ORAL HEALTH RELATED QUALITY OF LIFE AND ESTHETIC OUTCOMES IN SINGLE
ANTERIOR MAXILLARY IMPLANTS

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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Esthetic Restorative and Implant Dentistry
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คุณภาพชีวิตในมิติสุขภาพช่องปากและผลลัพธ์ด้านความสวยงามของรากเทียมฟันหน้าบนซี่เดี่ยว

นางสาวชญานุช อ่างแก้ว

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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Field of Study	Esthetic Restorative and Implant Dentistry
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ชญานุช อ่างแก้ว : คุณภาพชีวิตในมิติสุขภาพช่องปากและผลลัพธ์ด้านความสวยงามของราก
เทียมฟันหน้าบนซี่เดี่ยว (ORAL HEALTH RELATED QUALITY OF LIFE AND ESTHETIC
OUTCOMES IN SINGLE ANTERIOR MAXILLARY IMPLANTS) อ.ที่ปรึกษาวิทยานิพนธ์หลัก:
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พงษ์, 66 หน้า.

วัตถุประสงค์: การศึกษานี้มีเป้าหมายเพื่อประเมินความสวยงามของรากเทียมฟันหน้าบนซี่เดี่ยว
หลังการรักษาอย่างน้อยหกเดือนถึงสามปี และเพื่อวิเคราะห์ความสัมพันธ์ระหว่างความสวยงามของราก
เทียมที่ประเมินโดยทันตแพทย์และคุณภาพชีวิตในมิติสุขภาพช่องปากของผู้ป่วย

วิธีการศึกษา: ผู้ป่วย 20 รายที่ได้รับการบูรณะฟันหน้าบนซี่เดี่ยวที่สูญเสียไปด้วยรากเทียมอย่าง
น้อยหกเดือนถึงสามปีถูกประเมินค่าความสวยงามโดยใช้ดัชนีวัดความสวยงามสีชมพูและสีขาว (Pink and
white esthetic score: PES/WES) ผู้ป่วยทุกรายตอบแบบสอบถามเรื่องความพึงพอใจของผลการรักษาใน
แง่ของความสวยงาม ในแง่ของการใช้งาน และความพึงพอใจในภาพรวมในรูปแบบของวิชวลอนาล็อกสเกล
(Visual analog scale: VAS) รวมทั้งตอบแบบสอบถามเรื่องคุณภาพชีวิตในมิติสุขภาพช่องปากและ
วิเคราะห์ด้วยด้วยดัชนีผลกระทบทางช่องปากต่อกิจกรรมในชีวิตประจำวัน (Oral impacts on daily
performances: OIDP)

ผลการศึกษา: ผลความสวยงามของรากเทียมซี่เดี่ยวจากการประเมินด้วยดัชนีวัดความสวยงาม
ของรากเทียม PES/WES ได้ผลที่น่าพึงพอใจ ค่าเฉลี่ยของคะแนนเท่ากับ 15.65±1.66 (คะแนนเต็ม 20) โดย
ค่าเฉลี่ยดัชนี PES และ WES เท่ากับ 7.50±1.05 และ 8.15±1.09 ตามลำดับ ค่าคะแนนความพึงพอใจของ
คนไข้โดยมาตรวัด VAS อยู่ในระดับ 8 ถึง 10 (คะแนนเต็ม 10) จากดัชนี OIDP พบผู้ที่ได้รับผลกระทบใน
การใช้ชีวิตประจำวันจากรากเทียมฟันหน้าจำนวน 45% ของผู้ป่วย ผู้ป่วย 5 รายมีปัญหาด้านการ
รับประทานอาหารและ 4 รายมีปัญหาในการทำความสะอาดช่องปาก ไม่พบความแตกต่างอย่างมีนัยสำคัญ
ของค่า PES/WES ในกลุ่มผู้ป่วยที่ได้รับและไม่ได้รับผลกระทบต่อการใช้ชีวิตประจำวัน พบผลกระทบต่อการ
ใช้ชีวิตประจำวันระดับกลางในมีผู้ป่วยจำนวน 4 คนที่ได้คะแนน PES/WES ในระดับยอดเยี่ยม

บทสรุป: การวิจัยแบบตัดขวางนี้แสดงถึงผลลัพธ์ที่น่าพึงพอใจของรากเทียมฟันหน้าบนซี่เดี่ยว
ภายหลังการรักษาอย่างน้อยหกเดือนถึงสามปี ไม่พบค่า PES/WES ที่ต่ำกว่าระดับที่ยอมรับได้ทางคลินิก พบ
ความขัดแย้งบางส่วนของผลลัพธ์ด้านความสวยงามที่ได้จากการประเมินโดยทันตแพทย์และความรู้สึกรับรู้
ของผู้ป่วย ผู้ป่วยที่ได้รับการประเมินความสวยงามของรากเทียมในระดับยอดเยี่ยมโดยทันตแพทย์อาจพบ
ผลกระทบจากรากเทียมต่อการใช้ชีวิตประจำวันได้ อย่างไรก็ตามผู้ป่วยทุกรายมีความพึงพอใจระดับสูงต่อ
ผลการรักษา

สาขาวิชา	ทันตกรรมบูรณะเพื่อความสวยงามและ	ลายมือชื่อนิสิต	_____
	ทันตกรรมรากเทียม	ลายมือชื่อ อ.ที่ปรึกษาหลัก	_____
ปีการศึกษา	2557	ลายมือชื่อ อ.ที่ปรึกษาร่วม	_____

5475827932 : MAJOR ESTHETIC RESTORATIVE AND IMPLANT DENTISTRY

KEYWORDS: ANTERIOR IMPLANT RESTORATION / SINGLE DENTAL IMPLANT / PINK AND WHITE ESTHETIC SCORES / ORAL HEALTH-RELATED QUALITY OF LIFE (OHRQOL) / ORAL IMPACT ON DAILY PERFORMANCES / VISUAL ANALOG SCALES

CHAYANUCH ANGKAEW: ORAL HEALTH RELATED QUALITY OF LIFE AND ESTHETIC OUTCOMES IN SINGLE ANTERIOR MAXILLARY IMPLANTS. ADVISOR: ASST. PROF. DR. ATIPHAN PIMKHAOKHAM, CO-ADVISOR: ASSOC. PROF. DR. SUDADUANG KRISDAPONG, 66 pp.

Purposes: The aim of this study is twofold: to assess the esthetic outcome of single dental implant restorations in the anterior maxillary area after up to 3 year of function, and to evaluate the relationship between the esthetic outcome and oral health-related quality of life.

Materials and Methods: Twenty patients who were treated with an anterior maxillary single implant restoration were recalled for esthetic outcome evaluation using pink and white esthetic scores (PES/WES). All patients completed a questionnaire regarding satisfaction of treatment outcome and quality of life related to the implant restorations. Patient satisfaction was assessed by visual analog scales (VAS) analysis, whereas oral impact on daily life performances (OIDP) was used to evaluate the quality of life of patients.

Results: The esthetic outcome assessed by PES/WES showed favorable results. The mean PES/WES scores was 15.65±1.66 (maximum possible score = 20). The mean PES score and WES score was 7.50±1.05 and 8.15±1.09, respectively. Patient satisfaction rated in VAS scale ranged from 8 to 10. OIDP assessment showed an impact on daily life performance in 45% of patients. The most common impacts were eating (n = 5) and cleaning teeth (n = 4). No significant difference in PES/WES scores was found between the patients who perceived and did not perceive oral impacts. There were four subjects with an excellent score (PES/WES = 17-20) who reported a moderate intensity of impact.

Conclusions: This cross-sectional study exhibited a satisfactory outcome of anterior single implants at a follow-up period up to 3 years. None of the implants was rated below the clinically acceptable level. There was some discrepancy between the dentist's evaluation and patient's perception. An impact on daily life may be seen in the patients with excellent esthetic outcome of single implant restoration. However, a strong positive satisfaction was reported from all patients.

Field of Study: Esthetic Restorative and Implant Dentistry

Academic Year: 2014

Student's Signature _____

Advisor's Signature _____

Co-Advisor's Signature _____

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CHAPTER I

INTRODUCTION

Rationale and Significance of the Problem

For many decades the implant restorations have been proved to be one of the success treatments for replace the missing teeth, both complete and partial edentulous arch. Many recent studies reported the increasing of the implants survival rate in consideration of the development of implant surface technology and the improvement of treatment techniques. However, implant placement in anterior maxillary region is significantly difference from the posterior region in term of the favorable esthetic outcome as well as patient satisfaction.

In order to assess the esthetic outcome of the implant, most studies focus on the presence of unpleasant black triangles between the teeth[1-5]. In some studies, the level of interproximal gingival papillae was analyzed using papilla index, which was introduced by Jemt in 1997[5]. However, the cosmetic appearance involves other variables than the level of interdental papilla such as facial mucosa, quality of soft tissue and the prosthetic part. There are other indices used as esthetic parameters to measure the prosthetic part and surrounding mucosa, such as the pink esthetic score (PES), the implant crown aesthetic index (ICAI) the modified ICAI (mod-ICAI) and the index of Californian Dental Association (CDA index)[6-8]. However, these indices do not fully cover the esthetic assessment. The PES index focuses on the mucosa, while

CDA index assesses only the restorative part. Recently the pink and white esthetic score (PES/WES) has been introduced to evaluate both pink components and white components of the implant restoration and surrounding tissue[9]. Recent clinical studies evaluating the esthetic outcome using PES/WES analysis are increasingly popular and it has become one of the standard assessment tools to measure the esthetic outcome of implant restorations in anterior esthetic zone[10-13].

Patient satisfaction is also key to achieve and can truly indicate the success of implant treatment from patient's perspective. Previously, subjective esthetic evaluations were performed by using various types of questionnaires. The questions evaluated overall satisfaction of the treatment through visual analog scale (VAS) analysis or another kind of ordinal scale measurement.[9, 10, 14-16] The VAS analysis mostly reports the degree of satisfaction; nevertheless, it does not represent the patient's quality of life. Oral health related quality of life (OHRQoL) is defined as the effect of the impairment, disability and handicap from an oral condition to common daily activities such as eating, talking, cleaning teeth, sleeping, smiling and social contact.

Previous studies evaluated OHRQoL before and after patients received final implant-supported prostheses, demonstrating the effectiveness of implant treatment in improving the patient's quality of life[17-22]. Furuyama et al, investigated the OHRQoL in patient treated with implant-supported fixed dentures comparing to patients received removable partial dentures using Oral Health Impact Profile (OHIP-

J-49), found the better result in implantation group[19]. Yu et al. using OHIP-14 to assess the result of implant treatment, revealed that implant treatment in anterior region provide a positive relationship with the improvement of patient OHRQoL[17].

Longitudinal study of Berretin-Felix et al. assessed OHRQoL in elderly with mandibular implant-support fixed prostheses using 3 indices which were OHIP-14, Oral Impact on Daily Performance (OIDP) and World Health Organization Quality of Life (WHOQOL-BREF). They found that OHIP-14 and OIDP were confirmed the higher sensitivity and reliability in measuring the quality of life of implant patients[22]. Author also suggested that the questions of these two instruments are specifically focused on oral health more than WHOQOL-BREF.

