Mandibular Growth Stimulation Produced by Easy Jaw Advancer in Skeletal Class II Retrognathic Mandibular Patients

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ชื่อวิทยานิพนธ์	ผลการกระตุ้นการเจริญเติบโตของขากรรไกรล่างโดยเครื่องมือ Easy Jaw Advancer (EZJA) ในผู้ป่วยโครงสร้างใบหน้าชนิดที่สองที่มีขากรรไกรล่างเล็ก
ผู้เขียน	นายอาทิตย์ สิทธิพรชัย
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ปีการศึกษา	2554

บทคัดย่อ

เครื่องใช้กระตุ้นเพื่อการจัดฟันแบบติดแน่นได้รับการใช้โดยทั่วไปเพื่อกระตุ้นการเจริญเติบโตของขากรรไกรล่างโดยมีวัตถุประสงค์เพื่อแก้ไขโครงสร้างใบหน้าชนิดที่สองในผู้ป่วยที่ไม่ให้ความร่วมมือ เนื่องจากเครื่องมือมีโอกาสที่จะให้แรงขนาดมากไปสู่ฟันหลักจากส่วนประกอบที่ใช้ยื่นขากรรไกรล่าง จึงมีการแนะนำให้ใช้แหวนรัดฟันในฟันกรามแท้ซี่ที่หนึ่ง อย่างไรก็ตามการใช้แหวนรัดฟันมีโอกาสที่จะทำให้เกิดความเสียหายต่ออวัยวะปริทันต์และยังใช้เวลาในคลินิกมาก เพื่อหลีกเลี่ยงข้อเสียที่อายเกิดจากการใช้แหวนรัดฟันจึงมีแผนที่จะพัฒนาเครื่องมือกระตุ้นเพื่อการจัดฟันอย่างง่ายขึ้น <u>วัตถุประสงค์</u> เพื่อพัฒนาและประเมินผลเครื่องมือกระตุ้นเพื่อการจัดฟันแบบติดแน่นชนิดใหม่ที่เรียกว่า Easy Jaw Advancer (EZJA)ร่วมกับการใช้เครื่องมือ จัดฟันชนิดติดแน่น เพื่อกระตุ้นการเจริญเติบโตของขากรรไกรล่างในผู้ป่วยโครงสร้างใบหน้า ชนิดที่สองที่มีขากรรไกรล่างเล็ก <u>วิธีการวิจัย</u> กลุ่มศึกษาประกอบด้วยผู้ป่วยที่ยังมีการเจริญเติบโต ที่มีโครงสร้างใบหน้าประเภทที่สองและการสบฟันผิดปกติแบบที่สองจำนวน 11 คน หลังจากเรียงและปรับระดับฟันจนถึงลวดเหล็กไร้สนิมขนาด 0.021 x 0.025 นิ้ว สร้างเครื่องมือ EZJA บนฟันกรามน้อยซี่ที่หนึ่งบนและล่าง เพื่อกระตุ้นให้ขากรรไกรล่างยื่นมาด้านหน้า 2 มม. จากนั้นเพิ่มอีก 2 มม. ทุกๆ 2 เดือนจนกระทั่งได้ตำแหน่งของคางที่ปกติเมื่อเทียบกับหน้าผาก ผลของเครื่องมือ จะถูกวัดโดยภาพลอกลายภาพรังสีวัดศีรษะด้านข้างตามวิธีของ Pancherz <u>ผลการศึกษา</u> การเจริญ เติบโตของขากรรไกรล่าง (Co-Pg) ในผู้ป่วยกลุ่มศึกษาในช่วงที่ใช้เครื่องมือ EZJA มีการเพิ่มขึ้น 5.09 มม. ส่วน กลุ่มควบคุม มีการเพิ่มขึ้น 1.36 มม. ผลสุทธิที่ได้จากเครื่องมือคือ 3.73 มม. ทั้งปริมาณ และทิศทางของการเจริญเติบโตที่พบเหมาะสมที่จะใช้ในการแก้ไขโครงสร้างใบหน้า ประเภทที่สอง <u>สรุปผลการศึกษา</u> เครื่องมือ EZJA สามารถกระตุ้นการเจริญเติบโตของขากรรไกร ล่าง และแก้ไขโครงสร้างใบหน้าประเภทที่สองในผู้ป่วยที่ยังมี การเจริญเติบโตอยู่ได้

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ABSTRACT

Fixed functional appliances were regularly used to stimulate the mandibular growth aiming to correct the skeletal class II discrepancy in non-compliance patients. Due to possible heavy force from the advancing component applied to the anchorage teeth, banding is recommended for the molar teeth. However, banding has potential to damage the periodontium and need longer chair time to apply. To avoid banding disadvantages, a simplified functional appliance was planned to develop. **Objectives:** The aim of this study was to develop and evaluate a new system of fixed functional appliance, called Easy Jaw Advancer (EZJA), combined with the use of conventional orthodontic fixed appliance to promote mandibular growth in skeletal class II retrognathic mandibular patients. **Methods:** Treatment group composed of 11 growing patients with skeletal class II retrognathic mandible and dental class II malocclusion. After leveling and aligning until upper and lower archwires were 0.022 x 0.025 inches stainless steel, EZJA was constructed on maxillary and mandibular fist premolars for advance the mandible by 2 mm and then an additional 2 mm every 2 months until normal soft tissue chin position when compared to the forehead will be achieved. Treatment effects were identified with Pancherz's analysis and conventional cephalometric analysis. **Results:** Results indicated that mandibular growth (Co-Pg) in the treatment group was on average 5.09 mm compared with the control group increase in Co-Pg of 1.36 mm, resulting in a net gain of 3.73 mm during the EZJA treatment period. The magnitude and direction of the skeletal changes were found to be quite favorable for correct skeletal class II relationship. **Conclusions:** Overall, this treatment technic, EZJA, can induce mandibular growth and correcting class II skeletal disharmony in growing patients.

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Arthit Sittipornchai

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LISTS OF ABBREVIATIONS AND SYMBOLS

mm	=	millimeter
et al.	=	and others
CT	=	Computed tomography
SS	=	Stainless steel
Fig.	=	figure
T_1	=	time at the start of EZJA
T_2	=	time at the complete advancement
C_1	=	time at the start of growth observation
C_2	=	time at the end of growth observation
%	=	percent
”	=	inch (es)

CHAPTER 1

INTRODUCTION

Background and rationale

Fixed functional appliances were regularly used to stimulate the mandibular growth aiming to correct the skeletal class II discrepancy in non-compliance patients. PSU-fixed functional appliance is one of the fixed categories that can promote growth of the mandible, that have orthopedic effect more than orthodontic effect. Due to possible heavy force from the advancing component applied to the anchorage teeth, banding is recommended for the molar teeth. However, banding has potential to damage the periodontium and need longer chair time to apply. To avoid banding disadvantages, a simplified functional appliance was planned to develop at Prince of Songkla University.

Easy Jaw Advancer (EZJA) was developed base on the Twin-Blocks principle. EZJA was composed by inclined planes attached on the occlusal surfaces of upper and lower first premolars to guide the mandible into forward position. The advantages of these occlusal inclined planes liked appliance were better adaptation for normal functions such as mastication, swallowing, speech, and breathing would be created. Therefore the lower jaw was allowed opening and moving freely. Due to no attachment connected between upper and lower teeth, the inclined planes were the major components for guiding the patients to move their jaw forward. Together with a forward jaw training program, adaptive forward mandibular position will be initiated, more orthopedic effect could be expected over orthodontic effect.

Review of literatures

The class II malocclusion is the skeletal facial disharmony that the position of mandible is posterior to the maxilla. This malocclusion can be result from maxillary prognathism, mandibular deficiency or a combination of both.

In growing patients, Stahl *et al*[1] reported that, patterns of craniofacial growth in patients with class II malocclusion essentially were similar to those of patients with normal occlusion, with the exception of significantly smaller increases in mandibular length. The deficiency in mandibular growth in class II subjects was significant at the growth spurt, and it was maintained at the postpubertal observation. These findings show that class II dentoskeletal disharmony did not have a tendency to correct during growth period, in association with worsening of the deficiency in mandibular dimensions. Growth modification with headgear or functional appliance during the circumpubertal period was recommended.[2-4]

The Twin-Blocks appliance was removable functional appliance, which comprised of upper and lower bite-blocks that effectively modify the occlusal inclined plane. It induces favorably directed occlusal forces producing a functional mandibular forward displacement and change from class II to class I jaw relationship. In comparison to other removable functional appliances, these occlusal inclined planes like appliance give greater freedom of anterior movement and lateral excursion and cause less interference with normal function.[5]

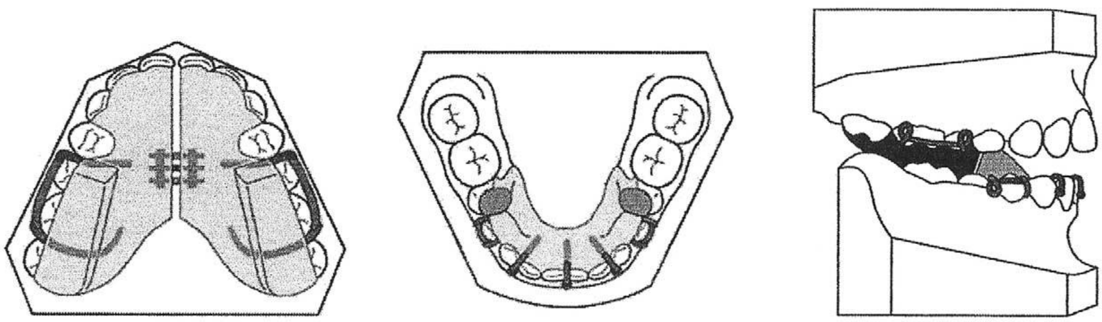


Fig. 1: Twin-Blocks appliance[6]

The disadvantage of Twin-Blocks appliance is more dental movement than skeletal effects during the treatment, it probably was an appliance of choice for the class II patients suffering from dentoalveolar malrelation. Several studies,[5, 7-9] illustrated that in Twin-Blocks appliance group the ANB angle and overjet were significantly reduced. These were due to increase in the SNB angle. However, the lower incisors proclined considerably in the patients treated by Twin-Blocks appliance.

