that the soft tissue esthetics, and less surprisingly, the prosthesis esthetics may tend to remain constant over an extended timeline following delivery.[31] In this study, single tooth implant prostheses were assessed for esthetic results as per the Belser et al 2009 protocol, and found that the esthetic scores were greater after 1.5 years, and as great as 5.5 years, compared to the esthetics at time of delivery.[8] The PES, as in the Lai study, improved after the initial placement of the final prosthesis and remained consistent over a long-term follow up report.

Also in 2009, Chen et al used the PES as well as the Subjective Esthetic Score (SES) that had previously been developed by Evans and Chen in 2008.[22, 32] In both studies, objective esthetic assessments were being used to rate the outcome of immediately placed single-tooth implants and their subsequent prostheses. The SES was developed to rate the esthetic outcome based on the vertical changes of the mucosal margin position. In both studies, the esthetics was not always predictable for immediately placed implants and many demonstrated an increased loss of tissue level, especially with thinner gingival biotypes.

Hof et al, in 2011, used the PES from Furhauser et al to assess the esthetics of single tooth implants placed in sites that had undergone autologous bone augmentation of deficient maxillary sites.[9, 24] Sixty implants located in the esthetic zone were assessed using both the PES as well as the Papilla Index (PI). The PI incorporates the principles that had been described by Jemt in 1997, and ranges from a PI of 0 with no papilla present to a PI of 4 with an overabundance of hyperplastic soft tissue.[33] Hof et al found that the intra- and inter-observations demonstrated “respectable” levels of agreement, with κ values greater than .70.[24]

Belser et al, in 2009, further modified the PES by implementing a White Esthetic Score (WES).[8] This approach reviews five different aspects of the soft tissue and implant prosthesis, respectively. The new criteria extrapolated five PES assessments from Furhauser et al including 1) mesial papilla 2) distal papilla 3) curvature of the facial mucosa 4) level of the facial mucosa and 5) root convexity/soft tissue color and texture at the facial aspect of the implant site.[9] For the WES, Belser and colleagues also selected five criteria of assessment, including 1) general tooth form 2) outline and volume of the clinical crown 3) color, which includes the assessment

of the dimension's hue and value 4) surface texture and 5) translucency and characterization.[8] The maximum score for each category is 10, with a range of 0 to 2 per category. The authors arbitrarily set 6 as the threshold for clinical acceptability within each category. A total of 45 patients participated in the study. One prosthodontist evaluated the single tooth implant prostheses twice. If there were discrepancies between the scores, the evaluator would review those discrepancies and make a final evaluation. Following the initial evaluations, a second prosthodontist also assessed the prostheses, with the initial evaluator, to reach a final consensus. The patients were asked to complete a visual analog scale that had three questions related to the esthetics of their prostheses. Results demonstrated that all of the prostheses were clinically acceptable in terms of the esthetics, according to the arbitrary cutoff established by the authors. In their study, Belser et al found that the PES was greater, with an average of 7.8, versus the WES at 6.9. It is important to note that this study had an experienced oral surgeon who placed all of the implants, while the prostheses were delivered by various practitioners, hence a possible source of discrepancy between the PES and WES.

Some studies have used a combination of both Furhauser and colleague's PES and Belser and colleague's WES.[8, 9] In both 2010 and 2011, Cosyn et al published on the subject of esthetics of anterior single tooth implant prostheses.[12, 34] Instead of using only Belser et al's format of PES and WES, he combined the two techniques, forming a more complex analysis of the esthetics. The aim of Cosyn et al was to assess the clinical esthetic outcomes of various surgical approaches to single tooth implant placement and how it affects the esthetic outcome. In both studies, he found that the esthetic outcomes were acceptable, regardless of surgical technique.

Another study which combined the PES of Furhauser et al and Belser et al's esthetic indices came from Dierens et al in 2012.[35] Here, they assessed the changes in soft tissue over a long-term period spanning from 16 to 22 years in periodontally healthy teeth. They found no significant difference between baseline and reexamination and noted that both the alveolar process anatomy and the papillae scored worst at both time points while soft tissue contour was most favorable. There was also no significant difference found in the WES and they noted that 46% (WES = 5.43) and 42% (5.33) of the restorations were considered esthetic failures at both time points respectively. Interestingly, while the implant prostheses did maintain similar esthetic results, the study did find that the adjacent natural teeth showed evidence of mid-facial recession and supraeruption.

Cho et al, in 2010, studied the effect of practitioner training and its relation to the use of the PES and WES.[11] Two orthodontists, 2 prosthodontists, 2 periodontists and 2 senior dental students were recruited for the study. They assessed 41 adult patients who had been treated with a single tooth implant prosthesis in the maxillary esthetic zone. The evaluations were performed twice at a 4 week interval. The patients were asked to complete a visual analog scale to assess their satisfaction with the treatment in regards to the esthetic outcome. Cohen's κ values were calculated to compare the agreement between the evaluators' first and second scores. They found that the repeatability of the evaluators ranged from moderate to very good. Unlike Belser et al's study, Cho et al found that the WES values were greater than the PES, and that the PES average value did not attain the esthetic cutoff value of 6, hovering at 5.17.[8, 11] Again, orthodontists were found to be the most critical, though statistical analysis revealed no significant difference among the specialty groups when combining PES and WES.

Interestingly, there were statistically significant differences noted for the WES alone, with the prosthodontists scoring most critically.

2.4 Esthetics

The purpose of the PES/WES system is to attempt an objective measurement of the different factors that are part of esthetic outcomes. But how do patients and practitioners weigh each esthetic factor? Determining the role each esthetic variable affects patient satisfaction and can help refine these objective assessments.

A 2009 study by Esposito et al attempted to assess whether or not practitioners and patients can have reliable agreement between themselves and each other when evaluating esthetic changes of the maxillary anterior esthetic zone.[36] Thirty patients were included in the study. Each were treated with implant prostheses. Ten practitioners, of various clinical experience, were included as evaluators. A total of four clinical photographs were included, two pre-treatment and two post-treatment. Both patients and practitioners had to indicate which were pre- or post-operative photographs, use the visual analog scale to rate the esthetic changes, and grade the prostheses on an ordinal scale of 1 to 4 and to also indicate whether or not they were satisfied with the esthetic outcome of the photographs. Statistical analyses were performed using the κ value scoring system, which was outlined by Landis et al in 1977. The authors found that patients tended towards better agreement, though they only evaluated their own outcomes; they also found that practitioners were not in high agreement and that agreement between patients and clinicians was poor.

A 2012 study from Suphanantachat et al examined how patients rate the importance of various aspects of their maxillary anterior single tooth implant prostheses.[37] Forty patients used the visual analog scale to rate their satisfaction of their prostheses according to different variables, including harmonization of the gingival margin, crown color and shape and overall esthetic satisfaction. The authors measured facial and inter-proximal mucosal levels and also assessed the various components of the prosthesis. While the patients reported that they were satisfied with the overall esthetic result (84.5%), the variable of gingival harmony only received a 67.4% satisfaction result. This suggests that patients may be aware of various components of their prostheses, but that other variables, like the crown shape and color, have a more important impact on their assessment of esthetic outcomes. The pink esthetic variable may be less important for patient satisfaction.

2.5 Patient Satisfaction

Patient satisfaction is not an outcome that lends itself to easy objective assessment. Aside from an esthetic outcome, quality of life assessment is an important factor to consider when quantifying patient satisfaction. An early study in the reliability and validity of patient population health surveys suggested three general guidelines that should be met for any format, including 1) they should represent multiple health concepts and relate to general function 2) they should be reliable, valid and precise and 3) they should be simple to use in the clinical setting.[38]

There are multiple ways that quality of life and patient satisfaction has been measured over the years, though not all areas of restorative dentistry have been assessed. A systematic review from Thomason et al, in 2007, attempted to gather publications that assessed quality of life of patients.[13] The authors found numerous articles that suggested the improvement of quality of life when the patient was fully edentulous and received implant-supported mandibular prostheses, but they also noted that there was a lack of publications on the subject of maxillary implant prostheses. A similar outcome was noted in a 2004 study that noted a deficit in high quality level of evidence studies that report on patient satisfaction when related to implant and subsequent prosthetic therapy.[39] That same study also suggests the benefits of having a standardized format to assess quality of life factors to have a way of comparing across different studies.[39] Quality of life and patient satisfaction studies that assess maxillary esthetic prostheses, whether implant-supported or not, are needed because esthetics is a factor that is highly important to patients.

Slade developed the Oral Health Impact Profile (OHIP) questionnaire in 1994.[40] The initial questionnaire design included 49 questions related to a patient's experience with his dental therapy. The goal of the OHIP is to determine how the individual's oral condition affects his social situation. The basis of the assessment stems from seven dimensions that extend from a theoretical model of oral health which include functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap.[41] In 1997, Slade published a revised version of the OHIP questionnaire after modifying it to a shorter version, OHIP-14.[42] The modified version demonstrated reliability and validity and has been commonly used for quality of life assessment. The OHIP-14 was

further assessed in a 2002 study, which also demonstrated that it was a reliable survey but noted that different formats could be used to address different patient populations.[43] Specifically, Slade's regression short form questionnaire is used when discriminating between different patients while the impact short form is better suited for describing oral health-related quality of life of a population or to detect change within that population.[43] The benefit of using the OHIP format is that it allows measurement of consequences of oral disorder and the effects on oral health related quality of life.[43] While the OHIP format may demonstrate how a patient feels about his overall social outcome, the questionnaire would not necessarily address esthetic outcomes to a high degree.[44]

Though many studies have used the OHIP model to assess completely edentulous patients, there have also been instances where the OHIP format has been used for other patient populations.[45] The study addressed the question of how dental esthetics affects the adolescent population.[45] Using the OHIP-14 model, the authors found that there was a correlation between adolescents' self-perceived impact of dental esthetics when considering the degree of malocclusion and body satisfaction. In the younger population, self-perception can have lasting effects on mental-well-being, and this study suggests that dental esthetics can play a role in that self-perception.