A combination of objective and subjective evaluations of the esthetic outcome is essential for patients receiving dental implant restorations in the esthetic zone. Thus the objective of this study was twofold, firstly to assess the esthetic outcome of single implant restorations placed in the anterior maxilla after an evaluation period of up to three years by using the PES/WES index, secondly to evaluate the relationship between esthetic results, patient satisfaction and patients OHRQoL.

Research Questions

1. What is the esthetic outcome of single implant restoration in anterior region after function up to three years?

2. Is there any relationship among esthetic outcome, patient satisfaction and patient OHRQoL?

Research Objectives

The primary objective of this study was to assess the esthetic outcome of single dental implant restorations treated in anterior maxillary region.

The secondary objective was to evaluate the relationship among the implant esthetic results, patients OHRQoL and patient satisfaction.

Hypotheses

The mean PES/WES score is more than 14.5 (of 20). There is a relationship among the esthetic outcomes (PES/WES), patient satisfaction using VAS analysis and OHRQoL of patients assess by self-administered OIDP.

Conceptual Framework
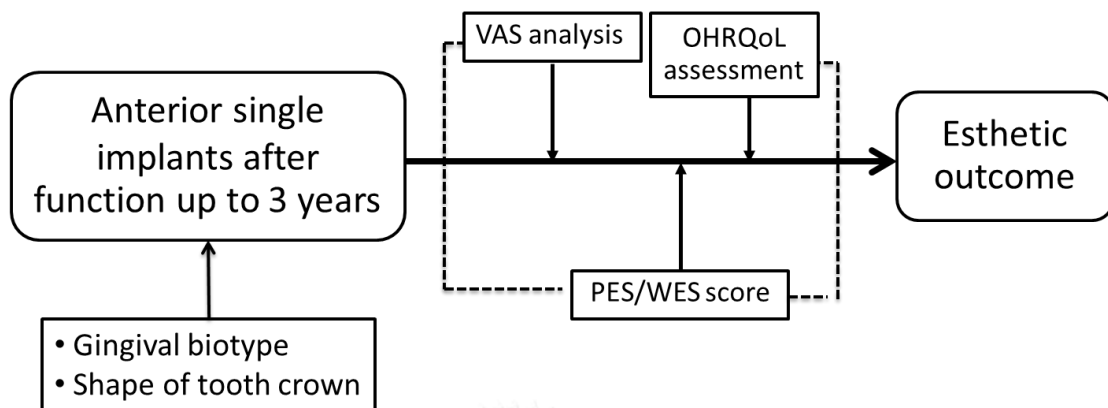
Figure 1 Conceptual framework

Assumption

Every implant operators was assumed to perform the same standard technique with equal clinical skill and knowledge.

Study Limitations

This study was cross-sectional study with small number of subjects and the evaluation period up to three years is a short-term study for the esthetic outcome of anterior single dental implants.

Long-term prospective study with the higher number of subjects is advocated to conduct in the future.

Key Words

ANTERIOR IMPLANT RESTORATION / SINGLE DENTAL IMPLANT / PINK AND WHITE ESTHETIC SCORES (PES/WES SCORE) / ORAL HEALTH-RELATED QUALITY OF LIFEF (OHRQOL) / ORAL IMPACT ON DAILY PERFORMANCES / VISUAL ANALOG SCALES

The Expected Benefits

The results from this study will give information about up to three years esthetic outcome of single implants placed in anterior maxillary region. The relationship between esthetic objective measurement by clinical index, patient satisfaction and quality of life that reported by patient's perception will be assessed in order to study the impact of implant treatment in esthetic zone on daily life performance of patient.

CHAPTER II
REVIEW OF LITERATURES

The literature in the following topics was reviewed.

- Dental implant survival and success rate

- Objective esthetic evaluation

- Subjective esthetic evaluation

- Factors related implant restoration in esthetic zone

Dental implant survival and success rate

In order to restore the missing dentition, dental implant treatment is documented to be successful and has become a popular treatment of choice. With the improvement of surface topography and treatment technology, dental implants have become more predictable in terms of osseointegration. Regarding the longevity of the single tooth implant placed in the anterior region, it has been found that a high survival rate can be expected.[2-4, 23, 24] However, in some studies, assessment criteria in terms of esthetic outcome were not defined. The success rate of implant treatment should not only focus on the functions of the restorations but should also be associated with the esthetic point of view and patient satisfaction, including their quality of life.

Objective esthetic evaluation

1. Papilla index by Jemt

In 1997, Jemt introduced the first parameter to assess the surrounding gingival around dental implants by evaluate the level of interdental papilla, called Papilla index[5]. These esthetic score range between 0 and 4 points. Score 0 shows the flat gingival, score 1 presents papilla fills less than half interdental space, more than half of papilla fills the index will rate as score 2, score3 will be rated if the interdental space is completely filled by gingival and score 4 present the hyperplasia of interdental gingiva (Table1).

Table 1 Papilla index score

Papilla index	
Score 0	No papilla; flat interproximal contour
Score 1	Papilla fills >0 and <50% of interdental space
Score 2	Papilla fills ≥50, but <100% of interdental space
Score 3	Papilla fills 100% of interdental space
Score 4	Papilla fills >100% of interdental space (hyperplasia)

Lindeboom et al in 2006, found favorable esthetic result of the study of immediate implant loading versus immediate provisionalization of maxillary single-tooth. PI was used to evaluate the esthetic outcome at 12 months. The result found 70% of complete papilla filled (score 3) at mesial aspect in immediate loading group and 91% in immediate restored group, while at the distal aspect both group showed 91% of complete papilla regeneration[1]. On the contrary, Cornelini et al in 2005,

presented case series of 22 cases with 12 months follow up, 61% of implant were rated in score 2 while only 39% show completed papilla fills[4]. The long term study of Degidi et al, 52 single-tooth implants were immediately restored, at the follow up period of 48 to 72 months the frequency of papilla index score 1 was 14.52% score 2 was 50% and score 3 was 35.48% respectively[2].

2. Pink esthetic score (PES)

Pink esthetic score was defined by Fürhauser in 2005[6]. These esthetic analysis are composed of 7 variables, assess mucosal tissue around implant prosthesis. The variables are mesial papilla, distal papilla, soft tissue level, soft tissue shape, deficient alveolar process, soft tissue color and soft tissue texture. Each variable is score from 0 to 2, 0 shows the poor result while 2 is the perfect score. The maximum total score is 14 (Table 2).

Table 2 Pink esthetic variables and score

PES variables			
Variables	0	1	2
1. Mesial papilla	absent	incomplete	Complete
2. Distal papilla	absent	incomplete	Complete
3. Soft tissue level	>2mm	1-2mm	<1mm
4. Soft tissue shape	Not very natural	Natural	Very natural
5. Deficient alveolar process	Obvious	Slight	None
6. Soft tissue color	Different	Slight difference	No difference
7. Soft tissue texture	Different	Slight difference	No difference

In this study of 30 cases implants evaluation, 20 observers were participated and each measured the cases 2 times, the mean PES of first assessment was 9.46 and 9.24 in the second evaluation, which was not significantly difference[6]. They found that this tool is the reproducibly evaluating index for assess soft tissue around single-tooth implant crown restorations.

3. The index of Californian Dental Association (CDA index)

CDA index has been used to evaluate the conventional prosthesis since 1977. This index analyzes only the prosthesis part which composes of 3 variables; surface and color of crown, anatomic form, and marginal integrity. Score points range between 0-3, score 0 is no mismatch, score 1 is slight mismatch, score 2 is mismatch and score 3 presents gross mismatch. The maximum point is 9 (Table 3).

Table 3 The index of the Californian Dental Association score

The index of the Californian Dental Association (CDA index)		
Score 0	R-level	No mismatch
Score 1	S-level	Slight mismatch
Score 2	T-level	Mismatch
Score 3	V-level	Gross mismatch

However, this index is not specially designed for evaluated the success of implant crowns restoration. Vilhjálmsson et al in 2011 study four of the esthetic indices in implant assessment PES, ICAI, Mod-ICAI and CDA. They found the poorest correlation of CDA index with other indices and patient self-reported outcome[8].

4. The implant crown aesthetic index (ICAI) and mod ICAI index

The ICAI index assesses both peripheral mucosa and dental prosthesis, there are five variables associated with implant restoration and four others evaluate soft tissue[7] (Table 4). From each variable, the score 0 presents no deviation, score 1 is slightly deviation while score 5 will be given for the gross deviation of the parameter. According to Meijindert et al, the acceptable result is the scores which from 0 to 4[16]. The maximum total score is 45 in ICAI index. However the modified ICAI has been changed, the 5 penalty point was replaced by 2 points. In this case the maximum score of mod-ICAI index is 18 points.

Table 4 The implant crown aesthetic Index

ICAI variables
Mesiodistal dimension of the crown
Position of the incisal edge of the crown
Labial convexity of the crown
Colour and translucency of the crown
Surface of the crown
Position of the labial margin of the periimplant mucosa
Position of mucosa in the approximal embressure
Contour of the labial surface of the mucosa
Colour and surface of the labial mucosa

There is a few publication related to this esthetic index. In 2007, anterior maxillary single tooth implants were evaluated using this index. The crown penalty score was 1.3 ranges from 0 to 9, the mucosa score was 3.4 ranges from 0 to 11. The overall penalty score was 4.8[16].

5.   Pink and white esthetic score (PES/WES)

This analysis was introduced by Belser in 2009, in order to measure the esthetic outcome of the dental implant[9]. PES/WES composes of ten parameters. Pink esthetic score (PES) measure soft tissue around implant restoration, while white esthetic score (WES) measure the prosthesis part (Table 5). The esthetic parameter is measured on ordinal scale range from 0 to 2. Score 0 shows the major discrepancy between implant restoration and reference contralateral teeth. Score 1 shows average result, while score 2 presents the greatest esthetic outcome.

Table 5 PES/WES parameter

PES parameter	WES parameter
Mesial papilla	Tooth form
Distal papilla	Tooth volume/outline
Curvature of facial mucosa	Color (hue/value)
Level of facial mucosa	Surface texture
Root convexity/soft tissue color and texture	Translucency

The maximum total positive score is 20. According to Belser 2009, a total PES/WES which was 17 or above were defined as an excellent overall esthetic outcome, while the score which less than 12 showed less favorable outcomes, corresponding to the clinical acceptability threshold level[9].

PES/WES score was used to measure the esthetic result of single tooth implant in many of previous studies. According to Buser et al, the esthetic outcome of implant-supported single crown showed favorable results after 3 years follow up,

using PES/WES index, they evaluated 20 single implants[10]. The mean PES was 8.1, while mean WES was 8.65. The total PES/WES score was 16.75 which were the same as mean PES/WES score at 1 year follow up.