The short-term treatment effects produced by the Twin-Blocks appliance evaluates the dentoalveolar and skeletal cephalometric changes, the results indicated that, the mandibular incisors were tipped labially and the maxillary incisors were retroclined.[3-5, 10-13] In comparison with the controls, however, the Twin-Blocks treatment produced a statistically increase in the total mandibular length.[5, 7-9] The increase in mandibular length could possibly be due to condylar growth stimulation as an adaptive reaction to the forward positioning of the mandible. Thus, the change in the SNB angle may be a result of both an increase in mandibular length and forward displacement of the articular portion of the temporal bone.[14-17]

Most of cases that use Twin-Blocks appliance revealed orthodontic effect more than orthopedic effect, therefore will require a subsequent dental alignment treatment phase with a multibracket appliance with or without extraction of teeth. But by starting treatment with the Twin-Blocks, the sagittal jaw base relationship was normalized to skeletal class I, thus making subsequent treatment with the multibracket orthodontic appliance much easier.

To maximized the orthopedic effect

1. Anchorage preparation

Dischinger[18, 19] designed the edgewise Herbst using a fixed appliance with the stainless steel crown Herbst appliance to maximize the skeletal changes of the treatment by incorporating more dental units, lower anchorage may be increased. Unnecessary forward tipping of the lower incisors was avoided by using -10^{o} torque brackets and maxillary arch was tied back to the molar tubes to prevent space from opening between the molars and the second premolars that prevented the distal movement of the maxillary molars. VanLaecken *et al*[20] reported the use of edgewise Herbst appliance, which was described by Dischinger.[18, 19] The net effect of the edgewise Herbst treatment in this study was primarily skeletal (85% of the overjet correction and 96% of the molar correction). They believed that the use of super-torque brackets on the maxillary incisors and negative-torque brackets on the mandibular incisors aids in this recovery of incisors to pretreatment levels.

Proper anchorage preparation was critical to achieve successful results. It was necessary to align and level arches until hard wires before insert fixed functional appliance. By fully engaging the brackets in both arches, anchorage was maintained during the activation for preventing unwanted forward movement of the lower incisors and distal movement of the upper molars. The upper arch wire should be cinched to increase anchorage and minimize dentoalveolar movements. The fixed functional appliance can use in conjunction with fixed appliance lead to get good anchorage preparation.[18-20]

2. Step-by-step mandibular advancement

It has been indicated in a clinical study that step-by-step advancement of the mandible might enhance mandibular growth more than maximum jumping only.[21, 22] In previous comparison of treatment result over 12 months, it was shown that the improvement in the jaw base relationship produced by the headgear-Herbst appliance with step-by-step advancement of the mandible was twice as large as that of the conventional Herbst appliance with maximum jumping of the mandible. The results of an animal study also indicated that the stepwise advancement produced more skeletal effects than single advancement and a more prominent effect with stepwise advancement was found in the glenoid fossa compared with the condyle.[(23)] Results of this study showed that forward mandibular positioning led to increased bone formation in the condyle and the glenoid fossa when compared with natural growth. Stretching of the posterior attachment of the fibrous capsule during mandibular advancement causes a series of cellular and molecular events that lead to bone formation in the condyle and the glenoid fossa.[24]

Ruf and Pancherz[25] using magnetic resonance imaging (MRI) have conclusively shown that used of the Herbst appliance leads to remodeling of the glenoid fossa and the condyle. A recent study showed an increase in bone formation in both condyle and glenoid fossa after mandibular advancement using a fixed functional appliance.[24] Moreover, the amount of bone formation of the condyle and the glenoid fossa was observed to be significantly higher in the posterior region. A better response was believed to occur when advancement took place in a gradual manner, to allow the muscle and condyle to adapt to the new position, an increase in the amount of skeletal effect, a reduction in the amount of dentoalveolar compensation, and better stability.

Falck and Frankel[26] showed that there was an obvious link between the rate of mandibular advancement and the dentofacial changes during treatment with Frankel appliance. In patients, who were advanced the mandible in small steps have significantly improved in jaw discrepancy. The results also indicated that in small-step group the initial position of the condyle relative to the glenoid fossa was maintained during treatment whereas it changed anteriorly in maximum advancement group. Another finding of this study was that maximum advancement group had mainly a tooth-moving effect, whereas in small-step group, basal development of the mandible was simultaneously stimulated sagittaly. Normally, whatever appliance was used for altering mandibular position anteriorly in the treatment of class II malocclusion, the resultant effect of the stretched retractors on the maxillary structures must be taken into consideration. The results of this study indicate that the restricting effect of these forces on the maxilla can be eliminated, or at least minimized, when the mandible was advanced in small steps because the retractors were only slightly stretched.

Therefore, the aim of this study was to develop a new mandibular advancement system “Easy Jaw Advancer” (EZJA) for enhancing the mandibular growth which have a simple structure and easy to assemble directly in the clinic.

EZJA was inclined planes constructed by Band-lok® attached on the occlusal surfaces of upper and lower first premolars to guide the mandible into forward position.

Upper arch: use 0.022” x 0.025” stainless steel wire (SS)

Lower arch: use 0.022” x 0.025” SS with curve of Spee

Band-lok® will be added occlusally on the lower molars for chewing.

For patients with narrow maxillary arches, a first-phase expansion could be done.

EZJA was designed to be used 24 hours a day that there was a continuous stimulus for mandibular growth. Due to no attachment connected between upper and lower teeth, better adaptation for normal functions such as mastication, swallowing, speech, and breathing would be created. Therefore the lower jaw was allowed opening and moving freely. Since the application of force was transmitted directly to the teeth through a supporting system, the main disadvantage may be encountered the dental movements during treatment. However, the unwanted dental movement could be avoided by good anchorage preparation and forward jaw training program. The EZJA was simple to use, easy to make and not need laboratory process.

Objectives

The aims of this study were

1. To develop a new mandibular advancement appliance “Easy Jaw Advancer” (EZJA) under the same principle as Twin-Blocks appliance
2. To determine the treatment effects of EZJA

Hypothesis

Mandibular growth of the Class II patients treated with EZJA is more than that of untreated patients.

Significances of the study

1. The treatment of Class II with retrognathic mandible can be treated with comparable orthopedic effect but possible easier clinical application.
2. With the new system, the treatment of Class II by inducing mandibular growth will consume less chair time because it does not need banding and laboratory processing.
3. Comfortable to patient due to the small size of the appliance.
4. The new system will reduce the cost of treatment because it needs less materials and chair time.

The limitations of the study

This study was performed under the limitation of time, thus the long-term effect from this technique, such as remaining mandibular growth could be investigated in the future.

CHAPTER 2

MATERIALS AND METHODS

2.1 Sampling selection

Twenty two orthodontic patients, 8 boys and 14 girls, age range 11-14 years were randomly selected from Orthodontic clinic, Dental hospital, Faculty of Dentistry, Prince of Songkla University. The inclusion criteria for all subjects were:

1. Healthy patients, no underlying disease
2. Skeletal Class II with retrognathic mandible indicated by retruded chin compared to the forehead.
3. During MP_3 stage (maximal pubertal growth not yet reached) assessed by hand & wrist radiographic examination.
4. Complete eruption of the maxillary and mandibular permanent first premolars was necessary, the appliance to be attached to the teeth.

All of patients were informed about step of treatment and willing to participate. Exclusion criteria were:

1. Missing of maxillary permanent first premolars and/or mandibular permanent first premolars
2. During end stage of growth
3. Could not have continuous treatment

When the patients were satisfied the inclusion criteria, they were invited to join this project. All patients and their parents were informed about the purpose of this study and steps of treatment. Each patient who agreed to participate in our study signed in consent form.

The new patients who came to Orthodontic clinic, Dental hospital, Faculty of Dentistry, Prince of Songkla University and met the inclusion criteria were randomly included in control group. While, the patients in treated group were selected from the waiting lists.

1. Control group: 4 boys and 7 girls were observed for 6-12 months.

2. Treatment group: 4 boys and 7 girls were treated with EZJA until edge-to-edge position was achieved or overcorrected in Class I malocclusion.

1.2 Experimental design in sample patients

All patients were treated with upper and lower preadjusted edgewise fixed appliance (Roth's prescription). The brackets were 0.022 x 0.028 inches slot size. The first stage of treatment, upper and lower arch were leveling until 0.021" x 0.025" stainless steel wires. In the lower arch, curve of Spee and lingual crown torque were maintained. For patients with narrow arches could use expansion in order to expand upper arch. The goals of this phase were to align teeth and harmonize arch form prepared for mandibular advancement. By expanding the maxillary dental arch in order to allowing the mandible to move to a more comfortable anterior position, facilitating Class II correction.

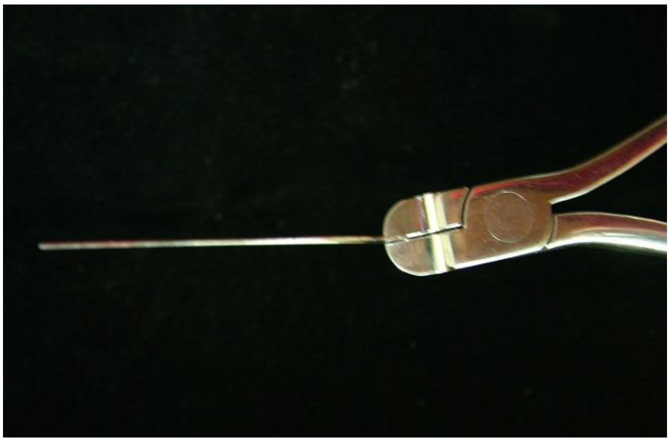


Fig. 2: For anchorage preparation, placed lingual crown torque in lower incisors (about 10-15^{o})

For avoiding unwanted dental movement, good anchorage preparation should be carried out. The mandibular incisors were placed lingual crown torque to prevent labial crown tipping of these teeth.[18-20]

To construct the EZJA, Band-lok® were bonded on the maxillary permanent first premolars and mandibular permanent first premolars with the shape similar to inclined plane of Twin-Blocks appliance for 2 mm mandibular advancement. Every 2 months, the stepwise mandibular advancement was done by 2 mm additional resin composite.[22] For the reason of chewing, the Band-lok® were constructed on the occlusal surface of lower molars. The patients were followed up every month; with activations at each succeeding appointment until normally positioned of chin when compared with forehead was achieved.

