การเปรียบเทียบระหว่างวิธีการตรวจพินิจแบบจิตวิสัยกับวิธีการตรวจพินิจแบบวัตถุวิสัย ต่อความสามารถในการบดเคี้ยวของผู้ป่วยที่ใส่ฟันเทียมทั้งปากล่างคร่อมรากฟันเทียม

นางสาวนีรัช กุลอ่อน

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COMPARISON BETWEEN THE SUBJECTIVE AND OBJECTIVE ASSESSMENTS OF CHEWING ABILITY IN MANDIBULAR IMPLANT-RETAINED OVERDENTURE PATIENTS

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A Thesis Submitted in Partial Fulfillment of the Requirements

for the Degree of Master of Science Program in Prosthodontics

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นีรัช กุลอ่อน: การเปรียบเทียบระหว่างวิธีการตรวจพินิจแบบจิตวิสัยกับวิธีการตรวจพินิจแบบวัตถุวิสัยต่อความสามารถในการบดเคี้ยวของผู้ป่วยที่ใส่ฟันเทียมทั้งปากล่างคร่อมรากฟันเทียม (COMPARISON BETWEEN THE SUBJECTIVE AND OBJECTIVE ASSESSMENTS OF CHEWING ABILITY IN MANDIBULAR IMPLANT-RETAINED OVERDENTURE PATIENTS) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ.ทญ.ดร. อรพินท์ แก้วปลั่ง, 78 หน้า.

การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาความสัมพันธ์ระหว่างวิธีการตรวจพินิจแบบจิตวิสัยกับวิธีการตรวจพินิจแบบวัตถุวิสัยต่อความสามารถในการบดเคี้ยวของผู้ป่วยที่ใส่ฟันเทียมทั้งปากล่างคร่อมรากฟันเทียม โดยผู้เข้าร่วมวิจัยจำนวน 38 ราย (อายุเฉลี่ย 69.2±8.3 ปี) จะได้รับการประเมินการทำหน้าที่การบดเคี้ยวจำนวน 3 ครั้ง ได้แก่ ภายหลังการฝังรากฟันเทียม 1 เดือน ภายหลังใส่ฟันเทียมทั้งปากล่างคร่อมรากฟันเทียม 1 เดือน และภายหลังใส่ฟันเทียมทั้งปากล่างคร่อมรากฟันเทียม 3 เดือน โดยการประเมินความสามารถในการบดเคี้ยวด้วยวิธีการตรวจพินิจแบบจิตวิสัยจะใช้แบบสอบถามที่พัฒนาขึ้น ซึ่งประกอบด้วยรายการอาหารจำนวน 14 ชนิด ส่วนการประเมินความสามารถในการบดเคี้ยวด้วยวิธีการตรวจพินิจแบบวัตถุวิสัยจะใช้วิธีการวิเคราะห์ชิ้นขี้ผึ้ง ผลศึกษาพบว่า ที่ระยะเวลา 3 เดือนภายหลังจากผู้เข้าร่วมวิจัยได้รับการใส่ฟันเทียมทั้งปากล่างคร่อมรากฟันเทียม ผลลัพธ์ที่ได้จากการประเมินความสามารถในการบดเคี้ยวด้วยวิธีการตรวจพินิจแบบจิตวิสัยมีความสัมพันธ์ในทิศทางเดียวกันกับผลลัพธ์ที่ได้จากการประเมินความสามารถในการบดเคี้ยวด้วยวิธีการตรวจพินิจแบบวัตถุวิสัย

ภาควิชา ..ทันตกรรมประดิษฐ์.....ลายมือชื่อนิสิต.....
สาขาวิชา..ทันตกรรมประดิษฐ์.....ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก.....
ปีการศึกษา .....2555……

5376118732 : MAJOR PROSTHODONTICS

KEYWORDS : CHEWING ABILITY / IMPLANT-RETAINED OVERDENTURE / SUBJECTIVE ASSESSMENT / OBJECTIVE ASSESSMENT

NEERUSH KUNON: COMPARISON BETWEEN THE SUBJECTIVE AND OBJECTIVE ASSESSMENTS OF CHEWING ABILITY IN MANDIBULAR IMPLANT-RETAINED OVERDENTURE PATIENTS. ADVISOR: ASST. PROF. ORAPIN KAEWPLUNG, Ph.D., 78 pp.

This study aimed to investigate the relationship between the subjective and objective assessments of chewing ability in mandibular implant-retained overdenture patients. Thirty-eight participants (mean ages: 69.2±8.3 years) were evaluated their chewing function 3 times: 1 month after implant placement, 1 month after the insertion of a mandibular implant-retained overdenture and 3 months after the insertion of a mandibular implant-retained overdenture. Subjective chewing ability was evaluated using a developed questionnaire consisting of 14 common food types. Objective chewing ability was assessed by a wax cube analysis method. The results showed that, at 3 months after the insertion of mandibular implant-retained overdenture, the outcome of the subjective assessment of chewing ability positively relate to the outcome of the objective assessment of chewing ability.

Department : Prosthodontics Student's Signature .....
Field of Study : Prosthodontics Advisor's Signature .....
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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
cm.	centimeter
N	newton
OHRQoL	Oral health related quality of life
mm.	millimeter
S.D.	standard deviation

CHAPTER I

INTRODUCTION

Background and rationale

Extensive tooth loss commonly occurs with advancing age. (Locker., 2002) This process tends to result in reduced chewing function. Kapur and Soman (2006) concluded that the masticatory efficiency of a patient wearing a complete denture is less than one-sixth that of a dentate subject. Totally edentulous are typically treated with conventional complete dentures. However, more than 50% of those receiving a mandibular conventional complete denture have problems with denture stability and retention. (Redford, Drury, and Kingman., 1996) This results in a range of problems including difficulty of eating, particularly hard or tough food. Consequently, patients compensate for this by selecting softer food. This often contributes to a low fiber diet containing high amounts of carbohydrates and fats and can lead to malnutrition. (Sheiham et al., 2001) In 2002, the McGill Consensus Statement on Overdentures suggested that a 2-implant retained mandibular overdenture should be the treatment of choice for an edentulous mandible. (Feine et al., 2002) This treatment option offers better stability and retention of the mandibular denture, better chewing function (van der Bilt et al., 2010) and improved quality of life of the patients. (Harris et al., 2013)

Assessment of chewing ability can be classified into two broad categories. The first category, chewing ability is examined objectively. Various chewing tests have been developed in this regard. (Kapur, Soman, and Yurkstas., 1964; Matsui et al., 1996)

In 2003, Sato et al. developed a paraffin wax cube as a test food to evaluate chewing ability on the basis of the degree of color mixing and the shape of the chewed wax. (Sato et al., 2003a; Sato et al., 2003b) In 2010, a wax cube analysis method was developed for use in Thailand. (Prapatrungsri, Petsom, and Kaewplung., 2010) This system can be an option for the assessment of chewing ability of complete denture wearer. (Liangbunyapan, Petsom, and Kaewplung., 2012) The second category, chewing ability can be subjectively evaluated using either a questionnaire or interviewing patients. Although objective methods are reliable and valid, there are some impediments to their clinical use, including complicated procedures and higher cost. A questionnaire may be considered as a useful screening method for clinically assessing chewing function with considerable cost and time saving compared to objective methods. (Feine and Lund., 2006) Importantly, the subjective analysis of chewing function can generate a broader and more in depth understanding of patients' treatment experiences. (Demers et al., 1996)

Several food lists have been proposed for evaluate subjective chewing ability. However, they were impracticable for use in Thai older adults because of the difference

in culture and ethnicity. Then, for geriatric population, the food intake questionnaire should be developed for use in Thailand.

Objective

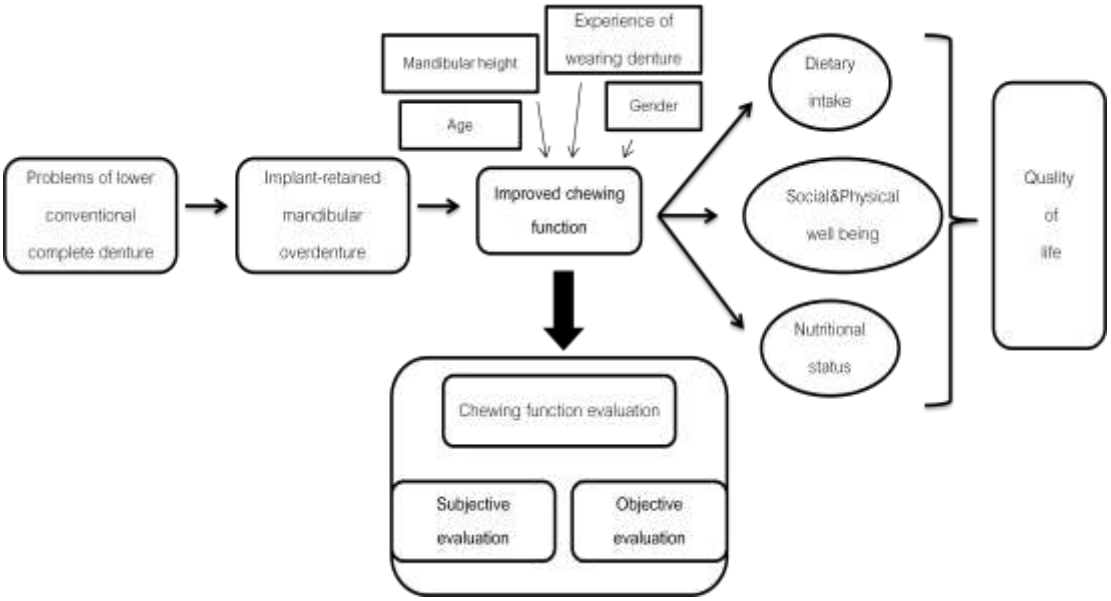
The objective of this study is to determine the relationship between subjectively evaluating chewing ability using a developed questionnaire and objectively determining chewing ability using a two-colored wax cube.

Hypothesis

Null hypothesis: There is no relationship between subjectively evaluating chewing ability using a developed questionnaire and objectively determining chewing ability using a two-colored wax cube.

Alternative hypothesis: There is relationship between subjectively evaluating chewing ability using a developed questionnaire and objectively determining chewing ability using a two-colored wax cube.

Conceptual framework



Definitions

Subjective chewing ability is defined as the subject's own assessment of his or her chewing function.

Objective chewing ability is defined as an assessment of chewing ability determining by an objective test.

Expected outcomes

1. The developed questionnaire can be used for assessing the subjective chewing ability of elderly Thais using mandibular implant-retained overdentures.
2. The results may be the basis for further study.