In recent study of Furze et al in 2012 also found the pleasing esthetic outcomes, 10 consecutive single-implants were evaluated after 1 year of loading. PES/WES were scored and showed the PES mean of 7.9 ± 1.7 and WES mean of 7.0 ± 1.5[12]. Similar result was found in 26 anterior maxillary tooth implants after 2 year of loading. The mean total PES/WES was 14.30, the mean PES was 7.3 ± 1.78, while WES was 7.0 ± 1.35[13]. The less favorable result found in the study of Cho et al, they evaluated the esthetic outcome of 41 implant-supported single restorations[11]. The mean total PES/WES was only 11.19 ± 3.59. The mean PES was 5.17 ± 2.29 and 6.02 ± 1.96 for the mean WES.

Subjective esthetic evaluation

Previously, the subjective esthetic evaluations were performed by using questionnaire. The questions were evaluated overall satisfaction of the treatment through Visual Analog Scale (VAS) analysis or other kind of ordinal scale[15, 25, 26]. Meijndert et al, assessed overall satisfaction as well as patients point of view of the crown and mucosa appearances[16]. The mean overall satisfaction score was 8.5 of 10. The totally satisfied of crown found in 82.4% of subjects, while the totally satisfied score of mucosa found in 42.9%. Oh et al, divided the question in to three aspect, patient comfort, functional and appearance of the prosthesis[27]. The scale range from

1 to 4, score 1 is excellent while score 4 is poor. At 6 months, the overall mean were 1.17 and 1.00 for delay loading and immediately loading groups respectively. All subjects in immediately loading group scored "excellent" to the questionnaire. These methods can be used to measure the satisfaction of patient in the specific question. However, the measurement cannot truly indicate whole satisfactory of the treatment including the result of treatment related to their daily life activities.

Hans-Joachim Nickenig et al. and John assessed OHRQoL by using the OHIP-21 which originally adapted from Oral Health Impact Profile (OHIP) questionnaire by Slade and Spencer, 1994[20-22]. There are 21 questions included in six categories of problems that could be found in patients, which are functional limitation, physical pain, psychological discomfort, Psychological disability, social disability and handicap.

Participants were asked to identified the level of each question by 5-point Likert scale of 0 to 4 (0= never, 1 = hardly ever, 2 = occasionally, 3 = fairly often, and 4 = very often). The overall score of OHIP-21 range between 0 and 84, which the low score indicated the satisfactory result of OHRQoL while the higher score exhibited the poorer OHRQoL [18, 20, 21].

However, OHIP is only assesses the frequency of the problems but cannot give an information about the severity of each problem. Another method which has been widely used to measure OHRQoL of patients is Oral Impacts of Daily Oral Performance (OIDP)[28].

OIDP assessment consists of 8 daily life activities from 3 major categories which are physical, psychological and social performances[28]. Physical consideration composes of eating, speaking and ability to clean their mouth. Psychological issue composes of relaxing including sleeping, maintaining your usual emotional state without being irritable and smiling laughing and showing your teeth without embarrassment. There are 2 activities in social group which are carrying out major work or social role and contact with people.

Participants are face-to-face interviewed with the question related to these 8 activities include the frequency of problem, severity of each problem over the past six months and cause of those impacts which has been reported by patient.

OIDP score analysis can be divided into two types, which are Overall impacts score and Condition-specific impacts score (CS-impacts score). Overall impacts score is calculated from the frequency and severity score of every causes that has been reported from patients. Whereas, CS-impacts score is focused only on specific cause and condition that are interested, therefore the frequency and severity score of other conditions are excluded from the calculation. For example, the CS-impacts attributed to periodontal disease are calculated from the performance scores of these following causes gingival inflammation, gingival swelling, gingival bleeding, calculus, tooth mobility, gingival recession or bad breathing.

This instrument had been used to assess the quality of life in relation with oral disease in children[29, 30]. Costes MI et al. studied the socio-dental impacts of

untreated fractured anterior teeth in Brazilian children age of 12-14 year old[30]. The results show that the daily living of children with traumatic injury significantly impacted by their oral health compared to Children without anterior teeth injury, especially in the issue of smiling, maintaining emotional state, eating and enjoying contact with people. OIDP was also used to evaluate the quality of life in clinical situation, including implantation patients with various kind of implant prostheses such as implant-supported fixed prostheses and implant-retained overdenture[22, 31]. The results showed the improvement of life quality of the patients after they received the dental implant treatment.

Factors related dental implant in esthetic zone

There are many factors influence dental implant restoration treatment placed at anterior maxilla. According to ITI treatment guide volume I in 2007, there are risk factors that lead to implant esthetic results, which are medical status of the patients, smoking habit, patient's esthetic expectations, lip line, gingival biotype, shape of tooth crowns, Infection at implant site, bone level at adjacent teeth, restoration status of neighboring teeth, width of edentulous span, soft-tissue anatomy and bone anatomy of alveolar crest (Table 6).

Table 6 Esthetic risk assessment, ITI treatment guide volume 1

Esthetic risk assessment

Esthetic risk factor	Low risk	Moderate risk	High risk
Medical status	Healthy, cooperative patient with an intact immune system		Reduced immune system
Smoking habit	Non-smoker	Light smoker(<10cig/d)	Heavy smoker(>10cig/d)
Patient's esthetic expectations	Low	Medium	High
Lip line	Low	Medium	High
Gingival biotype	Low scalloped, thick	Medium scalloped, medium thick	High scalloped, thin
Shape of crowns	Rectangular		Triangular
Infection at implant site	None	Chronic	Acute
Bone level at adjacent teeth	<5 mm to contact point	5.5 to 6.5 mm to contact point	>7 mm to contact point
Restorative status of neighboring teeth	Virgin		Restored
Width of edentulous span	1 tooth (>7 mm)	1 tooth (<7 mm)	2 teeth or more
Soft-tissue anatomy	Intact soft tissue		Soft-tissue defects
Bone anatomy of alveolar crest	Without bone deficiency	Horizontal bone deficiency	Vertical bone deficiency

Medical status and smoking habit are known as the relative contraindication for implant therapy, which may increase complication, compromise esthetic result as well as reduce the implant survival rate[32]. Therefore, patients with uncontrolled systemic disease and smoking patients were normally excluded from inclusion criteria of implant therapy. Patient's esthetic expectation is a subjective factor which cannot exactly measure in the scale. There was no study on calculation or analysis of patient's esthetic expectation.

PES/WES assessment was introduced to perform in single tooth implant and the reference neighboring teeth should be virgin natural tooth in order to avoid the correction of the control tooth by the restoration such as making a long contact tooth to fill the interdental space. This study protocol was a cross-sectional study, which all the measurements was settled at the follow up visit, hence the subject of infection at implant site, soft-tissue anatomy and bone anatomy of alveolar crest at the time of placement were not included.

According to Kan et al. 2011, facial gingival tissue stability is affected by gingival biotype. The thick gingival biotype showed lower changes in facial gingival levels compared to thin gingival biotype significantly[33]. Shape of the crown is one of the factors that involve with the esthetic of the implant restoration. Triangular-shaped crown exhibited the larger black triangle at the interproximal area and required an additional restoration on the adjacent teeth more than square group shape[34]. Bone level at adjacent teeth is also one of the issues that impact the

esthetic results of the implant restoration. Choquet et al. 2001 revealed that the papilla was fully present, if the distance from the contact point to the crest of bone was 5 mm or less. In case of, the distance was greater than 5 mm, papilla was filled only 50% of time or less than that[35].

CHAPTER III

MATERIALS AND METHODS

Research Design

This analytical study was carried out as a cross-sectional study.

The clinical esthetic outcome was assessed using PES/WES index. Patient satisfaction was assessed by VAS scores analysis. While the OHRQoL of the patient was evaluated using OIDP self-administered Thai version.
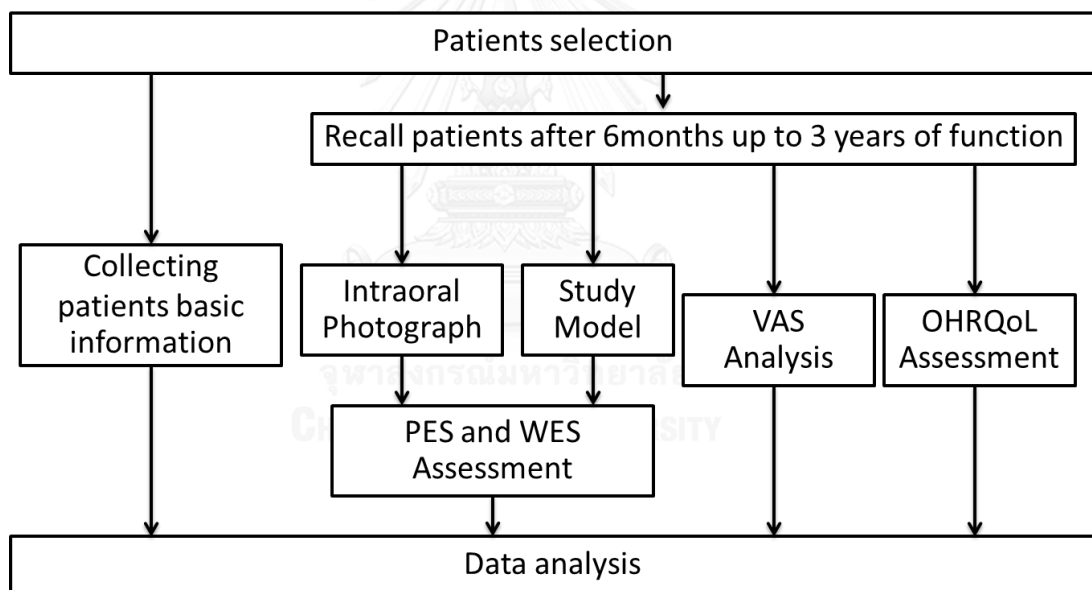
Figure 2 Research Design

Ethical Consideration

This study protocol had been approved by the ethical committee of the Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand. The study code was HREC-DCU-P 2013-057

Study Population

Patients who were treated with single implant restoration placed in the anterior maxillary region at Faculty of Dentistry, Chulalongkorn University, between January 2009 and December 2013, were included in this study. The inclusion criterion was single anterior maxillary implant restoration after loading at least 6 months up to 3 years. After the study protocol had been approved by the Ethics Committee of the Faculty of Dentistry, Chulalongkorn University and all patients signed an informed consent form, the basic clinical information of the patients and treatment procedure were retrieved from hospital records, including sex, age, the present of parafunctional habit, smoking habit, date of implant placement and loading, treatment protocol, implant system, type of implant abutment and restoration, bone augmentation procedure and previous complication. The exclusions were multi-unit restoration, restored contralateral tooth, ridge lap implant prosthesis, lack of posterior support, active periodontitis patient, uncontrolled systemic patient, parafunctional habit patient and heavy smoker (>10 cigarettes/ day).

Oral Examination

Patient was recalled for esthetic outcome evaluation. The general oral examination was performed and the follow up periapical radiographs were taken with parallel technique which the implant restorations were at the center of radiographs, according to a regular maintenance protocol. Briefly, the digital periapical radiographs was taken using digital radiographic machine (Kodak 2200,

Carestream Health, NY, USA). The XCP film holder (XCP Film Holder, Densply Rinn, UK) was used according to the standard parallel technique. Patients who met the inclusion criteria were included in this study, while the one who was not, was excluded.

