Thesis Title: Mini-Implant Application for Molar Distalization and Extrusion
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ชื่อวิทยานิพนธ์ การประยุกต์ใช้หมุดปลูกฝังขนาดเล็กเคลื่อนฟันกรมยอดหลังและลงล่าง ผู้เขียน นางสาวจินตรัตน์ เจ้านครสุข สาขาวิชา วิทยาศาสตร์สุขภาพช่องปาก ปีการศึกษา 2551

บทคัดย่อ

การเคลื่อนฟันกรมยอดหลังเป็นวิธีแก้ไขการสำเร็จตามที่ได้การรวมลักษณะการเคลื่อนฟันบนหลังในปากที่มีความตังตระหนกข้างมากและลงล่างในคู่ๆที่มีการสำเร็จปฏิบัติปฏิบัติที่ 2 ร่วมกันมีการสำเร็จที่ดี วัสดุและวิธีการ ผู้ป่วย 14 รายเป็นเด็กชาย 4 คนและผู้หญิง 10 คนได้รับการรักษาด้วยการเคลื่อนฟันกรมยอดหลังและลงล่างโดยผู้ป่วยมีลักษณะการทำงานแบบที่สองร่วมกับมีฟันบนสั้นและฟันนินกราม ผู้ป่วยที่ปฏิเสธการใช้ cervi cal pull headgear ได้รับการแนะนำให้ใช้หมุดปลูกฝังขนาดเล็กเป็นหลักยึดรวมกับ “extruded sectional arch wire” ที่ออกแบบพิเศษ หมุดปลูกฝังขนาดเล็กมีขนาดเส้นผ่าศูนย์กลาง 1.3 มิลลิเมตร และมีความยาว 8 มิลลิเมตรที่มีแรงดึงจากๆการที่เหนือและฟันกรมน้อยซี่ที่สองค้นในที่ๆซีนซีนและระหว่างข้างๆข้างหนึ่งของลาดเด็กกล่าวไว้ที่มีถูกฝังกับศูนย์กลาง 1 มิลลิเมตรที่เทคนิคเป็นลักษณะในที่มีหน้าที่สำหรับ芳ก์ช่องกระดาษซี่ที่หนึ่ง และก้านหลังที่นิ่งมีถูกฝังเป็นลักษณะในข้างๆข้างหนึ่งของลาดเด็กกล่าว กล้องแสดงการเคลื่อนฟันกรมน้อยซี่ที่หนึ่งใช้รูปภาพ 250 กรัมต่อเกินอาจจะไปที่หมุดปลูกฝังขนาดเล็ก ลักษณะแนวตรงขึ้นไปทางคันหลังและลงล่าง ภาพรังสีด้านข้างก่อนและหลังการเคลื่อนฟันใช้เปรียบเทียบในการเคลื่อนฟันกรมน้อยซี่ที่หนึ่ง ผลการทดลอง ผู้ป่วยมีอายุเฉลี่ย 13.13 ± 1.19 ปี อายุนิ่ง 11 - 15 ปี ฟันกรมน้อยซี่ที่หนึ่งถูกเคลื่อนเป็นระยะละ 3.82 ± 1.30 เดือนอยู่ในช่วง 2 - 6 เดือนจนมีการสำเร็จ เทียบกับปฏิบัติ 2 มิลลิเมตร ฟันกรมน้อยซี่ที่หนึ่งถูกเคลื่อนอย่างมีนัยสัถรยานทางสถิติและดูมันมี 2.59 มิลลิเมตรและลงล่าง 13.2 ± 0.61 มิลลิเมตร และดูฟันกรมน้อยซี่ที่หนึ่งถูกเคลื่อนไปทางด้านหลังเพิ่มขึ้น 18.71 ± 6.79 องศาอย่างมีนัยสัถรยานทางสถิติ จุดการเคลื่อนฟันกรมน้อยซี่ที่หนึ่งถูกเคลื่อน และลงล่างเกิด 1.70 ± 0.57 และ 0.39 ± 0.24 มิลลิเมตรต่อเดือนตามลักษณะ สรุป ฟันกรมน้อยซี่ที่หนึ่งสามารถเคลื่อนข้างหลังและลงล่างได้การสำเร็จแบบที่ 1 ได้ด้วยการใช้หมุดปลูกฝังขนาดเล็กและ extruded sectional arch wire ในระยะเวลาสั้น
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Major Program: Oral Health Sciences

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ABSTRACT

The molar distalization has been regularly used to correct Class II dental relation to Class I occlusion. The cervical pull headgear always needs patient’s compliance which is a key for success of treatment. The effectiveness of the conventional intra-oral appliance does not move the maxillary molar distally only, but also the anchorage was loss. Improvements in implants have made their use possible as anchorage in orthodontic patients. So that the mini-implant is an anchorage of interest to move the molar substituted the cervical pull headgear. Objectives: To design a new appliance in conjunction with mini-implant to distalize and to extrude the first molar in class II deep bite patients. Materials and methods: Fourteen patients (4 male and 10 female) with a Class II molar relationship with large overjet and deepbite were selected and planned for correction by the maxillary molar distalization and extrusion. The patients declined the cervical headgear application. Mini-implants as anchorage together with a special design sectional wire developed at Prince of Songkla University were introduced to the patients. The 1.3-mm diameter and 8-mm length mini-implants were placed bilaterally and buccally between the roots of the upper second premolars and the first molars. A 1 mm stainless steel wire, placed in the headgear tube of the upper first molars on each side, was bended as a molar stop and extended to the vestibule to form a hook, positioned anteriorly and superiorly to the implants. A force of 250 gm, applied between the implant and the hook of the bended wire, was directed distally and occlusally for molar movement. The lateral cephlometric films were measured to compare the difference between before and after the maxillary molar distalization, using the Wilcoxon signed – rank test. Results: The mean age at the start of treatment was 13.13 ± 1.19 years, range from 11 to 15 years. The first molars were successfully distalized into an over corrected 2 mm Class I occlusion for 3.82 ± 1.30 months, range from 2 to 6 months. The maxillary molars were statistically significant having moved 6.18 ± 2.59 mm distally and 1.32 ± 0.61 mm occlusally. Also the maxillary molars were statistically significant having tipped distally at an average of 18.71 ± 6.79 degree. The
rate of maxillary molar distalization and extrusion were $1.70 \pm 0.57$ mm per month and $0.39 \pm 0.24$ mm per month, respectively. **Conclusion:** Molar distalization and extrusion were achieved in Class II patient with hypodivergent facial pattern by mini-implant anchorage with an extruded sectional arch wire in a short time.
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CONTENTS

CONTENTS vii
LIST OF TABLES viii
LIST OF DIAGRAMS/FIGURES ix
LIST OF ABBREVIATIONS AND SYMBOLS xi

CHAPTER

1. INTRODUCTION
- Background and rationale 1
- Review of Literature 1
- Objective 7

2. RESEARCH METHODOLOGY
- Sample 8
- Materials and methods 8
- Cephalometric variables and analysis 10
- Statistic analysis 11