Fig. 3: The overall component of EZJA

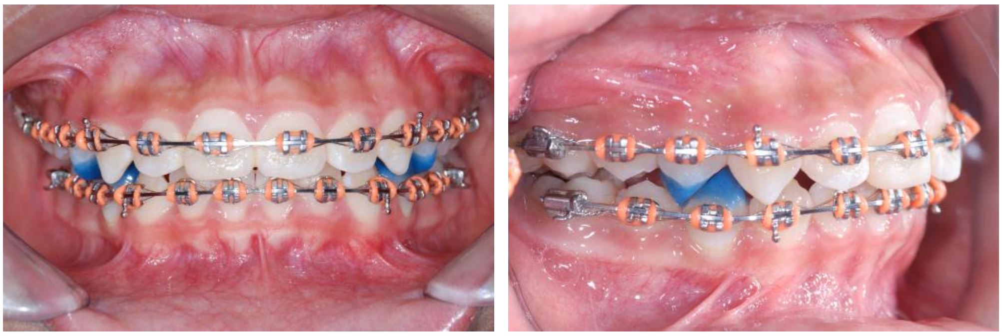


Fig. 4: The first activation for induced forward movement of mandible by stepwise advancement

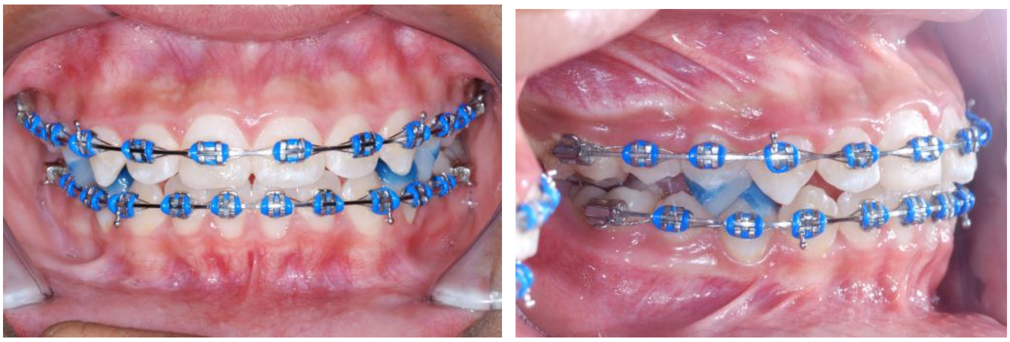


Fig.5: The second activation, the resin composite could be added approximately 2 mm. until normally positioned of chin when compared with forehead was achieved

2.3 Data recording

Data recording of control group and treatment group (initial record)

- X-ray (Lateral cephalogram, Hand & Wrist)
- Photo
- Study model

Data recording of treatment group (Before EZJA)

- X-ray (Lateral cephalogram)
- PhotoStudy
- Study model

Data recording of control group after observed for 6-9 months and treatment group after treatment until normally positioned of chin when compared with forehead was achieved (Final record)

Control group

- X-ray (Lateral cephalogram, Hand & Wrist)
- Photo

Sample group

- X-ray (Lateral cephalogram, Hand & Wrist, OPG)
- Photo

2.4 Cephalometric analysis

The analyses of treatment effects (skeletal and dental changes) were investigated from the tracing of the lateral cephalogram before and after treated with EZJA. These data were compared with corresponding data from the control group. The cephalometric systems described by Pancherz were used to analyze the treatment effects.[27] The landmarks were showed in Figure 6. The measurement for each variable was made with cephalometric protractor. Linear measurements were made to the nearest 0.5 mm and angular measurements were made to the nearest 0.5°which perform on acetate tracing paper.

Using cephalometric analysis in this trial assessed three relationships:

- Sagittal position changes of the maxillary and mandibular landmarks
- Vertical position changes of the maxillary and mandibular landmarks
- Angles (°)

The measuring points, reference points and reference lines were defined as follows

Measuring points

- Co (condyle): The most superoposterior point on the curvature of the condylar head determined by bisecting the angle formed by the lines which are tangent to the superior and posterior border of the condyle parallel with OL and OLp respectively.
- Ii (Incision inferius): The incisal tip of the most prominent mandibular incisor
- Is (Incision superius): The incisal tip of the most prominent maxillary incisor
- Pg (Pogonion): The most anterior point on the bony chin determined by a tangent perpendicular to OL.
- Me (Menton): The most inferior point on the bony chin determined by a tangent parallel to OL.
- Gn (Gnathion): The point between menton and pogonion
- Ss (Subspinale): The deepest point on the anterior contour of the maxillary alveolar projection determined by a tangent perpendicular to OL.
- Pg' (soft tissue Pogonion): The point of soft tissue chin determined by trace from the Pg point perpendicular to N-Pg plane

Reference points

- N (Nasion): The most anterior limit of suture nasofrontalis.
- S (Sella): The center of sella turcica. The point was used as registration point for all head film.

Reference lines

- NSL (nasion-sella line): The line through n and s. The line will be used for orientation of all head films.
- OL (occlusal line): A line through is and the distobuccal cusp of the maxillary permanent first molar. The line from the initial head film will be used as reference line for measurements on all head films.
- OLp (occlusal line perpendiculare): A line perpendicular to OL through s. The line from the initial head film will be used as reference line for measurements on all head films.
- OLs: A line parallel to OL through s. The line from the initial head film will be used as reference line for measurements on all head films.

Measuring procedure

The profile radiographic analysis will be comprised the following variables:

1. Is/OLp minus Ii/OLp: overjet

Skeletal measuring points

2. Ss/OLp: position of the maxillary base
3. Pg/OLp: position of the mandibular base
4. Co/OLp: position of the condylar head
5. Pg/OLp + co/OLp: mandibular length
6. Pg/OLs: vertical position of the mandibilar base

Dental measuring points

7. Is/OLp: position of the maxillary central incisor
8. Ii/OLp: position of the mandibular central incisor
9. Is/Ols: vertical position of the maxillary central incisor
10. Ii/Ols: vertical position of the mandibular central incisor

Soft tissue measuring point

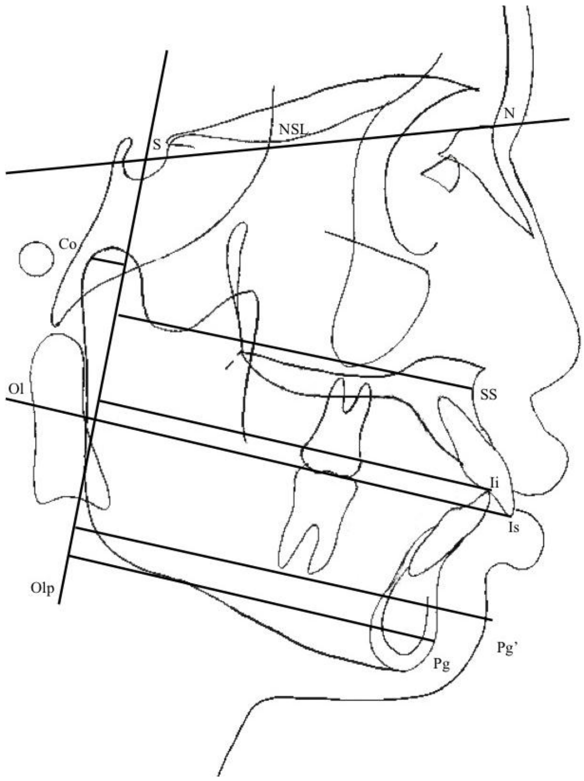
11. Pg'/Olp: position of the soft tissue chin

12. Pg'/Ols: vertical position of the soft tissue chin

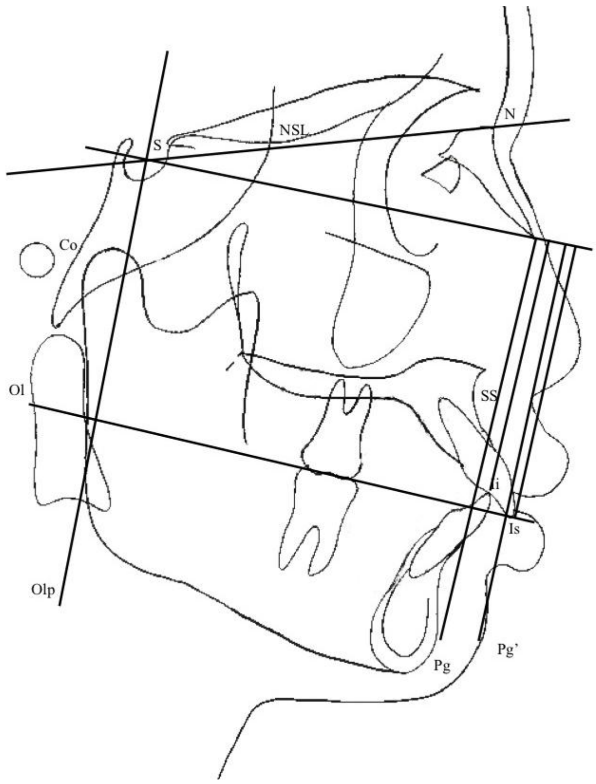
Angles (^{o})

13. SNA: Maxillary position
14. SNB: Mandibular position
15. ANB: Sagittal jaw relation
16. UI to PP: Maxillary incisors inclination
17. LI to MP: Mandibular incisors inclination

A



B



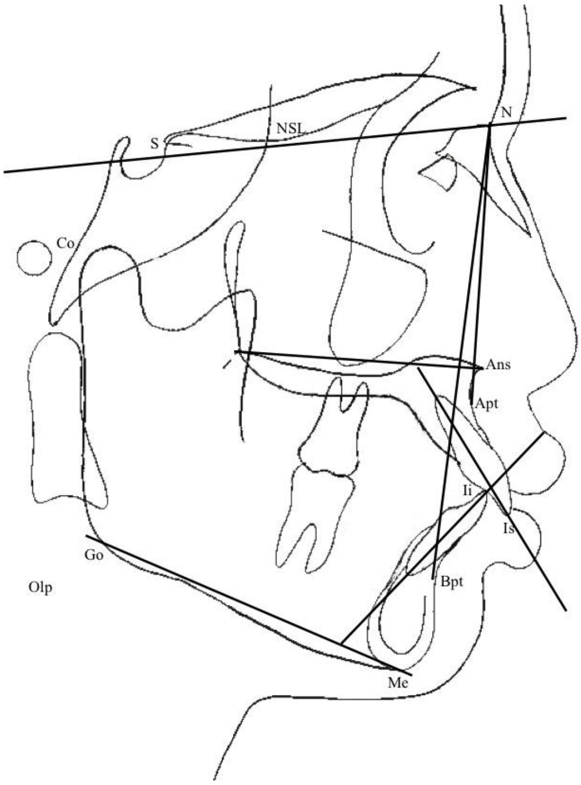


Fig. 6: Cephalometric landmarks for investigated treatment effects: A, Horizontal measurements (Olp); B,Vertical measurements (Ols); C, Angular measurement

For all cephalometric landmarks with right and left images, the midpoints bisecting the 2 images were used. The analyses of the skeletal, dental and soft tissue changes were recorded along the occlusal line (OL) and to the occlusal line perpendicular (OLp) from the first cephalogram were used as a reference grid. The grid was then transferred from the first tracing to the following tracings by superimposition of tracings on the middle cranial structure.