Research design

Clinical research

CHAPTER II

LITERATURE REVIEW

1. Effect of tooth loss

Natural teeth give a person the ability to chew a wide variety of foods with different hardness's and textures. Studies have demonstrated that chewing ability is affected by oral health, tooth position (Ikebe et al., 2007), and the number of teeth in the mouth. (Agerberg and Carlsson., 1981) In spite of the progress in oral health promotion and restorative techniques, tooth loss accelerates with increasing age. (Locker, 2002) People without teeth, or with dentures, tend to chew less effectively than people with healthy natural teeth. The chewing efficiency of those wearing complete dentures is less than one-sixth that of dentate subjects. (Kapur and Soman., 2006) This reduced masticatory function results in a significant alteration of dietary habits. (Wayler and Chauncey., 1983)

Several factors are thought to be responsible for the limited masticatory function of denture wearers. These include limitations in the ability to exert and control bite forces, pain from the mucoperiosteum of the denture-bearing areas, and functional problems from denture instability. (Wilding., 1993) As a result, complete denture wearers experience more difficulty in chewing hard or tough foods such as fruits, vegetables, and meat that are major sources of vitamins, minerals, and protein. (Millwood and

Heath, 2000) Furthermore, they have to modify their food choices by increasing their consumption of soft, easy-to-chew, and more processed foods that tend to have a low content of many essential nutrients and have a high content of sugar, fat, and cholesterol. (Hutton, Feine, and Morais., 2002) A study indicated that complete denture wearers consume significantly lower levels of vitamin A and C than dentate individuals. (Greksa, Parraga and Clark., 1995) These changes in dietary habits can result in a decrease in dietary sufficiency that can adversely affect a person's overall nutritional status. (Sheiham et al., 2001) Due to this, denture wearers may be at a greater risk for a number of chronic diseases. A study revealed that elderly edentulous subjects with insufficient masticatory function and reduced consumption of fiber-rich foods could develop gastrointestinal disorders. (Brodeur et al., 1993)

One of the major benefits of prosthodontic treatment for older adults is to improve masticatory function because this allows them to eat a healthy diet and have a higher nutritional status. (John et al., 2004) Furthermore, improving their chewing ability is the most frequent patient-expressed reason for seeking dental treatment. (Youdying, Somkotra and Kaewplung., 2012)

2. Implant-supported prosthesis

The chewing ability of a denture wearer is affected by many factors including the shape and height of the residual alveolar ridge, denture quality, and the subjective experience of wearing a denture. (Slagter et al., 1992) Edentulous patients typically are treated with conventional complete dentures that rely upon the residual alveolar ridge and alveolar mucosa for support and retention. This treatment option is considered a safe, predictable, and cost-effective treatment to restore an edentulous ridge. However, physical retention of this prosthesis is limited in patients with significant bone resorption. The irreversible continuous resorption of the alveolar bone following tooth loss gradually leads to a reduced denture bearing area. (Allen and McMillan, 2003) The long term result is the extensive loss of the bony alveolar ridge, causing an increased interarch distance, increased influence of the surrounding soft tissue, decreased stability and retention of the prosthesis, and increased discomfort from improper prosthesis adaptation. Alveolar bone resorption tends to affect the mandible more than the maxilla. The mean reduction in the lower ridge during long term follow-up periods was approximately 4 times greater than that of the upper arch. (Tallgren, 1972) These anatomic changes, and their consequences, lead the majority of edentulous people to complain about impaired function of their lower dentures. (Redford et al., 1996)

Since the 1980s, the use of dental implants as a supporting, stabilizing, and retentive mechanism for implant-supported prostheses has become more common. This treatment modality can overcome some of the functional limitations of a conventional complete denture. The use of a dental implant in combination with a prosthesis offers an edentulous patient a better retained and more stable prosthesis, resulting in improved oral function. Maximum bite force and masticatory efficiency are greatly improved when complete denture wearers have dental implants placed to support their existing dentures. (van der Bilt et al., 2010) Edentulous patients reported high levels of satisfaction regarding various aspects of their denture function after receiving implant overdenture treatment. (Ellis et al., 2009) Moreover, an implant overdenture provided a significant improvement in dietary intake, nutritional status, and oral health-related quality of life. (Suriyan et al., 2011) Importantly, the presence of functioning implants also prevents clinically significant progressive bone loss. (von Wovern et al., 1990)

For the edentulous patient with denture problems, treatment with dental implants consists of the placement of implants to support either a fixed prosthesis or an overdenture. An overdenture is defined as any removable dental prosthesis that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants. (The Glossary of Prosthodontic Terms., 2005: 58) It has been suggested that restoring chewing function using an implant-supported fixed prosthesis

is better than an implant-retained overdenture in terms of patients' comfort and adaptation. However, anatomical limitations may preclude the use of an implant-supported fixed prosthesis. For a patient with severe residual ridge resorption, an implant-retained overdenture can provide a better esthetic result and cause less phonetic problems compared to an implant-supported fixed prosthesis. (Fitzpatrick., 2006) In addition, the difference in the cost between these two treatment modalities can also be an issue. Zitzmann and Marinello. (2000) stated that a fixed prosthesis supported by implants is expensive and will not be financially feasible for many patients.

There are a wide variety of implant-supported prosthodontic rehabilitation options for an edentulous mandible. However, the use of 2 interforamenal implants with an implant-retained overdenture is recommended as the standard treatment for achieving good long-term results. In 2002, The McGill consensus statement suggested that a mandibular two-implant overdenture should be the first choice of treatment for an edentulous mandible. (Feine et al., 2002)

When designing an implant-retained overdenture, several attachment designs can be used to connect the prosthesis to the implants. Commonly used attachment types include splinted attachments such as a bar with different designs, and single attachments such as a magnet or ball. No significant difference in patient satisfaction with implant-retained overdentures was found between splinted or single attachments.

(Naert et al., 1994) In contrast, difference has been described in the ability to perform prosthetic maintenance during the follow up period based on attachment type.

(van Kampen et al., 2004) Because of their superior accessibility, single attachments may be suitable for patients experiencing problems with oral hygiene maintenance. (Batenburg et al., 1998) In addition, the anatomic structure of the mandible should be considered during selection of the appropriate attachment. With limited anatomy of the mandible, or excessively distal implant placement, the tongue space may be restricted when using splinted bar configurations. Furthermore, using a bar attachment requires the dentist and technician to construct a new prosthesis, while a single attachment system can use an existing denture. This leads to a lower cost for single attachment treatment. (Spiekermann, Jansen, and Richter., 1995; Naert et al., 1999) Therefore, a single attachment is recommended for use in the dentures of elderly patients, because it is often more convenient in terms of construction and maintenance.

When investigating single attachment use, Stellingma et al. (2005) found no differences in masticatory function between ball and magnet attachment types in implant-retained overdenture wearers. Nevertheless, the use of magnetic attachments resulted in a number of problems including corrosion, wear, and demagnetization. Another study found that, in terms of general satisfaction, individuals preferred ball attachments to magnetic attachments. (Ellis et al., 2009)

3. Chewing function evaluation

It is generally recognized that tooth loss can lead to functional impairment, including difficulty in eating. This can lead to decreased of food intake and a diet that is low in nutrition. (Greksa et al., 1995) The replacement of missing teeth by prosthetic treatment is performed to restore masticatory function. Improved masticatory function can maintain the healthy status of patients by allowing them to eat a variety of foods. This contributes to an improved quality of life. Because chewing ability is an important dimension of oral health-related quality of life; chewing function assessment is an important indicator of the success of dental treatment and improved quality of life.

Chewing function measurement approaches can be divided into two broad categories: laboratory-based measures and patient-based measures. Most researchers have used the terms “objective assessment” and “subjective assessment” when referring to data gathered through lab tests and those gathered from patients’ verbal reports, respectively

.

Objective assessment

Quantitative masticatory tests allow an assessment of masticatory function by objective means. Several objective methods have been proposed in this regard. Masticatory force measurement measures functional forces when a patient is biting or chewing. (Helkimo et al., 1977) Electromyography records the activity of masticatory muscles during chewing and maximum biting. (Heqberg., 1987)

Other objective methods have been reported to evaluate masticatory performance. Some methods measure the comminution of food during mastication by analyzing the particle size. Test foods are given to subjects to chew and the food particle size is analyzed using various laboratory techniques. The sieving method is a generally well-accepted evaluation method that was proven to have both validity and reliability. (Kapur et al., 1964) This technique determines the volume percentage of the chewed food that passes through a sieve system consisting of sieves with different sized meshes after a given number of chewing strokes. Both natural foods such as peanuts, almonds, and carrots, and synthetic materials such as Optosil and Optocal have been used as test foods. Each food type has generated disparate results because of their inherent physical properties and solubilities. (Wang and Stohler., 1990) Because of the superior reproducibility of the shape dimensions and physical properties of artificial test food particles, which have no taste or odor that might affect masticatory

activity, the use of artificial test food is preferred to natural food for the measurement of masticatory performance. (Sato et al., 2003b)

An additional method to determine masticatory performance is the evaluation of the ability to mix and knead a food bolus. Chewing gum and paraffin wax cubes with various shapes and colors have been developed as test foods to evaluate masticatory performance based on mixing ability. (Matsui et al., 1996; Sato et al., 2003b) The mixing ability test assesses masticatory performance by calculating the mixing ability index using a discriminant function, by which the degree of color mixing and the shape of the chewed test food are integrated into a one-dimensional value. The degree of mixing of the different colors can be determined using a computer-assisted method or by visual inspection. However, visual assessment appears to be less reliable than digital image processing. (van der Bilt et al., 2012) Compared to the sieving method, the mixing ability test using either chewing gum or paraffin wax has the advantage that it forms a bolus; then the manipulation of the food is relatively easy. Furthermore, image analysis of these artificial test materials offers considerable advantages such as simplicity, speed, accuracy, reproducibility, and hygiene.

In Thailand, a two-colored wax cube has been created to determine an individual's food mixing ability. (Prapatrungsri et al., 2010) This method can be utilized clinically to evaluate masticatory performance after dental treatment both in patients with

normal dentition and removable dental prostheses. (Liangbunyaphan, Chaiteerapapkul and Kaewplung., 2011) In 2012, this paraffin wax cube system was modified to have different levels of hardness to evaluate the masticatory function of totally edentulous patients. It was concluded that the original and soft wax cubes were suitable for use by totally edentulous patients, because the hardness score of those cubes were in the range of foods commonly eaten by the study's population. (Liangbunyaphan et al., 2012)

In summary, a wide variety of objective methods exist for evaluating the masticatory performance of elderly denture wearers. Several studies have claimed that objective measures are superior to subjective measures in several aspects, such as comparable and quantitative data and no emotional effect from the subject. (Slagter et al., 1992) However, these objective masticatory tests are time consuming and require special equipment and specialized personnel, which makes them expensive and impracticable in investigations utilizing a large population.

Subjective assessment

Many studies use objective methods to evaluate masticatory function. However, the subjective assessment of chewing ability as determined by patients themselves also can be of value. Although the objective tests can offer quantitative data, they fail to consider the psychosocial aspect of patients' oral function. Giddon and Hittelman (1980) stated that the psychological assessment of a patient is essential because treatment success depends on the patients' expectations and opinions. In addition, Miura et al. (2000) found a close relationship between subjective chewing ability and perceived quality of life. This suggests that the assessment of treatment success should be based on the patients' own rating of treatment outcome.