3. RESULTS
- Cephalometric analysis 13
- Appliance design 18
- Clinical observations 19

4. DISCUSSIONS 21

5. CONCLUSIONS 27

REFERENCES 28
APPENDICES 33
VITAE 39
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The measurements of each patients</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>Descriptive statistics of cephalometric measurements at before and after molar distalization</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>The measurements of right side</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>The measurements of left side</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>The means of measurement in left and right sides</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>The distance and the rate of molar distalization</td>
<td>22</td>
</tr>
<tr>
<td>7</td>
<td>Reference line and point of the recent study used to measurement molar movement</td>
<td>23</td>
</tr>
</tbody>
</table>
#LISTS OF DIAGRAMS/FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transpalatal arch bar (left) and bracket bonding at second premolar (right)</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>The guided wire in the bite wing film to facilitate the mini-implant placement</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>Force was applied from the hook of ESAW to mini-implant anchorage</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>The wire guiding markers</td>
<td>10</td>
</tr>
</tbody>
</table>
| 5      | The references and the variables were used for measurement of molar movement:  
|        | a is \( \theta \)-PP (degree), b is \( \delta \)-PP (mm), and c is \( \delta \)-to-PP-ptm (mm) | 11   |
| 6      | The intra-oral photographs before (right) and after (left) molar distalization | 13   |
| 7      | The superimposition of the maxilla between before and after molar distalization | 14   |
| 8      | Diagram of extruded sectional arch wire (ESAW) related to mini-implant      | 19   |
| 9      | Separated force in horizontal and vertical vector                          | 19   |
| 10     | The two case that loss of the mini-implants were excluded                   | 20   |
| 11     | The palatal arch was pressed into the mucosa                               | 20   |
| 12     | The raised occlusion with composite                                         | 20   |
**LISTS OF ABBREVIATIONS AND SYMBOLS**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEJ</td>
<td>cementoenamel junction</td>
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<tr>
<td>cm</td>
<td>centimeter</td>
</tr>
<tr>
<td>cNmm</td>
<td>centinewton-millimeter</td>
</tr>
<tr>
<td>et al</td>
<td>and others</td>
</tr>
<tr>
<td>ESAW</td>
<td>extruded sectional arch wire</td>
</tr>
<tr>
<td>Fig.</td>
<td>Figure</td>
</tr>
<tr>
<td>g</td>
<td>gram</td>
</tr>
<tr>
<td>mm</td>
<td>millimeter</td>
</tr>
<tr>
<td>NiTi</td>
<td>nickel titanium</td>
</tr>
<tr>
<td>PP</td>
<td>palatal plane</td>
</tr>
<tr>
<td>ptm</td>
<td>the most superoposterior point on the outline of pterygomaxillary fissure</td>
</tr>
<tr>
<td>SD</td>
<td>standard deviation</td>
</tr>
<tr>
<td>T1</td>
<td>time before molar distalization</td>
</tr>
<tr>
<td>T2</td>
<td>time after molar distalization</td>
</tr>
<tr>
<td>6</td>
<td>the maxillary first molar</td>
</tr>
<tr>
<td>/</td>
<td>per</td>
</tr>
<tr>
<td>%</td>
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</tr>
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<td>&quot;</td>
<td>inch(es)</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

Background and rationale

The molar distalization has been commonly used to correct Class II dental relation to Class I occlusion. In the past, extra-oral appliance was commonly used but the patient’s compliance is the major factor to obtain successful results. Beginning in the 1980s, non-compliance intra-oral appliances have been wildly used such as repelling magnets\(^1\), open coil springs\(^3\)-\(^6\), and pendulum\(^7\),\(^8\). These intra-oral appliances do not move only the maxillary molar distally, but also the premolars and the anterior teeth which are the anchorage to move mesially and the overjet is increased eventually.

Mini-implant as intra-oral anchorage without patient compliance has been developed since 1983. Creekmore and Eklund\(^9\) were the first orthodontist to apply a small screw for reposition the anterior teeth. Interestingly, the mini-implant could be loaded force immediately.\(^10\),\(^11\) The mini-implant has been used in the case of Class II malocclusions combined the other appliances for preventing the loss of anchorage.\(^12\) For example, it was used as absolute anchorage by installed at palate or the maxillary interradicular bone for distalization and intrusion of molars.\(^13\),\(^14\) Unfortunately, mini-implants have never been applied for distalization and extrusion of the molars.

The correction of Class II malocclusion with cervical pull headgear needs patient’s compliance which is a limitation for the success of the treatment. The use of mini-implant to distalize and to extrude the molars as cervical headgear is of interest to study.

Review of Literatures

Conventional molar distalization is not always indicated for Class II correction. It is contraindicated in open-bite patients and in the presence of a protrusive facial profile. In open-
bite patients molar distalization would determine a clockwise mandibular rotation, thus increasing the lower face height and worsening the facial appearance. In the case of protrusive facial profile, the anterior anchorage loss, which occurs during molar distalization, would be worsened the inclination of the front teeth and, consequently, the profile itself. Molar distalization is recommended for the correction of Class II malocclusions in deep-bite patients and in the presence of a concave or normal facial profile.

Non-extraction treatment of Class II malocclusion frequently requires upper molar distalization into a final Class I relationship. To achieve this, a variety of treatment modalities have been suggested. For more than 100 years the most common procedure has been the headgear applied to upper molars, and its performance has been reliable. Unfortunately, headgear requires patient compliance to be effective. Often, the patient is not willing to wear the headgear for the recommended 12–14 hours per day.15

The cervical pull headgear and the patient compliance

Klein16 investigated the movement of molars in the 24 patients, age range from 7 to 10 years, treated by cervical headgear. The average time for Class II division 1 correction was 17 months, range 6 to 33 months. During treatment the upper molar tipped distally for an average of 1.2 degree. In the average, distal movement was 1 mm. As much as 3 mm distal movement was recorded. There was no the upper molar reported moving forward. In vertical, the average cases demonstrated 2.3 mm of elongation, range 0 to 3.5 mm.

Gadini et al17 evaluated maxillary basal bone, dentoalveolar, and dental changes in Class II Division 1 patients, age from 7.5 to 13.5 years, treated to normal occlusion by using cervical headgear and edgewise appliances ranged and compared to untreated group. However, maxillary basal bone changes were not significantly different between the treated and untreated groups. Distal dental relocation was more significant in the apex of the maxillary molars (0.47 mm/year) and gradually decreased in the center of resistance (0.34 mm/year) and in the molar cusp (0.25 mm/year). Vertically, none of the skeletal (0.67 mm/year) or dental (1.19 mm/year) changes was significant.

Taner et al18 evaluated the effects of cervical headgear on the maxillary first molar, second molar, first premolar, and upper incisors. The mean amount of first molar
distalization was 3.15 ± 1.94 mm. The second molars were also distalized to a mean amount of 2.27 ± 1.33 mm. The mean treatment time for distalization was 11.38 ± 3.18 months. During distalization, the maxillary molars were tipped distally for average 6.69 degree. Maxillary molars were extruded for average 1.42 mm.

Cole\textsuperscript{19} evaluated twenty patients were supplied with electronic timing headgears that enabled to compare their reported hours of headgear use with electronically measured actual usage. Compliance levels varied from a low of 5.6\% to a high of 107.7\% with a mean of 74.5\% and a standard deviation (SD) of 30.3. This showed that one third of patient that recommended to use headgear had compliance level lower than 50\%.