Esthetic Assessment

PES/WES analysis

In order to assess the esthetic result of the implant prostheses, the anterior teeth including the treated implants and contralateral teeth were photographed with a digital camera (Nikon D80, Nikon, Tokyo, Japan), using a 105 mm lens (AF Micro-Nikkor 105mm f/2.8D; Nikon) and a dual-point wireless flash (R1C1, Nikon). Standardized clinical photographs were taken according to previously published methods[9]. Briefly, the implant restoration was at the center of the photograph, contralateral tooth was completely and symmetrically presented. When the implant restoration was at central incisor, the midline between two central incisors was located at the center of the photograph, and the contralateral tooth was symmetrically presented as well. Then, the upper and lower arch impressions were made by alginate impression material (Jeltrate, Densply, DE, USA), a pair of study models was fabricated using type III stone (Sirius, Ultima, France).

The esthetic evaluation was assessed using PES/WES analysis[9]. The photographs and the study models were used to evaluate the gingival and prosthesis condition according to 10 criteria of PES/WES analysis.

Table 7 PES/WES parameter and score

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
Total 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
Total score			10

PES criteria, relates to gingival appearance, which composes of a presence or absence of mesial papilla, distal papilla, curvature of facial mucosa, level of facial mucosa and root convexity/soft tissue color and texture (Table 7). The score of each parameter was ranged from 0 to 2. Score 2 represented the best outcome, score 1 showed the average, while score 0 showed the unsatisfactory results.

The papilla score 2 represented the complete presence of the interdental papilla, score 1 was incomplete presence and score 0 mean the absence of the papilla. The curvature of the gingival margin was evaluated as being identical (score 2), slightly different (score 1) and major different (score 0). The level of the facial peri-implant mucosa was compared to the gingival level of the contralateral natural tooth, identical vertical level (score 2), less than 1 mm discrepancy (score 1) and more than 1 mm discrepancy (score 0). The last variable related to the peri-implant mucosa composed of three components, which are root convexity, soft tissue color and soft tissue texture. Score 2 represented the identical of all three parameters compared to the contralateral tooth. Score 1 was given if two of those were identical to their natural one, while score 0 was assigned in case of none or one of the three criteria is fulfilled.

WES criteria based on the harmonization of the implant crown restoration compared to their contralateral natural tooth. The assess variables are including tooth form, outline and volume of restoration, color, surface texture and translucency and characterization of the prosthesis (Table 7). Line angle of the tooth and tooth shape were assessed to identify the identical of tooth form. Outline and volume was defined as the trace line of the outer edge of the tooth and tooth contours. In order to assess the color of the tooth, hue and value of the restoration were evaluated from the photographs. The esthetic score was ranged from 2 to 0 according to the degree of match or mismatch compared to the reference tooth.

Combining each variable from PES and WES scores, the total maximum score was 20. The clinical acceptance score was 12 (6 for PES and 6 for WES). The score of 17 or above was defined as an excellent esthetic outcome[9].

In PES parameters, intraoral photographs were used to assess the gingival curvature, gingival level and soft tissue color, while the study models were used to assess the root convexity and soft tissue texture. In WES variables, crown form, crown color, incisal translucency and characterization of the prosthesis were evaluated using photographs whereas study models were used to assess crown outline, crown volume and surface texture of the crown.

The examiners got familiarized with the index according to criteria and examples from previous studies.[9, 10, 24] Intra-examiner calibration of the PES/WES assessment was performed to make sure that the measurement method was consistent and reproducible, by repeating the assessment three times by one examiner who was not involved in the implant treatment. The second and third evaluations were performed one week after the previous assessment. In case the scores of the three evaluations were not the same, the examiner reassessed the study models and photographs once more before making the final decision. Inter-examiner calibration was performed in five subjects, and was done by two examiners. The agreement between each measurement was tested using Cohen's Kappa.

Patient satisfaction using Visual Analog Scale (VAS) analysis

Patients were asked to rate their satisfaction regarding the overall implant treatment, the functions of the implant and the esthetics of the implant restoration using VAS. This scale ranged from 0 to 10. A score of 0 was referred to no satisfaction, while a score of 10 corresponded to optimum satisfaction (Figure 3).

Figure 3 Visual Analog Scale (VAS) ranges from 0 to 10 in ordinal scale

Oral health-related quality of life (OHRQoL) analysis

At the same follow-up visit, patients completed the self-administered OIDP form. The OIDP index is composed of 8 major questions related to the impact of oral health on their daily life activities, including eating, speaking, cleaning teeth, sleeping and relaxing, emotional state, smiling, occupational activities and social relation [22, 28, 36]. From each question, if the answer was "yes" the frequency of those impacts were further evaluated in five levels according to the frequency or duration of incident over the past 6 months (Table 8). In addition, severities of the impaired performances were defined as no effect, a very minor effect, a fairly minor effect, a moderate effect, a fairly severe effect, and a very severe effect according to patient's perception (Figure 4).

Table 8 Frequency score of Oral Impacts on Daily Performances (OIDP)

Score	Frequency of the impaired performance	Number of days affected
1	Less often than once a month	For 5 days or less
2	About 1-2 times a month	For more than 5 days, up to a month
3	About 1-2 times a week	For more than 1, up to 2 month
4	About 3-4 times a week	For more than 2, up to 3 month
5	Everyday or nearly everyday	For more than 3 months
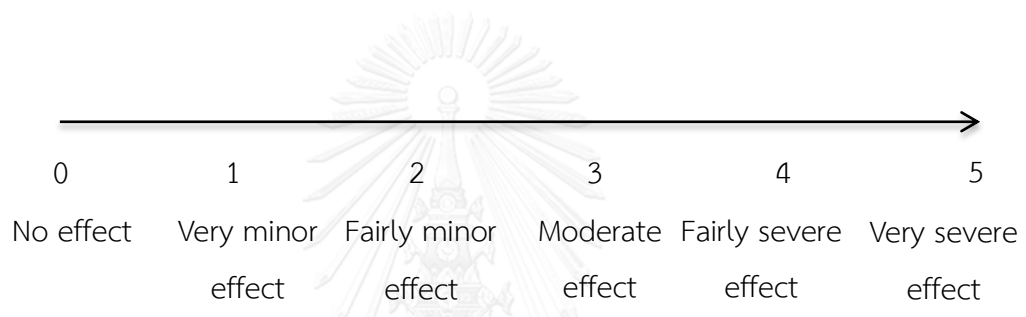
Figure 4 The severity scale of Oral Impacts on Daily Performances (OIDP)

In this study, all the questions related to 8 daily life performances were focusing only on the effect of anterior implant restorations. Hence, the perceived clinical causes were focusing only on the problems related to anterior implant prostheses. Other problems from other parts of the mouth were excluded from the calculation. These CS-impacts score related to the anterior implant restorations were calculate into the percentage score. First of all, the performance score was calculated by multiply the frequency score and the severity score of each activity. The maximum performance score is 25. After summarizing all eight activities the

maximum summary performance score is 200.   The frequency and severity scores of each activity were calculated into percentage impact scores by using the following equation:

$$\text{Impact score} = \sum_{i=1}^{8} \frac{(\text{frequency score}_i * \text{severity score}_i)}{\text{maximum possible score}} * 100$$

In addition, patients were classified by intensity of impact into three categories which were minor impact, moderate impact and severe impact according previous categorization by Krisdapong et al, 2009[37]. Briefly, the performance score of each daily performance was calculated by multiply the frequency score and the severity score, and then oral impact intensity was defined according to the highest performance score among the eight activities. The performance score was categorized into the groups of intensity as in Table 9.

Clinical measurements

Gingival biotype of the patients was recorded. It was classified into thick biotype and thin biotype which was assessed using periodontal probe recommended by Kan[38]. Briefly, the periodontal probe (Periowise, Premier Dental, PA, USA) was inserted into the gingival sulcus of the adjacent natural tooth at the midfacial aspect. Thin biotypes were identified, if the shadow of the ban of the probe was visible

through the thickness of gingiva. On the other hand, if the color of the probe was not shown through, then patient was categorized as thick gingival biotype.

Table 9 Oral impact intensity classification assessed by OIDP indices

Intensity	Frequency/severity score		Frequency/severity score	Performance score
Minor	1	x	1	1
	2		1	2
	3		1	3
	4		1	4
	2		2	4
	5		1	5
Moderate	3	x	2	6
	4		2	8
	3		3	9
	5		2	10
	4		3	12
Severe	5	x	3	15
	4		4	16
	5		4	20
	5		5	25

Central incisor was used as reference to classify the tooth shape of each patient as triangular, square-tapered or square shape according to the percentage ratio of contact surface length (CS) and crown length (CL)[39] (Figure 5). The measurement was performed using intraoral photograph. CS was a distance of the contact area between two central incisors, while CL was measure along a straight line

between the gingival zenith and the incisal edge of the tooth. The ratio of the CS

and CL that less than 43% was classified as triangular shape. If the ratio was in the

range of 43-57%, the tooth shape is square-tapered. The tooth was identified as

square shape, if the calculation was more than 57%.
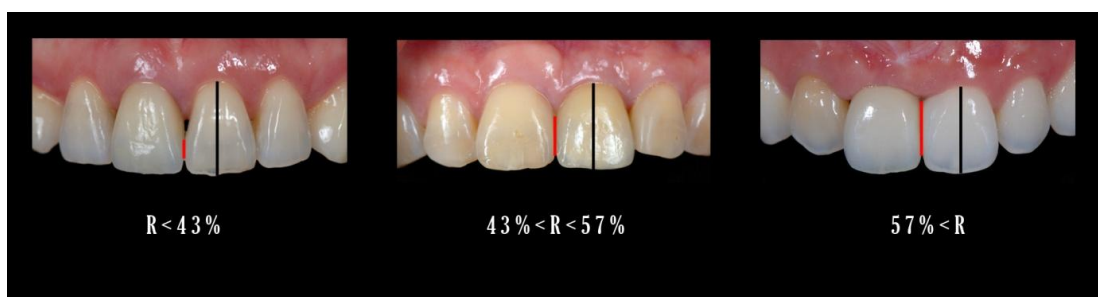
Figure 5 Tooth shape classification according to the percentage ratio (R) of CS
(red line) and CL (black line) of central incisor.