Indicators of health status and quality of life are generally referred to as patient based measures because they are derived from the patient's perceptions of their emotional and behavioral responses to the intervention. The subjective assessment of chewing ability is necessary because it is an effective way to gain a greater understanding of how patients' perceive masticatory function. Hsu et al. (2012) claimed that self-assessed masticatory ability is crucial in determining how dental treatment improved masticatory function. Furthermore, this method is more suitable for an epidemiological study with a large sample size than the objective chewing tests. (Hirai et al., 1994)

An individual's masticatory ability can be assessed subjectively by personal interviews or using a questionnaire related to the psychosocial consequences of limitations in chewing ability and self-satisfaction with chewing ability.

Using subjective methods, chewing ability can be measured through self assessment of chewing complaints by answering simple questions such as "How well you can chew your food?" (Agerberg and Catlsson, 1981) and "Do you consider yourself as having a good masticatory capacity?" (Drake, Beck, and Strauss., 1990) Despite being easy to answer, these are crude measures of chewing ability and do not provide detailed information on which foods people have difficulty eating or can eat with ease. (Zeng, Sheiham, and Tsakos., 2008)

In 1990, Leake created a scale with five food items that ranged from the most difficult to chew to the least difficult to chew, as an indicator of an individual's perception of their chewing ability. In this study, the subjects related their chewing difficulty with foods of various textures and hardness. The author claimed that the evaluation of chewing activity using a questionnaire on food intake is simple and accurate. (Leake., 1990) Hirai et al. (1994) also suggested that a masticatory ability index established by using a food intake questionnaire has higher validity and provides more consistent results than does masticatory ability evaluated using precision tools. Questionnaires concerning food intake have been valuable in epidemiological surveys of masticatory

function. However, there are large differences in the preference of foods between different countries and ethnic backgrounds. Therefore, several food lists have been developed for use in the target population in each country. Yamamoto's chewing ability test using typical Japanese foods has been widely used in Japan to evaluate chewing function. (Miura et al., 2000) Hsu et al. (2012) proposed a 14 food group questionnaire for evaluate masticatory ability of Taiwanese older adults.

Because subjective chewing ability assessment reflects the subject's self-perceived ability to chew different foods, it may be more closely related to the subject's overall satisfaction with their daily life, social interactions, and other quality of life measures. Oral health related quality of life (OHRQoL) is defined as a multi dimensional construct that reflects a patient's comfort with eating, sleeping, and engaging in social interaction; their self esteem; and their satisfaction with respect to their oral health (Lawrence and Leake, 2001) Several OHRQoL indices have been developed to measure the impact of oral health on a patient's life such as the Oral Health Impact Profile (Slade and Spencer, 1994) and the Oral Impacts on Daily Performance (Adulyanon and Sheiham., 1997)

The elderly are particularly likely to suffer from dietary inadequacy due to a number of reasons including a deficient dental or prosthodontic status. (Greksa et al., 1995) In order to develop an optimal prosthetic treatment plan and assessment of the

prognosis for an elderly patient, it should be taken into consideration whether they are candidates for malnutrition. Nutritional status can be assessed in several ways. Dietary assessment is performed by asking participants about their food consumption. The obtained information is then converted to nutritional intake data. Anthropometric measurement of height and weight such as body mass index is an assessment of body composition to identify obesity and to detect individuals who are significantly underweight. Biochemical and hematological indices are important for evaluating a patients' nutritional status and the functional impact of nutritional deficiency. The Mini Nutritional Assessment is a questionnaire developed to identify geriatric patients with nutritional problems. This method can easily be performed by health care professionals, including dentists, along with an evaluation of oral health for early detection of the risk of malnutrition and masticatory deficiencies.

CHAPTER III

METHODOLOGY

1. Patient population

The Ethics Committee of the Prasat Neurological Institute, Bangkok, Thailand approved the protocol of this study. Written informed consent was obtained from each patient after a full explanation of the clinical trial. The subjects in this study were patients with edentulous mandibles. These individuals had participated in the "Royal Dental Implant Project" at Prasat Neurological Institute, Bangkok, Thailand from May 2011 to September 2011, and had received lower conventional complete dentures.

All subjects were recruited into this project using the following inclusion criteria:

<u>General Inclusion criteria</u>

- Ability to understand written and spoken Thai language and respond to the point range used in the questionnaire.
- No previous or current radiotherapy or chemotherapy in the head and neck region.
- No smoking or smoking of < 1 pack of cigarettes per day.
- No physical condition contraindicating implant surgery.
- No treatment with any of the bisphosphonate drugs.

- No psychological or psychiatric conditions that could influence treatment or the study.

Dental Inclusion criteria

- Individuals with conventional upper and lower dentures of acceptable quality, but experiencing functional problems with their lower complete denture.
- Upper prosthesis could be a conventional complete denture, acrylic removable partial denture, or metal removable partial denture.
- Sufficient bone to install implants in the appropriate areas of the mandible.
- At least 6 mm. keratinized mucosa in the implant placement area.

Subjects who did not completely fulfill the above criteria were not recruited into the study.

2. Surgical and prosthetic procedures

Prior to surgery, all subjects had the bone at the implant placement sites evaluated using panoramic radiography. Using the panograph, their minimum vertical mandibular height was measured and recorded. (McGarry et al., 1999) All surgical procedures were performed by a dentist from the Dental Department of the Prasat Neurological Institute. The surgeries were done according to a standardized two-stage

implant placement protocol as previously described. (Lapsukkitkul, and Sessirisombat., 2012) In the first stage, a dental implant fixture, designed and produced in Thailand ("Fun-Yim", Advanced Dental Technology Center, Thailand; diameter 3.7 mm; length 10 or 13 mm), was placed in each of the lower canine regions of each patient. The appropriate implant fixture diameter and length were determined from the panoramic radiograph. Fifty-eight implant fixtures 10 mm. in length were used in twenty-nine subjects and thirty fixtures 13 mm. long were selected for fifteen participants. Four months later, at the second stage, healing abutments (diameter 5 mm; length 3 or 5 mm) were placed. Three weeks after the second stage surgery, the healing abutments were replaced with ball attachments, which were tightened with a torque wrench to 20 N/cm. Using an intra-oral technique, the patient's preexisting lower complete denture was modified to contain O-ring attachments, which fit with the ball attachments. The occlusion of the prosthesis was thoroughly verified in both centric and eccentric position. The treatment was completed as a mandibular implant-retained overdenture. The prostheses were evaluated after 1 day, 1 week, 1 month, and 3 months. All abutment placement surgery and prosthodontic procedures were performed according to the manufacturer's instructions by one experienced prosthodontist. A schematic of the methodology of our study can be seen in Figure1.

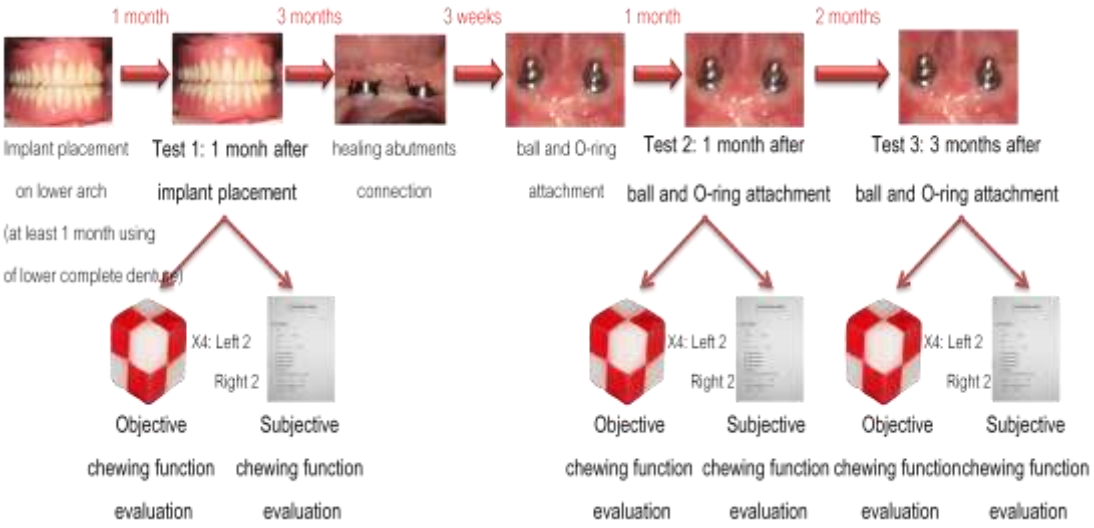


Figure 1 Schematic of the methodology.

3. Chewing function evaluation

Each subject's chewing function was evaluated 3 times: 1 month after implant placement while wearing their conventional lower complete denture (Test 1), 1 month and 3 months after the insertion of their ball and O-ring attached overdentures (Test 2 and Test 3). The 2 methods used are shown in Figure 1; the wax cube analysis method to objectively evaluate chewing ability and interviewing with a self-reported questionnaire to assess subjective chewing ability.

3.1 Objective assessment using a two-colored (red and white) wax cube

The present study objectively measured masticatory performance using the wax cube analysis method as described in a previous study. (Prapatrungsri et al., 2010) Subjects were given chewing tests one month after implant placement while wearing

their conventional dentures and 1 month and 3 months after overdenture insertion. At each test, the subjects were asked to chew a wax cube using ten habitual strokes (4 pieces per person). Thus, twelve pieces of chewed wax per subject were obtained for analysis. Images of both sides of the chewed wax were captured using a digital camera (Canon EOS 500D, Canon Inc., Tokyo, Japan) with a macro lens (Canon macro 100 mm.) under standardized distances and light conditions (a photo stand kit; Copy stand CS920 and Copy light CL-150 with 2 light bulbs; Phillips® Cool Daylight 125 Watts, Color temperature 6,500 K and a lux meter; DigiconLX-70, Protonics Inter-trade Co,Ltd., Thailand). Thus, 8 digital images per subject were obtained from each evaluation time. All images were analyzed using the Image J program (Version 1.42Q, NIH, MD, USA). The average value of the degree of mixing of the white and red wax was calculated after each test to determine the average “percentage of chewing ability” of each subject. The procedure of the wax cube analysis method is seen in Figure 2.

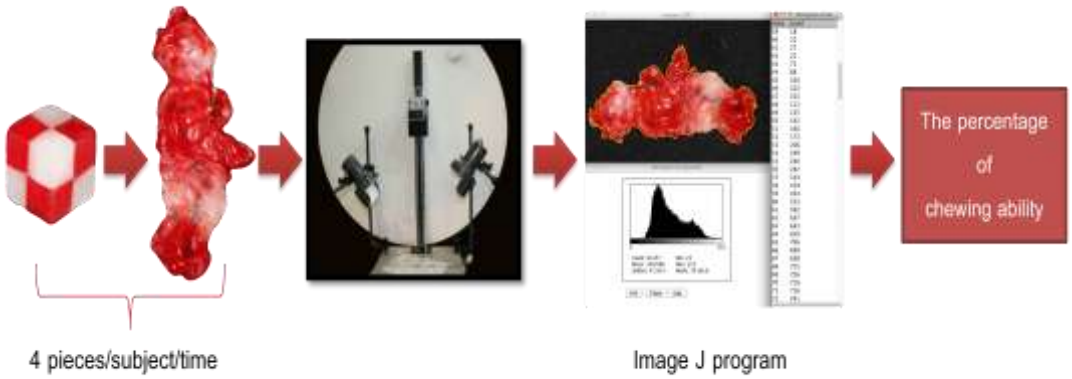


Figure 2 Chewed wax cube analysis method.