Doruk \textit{et al}\textsuperscript{20} and Agar \textit{et al}\textsuperscript{21} used cervical pull headgear to correct the malocclusion. An electronic module timer was attached to the neckstrap to evaluate the number of hours the patients wore the headgear. The result showed that more than one half of patients wore headgear less than recommend and 20-30\% of un-compliance patients were not better after monitoring process.

Egolf \textit{et al}\textsuperscript{22} evaluated factors related to compliance with the wearing of headgear and intraoral elastics by a questionnaire in 100 university clinic orthodontic patients. The result showed that headgear was rejected by many patients because of esthetic and social concerns. And major factors related to patient compliance wear are personality type, pain, interference with oral activities, health awareness, and self-consciousness about the oral condition.

Cureton \textit{et al}\textsuperscript{23} determined the role of the headgear calendar and its relationship to headgear compliance. Headgear timers were used covertly to monitor actual headgear wear of 28 patients for three consecutive orthodontic appointments. Fourteen patients were asked to monitor their daily headgear wear by using a headgear calendar. The other 14 patients did not use a calendar. The results show that patients who monitor their headgear wear with a headgear calendar are more compliant than those patients who do not (7.9 hours compared with 5.3 hours).

The intra-oral appliance for molar distalization

The use of an extra-oral appliance, the headgear, needs the patient compliance to wear. The difficulties of a headgear wear and the factor depended on patient cooperation
stimulated many investigators to develop new intraoral devices and techniques for distal movement of molars.

Oztuk et al. used 250 g NiTi coil spring with a modified Nance’s appliance in the late mixed or permanent dentition stage to correct Class II malocclusion. The results were that the mean maxillary first molar distalization was 5.44 mm (right) and 3.75 mm (left), with a mesial tipping of 11.56 degrees (right) and 11.34 degree (left), and the anchorage loss occurred as defined by mesial movement of the first premolars and proclination of the central incisors.

Mavropoulos et al. analyzed the maxillary molar movement in the patients (mean age 13.2 years) treated with a modification of the Jones jig appliance, which consisted of a modified Nance button as anchorage and an active unit. The average maxillary first molar distal movement was 2.8 mm. An anchorage loss was expressed by a 1.9-mm proclination of the central incisors.

Bolla et al. evaluated the nature of maxillary molar movement with the distal jet alone, to determine the extent of mesial movement of the anchorage unit. They found that the crowns of the maxillary first molars were distalized for an average of 3.2 mm and tipped distally an average of 3.18 degree. An anchorage loss was measured at the first premolars for averaged 1.3 mm and maxillary incisors were proclined an average of 0.68 degree.

Gulati et al. evaluated dental and skeletal changes after intraoral molar distalization with a sectional jig assembly. The first molars were moved for average 2.78 mm, at the rate of 0.86 mm/month. And there were increase in the overjet and mesial tipping of second premolar.

Ghosh and Nanda used the pendulum appliance to move the maxillary first molars. The teeth were moved distally for the mean of 3.37 mm with a distal tipping of 8.36 degree. The mean reciprocal mesial movement of the first premolar was 2.55 mm with a mesial tipping of 1.29 degree.

Chiu et al. compared the pendulum and the distal jet. They found that the pendulum distalized the maxillary molars 6.1 mm more than distal jet 2.8 mm. The premolars and the incisors were moved anteriorly 1.4 mm, 1.1 mm in pendulum and 2.6 mm, 3.7 mm in distal jet.
Itoh et al. distalize molar with the repelling magnets. Molar distalization averaged 2.1 mm and distal tipping 7.4 degree. Labial movement of the anterior teeth averaged 1.2 mm and labial tipping 3 degree.

Bondemark et al. evaluated two force systems, repelling rare earth magnets and superelastic nickel-titanium coils, with respect to the clinical and the dentofacial treatment effects of the simultaneous distal movement of maxillary first and second molars in subjects with Class II malocclusion and deep overbite. The magnets and the supercoils moved the molar distally by mean 2.2 mm and 3.2 mm for 6 months, respectively. The decrease of the overbite was average 3.6 mm.

The most past study showed that the intra-oral appliance for molar distalization may cause anchorage loss characterized by the mesial movement or tipping of premolars or anterior teeth and the increase of the overjet. It may increase treatment time to move the teeth back and to create Class I occlusion.

The mini-implant anchorage

Improvements in implants have made their use possible as anchorage in orthodontic patients. A mini-implant for orthodontic anchorage should be small enough to place in any areas of alveolar bone, even apical bone. The surgical procedure should be easy enough for an orthodontist to perform and minor enough for rapid healing. The implant should be easily removable after finishing orthodontic treatment.

In 1983, Creekmore and Eklund used a surgical vitallium bone screw inserted below anterior nasal spine in a 25-year-old female patient with a Class I molar relationship and a very deep overbite. Ten days after the screw was placed, a light elastic thread was tied from the head of the screw to the archwire. The result showed that the maxillary central incisors were elevated approximately 6 mm and torqued lingually about 25 degrees. The bone screw did not move during treatment and was not mobile at the time it was removed.
In 1997, Kanomi\textsuperscript{25} was treated a 44-year-old male patient with severe curve of Spee and deep bite. The treatment plan was intrusion of the mandibular incisors. A mini-bone screw was implanted in the alveolar bone between the root apices of the mandibular central incisors. After four months, the mandibular incisors had been intruded 6 mm. Neither root resorption nor periodontal pathology was evident. The patient was satisfied with the overbite reduction without reported.

For molar distalization, the mini-implant was applied for direct and indirect anchorage. Kircelli\textsuperscript{26} used modified pendulum appliance with mini-implant in the palatal region for an average of 6.4 mm molar distalization with 10.98 mm distal tipping. Also, the maxillary second premolar and first premolar were moved distally for an average of $5.4 \pm 1.3$ mm and $3.8 \pm 1.1$ mm, respectively.

Gelgor\textsuperscript{27} was used intraosseous screw at palate to support anchorage unit for molar distalization with 250 g NiTi open coil spring between the first premolar and molar. For 4.6 months, the upper first molars were tipped 8.88 degree and moved 3.9 mm distally on average.

Keles\textsuperscript{13} used the paramedian palatal implant instead of a Nance button for molar distalization with NiTi coil spring (the Keles slider appliance). The result showed that the molars were distalized bodily in 5 months, and no anchorage loss was observed.

Park\textsuperscript{14} used a mini-implant which placed between first molars and second premolars buccally for distalized posterior teeth and canines with NiTi coil spring. The first molars were distalized on average of 1.64 mm. Moreover, in another study, Park\textsuperscript{28} used a maxillary mini-implants placed between second premolar and first molar to provide anchorage for intruding the posterior teeth and retracting the anterior teeth, simultaneously.

