การประเมินประสิทธิภาพการบดเคี้ยวภายหลังการผ่าตัดกระดูกขากรรไกรในผู้ป่วยกระดูกขากรรไกรล่างยื่น

นางสาวพัชชา วรรณจารุรัตน์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาศัลยศาสตร์ช่องปากและแม็กซิลโลเฟเชียล ภาควิชาศัลยศาสตร์
คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2553

EVALUATION OF MASTICATORY FUNCTION AFTER ORTHOGNATHIC SURGERY IN MANDIBULAR PROGNATHISM

Miss. Patcha Wanjarrurat

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หัวข้อวิทยานิพนธ์	การประเมินประสิทธิภาพการบดเคี้ยวภายหลังการผ่าตัดกระดูกขากรรไกรในผู้ป่วยกระดูกขากรรไกรล่างยื่น
โดย	นางสาวพัชชา วรรณจารุรัตน์
สาขาวิชา	ศัลยศาสตร์ช่องปากและแม็กซิลโลเฟเชียล
อาจารย์ที่ปรึกษาวิทยานิพนธ์หลัก	ผู้ช่วยศาสตราจารย์ ทันตแพทย์ ดร. อาทิพันธุ์ พิมพ์ขาวขำ
อาจารย์ที่ปรึกษาวิทยานิพนธ์ร่วม	รองศาสตราจารย์ ทันตแพทย์หญิง สุขนิภา วงศ์ทองศรี

คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย อนุมัติให้นับวิทยานิพนธ์ฉบับนี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญามหาบัณฑิต

..... คณบดีคณะทันตแพทยศาสตร์
(รองศาสตราจารย์ ทันตแพทย์หญิง วัชราภรณ์ ทัศจันทร์)

คณะกรรมการสอบวิทยานิพนธ์

....ประธานกรรมการ
(อาจารย์ ทันตแพทย์ ดร. ณรงค์ ลุมพิกานนท์)

..... อาจารย์ที่ปรึกษาวิทยานิพนธ์หลัก
(ผู้ช่วยศาสตราจารย์ ทันตแพทย์ ดร. อาทิพันธุ์ พิมพ์ขาวขำ)

..... อาจารย์ที่ปรึกษาวิทยานิพนธ์ร่วม
(รองศาสตราจารย์ ทันตแพทย์หญิง สุขนิภา วงศ์ทองศรี)

..... กรรมการภายนอกมหาวิทยาลัย
(รองศาสตราจารย์ ทันตแพทย์หญิง กอบสุข สมบัติเปี่ยม)

.....กรรมการ
(อาจารย์ ทันตแพทย์หญิง ดร. เกศกัญญา สัพพะเลข)

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วัตถุประสงค์ การศึกษานี้เป็นการศึกษาเพื่อเปรียบเทียบประสิทธิภาพการบดเคี้ยวของผู้ป่วยกระดูกขากรรไกรล่างยื่น ก่อนผ่าตัดและหลังรับการผ่าตัดกระดูกขากรรไกร 3 เดือน และศึกษาความสัมพันธ์ระหว่างการประเมินเชิงจิตวิสัยกับเชิงวัตถุวิสัย

วัสดุและวิธีการ ผู้ป่วยกลุ่มศึกษาได้แก่ ผู้ป่วยกระดูกขากรรไกรล่างยื่นที่ได้รับการจัดฟันเพื่อผ่าตัดกระดูกขากรรไกรล่าง จำนวน 10 ราย โดยทำการประเมินผลก่อนผ่าตัดและหลังผ่าตัด 3 เดือน ผู้ป่วยกลุ่มควบคุมได้แก่ ผู้ป่วยที่มีโครงกระดูกศีรษะและใบหน้าเป็นปกติ มีสุขภาพฟันดีและไม่เคยได้รับการถอนฟันกราม จำนวน 10 ราย ก่อนการประเมิน ผู้ร่วมทดสอบทุกรายได้รับการตรวจช่องปากเพื่อตรวจชุดของฟัน และจำนวนจุดสบของฟัน การประเมินประสิทธิภาพการบดเคี้ยวสามารถได้ทำทั้งในเชิงจิตวิสัยและวัตถุวิสัย ประเมินเชิงจิตวิสัยโดยใช้แบบสอบถาม 7 ข้อ ประเมินเชิงวัตถุวิสัยโดยดูความสามารถในการคลุกเคล้าอาหารจากความเข้มของสีหมากฝรั่งและการวัดแรงกัดสูงสุด เปรียบเทียบค่าประสิทธิภาพการบดเคี้ยวระหว่างกลุ่มศึกษาและกลุ่มควบคุมโดยใช้สถิติอินดิเพนเดนต์ ที-เทสต์ และเปรียบเทียบค่าประสิทธิภาพการบดเคี้ยวเฉพาะในกลุ่มศึกษาระหว่างก่อนผ่าตัดและหลังผ่าตัดโดยใช้สถิติแพร์ ที-เทสต์ หาความสัมพันธ์ระหว่างการประเมินเชิงจิตวิสัยและวัตถุวิสัยโดยใช้สถิติสัมประสิทธิ์เพียร์สัน

ผลการศึกษา ในทางคลินิกพบว่า ภายหลังการผ่าตัด 3 เดือน ผู้ป่วยกระดูกขากรรไกรล่างยื่นมีค่าเฉลี่ยคะแนนแบบสอบถาม ความเข้มของสีหมากฝรั่ง แรงกัดสูงสุดและจำนวนจุดสบเพิ่มขึ้น อย่างไรก็ตาม ในทางสถิติไม่พบว่ามีการเพิ่มขึ้นอย่างมีนัยสำคัญ ($p<0.05$) รวมทั้งไม่พบความสัมพันธ์ระหว่างการประเมินในเชิงจิตวิสัยและวัตถุวิสัยทั้งในกลุ่มศึกษาและกลุ่มควบคุม

สรุป ภายหลังการผ่าตัด 3 เดือน พบการเปลี่ยนแปลงของประสิทธิภาพการบดเคี้ยวในผู้ป่วยกระดูกขากรรไกรล่างยื่นในทางคลินิก โดยพบว่ามีค่าเข้าใกล้ค่าของกลุ่มควบคุมมากขึ้น แต่ไม่มีนัยสำคัญทางสถิติ รวมทั้งไม่พบความสัมพันธ์ระหว่างการประเมินเชิงจิตวิสัยและวัตถุวิสัยอย่างมีนัยสำคัญทางสถิติ

ภาควิชา ศัลยศาสตร์ ลายมือชื่อนิสิต .....

สาขาวิชา ศัลยศาสตร์ช่องปากและแม็กซิลโลเฟเชียล ลายมือชื่ออ.ที่ปรึกษาวิทยานิพนธ์หลัก .....

ปีการศึกษา 2553 ลายมือชื่ออ.ที่ปรึกษาวิทยานิพนธ์ร่วม .....

5176121332 : MAJOR ORAL AND MAXILLOFACIAL SURGERY
KEYWORDS : MASTICATORY FUNCTION / ORTHOGNATHIC SURGERY / QUESTIONNAIRE / MIXING ABILITY / MAXIMUM BITE FORCE

PATCHA WANJARRURAT: EVALUATION OF MASTICATORY FUNCTION AFTER ORTHOGNATHIC SURGERY IN MANDIBULAR PROGNATHISM. THESIS ADVISOR: ASSIST. PROF. ATIPHAN PIMKHAOKHAM, Ph.D., THESIS CO-ADVISOR : ASSOC. PROF. SUKNIPA VONGTHONGSRI., 52 pp.

Objective This study was to compare masticatory function before orthognathic surgery and 3 months after orthognathic surgery in mandibular prognathism patients and to study the relationship between the subjective assessment and the objective assessment of masticatory function.

Material and Method The study group was 10 mandibular prognathism patients who had undergone pre-surgical orthodontic treatment. The masticatory function test was done before orthognathic surgery and 3 months after surgery. The control group was 10 skeletal class I patients with healthy dentate. Before the test, the dentition and the numbers of occlusal contact point were recorded in all subjects. The masticatory function test could be done by subjective and objective assessment. The subjective assessment was evaluated by using 7-item questionnaire. The objective assessment was evaluated by mixing ability test and maximum bite force test. To compare masticatory function between study and control group, the independent t-test was used. In comparison between pre- and post- operation in the study group, the paired t-test was used. Pearson correlation was used to analyze the relationship between the subjective and objective assessment.

Result The clinical test showed the increasing of questionnaire score, the color of chewed gum, the maximum bite force and the numbers of occlusal contact point. There was no statistical significance ($p<0.05$) neither the relationship between subjective and objective assessment in the study nor the control group.