3.2 Subjective assessment using the self-reported questionnaire

After the objective chewing test, the patients were interviewed to evaluate their subjective chewing ability using a self-reported questionnaire consisting of 3 parts.

Part I: Demographic data (age and sex) and variables that might affect masticatory capacity (type of upper prosthesis and denture wearing experience).

Part II: Two open-ended questions asking about the foods that individuals were able or unable to chew.

Part III: A food intake questionnaire consisting of 14 food items developed from the pilot investigation. We first gathered information on the daily diets of older people by interviewing 25 elderly Thais (12 males and 13 females, mean age 72.4±7.9 years) who received dental care at the Postgraduate prosthodontic clinic, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand about their daily food intake for breakfast, lunch, and dinner both in and out of the home for 7 days. Based on this data, we selected the 14 most frequently consumed food items for use in the questionnaire. Next, the forty-seven lower edentulous subjects who attended the follow up visit at 1 month after implant placement (16 males and 31 females, mean age 68.4±8.4 years) were asked to rate the hardness of these 14 foods using a 100 mm. visual analogue scale. Each scale used a 100 mm. line to represent a continuum with the softest on the left end

of the line (0) and the hardest on the right end (10), with a vertical line at every 1 mm. as shown in Figure 3. The hardness score of each food item could range from 0 to 100.

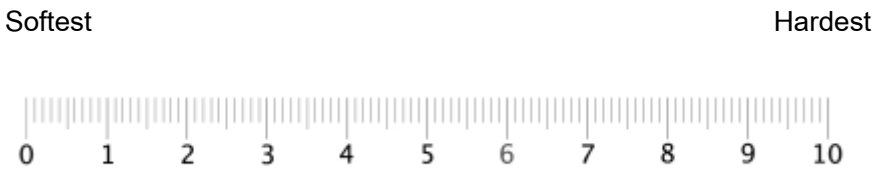


Figure 3 The 100 mm. visual analogue scale used to evaluate a participants perception of a food's hardness.

A food ranking based on the average score was derived. The results indicated that there were various textures and hardness of the foods listed on the questionnaire. The average hardness score of each food type is seen in Table 1.

Table 1 Mean and standard deviation of the hardness score of each food type.

The 14 most common food items	Hardness score ascending from minimum to maximum (mean ± s.d.)
Porridge	3.9 ± 5.6
Chinese Vegetable Stew	10.0 ± 10.5
Steamed Fish	11.8 ± 11.7
Omelet	18.3 ± 14.7
Banana	19.5 ± 15.4
Chinese Cabbage Soup	20.8 ± 20.9
Orange	22.2 ± 14.6
Steamed Rice	22.7 ± 16.3
Noodle Soup	26.6 ± 20.3
Fried fish	34.1 ± 16.6
Sour Curry	37.3 ± 22.3
Fried pork	74.1 ± 20.5
Stir-fried Vegetables	75.2 ± 23.0
Fresh Guava	84.3 ± 19.8

From this information we developed a food intake questionnaire comprising the 14 most frequently consumed food items with their various textures and hardness's: Porridge, Chinese Vegetable Stew, Chinese Cabbage Soup, Steamed Rice, Noodle Soup, Omelet, Steamed Fish, Sour Curry, Banana, Fried fish, Orange, Fresh Guava, Fried pork and Stir-fried Vegetables. The subjects were asked to rate their chewing ability for each food type. Each food was to be rated using a four-point rating scale

ranging from could not chew at all (0 points) to could chew well (3 points). The four-point rating scale of each food item was on a separate page to prevent subjects from comparing the scores between food items as shown in Figure 4.

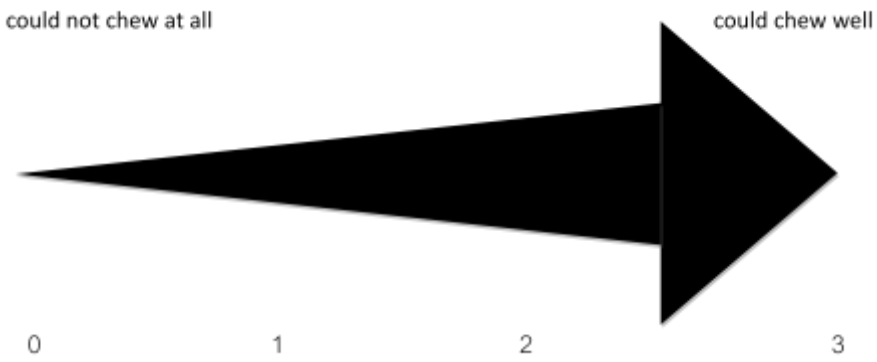


Figure 4 The four-point rating scale for each food choice.

The total score of these 14 foods, ranging from 0–42, was calculated as the "perceived chewing ability score" of each subject. Higher scores indicated better chewing ability.

The test-retest reliability of this questionnaire was investigated by having a subset of subjects (N=30) complete the questionnaire a second time, 1 week after the initial evaluation 1 month following implant placement. All procedures for the interviews were performed by one examiner.

4. Statistical analysis

The normality of the data distribution was tested using a one sample Kolmogorov-Smirnov test. The test-retest reliability was assessed on the basis of the Kappa Statistic. Repeated measures ANOVA was used to compare the values of the percentage of chewing ability and perceived chewing ability score of the three tests. An independent t-test or Mann-Whitney U test was used to identify the effect of sex on the percentage of chewing ability, perceived chewing ability score percentage change of the percentage of chewing ability, and percentage change of the perceived chewing ability score depending on data distribution. One-way repeated measures analysis of variance (ANOVA) or Kruskal-Wallis test was used to determine the influence of age, denture wearing experience, and minimum vertical mandibular height on all measurement outcomes depending on data distribution and homogeneity of variance. Pearson's correlation analysis was carried out to evaluate the relationship between subjective and objective chewing ability.

The statistical analyses described above were carried out using the Statistics Package for the Social Sciences (SPSS) version 17.0 (SPSS [Thailand] Co., Ltd., Bangkok, Thailand). In all statistical analyses, a *p*-value less than .05 was considered significant.

CHAPTER IV

RESULTS

1. Subject characteristics

Forty-four participants were initially recruited into this project. Six subjects dropped out at the one month follow-up visit. Then, thirty-eight subjects remained in this study. The 38 subjects consisted of 13 males and 25 females with a mean age of 69.2 ± 8.3 years. They had worn their dentures for 1–48 months prior to participating in this project. Thirty-three subjects had worn conventional complete dentures on their upper arch, while five individuals had worn removable partial dentures. After the implant placement stage, the lower conventional complete dentures of 6 participants were relined with heat-cured acrylic resin so they would better adapt to the changes that had occurred to the alveolar bone. One of 10 mm. length implant fixtures failed to integrate with the alveolar bone during the 4 month healing phase; however, its replacement was fully osseointegrated. Thus, this case remained in our study.

2. An effect of variables on the subjective and objective chewing ability

The descriptive statistics of the percentage of chewing ability and perceived chewing ability scores determined at one month post implant placement, 1 month and 3

months after the insertion of the overdentures grouped by age, sex, period of denture wearing, and minimum mandibular height are presented in Table 2.

Due to the differences in the measurement scales between the outcomes of the percentage of chewing ability and the perceived chewing ability score, these two values were converted into the same measurement type as the “percentage change of the percentage of chewing ability” and “percentage change of the perceived chewing ability score”. They were calculated using the following formula.

$$\text{Percentage change of the percentage of chewing ability} = \frac{(\text{Test 3 score} - \text{Test 1 score})}{100} \times 100$$

$$\text{Percentage change of the perceived chewing ability score} = \frac{(\text{Test 3 score} - \text{Test 1 score})}{42} \times 100$$

The outcome of these two measures broken down by age, sex, period of denture wearing, and minimum mandibular height can be seen in Table 2.

Statistical analysis revealed that there were no significant differences in the percentage of chewing ability, perceived chewing ability scores, percentage change of the percentage of chewing ability and percentage change of the perceived chewing ability score between the three age groups, the three periods of denture wearing, and the four ranges of minimum vertical mandibular height. We found no significant differences in all measurement outcomes between males and females.

Table 2 Mean and standard deviation of the percentage of chewing ability (PCA) and perceived chewing ability scores (PCAS) determined at Test 1, Test 2 and Test 3 as well as mean and 95% Confidence Interval for the mean of the percentage change of PCA and percentage change of PCAS shown by age, sex, period of denture wearing and minimum mandibular height. (n=38)

		Test 1		Test 2		Test 3			
		PCA	PCAS	PCA	PCAS	PCA	PCAS	Percentage change of PCA	Percentage change of PCAS
Characteristics	N (%)	(0-100)	(0-42)	(0-100)	(0-42)	(0-100)	(0-42)	Mean (95%CI)	Mean (95%CI)
Age (years)									
< 65	11 (28.9)	22.12±7.34	30.45±5.24	27.29±4.54	39.09±3.65	32.66±4.12	39.27±4.45	10.53 (5.28, 15.79)	21.00 (11.87, 30.12)
65 – 70	12 (31.6)	25.49±8.07	28.58±6.49	31.54 ±5.79	37.17±5.29	35.29±4.77	41.08±1.38	9.81 (4.52, 15.09)	29.76 (20.58, 38.94)
> 70	15 (39.5)	25.25±7.57	29.73±6.08	30.98 ±4.69	37.80±6.07	33.31±4.69	38.27±5.72	8.06 (3.98, 12.14)	20.32 (7.96, 32.68)
Sex									
Male	13 (34.2)	23.68±6.68	29.69±4.80	28.97±5.09	39.00±4.24	35.11±4.34	39.92±5.85	11.43 (7.34, 15.52)	24.36 (11.80, 36.92)
Female	25 (65.8)	24.81±8.15	29.52±6.45	30.67±5.29	37.44±5.56	33.04±4.61	39.20±3.62	8.23 (4.93, 11.54)	23.05 (16.20, 29.90)
Period of denture wearing (months)									
< 12	16 (42.1)	26.62±7.30	29.94±4.88	30.19 ±6.13	37.44±6.06	34.21±3.91	39.44±4.03	7.59 (3.08, 12.11)	22.62 (14.88, 30.36)
12-24	10 (26.3)	22.56±8.46	29.00±5.64	29.74 ±3.75	38.30±4.45	32.40±5.18	38.10±6.37	9.84 (5.14, 14.54)	21.67 (5.94, 37.39)
> 24	12 (31.6)	23.05±7.16	29.58±7.55	30.25 ±5.34	38.42±4.70	34.26±5.03	40.58±2.81	11.22 (6.46, 15.97)	26.19 (13.83, 35.55)
Minimum mandibular height (mm.)									
≥ 21	5 (13.2)	24.10±10.43	27.60±6.80	33.96 ±7.61	35.40±6.07	35.30±5.89	37.00±9.11	11.21 (0.13, 22.28)	22.38 (18.08, 62.84)
16-20	14 (36.8)	25.31±5.96	30.21±5.63	28.35 ±4.74	38.36±5.56	33.00±4.21	40.29±2.46	7.69 (3.74, 11.64)	23.98 (16.40, 31.56)
11-15	14 (36.8)	22.33±9.10	29.79±5.58	30.25 ±4.99	38.14±4.98	33.11±4.04	39.50±3.96	10.77 (5.83, 15.71)	23.13 (14.44, 31.81)
≤10	5 (13.2)	28.08±2.61	29.20±7.86	30.64 ±3.15	39.00±4.12	36.07±5.89	39.40±4.34	7.99 (0.92, 16.91)	24.29 (5.89, 54.46)

The minimum vertical mandibular bone height was measured from the panoramic radiograph. (McGarry et al., 1999)

All the above comparison of outcome measures between subcategories reveal statistic insignificance (p>.05)

3. The percentage of chewing ability and perceived chewing ability scores of the three tests.

The means and standard deviations of the percentage of chewing ability and the perceived chewing ability scores determined one month post implant placement, 1 month and 3 months after overdenture delivery are presented in Table 3.