Buchter \textit{et al}\textsuperscript{10} and Kim \textit{et al}\textsuperscript{29} evaluated the stability of the mini-implant during loading force. The results showed that an immediate loading of mini-implants in the minipig can be performed without loss of stability when the load-related biomechanics do not exceed 900 cNmm.\textsuperscript{10} Furthermore, the drill-free mini-implants, which were loaded a force of 200 to 300 g with nickel-titanium coil springs after 1 week after insertion, were stable when twelve weeks ago.\textsuperscript{29} And Ohashi\textsuperscript{30} presented that the loading protocols for mini-implants involved immediate loading or a waiting period of 2 weeks to apply forces.
Success rate of the mini-implants were associated with inflammation around them and did not depend on the clinical variables of the mini-implant factors (type, diameter, and length), local host factors (occlusogingival positioning), general host factors (age, sex) and management factors (angle of placement, onset and method of force application, ligature wire extension, exposure of screw head, and oral hygiene).11

Objective

The purpose of this investigation is to design a new appliance in conjunction with mini-implant to distalize and to extrude the first molar in Class II deep bite patients.

Hypothesis

The first permanent molar can move distally and occlusally by mini-implant anchorage.

Significance of the study

The mini-implant anchorage will be another option for correcting the Class II deep bite without compliance.

The limitations of the study

The study can be applied to the patients after the eruption of permanent upper second premolars. This approach cannot deliver for adult patients because there is no growth to compensate the mandibular rotation from the molar extrusion.
CHAPTER 2

RESEARCH METHODOLOGY

Sample

Samples were selected from patients received treatment at the postgraduate orthodontic clinic, Prince of Songkla University. The criteria for subject selection included:

- Patients younger than 16 years-old having the permanent upper second premolars in the oral cavity.
- The occlusion was Class II malocclusion with a deep bite.
- Short lower anterior facial height with hypodivergence mandibular rotation.
- They never had either orthodontic or orthopedic treatment.
- They have no systemic, mental, behavioral, bleeding, and craniofacial disorders.
- The details of the study was explained to the patients. Inform and consent was signed by the patients before the study started.

Materials and methods

The transpalatal arch was placed on the upper permanent first molars before the brackets were bonded. At the second premolars, brackets were angulated by rotating the distal wing toward the occlusal plane for leveling and tipping the roots mesially to create spaces between the root of first molars and second premolars for mini-implant placement (Fig. 1).
When there were enough spaces (at least 5.5 mm) between the roots of first molars and second premolars, the bite wing films were taken to confirm the space and to locate the position by using the guided wire as shown in Fig 2. Then the mini-implants (1.3 mm in diameter and 8 mm in length) were installed buccally between the teeth. After that the lateral cephalogram was taken before molar distalization (T1).

The next visit, the 1-mm-diameter stainless steel wire was bended as shown in Fig 3. One end with bended stop was placed in the headgear tube of the first molar. Another end with bended hook was located anteriorly and superiorly from the mini-implant. It was called “extruded sectional arch wire” (ESAW). The wire was fixed by ligating the stop with the hook of the first molar for stabilization.

A force of approximately 250 g was applied from the hook of the ESAW to the mini-implant. The force vectors were inferior and posterior for molar distalization and extrusion.
Fig. 3 Force was applied from the hook of ESAW to mini-implant anchorage

The force was measured and activated to maintain the force level of 250 g every month. And if the distance from the hook of the ESAW to mini-implant was too short to generate appropriate force, the ESAW was adjusted at the molar stop and the arm to keep the hook anterior and superior enough for 250g force application. When 2-mm Class III molar relationship was obtained as overcorrection, the lateral cephalogram was taken for post molar distalization records (T2).

Cephalometric variables and analysis

The films taken at T1 and T2 had wire guiding markers which are 0.018” x 0.022” stainless steel wire bended a right angle and the end of the wires were bent either anteriorly or posteriorly (Fig 4). Wire markers were inserted in the buccal tube of the first molars to identify the left and right sides.

Fig. 4 The wire guiding markers

The cephalograms were traced with one investigator on separate occasions and repeated four weeks later for evaluation of errors in method. From the tracing, variables measured in distances and angles were indicated the movement of the first molars vertically and horizontally. The reference lines and the variables used for measurement as follow (Fig 5):

- PP line: the palatal plane.
- PP-ptm line: line perpendicular to PP that passes through the ptm.
- $\theta$-PP (degree): the angle of intersection of the long axis of the upper first molar and PP line.
- $\theta$-PP (mm): the distance from the PP line to the lowest of the upper first molar.
- $\theta$-to-PP-ptm (mm): the distance form the PP-ptm line to the mesiobuccal cusp of the upper first molar.

The measurements at T1 and T2 were compared to explain the effects of the force applied to the first molars via ESAW by mini-implant anchorage.

![Diagram with PP line and PP-ptm line with variables a, b, and c labeled.]

**Fig. 5** The references and the variables were used for measurement of molar movement:

a is $\theta$-PP (degree), b is $\theta$-PP (mm), and c is $\theta$-to-PP-ptm (mm)

**Statistic analysis**

Ten cephalograms of 10 patients were randomly chosen and measured to calculate the accidental errors using Dahlberg’s formula as follow:

$$ s = \sqrt{\frac{\sum D^2}{2N}} $$
Where: \( S_e \) = the error of the measurement
\( D \) = the difference in measurements of cephalometric values on two different occasions
\( N \) = the number of double measurements

Statistical analysis was performed using SPSS software, and the results of the measurements were shown as means ± standard deviations. The differences between the T1 and T2 measurements were evaluated with a Wilcoxon signed – rank test and \( \alpha \) less than or equal to 0.05 was considered as statistically significant.
CHAPTER 3

RESULTS

In this study, there were 14 patients, 4 male and 10 female participated and finished the investigation. The mean age at the start of treatment was $13.13 \pm 1.19$ years, range from 11 to 15 years. The first molars were successfully distalized into an over corrected 2 mm Class I occlusion by mini-implant anchorage at the end of the study. Distalization time was $3.82 \pm 1.30$ months, ranging from 2 to 6 months. An example of the distalization is presented in Fig. 6.

![Fig. 6](image)

**Fig. 6** The intra-oral photographs before (right) and after (left) molar distalization

**Method error study**

The three measurements were re-evaluated four weeks apart and calculated to determine intra-examiner error. No significant mean differences between the two series of records were found. The measurement error was 0.32, ranging from 0 to 0.50 mm for linear measurement, $6\text{-PP}$ and $6\text{-to-PP-ptm}$. In the angular measurement ($6\text{-PP}$), the error was 0.28 degrees with a range from 0 to 1 degree.

**Cephalometric analysis**

The descriptive statistics, including the means and standard deviations before and after molar distalization, as measured from the cephalometric radiographs, are summarized in table 1, 2.
For the average treatment time of 3.82 months, the mean amount of maxillary molar distalization was 6.18 ± 2.59 mm measured at the mesial buccal cusp tip (6-to-PP-ptom). The maxillary molars were extruded 1.32 ± 0.61 mm from the palatal plane. The maxillary molars were tipped distally at an average of 18.71 ± 6.79 degrees (6-PP). The rate of maxillary molar distalization and extrusion were 1.70 ± 0.57 mm per month and 0.39 ± 0.24 mm per month, respectively.

There was a statistically significant difference (P = 0.001) between the position of the maxillary first molars at initial and after destalization stages. The teeth were distalized and extruded. At right and left sides, the movement of the molars was statistic significant difference before and after distalization. The molars were distalized 6.14 ± 2.54 mm and 6.12 ± 2.72 mm in right and left sides, respectively, and extruded 1.32 ± 0.64 mm in both sides (Table 3, 4). In comparison, Left and right sides were not statistic significant difference (Table 5).