Conclusion The masticatory function efficiency in the study group was close to the control group without statistical significant at 3 months after surgery. The statistical significance was not found in both the relationship between subjective and objective assessment.

Department : Surgery ..... Student's Signature .....
Field of Study : Oral and Maxillofacial Surgery ... Advisor's Signature .....
Academic Year : 2010 ..... Co-Advisor's Signature .....

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CHAPTER I
INTRODUCTION

Background

Dentofacial deformities (DFDs) are developmental abnormalities in facial proportion and dental relationship. These abnormalities could affect quality of life, not only poor mastication but also esthetics.[1] Generally, orthodontic treatment alone cannot resolve these problems. Surgery, in conjunction with orthodontic treatment, known as orthognathic surgery, results in better consequences. Therefore, masticatory function is one of the parameters used to assess the outcome of orthognathic surgery. Masticatory function can be assessed subjectively by means of questionnaires or objectively by using clinical tests.

The patients' subjective assessments reflect patients' overall satisfaction. These can be accomplished by using questionnaires. However, objective assessments for example; masticatory performance, mixing ability and bite force measurement are considered more reliable tools for evaluating treatment outcomes. [2] Many studies demonstrated the evaluation of masticatory performance or mixing ability in various kinds of maxillofacial prosthodontic treatment.[2-11] Nevertheless, there are relatively few reports on patient-based assessment of the masticatory function after orthognathic surgery.[12-16]

As there was no report of satisfaction in DFDs patients in Thailand, moreover, none of reports comparing the subjective and objective assessments at pre- and post-orthognathic surgery was found in Thai people. Therefore, the mandibular prognathism patients, most of the skeletal abnormality treated in Faculty of Dentistry, Chulalongkorn University were studied.

Research Question

1. Does BSSRO improve masticatory function of patients with mandibular prognathism in subjective aspect?
2. Does BSSRO improve the masticatory function of patients with mandibular prognathism in objective aspect?
3. Is there any correlation of the outcome between subjective assessment and objective assessment?

Objective

1. To assess the masticatory function subjectively and objectively in Thai patients with mandibular prognathism receiving orthognathic surgery before and 3 months after Bilateral Sagittal Split Ramus Osteotomy (BSSRO)
2. To study correlation between subjective assessment and objective assessment

Hypothesis

H_0 : There is no difference in the subjective assessment outcomes between pre and post BSSRO

H_1 : There are differences in the subjective assessment outcome between pre and post BSSRO

H_0 : There is no difference in the objective assessment outcome between pre and post BSSRO

H_1 : There are differences in the objective assessment outcome between pre and post BSSRO

H_0 : There is no correlation of the outcome between subjective and objective assessment before BSSRO

H_1 : There is correlation of the outcome between subjective and objective assessment before BSSRO

H_0 : There is no correlation of the outcome between subjective and objective assessment after BSSRO

H_1 : There is correlation of the outcome between subjective and objective assessment after BSSRO

Research design

Cross-sectional analytical design

Terminology

Masticatory performance: The size of food particles after a fixed number of chewing cycles

Mixing ability: The ability of kneading and mixing food bolus after a fixed number of chewing cycles

Bite force: The clenching force

Occlusal contact point: The point on opposed teeth in centric occlusion

Shim stock: The stainless steel sheet used for occlusion checking

Chewing gum: The low-adhesive, color-developing chewing gum comprising of Phloxine and Sodium bicarbonate generates the color red after chewing.

Limitation

This study reported the short period outcome after orthognathic surgery as a pilot study. All data is still being recorded for a longer reporting period. Due to the strict exclusion criteria in case selection, the numbers of attended patients were small.

Expected Benefit

The mixing ability test and maximum bite force measurement can be routine method for evaluation the outcome of orthognathic surgery in mandibular prognathism and other categories of DFDs.

Conceptual framework

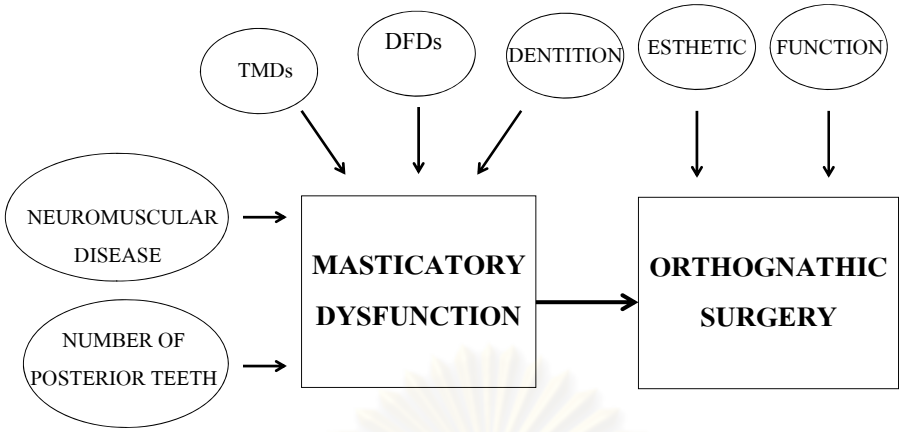

Figure1. Conceptual framework

The masticatory function is affected by DFDs, neuromuscular diseases, temporomandibular disorders, dentition and numbers of posterior teeth. The DFDs patients generally receive correction of malocclusion by orthodontic treatment and orthognathic surgery. Masticatory function may be a good indicator for evaluating the treatment outcome.

CHAPTER II
REVIEW OF BASIC KNOWLEDGE AND LITERATURE

REVIEW OF BASIC KNOWLEDGE AND LITERATURE

I. Dentofacial Deformities (DFDs)

DFDs, the abnormality in facial proportion and dental relationship can handicap a person in two ways. [1] First, jaw function is compromised and results in poor mastication and speech. Second, the abnormal dental and facial appearances lead to discrimination in social interaction.[1] The aetiology of dentofacial deformity is difficult or impossible to be described, but the interaction of environment and hereditary is a likely cause.[17] A reasonably current assumption might be that 50% of variations in facial skeleton characteristics is caused by inherited factors and 50% is environmentally influenced.[18] However, mandibular prognathism in which inherited tendencies seem to be strong aetiology.[18]

To treat the DFDs, the categories of abnormality should be defined. According to the international craniofacial institute [19], Craniofacial abnormalities can be classified to be cleft lip and palate, craniofacial syndromes and DFDs. Craniofacial syndrome is the abnormality of the bones of the skull and face that contains groups of craniofacial deformities such as; Apert's syndrome, Crouzon's syndrome, Pierre Robin syndrome. Whereas DFDs is the abnormality of the bones of the skull and face apart from the syndrome.[19] The DFDs can be categorized as many types such as long maxilla, short maxilla and mandibular prognathism. The mandibular prognathism is the highest prevalence DFDs from the record of Faculty of Dentistry, Chulalongkorn University (2006-2008). For this reason, the mandibular prognathism patients were studied here.

II. Malocclusion

The handicapping malocclusion, as a major problem, was used to describe dentofacial deformity. [1] The classification by Angle (1980s)[20] was defined occlusion into four classes based on the occlusal relationship of the first molar:

Normal occlusion (Fig.2A): Mesiobuccal cusp of upper first molar is rest on mesiobuccal groove of lower first molar.

Class I malocclusion (Fig.2B): Normal relationship of the molar, but line of occlusion uncorrected because of malposed teeth, rotations or other causes such as anterior teeth crowding.

Class II malocclusion (Fig.2C): Lower molar distally positioned relative to upper molar, line of occlusion not specified.

Class III malocclusion (Fig.2D): Lower molar mesially positioned relative to upper molar, line of occlusion not specified.

Note that normal occlusion and class I malocclusion share the same molar relationship but differ in the arrangement of the teeth relative to the line of occlusion.