2.5 Statistical analysis

Mean and standard deviation (SD) of subjects were calculated for all cephalometric variables. Means of individuals cephalometric variable at before EZJA was T1, post-treatment was T2, pre-observe was C1, post-observe was C2. These data were compared means in difference within sample group (ΔT) and control group (ΔC). Between sample and control groups also were compared means in difference. The statistical comparisons were performed by means of nonparametric test: Mann-Whitney *U* test that were carried out with the aid of a commercial statistical package (SPSS for Windows). The differences of probabilities of less than 5% ($P \leq 0.05$) were considered statistically significant.

Error measurement

The errors in locating, superimposing and measuring the changes of the reference points by 1 examiner were measured on the cephalograms. To assess the error of locating and the digitizing procedure, 10 randomly selected cephalograms were retracted and remeasured after approximately four weeks by the same examiner. The casual error of the method by the Dahlberg formula did not exceed 0.8°or 0.6 mm.

The magnitude of the combined method error (ME) in locating, superimposing and measuring the changes of the different cephalometric landmarks were calculated with the formula

$$ME= \sqrt{(\Sigma d^2/2n)}$$

Where *d* was the difference between 2 registrations of a pair, *n* was the number of double measurements. The error in this study was found to be 0.25 mm (range, 0 to 0.50 mm) for linear measurements, 0.33° (range, 0° to 1.0°) for angular measurements.

2.6 Table of outcome

Cephalometric variables	C_1	C_2	C_2-C_1 (ΔC)	T_1	T_2	T_2-T_1 (ΔT)	ΔT – ΔC	Sig ($p \leq 0.05$)
Sagittal distances								
1. Overjet								
2. Maxillary base								
3. Mandibular base								
4. Condylar head								
5. Mandibular length								
6. Co-Gn								
7. Maxillary incisor								
8. Mandibular incisor								
***Vertical distance**s*								
9. Maxillary incisor								
10. Mandibular incisor								
11. Vertical mandibular position								
Soft tissue distance								
12. Soft tissue chin								
13. Soft tissue chin vertical								
Angle(^{o})								
14. SNA								
15. SNB								
16. ANB								
17. UI to PP								
18. LI to MP								

CHAPTER 3

RESULTS

This study was designed to develop a new system of fixed type functional appliance to enhance the orthopedic effect, reduce orthodontic effect and investigate skeletal and dental changes in patients treated with Easy Jaw Advancer. All patients were divided into two groups. The control group consisted of 11 healthy patients, 4 boys and 7 girls with mean 11.95 years of age at pre-observed period. Each patient had bilateral Class II molar relationship, none of subjects had passed maximal pubertal growth, as assessed by hand and wrist radiograph, and no orthodontic treatment was performed during follow up period. In this group, all subjects were investigated growth changes for 9 months in average by analysis of lateral cephalogram from before and after follow up period, according to the method of Pancherz(27). The subjects' mean and standard deviation (SD) were calculated for all cephalometric variables. Between sample and control groups also were compared means in difference. After each variable of results were analyzed for normal distribution, it found that the data was not the normal distribution therefore nonparametric statistical test was used to analyze in this study. The differences of probabilities of less than 5% ($P<0.05$) were considered statistically significant.

The comparison of cephalometric records before (C1) and after (C2) follow-up period was presented in Table I. From the representing normal growth changes, the results could be defined as follows.

Sagittal changes

Sagittal changes in control group were compared in Table I. Overjet reduced 0.41 mm. Both maxillary base (OLp-Apt) and mandibular base (OLp-Pg) moved forward 1.23 and 1.36 mm. respectively. Mandibular length (Co-Gn) increased 1.36 mm. during follow-up period.

Table 1 Comparison of cephalometric records before and after follow-up period (6-12 months)

Variables (mm.)	Control group (n=11)						Sig. (P ≤ 0.05)
	C1		C2		Control different (ΔC)		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Sagittal distances							
1. Overjet	9.09	3.23	8.59	2.70	-0.41	2.01	NS
2. Maxillary base	78.77	4.16	79.91	4.23	1.23	1.25	NS
3. Mandibular base	78.36	5.12	79.72	5.23	1.36	1.23	NS
4. Condylar head	9.27	3.14	9.23	3.17	-0.05	-0.57	NS
5. Mandibular length	87.64	4.43	88.95	4.84	1.36	1.20	NS
6. Co-Gn	108.50	5.58	110.82	5.33	2.32	1.54	0.003*
7. Maxillary incisor	90.82	6.01	91.14	6.20	0.32	2.98	NS
8. Mandibular incisor	81.59	4.16	82.50	4.76	0.91	2.64	NS
Vertical distances							
9. Maxillary incisor	55.45	5.93	57.27	6.21	1.82	1.23	0.005*
10. Mandibular incisor	51.23	6.60	53.18	6.52	1.95	1.27	0.005*
11. Vertical mandible	82.73	7.76	85.64	7.78	2.91	1.67	0.003*
Soft tissue distances							
12. Soft tissue chin	91.32	5.35	92.32	4.98	1.00	1.26	NS
13. Soft tissue chin vertical	80.05	7.52	82.50	7.69	2.45	1.25	0.003*
Angles (^{o})							
14. SNA	82.59	2.65	82.91	3.02	0.32	1.33	NS
15. SNB	76.32	2.35	76.27	2.88	-0.05	0.91	NS
16. ANB	6.27	1.68	6.64	1.78	0.36	1.16	NS
17. UI to PP	120.73	11.28	119.18	5.49	-1.55	7.01	NS
18. LI to MP	101.14	4.79	100.27	7.70	-0.86	5.00	NS

For the angular measurement, the position of maxilla (SNA) and mandible (SNB) relative to cranial base were increased 0.32^{o} and 0.05^{o} respectively. ANB angle had increase for 0.36^{o}

For the dental changes, maxillary (Is/OLp) and mandibular (Ii/OLp) incisor showed forward movement of 0.32 and 0.91 mm. respectively. The maxillary incisor angle (UI to PP) moved palatally 1.55^{o} whereas the mandibular incisor angle (LI to MP) retroclined 0.86^{o} during observation.

Vertical changes

For the dental changes, the maxillary incisor (Is/OLs) moved downward 1.82 mm. and the mandibular incisor (Ii/OLs) exhibited downward movement of 1.95 mm. The mandible (Pg/OLs) also moved downward 2.91 mm. during follow-up period.

Soft tissue changes

For the soft changes, the chin (Pg'/OLp) moved forward 1.00 mm. and the vertical dimension (Pg'/OLs) exhibited downward movement of 2.45 mm. during follow-up period.

Treatment group

In treated group, 11 other subjects (4 boys and 7 girls) with mean age of 12.67 years of age and with the same type of malocclusion and dental morphology as the control group were used as a sample group. The average of treatment time was 7.55 months. The comparison of starting craniofacial morphology of treated and control subjects was showed in Table II, no statistically significant differences between treated and control groups were found in all cephalometric variables.

After treatment, we founded the significant differences of 12 variables such as overjet, maxillary base, mandibular base (sagittal distances), mandibular length, SNB and ANB angle as showed in Table III. The treatment result had improved the occlusion and skeletal relationship that can be defined as follows.

Sagittal changes

Sagittal changes in treated group were compared in Table III. The use of EZJA induced forward movement of the mandibular base (OLp-Pg) 5.50 mm. The position of the condyle (OLp-Co) was maintained with treatment. Effective mandibular length (Co-Gn) increased 5.09 mm. during treatment.

For the angular measurement, the position of the maxilla relative to the cranial base (SNA) had maintained during treatment. The treatment induced forward movement of the mandible 2.73° relative to the cranial base (SNB). ANB angle had a decrease of 2.91°

For the dental changes, the mandibular incisor (Ii/OLp) showed forward movement of 5.09 mm. after treated with EZJA. Overjet improved significantly, showing a decrease of 4.32 mm. after treatment. The maxillary incisor angle (UI to PP) moved palatally 1.23° while the mandibular incisor angle (LI to MP) retroclined 2.00° during treatment. No statistically significant differences were found in the inclination of lower incisors.

Vertical changes

For the dental changes, the maxillary incisor (Is/Ols) was move downward 1.77 mm. and the mandibular incisor (Ii/OLs) exhibited downward movement of 3.95 mm. during treatment. The mandible (Pg/OLs) was downward growth 3.86 mm. during treatment. The relationship between skeletal and dental changes contributing to Class II correction in the incisor segment was seen in Fig 9. From the representing treatment effects in Table IV, the group differences for the different variables were considered to represent the treatment effects of the EZJA. The result can be defined as follows

Soft tissue changes

For the soft changes, the chin (Pg'/OLp) moved forward 5.91 mm. and the vertical dimension (Pg'/OLs) exhibited downward movement of 3.91 mm. during EZJA period.

<u>Treatment and control subjects</u>

Sagittal changes

Sagittal changes in patients in treatment and control group were compared in Table IV. Compared with the control group, the treatment effects could maintain the maxillary base (OLp-Apt) while the mandibular base moved forward 4.14 mm. The position of the condyle (OLp-Co) was found to move forward 0.18 mm. Effective mandibular length (Co-Gn) increased 3.73 mm. during treatment compared with the control group.

For the angular measurement, the position of the maxilla relative to the cranial base (SNA) had a decrease during treatment (0.13^{o}) compared with the control group, but no statistically significant. The treatment induced forward movement of the mandible (2.77^{o}) relative to the cranial base (SNB). ANB angle had a decrease of 3.24^{o}

For the dental changes, the maxillary incisor (Is/OLp) showed forward movement of 0.45 mm. after treatment compared with the control group. Treatment effects on the position of the mandibular incisor (Ii/OLp) showed forward movement of 4.18 mm. with treatment. Overjet improved significantly, showing a decrease of 3.91 mm. during treatment resulting from forward movement of the mandibular incisors.

The maxillary incisor angle (UI to PP) moved labially 0.32^{o} but the mandibular incisor angle (LI to MP) retroclined 1.05^{o} during treatment. No statistically significant differences were found in the position of lower incisors.

Mandibular length (Co-Gn)

Compared with the control group, mandibular length (Co-Gn) increased 4.77 mm. during treatment compared with the control group. A statistically significant difference was found in this variable.

Vertical changes

For the dental changes, the maxillary incisor (Is/OLs) was maintained while the mandibular incisor (Ii/ML) exhibited downward movement of 2.00 mm. compared with the control group during treatment. The mandible (Pg/OLs) was move downward 0.95 mm. during treatment.

Soft tissue changes

For the soft tissue changes, the chin (Pg'/OLp) was move forward 4.95 mm. compared with the control group during treatment. The vertical changes (Pg'/OLs), chin was move downward 1.46 mm. during treatment.