The majority of studies that have evaluated the quality of life have focused on the edentulous patient population, while few have addressed the partially edentulous patient.[46] In fact, a 2002 study from Allen et al presented a revised OHIP format specifically addressing the completely edentulous patient, the OHIP-EDENT.[46] They found that the OHIP-EDENT was

more sensitive to patient satisfaction in the edentulous population versus the OHIP-14, which failed to discriminate any difference in quality of life with prosthetic treatment.

There has been an attempt to develop a version of the OHIP questionnaire that specifically relates to esthetics.[47] A 2007 study from Wong et al developed an esthetically oriented version of the OHIP-14 and compared its benefits to Slade's OHIP-14 as well as the original OHIP-49. While their study did suggest the effectiveness of the revised format, it was used for an esthetic outcome based on bleaching, and was therefore not used in our study which focused on new prostheses.

Another form of assessing quality of life in the dental setting is the semantic differential scale.[48] Scaling methods, such as visual analogue scale, adjectival scales or semantic differentials can allow an examiner to develop questionnaires that directly address the specific dental treatment a patient received.[48] The semantic differential scale sets a series of factors along a continuous bipolar scale and the patient is able to select where he feels his treatment falls along the included topics.

This study addressed the lack of information on the partially edentulous population by assessing patient satisfaction and quality of life in correlation with treatment received at the UIC COD for single tooth implant prostheses in the predoctoral setting.

3. MATERIALS & METHODS

Clinical Study

Patient Population

Fifty-three patients were invited to participate following the initial chart screening from the University of Illinois at Chicago College of Dentistry (UIC COD) predoctoral program. The patients were selected from a comprehensive list of all patients who had received single tooth implants and subsequent prostheses in the maxillary anterior esthetic zone (first premolar to first premolar) at the UIC COD since the predoctoral implant program had been in practice, in 2006. A list of 973 patients was generated. From there, patients who did not meet the inclusion criteria were removed from the list, with a total of 53 patients qualifying for the study. Informed consent was obtained under a protocol reviewed and approved by the Institutional Review Board at UIC (IRB#2012-0396). To be included in the study, subjects had to be over the age of 18 and had received single tooth implant prostheses placed in the maxillary esthetic zone, from first premolar to first premolar. The implants were placed in the UIC COD specialty programs, including Periodontics, Oral and Maxillofacial Surgery and Prosthodontics. All prostheses were delivered by predoctoral students and were in place for at least six months prior to recall. Patients were excluded if the contralateral tooth (for canine through canine) or adjacent second premolar (for first premolars) was missing or had a full coverage restoration. The single tooth implant of interest could not be adjacent to another implant prosthesis.

Clinical Examination

The clinical exam was performed according to Belser et al. 2009.[8] One periapical radiograph was obtained of each implant prosthesis, using the paralleling technique. Intraoral photographs were taken perpendicular to all implant prostheses with a Canon EOS Rebel SLR camera (Lake Success, NY, USA) by a single operator (EJT) at a magnification between 1:2 to 1:3. For implant prostheses placed from canine to canine, photographs were centered at the midline to capture a consistent symmetrical representation of the contralateral tooth. Also, photographs were taken of each implant site to capture the adjacent teeth and the gingival architecture. In the case of first premolars, the method was modified to capture the adjacent second premolar as the reference tooth. Study casts were poured in type III dental stone (COECAL, GC America Inc, Alsip, IL, USA) from irreversible hydrocolloid impressions (Jeltrate Plus, Denstply Caulk, Milford, DE, USA).

Patient Questionnaire

All patients completed two questionnaires: the modified Oral Health Impact Profile-14 (OHIP-14), and a semantic scale questionnaire.[40, 48] Both served as assessments of the patients' satisfaction with the implant therapy they received.

Evaluation

PES/WES

Three board-certified Prosthodontists, two board-certified Periodontists and two UIC COD fourth year dental students were recruited to evaluate the collected data. The data

included a PowerPoint presentation of all included patients with the intraoral photographs with the site of interest specified and the periapical radiograph. Neither the photographs nor the radiographs were standardized for size and the viewing distance of the examiners was not controlled. All examiners performed their assessments on a single computer screen with the same presentation format. The study casts were given with the site of interest identified. Prior to their assessment, each examiner took, and passed, a color vision test (Ishihara color blindness test, <http://colorvisiontesting.com/ishihara.htm>). The examiners were blinded to patient information. Each examiner was asked to assess the photographs twice, using the Pink and White Esthetic Scoring system outlined by Belser et al (Tables I, II).[8] The order of photographs was changed from the first to second assessment, which were scheduled at least two weeks apart. If the examiner was not consistent between the two assessments, he was asked to select one value to allow for inter-examiner assessment.

TABLE I
SCORING SYSTEM FOR 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

TABLE II
SCORING SYSTEM FOR 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

Statistics

Data were collected and entered into a software database (Microsoft Excel 2007, Microsoft). Descriptive analyses were generated, including information on gender, age, implant type, length, platform width, abutment style and site of prosthesis. The Cohen kappa test was used to analyze the reliability between the two assessment times by the same observer. The mean and standard deviation of each variable of PES and WES from individual examiners were calculated. The mean and median of the modified OHIP-14 and median of the semantic scale were calculated. To assess the correlation between the semantic scale questions 4, 6, and 7 and the PES/WES, the Spearman rank correlation coefficient was calculated and graphed. Statistical software (SPSS v. 20.0, SPSS Inc., Chicago, IL, USA) was used for descriptive and statistical analyses. For all analyses, $\alpha = 0.05$.

4. **RESULTS**

Twenty-seven patients (51%) agreed to participate in the study. Twelve were male and 15 were female for a relatively equal distribution of 44% and 56% respectively. The age range was from 21 to 76 years, with a mean age of 51. There were a total of 27 predoctoral students involved in the restorative treatment and 17 residents who performed the surgeries. A total of 11 implants were placed by the Oral Surgery department, 7 by Prosthodontic discipline and 8 by the Periodontic department. The restorative therapy was overseen by 5 faculty, all trained in an Advanced Prosthodontics program. The surgeries were overseen by 11 faculty members from the three disciplines, all trained in the specialty of their department. Twenty of the implants were Nobel Biocare (Nobel Biocare USA, LLC, Yorba Linda, CA USA), and 7 were Astra Tech (DENTSPLY, Molndal, Sweden). Prostheses were placed using 10 custom abutments fabricated by Atlantis (DENTSPLY, Molndal, Sweden) and 17 prefabricated manufacturer specific abutments. Only one of the custom abutments was gold-hue titanium, and all others were titanium. Twenty-six (96%) of the single tooth prostheses were porcelain fused to metal, and one was a zirconia prosthesis. The distribution of implant sites are listed in Table III, with the majority of sites being in the first premolar region (78%).

TABLE III
IMPLANT DISTRIBUTION PER SITE

Implant site	#5	#6	#7	#9	#10	#12
N	17	2	2	1	1	4
%	63%	7%	7%	4%	4%	15%

The intra-rater agreement was calculated for each examiner (Table IV).

TABLE IV
INTRA-EXAMINER RELIABILITY AND AVERAGE TOTAL PES/WES SCORES

	Kappa value*	Average Total
Prosthodontist 1	0.417	12.5
Prosthodontist 2	0.552	11.6
Periodontist 1	.453	13.2
Periodontist 2	.481	14.2
Student 1	.357	10.4
Student 2	.390	12.2

-Kappa Value Range: 0.0-0.20 = Slight Agreement, 0.21-0.40 = Fair Agreement, 0.41-0.60 = Moderate Agreement, 0.61-0.80 = Substantial Agreement, 0.81-1.00 = Almost Perfect Agreement

The faculty examiners all had moderate agreement between their first and second ratings, with a prosthodontist performing most consistently at $k = .552$. The other prosthodontist and two periodontists had kappa values of .417, .453 and .481. The students had lower kappa values of .357 and .390, a fair agreement between the first and second scoring.

The PES raw scores for all examiners are reported in Appendix 1. The total PES of all examiners combined was 6.10 (Table 5). Student 1 had the lowest PES with 4.6 while Prosthodontist 1 had the highest PES with 6.4 (Table 5). The mean level of the facial mucosa of all examiners was the highest scored factor at 1.5 while the lowest scoring factor was the distal papilla at 1.0 (Table 5). The lowest score for a single factor of the PES/WES was 0.6, given by a student for the distal papilla (Table 5). If the anterior teeth are calculated separately from the first premolars, which accounted for 78% of the implant sites, the overall PES score is slightly lower at 6.0 and the lowest scoring factor was the distal papilla at 1.1 (Table V).