The digital periapical radiographs were measured the distance between

implant shoulder and alveolar bone crest (DIB) by using digital x-ray software (Vixwin,

Gendex Dental Systems, Hatfield, PA, USA). First of all the radiograph was expanded

to the maximum magnification, and then pixel-to-mm calibration was performed in

every case by using the implant length as reference. Finally, the straight line between

implant shoulder and the peak of bone crest was measured three times (Figure 6).
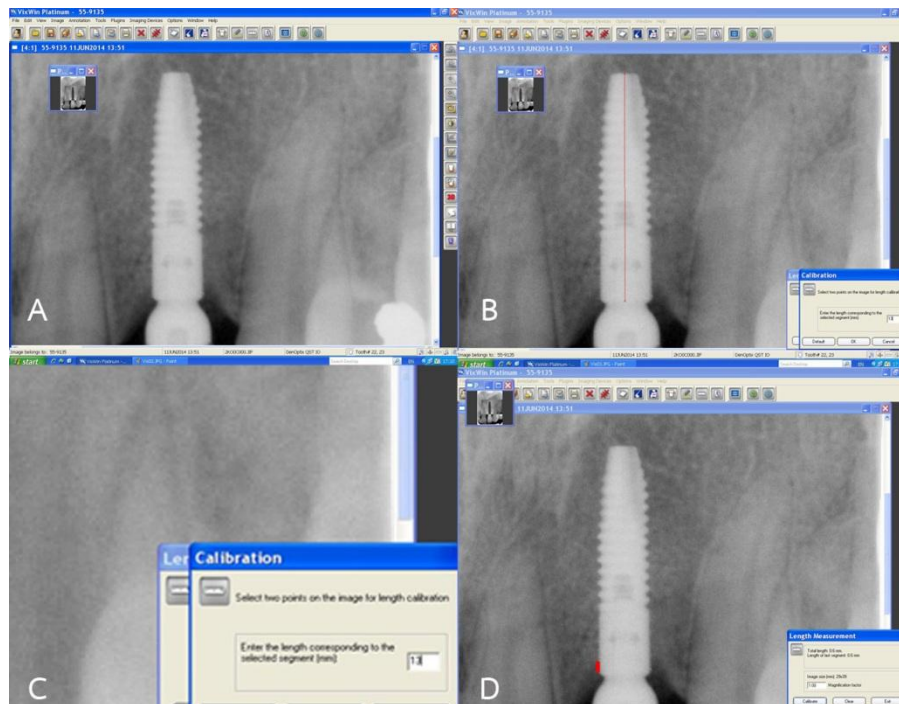
Figure 6 Distance between implant shoulder and alveolar bone crest was measured using Vixwin digital x-ray software (D), the pixel-to-mm calibration was performed in every case (B and C).

Data collection and Analysis

All data were analyzed using statistical software (SPSS 18.0, SPSS, Chicago, IL, USA). Means and standard deviations as well as frequency analysis of PES/WES scores were analyzed. Spearman's correlation was used to identify the relationship between PES/WES and VAS scores. Descriptive and frequency analysis of OIDP were performed, then Chi-square and Mann-Whitney U test were used to analyze the difference of PES/WES between groups of OIDP prevalence. The differences of PES/WES between groups of treatment protocols, gingival biotype and shape of the tooth were assessed using Mann-Whitney U test.

CHAPTER IV
RESULTS

A total of 20 subjects, 6 males and 14 females, with 20 maxillary single implants fulfilled the inclusion criteria. The age ranged from 28 to 65 years (mean; 48.2 years). The clinical characteristics related to anterior single implant are shown in Table 10. Out of 20 implants, 13 were placed in the central incisor area, 3 were placed in the lateral incisor area and 4 were at the canine region.

Table 10 Demographic data and clinical characteristics

	Subjects (n = 20)
Age (years)	48.2 (28-65)
Male/female	6/14
Central incisor/lateral incisor/canine	13/3/4
Bone block grafted/non-grafted sites	2/18
GBR/non-GBR	19/1
Soft tissue grafted/non-grafted sites	4/16
Screw/cement type	12/8
Titanium/burn-out/burn-out with porcelain abutment	6/10/4
Metal base/All ceramic crown	14/6
Thick/thin biotype	5/15
Triangular/square-tapered/square shape	11/9/0

GBR: guided bone regeneration

The most common implant system and diameter that was used were OsseoSpeed (Dentsply Implants, Mölndal, Sweden), 4.5 mm in diameter and

Straumann (Institute Straumann, Basel, Switzerland), 4.1 mm in diameter. The distribution of the implant systems and diameters was described in Table 11. The mean follow-up period was 16±10 months, with a minimum of 6 months and a maximum of 36 months. The mean DIB at the mesial and distal aspects were 0.580±0.73 and 0.625±0.60, respectively.

Table 11 Implant systems and diameters

Implant system	Implant diameter (mm)	Frequency
Straumann	3.3	1
	4.1	6
OsseoSpeed	3.0	1
	3.5	2
	4.0	3
	4.5	7

Straumann Dental Implant, Insititute Straumann AG, Basel, Switzerland

OsseoSpeed Implant, Dentsply Implants, Mölndal, Sweden

Figure 7 Final restorations of 20 patients at follow-up, the follow-up period ranged from 6 months up to 3 years of function
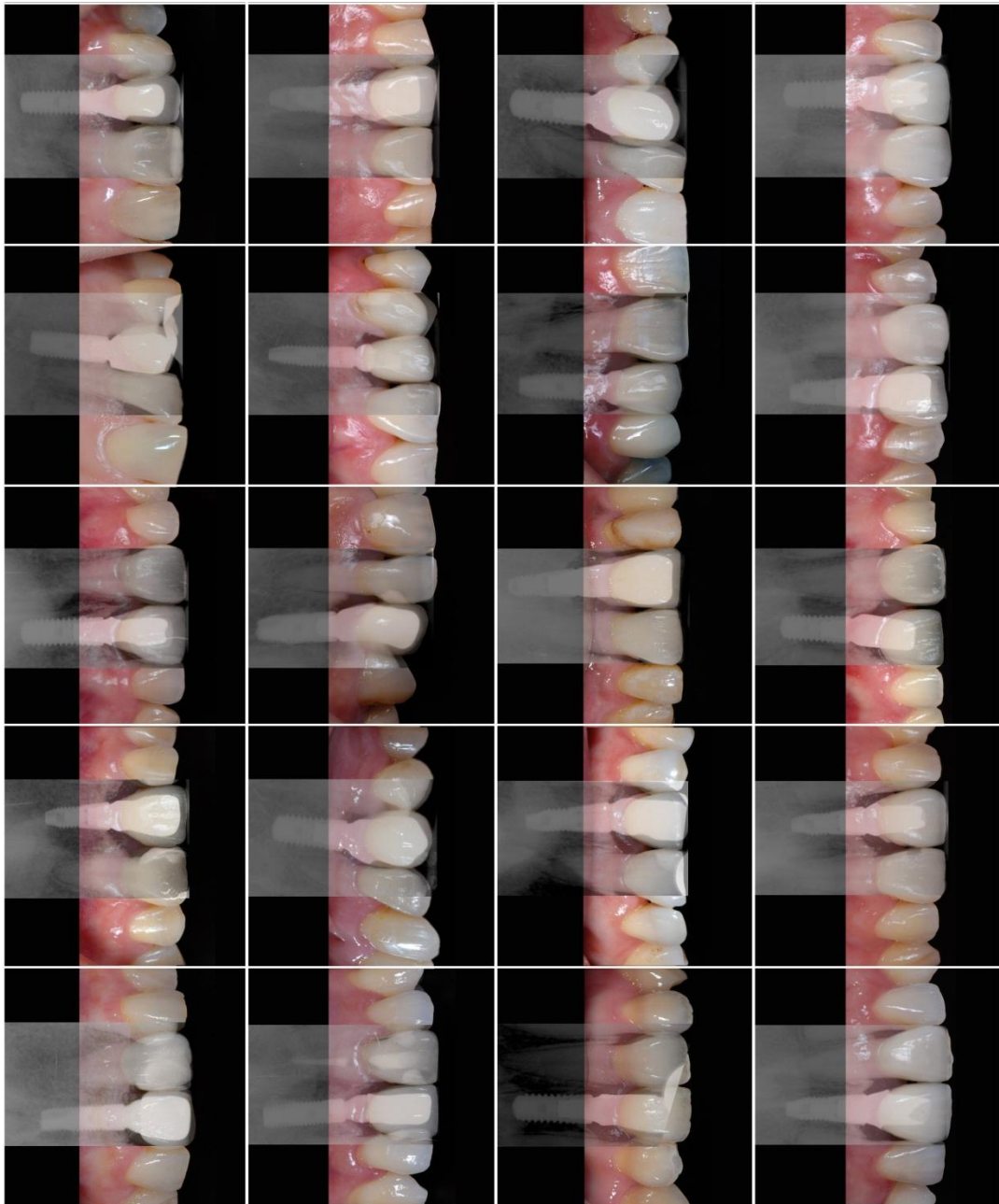
Figure 8 Periapical radiograph superimposed on final restorations of 20 patients at follow-up

PES/WES analysis

Figure 7 and 8 illustrated the final restoration for all cases. There was a very good agreement between the two observers for the PES/WES analysis (κ = 0.88). The

mean total PES/WES score was 15.65±1.66 (7.50±1.05 for PES and 8.15±1.09 for WES).

Seven cases showed excellent results (PES/WES ≥ 17). The highest score was 18,

which was found in three cases. The other thirteen cases presented an acceptable

outcome (PES/WES = 12-16). The lowest score was 12, which was found in one case.

None of the treatment outcomes showed an unfavorable esthetic result (PES/WES <

12).

Table 12 Esthetic scores of each variables (n = 20)

	Esthetic score (n)		
PES	0	1	2
Mesial papilla	0	10	10
Distal papilla	0	9	11
Curvature of labial mucosa	0	7	13
Level of labial mucosa	1	7	12
Root convexity/soft tissue color and texture	0	15	5
WES	0	1	2
Tooth form	0	4	16
Tooth volume/outline	0	8	12
Color (hue/value)	0	13	7
Surface texture	0	3	17
Translucency	1	7	12

PES: pink esthetic score, WES: white esthetic score

Among the PES variables, completely filled interproximal papillae were

found in 50% and 55% of the implants on the mesial and distal aspects respectively

(Table 12). In the majority of the cases, the curvature of the labial mucosa at the

implant site and at their contralateral tooth was identical (65%), while in 60% of the case the level of labial mucosa was the same as that of the reference. However, for one of the implants, a >1 mm mismatch of the level of mucosa was found.

Surface texture showed the most favorable results among the WES parameters, with 85% of the texture of the crowns naturally matching with their contralateral teeth. A slight discrepancy of the implant crown color was found for 65% of the single implants. A major mismatch of crown translucency was found in one case (5%).