Table 2 Comparison of starting craniofacial morphology of treated and control subjects

Variables (mm.)	Control group (n=11)		Treated group (n=11)		Sig. ($P \leq 0.05$)
	Mean	S.D.	Mean	S.D.	
Sagittal distances					
1. Overjet	9.09	3.23	8.45	2.72	NS
2. Maxillary base	78.77	4.16	79.95	4.29	NS
3. Mandibular base	78.36	5.12	80.14	5.13	NS
4. Condylar head	9.27	3.14	9.27	3.09	NS
5. Mandibular length	87.64	4.43	89.41	4.49	NS
6. Co-Gn	108.50	5.58	109.14	4.93	NS
7. Maxillary incisor	90.82	6.01	91.00	6.06	NS
8. Mandibular incisor	81.59	4.16	82.55	4.87	NS
Vertical distances					
9. Maxillary incisor	55.45	5.93	57.45	6.41	NS
10. Mandibular incisor	51.23	6.60	53.14	6.51	NS
11. Vertical mandible	82.73	7.76	85.86	7.76	NS
Soft tissue distances					
12. Soft tissue chin	91.32	5.35	93.73	5.00	NS
13. Soft tissue chin Vertical	80.05	7.52	82.23	7.80	NS
Angles(^{o})					
14. SNA	82.59	2.65	82.91	3.02	NS
15. SNB	76.32	2.35	76.36	3.06	NS
16. ANB	6.27	1.68	6.50	1.67	NS
17. UI to PP	120.73	11.28	119.18	5.16	NS
18. LI to MP	101.14	4.79	100.18	9.04	NS

Table 3 Comparison of cephalometric records before and after treated with EZJA

Variables (mm.)	Treatment group (n=11)						Sig. ($P \leq 0.05$)
	T_1		T_2		Treatment different (ΔT)		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Sagittal distances							
1. Overjet	8.45	2.72	4.14	2.35	-4.32	2.16	0.05*
2. Maxillary base	79.95	4.29	81.23	4.60	1.27	1.62	0.018*
3. Mandibular base	80.14	5.13	85.64	5.04	5.50	3.42	0.005*
4. Condylar head	9.27	3.09	8.86	3.04	-0.23	0.72	NS
5. Mandibular length	89.41	4.49	94.50	4.56	5.09	3.29	0.005*
6. Co-Gn	109.14	4.93	116.05	2.65	7.09	3.65	0.003*
7. Maxillary incisor	91.00	6.06	91.77	5.61	0.77	2.78	NS
8. Mandibular incisor	82.55	4.87	87.66	5.75	5.09	3.45	0.003*
Vertical distances							
9. Maxillary incisor	57.45	6.41	59.23	6.64	1.77	1.52	0.007*
10. Mandibular incisor	53.14	6.51	57.00	6.73	3.95	1.21	0.003*
11. Vertical mandible	85.86	7.76	89.73	7.34	3.86	1.38	0.003*
Soft tissue distances							
12. Soft tissue chin	93.73	5.00	99.64	5.10	5.91	3.73	0.003*
13. Soft tissue chin vertical	82.23	7.80	85.82	7.59	3.91	1.63	0.003*
Angles (^{o})							
14. SNA	82.91	3.02	82.72	2.85	0.05	0.52	NS
15. SNB	76.36	3.06	79.09	2.94	2.73	0.88	0.003*
16. ANB	6.50	1.67	3.59	1.38	-2.91	1.02	0.003*
17. UI to PP	119.18	5.16	117.95	5.81	-1.23	4.13	NS
18. LI to MP	100.18	9.04	98.18	8.65	-2.00	5.27	NS

Table 4 Changes in cephalometric records during the examination period

Variables (mm.)	C_2-C_1		T_2-T_1		Group difference	
	Mean	S.D.	Mean	S.D.	Mean	Sig. (P≤0.05)
Sagittal distances						
1. Overjet	-0.41	2.01	-4.32	2.16	-3.91	0.001*
2. Maxillary base	1.23	1.25	1.27	1.62	0.04	NS
3. Mandibular base	1.36	1.23	5.50	3.42	4.14	0.002*
4. Condylar head	-0.05	-0.57	-0.23	0.72	-0.18	NS
5. Mandibular length	1.36	1.20	5.09	3.29	3.73	0.004*
6. Co-Gn	2.32	1.54	7.09	3.65	4.77	0.004*
7. Maxillary incisor	0.32	2.98	0.77	2.78	0.45	NS
8. Mandibular incisor	0.91	2.64	5.09	3.45	4.18	0.006*
Vertical distances						
9. Maxillary incisor	1.82	1.23	1.77	1.52	-0.05	NS
10. Mandibular incisor	1.95	1.27	3.95	1.21	2.00	0.020*
11. Vertical mandible	2.91	1.67	3.86	1.38	0.95	0.049*
Soft tissue distances						
12. Soft tissue chin	1.00	1.26	5.91	3.73	4.95	0.000*
13. Soft tissue chin Vertical	2.45	1.25	3.91	1.63	1.46	0.030*
Angles(^{o})						
14. SNA	0.32	1.33	0.05	0.52	-0.13	NS
15. SNB	-0.05	0.91	2.73	0.88	2.77	0.000*
16. ANB	0.36	1.16	-2.91	1.02	-3.24	0.000*
17. UI to PP	-1.55	7.01	-1.23	4.13	0.32	NS
18. LI to MP	-0.86	5.00	-2.00	5.27	-1.14	NS

A

B

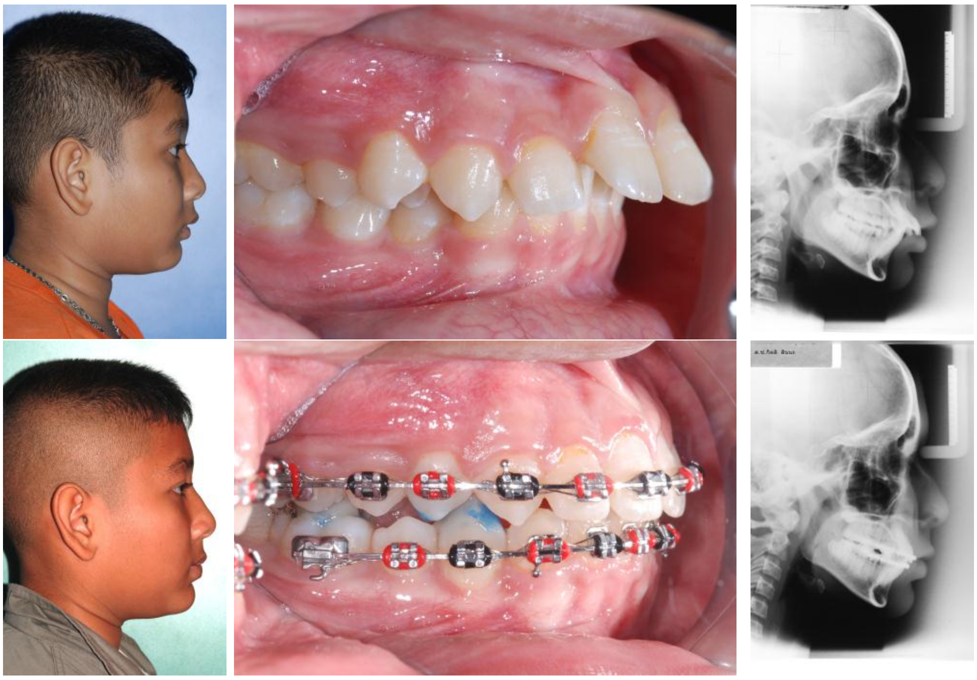


Fig. 7: Extraoral photographs, intraoral photographs (lateral view), lateral cephalogram of boy patient, 12 years of age, treated with EZJA (**A,** Before treatment. **B,** After treatment)

A

B

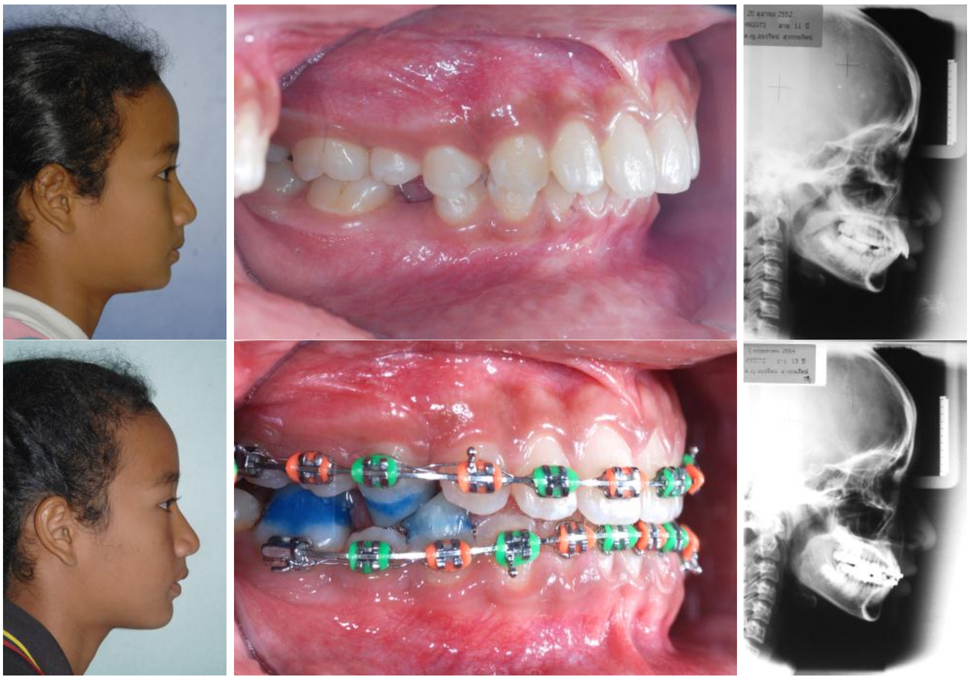


Fig. 8: Extraoral photographs, intraoral photographs (lateral view), lateral cephalogram of girl patient, 11 years of age, treated with EZJA (**A,** Before treatment. **B,** After treatment)