A repeated measures ANOVA found statistically significant differences in the mean of the percentage of chewing ability between the 3 tests ($p<.001$). Post hoc tests (Bonferroni test) showed significant differences between the mean values of each test. Statistically significant difference was also found between the means of the perceived chewing ability score among the 3 tests ($p<.001$). Post hoc tests (Bonferroni test) demonstrated significant differences between the means of the scores in each test except the means of the scores between Test 2 and Test 3 as shown in Table 3.

Table 3 The percentage of chewing ability and perceived chewing ability scores obtained from the 3 tests and the percentage change (n=38).

	Test 1	Test 2	Test 3	Percentage change Mean (95% CI)
Percentage of chewing ability (mean ± s.d)	24.42±7.61	30.09±5.22	33.75±4.57	9.33 (6.81, 11.85)
Perceived chewing ability scores (mean ± s.d)	29.58±5.80	37.97±5.14	39.45±4.44	23.50 (17.62, 29.37)

"a" denotes statistical difference with $p<.001$, "b" denotes statistical difference with $p=.001$

4. Correlation between the subjective and objective assessment of chewing ability

Prior to analyzing the relationship between the outcomes of the subjective and objective assessments of chewing ability, the percentage of chewing ability and the perceived chewing ability score were converted into the same measurement type, the so-called percentage change of the percentage of chewing ability and percentage change of the perceived chewing ability score as described above.

Pearson's correlation coefficient between the percentage change of the perceived chewing ability score and the percentage change of the percentage of chewing ability indicated that these two measurements were positively related to each other. (r = .29)

CHAPTER V

DISCUSSIONS

As shown by the descriptive data, the subjects in the present study belong to the early elderly group, with a mean age of 69.1±8.1 years. The systemic diseases reported by some participants included hypertension and diabetes mellitus. Nearly all the implant fixtures successfully integrated with the alveolar bone, with only 1 fixture lost during the 4 month healing phase. This result suggests that advancing age is not a limitation for implant treatment. Any geriatric patient whose systemic illnesses are being controlled can be considered as a candidate for implant placement with favorable outcome i.e. osseointegration. Nevertheless, this result should be confirmed in a longer term study.

Patients have been shown to benefit from receiving a mandibular implant-retained overdenture in several ways, including better chewing function (van Kampen et al., 2010), greater satisfaction (Ellis et al., 2009), and increased quality of life. (Harris et al., 2013) However, financial issues are a barrier to many edentulous patients in accessing this treatment. (Müller et al., 2012) Therefore, it is important that this treatment should be included in all oral health insurance programs to subsidize patients with financial problems. The Royal Dental Implant Project provided dental implants patients at no cost to them. Although this treatment modality requires considerable maintenance

and follow up visits, the cost of these are low, and can be afforded by most people. Therefore, dentists' should be well trained in delivering this treatment to prepare for the increasing number of patients who will require it.

The chewing ability of denture wearers is multi-factorial in nature. We investigated the variables affecting chewing ability pre- and post-treatment with a mandibular implant-retained prosthesis. We found that chewing ability is not influenced by age or sex. These results confirm the clinical findings of Millwood and Health (2000). In addition, denture wearing experience did not affect subjective and objective chewing ability. This might be because the study participants were recruited according to the general and dental inclusion criteria as previously described. Consequently, their chewing functions were similar; however, their dentures had been in place for different time periods. We also determined that mandibular bone height did not have an impact on chewing ability. This finding is in contrast to a report by Slagter et al. (1992), who found a weak relationship between subjective and objective chewing ability and the degree of resorption of the mandibular residual ridge. The contradictory results may be due to the different sample sizes, different techniques of measuring mandibular bone height, and the chewing tests applied in each study.

Although the dentures of each individual in the present study were prepared by different dentists, the parameters of the upper dentures were all clinically acceptable

including stability and retention. Potential confounding effects from the type of upper denture worn by the study subjects was not taken into consideration because all participants had opposing pairs of posterior teeth. In the present study, most of these posterior tooth contacts were artificial teeth. As demonstrated by Nasr et al. (1967), the difference in masticatory efficiency between porcelain and acrylic resin teeth was too small to be statistically significant. They also claimed that there were no statistically significant differences in the masticatory efficiency between 30, 20, and 0 degree false teeth.

Many studies have demonstrated that patients treated with mandibular implant-retained overdentures experienced improvement in chewing function compared to conventional mandibular complete dentures. (Stellingsma et al., 2005; van Kampen et al., 2010) The present study aimed to develop a food intake questionnaire for use by elderly Thais and to identify the relationship between subjective chewing ability using a developed questionnaire and objective chewing ability as determined by a two-colored wax cube method in mandibular implant-retained overdenture patients. The first measurement of subjective and objective chewing ability was performed one month post implant placement. At that time the participants' existing mandibular denture had additional support from the implant fixtures that had been placed in the edentulous ridge. Thus, the subjects perceived that their chewing ability had improved. In addition,

subjects with relined lower complete dentures were recruited into this study because relining complete denture with heat-cured acrylic resin has been shown not to affect masticatory function. (Lindquist and Carlsson, 1982)

A number of objective methods exist for evaluating the chewing ability of denture wearers. Although these methods can generate accurate information, they are time consuming, requiring special equipment, specialized personnel, and the subjects' willingness and co-operation. Alternatively, the subjective assessment of chewing ability is straightforward and easy to administer. Furthermore, additional information from a qualitative interview can help to gain a better understanding of the subjective chewing experience. (Demers et al., 1996) Hence, the use of a food intake questionnaire is important and necessary for epidemiological studies and the clinical evaluation of chewing ability.

The studies using a food intake questionnaire to evaluate subjective chewing ability vary in the number and types of foods used based on culture and ethnicity. In Thailand, there was no suitable food intake questionnaire for use in evaluating the geriatric population. Therefore, a self-reported questionnaire has been developed in the present study. The food list in this questionnaire was derived from interviewing older adults in the pilot investigation. This method provided a way of exploring the appropriate foods and food preparation techniques to use in assessing perceived chewing ability.

Thus, all foods were common native Thai foods that properly reflect the actual chewing function of elderly Thais. However, to be more effective, we selected the 14 most common items from 80 food choices for use in our questionnaire as described in appendix A. These 14 foods varied in their nutritional value, i.e. the carbohydrate, protein, vitamin, and mineral content as recommended being in an elderly person's diet. Moreover, they consisted of foods of different hardness and texture. Thus, this questionnaire can provide details about the kinds of foods people could eat and how that could affect their nutritional status and general health.

We assessed the test-retest reliability of this questionnaire by having a subset of subjects answer the questionnaire a second time, 1 week after the initial evaluation at 1 month following implant placement. A Kappa value of .733 indicated that the responses between these two time points were in substantial agreement. (Viera and Garrett., 2005)

An appropriate response scale is necessary for use in a study of this nature. A visual analogue scale is typically used to measure the perception of subjective experiences such as pain and denture satisfaction. However, a report suggested that some subjects found this scale confusing, and difficult to use because they could not easily relate to the line as a quantitative measure of how they felt about a particular situation. (McDowell and Newell., 1996) Therefore, for the evaluation of food hardness and toughness, we modified this scale by marking a vertical line at every 1 mm. with

each integer every 1 cm. to make it more easily used by elderly individuals. In assessing subjective chewing ability, a four-point rating scale was selected because this response measurement is easy to use and be understood by most people. Moreover, social desirability bias, arising from the respondents' desires to please the interviewer or appear helpful by giving what they perceive to be a socially acceptable answer, can be minimized by eliminating the mid-point category from 5 point Likert scales. (Garland, 1991) In addition, the total score obtained using this four-point rating scale will range from 0–42. This range was sufficient to discriminate changes in the chewing ability of the subjects before and after the insertion of their implant-retained overdentures.

To achieve proper denture function, patients require time to adjust themselves to wearing prostheses in their mouth. According to a study by van Kampen et al. (2003) performed 3 months after the delivery of overdentures, the ball attachments exhibited no alteration of retentive force and few functional problems were detected. These findings are in accordance with the results of our study. In the present study, a wide variety of post-operative complications were observed 1 month after the insertion of the mandibular overdentures. Five participants (13.2%) experienced peri-implant tissue inflammation. Eight subjects (21.1%) required O-ring replacement because of excessive wear. The ball attachments of 4 individuals (10.5%) had to be reactivated as a result of attachment loosening. However, few problems were found at the 3-month recall visit: 2

cases of attachment loosening (4.5%) and 2 cases (4.5%) of excessive O-ring wear. The majority of these problems were detected by the dentist, and patients did not have any complaints about their denture's function. This suggests that compliance with regular recall appointments may reduce complications and maintenance requirements. However, the present study was carried out over a short period (1 year), and long term evaluation of post-treatment problems is required.

A previous study demonstrated an improvement in the masticatory capacity 3 months after the delivery of implant-retained prostheses. (Stellingsma et al., 2005) After 3 months, the patients appeared to be more motivated and also more capable of judging their chewing ability. (Gunne and Wall., 1985) Therefore, we chose to examine the relationship between subjective and objective chewing ability determination 3 months after the insertion of the mandibular implant-retained overdentures. However, it should be noted that, the responses to the questionnaire in each test could have been influenced by recall bias because the interviews were conducted during three different phases of the treatment. (Coughlin, 1990)

In the present study, the correlation between the subjective and objective chewing ability was weak, which is in agreement with the findings of most studies. (Slagter et al. 1992; Boretti, Bickel, and Geering, 1995) It is possible that the subjects' responses were affected by food preference more than by physical limitation.