TABLE V
PES RESULTS

	PES	Mesial Papilla	Distal Papilla	Curvature of facial mucosa	Level of facial mucosa	Root convexity, soft tissue color and texture	Total PES (Max 10)
Prosthodontist 1	Mean	1.3	1.0	1.1	1.6	1.2	6.1
	SD	0.8	0.9	0.9	0.7	0.8	4.1
Prosthodontist 2	Mean	1.3	.9	1.1	1.3	1.3	6.0
	SD	.7	.7	.7	.7	.7	2.1
Periodontist 1	Mean	1.3	1.0	1.1	1.4	1.2	5.9
	SD	.8	.8	.6	.6	.6	2.2
Periodontist 2	Mean	1.2	.9	1.6	1.8	1.0	6.4
	SD	.8	.8	.6	.5	.6	2.1
Student 1	Mean	1.0	.6	1.0	1.1	1.0	4.6
	SD	.7	.7	.4	.5	.5	1.6
Student 2	Mean	1.3	.8	1.3	1.3	1.1	5.6
	SD	.8	.7	.6	.7	.5	2.1
All	Mean	1.2	1.0	1.2	1.5	1.2	6.1
	SD	0.7	0.7	0.6	0.6	0.6	2.1

The WES raw scores for all examiners are reported in Appendix 2. The overall WES all examiners was 6.56. Prosthodontist 2 had the lowest total WES with 5.6, and Periodontist 2 had the highest total with 7.5 (Table IV). The factor that scored the highest was the surface texture at 1.7, and there was not one factor that scored lower than the rest (Table VI).

TABLE VI
WES RESULTS

	WES	Tooth form	Tooth volume/ outline	Color (Hue/ Value)	Surface texture	Translucency and characterization	Total WES (Max 10)
Prosthodontist 1	Mean	1.3	1.0	1.2	1.8	1.1	6.4
	SD	0.9	0.8	0.9	0.4	0.9	2.8
Prosthodontist 2	Mean	1.1	1.2	1.0	1.3	1.0	5.6
	SD	.7	.7	.7	.8	.7	2.7
Periodontist 1	Mean	1.4	1.3	1.6	1.9	1.5	7.3
	SD	.6	.7	.6	.4	.5	1.9
Periodontist 2	Mean	1.3	1.4	1.4	1.8	1.5	7.5
	SD	.7	.7	.7	.5	.6	5.6
Student 1	Mean	1.1	1.1	1.1	1.3	1.2	5.8
	SD	.6	.6	.7	.7	.6	2.7
Student 2	Mean	1.4	1.3	1.4	1.2	1.3	6.6
	SD	.6	.6	.5	.4	.5	1.8
All	Mean	1.3	1.2	1.2	1.7	1.2	6.6
	SD	0.6	0.6	0.7	0.4	0.6	2.3

Instead, the 3 lowest scoring factors were all a score of 1.2 and included the tooth volume and outline, the tooth color and the translucency and characterization of the prostheses. The overall WES of the anterior teeth alone was 6.5 and the lowest factor within that group was tooth volume and outline at 1.1 (Table VII).

TABLE VII
ANTERIOR TEETH

PES						
	Mesial Papilla	Distal Papilla	Curvature of Facial Mucosa	Level of Facial Mucosa	Root Convexity/Soft Tissue Color and Texture	Total Score (maximum 10)
Mean	1.2	1.1	1.3	1.3	1.2	6.0
SD	.9	.7	.7	.7	.7	2.6
WES						
	Tooth Form	Tooth Volume/Outline	Color (hue/value)	Surface Texture	Translucency/Characterization	Total Score (maximum 10)
Mean	1.3	1.1	1.3	1.6	1.2	6.5
SD	.6	.5	.8	.4	.7	2.5

Examples are given of patients that received high, medium and low scoring PES/WES (Figures 1, 2, 3).



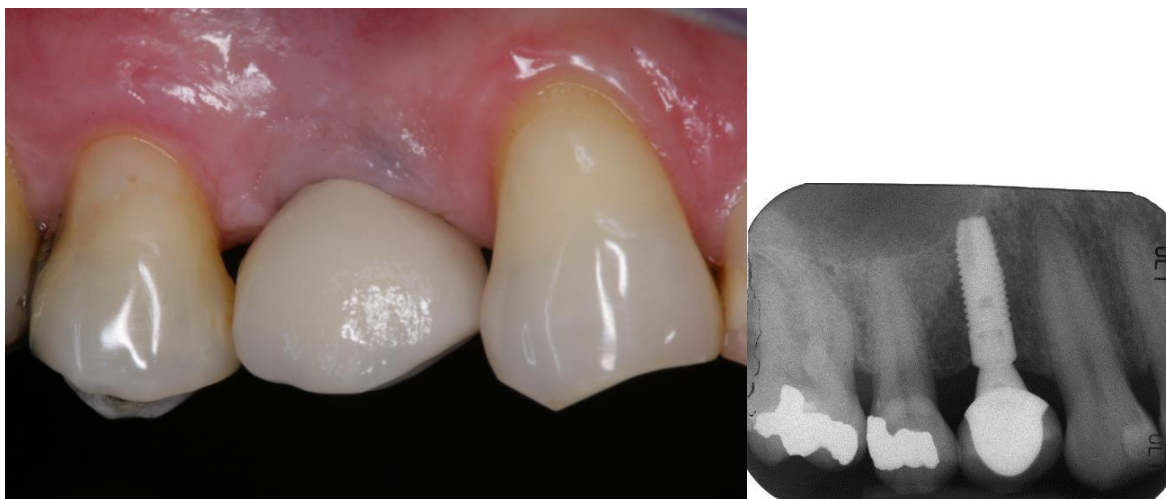
PES	Mesial Papilla	Distal Papilla	Curvature of facial mucosa	Level of facial mucosa	Root convexity, soft tissue color and texture	Total PES (Max 10)
Score	2	1	1	2	2	8
WES	Tooth form	Tooth volume/outline	Color (Hue/Value)	Surface texture	Translucency and characterization	Total WES (Max 10)
Score	2	2	2	2	2	10

Figure 1. Example of high WES/PES for tooth #7



PES	Mesial Papilla	Distal Papilla	Curvature of facial mucosa	Level of facial mucosa	Root convexity, soft tissue color and texture	Total PES (Max 10)
Score	0	1	1	1	1	4
WES	Tooth form	Tooth volume/outline	Color (Hue/Value)	Surface texture	Translucency and characterization	Total WES (Max 10)
Score	1	1	2	1	1	6

Figure 2. Example of moderate WES/PES score for tooth #5



PES	Mesial Papilla	Distal Papilla	Curvature of facial mucosa	Level of facial mucosa	Root convexity, soft tissue color and texture	Total PES (Max 10)
Score	1	0	0	0	0	1
WES	Tooth form	Tooth volume/outline	Color (Hue/Value)	Surface texture	Translucency and characterization	Total WES (Max 10)
Score	0	0	0	1	0	1

Figure 3. Example of low WES/PES for tooth #5

The OHIP-14 results demonstrated an overall patient satisfaction with the therapy they received, with a mean value of .1 (Table VIII).

TABLE VIII
OHIP RESULTS

Question	Mean±SD	Median
1) Have you had trouble pronouncing any words because of your implant restoration(s)?	0±0	0
2) Have you felt that your sense of taste has worsened because of your implant restoration(s)?	0±0	0
3) Have you had painful aching in your mouth?	0.1±0.4	0
4) Have you found it uncomfortable to eat any foods because of your implant restoration(s)?	0±0.6	0
5) Have you been self-conscious because of your implant restoration(s)?	0.2±1	0
6) Have you felt tense because of problems with your implant restoration(s)?	0.1±0.4	0
7) Has your diet been unsatisfactory because of your implant restoration(s)?	0±0.4	0
8) Have you had to interrupt meals because of your implant restoration(s)?	0±0.8	0
9) Have you found it difficult to relax because of your implant restoration(s)?	0±0.2	0
10) Have you been embarrassed because of your implant restoration(s)?	0.1±0.7	0
11) Have you been a bit irritable with other people because of your implant restoration(s)?	0±0.6	0
12) Have you had difficulty doing your usual jobs because of your implant restoration(s)?	0±0	0
13) Have you felt that life in general was less satisfying because of your implant restoration(s)?	0.1±0.6	0
14) Have you been totally unable to function because of your implant restoration(s)?	0.1±0.4	0

0 = Never, 1 = Hardly Ever, 2 = Occasionally, 3 = Fairly Often, 4 = Very Often

The semantic scale results were high with an overall satisfaction of 10 and an esthetic assessment of 9 (Table IX).