From maxillary superimposition, the maxillary molars were moved mostly at the crown, whereas the apical was moved minimally. In addition, the maxillary premolars and canines were distalized naturally, and the maxillary incisors displayed palatal tipping during distalization of the maxillary molars with the mini-implant anchorage. There was no appliance connected between premolars and molars. All maxillary teeth showed extrusion during distalization (Fig. 7).

![Fig. 7 The superimposition of the maxilla between before and after molar distalization](image-url)
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Table 2  Descriptive statistics of cephalometric measurements at before and after molar distalization

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Table 3  The measurements of right side

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Table 5  The means of measurement in left and right sides

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* p = 0.001

Appliance design

The maxillary first molars were distalized and extruded with mini-implant anchorage and extruded sectional arch wire (ESAW). ESAWs (Fig. 8) were constructed in the following way:

1. A molar end was placed in the headgear tube of the molar band.
2. A molar stop was used to transfer force to the molar, to adjust for moving the hook of the ESAW to the same location after the molar movement at the next visit, and to ligate to the a hook of the molar band for preventing the rotation of ESAW.
3. The arm was bent in a horizontal and vertical part. The ratio of the horizontal and vertical part of the ESAW related to the mini-implant was approximately 2:1.
4. A hook was located anteriorly and superiorly in relation to the mini-implant for applying distalized and extruded force.
A force vector was angulated to horizontal plane 30 degree. When 250-g force was separated to vertical and horizontal vector, force was 216 g in horizontal and 125 g in vertical. (Fig. 9)

Fig 8. Diagram of extruded sectional arch wire (ESAW) related to mini-implant

Fig 9. Separated force in horizontal and vertical vector

Clinical Observations

The insertion of the mini-implant was quick and simple. But two patients were excluded because of the failure of the mini-implants before and initial molar movement. (Fig. 8) In one case, the mini-implants were placed for 3 times but the mini-implants were displaced and mobility during initial force application. In another case, the mini-implants were not stable after the placement and dislodged after force application. Soft-tissue inflammation problems around the mini-implants were noted in two cases and suspected as the cause of failure.

However the maxillary first molars were overcorrected by the mini-implant anchorage, the extruded sectional arch wire, in some case, exhibited a problem during the treatment. Two failed mini-implants were on the left of 2 patients from 14 patients. The
distalization of the teeth was continued by unilateral force application on right side until the overcorrection was done. No problem of the molar was rotation.

Fig. 10 The two case that loss of the mini-implants were excluded

Two cases presented palatal ulcer related to the palatal arch with loop. When the molar were distalized for a few months, the palatal arch was tipping and impinged into the palatal mucosa. (Fig. 9) In one case, the patient complained about pain but another case was no pain. New palatal arches without loops were replaced.

Fig. 11 The palatal arch was pressed into the mucosa

In 2 cases, the extruded maxillary first molars had first degree mobility indicated traumatic from occlusion. The molars were intruded during biting. Therefore, the bite was raised with composite on the occlusal surface of the maxillary premolars during molar distalization. (Fig. 10)

Fig. 12 The raised occlusion with composite
CHAPTER 4

DISCUSSION

The use of mini-implants has become an alternative mode of treatment in orthodontics over the last two decades. The esthetic and social concerns of the use of headgear wear for molar distalization and the anchorage loss that occurs with the application of intraoral molar distalization mechanics stimulated many investigators to use mini-implants for anchorage.

The objective in this study was to design a new appliance in conjunction with mini-implant to distalize and to extrude the first molar in Class II patients with hypodivergent facial profile.

The maxillary molars were moved 6.18 mm distally and 1.32 mm occlusally during 3.82 months with mini-implant anchorage and extruded sectional arch wire. The rate of movement was 1.7 mm per month distally. In previous studies, the cervical headgear moved maxillary molars 3 - 4 mm distally and 1 – 1.5 mm occlusally during 10 -11 months.18, 31 Additionally, at age from 7.5 to 13.5 years, distal dental relocation by using cervical headgear and edgewise appliances was more significant in the apex of the maxillary molars (0.47 mm/year) and gradually decreased in the center of resistance (0.34 mm/year) and in the molar cusp (0.25 mm/year).17 Vertically, none of the skeletal (0.67 mm/year) or dental (1.19 mm/year) changes was significant.17 So it can be implied that mini-implant anchorage and extruded sectional arch wire can move maxillary molars more distally and occlusally than the cervical headgear in shorter period of time.

Compared to other intra-oral molar distalization appliances, our appliance can move molar 6.18 mm distally during 3.82 months. The distal jet moved the crowns of the maxillary first molars distally of an average of 3.2 mm during five months.3 And the Jones jig moved the maxillary molars 2.8 mm distally with 2.5 months.31 Additionally, the rate of molar distalization was 1.7 mm per month in our study while the conventional intra-oral appliances distalized the maxillary first molar at the rates of 0.6 to 1.2 mm per month.3, 8, 18, 24, 27, 32 The amount of distalization in this study is greater than other intraoral techniques due to light continuous force appliance without anchorage movement. The comparison is shown in Table 6.
Table 6  The distance and the rate of molar distalization

<table>
<thead>
<tr>
<th>Authors</th>
<th>Appliance</th>
<th>Distance (mm)</th>
<th>Time (months)</th>
<th>Rate (mm/months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra-oral appliance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taner et al(^{18})</td>
<td>Cervical headgear</td>
<td>3.15</td>
<td>11.38</td>
<td>0.28</td>
</tr>
<tr>
<td>Haydar and Uner(^{31})</td>
<td>Cervical headgear</td>
<td>3.60</td>
<td>10.7</td>
<td>0.34</td>
</tr>
<tr>
<td>Intra-oral appliance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolla et al(^{3})</td>
<td>Distal jet</td>
<td>3.2</td>
<td>5-7</td>
<td>0.6</td>
</tr>
<tr>
<td>Ghosh and Nanda(^{8})</td>
<td>Pendulum</td>
<td>3.37</td>
<td>6.21</td>
<td>0.55</td>
</tr>
<tr>
<td>Taner et al(^{18})</td>
<td>Pend-X</td>
<td>3.81</td>
<td>7.31</td>
<td>0.52</td>
</tr>
<tr>
<td>Bondemark et al(^{24})</td>
<td>Supercoils Magnets</td>
<td>3.2</td>
<td>6</td>
<td>0.53</td>
</tr>
<tr>
<td>Gelgor et al(^{27})</td>
<td>Screw–supported</td>
<td>3.9</td>
<td>4.6</td>
<td>0.85</td>
</tr>
<tr>
<td>Gelgor et al(^{32})</td>
<td>Intraosseous screw</td>
<td>3.95</td>
<td>4.6</td>
<td>0.86</td>
</tr>
<tr>
<td>Haydar and Uner(^{31})</td>
<td>Jones jig</td>
<td>2.80</td>
<td>2.5</td>
<td>1.12</td>
</tr>
<tr>
<td>Our study</td>
<td>Mini-implant</td>
<td>6.18</td>
<td>3.82</td>
<td>1.7</td>
</tr>
</tbody>
</table>

During the molar distalization, the teeth were tipped 18.71 degree. Many reports have found tipping of the first maxillary molar occurring as a result of distalization, which ranges from 4 to 48 degree with the intra-oral appliance and 6.96 degree with the headgear.\(^{3, 8, 18, 33-37}\) However, the broad range of the standard deviation of angular changes in maxillary first and second molar positions suggest that the amount of distal tipping cannot be predicted for both appliances.\(^{38}\) The reason of molar tipping is in the fact that the vectors of the distalizing force and the reactive force were located occlusally to the center of resistance (CR) of the molars. In a case when only the maxillary first molar is banded, the center of resistance lies at approximately the trifurcation of the root. When the force vector passes below the center of resistance, then distal crown tipping is introduced. By this way, the moments were generated on teeth, tending to tip the molars distally.