When consider to the aetiology, the hereditary influences on the development of class III malocclusion are great.[18,21] Unlike class I malocclusion, the soft tissues do not influence the development of class III malocclusion. Nevertheless, the soft tissues encourage dento-alveolar compensation. The tongue may procline the maxillary incisors, whilst a strong lower lip frequently retroclines the mandibular incisors, in an attempt to achieve a class I incisal relationship. Thus, these dental features are an adaptive phenomenon to the underlying skeletal discrepancy.[21]

A pseudo-class III malocclusion may be caused by a loss of posterior tooth support. Although tooth movement may occur secondarily to accommodate the postured mandibular position, the primary treatment objective in these patients is prosthodontic rehabilitation; as usually there are insufficient posterior teeth for orthodontic anchorage.[21]

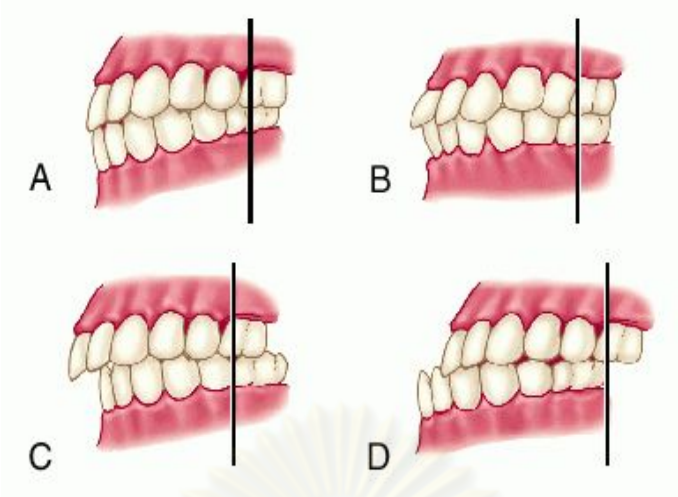

Figure2. Four classes of classified by Angle

III. Skeletal Class III

The oral examination can only diagnose the malocclusion, not skeletal relationship. To categorize the DFDs, the malocclusion and skeletal relationship is altogether process need to be done.

Antero-posterior skeletal relationship can be classified by cephalometric study to be three classes[20]:

Skeletal class I (Fig.3A): Normal relationship between maxilla and mandible

Skeletal class II (Fig.3B): Maxilla is anterior positioned relative to mandible which is resulted from 1) protrude maxilla with normal mandible or

2) normal maxilla with retrude mandible or

3) protrude maxilla with retrude mandible

Skeletal class III (Fig.3C): Maxilla is posterior positioned relative to mandible which is resulted from 1) normal maxilla with protrude mandible or

2) retrude maxilla with normal manandible or

3) protrude maxilla with retrude mandible

Skeletal class III (Fig.3C): Maxilla is posterior positioned relative to mandible which is resulted from 1) normal maxilla with protrude mandible or

2) retrude maxilla with normal mandible or

3) retrude maxilla with protrude mandible

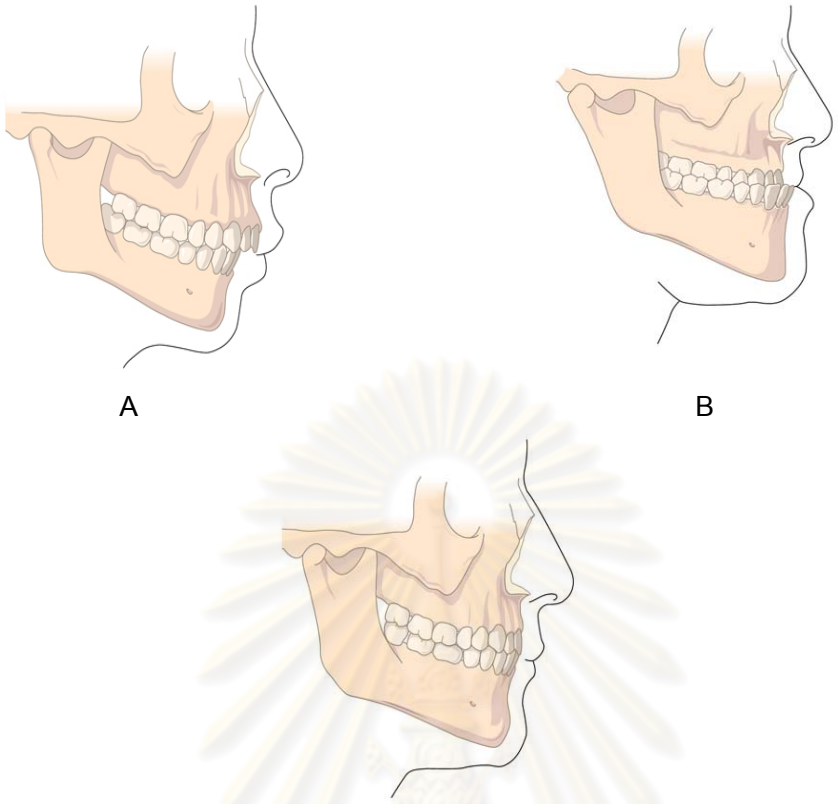

Figure3. Three classes of skeletal relationship

IV. Treatment for dentofacial deformity

The IOTN (Index of Treatment Need) [21] is used for estimating the prevalence of dentofacial deformity. The concept is that if the overjet is more than ten millimeters, the problem is considered as severe despite the teeth being well aligned. But, if the incisors are mild irregular and modest overjet, the problem may be considered as mild. This index has been successful in judging treatment need. [22]

The optimal management of class III malocclusion depends on accurately diagnosing the etiological factors.[23] Malocclusion but good skeletal relationship, the orthodontic treatment alone is usually sufficient to correct crowed and irregular dentition. In a severe malocclusion, a jaw discrepancy also often exists leaving only three broad possibilities for correction: 1) growth modification, 2) camouflage (orthodontic positioning of the teeth to compensate for the jaw discrepancy), or 3) orthognathic surgery to reposition the jaws or the dentoalveolar segments or both.[2] Cases involve severe class III skeletal discrepancy usually require orthognathic surgery.[23]

Pre-surgical orthodontic treatment

The pre-surgical orthodontic treatment is to place the teeth relative to the supporting alveolar bone.[20] The maximal intercuspation and dental occlusion were not concern in this phase. The length of pre-surgical orthodontic treatment is varied but normally not more than twelve months.[20]

Orthognathic surgery

The basic indication for surgical-orthodontic treatment is to correct the skeletal problem of severe magnitude of the malocclusion which is not possible with orthodontics alone. Merely correcting the dental malocclusion under orthodontic treatment does not adequately resolve the problem; the goals of treatment must include both good facial aesthetics as well as stability in the ultimate positions of the dentition and the jaws. With this in mind, the clinician's responsibility to the potential orthognathic patient is to offer a treatment plan that will accomplish both desirable stability and aesthetic results.[24]

Healing and Revascularization in Mandibular Osteotomy

The plates and monocortical screws is preferred for fixation after correction of mandibular prognathism[25] because of shorter recovery time. [26]The healing of the surgical site occurred immediately after surgery. After that the intramedullary circulation in the proximal and distal segments appeared and being well varcularized in first week. The reattachment of soft tissue is completed and the signs of vascular anastomoses between proximal and distal segments of bone are presented at three weeks post-operation. The flap is revascularized and the muscle reattachment complete at six weeks after surgery. The continuous cortex between proximal and distal cortex is presented with good vascular circulation in the healed site at 12 weeks post-operation. [27,28]

Post-surgical orthodontic treatment

The post-surgical orthodontic treatment after surgery will be continue until estimate twelve weeks. The goal of this phase is to accomplish the maximum aesthetic and intercuspation. [20]

V. Masticatory Function

Mastication is a voluntary movement response from the motor cortex. The signals from the motor cortex passed directly through the trigeminal motor neuron. Then, the trigeminal motor neuron is activated and passes the signal in to the corticobulbar pathway. After that, the signal will be sent to the muscle to execute the movement.[29]

Mastication results in reducing the size of food particles in preparation for swallowing and digestion.[30] Masticatory performance is related to quality of life since it influences food selection, the quality of digestion and the experience or enjoyment of eating.[31-32] Incomplete masticatory performance influences gastrointestinal disease[32] and results in malnutrition.[33-34]

Several factors influence masticatory performance including severity of malocclusion[34], occlusal contact area and body size[35-36], number of functional tooth units and bite force.[37] The number of posterior functional teeth and occlusal contact point have been considered one of the best predictors of masticatory performance[37-38] because the contact between occluding teeth determine the area available for shearing and grinding food during the chewing cycle[35-36]

The methods for measurement of masticatory function are varied. It can be assessed subjectively or objectively. Most studies in patients undergoing orthognathic surgery have been investigated by objectively assessment using multiple parameters such as levels of occlusal bite force, voluntary range of motion, electromyography activity of masticatory muscles, and morphologic change.[12-16] Though the objective assessments are considered as more reliable tools for evaluating treatment outcomes, the questionnaire could be better for evaluation the patients' satisfaction. [2]

Subjective assessment

Patients' subjective assessment by using questionnaires for evaluating the treatment outcome after orthognathic surgery in Thailand is not available. Most questionnaires used to evaluate the masticatory function after treatment were for cancer patients or denture wearers. [2,39-40] These questionnaires were mainly ask for the level of difficulty and pain after chewing a soft or hard foods.[39-40] Although, there were some

questionnaires used for evaluate the quality of life after orthognathic surgery.[41-43] Those questions measured overall quality of life, not specific in masticatory function.