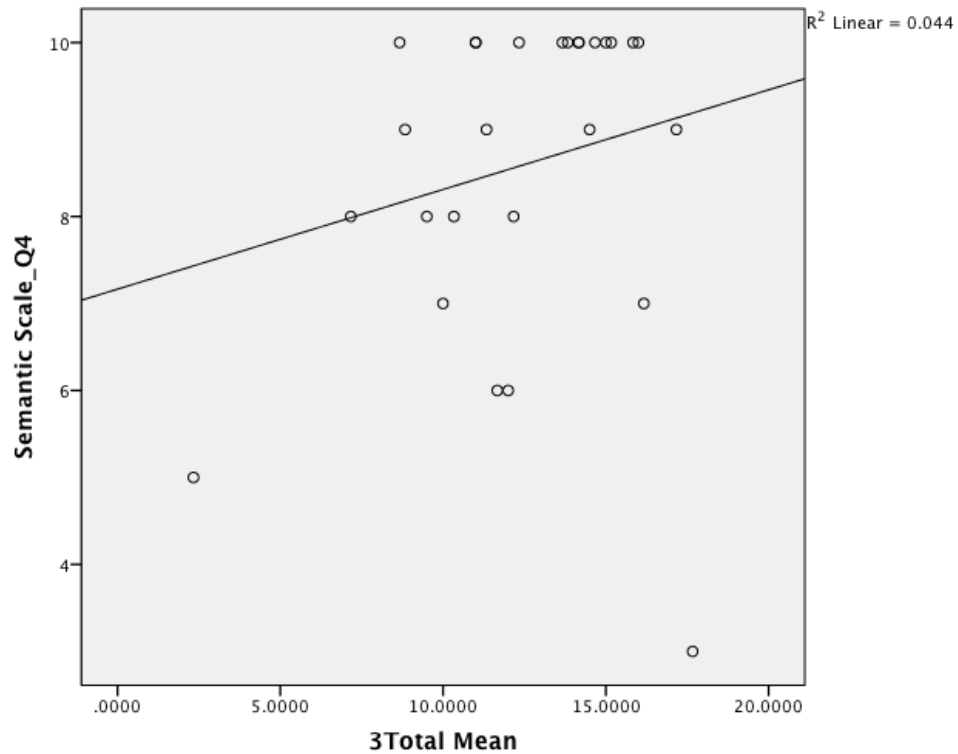
TABLE IX
SEMANTIC SCALE OF 27 PATIENTS

My treatment was...(1-10)	Median
1) Expensive---Inexpensive	6
2) Time-consuming---Quick	5
3) Painful---Pain Free	8
4) Poor Aesthetics---Good Aesthetics	9
5) Poor Chewing Ability---Good Chewing Ability	10
6) Unpleasant---Pleasant	9
7) Very Dissatisfied---Very Satisfied	10

The lowest scores were the perceived cost and amount of treatment time of the treatment received at a 6 and 5 respectively. The range of responses for the semantic scale question 4, which addresses esthetics, was from 3 to 10.

The relationship between total PES and WES and the semantic scale questions 4, 6 and 7 was calculated using Spearman's rho correlation coefficient. No statistically significant

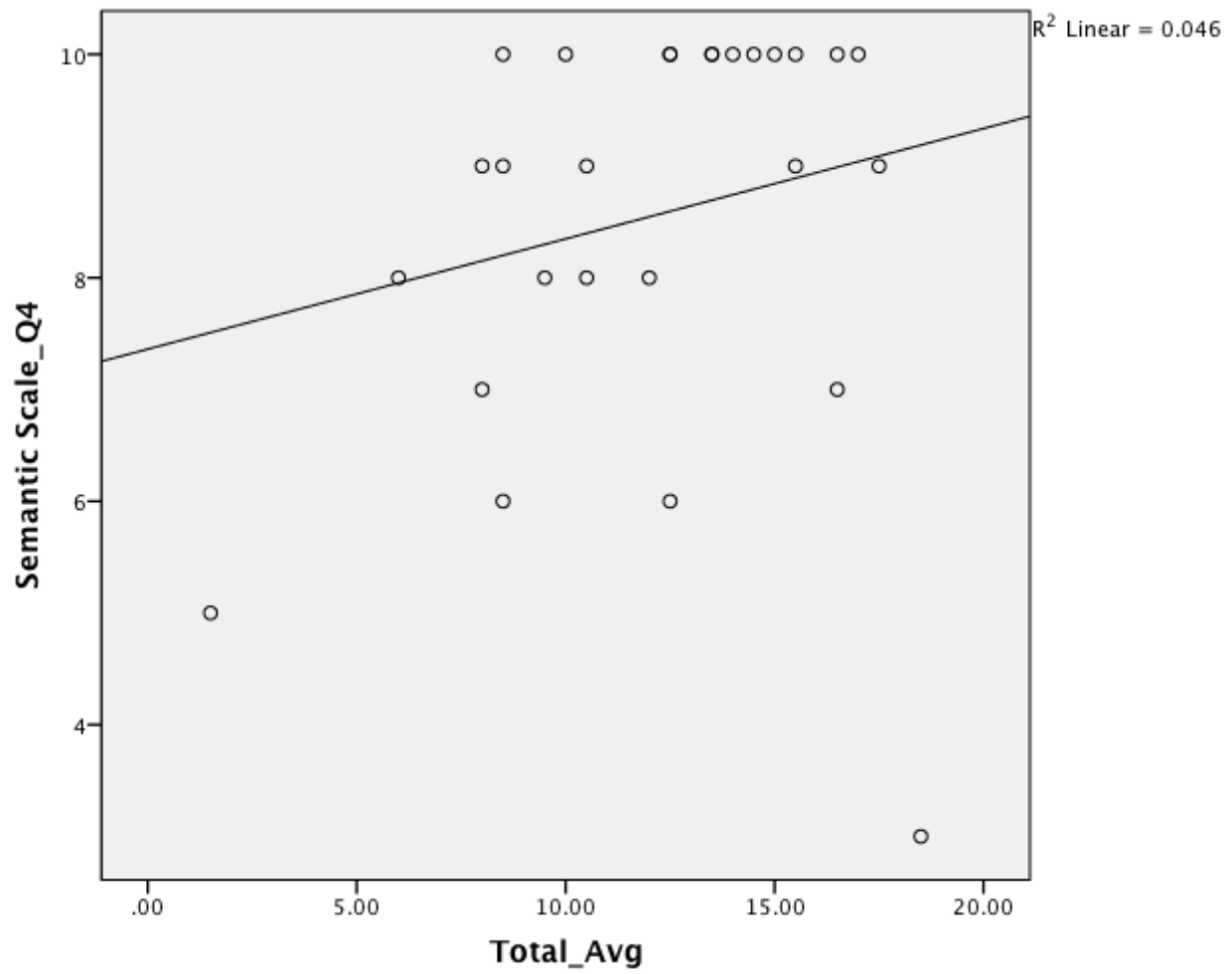
correlation was found between total PES and WES and semantic scale question 4 ($r = 0.237$, $p = 0.233$) (Figure 4).



$$r = 0.237, p = 0.233$$

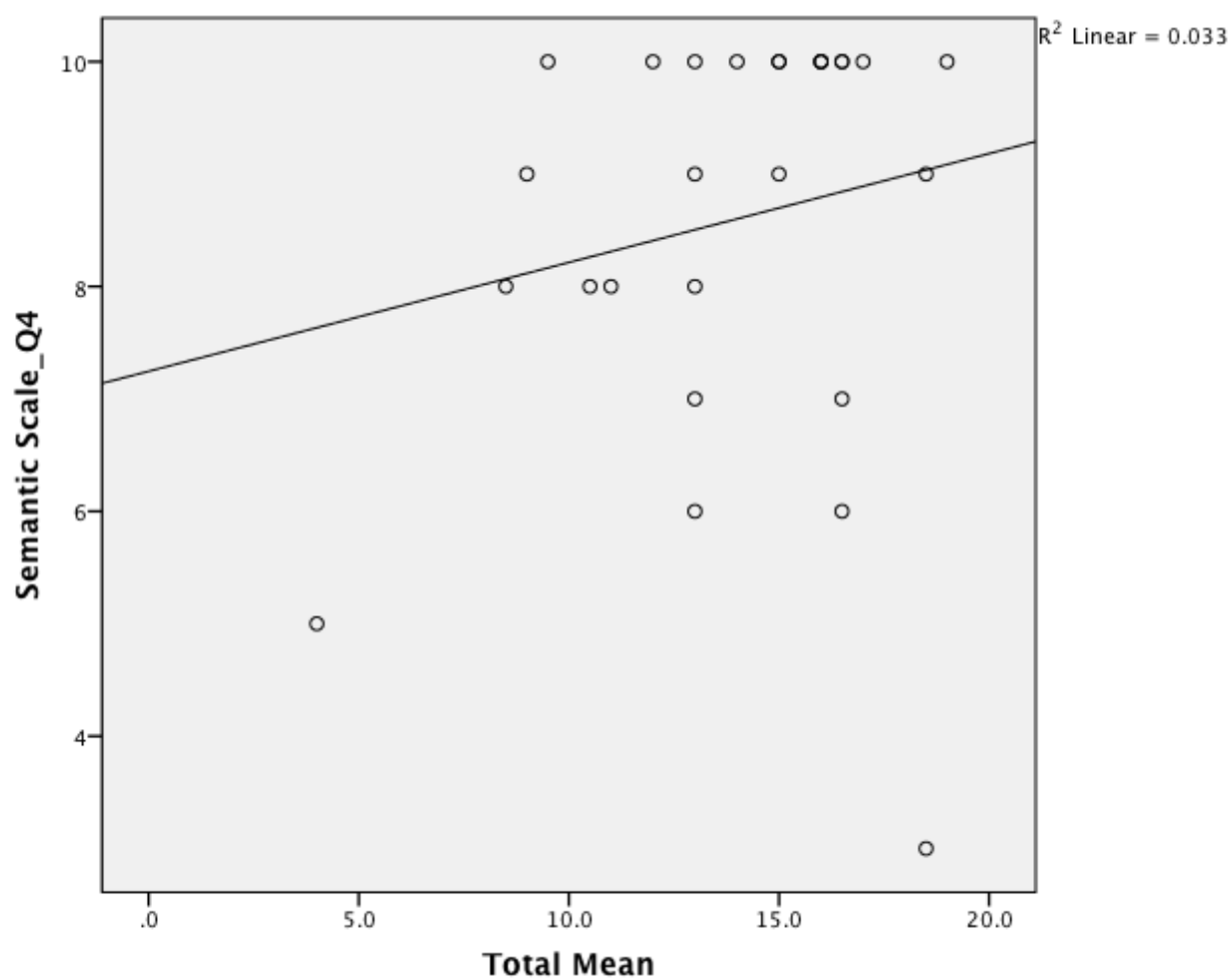
Figure 4. Correlation of Semantic Scale Question 4 and total PES/WES for All Examiners