The maxillary molar were moved 1.32 mm occlusally during 3.82 months with the rate of 0.39 mm per month with mini-implant anchorage and extruded sectional arch wire. In
normal eruption, the values of the maxillary molars to palatal plane between age 12 to 15 years occurred 2.5 mm in male and 1.1 mm in female. And during mixed to early permanent (9-13 years) and early permanent to adult (13- 20 years) dentition, the means maxillary molar eruption related to the palatal plane were 3.38 mm and 4.42 mm in male and 4.96 mm and 1.63 mm in female, respectively. When measured from Sella, the teeth moved downward 0.4 mm and 4.5 mm in female and 3.5 mm and 3.2 mm in male between 10 to 12 and 12 to 14, respectively. In Class II division 1, the maxillary molar moved downward from Sella 2 mm and 2 mm in female and 3.4 mm and 2.9 mm in male between 10 to 12 and 12 to 14, respectively. This may suggest that the appliance was increase the eruption rate of the maxillary eruption due to light persisting force was applied.

Table 7  Reference line and point of the recent study used to measurement molar movement

<table>
<thead>
<tr>
<th>Authors</th>
<th>Reference line</th>
<th>Reference point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizontal</td>
<td>Vertical</td>
</tr>
<tr>
<td>Taner et al14</td>
<td>Maxillary superimposition at ANS</td>
<td>Mesiobucal cusp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Most distal point in a line to palatal plane</td>
</tr>
<tr>
<td>Haydar and Uner31</td>
<td>CT line</td>
<td>RD1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mesiobucal cusp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Most distal point</td>
</tr>
<tr>
<td>Bolla et al3</td>
<td>PP line</td>
<td>PTV line</td>
</tr>
<tr>
<td>Ghosh and Nanda8</td>
<td></td>
<td>Centroid point</td>
</tr>
<tr>
<td>Bondemark et al24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gelgor et al27,32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gandini et al17</td>
<td>SN-7°</td>
<td>A line perpendicular of SN pass anterior of sella</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rana and Becher35</td>
<td>Palatal plane</td>
<td>Most distal point</td>
</tr>
<tr>
<td>Joseph and Butchart33</td>
<td>Palatal plane</td>
<td>Mesiobucal cusp</td>
</tr>
<tr>
<td>Fudalej et al39</td>
<td>Palatal plane</td>
<td>Mesiobucal cusp</td>
</tr>
<tr>
<td>Sinclair and Little40</td>
<td>Palatal plane</td>
<td>Central pit</td>
</tr>
<tr>
<td>Rothstein and Yoon41</td>
<td>SN-7°</td>
<td>Tip cusp</td>
</tr>
</tbody>
</table>
The anchorage unit of conventional intra-oral distalization appliance, which consists of the first and second premolars and the incisors, is unable to completely resist the reciprocal force and move mesially during distal movement of the molars.\textsuperscript{18, 31} This is contrary to the finding in the headgear appliance in which spontaneous distalization of premolars was observed as a result of the distalization of molar teeth.\textsuperscript{18, 31} Similarly, our appliance was able to initiate first and second premolars to freely drift distally with the help of the transeptal fibers. The main reason was the fact that the main anchor was the implant. Likewise, direct palatal mini-implant anchorage allowed distal drift of the premolars with the help of the transeptal fibers while moving the molars distally.\textsuperscript{13, 26} Moreover, anterior crowding has been spontaneously corrected because of the stretched transeptal fibers.\textsuperscript{26}

The proper correction of Class II malocclusion with hypodivergent facial profile is molar distalization and extrusion to increase the lower facial height. However, when molars are distalized into the wedge, clockwise mandibular rotation may be initiated and the chin was retracted, subsequently. And the backwards movement of the mandible would open the anterior dentition. Consequently, molar distalization is not often recommended as a treatment strategy for hyperdivergent patients (ie, those with open bites or high mandibular plane angles).\textsuperscript{42}

Most rapid molar distalization appliances tend to cause the mandible to rotate downward and backward, opening the mandibular plane angle.\textsuperscript{4, 8, 18, 24, 34, 38} However, after molar distalization, the mandibular rotation reflects more of the inherent growth pattern of an individual reasserted and rebound is relatively minor.\textsuperscript{43} The mandible was return to the initial sagittal and vertical positions, especially because of maintenance of the mesofacial growth pattern throughout treatment.\textsuperscript{44} If treatment had been done earlier, so that more growth remained after treatment is expected, and more closing rotation of the mandible will be presented.\textsuperscript{43} So that the cases for our study were carefully selected from a growing age group, with younger than 16 year old.

The distalization of maxillary molars is often accompanied by distopalatal rotation, distal tipping, and extrusion of the molars.\textsuperscript{1, 2} Moreover, the effects of maxillary molar extrusion is palatal crown tipping. In the study, a transpalatal arch was used to exert a control of molar rotation and palatal tipping.

The overcorrection is necessary because the distalized molars that used as anchorage will be moved forward during the retraction of the premolars, canines, and incisors, so
that the overcorrection serves to compensate for the anchorage loss. In addition, distal tipping of the molars produces more crown than root movement, and overcorrection compensates for the subsequent forward movement of the molars into a Class I position because the crowns move mesially more than the roots.

There were 2 patients excluded from this study because of the failure of the mini-implant. They showed local inflammation around the mini-implant before or initial force application. Cheng et al stated that two-thirds of the failures were noted before loading or within 1 month after orthodontic loading was initiated. Mini-implants are troublesome for patients because of the severity of the surgery, the discomfort during initial healing, and the difficulty in oral hygiene. The previous study stated that the mini-implant may be lost or become loose as a result of various factors, such as inflammation of the peri-implant tissues and improper placement. Inflammation of the soft tissues around the implant can damage the bone surrounding the neck of the mini-implants. With progressive damage of the cortical bone, the mini-implants can be endangered and produced the mobility and loss of the implants.

Poor attention to oral hygiene lead to inflammation in the tissues around the mini-implants and hastened their loss. At other times, oral hygiene did not affect success, but local inflammation around the mini-implants did. Local inflammation can be exaggerated not only by oral hygiene but also by weak nonkeratinized soft tissue around the neck of the mini-implant.