Table 13 VAS and Spearman's correlation between PES/WES score and VAS score

	Overall	Function	Esthetics
Mean (SD)	9.00 (0.918)	9.00 (0.858)	9.15 (0.813)
Correlation Coefficient	-0.291	0.005	-0.029
p-value	0.213	0.982	0.902

PES/WES: pink and white esthetic score, VAS: visual analog scale

Patient satisfaction and OHRQoL

The questionnaire regarding the satisfaction of the implant prosthesis showed favorable results. The VAS score ranged from 8 to 10 in overall satisfaction, function and esthetics. The mean VAS score in terms of esthetics was 9.15±0.81 (Table 13). There was no correlation between VAS score and PES/WES (R = -0.291-0.005).
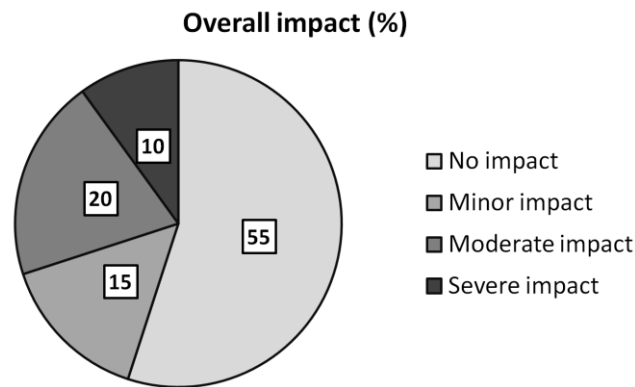
Overall impact (%)

Figure 9 Overall oral impact based on OIDP score, classified by intensity (n = 20)

The mean OIDP impact score was 2.23±3.60, ranging between 0.00 and 13.50 (maximum possible score is 100). The severity of impact of anterior single implant restoration on daily life performance is described in Figure 9. Nine patients reported that daily activities were impacted by their anterior single implant restoration over the past 6 months. Two of them were categorized in the severe intensity group. An impact was found on eating, speaking, cleaning teeth, sleeping and relaxing, emotional stage and smiling activity (Figure 10). The highest prevalence impacts were on the difficulty of eating (n = 5) and cleaning teeth (n = 4).
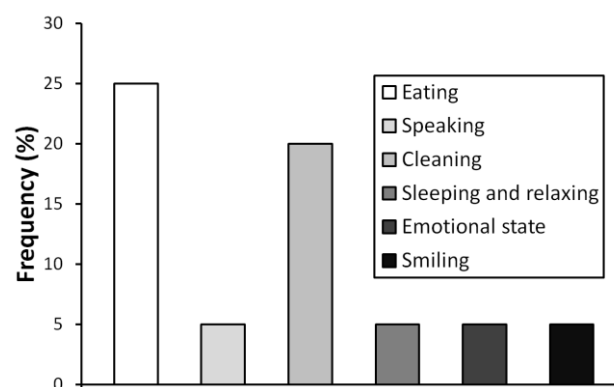
Figure 10 Frequency (%) of patients per impact type

PES/WES scores found no significant difference between groups of patients who reported oral impact on their quality of life and patients who did not (Table 14). The percent of disagreement found in 60% of the cases. Four patients who reported an oral impact showed an excellent clinically assessed esthetic outcome, while eight of them showed acceptable PES/WES scores and did not perceive any oral impact.

Table 14 Prevalence of OIDP and PES/WES scores

	PES/WES score		
	12-16	17-20	
Oral Impact	n (%)	n (%)	Mean ± SD
Yes	5 (38.46)	4 (57.14)	15.89±1.69
No	8 (61.54)	3 (42.86)*	15.45±1.70
Total	13 (100.00)	7 (100.00)	

OIDP: oral impact on daily life performances, PES/WES: pink and white esthetic score
* Comparing proportion between groups (Chi-square test), No significant difference (p = 0.642) ** Comparing mean rank between groups (Mann-Whitney U test), No significant difference (p = 0.656)

The relationship between VAS analysis and OIDP prevalence was described in figure 11. The lowest score of satisfaction was 8, and the majority of oral impact was found in this group (n = 5). While only one patient who gave maximum satisfaction score reported oral impact on cleaning teeth. However, no statistically significant difference in VAS score was found between groups of OIDP impact (p = 0.147).
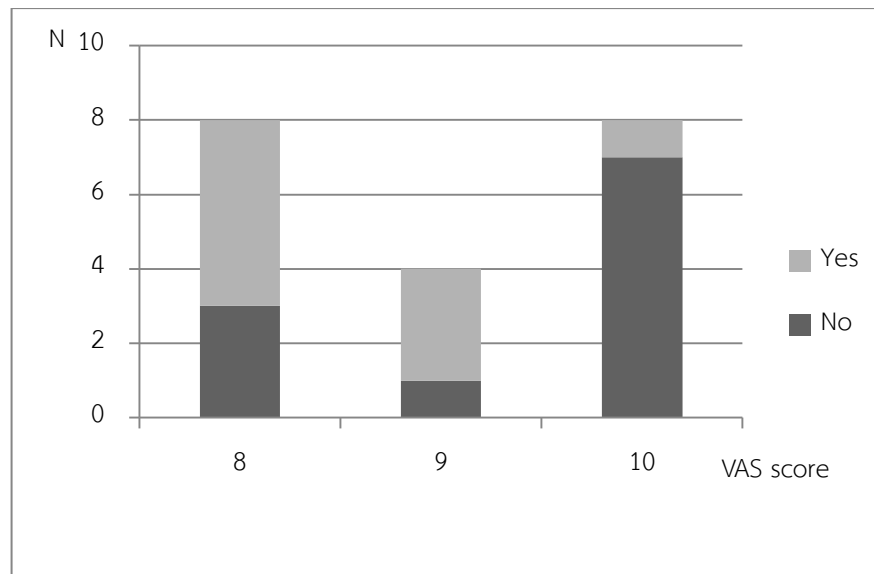
Figure 11 OIDP prevalence in patient who report VAS score of 8 to 10 (n=20)

No significant difference was found between groups of patient with or without oral

impact in daily performance (p = 0.147)

There was no statistically significant difference of PES/WES as a result of bone

grafting, soft tissue grafting, type of implant restoration and tooth shape (Table 15).

The PES/WES score in thick gingival biotype patients was significantly higher than in

thin biotype patients (p = 0.013).

Table 15 Comparison of PES/WES scores between groups

	Total n (%)	Mean	p-value
Ramus bone graft			
Grafted site	2 (10%)	15.67 ± 1.528	0.847
Non-grafted site	18 (90%)	15.59 ± 1.661	
GBR			
Grafted site	19 (95%)	15.63 ± 1.640	0.659
Non-grafted site	1 (5%)	15.00	
Soft tissue graft			
Grafted site	4 (20%)	16.25 ± 1.708	0.441
Non-grafted site	16 (80%)	15.44 ± 1.590	
Type of restoration			
Screw	12 (60%)	15.67 ± 1.875	0.906
Cement	8 (40%)	15.50 ± 1.195	
Type of abutment			
Titanium	6 (30%)	15.50 ± 1.049	0.513
Burn-out	10 (50%)	15.40 ± 1.955	
Burn-out with porcelain	4 (20%)	16.50 ± 1.732	
Type of crown			
Metal base	14 (70%)	15.57 ± 1.697	0.801
All ceramic	6 (30%)	15.83 ± 1.722	
Gingival biotype			
Thin	15 (75%)	15.25 ± 1.571	0.013*
Thick	5 (25%)	17.00 ± 0.816	
Tooth shape			
Triangular	11 (55%)	15.64 ± 1.433	0.615
Square-tapered	9 (45%)	15.56 ± 1.878	

*Significant at the 0.05 level (Mann Whitney U test)

Statistically significant difference between 3 types of abutment found in root convexity/soft tissue color and texture (p = 0.040). Burn-out metal abutment coated with porcelain showed highest mean esthetic score for root convexity/soft tissue color and texture (1.75 ± 0.50), meanwhile mean score of titanium and burn-out metal abutment were 1.17 ± 0.41 and 1.10 ± 0.32 respectively (Table 16). Major mismatch of crown translucency/characterization was found in one metal base restoration. However, no significant difference between metal base and all-ceramic groups was shown in translucency/characterization variable.

Complete mesial and distal papillae fill were found in 36.36% of triangular shape crown, while 66.67% and 77.78% of square-tapered shape showed the complete gingival fill in mesial and distal aspects respectively. However, no significant difference was noted between group of crown shapes in mesial papilla (p = 0.189) and distal papilla (p = 0.071).

Table 16 Comparing related variables in groups of implant characteristic

	Total n (%)	Mean ± SD	p-value
	Root convexity/soft tissue color and texture		
Type of abutment			
Titanium	6 (30%)	1.17 ± 0.41	0.040*
Burn-out	10 (50%)	1.10 ± 0.32	
Burn-out with porcelain	4 (20%)	1.75 ± 0.50	
	Crown translucency		
Type of crown			
Metal base	14 (70%)	1.57 ± 0.65	0.667
All ceramic	6 (30%)	1.50 ± 0.55	
	Mesial Papilla		
Tooth shape			
Triangular	11 (55%)	1.36 ± 0.51	0.189
Square-tapered	9 (45%)	1.67 ± 0.50	
	Distal Papilla		
Tooth shape			
Triangular	11 (55%)	1.36 ± 0.51	0.071
Square-tapered	9 (45%)	1.78 ± 0.44	

*Significant at the 0.05 level (Kruskal-Wallis test)

CHAPTER V

DISCUSSIONS AND CONCLUSIONS

Discussion

This cross-sectional study observed the esthetic result of single implants in the esthetic zone from 6 months up to 3 years follow-up, along with patient satisfaction and their quality of life at that time. All twenty patients showed highly satisfactory results in PES/WES score analysis. The mean total PES/WES was 15.65. The PES score (mean: 7.50) was slightly lower than the WES score (mean: 8.15).

The gingival appearance in four cases showed excellent PES results, with a score of 9. A score of 1 was given for curvature of mucosa and level of mucosa in one of these four cases, while one point for root convexity/soft tissue color and texture was deducted for two others. The lowest PES score was 6. It was found in four cases, all of which were scored 1 for mesial papilla, distal papilla and root convexity/soft tissue color and texture. In this study, root convexity/soft tissue color and texture showed the most unfavorable results among PES variables. Contour augmentation has a great influence on the esthetic result of anterior implants.[10, 24] In recent studies, the guided bone regeneration (GBR) bone grafting technique was immediately performed in all cases after implant placement as a surgical protocol, showing reliable esthetic results, with a mean PES score above 7.[9, 10, 12, 24] On the contrary, a retrospective study of Cho et al observed 41 patients who had been

treated with an anterior single implant, showing a mean PES score of 5.17 which does not reach the clinically acceptable level. However, the surgical technique was not described and the bone grafting procedure was not mentioned.[11] In the present study, the GBR technique simultaneously with implant placement was used in most cases. There was only one patient, treated with a dental implant in the canine region that did not receive any bone grafting procedure. Due to a low number of subjects in non-GBR group, the conclusion regarding to the difference of esthetic score between the GBR and non-GBR patients cannot be drawn.

The gingival biotype showed an association with peri-implant facial gingival tissue stability, whereas the interproximal papilla was not affected by the gingival thickness.[32] The presence or absence of the papilla is influenced by the level of the proximal crestal bone.[34] The tissue biotype shows to be a significant parameter related to the esthetic outcome of the implant restoration;[39-41] therefore, a thin gingival biotype was an exclusion criterion in certain studies on the esthetic results of implant treatment.[13, 42] In the present study, both thick and thin biotype patients were included, and a statistically significant difference mean PES/WES was found between the thick and thin gingival biotype patients. This result demonstrated the influence of gingival thickness on the esthetic outcome of single implant restorations. However, the mean gingival score in thin biotype patients was clinically acceptable. With a strict proper implant surgical protocol, an acceptable esthetic result of single implants can be expected from thin gingival biotype patients.