This relationship was also found for the Prosthodontists ($r = .305$, $p = .122$), Periodontists ($r = .219$, $p = .272$) and students ($r = .281$, $p = .156$) (Charts 5, 6, 7).



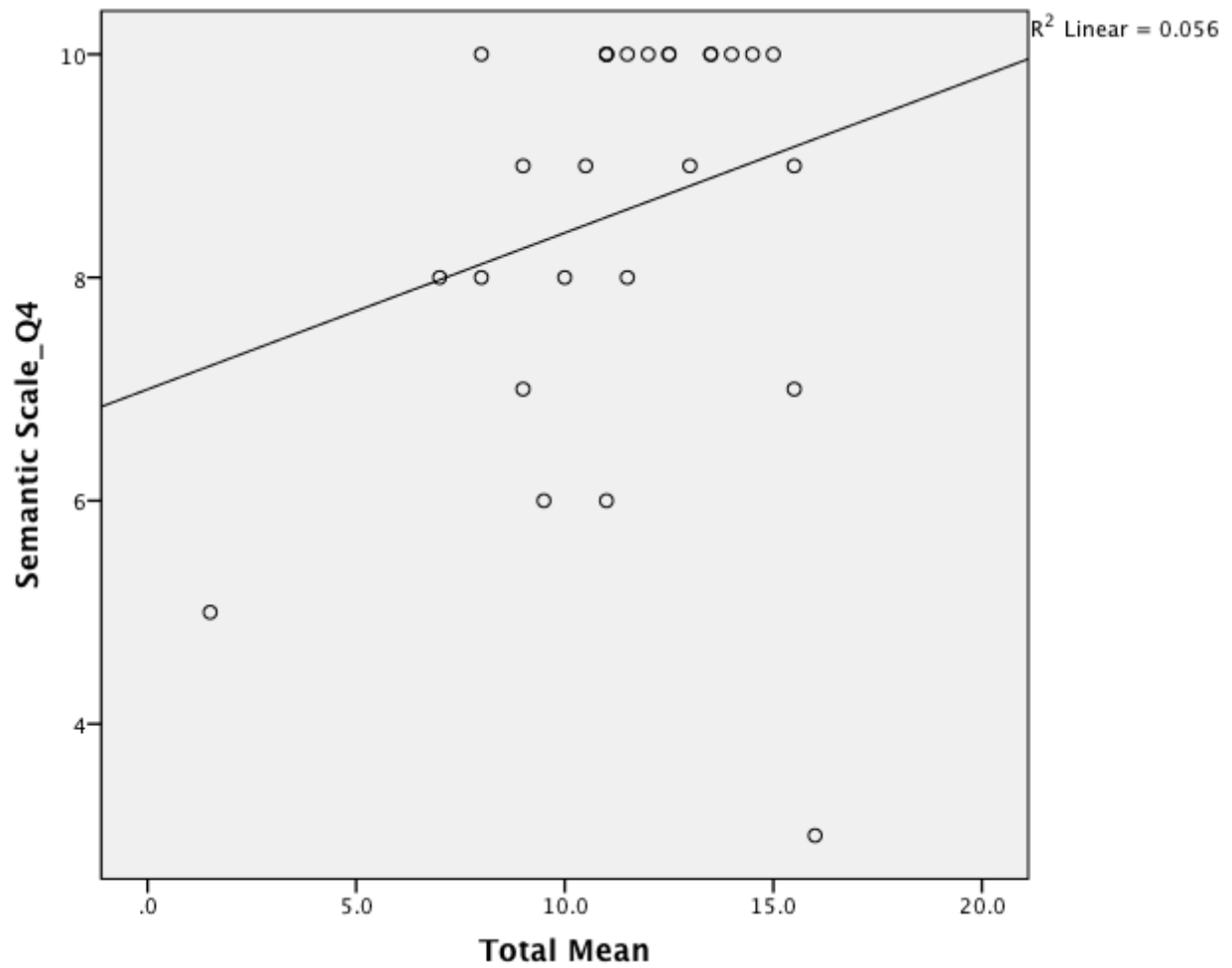
$r = .305, p = .122$

Figure 5. Correlation of Semantic Scale Question 4 and total PES/WES for Prosthodontists



$r = .219, p = .272$

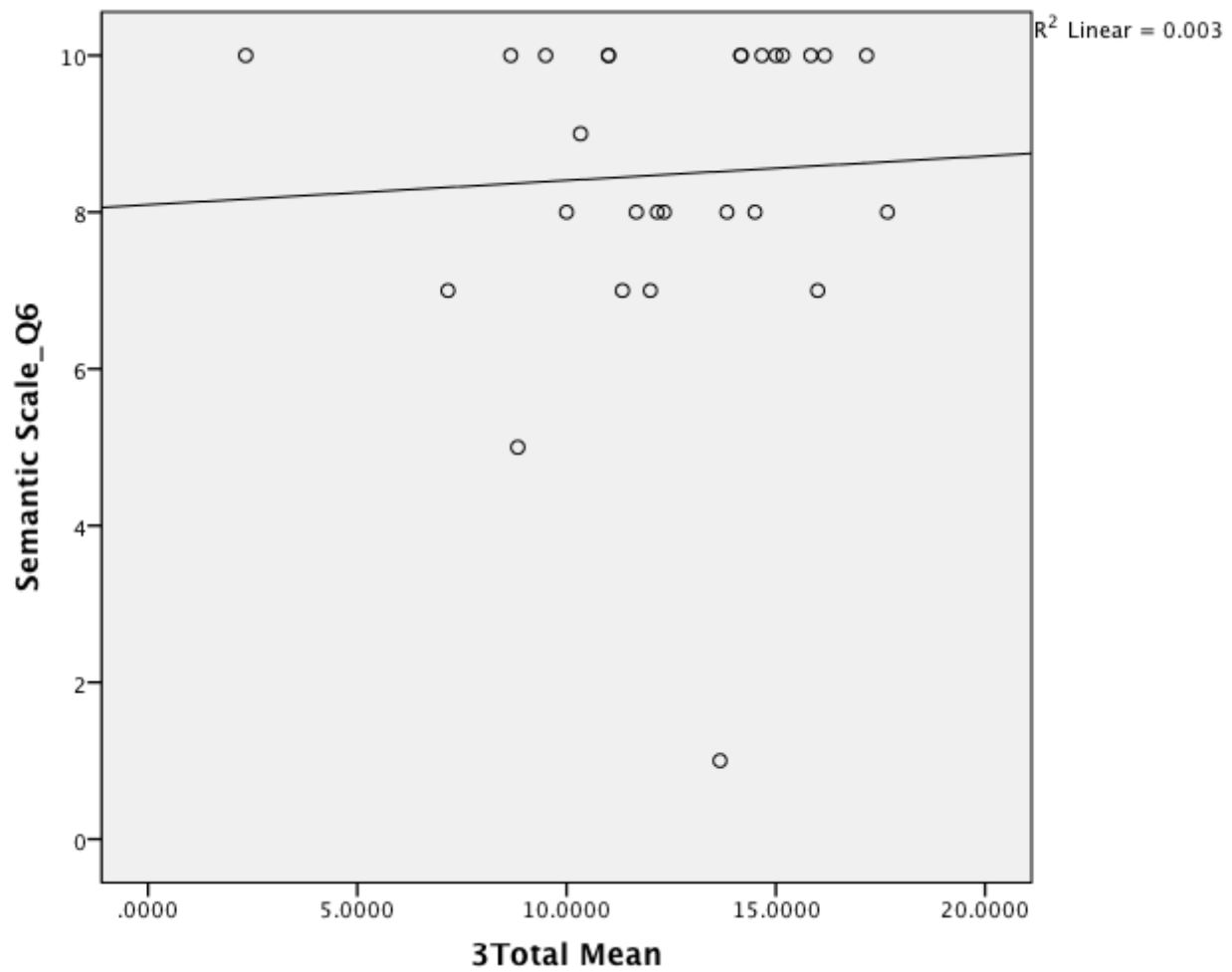
Figure 6. Correlation of Semantic Scale Question 4 and total PES/WES for Periodontists