Objective assessment

Patients' objective assessments are masticatory performance, mixing ability and bite force measurement.[10] Masticatory performance test is the evaluation of the size of food particles after a fixed number of chewing cycles.[3] Mixing ability is the measurement of the ability of kneading and mixing food bolus after a fixed number of chewing cycles.[11] Maximum bite force test is to evaluate the amount of tooth clenching force.

Mixing ability

Poor masticatory function also affects the degree of mixing the food. To evaluate mixing ability, the change in shape or color of tested food after a fixed number of chewing cycles is a good indicator. Many methods used to evaluate color change include the computerized assessment [10-11], the L*a*b* color system [44-45] and the mixing ability index[46]. The tested food for masticatory performance can be natural or artificial for example, peanuts [3-5], bread [6] or coffee beans [7], modified natural products such as hardened gelatin[8] or artificial materials such as silicone[9] or chewing gum. [10-11] However natural food is unpractical for routine use in a clinical setting [10] since it is subject to quality and seasonal changes. These disadvantages are not found when using artificial test foods.

Chewing gum is one of the most frequently used in mixing ability test. It's advantages over natural foods is that no food particle can get stuck under dentures during chewing or is swallowed, easily storable, not expensive and familiar to most of the people.[11] Moreover, performing the two-color chewing gum test with a visual assessment of the bolus is quick, simple and can be performed by a researcher after minimal training. Previous successful approaches demonstrated the estimation of the chewing gum by weight loss [47] or color changing. [10-11,44-45,48] However, chewing gum also has disadvantages. It can stick to intraoral appliances such as dentures, if not specially formulated like Freedent® which is no longer available, or bracelets.

Maximum bite force

Though the bite force is not a primary determinant of masticatory performance [30], the bite force remains one of the components of the chewing function. The factors that may influence bite force are facial structure, general muscular force, gender, age, overbite, anterior linear contact[49-50], state of dentition, instrumentation design and transducer position related to dental arch[51-52], malocclusion, temporomandibular disorder including size, composition and mechanical advantage of jaw-closing muscles. [51-53]The subjects' sensory feedback may limit willingness to exert the maximum effort. [49] The bite force increases with age from childhood[53], stays fairly constant from 20-40 years of age and then declines.[49]The decrease in the maximal bite force[37] and loss of muscle mass[54] in aging is associated with the decline in the masticatory apparatus. But if the confounding factors such as missing teeth are controlled, then aging alone has little impact on the ability to reduce food into small particles. [37, 55-57] Males produce a higher biting force than females. [49, 58]

Masticatory performance

The masticatory performance, also called "sieving method", is the method for analyzing the food particles.[35] The food was chewed for a fixed number of chewing cycles. After that, the food particles will be diluted and analyzed by many methods such as calculating weight percent [35,59] and spectrophotometer.[60] Various materials have been used for testing masticatory performance, for example; peanuts [3-5], or coffee beans [7], ATP granule. [60]

CHAPTER III
MATERIALS AND METHODS

Samples

The samples were divided into two groups (Table 1 and 2). Group 1, study group; consisted of ten patients with skeketal class III having normal maxilla but mandibular prognathism. All of the participants had undergone orthognathic surgery with bilateral sagittal splitting osteotomy (BSSRO) setback at the Faculty of Dentistry, Chulalongkorn University from Jun 2009 - Feb 2010. All patients in study group were operated by using Epker's modification technique. Group 2, control group; were ten patients with skeletal class I maxilla-mandibular relationship. All of the controls had normal occlusion as Angle's classification [20] and healthy dentate. Subjects were excluded if they had Temporomandibular Disorder (TMDs), craniofacial syndrome, history of previous maxillofacial trauma, degenerative conditions (muscular atrophy, myasthenia gravis, etc.) and systemic conditions limiting surgery.

All study related procedures and tests were approved by the ethical committee at the Faculty of Dentistry, Chulalongkorn University (20/2009). All subjects received a written informed consent before enrollment into the study.

Materials

1. Questionnaire

The questionnaire was translated from an existent of Sloan et al (2001: 225-245) and Bakke, Holm and Gotfredsen (2002: 575-581). [39,40] Before using the questionnaire, the validity of questionnaire was approved by three specialists and the reliability test was recruited from pilot group of 30 healthy dentate patients of the Faculty of Dentistry, Chulalongkorn University. The Cronbach's alpha coefficiency test was used for the internal consistency reliability test (0.739).

2. Chewing gum

Chewing gum (Meiji, Japan) in this study is color-developing chewing gum which was used for masticatory function test. [44] It consisted of two pieces of A and B sheet. A sheet was rectangular shape with fifteen mm. width, forty mm. length, and five mm. thick. B sheet was square with fifteen mm. width, fifteen mm. length, and five mm. thick. The original color of this chewing gum is beige. (Fig.4)

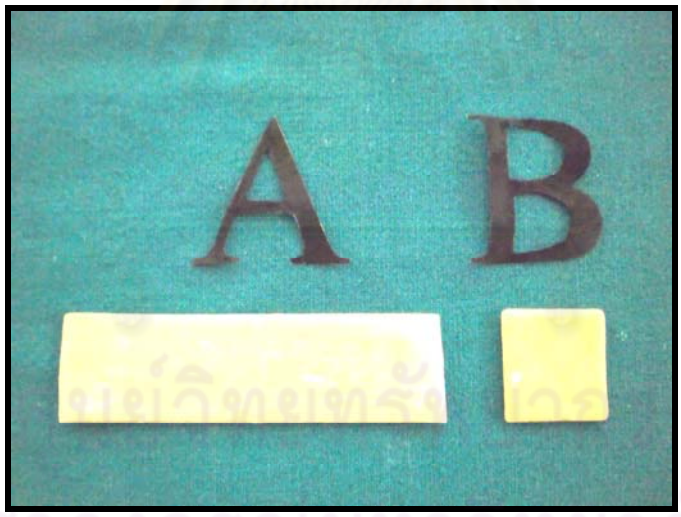

Figure4. The low-adhesive color-developing chewing gum (Meiji, Japan)

3. The compressing machine

The Universal Testing machine (LR10K, LLOYD Instruments, England) is a machine used for compressing static force on testing materials. [61-63]This machine was used to flatten chewed gum in order to standardize the thickness of chewed gum in this study. (Fig.5)

Figure5. The Universal Testing machine (LR10K, Lloyd Instruments, England)

4. Color reader

A Color reader (CR-10, Konica Minolta, Japan) is the digital reader instrument used for measuring the color of objects. [64-65]This machine was used to measure the color of chewed gum after compression by the compressing machine. (Fig.6)

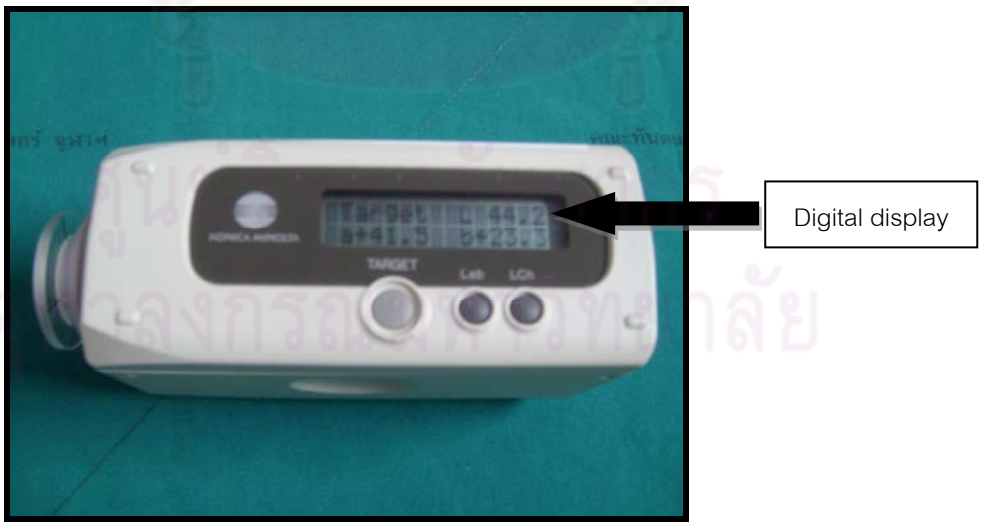

Figure6. The color reader (CR-10,Konica Minolta, Japan)

5. Occlusal force meter

The occlusal force meter (GM10, Keiki, Japan) is a device for measuring the maximum bite force. [66-70] The beep sound will alarm and shows digital number at the peak clenching of the occlusal force meter. (Fig.7)