Individuals may rate their chewing ability in each food on the list; even if they have not eaten these foods before.

We found that in the patients' subjective analysis of their chewing ability; they described a marked increase at the second test, averaging nearly a full score. The increased scores suggest that the patient's demands and expectations were either very modest or easily met. (Geertman et al., 1999) As a result, there was no statistically significant difference in the perceived chewing ability scores between 1 month and 3 months after the insertion of mandibular overdentures.

Although there was only a weak correlation between the subjective and objective assessments of chewing ability, it is reasonable to assess masticatory function using a questionnaire. (Boretti et al., 1995) As the goal of oral rehabilitation is to provide palliative treatment to improve patients' quality of life, it seems logical that patient-based ratings of performance be considered as valid outcome measures. (Feine and Lund., 2006) Nevertheless, it is recommended to evaluate this relationship over a longer time.

The two-colored wax cube is an efficient tool for evaluating masticatory function. However, its manufacturing and analyzing processes remain complicated, expensive, and time-consuming. The entire process of this method, from chewing to processing with the Image J program, was completed in approximately 30 minutes. In contrast, the questionnaire in this study required only a few minutes for the evaluation and analysis

process. Thus, the developed questionnaire can be used as a simple screening test for assessing chewing function with considerable cost and time saving compared to objective methods, especially in studies with a large sample size.

However, it is recommended that a future study assesses chewing ability by having study subjects chew the foods listed on the questionnaire and respond with the same 4-point scale to confirm the results of our study. Importantly, for the accurate and sensitive appraisal of food intake ability, it is essential to select foods relevant for the culture of the group being studied. In the present study, the developed questionnaire was created based on elderly Thais residing in the central region. To appropriately apply this questionnaire in other areas, the food items may need to be modified accordingly.

CHAPTER VI

CONCLUSIONS

From results of the present study, it can be concluded that

1. There is a positive relationship between the subjective chewing ability using a self-reported questionnaire and the objective masticatory performance measured from the wax cube analysis method
2. The use of self-reported questionnaire might be considered as a simple screening test in assessing the chewing function of elderly Thais using mandibular implant-retained overdentures.

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APPENDICES

APPENDIX A

The results acquired from the interview of 25 elderly Thais.

Eighty food items derived from the pilot investigation	The 14 most common foods
Porridge, Fried rice, Rose-apple, Shaved ice, Grass jelly, Sugar palm, ,Chinese vegetable stew, Steamed duck, Papaya, Dragon fruit, Chinese cabbage soup, Durian, Steamed rice, Bread, Thai papaya salad, Dim Sum, Ice-cream, Grilled fish, Vegetables salad, Green chicken curry, Rice noodles in fish curry sauce, Noodle soup, Omelet, Steamed fish, Sour curry, Banana, Fresh vegetables, Steamed chicken with rice, Chicken fried in holy basil, Fried noodle with pork and broccoli, Hot and spicy anchovy dip, Fish curry in banana leaves, Fried fish, Simmered beef soup with herb, Fried chicken, Fermented anchovy fish Northeastern style, Spicy canned fish, Soft-steamed egg, Grilled chicken, Rambutan, Jelly noodle soup, Spicy noodle salad, Stir-fried kale with sun-dried fish, Tom Yam, Congee, Fried egg, Salt-preserved egg, Stir-fried cabbage, Spicy vegetable and prawn soup, Fried sausage, Grape, Green mango, Pineapple, Mangosteen, Watermelon, Bitter melon soup, Orange, Fresh guava, Fried pork, Stir-fried vegetables. Stir-fried mountain melon green, Langsat, Sticky rice, Boiled Chinese pasta square, Lod Chong dessert in coconut milk, Vegetable soup, Mixed fruit and Vegetable smoothie, Moon cake, Ripe mango, Spinach, Suki, Fish organs sour soup, Sarim, Sun-dried salt fish, Melon, Stir-fried Choy Sum, Pickled mustard greens, Pork spare rib soup, Ripe guava, Boiled vegetables,	Porridge, Chinese Vegetable Stew, Chinese Cabbage Soup, Steamed Rice, Noodle Soup, Omelet, Steamed Fish, Sour Curry, Banana, Fried fish, Orange, Fresh Guava, Fried pork, Stir-fried Vegetables.

APPENDIX B

แบบบันทึกข้อมูลสัมภาษณ์ผู้ป่วย

No.

.....

ส่วนที่ 1 ข้อมูลพื้นฐาน

1. เพศ

☐ ชาย ☐ หญิง

2. อายุ

อายุ ..... ปี ..... เดือน

3. ประเภทของฟันคู่สบด้านบน

☐ ฟันเทียมบางส่วนติดแน่น

☐ ฟันเทียมบางส่วนถอดได้

☐ ฟันเทียมถอดได้ทั้งปาก

☐ ฟันธรรมชาติ

4. ระยะเวลาในการใช้งานฟันเทียมทั้งปากล่างถึงปัจจุบัน

ระยะเวลา..... ปี ..... เดือน

5. ระยะเวลาในการใส่ฟันเทียมทั้งปากล่างใน1วัน

ระยะเวลา..... ชั่วโมง

<u>ส่วนที่ 2</u> ข้อมูลส่วนอาหาร

1. อาหารที่สามารถรับประทานได้ เคี้ยวได้ละเอียดโดยไม่มีอาการใดๆ

.....

2. อาหารที่ไม่สามารถรับประทานได้หรือรับประทานแล้วมีอาการเจ็บปวด

……

ส่วนที่ 3 **ข้อมูลความสามารถในการบดเคี้ยวอาหาร**

คำชี้แจง กรุณาตอบแบบสอบถามโดยทำเครื่องหมายกรุณาทำเครื่องหมาย ◯ ที่ระดับตัวเลขที่ตรงกับสภาพความเป็นจริงของท่านหรือความน่าจะเป็นตามความคิดเห็นของท่านเมื่อรับประทานอาหารดังต่อไปนี้

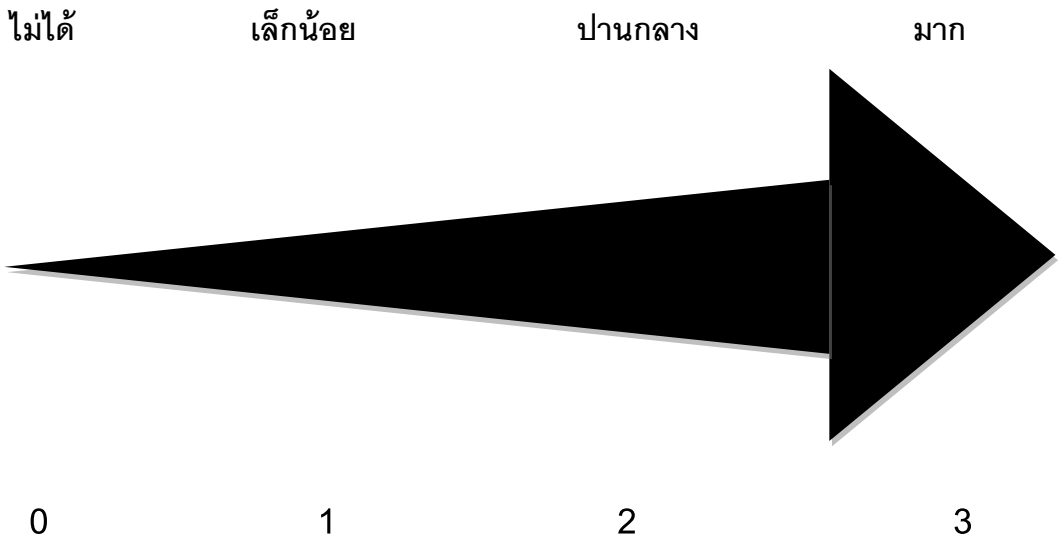
0 หมายถึง **ไม่สามารถเคี้ยวอาหารได้เลย** และ/หรือมีอาการ**เจ็บปวด**บริเวณเนื้อเยื่อที่รองรับฟันเทียม**มาก**

1 หมายถึง สามารถเคี้ยวอาหารได้**ละเอียดเล็กน้อย** และ/หรือมีอาการ**เจ็บปวด**บริเวณเนื้อเยื่อที่รองรับฟันเทียม**ปานกลาง**

2 หมายถึง สามารถเคี้ยวได้อาหารได้**ละเอียดปานกลาง** และ/หรือมีอาการ**เจ็บปวด**บริเวณเนื้อเยื่อที่รองรับฟันเทียม**น้อย**

3 หมายถึง สามารถเคี้ยวได้อาหารได้**ละเอียดมาก** โดยไม่มีอาการใดๆ

1. ข้าวต้ม



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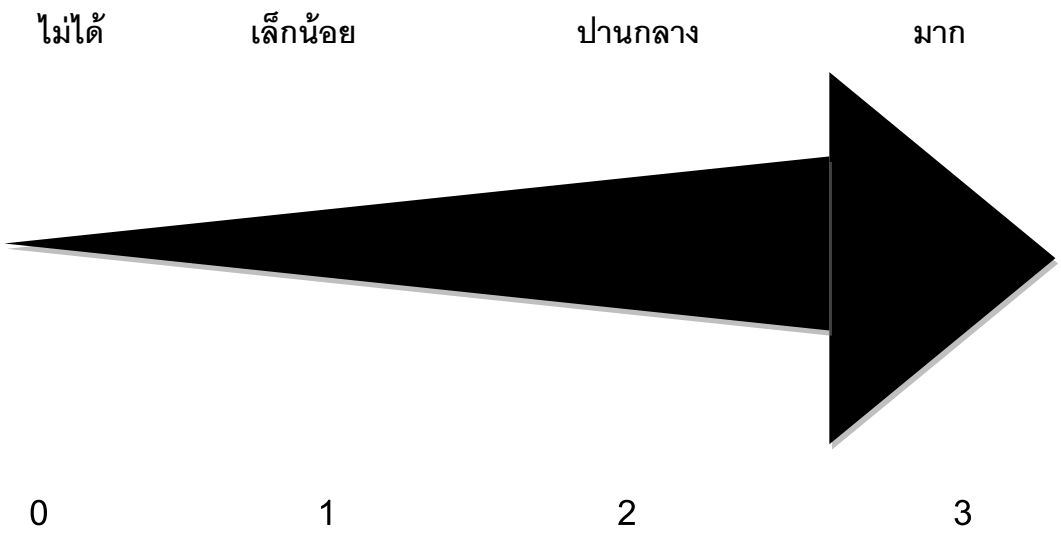