$r = .281, p = .156$

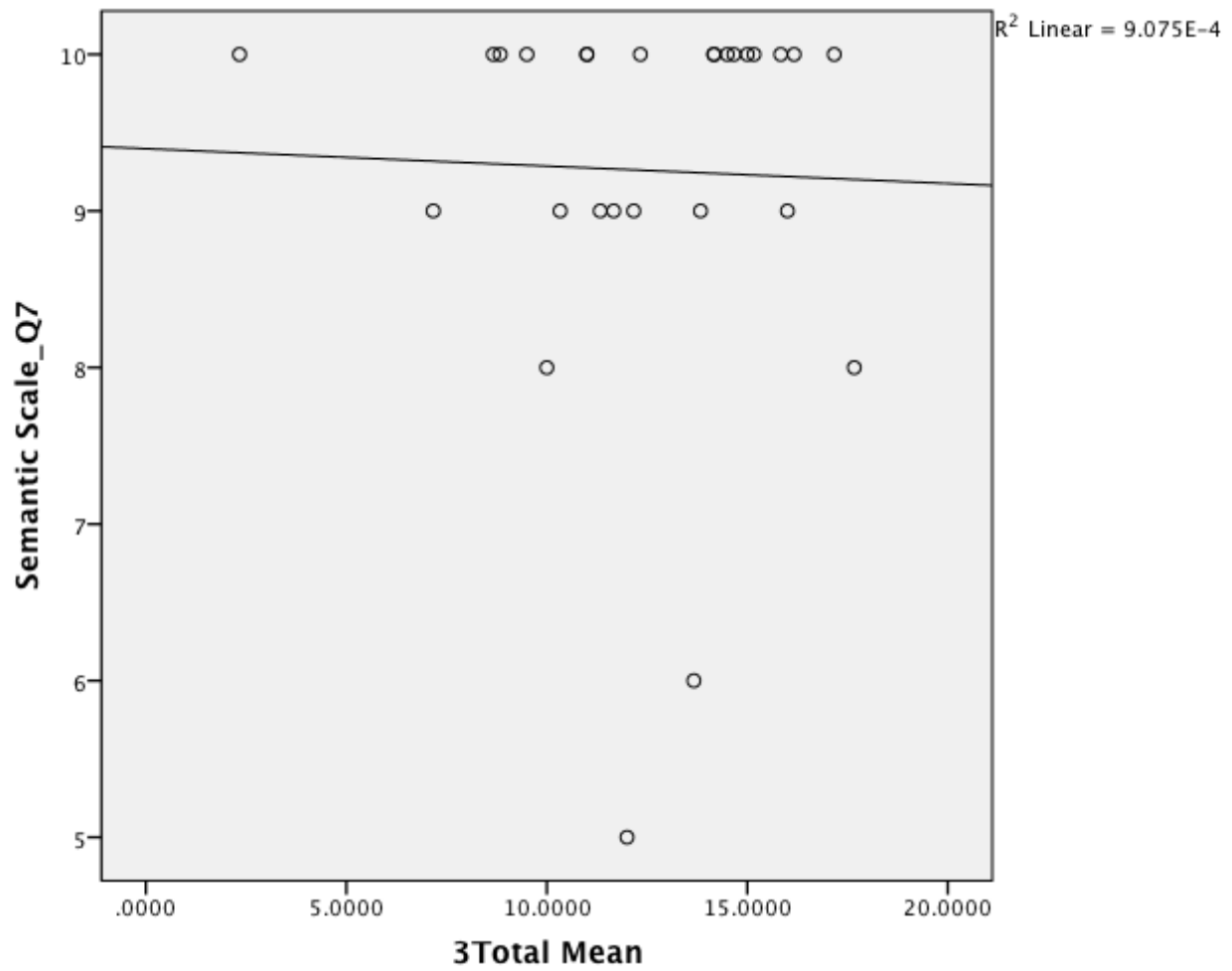
Figure 7. Correlation of Semantic Scale Question 4 and total PES/WES for Students

There was also no statistically significant correlation found between the total PES and WES and semantic scale question 6 ($r = .172$, $p = .390$) and question 7 ($r = .078$, $p = .700$) (Charts 8, 9).



$r = .172$, $p = .390$

Figure 8. Correlation of Semantic Scale Question 6 and total PES/WES for All Examiners



$r = .078, p = .700$

Figure 9. Correlation of Semantic Scale Question 7 and total PES/WES for All Examiners

5. **DISCUSSION**

The aim of this study was to use the objective esthetic index of the PES/WES system to assess the ability of predoctoral students to deliver esthetically pleasing anterior, maxillary single tooth implant prostheses. It was a retrospective, cross-sectional study design that assessed previously completed implant therapy at the UIC COD. The objective faculty and student assessments suggest that the predoctoral students are successful in fabricating clinically acceptable prostheses for their patients. The results of both the modified OHIP-14 and the semantic scale demonstrated that patients were very satisfied with the treatment they received at the UIC predoctoral level, and that they also believed they have received esthetically pleasing single tooth prostheses. The findings of the study support our null hypotheses.

The study focused on the maxillary esthetic zone, which includes the first premolars. Out of the 27 patients, 78% of the prostheses were for the first premolar region, with the remaining 22% having prostheses placed in the area classically defined as the anterior maxilla. This finding is perhaps consistent with the strict criteria for implant placement at the predoctoral level. If additional surgical intervention is required, the patient is referred to the specialty clinics for treatment.

Studies have suggested that more conservative approaches to implant therapy can result in better outcomes.[5, 7] Preiskel et al's study suggested the more conservative treatment approach of the more experienced practitioners was rationale for their higher prosthetic success rate compared to the less experienced group.[7] Andersson et al also suggested that general practice practitioners can have a higher rate of success because they

tend to treat less complex situations than those that are more frequently referred to specialists.[5] At the UIC COD, the strict patient selection criteria for the predoctoral implant clinic has been referenced as why there is a high level of implant survival.[4]

The overall PES was 6.10, which meets the standard of clinical acceptability according to Belser et al.[8] This result is consistent with Belser et al, though to a lesser degree. Belser found a higher overall PES of 7.8, but a single surgical operator with a high level of implant expertise placed all of the implants. That experience and consistency likely resulted in improved treatment.[7, 21] Also, Belser placed implants according to an early timeline protocol, which may contribute to favorable soft tissue esthetics.[49] In this study, a total of 17 residents from 3 different specialties surgically placed the implants. This number of providers, all with a relatively low level of experience, may factor into the lower PES compared to Belser et al's study. Not only were there 17 surgical operators, there were also 10 advising faculty who also participated in the treatment. Having this wealth of providers is beneficial from an academic training aspect, but this can also lead to greater variation in the results of a study such as this one.

In contrast to the results of this study, the Cho et al study found an overall esthetically unacceptable result of 5.17.[11] Similar to the present study, the implant placement protocol was delayed, which may factor into a less favorable PES. The level of interproximal bone height between the implant and adjacent teeth may influence the height of resulting papillary fill, and if the implant placement is delayed, the initial bone level at time of extraction may decrease.[50] The PES is dependent on many factors that are less controlled at the predoctoral level due to stringent patient selection criteria. Factors such as the patient's bony anatomy,

type of mucosa, and surgical approach to implant therapy can have positive or negative impacts on the resulting PES.[8, 39, 49-51] A minor soft tissue defect cannot always be properly addressed, and the patient may have to accept the lack of soft tissue fill or change in mucosal contour. The lowest score, .97, within the PES was the distal papilla, though the mesial papilla score was greater at 1.22. Cho et al also noted that the lowest scoring factors within the PES were the mesial and distal papilla, scoring a .63 and .64, respectively.[11] The Dierens et al study also found that the worst scoring factors were the papillae, though they also noted the alveolar process contour also scored low.[35] Again, the delayed protocol which may lead to increased bone loss may have a negative effect on the outcome of the PES. The approach of the surgeon can play a major role in the outcome of the soft tissue esthetics.[8, 49-51]

The overall WES was 6.6, also a clinically acceptable result according to Belser et al.[8] Contrary to the Belser et al study, the UIC COD uses one laboratory for all implant prostheses fabricated through the predoctoral program. The consistency of a single lab can help create a more unified result. Belser et al's study noted that the variety of laboratories and restorative dentists used for their patients may have resulted in a wider discrepancy of esthetic outcomes, though they still maintained a high level of esthetics with a 6.9. One suggestion as to why the WES may not be as high as seen in the Belser et al study could be due to financial limitations of the patient population that leads to a lesser quality prosthesis.[8] Within the WES results, it is interesting to note that the lowest average was the total tooth volume, 1.2. While this is a product of the form of the prosthesis itself, the technician must also fill the space of the missing tooth that it is replacing. If the space had been present for an extended period of time, there is a possibility that the adjacent teeth had shifted and changed the volume to a greater or lesser

volume than the ideal tooth would otherwise be. Again, this is less the result of the prosthesis itself and more a result of the anatomical presentation of the site. The highest component to the WES was the surface texture, 1.67, a factor that should be well-managed by a laboratory technician. The lack of a single operator will tend to introduce variability in the esthetic outcome of the prostheses.[8]

Another factor that may contribute to the higher WES compared to the PES is that there were fewer faculty involved in overseeing the restorative phase versus the surgical phase. There were 5 restorative faculty involved with the predoctoral care, all of whom had received training in advanced Prosthodontic programs, 3 of those from the same program. For the surgical component, there were 10 faculty members that were noted, all with different training backgrounds based on which program they were working in. The greater number of instructors for the surgical aspect, along with the variation of background training, may contribute to the less consistent PES, which is more dependent on the surgery versus the prosthesis.