Previous authors have implicated that the grayish color of metal abutments can visible through facial mucosa and compromise the esthetic result, especially in thin gingival biotype case.[43-45] There were 3 types of abutments in this study: titanium, burn-out metal abutment and burn-out metal abutment baked with porcelain. Burn-out metal abutment baked with porcelain is normally chosen for cement-retained with all-ceramic crown case. Margin of this custom abutment allows dentist to clean excess cement easier at the cementation visit, and yet it provides a tooth-colored area below the gingival margin. Our study found that the esthetic score of root convexity/soft tissue color and texture in tooth-colored abutment was higher than in two other metal abutments significantly.

Soft tissue grafts sustain volume of soft tissue both in vertical and horizontal aspects and many surgical techniques have been used to correct soft tissue thickness and the level of buccal mucosa at an implant site. In a short-term study, soft tissue dehiscence at implant site was improved by free connective tissue grafting.[46, 47] Hidaka and Ueno performed a split pouch technique using a subepithelial connective tissue graft twice in the duration of 12 month in the implant site, in which 3 mm of abutment exposure was present.[46] The second surgery was done to resolve the recession from tissue shrinkage after the first graft and found a satisfactory result at the observation period of 9 months. With the improvement of soft tissue volume, not only the level and contour of the mucosa was regained, but the gingival zenith of the crown was improved as well. In this study, soft tissue grafting was done in four

cases. The split pouch technique using subepithelial connective tissue graft was performed one time. At a mean observation period of 15 months, the mean PES/WES score was 16.25, and 50% of implants showed an excellent esthetic score. However, the need of the soft tissue correction at an implant site should be considered along with the patient's expectation.

Triangular-shaped crown exhibited the larger black triangle at the interproximal area. Gobbato et al. studied influence of tooth shape on the need of additional restoration on adjacent teeth in single implant patient.[33] They found that triangular-shaped crown required additional restoration on the adjacent teeth more than square-shaped crown significantly. The restoration can change the triangular tooth shape to square shape by extending the contact area between teeth. Long contact teeth without black triangle space would get higher PES score when compare to the shorter one, however in many cases, it compromises the esthetic of the crown because of the unnatural look. In our study, the case with additional restoration on adjacent teeth was excluded. Triangular tooth shape was observed for about half cases. From 11 patients with triangular tooth shape, 7 of them got score 1 in mesial and distal papilla while score 2 was rated to 4 others. On the other hand, score of 2 was given to about 65-75% of patient with square-tapered crown. However, the differences of papillae esthetic score between groups of tooth shape were not detected.

In patients with periodontitis background, black triangles developed previously before the implant treatment. Preexisting conditions should be considered in the evaluation of implant esthetic results in these cases. The information of level of dental papillae and the presence of black triangle before treatment might be necessary for assessing the true esthetic score after treatment by adapting scoring criteria. When considering about the preexisting condition, score of 2 in dental papilla should be given if the level of papilla were the same as previous.

In this study, the implant crowns were fabricated by the same technician in most cases. The mean WES score showed a favorable result of 8.15, with no scores was below the clinically acceptable threshold. A previous study reported an excellent mean WES score of 8.65, with all 20 implant crowns having been fabricated by the same technician.[10] On the other hand, lower scores were reported in studies in which many technicians were involved,[9, 11, 13] with about 15 to 20% of the implant crowns scoring less than the clinically acceptable threshold. This was most notable in a study on 41 single implants by Cho et al, showing a mean WES of 6.02 which was slightly above the threshold.[11] Variable technical skill might lead to an unpredictable esthetic result of the restoration; however, these results represent the real situation in daily private practice.

Belser et al. found 100% of maximum esthetic score for translucency/characterization, while only 60% was noted in this study. One crown was scored 0 for this variable. Types and materials of implant crown play important

role in this subject. All-ceramic crown provides higher translucency than in PFM crown. Gallucci et al. studied esthetic outcome using PES/WES between all-ceramic and PFM crown on single implant in anterior region.[48] All-ceramic restoration presented higher mean score for translucency/characterization. However, the difference of this variable nor PES/WES was not observed between groups of crown. A similar result found in our study, no significant difference was noted. Minor mismatch of translucency/characterization was observed in 3 all-ceramic crowns out of 6. One of them, the translucency of implant crown was greater than that of the natural reference tooth.

In this study, only 7 implant restorations got a full score for color matching, which was the lowest number of all variables in implant crown esthetic assessment. Similar results were reported in previous studies.[9-13] Although skills of dental technician play an important role in creating a highly esthetic restoration, dentist is also an essential key to the success of a restoration in esthetic zone. Proper tooth shade selection and a good communication between dentist and lab technician are needed. Bahannan in 2014 showed an inaccuracy of visual tooth shade selection (36.3%) in dental students and found a better result when using shade selection instruments (80.4%).[49] The study advocated the use of instrumental methods in the selection of tooth shade, especially by an inexperienced clinician. Moreover, the type of the implant restoration and materials also affect the esthetic results of the implant crown in terms of color and translucency. A tooth-color abutment such as a

zirconia abutment on top with an all-ceramic crown restoration was expected to show a better esthetic result than any other metal-base restoration. However, since this study is a cross-sectional study, the information about abutment material was not recorded.

Questionnaire responders expressed a strong positive attitude toward their treatment. They rated the VAS at 8 or above for all three aspects: overall satisfaction, functional and esthetic outcome. However, these opinions from patients were not significantly correlated with the clinical assessment using PES/WES index. One patient gave the maximum satisfaction of 10 points for the 3 parts, while the esthetic score was rated equal to the clinically acceptable level (PES/WES = 12). The same was found in a patient whose implant was rated highest among all implants (PES/WES = 18), but who gave 8 points for all satisfaction-related aspects which was the lowest score of all patients. A similar result was found in the study of Belser et al, in which 45 single tooth implants showed no correlation between PES/WES score and VAS.[9] In the study of Meijndert et al, no correlation between the ICAI assessment by the clinician and the patient's opinion was revealed in the overall part and the implant crown part; however, a statistically significant correlation was noted in the mucosal part.[16] A significant correlation between scores from dentists and patients was also stated by Cho et al, when asking about satisfaction with the esthetic treatment outcome.[11] However, patient's ratings were commonly higher than dentist scores.[9, 11,

[14, 16] This study confirms that minor details of mismatch of the implant restoration, which can be noticed by the dentist, are normally not perceived by patients.

In our study, an oral impact on daily life performance related to anterior single implant restoration was found in nine cases. However, the intensity of the impact was categorized as minor affect in most cases. Patients with severe intensity of impact were in the acceptable group. One of them, who reported an impact on taking care of oral hygiene, had a reduced periodontium, resulting in a permanent difficulty regarding teeth cleaning. A moderate intensity of impact on smiling was reported by one patient; nevertheless, a high esthetic score was given by the dentist. Patients who found a difficulty in eating stated that they sometimes pay too much attention to avoid using their front teeth, because they believe that the crown might fall out if the implant restoration is overloaded. In addition, some of them experienced problems related to the temporary implant crown such as a broken crown structure or detachment of filling material in the screw hole.

Patients with an acceptable PES/WES score (12-16) showed an incidence of performance impacts of approximately 40%, while 60% did not reported any difficulty in their daily life activities. Some mismatches of the treatment outcome which were indicated by the dentist might not have an effect from the patient's point of view. Objective assessments of oral health by dentists were found to be different from subjective measurements by assessing the quality of life of the patient.[50, 51] The patient's need for dental treatment is commonly lower than the

need for treatment from the dentist's point of view. Colussi et al. report this discrepancy for patients who lost their teeth. A total of 228 patients were indicated to need prostheses by their dentist, while only 135 patients felt themselves that they needed the prostheses.[50] Taking this subjectivity into considerations, a corrective treatment of a small mismatch in some patients might not be needed.

In this study, an impact of moderate intensity on daily performance was observed in more than half of the patients with excellent PES/WES results (17-20). The perspective of patients toward dental treatment is not only influenced by the clinical appearance but is also associated with their underlying psychosocial status. There are social factors aside from treatment outcome, such as age, gender and education level, that have an influence on the patient's perception toward dental treatment.[17, 19] In the study about socio-demo-economic status of patient, Colussi et al. also found the influence of this status in patient perspective toward dental need. They noted that patient who perceived less need for prosthesis in relation to the professional diagnosis found in elderly male above 70 years, resident in rural areas. They did not participate in third age social groups and had not sought dental services for most of their lives.[50]

Moreover, when considering about human need, Maslow proposed the hierarchy of need that related to human health. Spiritual health or intellectual heath at the peak of the pyramid is the final level of psychological development. This kind of health is defined as the path to inner peace regardless of the turmoil around you.

Spiritual health related to the perception of the world, which is an appreciation of humanity and the world, despite also having a realistic understanding of its inherent faults.[52] Since patient perception is influenced by many factors other than the physical appearance which can be evaluated by dentist. It can be imply that with the improvement of a communication with patient, defying problem and evaluating outcome together can lead to a successful treatment from both side perspectives.

Missing anterior teeth or defected front teeth have a strong influence on the patient's physical and mental OHRQoL.[17, 29] Traumatic anterior teeth patients reported a difficulty with smiling, maintaining emotional state, eating and social contact.[29] Yu et al presented a significant improvement of OHRQoL after 6 months in patients with missing anterior teeth who were treated with anterior implant restorations.[17] As this current cross-sectional study examined the patients at the follow-up visit, all the patients had already finished the implant treatment, and information about the quality of life before treatment was not collected. However, the low OIDP mean impact scores indicated the success of implant treatment in terms of OHRQoL of patients.

Our study presented acceptable to excellent esthetic results recorded by the dentist. Even though a low to severe intensity of impact was found in 45% of patients, all of them showed a positive attitude toward the treatment outcome via an excellent VAS score. However, there was no significant correlation between the dentist's assessments and the patient's perception. A long-term assessment with a

higher number of subjects needs to be conducted to further determine the association between the patient's perception and the esthetic outcome of a single implant in the anterior region.

Conclusions

Anterior single implants in this study showed favorable esthetic results. None of the implant restorations was rated below the clinically acceptable limit. The dentist's assessment may be different from that of the patient, because the latter is more subjective.