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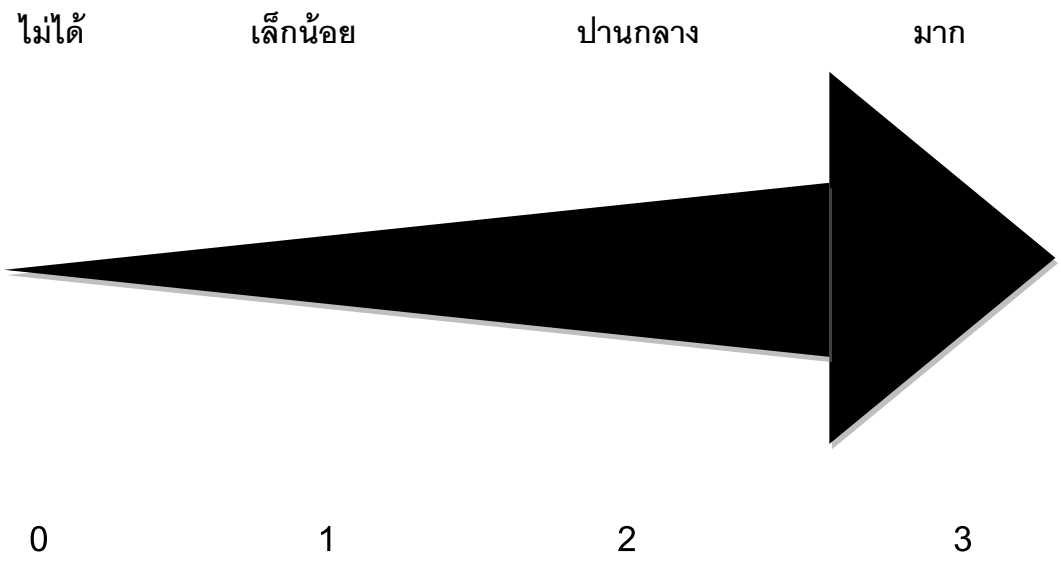

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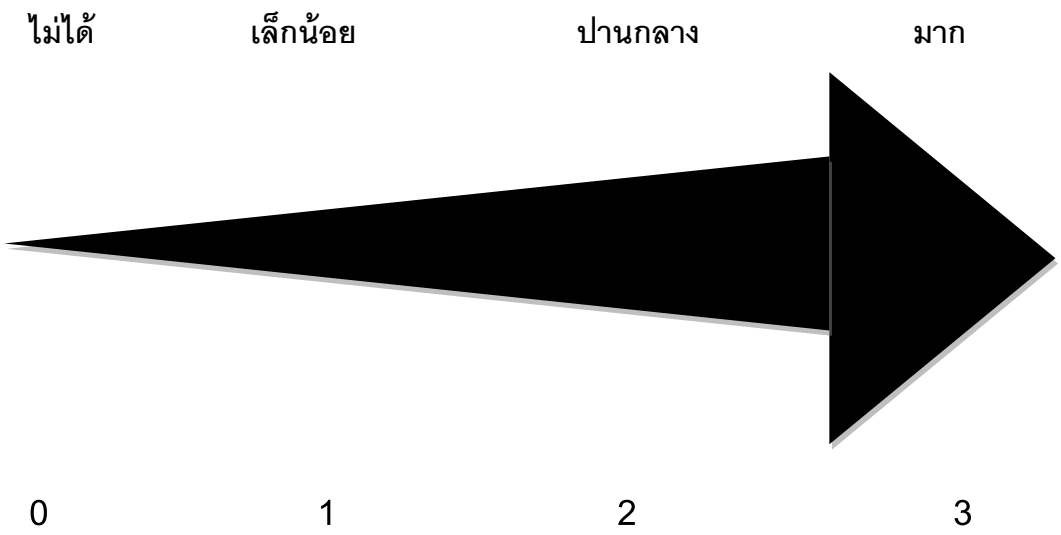

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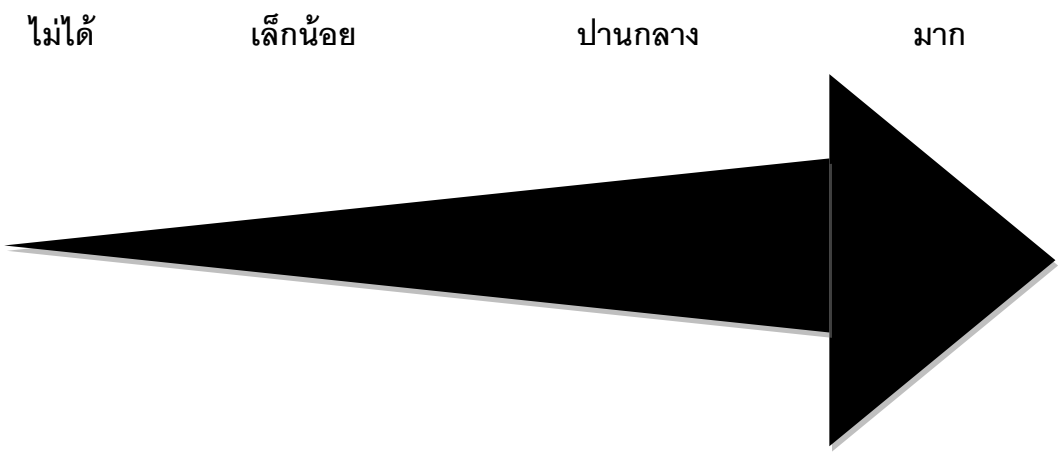

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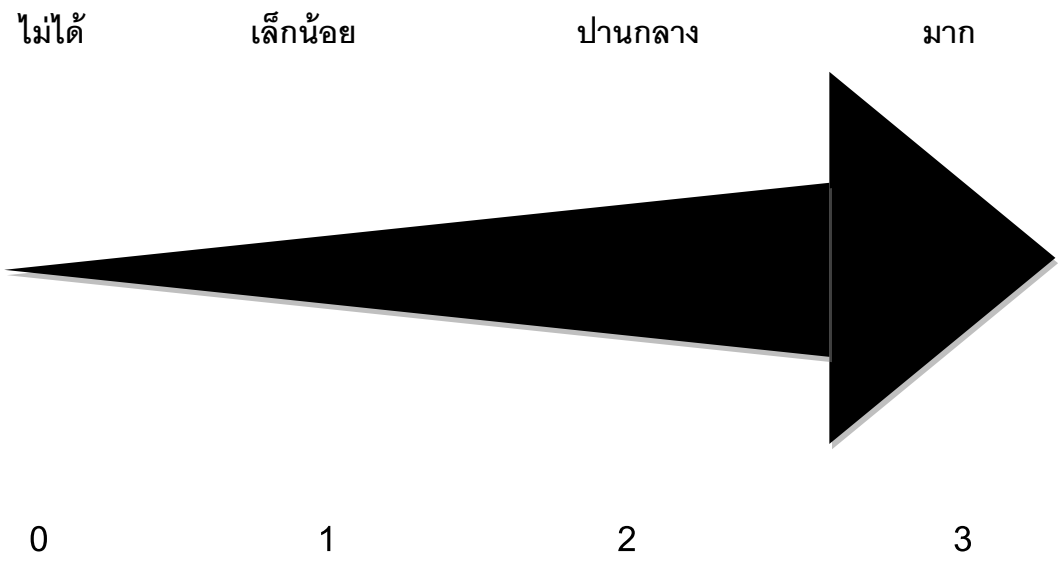

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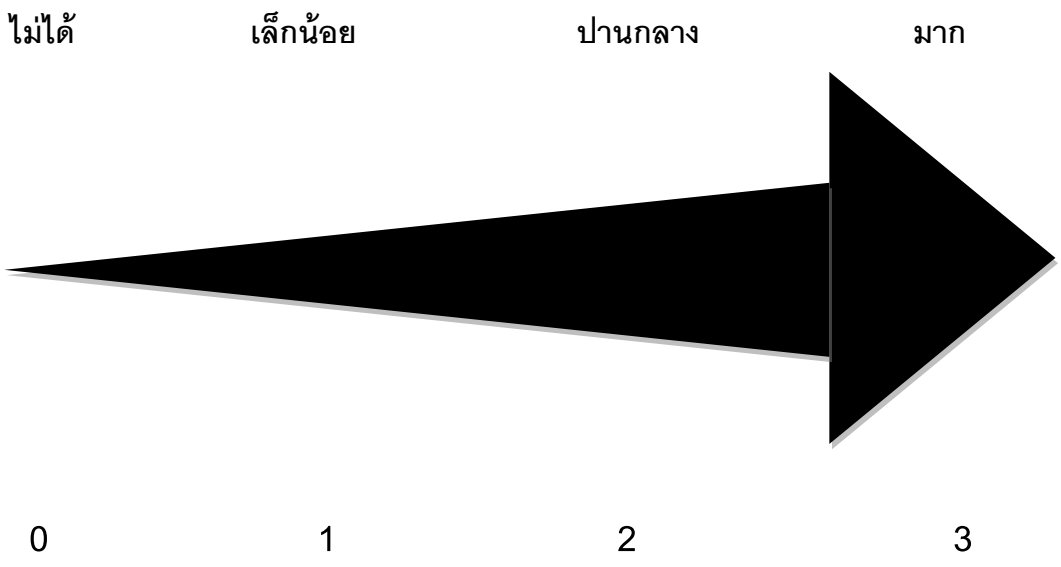

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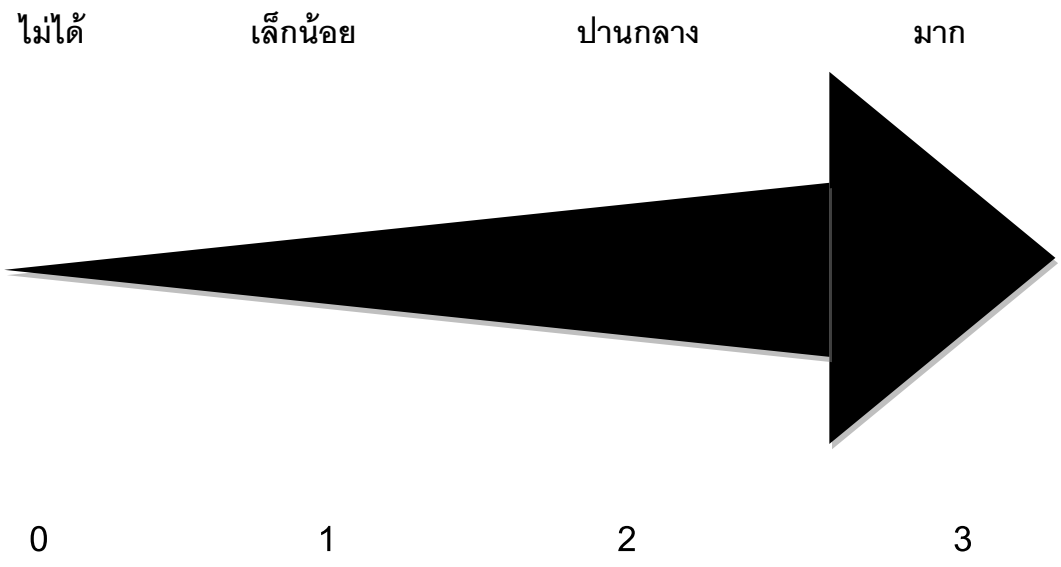