In this study, the Prosthodontists (6.0) were more critical of the WES in comparison to the Periodontists (7.6), similar to what Cho et al reported.[11] This suggests that Prosthodontists are more critical of the prosthesis outcome in comparison with other specialties which have other focuses. In both the Cho et al and Furhauser et al study, Orthodontists were the most critical examiners.[9, 11]

Our study found that the WES was more favorable at 6.6 compared to the PES of 6.1. The Belser et al study had results where the PES was greater than the WES.[8] In their study, there was a single, experienced surgeon placing all implants, and the implants were placed between 4 to 8 weeks after extraction and also provisionalized with a screw-retained prosthesis

within 3 months post-implant placement. At the UIC COD predocotral level, specialty students with a wide range of experience are placing the implants within the strict guidelines of the predoctoral program, including no immediate placement and only two stage placements. These factors may contribute to the lower score of the PES in comparison to the WES though it is important to note a high level of implant survival.[4] Unlike a problem of soft tissue esthetics where there may be no opportunity for improvement, an unsuccessful esthetic prosthesis may be better addressed. If the provider or patient is not pleased with the esthetic outcome of the prosthesis, they can address the issue with recontouring, shading or even having it remade. Our result of a higher scoring WES than PES is similar to the Cho et al findings.[11]

A strength of this study is that the patients selected for implant therapy at the predoctoral level tend to have relatively uncomplicated clinical scenarios.[4] Due to these strict selection criteria, the applicability of the study's results can be applied to the larger predoctoral patient population. At the same time, these stringent criteria may affect the PES outcome.[8, 50] The sites cannot require any type of surgical augmentation prior to, or during, implant placement, as the treatment difficulty leads to referral to the advanced programs. Also, the predoctoral students are not allowed to plan or restore single tooth implants at the central incisor locations. It is difficult to maintain the bone and soft tissue levels at anterior sites, and recent studies demonstrated that more advanced techniques, such as grafting and immediate provisionalization of immediately placed implant sites, may be beneficial to maintaining papillary fill and bone volume.[49] Although there may be limitations to the esthetic outcome due to the limited surgical interventions at the predoctoral level, previous studies do suggest that the lack of complexity may result in higher survival and prosthesis success.[5, 7]

The examiner intra-rater agreement ranged from fair to moderate, with the dental students scoring the lowest (.374). This finding is consistent with the Gehrke et al study that noted the lowest agreement in laypeople as opposed to specialists.[30] While dental students have more dental knowledge than the general public, their relative lack of clinical experience may contribute to a lower agreement rating in comparison to the board certified faculty involved in our study. It should be noted that the agreement between the examiners increased for prostheses that scored the highest and lowest. This trend was also noted in previous publications by Furhauser et al as well as Gehrke et al.[9, 30]

The patient satisfaction results were very high and patients felt they received excellent care in various aspects of their treatment at the UIC COD predoctoral implant program. Notably, patients reported 9.26 out of 10 with their overall satisfaction of treatment related to their single tooth implant prostheses. They also reported 8.56 as their overall esthetic result. Perhaps not surprisingly, the lowest scores were given to timeliness and expense, at 4.41 and 6.56 respectively. Care within the academic setting often takes on extended time, as each step during treatment must be approved by the instructors.

Comparison between the patients' view of their esthetic results versus the examiners' assessments were not always strongly correlated ($r = 0.237$, $p = 0.233$). The patient with the lowest WES, an average of 1 out of 10, reported that he viewed his prosthesis as having the highest esthetic outcome at 10 out of 10 on the semantic scale. In contrast, the lowest patient esthetic score on the semantic scale was a 3, while the examiners' average objective assessment of the prosthesis was a 9.5. While this patient's overall esthetic assessment by the examiners was the second highest out of all the subjects included and therefore considered

clinically acceptable by Belser et al, the patient herself was in strong disagreement with the objective result.[8] Speaking with this patient further about her experience with her treatment, she revealed that the prosthesis was fabricated at least twice, and each time was sent back repeatedly for changes in contour and shading. In fact, the patient was asked to go to the dental laboratory for an in-person shade match appointment. Considering that the patient had invested significant time and effort towards a highly esthetic result, it may not be surprising that anything but an exact match would be disappointing and result in a lower esthetic assessment of her own prosthesis. The Esposito et al study also demonstrated that there was poor agreement between patients and clinicians.[36] These findings would be important because providers must consider the patient's perspective into account when fabricating prostheses. Understanding the patient's expectations allows the provider to better manage the treatment outcome, to achieve patient satisfaction.

There are a number of strengths within the study. Aside from the student examiners, all faculty examiners are board certified within their given specialty. These practitioners are well-trained and experienced in implant therapy. The fact that the predoctoral students were succeeding in producing clinically acceptable esthetic results is bolstered by the high level of training the examiners have. Also, the examiners were asked to complete the Ishihara color blindness test, to assure a uniformity of visual assessment.

A number of limitations to this study should be noted. The study was retrospective in design, as the treatment had already been completed before the patient population was defined. Aspects of the treatment were found from chart notes, and consistency in reporting and interpretation of clinical information could be questioned. While a total of 53 patients

were identified and contacted to join the study, only 27 patients agreed to participate. This is a participation rate of 51% and may be a factor in the outcomes. Those patients who are willing to participate in a study about their experience may have had a stronger reaction to their time at UIC COD, either positively or negatively, and this may have an influence on how they perceived their outcome. Perhaps those who chose not to participate had a less remarkable experience, though their assessment could influence the outcomes in a number of ways. The small sample size makes it difficult to draw larger conclusions, though we can still find trends in the treatment being completed at the predoctoral level.

Another limitation is that there were a multitude of surgical providers with varying levels of experience. Previous studies have noted that inexperienced surgeons tend to have a lower success rate.[21] The specialty clinics have a large variation of experience, with first year Prosthodontic, Periodontic and Oral Surgery students often placing their first implants during the first few months of training. Our patients had their treatment completed in the specialty programs and a student with limited to no experience may have placed the implant versus a specialty student towards the end of their training with a much greater amount of experience. The large variation of surgical expertise could influence the esthetic outcome of a single tooth prosthesis, especially considering the PES which is more affected by the surgical intervention compared to the WES.

A factor that may contribute to the large standard deviations of the PES and WES is the lack of standardization of the photography and assessment presentation. There were many measures taken to maintain consistency of the samples, including a single operator with the

same camera in a magnification range of 1:2 to 1:3 and a single computer used by all examiners to view the same Powerpoint presentation. Yet, there were also inconsistencies that must be noted. The intraoral photographs were not taken from a specified distance. Also, appointments varied from day and time, meaning that the natural light available was never the same between patients. The varying degrees of brightness may affect the appearance of both the soft tissue and prosthesis, making an inconsistent image of what the examiners were assessing versus what the patient himself views in a mirror.

Another aspect that may contribute to the lack of correlation between the examiners' and patients' interpretation of esthetics is how each party viewed the prostheses and surrounding soft tissues. Patients were not given a mirror to assess their own prosthesis, and instead completed their questionnaire without any extra time to assess their case. The examiners were viewing the images on a large computer screen and the images were not formatted in a standardized approach and were all larger than life-size. Because the examiners were viewing a large image of the area of interest, it may have been easier to note the imperfections, resulting in more negative numbers. The examiners were not given a time limit for completion, allowing them any amount of time they desired to scrutinize the images.

The prosthesis materials that the predoctoral students use may also contribute to lower PES and WES. Twenty-six out of the 27 abutments were titanium and one was gold-hue. Also, there was only one all ceramic prosthesis with the vast majority being porcelain fused to metal. Studies have suggested that the materials chosen may have an effect on the soft tissue and prostheses esthetics.[52-54] A study from Jung et al in 2008 performed an in vivo randomized

controlled clinical trial to assess the effect of PFM versus all ceramic on the peri-implant soft tissue color.[55] They found that the all-ceramic group induced a lesser degree of gingival color change, suggesting a more esthetic result for the PES. Similarly, another study from Bressan et al in 2010 assessed the effect of a titanium abutment, a gold abutment and a zirconia abutment on the periimplant mucosa.[56] They tried each abutment in on a total of 20 patients, allowing 10 minutes of rest after the initial placement. Their findings demonstrated that all of the abutments did significantly change the appearance of the mucosa when compared to the contralateral tooth. But, both the gold and zirconia abutments changed the soft tissue appearance less than the titanium. Perhaps the materials used by the majority of the predoctoral students are limiting the esthetic result that they are capable of delivering.

6. **CONCLUSIONS**

1. Predoctoral students, with the proper supervision and well-structured selection criteria, can provide esthetically acceptable STI treatment.
2. Patients were satisfied with their treatment provided at the UIC COD as well as the quality of life and esthetic outcomes of their STI treatment.
3. There was no correlation between patient satisfaction and examiner assessment using the PES and WES.