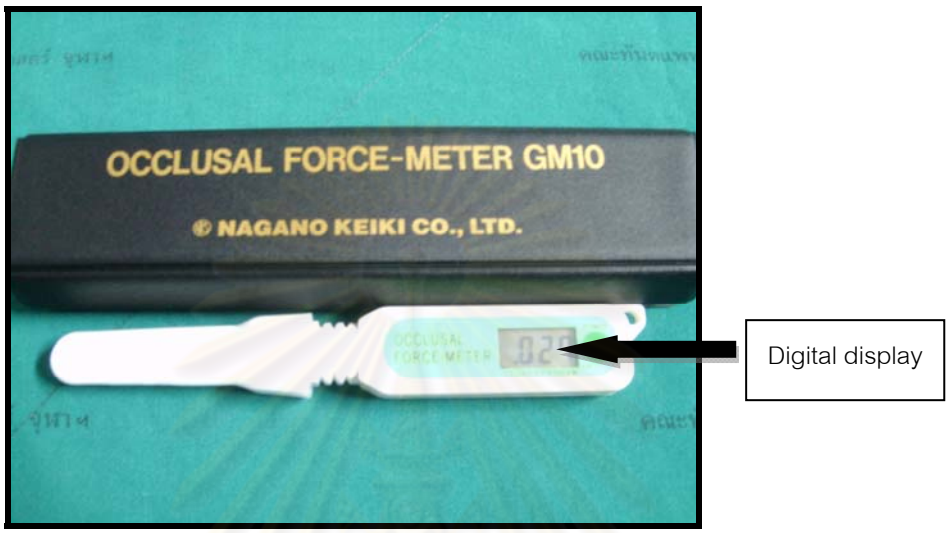

Figure7.The occlusal force meter (GM10, Keiki, Japan)

Methods

In study group, the masticatory function assessment was done one day before patients received orthognathic surgery. The same pattern was carried out three months after operation. In the control group, the masticatory function assessment was done on a single occasion. The dentition and the number of occlusal contact points were recorded pre- and post-operative surgery.

Subjective assessment

The questionnaires were completed by the patients themselves. The seven questions of a 4-point Likert scale was scored from “4” (very good) to “1” (very bad) for each question then the sum of all scores was calculated. The highest score should possibly be “28”.

Objective assessment

The patients seated in a dental chair, head upright and looking forward. First, the dentition and the number of teeth were examined. Second, the number of occlusal

contact points was examined by using a shim stock. Then, the objective assessment would proceed. The objective assessment was evaluated from 2 tests as: mixing ability test and maximum bite force test.

1) Mixing ability test

The chewing gum was prepared by flip the A layer into three folds, centered by the B layer (Fig.8). Then, the patient was instructed to chew the two-color chewing gum 50 cycles and spit. The chewed gum was then flattened to be 1 mm. thickness by compressing with applied 10Newton-force (10N-force) using the universal testing machine (Fig.10) and tested by the color reader (Fig.12). The color was evaluated using the L*a*b* color space, which was developed by the Commission Internationale de l'Eclairage (CIE) for measuring object color.[71] The a*-value was used to evaluated and calculated in this study because this chewing gum generates only the red color.

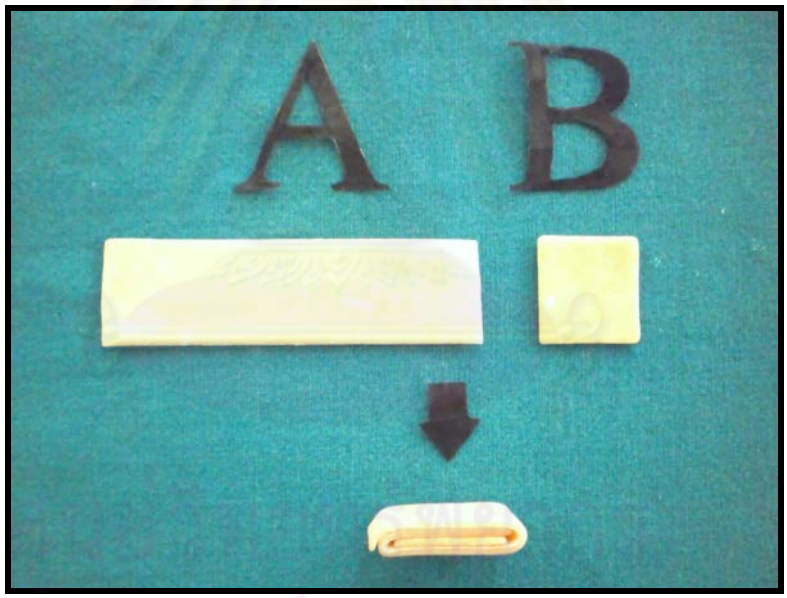

Figure8. The preparation of chewing gum

Figure9. The chewed gum before flattening

Figure10. Flattening chewed gum by compressing 10N-force

Figure11. The chewed gum after 1 mm. thickness flattening

Figure12. Measuring the color of chewed gum by using the color reader

2) Maximum bite force test

To evaluate bite force, the occlusal force meter GM10 (Fig.7) was applied on the occlusal tables of the upper first molar, then the same manner was done on the second premolar and the central incisor on both sides. The patients were required to bite as hard as they could without causing themselves any pain or injuries and stop after the meter alarm. The measurement for maximum bite force was done three times per tooth. The mean value of bite force of each tooth was calculated using the following formula.

$$\text{average maximum bite force} = \frac{\sum \text{maximum bite force of each tooth}}{\text{number of teeth}}$$

Statistical Analysis

The Kolmogorov-Smirnov test was used for normality test. The 4-point Likert scale, the a*- value and the maximum bite force between study and control group were analyzed by independent t-test. To compare pre- and post- operation of the same patients, the pair t-test was used. The correlation between the 4-point Likert scale, the a*-value and the maximum bite force was analyzed by the Pearson correlation. The statistical significance was accepted at $P<0.05$.

CHAPTER IV

RESULTS

Demographic data

Table1. Demographic data

Study group			Control group		
No.	Sex	Age	No.	Sex	Age
1	M	21	1	F	29
2	F	43	2	F	27
3	M	26	3	F	27
4	M	29	4	M	27
5	M	24	5	F	26
6	F	21	6	M	27
7	F	25	7	M	29
8	M	25	8	F	27
9	F	24	9	M	28
10	F	23	10	M	27
		$\bar{X}$ =26.1			$\bar{X}$ =27.4

The demographic data of the study and the control group showed in Table 1.

Questionnaire

Table2. The Likert scale value of the study and the control group

Sample no.	Study group		Control group
	Pre-op	Post-op	
1	20	23	16
2	22	21	28
3	19	17	22
4	24	22	23
5	18	26	24
6	24	21	21
7	12	16	27
8	17	17	26
9	15	17	25
10	21	17	25
mean	19.2	19.7	23.7

The questionnaire was scored using 4-point Likert scale. The Likert scale of the study group was 19.2 pre-operatively and 19.7 after BSSRO (Table 2).

Color of chewed gum

Table3. The a* value of the study and the control group

Sample no.	Study group		Control group
	Pre-op	Post-op	
1	38	35.9	31.85
2	36	35.05	35.5
3	30	32.65	33.85
4	33.1	19.45	32.35
5	31.4	34.66	34.5
6	25.35	28	36.05
7	27.9	36.57	33.1
8	29.85	37.4	34.85
9	36.65	27.35	36.85
10	29.4	36.1	36.75
Mean	31.765	32.313	34.565

The a*-value is the color red of the chewed gum. The a*-value of the study group was 31.765 pre-operatively and 32.313 after BSSRO (Table 3).

Maximum bite force

Table4. The maximum bite force value of the study and the control group

Sample no.	Study group		Control group
	Pre-op	Post-op	
1	0.187	0.196	0.173
2	0.037	0.015	0.129
3	0.056	0.033	0.173
4	0.158	0.522	0.163
5	0.121	0.253	0.158
6	0.034	0.028	0.171
7	0.052	0.054	0.14
8	0.06	0.083	0.065
9	0.037	0.03	0.198
10	0.068	0.016	0.171
Mean	0.081	0.123	0.154

The maximum bite force of the study group was 0.081 pre-operatively and 0.123 after BSSRO setback (Table 4).

The number of occlusal contact points

Table5. The number of occlusal contact points of the study and the control group

Sample no.	Study group		Control group
	Pre-op	Post-op	
1	4	8	12
2	5	4	8
3	8	13	13
4	9	9	12
5	6	7	12
6	8	14	12
7	2	7	8
8	9	14	11
9	7	8	14
10	4	14	14
mean	6.2	9.8	11.6

The number of occlusal contact points of the study group was 6.2 pre-operatively and 9.8 after BSSRO (Table 5).

Result

The demographic data showed statistically normal distribution and no statistically difference in sex and age between the study and the control group (Table 1). The increasing of mean value of Likert scale, a*-value, maximum bite force and number of occlusal contact points was close to the control value without statistically significant (*p=0.681, 0.817, 0.310 and 0.191* respectively).