Further study

The prospective long-term study with larger sample size should be conducted to investigate the differences of patients' OHRQoL before and after treatment and to further evaluate the correlation among the esthetic results of anterior single implant, patient's perception toward the treatment outcomes as well as their quality of life.
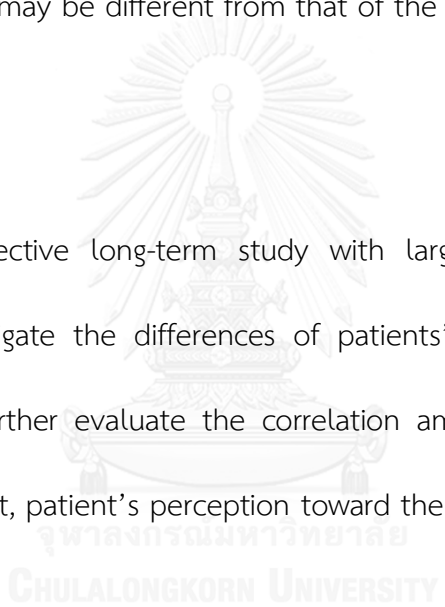
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APPENDIX

Appendix A. Study Protocal and Consent Form Approval

No. 077/2013

Study Protocol and Consent Form Approval

The Human Research Ethics Committee of the Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand has approved the following study to be carried out according to the protocol and patient/participant information sheet dated and/or amended as follows in compliance with the **ICH/GCP.**

Study Title   : ORAL HEALTH RELATED QUALITY OF LIFE AND ESTHETIC OUTCOMES IN SINGLE ANTERIOR MAXILLARY IMPLANTS

Study Code   : HREC-DCU **2013-057**
Study Center   : Chulalongkorn University
Principle Investigator : Dr. Chayanuch Angkaew
Protocol Date   : September 13, 2013
Date of Approval   : November 5, 2013
Date of Expiration   : November 4, 2015

(Associate Professor Dr. Veera Lertchirakarn)
Chairman of Ethics Committee

(Assistant Professor Dr. Kanokporn Bhalang)
Associate Dean for Research

*A list of the Ethics Committee members (names and positions) present at the Ethics Committee meeting on the date of approval of this study has been attached (upon requested). This Study Protocol Approval Form will be forwarded to the Principal Investigator.

Approval is granted subject to the following conditions: (see back of the approval)

Appendix B. Patient satisfaction and Oral impact on daily life performance Thai
version questionnaire

แบบสอบถามสำหรับงานวิจัย

เรื่อง คุณภาพชีวิตในมิติสุขภาพช่องปากและผลลัพธ์ด้านความสวยงามของรากเทียมฟันหน้าบนซี่เดียว

ส่วนที่ 1 ข้อมูลทั่วไป

เพศ ☐ ชาย ☐ หญิง

อายุ .... อาชีพ ....

โรคประจำตัว .... ประวัติการแพ้ยา ....

ประวัติการสูบบุหรี่ ☐ ไม่สูบ ☐ สูบน้อยกว่า10 มวน/วัน ☐ สูบ10 มวน/วัน หรือมากกว่า

การแปรงฟัน .... ครั้ง/วัน

การใช้ไหมขัดฟัน ☐ ไม่ได้ใช้ ☐ 2-3 ครั้ง/เดือน ☐ 2-3 ครั้ง/สัปดาห์ ☐ ทุกวัน

....

ส่วนที่ 2 แบบสอบถาม

1. ในระยะ 6 เดือนที่ผ่านมา คุณประสบปัญหาใน<u>การรับประทานอาหาร</u> อันเนื่องมาจากราก
   เทียมฟันหน้าของท่านหรือไม่

   ☐ ใช่ ☐ ไม่ใช่ (หากไม่ใช่ ข้ามไปขอถัดไป)

   1.1 หากใช่ ความถี่ในการประสบปัญหาคือ

   ☐ น้อยกว่าเดือนละครั้ง ☐ 1-2 ครั้ง/เดือน ☐ 1-2 ครั้ง/สัปดาห์

   ☐ 3-4 ครั้ง/สัปดาห์ ☐ ทุกวันหรือเกือบทุกวัน

   1.2 ความรุนแรงของผลกระทบคือ

☐	☐	☐	☐	☐	☐
ไม่มีผล	เล็กน้อยมาก	เล็กน้อย	ปานกลาง	รุนแรง	รุนแรงมาก

2. ในระยะ 6 เดือนที่ผ่านมา คุณประสบปัญหาใน<u>การพูดและออกเสียง</u> อันเนื่องมาจากราก
   เทียมฟันหน้าของท่านหรือไม่

   ☐ ใช่ ☐ ไม่ใช่ (หากไม่ใช่ ข้ามไปขอถัดไป)

2.1 หากใช่ ความถี่ในการประสบปัญหาคือ

☐ น้อยกว่าเดือนละครั้ง ☐ 1-2 ครั้ง/เดือน ☐ 1-2 ครั้ง/สัปดาห์

☐ 3-4 ครั้ง/สัปดาห์ ☐ ทุกวันหรือเกือบทุกวัน

2.2 ความรุนแรงของผลกระทบคือ

☐	☐	☐	☐	☐	☐
ไม่มีผล	เล็กน้อยมาก	เล็กน้อย	ปานกลาง	รุนแรง	รุนแรงมาก

3. ในระยะ 6 เดือนที่ผ่านมา คุณประสบปัญหาใน<u>การทำความสะอาดช่องปากและฟันปลอม</u> อันเนื่องมาจากรากเทียมฟันหน้าของท่านหรือไม่

☐ ใช่ ☐ ไม่ใช่ (หากไม่ใช่ ข้ามไปขอถัดไป)

3.1 หากใช่ ความถี่ในการประสบปัญหาคือ

☐ น้อยกว่าเดือนละครั้ง ☐ 1-2 ครั้ง/เดือน ☐ 1-2 ครั้ง/สัปดาห์

☐ 3-4 ครั้ง/สัปดาห์ ☐ ทุกวันหรือเกือบทุกวัน

3.2 ความรุนแรงของผลกระทบคือ

☐	☐	☐	☐	☐	☐
ไม่มีผล	เล็กน้อยมาก	เล็กน้อย	ปานกลาง	รุนแรง	รุนแรงมาก

4. ในระยะ 6 เดือนที่ผ่านมา คุณประสบปัญหาใน<u>การพักผ่อนรวมทั้งการนอนหลับ</u> อันเนื่องมาจากรากเทียมฟันหน้าของท่านหรือไม่

☐ ใช่ ☐ ไม่ใช่ (หากไม่ใช่ ข้ามไปขอถัดไป)

4.1 หากใช่ ความถี่ในการประสบปัญหาคือ

☐ น้อยกว่าเดือนละครั้ง ☐ 1-2 ครั้ง/เดือน ☐ 1-2 ครั้ง/สัปดาห์

☐ 3-4 ครั้ง/สัปดาห์ ☐ ทุกวันหรือเกือบทุกวัน

4.2 ความรุนแรงของผลกระทบคือ

☐	☐	☐	☐	☐	☐
ไม่มีผล	เล็กน้อยมาก	เล็กน้อย	ปานกลาง	รุนแรง	รุนแรงมาก

5. ในระยะ 6 เดือนที่ผ่านมา คุณประสบปัญหาใน<u>การรักษาอารมณ์ให้เป็นปกติ</u> (เช่น หุงหงิด
ง่าย) อันเนื่องมาจากรากเทียมฟันหน้าของท่านหรือไม่

☐ ใช่   ☐ ไม่ใช่ (หากไม่ใช่ ข้ามไปขอถัดไป)

5.1 หากใช่ ความถี่ในการประสบปัญหาคือ

☐ น้อยกว่าเดือนละครั้ง   ☐ 1-2 ครั้ง/เดือน   ☐ 1-2 ครั้ง/สัปดาห์

☐ 3-4 ครั้ง/สัปดาห์   ☐ ทุกวันหรือเกือบทุกวัน

5.2 ความรุนแรงของผลกระทบคือ

☐   ☐   ☐   ☐   ☐   ☐

ไม่มีผล   เล็กน้อยมาก   เล็กน้อย   ปานกลาง   รุนแรง   รุนแรงมาก

6. ในระยะ 6 เดือนที่ผ่านมา คุณประสบปัญหาใน<u>การยิ้ม หัวเราะให้เห็นฟันได้โดยไม่อาย</u> อัน
เนื่องมาจากรากเทียมฟันหน้าของท่านหรือไม่

☐ ใช่   ☐ ไม่ใช่ (หากไม่ใช่ ข้ามไปขอถัดไป)

6.1 หากใช่ ความถี่ในการประสบปัญหาคือ

☐ น้อยกว่าเดือนละครั้ง   ☐ 1-2 ครั้ง/เดือน   ☐ 1-2 ครั้ง/สัปดาห์

☐ 3-4 ครั้ง/สัปดาห์   ☐ ทุกวันหรือเกือบทุกวัน

6.2 ความรุนแรงของผลกระทบคือ

☐   ☐   ☐   ☐   ☐   ☐

ไม่มีผล   เล็กน้อยมาก   เล็กน้อย   ปานกลาง   รุนแรง   รุนแรงมาก

7. ในระยะ 6 เดือนที่ผ่านมา คุณประสบปัญหาใน<u>การทำงานหลักหรือการประกอบอาชีพ</u> อัน
เนื่องมาจากรากเทียมฟันหน้าของท่านหรือไม่

☐ ใช่   ☐ ไม่ใช่ (หากไม่ใช่ ข้ามไปขอถัดไป)

7.1 หากใช่ ความถี่ในการประสบปัญหาคือ

☐ น้อยกว่าเดือนละครั้ง   ☐ 1-2 ครั้ง/เดือน   ☐ 1-2 ครั้ง/สัปดาห์

☐ 3-4 ครั้ง/สัปดาห์   ☐ ทุกวันหรือเกือบทุกวัน

7.2 ความรุนแรงของผลกระทบคือ

☐ ☐ ☐ ☐ ☐ ☐
ไม่มีผล เล็กน้อยมาก เล็กน้อย ปานกลาง รุนแรง รุนแรงมาก

8. ในระยะ 6 เดือนที่ผ่านมา คุณประสบปัญหาใน<u>การออกไปพบปะผู้คน</u> อันเนื่องมาจากราก
เทียมฟันหน้าของท่านหรือไม่

☐ ใช่   ☐ ไม่ใช่ (หากไม่ใช่ ข้ามไปขอถัดไป)

1.1 หากใช่ ความถี่ในการประสบปัญหาคือ

☐ น้อยกว่าเดือนละครั้ง   ☐ 1-2 ครั้ง/เดือน   ☐ 1-2 ครั้ง/สัปดาห์
☐ 3-4 ครั้ง/สัปดาห์   ☐ ทุกวันหรือเกือบทุกวัน

1.2 ความรุนแรงของผลกระทบคือ

☐ ☐ ☐ ☐ ☐ ☐
ไม่มีผล เล็กน้อยมาก เล็กน้อย ปานกลาง รุนแรง รุนแรงมาก

....

ส่วนที่ 3 ข้อมูลการรักษา กรอกโดยทันตแพทย์

รหัส ....

ซี่ฟันที่ทำการรักษา ....

วันที่ทำการใส่ฟันตัวจริง ....   วันที่ทำการบันทึกข้อมูล ....

VITA

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INSTITUTIONS ATTENDED

-      2013-2013   Preceptorship   Program   in   Advanced
Implantology   from   University   of   California,   Los   Angeles   School   of   Dentistry,
California, USA

-      2011-2011   Mini   Master   of   Business   Administration
Program from Kasetsart University, Bangkok, Thailand