APPENDICES

APPENDIX A.

Raw data of PES per examiner

	M						D						C						L						R						T							
P	i	i	i	i	v	v	i	i	i	i	v	v	i	i	i	i	v	v	i	i	i	i	v	v	i	i	i	i	v	v	i	i	i	i	v	v	i	
P t 1	1	1	1	1	1	1	2	1	2	1	1	1	2	1	1	2	1	2	2	1	2	2	1	1	2	2	1	2	2	1	1	2	9	6	8	6	5	7
2	2	1	2	2	2	2	1	1	0	0	0	1	2	2	1	2	1	1	1	2	1	0	1	0	0	1	1	1	1	1	1	6	7	5	5	5	5	
3	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	2	1	2	2	2	1	2	1	1	1	2	2	1	2	1	4	6	5	6	5	5	
4	2	1	2	2	1	2	0	0	0	0	0	0	1	1	1	1	1	1	2	1	2	2	1	2	1	1	1	1	1	1	6	4	6	6	4	6		
5	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	0	1	2	1	1	2	0	1	1	0	1	1	1	1	2	9	6	7	8	5	8	
6	1	1	1	1	0	1	0	0	0	0	0	0	0	2	1	1	1	1	2	2	1	2	1	2	0	1	1	0	1	1	3	6	4	4	3	5		
7	2	1	2	2	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	2	1	1	1	1	1	1	1	4	3	4	6	3	3		
8	2	1	2	2	1	2	0	0	1	1	0	0	0	1	2	2	1	1	2	2	1	2	1	2	2	1	2	1	1	1	6	5	8	8	4	6		
9	2	2	2	2	1	2	0	1	0	1	0	1	0	2	1	1	1	1	2	1	2	2	1	1	0	1	1	1	1	1	4	7	6	7	4	6		
10	1	1	1	1	1	1	2	1	1	1	0	1	2	1	1	2	2	1	2	2	2	2	2	2	1	1	1	1	1	1	8	6	6	7	6	6		
11	0	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	2	2	1	1	1	1	0	1	1	0	1	1	2	6	3	2	3	3		
12	0	0	0	0	0	0	2	1	2	2	1	1	2	1	1	2	1	2	1	0	1	2	0	0	2	2	1	1	1	1	7	4	5	7	3	4		
13	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1	1	2	2	2	2	2	1	2	2	1	1	1	1	7	7	6	7	6	6		
14	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	1	0	0	0	1	1	3	2	0	1		
15	1	2	1	1	1	1	2	2	2	2	1	1	1	1	2	2	1	1	1	1	1	2	2	1	1	1	1	1	1	0	6	7	7	8	6	4		
16	0	0	0	0	0	0	0	1	1	0	0	1	2	2	1	1	1	1	2	2	2	2	1	1	2	2	1	2	2	1	6	7	5	5	4	4		
17	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	2	2	2	3	4	2		
18	2	2	2	2	2	2	2	1	2	2	1	1	1	1	2	2	1	2	1	1	1	2	1	1	1	1	2	1	1	1	7	6	9	9	6	7		
19	2	2	2	2	2	2	0	0	0	0	0	0	2	2	1	2	1	2	2	2	1	2	1	2	1	2	1	1	1	1	7	8	5	7	5	7		
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21	1	1	1	1	1	1	2	2	2	2	2	2	1	2	1	2	1	2	2	2	2	2	2	2	1	2	1	1	0	1	7	9	7	8	6	8		
22	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2	2	1	1	2	2	2	2	1	1	1	8	1	1	8	8		
23	0	0	0	0	0	0	1	1	1	1	0	1	2	1	1	1	1	1	2	1	2	2	1	2	2	1	1	2	1	1	7	4	5	6	3	5		
24	2	2	2	2	2	1	2	2	2	2	1	1	2	1	2	2	1	2	2	1	2	2	1	2	2	2	1	1	1	1	1	8	9	9	5	8		
25	0	2	0	0	1	1	2	1	1	1	0	1	1	1	1	2	1	2	2	2	2	2	1	1	2	2	2	2	1	2	7	8	6	7	4	7		
26	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	2	2	2	1	2	2	2	1	9	9	1	7	1	0	
27	2	2	2	2	2	2	1	1	1	1	0	1	2	1	1	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2	9	8	8	9	6	9		

i = Prosth 1 ii= Prosth 2 iii= Perio 1 iv = Perio 2 v = Student 1 vi = Student 2

APPENDIX B.

Raw data of WES per examiner

	F						V						C						S						Tr						To						
P	i	i	i	i	v	v	i	i	i	i	v	v	i	i	i	i	v	v	i	i	i	i	v	v	i	i	i	i	v	v	i	i	i	i	v	v	i
P t 1	2	1	2	2	2	2	2	1	1	2	1	1	2	1	2	1	2	2	2	2	2	2	2	1	2	1	2	1	1	2	1	0	6	9	8	8	8
2	0	1	2	1	1	1	0	1	1	0	1	2	0	0	0	0	0	1	1	1	1	2	0	1	0	0	1	0	0	1	1	3	5	3	2	6	
3	0	1	1	1	1	1	0	1	1	1	1	1	2	1	1	2	1	1	2	2	2	2	1	1	1	1	2	2	1	2	5	6	7	8	5	6	
4	2	1	1	1	0	1	1	0	0	1	0	1	0	1	1	1	1	1	2	1	1	1	2	1	2	1	1	1	1	2	7	4	4	5	4	6	
5	2	1	1	2	2	2	2	2	2	2	1	2	2	2	1	2	2	2	2	2	2	2	2	1	2	2	1	2	2	1	1	9	7	1	9	8	
6	2	2	2	2	2	2	2	2	1	2	2	2	0	0	1	1	1	1	2	1	2	2	1	1	0	0	2	1	1	1	6	5	8	8	7	7	
7	1	1	2	1	1	1	1	1	2	1	1	2	0	1	2	1	1	1	2	0	2	2	1	1	1	1	2	1	2	1	5	4	1	6	6	6	
8	2	2	2	2	1	2	1	2	2	2	1	2	1	1	1	2	1	2	2	2	2	2	1	1	2	1	1	2	1	2	8	8	8	1	5	9	
9	2	1	1	1	1	2	1	2	1	1	1	1	2	1	2	1	2	2	2	0	2	1	1	1	2	1	2	1	1	1	9	5	8	5	6	7	
1 0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1	2	2	2	2	1	9	1	1	1	9	
1 1	0	0	1	1	1	1	0	1	1	1	1	1	2	1	2	1	1	1	2	0	2	2	1	1	2	1	1	2	1	1	6	3	7	7	5	5	
1 2	1	1	1	1	2	2	1	1	1	1	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	8	8	8	1	1	8	
1 3	2	1	1	1	1	2	2	2	1	1	1	1	0	0	1	1	0	1	1	2	2	2	1	2	0	0	1	2	1	1	5	5	6	7	4	7	
1 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	0	0	1	0	0	0	1	0	3	0	0	2	
1 5	1	2	1	2	1	1	1	2	1	2	2	1	2	2	2	1	1	1	2	1	2	2	2	1	2	1	2	2	1	1	8	8	8	9	7	5	
1 6	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1	2	2	2	2	1	8	1	1	1	9	9	
1 7	0	0	1	0	0	0	0	0	0	0	1	0	2	1	2	2	1	2	2	0	2	2	1	1	2	1	1	2	1	1	6	2	6	6	4	4	
1 8	1	0	1	1	1	1	0	0	2	2	1	1	0	0	1	1	0	1	2	1	2	2	1	1	0	0	1	2	1	1	3	1	7	8	4	5	
1 9	2	2	2	1	1	2	1	2	2	2	1	2	2	1	2	2	1	2	2	2	2	2	2	1	2	2	1	2	1	2	9	9	8	9	6	9	
2 0	2	1	1	2	1	2	1	1	1	2	1	2	1	1	2	2	1	1	2	2	2	2	1	1	0	0	2	2	1	1	6	5	8	1	5	7	
2 1	2	1	1	2	1	1	2	1	2	2	1	1	1	1	2	2	1	1	2	2	2	2	1	1	1	1	1	2	1	1	8	6	8	1	6	5	
2 2	0	0	1	1	1	1	0	1	1	2	1	1	1	1	1	1	1	2	2	1	2	2	1	1	0	1	1	1	1	1	3	4	6	7	5	6	
2 3	2	1	2	1	1	2	2	1	1	1	1	1	2	1	2	2	1	1	2	2	2	2	1	1	0	1	1	1	1	1	8	6	8	7	5	6	
2 4	2	1	1	2	2	1	1	1	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	9	8	9	1	1	8	
2 5	0	1	1	0	0	1	0	0	1	1	0	1	0	0	1	0	0	1	1	1	1	2	0	1	0	1	1	1	0	1	1	3	5	4	0	5	
2 6	2	1	2	2	1	1	1	1	2	2	1	1	0	1	2	1	1	1	1	1	2	2	2	1	0	1	2	2	2	1	4	5	1	9	7	5	
2 7	2	2	2	2	2	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	8	9	

i = Prosth 1 ii= Prosth 2 iii= Perio 1 iv = Perio 2 v = Student 1 vi = Student 2

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