<u>The relationship between skeletal and dental changes of treated group</u>

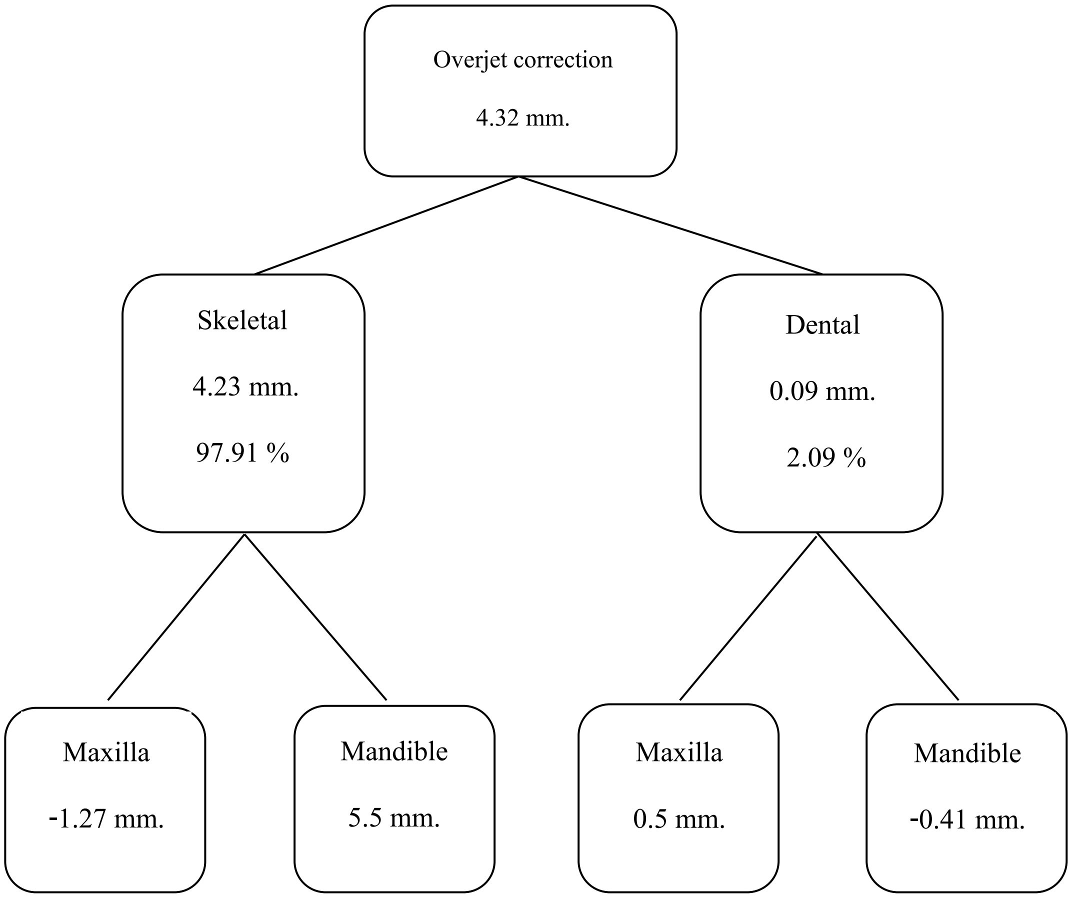


Fig. 9: Show the skeletal and dental contributions to overjet correction. During treatment, overjet correction was 4.23 mm. compared with the control group, 97.91% of this was due to skeletal changes and 2.09% to dental changes

CHAPTER 4

DISCUSSION

As a new intervention, treatment response to the Easy Jaw Advancer (EZJA) has not been reported. Our objective was to investigate skeletal and dental changes in patients with Class II malocclusions treated with the EZJA. The present study was conducted in 22 young patients with Class II malocclusion during the skeletal maturity stages MP3. The subjects were divided into two groups. In treated group, the subjects were treated with the new system of fixed functional appliance that is so-called EZJA. The average of treatment time was 7.5 months. All subjects were treated with upper and lower preadjusted edgewise appliance combined with EZJA. After an average of EZJA treatment for 7.5 months, all subjects developed facial appearance was improved to straight profile. In control group, all subjects were not treated. The treatment effects of this appliance could be estimated by deducting the growth changes obtained from control group, which also has been observed for 9 months in average. Compared to many previous studies,[2-4, 8-10, 15, 28-30] treatment times were approximately from 6 to 12 months which were comparable to our study.

From the control group results (Table I), showed small improvements and large individual variations. Some patients improved, some remained unchanged and other get worse. Both maxillary and mandibular base had forward growth whereas mandibular base growth was greater than maxillary base (1.36 and 1.23 mm. respectively). It may be assumed that the condylar growth was regularly taken place at this pubertal growth spurt whereas maxillary growth was already passed.[14] Both of SNA and SNB has demonstrated the same amount of forward growth which resulting in no change of ANB. The inclinations of maxillary incisors were not changed whereas mandibular arch some cases showed flaring of mandibular incisors due to a dental compensation for the skeletal discrepancy.

From treatment group results (Table III), the overjet was improved by 4.32 mm. There were orthopedic effects in both the maxilla and the mandible producing improvement in skeletal convexity and jaw base relationships. It has showed that the EZJA had the ability to increase growth in mandibular base. There were also increased in mandibular length (Co-Gn distance increase 7.09 mm.), which was possible resulted from both of anteroposterior growth of condyle (Co) and mandibular base. The forward position of the mandible found after EZJA was mainly a result of an increase in mandibular length supported by several studies, which thought to be due to condylar growth stimulation as an adaptive reaction to the forward positioning of the mandible.[6-8, 10, 25, 27, 31, 32] This would be in agreement with several animal bite jumping experiments in cellular level.[23, 24] This might be a result of remodeling process in the articular fossa as a compensatory reaction following an anterior displacement of the mandible.

The Class II skeletal correction was achieved by forward mandibular growth (SNB=2.73^{o}), which leaded to significant reduction of ANB (ANB=-2.91^{o}).

In this study, significant decreased in the amount of overjet were observed. This reduction of overjet was due to mandibular base protrusion and mandibular incisors forward movement.

The treatment effect results in this study were estimated by treatment group results deducting with the growth changes in control group (ΔT-ΔC) revealed in Table IV. The improvement seen in sagittal occlusal relationship was higher in skeletal effects (97.91%) than dental effects (2.09%). The change in position of the maxilla in treatment and control subjects did not significant difference. This indicated that its normal forward growth was not restrained, EZJA did not have headgear effects. While the mandibular base was improved significantly. The lower jaw moved forward 4.14 mm. during treatment compared with the control group. Since the appliance affects the maxilla minimally, it should not be used when the Class II malocclusion is due to a prognathic maxilla.

The mainly effect of enhancing mandibular growth with EZJA treatment resulted in significant improvements in overjet and skeletal relationships. Of the 4.32 mm. of overjet change, 97.91% was contributed by skeletal changes and 2.01% by dental changes. Our study has received more efficiency than other studies with the same treatment time (6-8 months) that reported about 18-71% of the changes from skeletal changes.[4, 6, 8, 10, 14, 33]

Table 5 Skeletal and dental components of overjet correction with Twin-Blocks appliance compared to EZJA

Authors	Skeletal change	Dental change	Mandibular base change
Sittipornchai and Charoemratrote 2012	97.91%	2.01%	5.5 mm.
Lund and Sander[10] 1998	18.00%	82.00%	2.3 mm.
Toth and McNamara[4] 1999	70.59%	29.41%	1.9 mm.
Mills and McCulloch[33] 2000	57.14%	42.86%	3.8 mm.
Baccetti *et al*[14] 2000	54.00%	46.00%	2.5 mm.
Schaefer *et al*[6] 2004	43.75%	56.25%	1.8 mm.

The skeletal and dentoalveolar contributions to overjet correction during Twin-Blocks therapy derived from previous studies were listed in Table V.[4, 6, 10, 14, 33] In these studies, there were variations in the skeletal and dental changes. The skeletal effects were reported to range from an average of 18.00% in study by Lund and Sander[10] to 70.59% in the study by Toth and McNamara[4] whereas dental change has been showed between 29.41% to 82.00%.[4, 10] The treatment times were approximately 8 months. The amount of mandibular base forward movement was approximately 1.9 - 3.8 mm.[8, 10] In our study, on average, there is enhanced sagittal growth of the mandible when using the EZJA 5.5 mm., but this effect varies between individual patients (from 3 to 9 mm. during 7.5 months of treatment in average). Therefore, our study was found that the use of EZJA enhances skeletal effect more than other previous studies.

Our study showed no significant change in maxillary incisors inclination and position during treatment because the heavy main arch wire (0.021” x 0.025”) fit in bracket slot hold all maxillary teeth as a unit counteract the distal force of the appliance, while the mandibular incisors position had significantly forward movement caused by forward growth of mandibular base.

The dental changes seen during EZJA treatment was minimized, basically result of anchorage preparation in both dental arches. The functional inclined plane effect produced a posterior-directed force on the upper teeth and an anterior-directed force on the lower teeth,[5] resulting in posterior tooth movements in the upper anterior teeth and anterior tooth movements in the mandible. Significant proclination of the mandibular incisors was found in the Twin-Blocks group. This proclination of the mandibular incisors probably is a consequence of the resultant mesial force on the lower incisors induced by the inclined plane of the Twin-Blocks appliance that produced a downward and forward vector of force. Our observation contrasted to the results of Twin-Blocks studies,[4, 6, 10, 33] which found an increase in IMPA of 2.8-8.2^{o} but retroclination in our study (-2.00^{o}).

The unwanted movement of the lower incisors were regularly associated with the anterior directed force exerted to the lower anterior teeth by inclined plane mechanism was planned to avoid by mandibular anchorage preparation. It should be prevented especially in those with an initial incisor proclination. We were placing lingual crown torque in lower anterior teeth;[18-20] however there was proclination of lower incisors that may be the results of the lower canine angulation was improper. When the crown of lower canine tipped forward, the anchorage also reduced. For this reason, the curve arch wire was placed to maintain curve of Spee and this distal tipping of lower canine during leveling period.

In our study, the appliance was advanced until normally positioned of chin was achieved with step-by-step advancement. In previous study,[21, 23, 24, 26, 27] indicated that step-by-step advancement of the mandible might enhance mandibular growth more than maximum jumping only. In 2002, Hagg *et al*[24] reported an increase in bone formation in both condyle and glenoid fossa after mandibular advancement using a fixed functional appliance. A better response was believed to occur when advancement took place in a gradual manner, to allow the muscle and condyle to adapt to the new position, an increase in the amount of skeletal effect, a reduction in the amount of dentoalveolar compensation, and better stability. Rabie *et al*[23] reported similar results using the headgear-Herbst appliance. It has been indicated in a clinical study[21] that step-by-step advancement of the mandible might enhance mandibular growth more than maximal jumping only. In a previous comparison of treatment results over 12 months, it was shown that the improvement in the jaw base relationship produced by the headgear-Herbst appliance with step-by-step advancement of the mandible was twice as large as that of the conventional Herbst appliance with maximum jumping of the mandible.[24]

On the other hand, Pancherz[27] and Clark[5] suggested that, for maximal treatment response on mandibular growth especially, the Herbs and Twin-Blocks appliance should be constructed with the mandible displaced anteriorly as much as possible, namely, to an edge to edge position between the incisors.