Peri-implant soft-tissue type, health, and thickness can affect stationary anchorage of the mini-implant. Mini-implants placed in nonkeratinized alveolar tissues have greater failure rates than those in attached tissues. The movable, nonkeratinized alveolar mucosa is easily irritated; soft-tissue inflammation around the mini-implant is directly associated with increased mobility. Additionally, mini-implants placed in regions of thick keratinized tissue are less likely to obtain adequate bony stability.

In patients with thick mucosa, the distance between the point of force application and the center of resistance of the mini-implant will be greater than usual, thus generating a large moment when a force is applied. So that, the mini-implant length was usually determined by the transmucosal depth (the distance between the anchoring bone surface and the emergence point through the mucosa), rather than by the depth of bone available for anchorage. However, the
selection of the mini-implant length was according to the thickness of the oral mucosa and recommended to allow 5 to 6 mm of bone support.\textsuperscript{52, 57, 58} But the short implant gives sufficient bone fixation, independently of placement.\textsuperscript{59} The quality of implantation and bone structure are more important than the length of the orthodontic implant.\textsuperscript{59} More bone contact with the implant surface is believed to imply higher implant stability.\textsuperscript{59}

In our clinical study, short facial patients mostly have short posterior alveolar height so that the vestibules were shallow with short keratinized tissue. The position for mini-implant placement was limited, so it was placed near the cervical of the teeth to accommodate the distance between the mini-implant and the hook of sectional wire for extrusion. However, buccal soft tissues are thickest, closest to and farthest from the cementoenamel junction (CEJ) and thinnest in the middle.\textsuperscript{60} We placed the mini-implant near CEJ where the soft tissue is thick, so that the bone contact with the mini-implant may be less. Luckily, buccal cortical-bone was thickest closest to and farthest from the CEJ and thinnest in the middle.\textsuperscript{60} This thick cortical bone can help to hold the mini-implant even it was stay in the bone lonely a couple millimeters. In 14 cases, the all mini-implants were success except 2 mini-implants were loss after loading the force.
CHAPTER 5

CONCLUSIONS

The present study aimed to invent the appliance using the mini-implant anchorage for maxillary molar distalization and extrusion in Class II malocclusion patients with hypodivergent facial pattern in adolescent patients. Class II molar relationships were overcorrected to Class I within 3.82 months. The maxillary first molars were moved by the mini-implant anchorage and the extruded sectional arch wire for an average of 6.18 mm distally and 1.32 mm occlusally with 18.71 of distal crown tipping. The rate of maxillary molar distalization was 1.70 mm per month. Additionally, the maxillary first premolars and the incisors were moved distally without applied force during the maxillary molar distalization.
REFERENCES


APPENDICES
ใบเชิญชวน

ขอเชิญเข้าร่วมโครงการวิจัยเรื่องประยุกต์ใช้สกรูขนาดเล็ก (mini-implant) ในการเคลื่อนทิ่มกรามไปทางด้านหลังและลงล่าง

เรียน ท่านผู้ป่วยและผู้ปกครอง

ข้าพเจ้า นางสาว จินตรัตน์ แจ้งศรีสุข กำลังศึกษาอยู่ในหลักสูตรปริญญาโท สาขาวินิจฉัยการจัดฟัน ภาควิชาทันตกรรมป้องกัน คณะทันตแพทยศาสตร์ โดยผู้วิจัยต้องการศึกษาผลการเคลื่อนที่ทางทันตกรรมจัดฟัน โดยใช้สกรูขนาดเล็กซึ่งมีขนาดเส้นผ่านศูนย์กลาง 1.3 มม. ความยาว 8 มม. ยี่ห้อ Abso Anchor สกรูขนาดเล็กจะถูกปักไว้ระหว่างรากฟันบนด้านซี่ที่ 1 และฟันบนด้านซี่ที่ 2 และทำการเคลื่อนที่ด้วยหลักยึดสปริง (NiTi coil spring) โดยจะเริ่มจากด้านหลังส่วน (extruded sectional arch wire: ESAW) ซึ่งตัดมาจากหลักยึดสปริงขนาดเล็กด้านซี่ที่ 1 มม. และอีกติดกับฟันบนซี่ที่ 1 ไปที่สกรูขนาดเล็ก (ดูรูปที่ 1) แล้วทำการเก็บข้อมูลด้วยการถ่ายภาพรังสีและการจัดฟันที่ 2 แบบเจาะลึก จากนั้นจะให้แรงในการเคลื่อนที่ด้วยแรงอิมพัลส์ในต่อเนื่อง และทุกๆเดือนจะต้องกลับมาตรวจสภาพและปรับแรงให้คงที่ ภายหลังจากเคลื่อนที่ได้ครบฟันที่เป็นชนิดที่ 1 จะทำการเก็บข้อมูลอีกครั้งเหมือนกับอันเดิม และทำให้ฟันที่เป็นชนิดที่ 1 ได้รับการรักษาทางทันตกรรมจัดฟันเพิ่มเติม หลังจากนั้นผู้ป่วยจะได้รับการรักษาทางทันตกรรมจัดฟันเพิ่มเติม เหลือแต่ส่วนที่ยกเว้นค่าใช้จ่ายที่เกี่ยวข้องกับการวิจัย
ความปลอดภัยของผู้เข้าร่วมวิจัยจากความเสี่ยงที่เกิดขึ้น

กรูพานเหล็ก มีส่วนประกอบเดียวกันกับกรูพานเทียม คือ โลหะไทเทเนียม (titanium alloy) ซึ่งใช้กันอย่างแพร่หลาย ในการฝังกรูพานเหล็กระหว่างกรูพานนั้น อาจส่งผลให้มีโอกาสเสี่ยงในการฝังโดยไม่รักษาที่ก่อนได้ แต่สามารถป้องกันได้ด้วยการถ่ายภาพรังสีวัตถุสั่นสะอาดกรูพานก่อนที่จะฝังกรูพานเหล็ก เพื่อตรวจจับระหว่างกรูพานที่มีช่องว่างเพียงพอสำหรับการฝังหรือไม่ โดยบริเวณที่จะฝังนั้นกรูพานจะตั้งกันประมาณ 5 mm และจะใช้ตะแหน่ง (guided wire) เพื่อบอกตำแหน่งในการฝัง (รูปที่ 2) หากยังมีช่องว่างไม่เพียงพอ จะใช้การเจาะผิวทำให้กรูพานเคลื่อนที่ออกจากกันและถ่ายภาพรังสีตรวจชัดเจนกว่าจะมีช่องว่างเพียงพอสำหรับการฝังกรูพานเหล็ก ในขั้นตอนการตัดสินตอนสำหรับการฝังกรูพานเหล็กสามารถทำได้ด้วยตัวผู้ทันตแพทย์ที่ตั้งเกี่ยวกับการฝังกรูพานเหล็ก ตามตัวแหน่งที่ได้จากการฝังกรูพานเหล็กแล้ว การรักษาตัวแหน่งของแผลที่เกิดขึ้นจะเป็นไปอย่างรวดเร็ว แต่อาจมีโอกาสเสี่ยงที่ในการเกิดการอักเสบหรือการติดเชื้อได้ ในการฝังจึงป้องกันโดยการฝ่ายที่จะมีช่องว่างที่จะฝังก่อน และผู้ป่วยควรดูแลความสะอาดแผลได้ดี ซึ่งทำได้ด้วยการใช้ผ้าปั้นมือที่สะอาด และผู้ป่วยควรดูแลข้อต่อผู้ป่วยด้วยการและทำให้การรักษาต่อตามขั้นตอนปกติ โอกาสที่จะฝังหลังอีกครั้งกรูพานเหล็กใดกรูพานนั้น ยกให้ผู้ป่วย เนื่องจากมีการตรวจสอบระยะระหว่างกรูพานก่อน และมีการระบุตำแหน่งที่เข้าเกี่ยวกรูพานนั้น นอกจากนี้ยังมีการใช้เครื่องมือที่มีความคุ้มครองแผลต่อข้างต่าง
ฟัน เมื่อนำหลักยึดสรุณยาตลาดออก เคลือบปากฟัน เอนออดวิธีที่นิยม และระดุกสามารถซ่อมสร้างกลับคืนมาได้ ส่วนการในกระดูกของสรุณยาตลาดนั้น เนื่องจากการใช้แรงในการเคลื่อนฟันอยู่ในปริมาณที่น้อยไม่ทำให้สูญเสียสาระคาระค์ของสรุณยาตลาดที่มีอยู่ในกระดูก จึงไม่มีโอกาสในการหลุดขณะที่ทำการเคลื่อนฟัน