The result demonstrated that all tests showed the same status which were increased at 3 months post-operation, but did not significantly differ from pre-operation. When comparing with the control group, the raw data were increased close to the control value without statistically significance in all tests.

The correlation of subjective assessment and objective assessment

Table.6 The correlation coefficiency (r) of the pre-operative study group

	Likert	a*-value	Bite force	Contact point
Likert	r = 1	r = 0.004	r = 0.250	r = 0.405
a*-value	r = -0.004	r = 1	r = 0.437	r = -0.110
Bite force	r = 0.250	r = 0.437	r = 1	r = -0.039
Contact point	r = 0.405	r = -0.110	r = -0.039	r = 1

Table.7 The correlation coefficiency (r) of the post-operative study group

	Likert	a*-value	Bite force	Contact point
Likert	r = 1	r = -0.186	r = 0.582	r = -0.395
a*-value	r = -0.186	r = 1	r = -0.591	r = -0.007
Bite force	r = 0.582	r = -0.591	r = 1	r = -0.213
Contact point	r = -0.395	r = -0.007	r = -0.213	r = 1

Table.8 The correlation coefficiency (r) of the control group

	Likert	a*-value	Bite force	Contact point
Likert	r = 1	r = 0.459	r = -0.442	r = -0.442
a*-value	r = 0.459	r = 1	r = 0.087	r = 0.299
Bite force	r = -0.442	r = 0.087	r = 1	r = 0.550
Contact points	r = -0.442	r = 0.299	r = 0.550	r = 1

There was no statistical significance in correlation among the subjective and objective assessment in all subject groups ($p \square 0.05$) (Table 6, 7 and 8).

CHAPTER V

DISCUSSION AND CONCLUSION

Discussion

The Chronbachs' value of questionnaire was used in this study and was translated from English version of well documented standard questionnaire[39-40] with some modification. The overall internal consistency reliability using Cronbachs' alpha co-efficient was acceptable at the value over 0.7. The Chronbach's of this 7-item questionnaire was 0.739 (show in page 50 in appendix). The question number 7 showed the lowest item-total correlation (0.089) while others had higher item-total (range 0.319-0.605). In case that question number 7 was deleted, the Chronbach's would rise to 0.781. Obviously, the validity would not be complete in all aspects. Thus, when considering proper validity and reliability, we then kept this question in the questionnaire.

This study showed the improvement of Likert scale, mixing ability, maximum bite force and number of occlusal contact points at three months after orthognathic surgery but was not statistically significance. The similar results were shown in many studies. Phillips, Blakey and Jaskolka (2008: 2110-2115) reported that oral function included mouth opening, chewing and biting food took six to eight weeks to return to usual activities as before orthognathic surgery .[72] In Iwase et al (2006: 1102-1107), the mixing ability was restored to the pre-operative value at six months follow up.[45] Kikuta et al (1994: 9-17) and Iwase et al (2006: 1102-1107) showed that the maximum bite force increased significantly at six months after BSSRO setback.[45,59] Whereas, Ohkura et al (2001: 141-145) reported that the maximum bite force and occlusal contact area were statistically significance higher than pre-operative value at one year after surgery.[73]

The correlation between subjective and objective assessment were not found statistically significance among studied groups as well as the number of occlusal contact points. Shiratsuchi, Kouno and Tashiro (1991: 299-303) showed similar results in correlation between masticatory efficiency, maximum bite force and occlusal contact area at six months after orthognathic surgical correction of mandibular prognathism.[60]

While Iwase et al (2006: 1102-1107) showed a strong correlation between occlusal contact area and bite force at one year after BSSRO setback.[45] In our study, the Pearson's analyses between mixing ability and bite force, mixing ability and occlusal contact area showed weak correlation. This could be explained by the complicated factors controlled masticatory function.[60]Thus the multiple approaches should be used for different purposes. The questionnaire is the patient-based assessment. Whereas the mixing ability test is food mixing measurement and the maximum bite force is tooth clenching force measurement. Therefore, there is no need for the correlation among these tools. From this study, we suggested that all tests including the questionnaire, mixing ability test and maximum bite force should be used for evaluating treatment outcome in the study of post-operative BSSRO set back.

As observation from the data of all tests, there were slightly improvement of clinical function eventhough there was no statistically significance of all tests. The bite force might not be at the highest point according to the fixation of orthodontic appliance which mostly removed after complete treatment at one year. The previous study showed statistical significance at six months to one year study.[45,59,73] Due to the limitation of year course, this research was studied in short period. Bone healing could be in stable shape at three month [6,28] and the study could be performed at this time for preliminary test.

Conclusion

The result of this study concluded that in a short timescale orthognathic surgery could improve masticatory function to be close to normal values. There was no statistically correlation between subjective and objective assessment in the masticatory function. However, a long term study involving larger number of patients especially after surgical orthodontic treatment and masticatory training should be considered.

Suggestion

This result implied that the orthognathic surgery could improve the masticatory function in three month post-operatively. However, to achieve the final treatment of orthognathic surgery, post- surgical orthodontic treatment together with masticatory

training need to be done. Thus long term study especially after overall treatment was suggested.

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APPENDIX

<u>แบบสอบถามประสิทธิภาพการบดเคี้ยวในผู้ป่วยที่เข้ามารับการผ่าตัดกระดูกขากรรไกร ร่วมกับการจัดฟัน</u>

เนื่องด้วยคณะผู้วิจัยได้ทำการวิจัยเรื่อง “การประเมินประสิทธิภาพการบดเคี้ยวภายหลังการผ่าตัดกระดูกขากรรไกรในผู้ป่วยกระดูกขากรรไกรล่างยื่น” จึงได้จัดทำแบบสอบถามชุดนี้ขึ้นเพื่อรวบรวมข้อมูลผู้ป่วยที่เข้ามารับการรักษา ณ คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

แบบสอบถามชุดนี้ประกอบด้วย 3 ส่วน ได้แก่

ส่วนที่ 1: ข้อมูลทั่วไปของผู้ป่วย

ส่วนที่ 2: แบบประเมินการเคี้ยว

ส่วนที่ 3: ปัญหาอื่นๆ ของผู้ป่วยที่ส่งผลต่อการเคี้ยว

ส่วนที่ 1 ข้อมูลทั่วไป

1. เพศ O ชาย O หญิง
2. อายุ _____ ปี _____ เดือน
3. เชื้อชาติ O ไทย O จีน O อื่นๆ (โปรดระบุ)_____
4. รหัสประจำตัวผู้ป่วย (HN) _____
5. ระดับการศึกษา O ต่ำกว่าประถมศึกษา O ประถมศึกษา
   O มัธยมศึกษาตอนต้น O มัธยมศึกษาตอนปลาย
   O ปริญญาตรี O สูงกว่าปริญญาตรี
6. ท่านใส่เครื่องมือจัดฟันในช่องปากมาเป็นเวลา _____ ปี _____ เดือน
7. ประเภทอาหารที่ทานเป็นประจำก่อนการผ่าตัดรักษา (ตอบได้มากกว่า 1 ข้อ)

   O อาหารนิ่ม เช่น ข้าวสวย

   O อาหารกึ่งแข็งกึ่งนิ่ม เช่น มะละกอในส้มตำ

   O อาหารแข็ง เช่น หมู, เนื้อแดดเดียวทอด

8. ในแต่ละวันท่านทานอาหาร_____มื้อ คือ (ตอบได้มากกว่า 1 ข้อ)

O เช้า O กลางวัน O เย็น Oอื่นๆ_____

9. ท่านทานอาหารหมดในแต่ละมื้อ O ใช่ O ไม่ใช่

10. ท่านได้รับการฝึกฝนการบดเคี้ยวเพิ่มเติม O ใช่ O ไม่ใช่

ส่วนที่ 2 แบบประเมินการเคี้ยว

<u>คำชี้แจง</u> ให้ทำเครื่องหมายกากบาท (x) ในช่องตามระดับความสามารถที่ท่านรู้สึก

	มาก	ค่อนข้างมาก	ค่อนข้างน้อย	น้อย
1. ท่านรู้สึกว่าท่านต้องใช้ความพยายามในการเคี้ยวอาหารนิ่ม ยกตัวอย่างเช่น ข้าวสวย ให้ละเอียด				
2. ท่านรู้สึกว่าท่านต้องใช้ความพยายามในการเคี้ยวอาหารแข็ง ยกตัวอย่างเช่น หมู,เนื้อแดดเดียวทอด ให้ละเอียด				
3. ท่านรู้สึกว่าท่านต้องใช้ความพยายามในการกัดอาหารนิ่ม ยกตัวอย่างเช่น ข้าวสวย ให้ละเอียด				
4. ท่านรู้สึกว่าท่านต้องใช้ความพยายามในการกัดอาหารแข็ง ยกตัวอย่างเช่น หมู,เนื้อแดดเดียวทอด ให้ละเอียด				
5. ท่านรู้สึกเจ็บขณะเคี้ยวหรือกัดอาหารนิ่ม ยกตัวอย่างเช่น ข้าวสวย				
6. ท่านรู้สึกเจ็บขณะเคี้ยวหรือกัดอาหารแข็ง ยกตัวอย่างเช่น หมู,เนื้อแดดเดียวทอด				
7. ท่านรู้สึกว่ามีความมั่นใจในการออกแรงกัดหรือบดเคี้ยวอาหารในระดับใด				