In our study, we investigated the effects of treatment with EZJA with step-by-step mandibular advancement, the results showed that it could reduce unwanted tooth movement and enhance orthopedic effects. The hard and soft tissues (teeth, bone and musculature) would need some time for physiologic adaptation to the new mandibular position. As a result of step-by-step advancement, its allow the muscle and condyle to adapt to the new position, an increase in the amount of skeletal effect, a reduction in the amount of dentoalveolar compensation and better stability.[24]

The advantage of this EZJA was effective to maximize orthopedic effect; the results were not routinely seen with other functional studies, this effect significantly contributed to the Class II skeletal correction by anchorage preparation and step-by-step advancement. The reduction of mandibular incisors forward tipping affected from anchorage preparation mechanics placing lingual crown torque in mandibular incisors and maintaining curve of Spee. To increase molars anchorage, the teeth were co-tied. This new system of fixed functional appliance has other advantages such as harmonize shape of dental arch by expansion in upper arch during leveling period, less chance of interference with the appliance because of the smaller size and not have interarch structure, no laboratory process needed, lower costs, easily cleaned and making oral hygiene care simple. In this investigation only minor functional disturbances were found during treatment. All subjects accepted the appliance easily, and no any problems in the cooperation. Breakage of the appliance was not found.

Regarding to treatment timing, the study was introduced at permanent dentition stage. After EZJA treatment, however, it is necessary to use of Class II elastics with edgewise appliance to maintain positive growth pattern and settling occlusion, but it easy to use together with EZJA. In 1985, Pancherz revealed that we should treat the patient in permanent dentition stage because this stage of dental development makes it possible to obtain a stable maximum intercuspation after therapy that will counteract an occlusal relapse.[34] Since good retention depends on sharp-cusped bicuspids to stabilize the correction, the absence of bicuspids at the conclusion of functional therapy jeopardizes the retention. The maturation level of the patients was certainly an important factor in the favorable treatment response found. Baccetti *et al* suggested that Twin-Blocks therapy be instituted during or slightly after the onset of pubertal peak in growth velocity to increase in condylar growth response and to reduce time of posttreatment retention.[14] Franchi *et al* indicated a favorable and clinically significant mandibular increase produced by the acrylic splint Herbst appliance when the patients began treatment at peak of mandibular growth (CVM stage 3 and 4).[35] McNamara *et al* examined a large group of patients treated with the FR-2 appliance of Frankel. Mandibular length increased by 6.4 mm during a two-year period in the younger age group (~8.5 years at the beginning of treatment) and 8.0 mm in the older age group (~11.5 years).[36]

After 7.5 months of active treatment, the net effect on the mandibular incisors seemed to be decreased in the inclination, resulting in an approximately -2.00°. Despite the mandible being advanced gradually during the course of treatment in the treated group, assuming that the forces transmitted to the dental arches would become relatively lower compared with maximal jumping of the mandible. The other reason, slightly retroclined lower incisors can be a result of over preparation of anchorage unit in lower arch. The dental changes seen during Twin-Blocks appliance treatment were basically a result of anchorage loss in the both dental arches. Proclination of the mandibular incisors has been also found in all previous Twin-Blocks studies.[4, 6-8, 10, 11, 14, 33] From treatment results, to maximize skeletal effect on mandibular growth especially, we suggested that EZJA should be constructed with proper anchorage preparation as following.

1. Placing lingual crown torque not more than 10° in lower arch wire for avoiding unwanted dental movement in order to enhancing orthopedic effects.
2. Maintain initially curve of Spee in order to allowing the mandible to move more anterior position and increasing dental anchorage.
3. Step-by-step mandibular advancement (2mm./2months) in order to allowing the muscle and condyle to adapt to the new position for increasing orthopedic effects, reducing dentoalveolar compensation and having better stability.

4. Training patient to protrude jaw all the time. All subjects have been advised to protrude their mandibles forward as much as they can in order to maximize mandibular growth and training muscle in new position. This training also made the dental free from the reaction force.

Further investigation, Temporomandibular joint (TMJ) imaging should be analyzed with respect to structural changes in the articular components. Imaging will be taken on all patients before treatment and prior to appliance removal to check that condylar position has not changed. Computed Tomography (CT) of TMJ of one patient was presented in Figure 10. At the time of T2, signs of condylar remodeling were seen. The postero-superior region of the condyle showed a distinct area of increased bony contour and lengthens the condyle. The increase in mandibular antero-posterior position accomplished by EZJA therapy seems to be a result of condylar growth, similar to the effect described by Ruf and Pancherz.[25] The use of CT will be a precise method to determine whether the condyles are in centric relation in the glenoid fossa. However, the long-term implications of permanent bite jumping still need to be investigated.

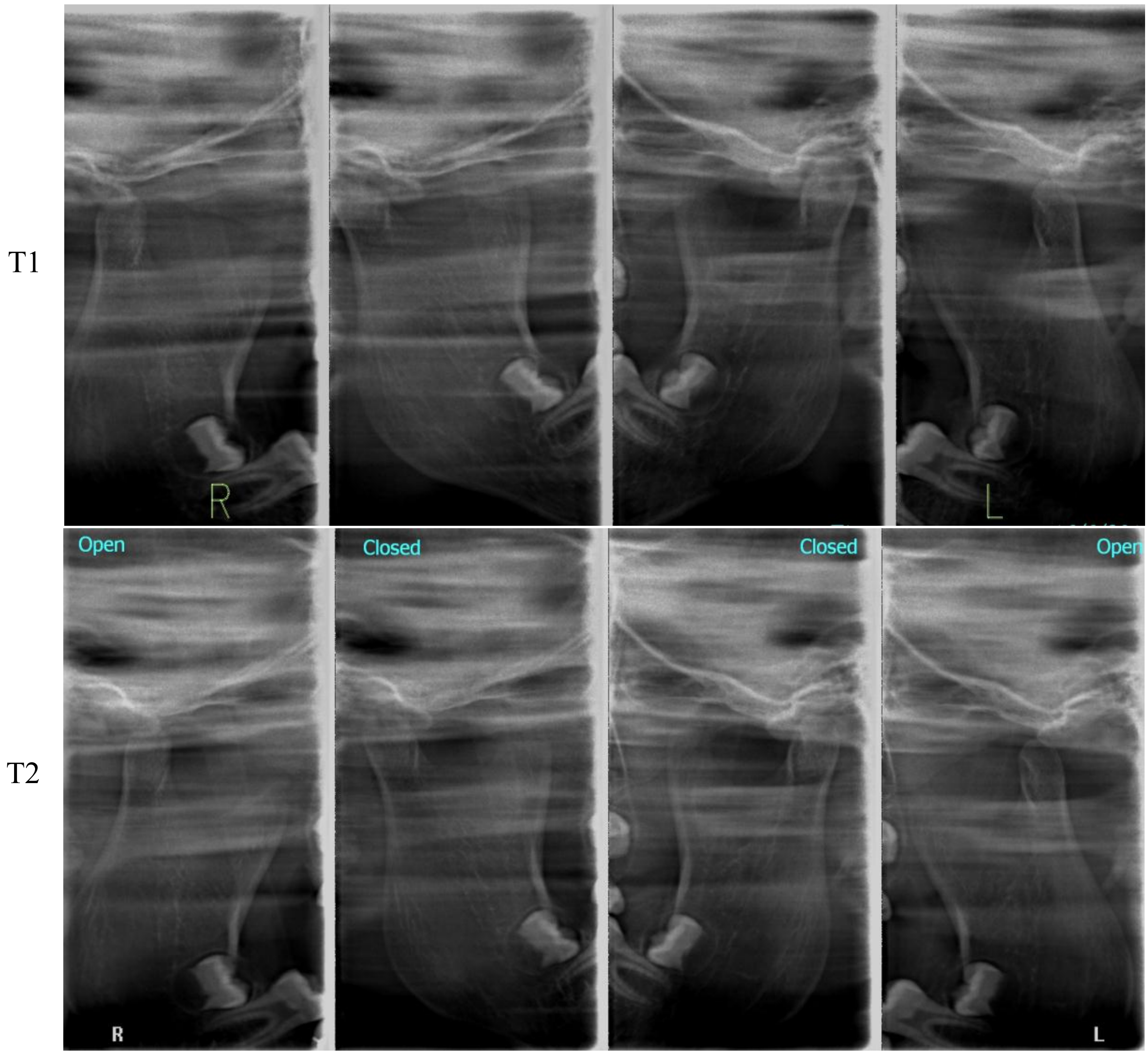


Fig. 10: Adolescent girl aged 11 years 11 months before EZJA treatment. CT of left and right TMJ from different treatment stages was shown: at start of treatment (T1), at 9 months of treatment, 2 months after final position of EZJA (T2)

CHAPTER 5

CONCLUSIONS

In our study, we investigated the effects of treatment with Easy Jaw Advancer (EZJA) with step-by-step mandibular advancement. For maximum orthopedic effects, a combination of factors is critical for the successful outcome of treatment with EZJA. The mandible should be advanced with step-by-step advancement to allow the muscle and condyle to have adaptation for new position of the mandible together with proper anchorage preparation on the upper and lower anterior teeth, sufficient length of treatment and a retention device that maintains a successful outcome.

After EZJA treatment, the results revealed that Class II correction mainly achieved by skeletal change (97.91%) whereas only 2.09% by dental changes. Therefore, we suggest that EZJA can enhance the orthopedic effects and reduce unwanted tooth movement in growing patients by means of proper anchorage preparation and step-by-step advancement. In addition, EZJA could enhance skeletal effect more than other previous studies.

Developing a new system of fixed functional appliance to be the one choice for clinical application in the future for Class II malocclusion with retruded mandible.