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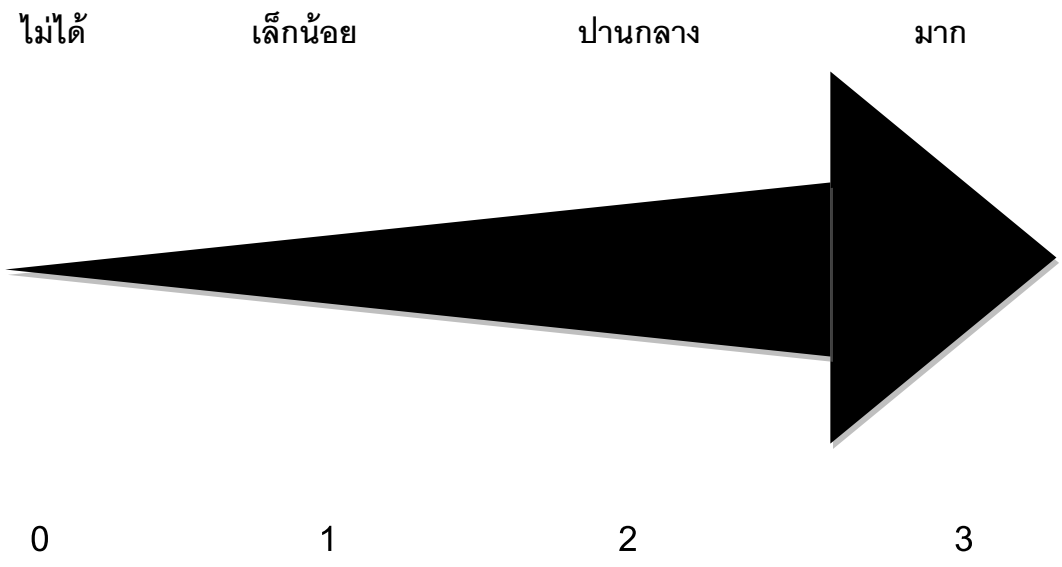

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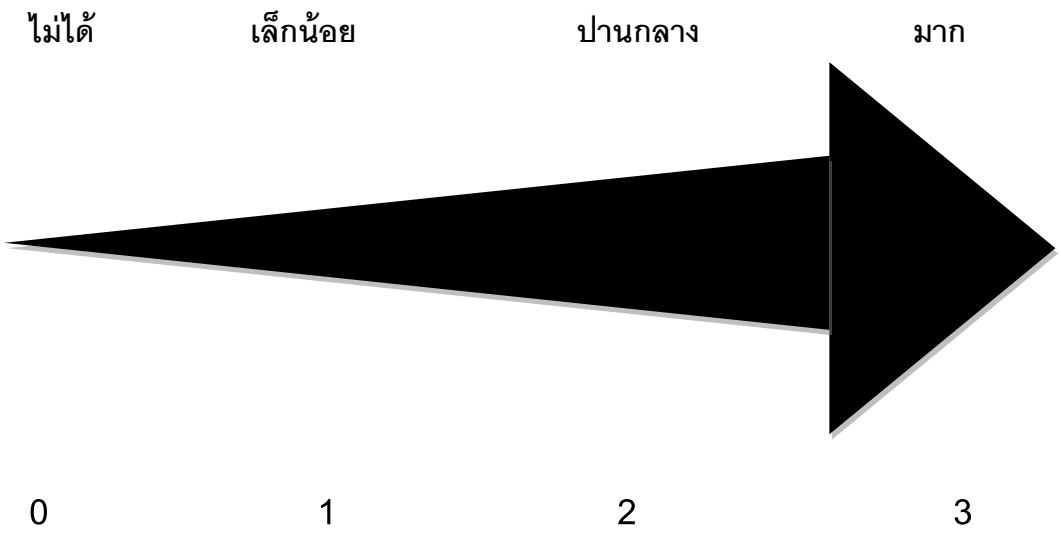

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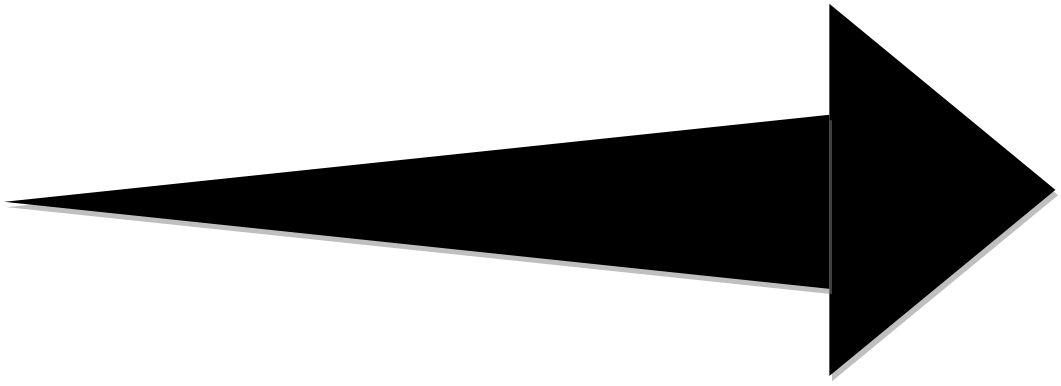

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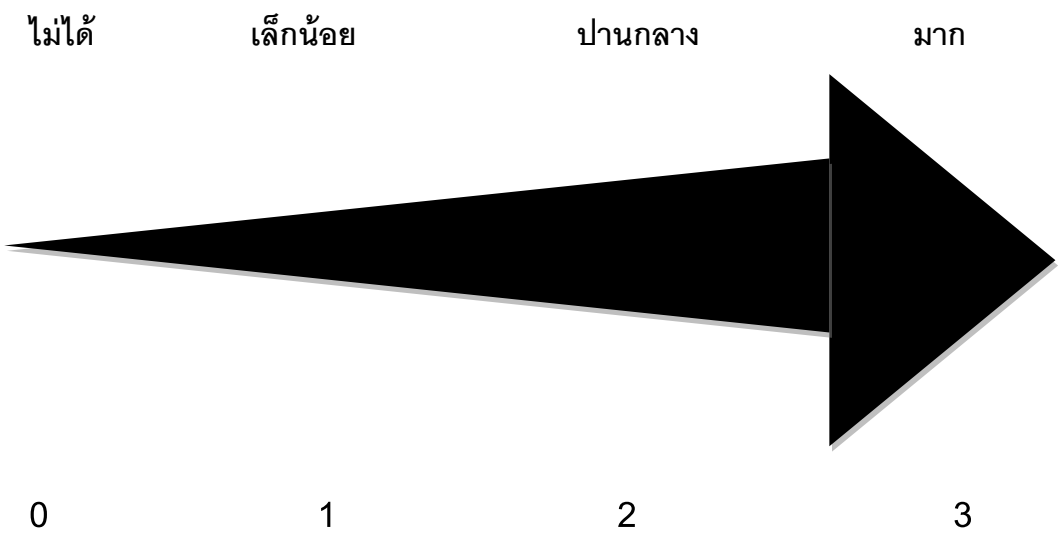

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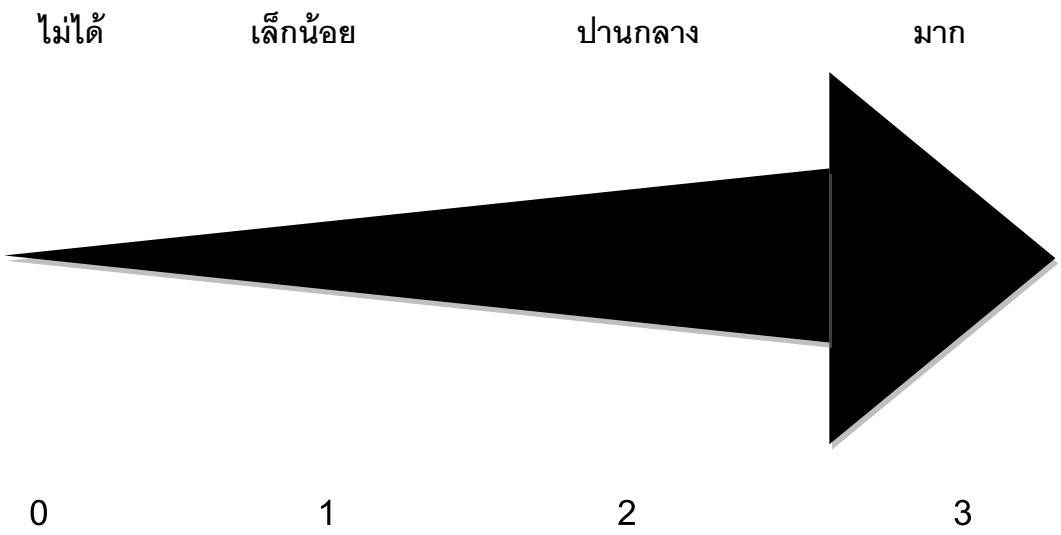

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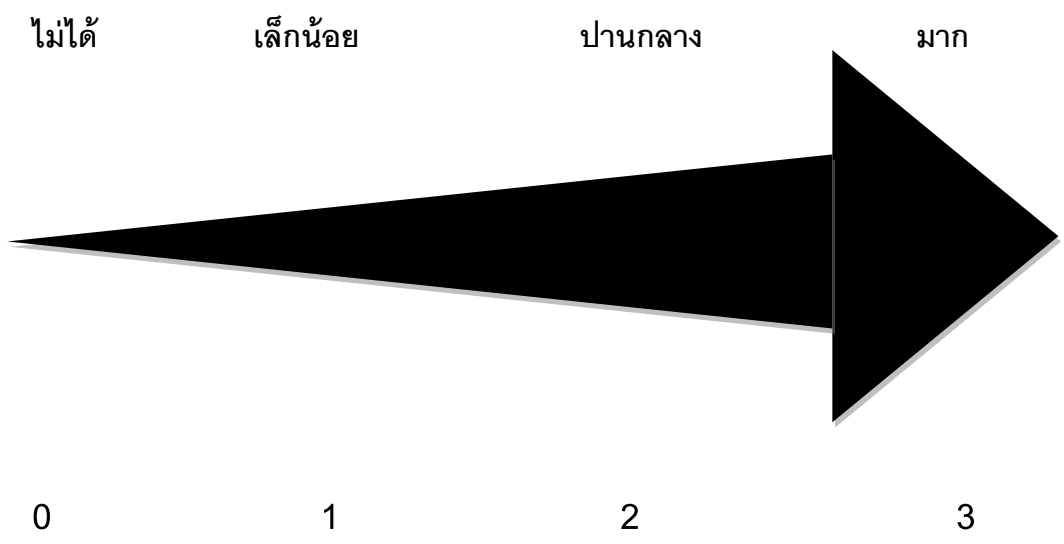

BIOGRAPHY

Miss Neerush Kunon was born on April 1, 1984 in Bangkok, Thailand. She received degree of Doctor of Dental Surgery (D.D.S) from Chulalongkorn University, in 2007. After graduation, she worked as general dentist at Khonburi Hospital Nakhon Ratchasima, Thailand during 2007-2008. After 2008 until now she worked as general dentist atPakthongchai Hospital, Nakhon Ratchasima, Thailand.