ส่วนที่ 3 ปัญหาอื่น ๆ ของผู้ป่วยที่ส่งผลต่อการเคี้ยว

1. ท่านมีปัญหาเกี่ยวกับฟันที่ทำให้ประสิทธิภาพในการเคี้ยวอาหารลดลงหรือไม่

   O ไม่มี O มี โปรดเลือก

   O ปวดฟัน

   O ฟันแตก, บิ่น, ร้าว, โยก (โปรดระบุ)_____

   O วัสดุอุดฟันแตก, บิ่น, ร้าว, หลุด (โปรดระบุ)_____

   O อื่นๆ (โปรดระบุ) _____

2. ท่านมีปัญหาเกี่ยวกับเหงือกที่ทำให้ประสิทธิภาพในการเคี้ยวอาหารลดลงหรือไม่

   O ไม่มี O มี โปรดเลือก

   O เหงือกอักเสบ

   O เหงือกบวม

   O มีเลือดออกตามไรฟัน

   O อื่นๆ (โปรดระบุ) _____

3. ท่านมักมีแผลบริเวณเยื่อเมือกในช่องปากที่ทำให้ประสิทธิภาพในการบดเคี้ยวลดลงหรือไม่

   O ไม่มี O มี โปรดเลือก

   O แผลร้อนใน

   O เครื่องมือจัดฟันบาด

   O อื่นๆ (โปรดระบุ) _____

4.กรุณาระบุปัญหาอื่นๆ ที่ท่านคิดว่าส่งผลกระทบต่อการเคี้ยวของท่าน

.....

.....

.....

THE PRE-OPERATIVE QUESTIONNAIRE

<u>แบบสอบถามประสิทธิภาพการบดเคี้ยวในผู้ป่วยที่เข้ามารับการผ่าตัดกระดูกขากรรไกรร่วมกับการจัดฟัน</u>

เนื่องด้วยคณะผู้วิจัยได้ทำการวิจัยเรื่อง “การประเมินประสิทธิภาพการบดเคี้ยวภายหลังการผ่าตัดกระดูกขากรรไกรในผู้ป่วยกระดูกขากรรไกรล่างยื่น” จึงได้จัดทำแบบสอบถามชุดนี้ขึ้นเพื่อรวบรวมข้อมูลผู้ป่วยที่เข้ามารับการรักษา ณ คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

แบบสอบถามชุดนี้ประกอบด้วย 3 ส่วน ได้แก่

ส่วนที่ 1: ข้อมูลทั่วไปของผู้ป่วย

ส่วนที่ 2: แบบประเมินการเคี้ยว

ส่วนที่ 3: ปัญหาอื่นๆ ของผู้ป่วยที่ส่งผลต่อการเคี้ยว

ส่วนที่ 1 ข้อมูลทั่วไป

11. เพศ O ชาย O หญิง
12. อายุ _____ ปี _____ เดือน
13. เชื้อชาติ O ไทย O จีน O อื่นๆ (โปรดระบุ)_____
14. รหัสประจำตัวผู้ป่วย (HN) _____
15. ระดับการศึกษา O ต่ำกว่าประถมศึกษา O ประถมศึกษา
    O มัธยมศึกษาตอนต้น O มัธยมศึกษาตอนปลาย
    O ปริญญาตรี O สูงกว่าปริญญาตรี
16. เคยรับการผ่าตัดกระดูกขากรรไกรร่วมกับการจัดฟันมาแล้ว O เคย O ไม่เคย
    (ถ้าตอบไม่ใช่ ให้ข้ามไปทำข้อ 8)
17. ได้รับการผ่าตัดกระดูกขากรรไกรร่วมกับการจัดฟันมาเป็นเวลา _____ ปี
    _____ เดือน
18. ท่านใส่เครื่องมือจัดฟันในช่องปากมาเป็นเวลา _____ ปี _____ เดือน

19. ประเภทอาหารที่ทานเป็นประจำหลังการผ่าตัดรักษา (ตอบได้มากกว่า 1 ข้อ)

O อาหารนิ่ม เช่น ข้าวสวย

O อาหารกึ่งแข็งกึ่งนิ่ม เช่น มะละกอในส้มตำ

O อาหารแข็ง เช่น หมู, เนื้อแดดเดียวทอด

20. ในแต่ละวันท่านทานอาหาร_____ มื้อ คือ (ตอบได้มากกว่า 1 ข้อ)

O เช้า O กลางวัน O เย็น Oอื่นๆ_____

21. ท่านทานอาหารหมดในแต่ละมื้อ O ใช่ O ไม่ใช่

22. ท่านได้รับการฝึกฝนการบดเคี้ยวเพิ่มเติมO ใช่ Oไม่ใช่

ส่วนที่ 2 **แบบประเมินการเคี้ยว**

<u>คำชี้แจง</u> ให้ทำเครื่องหมายกากบาท (x) ในช่องตามระดับความสามารถที่ท่านรู้สึก

	มาก	ค่อนข้างมาก	ค่อนข้างน้อย	น้อย
1. ท่านรู้สึกว่าท่านต้องใช้ความพยายามในการเคี้ยวอาหารนิ่ม ยกตัวอย่างเช่น ข้าวสวย ให้ละเอียด				
2. ท่านรู้สึกว่าท่านต้องใช้ความพยายามในการเคี้ยวอาหารแข็ง ยกตัวอย่างเช่น หมู,เนื้อแดดเดียวทอด ให้ละเอียด				
3. ท่านรู้สึกว่าท่านต้องใช้ความพยายามในการกัดอาหารนิ่ม ยกตัวอย่างเช่น ข้าวสวย ให้ละเอียด				
4. ท่านรู้สึกว่าท่านต้องใช้ความพยายามในการกัดอาหารแข็ง ยกตัวอย่างเช่น หมู,เนื้อแดดเดียวทอด ให้ละเอียด				
5. ท่านรู้สึกเจ็บขณะเคี้ยวหรือกัดอาหารนิ่ม ยกตัวอย่างเช่น ข้าวสวย				
6. ท่านรู้สึกเจ็บขณะเคี้ยวหรือกัดอาหารแข็ง ยกตัวอย่างเช่น หมู,เนื้อแดดเดียวทอด				
7. ท่านรู้สึกว่ามีความมั่นใจในการออกแรงกัดหรือบดเคี้ยวอาหารในระดับใด				

ส่วนที่ 3 ปัญหาอื่น ๆ ของผู้ป่วยที่ส่งผลต่อการเคี้ยว

1. ท่านมีปัญหาเกี่ยวกับฟันที่ทำให้ประสิทธิภาพในการเคี้ยวอาหารลดลงหรือไม่

   O ไม่มี O มี โปรดเลือก

   O ปวดฟัน

   O ฟันแตก, บิ่น, ร้าว, โยก (โปรดระบุ) _____

   O วัสดุอุดฟันแตก, บิ่น, ร้าว, หลุด

   (โปรดระบุ) _____

   O อื่นๆ (โปรดระบุ) _____

2. ท่านมีปัญหาเกี่ยวกับเหงือกที่ทำให้ประสิทธิภาพในการเคี้ยวอาหารลดลงหรือไม่

   O ไม่มี O มี โปรดเลือก

   O เหงือกอักเสบ

   O เหงือกบวม

   O มีเลือดออกตามไรฟัน

   O อื่นๆ (โปรดระบุ) _____

3. ท่านมักมีแผลบริเวณเยื่อเมือกในช่องปากที่ทำให้ประสิทธิภาพในการบดเคี้ยวลดลงหรือไม่

   O ไม่มี O มี โปรดเลือก

   O แผลร้อนใน

   O เครื่องมือจัดฟันบาด

   O อื่นๆ (โปรดระบุ) _____

4.กรุณาระบุปัญหาอื่นๆ ที่ท่านคิดว่าส่งผลกระทบต่อการเคี้ยวของท่าน

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THE POST-OPERATIVE QUESTIONNAIRE