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APPENDICES

ใบเชิญชวน

คณะทันตแพทยศาสตร์
มหาวิทยาลัยสงขลานครินทร์
วันที่____เดือน___________พ.ศ. 2552

เรื่อง ขอเชิญเข้าร่วมโครงการวิจัยเรื่อง ผลการกระตุ้นการเจริญเติบโตของขากรรไกรล่างโดยเครื่องมือ Easy jaw advancer (EZJA) ในผู้ป่วยโครงสร้างใบหน้าชนิดที่สองที่มีขากรรไกรล่างเล็ก

เรียน ผู้สนใจเข้าร่วมโครงการวิจัยฯทุกท่าน

ข้าพเจ้า ทพ. อาทิตย์ สิทธิพรชัย นักศึกษาระดับปริญญาโท สาขาทันตกรรมจัดฟันภาควิชาทันตกรรมป้องกัน คณะทันตแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์ ขอแจ้งรายละเอียดเกี่ยวกับโครงการวิจัยและขอเชิญชวนท่านผู้สนใจเข้าร่วมโครงการฯ ดังนี้

โครงการวิจัยนี้จัดทำขึ้น เพื่อพัฒนาเครื่องมือชนิดใหม่สำหรับกระตุ้นการเจริญเติบโตของขากรรไกรล่างในผู้ป่วยโครงสร้างใบหน้าชนิดที่สองที่มีขากรรไกรล่างเล็ก ผู้เข้าร่วมวิจัยจะได้รับการตรวจและบันทึกข้อมูลซึ่งประกอบด้วยการซักประวัติเช่น ข้อมูล ทั่วไป ประวัติทางทันตกรรม ประวัติทางการแพทย์ ได้รับการตรวจนอกช่องปากและภายในช่อง ปาก การถ่ายภาพภายนอกและภายในช่องปาก การถ่ายภาพรังสีกระโหลกศีรษะด้านข้าง ภาพ ถ่ายรังสีพานอรามิก และภาพถ่ายรังสีรังสีคอมพิวเตอร์ ของข้อต่อขากรรไกร

หลังจากนั้นผู้ป่วยจะได้รับการติดเครื่องมือจัดฟันติดแน่นตามปกติ และปรับระดับฟันหลังจากปรับระดับฟันจนได้ตำแหน่งที่เหมาะสม ผู้เข้าร่วมวิจัยจะเริ่มได้รับการกระตุ้นขากรรไกรล่างโดยเครื่องมือ EZJA ติดที่ด้านบดเคี้ยวของฟันกรามน้อยซี่ที่หนึ่งบนและล่าง เพื่อจัดให้ขากรรไกรล่างยื่นออกมาทางด้านหน้าเป็นระยะทาง 2 มิลลิเมตร และทำเพิ่มครั้งละ 2 มิลลิเมตรทุกๆ 2 เดือน ร่วมกับการฝึกฝนผู้ป่วยให้ยื่นขากรรไกรล่างมายังตำแหน่งที่กำหนด โดยให้เครื่องมือเป็นตัวบังคับตำแหน่งขากรรไกรล่างให้น้อยที่สุด จนกว่าจะได้ตำแหน่งของคางที่ปกติเมื่อเทียบกับหน้าผาก จากนั้นจึงนัดปรับเครื่องมือทุก 1 เดือนจนกระทั่งฟันอยู่ในตำแหน่งที่เหมาะสมจึงถอดเครื่องมือจัดฟันชนิดติดแน่นและใส่เครื่องมือคงสภาพฟัน

ถ้าท่านตัดสินใจเข้าร่วมโครงการวิจัยฯนี้ จะมีขั้นตอนของการวิจัยที่จำเป็นต้องขอความร่วมมือของท่านตามที่กล่าวมาข้างต้น ซึ่งจะไม่ก่อให้เกิดความเจ็บปวดและอันตรายต่อเนื้อเยื่อ มากไปกว่าการการใช้เครื่องมือกระตุ้นการเจริญเติบโตของขากรรไกรล่างชนิดอื่นแต่อย่างใด โดยผู้เข้าร่วมโครงการฯต้องมารับการรักษาและติดตามผล ณ คณะทันตแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์ ตามระยะเวลาที่กำหนดอย่างเคร่งครัด

ไม่ว่าท่านจะเข้าร่วมในโครงการวิจัยนี้หรือไม่ ท่านจะยังคงได้รับการรักษาที่ดีเช่นเดียวกับผู้ป่วยคนอื่นๆ และถ้าท่านต้องการที่จะถอนตัวออกจากการศึกษานี้เมื่อใดท่านก็สามารถกระทำได้อย่างอิสระ ถ้าท่านมีคำถามใดๆก่อนที่จะตัดสินใจเข้าร่วมโครงการนี้โปรดซักถามจากคณะผู้วิจัยได้อย่างเต็มที่

ขอแสดงความนับถือ

ทพ. อาทิตย์ สิทธิพรชัย

แบบยินยอมเข้าร่วมการศึกษา

โครงการวิจัยเรื่อง ผลการกระตุ้นการเจริญเติบโตของขากรรไกรล่างโดยเครื่องมือ Easy jaw advancer (EZJA) ในผู้ป่วยโครงสร้างใบหน้าชนิดที่สองที่มีขากรรไกรล่างเล็ก

วันที่_______เดือน__________________พ.ศ._______

ข้าพเจ้า__________________________________อายุ________ปี อาศัยอยู่ บ้านเลขที่_________หมู่_______ถนน__________________ตำบล________________ อำเภอ___________________จังหวัด_______________ ได้รับการอธิบายถึงวัตถุประสงค์ของการวิจัย วิธีการวิจัย อันตรายที่อาจเกิดขึ้นจากการวิจัย รวมทั้งประโยชน์ที่จะเกิด ขึ้นจากการวิจัยอย่างละเอียด และมีความเข้าใจดีแล้ว

หากข้าพเจ้ามีข้อสงสัยประการใด หรือเกิดผลข้างเคียงจากการวิจัยจะสามารถติดต่อกับ ทพ. อาทิตย์ สิทธิพรชัย ได้ที่ ภาควิชาทันตกรรมป้องกัน คณะทันตแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์ หมายเลขโทรศัพท์ 074-429876 หรือ เมื่อมีปัญหาใดๆ เกิดขึ้นเนื่องจากการทำวิจัยในเรื่องนี้ ข้าพเจ้าสามารถร้องเรียนได้ที่คณบดี คณะทันตแพทยศาสตร์ มหาวิทยาลัย สงขลานครินทร์ อ.หาดใหญ่ จ.สงขลา 90112 หมายเลขโทรศัพท์ 074-287510

หากผู้วิจัยมีข้อมูลเพิ่มเติมทั้งทางด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ข้าพเจ้าทราบอย่างรวดเร็วโดยไม่มีปิดบัง

ข้าพเจ้ามีสิทธิ์ที่จะของดการเข้าร่วมโครงการวิจัย โดยจะแจ้งให้ทราบล่วงหน้าโดยการงดการเข้าร่วมการวิจัยนี้จะไม่มีผลต่อการได้รับบริการหรือการรักษาที่ข้าพเจ้าจะได้รับแต่อย่างใด

ผู้วิจัยรับรองว่าจะเก็บข้อมูลเฉพาะที่เกี่ยวกับตัวข้าพเจ้าเป็นความลับ จะไม่เปิดเผยข้อมูลหรือผลการวิจัยของข้าพเจ้าเป็นรายบุคคลต่อสาธารณชน จะเปิดเผยได้ในรูปที่เป็นสรุปผลการวิจัยหรือการเปิดเผยข้อมูลต่อผู้มีหน้าที่ที่เกี่ยวข้องกับการสนับสนุนและกำกับดูแลการวิจัย

ข้าพเจ้าได้อ่านข้อความข้างต้นแล้วและมีความเข้าใจดีทุกประการ จึงได้ลงนามใน ใบยินยอมนี้ด้วยความเต็มใจ โดยผู้วิจัยได้ให้สำเนาแบบยินยอมที่ลงนามแล้วกับข้าพเจ้าเพื่อเก็บ ไว้เป็นหลักฐานจำนวน 1 ชุด

ลงชื่อ.....................................ผู้ยินยอม

ลงชื่อ.....................................มารดา

ลงชื่อ.....................................บิดา/ผู้ใช้อำนาจปกครอง

ลงชื่อ..หัวหน้าโครงการ

ลงชื่อ..พยาน

ลงชื่อ..พยาน

ที่ ศธ 0521.1.03/ ๗๒

คณะทันตแพทยศาสตร์
มหาวิทยาลัยสงขลานครินทร์
ตู้ไปรษณีย์เลขที่ 17
ที่ทำการไปรษณีย์โทรเลขคอหงส์
อ.หาดใหญ่ จ.สงขลา 90112

หนังสือฉบับนี้ให้ไว้เพื่อรับรองว่า

โครงการวิจัยเรื่อง "ผลการกระตุ้นการเจริญเติบโตของขากรรไกรล่างโดยเครื่องมือ Easy jaw advancer (EZJA) ในผู้ป่วยโครงสร้างใบหน้าชนิดที่สองที่มีขากรรไกรล่างเล็ก"

หัวหน้าโครงการ ทันตแพทย์อาทิตย์ สิทธิพรชัย

สังกัดหน่วยงาน นักศึกษาหลังปริญญา ภาควิชาทันตกรรมป้องกัน คณะทันตแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์

ได้ผ่านการพิจารณาและได้รับความเห็นชอบจากคณะกรรมการจริยธรรมในการวิจัย (Ethics Committee) ซึ่งเป็นคณะกรรมการพิจารณาศึกษาการวิจัยในคนของคณะทันตแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์ แล้ว ในคราวประชุมครั้งที่ 5/2552 เมื่อวันที่ 24 พฤศจิกายน 2552

ให้ไว้ ณ วันที่ 28 มกราคม 2553

(รองศาสตราจารย์ ทพ.นพ.ธงชัย นันทนรานนท์)
รองคณบดีฝ่ายวิจัยและวิเทศสัมพันธ์
ประธานกรรมการ

....กรรมการ
(ผู้ช่วยศาสตราจารย์ ดร.ทพญ.สุวรรณา จิตภักดีบดินทร์)

....กรรมการ
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(ผู้ช่วยศาสตราจารย์ ทพ.นพ.สุรพงษ์ วงศ์วัชรานนท์)

....กรรมการ
(ผู้ช่วยศาสตราจารย์ นพ.พรชัย สถิรปัญญา)

....กรรมการ
(ผู้ช่วยศาสตราจารย์ ดร.ทพญ.อังคณา เธียรมนตรี)

....กรรมการ
(อาจารย์วศิน สุวรรณรัตน์)

VITAE

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Student ID 5310820028

Educational Attainment

Degree	Name of Institution	Year of Graduation
Doctor of Dental Surgery	Chulalongkorn University	2004

List of Publication and Proceeding

Sittipornchai A, Charoemratrote C. Mandibular Growth Stimulation Produced by Modified Twin-Blocks in Skeletal Class II Retrognathic Mandibular Patients. Proceedings of the 23rd National Graduate Research Conference; 2011 December 23-24; Nakhon Ratchasima, Thailand. Faculty of Sciences and Liberal Arts, Rajamangala University of Technology Isan; 2011.