Normality test of pre and post-operative value in the patients' group

One-Sample Kolmogorov-Smirnov Test[d]

		ontact pr	ntact 3 m	q(0)	q(3)	color(0)	color(3)	MaxBite	MaxBite
N		10	10	10	10	10	10	10	10
Normal Parameters[a,b]	Mean	6.20	9.80	19.20	19.70	.76500	.31300	.08090	.12288
	Std. Deviation	2.394	3.645	3.853	3.368	096818	705853	054542	162281
Most Extreme Differences	Absolute	.174	.210	.106	.289	.167	.260	.296	.298
	Positive	.121	.189	.106	.289	.167	.186	.296	.298
	Negative	-.174	-.210	-.094	-.150	-.149	-.260	-.193	-.252
Kolmogorov-Smirnov Z		.550	.664	.337	.913	.527	.821	.936	.943
Asymp. Sig. (2-tailed)		.923	.770	1.000	.375	.944	.511	.346	.336
Monte Carlo Sig. (2-tailed)	Sig.	.876[c]	.694[c]	.999[c]	.315[c]	.905[c]	.435[c]	.288[c]	.280[c]
	95% Confidence Interval Lower Bound	.870	.685	.999	.305	.899	.425	.279	.271
	95% Confidence Interval Upper Bound	.883	.703	1.000	.324	.911	.444	.297	.288

a. Test distribution is Normal.

b. Calculated from data.

c. Based on 10000 sampled tables with starting seed 957002199.

d. group = test

Normality test of the patients' and the controls' group

One-Sample Kolmogorov-Smirnov Test

			ost teet	ontact pr	q(0)	color(0)	/MaxBite	ontact 3 m	q(3)	color(3)	/MaxBite
N			20	20	20	20	20	20	20	20	20
Normal Parameters[a,b]	Mean		15.20	8.90	21.45	.16500	.11748	10.70	21.70	.43900	.13847
	Std. Deviation		1.908	3.538	4.249	390005	058775	3.045	3.908	270237	115616
Most Extreme Di	Absolute		.312	.160	.126	.105	.202	.215	.185	.205	.202
	Positive		.288	.100	.062	.089	.202	.162	.185	.177	.202
	Negative		-.312	-.160	-.126	-.105	-.202	-.215	-.129	-.205	-.142
Kolmogorov-Smirnov Z			1.397	.714	.563	.467	.903	.963	.829	.916	.905
Asymp. Sig. (2-tailed)			.040	.689	.910	.981	.388	.312	.497	.371	.386
Monte Carlo Sig. (2-tailed)	Sig.		.031[c]	.632[c]	.870[c]	.963[c]	.342[c]	.271[c]	.448[c]	.326[c]	.341[c]
	95% Confid Interval	Lower Bound	.028	.623	.863	.959	.333	.263	.438	.317	.332
		Upper Bound	.035	.641	.876	.966	.352	.280	.457	.335	.350

a. Test distribution is Normal.

b. Calculated from data.

c. Based on 10000 sampled tables with starting seed 2000000.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
sex	Equal variances assumed	.	.	.000	18	1.000	.000	.236	-.495	.495
	Equal variances not assumed			.000	18.000	1.000	.000	.236	-.495	.495
age	Equal variances assumed	4.333	.052	-.637	18	.532	-1.300	2.042	-5.590	2.990
	Equal variances not assumed			-.637	9.412	.540	-1.300	2.042	-5.889	3.289
post teeth	Equal variances assumed	.948	.343	-1.723	18	.102	-1.400	.812	-3.107	.307
	Equal variances not assumed			-1.723	17.793	.102	-1.400	.812	-3.108	.308

Comparison in sex, age and the numbers of posterior teeth between the patients' and the controls' group

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
contact pre	Equal variances assumed	.630	.438	-5.341	18	.000	-5.400	1.011	-7.524	-3.276
	Equal variances not assumed			-5.341	17.737	.000	-5.400	1.011	-7.526	-3.274
contact 3 mo	Equal variances assumed	6.434	.021	-1.350	18	.194	-1.800	1.333	-4.601	1.001
	Equal variances not assumed			-1.350	14.458	.198	-1.800	1.333	-4.651	1.051
q(0)	Equal variances assumed	.202	.658	-2.746	18	.013	-4.500	1.639	-7.943	-1.057
	Equal variances not assumed			-2.746	17.802	.013	-4.500	1.639	-7.946	-1.054
q(3)	Equal variances assumed	.172	.683	-2.617	18	.017	-4.000	1.528	-7.211	-.789
	Equal variances not assumed			-2.617	17.985	.017	-4.000	1.528	-7.211	-.789
color(0)	Equal variances assumed	6.915	.017	-1.985	18	.063	-2.800000	1.410872	-5.764133	.164133
	Equal variances not assumed			-1.985	12.236	.070	-2.800000	1.410872	-5.867466	.267466
color(3)	Equal variances assumed	7.717	.012	-1.192	18	.249	-2.252000	1.888874	-6.220377	1.716377
	Equal variances not assumed			-1.192	10.710	.259	-2.252000	1.888874	-6.423150	1.919150
avMaxBite0	Equal variances assumed	2.571	.126	-3.521	18	.002	-.073167	.020782	-.116828	-.029506
	Equal variances not assumed			-3.521	15.753	.003	-.073167	.020782	-.117278	-.029055
avMaxBite3	Equal variances assumed	8.330	.010	-.593	18	.561	-.031183	.052611	-.141715	.079348
	Equal variances not assumed			-.593	9.916	.567	-.031183	.052611	-.148542	.086175

Comparison in the value of the numbers of occlusal contact point, the Likert scale, the a* and the maximum bite force between the patients' group and the controls' group

Correlations[a]

		contact pre	q(0)	color(0)	avMaxBite0
contact pre	Pearson Correlation	1	.405	-.110	-.039
	Sig. (2-tailed)		.246	.762	.914
	N	10	10	10	10
q(0)	Pearson Correlation	.405	1	.004	.250
	Sig. (2-tailed)	.246		.992	.486
	N	10	10	10	10
color(0)	Pearson Correlation	-.110	.004	1	.437
	Sig. (2-tailed)	.762	.992		.207
	N	10	10	10	10
avMaxBite0	Pearson Correlation	-.039	.250	.437	1
	Sig. (2-tailed)	.914	.486	.207	
	N	10	10	10	10

a. group = test

Correlation analyses between the numbers of occlusal contact point, the Likert scale, the a* and the maximum bite force in the patients' group before surgery

Correlations[a]

		contact 3 mo	q(3)	color(3)	avMaxBite3
contact 3 mo	Pearson Correlation	1	-.395	-.007	-.213
	Sig. (2-tailed)		.259	.984	.556
	N	10	10	10	10
q(3)	Pearson Correlation	-.395	1	-.186	.582
	Sig. (2-tailed)	.259		.606	.078
	N	10	10	10	10
color(3)	Pearson Correlation	-.007	-.186	1	-.591
	Sig. (2-tailed)	.984	.606		.072
	N	10	10	10	10
avMaxBite3	Pearson Correlation	-.213	.582	-.591	1
	Sig. (2-tailed)	.556	.078	.072	
	N	10	10	10	10

a. group = test

Correlation analyses between the numbers of occlusal contact point, the Likert scale, the a* and the maximum bite force in the patients' group after surgery

Correlations[a]

		contact pre	q(0)	color(0)	avMaxBite0
contact pre	Pearson Correlation	1	-.442	.299	.550
	Sig. (2-tailed)		.201	.402	.099
	N	10	10	10	10
q(0)	Pearson Correlation	-.442	1	.459	-.442
	Sig. (2-tailed)	.201		.182	.201
	N	10	10	10	10
color(0)	Pearson Correlation	.299	.459	1	.087
	Sig. (2-tailed)	.402	.182		.810
	N	10	10	10	10
avMaxBite0	Pearson Correlation	.550	-.442	.087	1
	Sig. (2-tailed)	.099	.201	.810	
	N	10	10	10	10

a. group = normal

Correlation analyses between the numbers of occlusal contact point, the Likert scale, the a* and the maximum bite force in the controls' group

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
q1	17.9000	7.541	.605	.671
q2	18.7000	7.459	.546	.685
q3	17.8667	7.637	.619	.669
q4	18.6667	7.057	.696	.644
q5	17.4667	9.568	.340	.733
q6	18.0667	8.616	.319	.741
q7	18.3333	9.885	.089	.781

Reliability test of the questionnaire

VITAE

PATCHA WANJARRURAT, D.D.S.

Date of birth	September 10, 1982
Place of birth	Samutprakarn, Thailand
Nationality	Thai
Education	Doctor of dental surgery degree from Chulalongkorn University, Thailand (2000-2006)
Work experience	Private hospital (2006-present)