สำหรับการถ่ายภาพรังสีด้านข้างก่อนและหลังการทำวิจัยนี้ ไม่ก่อให้เกิดอันตรายร่างร่างต่อผู้เข้าร่วมวิจัย เมื่อนำการปริมาณรังสีที่ได้รับจะต่ำกว่ารังสีต่ำกว่าครั้งที่ปริมาณเนื้อเยื่อเพียงแค่ 2-3 µSv เทียบกับปริมาณรังสีที่ได้รับเมื่อกิจกรรมที่มีปริมาณเนื้อเยื่อ 50% ภายหลังจากได้รับรังสี 60 วันที่มีขนาด 3.5-4.0 Sv และยังไม่มีหลักฐานพบว่ารังสีที่ได้รับในระยะสั้นขนาดปริมาณที่น้อยกว่า 50 mSv นั้นก่อให้เกิดอันตรายหรือทำให้เกิดมะเร็ง แสดงให้เห็นว่าการถ่ายภาพรังสีด้านข้างในแต่ละครั้งปริมาณรังสีที่ได้รับนั้นน้อยมากกว่าที่จะก่อให้เกิดอันตรายต่ำกว่าภายและสามารถป้องกันรังสีได้ด้วยการใส่เสื้อตะกั่วทุกครั้งที่ทำการถ่ายภาพรังสี

ชื่อผู้รับผิดชอบโครงการวิจัย และที่อยู่ที่สามารถติดต่อได้

นางสาว จินตรัตน์ แจงศรีสุข (ทันตแพทยศาสตร์บัณฑิต)
ภาควิชาทันตกรรมป้องกัน สาขาวันทันตกรรมจัดฟัน
คณะทันตแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์ 90112
หมายเลขโทรศัพท์ 074-429875, 287669, 287674 (ในเวลาราชการ)
01-7569010 (นอกเวลาราชการ)
ผศ. ดร. โชแรกัน เหลี่ยมรัตนโรจน์
สาขาทันตกรรมจัดฟัน ภาควิชาทันตกรรมป้องกัน
คณะทันตแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์ 90112
หมายเลขโทรศัพท์ 074-429875, 287669, 287674

ผู้ป่วยและผู้ปกครองมีสิทธิเลือกในการเข้าร่วมหรือไม่เข้าร่วมการวิจัย และไม่ว่าท่านจะเข้าร่วมในโครงการวิจัยหรือไม่ ท่านจะยังคงได้รับการรักษาที่ดีที่เดิมอย่างรับผิดชอบต่อการศึกษาที่เกิดขึ้นใดๆ ท่านจะได้รับการจัดพันธุ์สุขภาพที่ดีที่เดิม ท่านมีสิทธิ์ได้รับการรักษาที่ดีที่เดิม การที่ท่านจะเข้าร่วมโครงการวิจัย ท่านจะยังคงได้รับการรักษาที่เดียวกันที่ท่านได้รับในช่วงเวลาที่ผ่านมา

หากท่านมีคำถามใด ๆ ก่อนที่จะตัดสินใจเข้าร่วมโครงการนี้ โปรดสอบถามรายละเอียดเพิ่มเติม

ขอขอบคุณเป็นอย่างสูง

(นางสาว จินตรัตน์ เจิ้งศรีสุข)
ผู้วิจัย

(ผศ. ดร. โชแรกัน เหลี่ยมรัตนโรจน์)
อาจารย์ที่ปรึกษาการวิจัย

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แบบยินยอมเข้าร่วมการศึกษา
วันที่ .......... เดือน ......... พ.ศ. ..............

ชื่อพยาบาล................................................................. ผู้ปกครองของ

อายุ ................ อายุของผู้ยินยอมที่ .......... ขนำגדที่ .......... อน........................................

ขนำגד................................................................. อายุ ................

ได้รับการแจ้งเกี่ยวกับการวิจัยเรื่องการประยุกต์ใช้ micro-implant anchorage แทน cervical pull headgear ในรายละเอียดของการศึกษาวิจัย วัตถุประสงค์ วิธีการวิจัย ข้อควรระวังโอกาสเสี่ยงที่อาจเกิดขึ้นจากการวิจัย รวมถึงประโยชน์ที่จะเกิดขึ้นจากการวิจัยของผลและมีความเข้าใจดังนี้

หากขนำגדมีข้อสงสัยเกี่ยวกับการวิจัยหรือการวิจัยเกิดขึ้น จะได้รับการค้นหาและเรียกต่อจากทางโรงพยาบาล ในกรณีใดๆตามระเบียบการวิจัยที่เกี่ยวข้อง การวิจัยจะแจ้งให้ขนำגדทราบอย่างรวดเร็วโดยไม่ต้องมีการเป็นมิตรกับขนำגדก่อน การวิจัยหรือการวิจัยเกิดขึ้น

หากขนำแดงมีข้อมูลเพิ่มเติมที่เกี่ยวข้องกับการวิจัย ผู้วิจัยจะแจ้งให้ขนำแดงทราบอย่างรวดเร็วโดยไม่ต้องมีการเป็นมิตรกับขนำแดงก่อนเริ่มการวิจัย ขนำแดงมีสิทธิ์ที่จะขอการเข้าร่วมโครงการวิจัย โดยจะแจ้งให้ทราบล่วงหน้า โครงการวิจัยนี้จะไม่มีผลต่อการรักษาที่ขนำแดงได้รับแต่การวิจัยใด

ขนำแดงได้รับทราบจากผู้วิจัยว่า จะเก็บข้อมูลเฉพาะที่เกี่ยวกับความสัมพันธ์จะไม่เปิดเผยข้อมูลหรือผลการวิจัยของขนำแดงเป็นรายบุคคลต่อสาธารณะ จะเปิดเผยได้เฉพาะในรูปแบบทางการวิจัย หรือการเปิดเผยข้อมูลต่อผู้มีหน้าที่เกี่ยวกับการสนับสนุนและการติดตามการวิจัย

ขนำแดงได้รับการแจ้งข้อมูลเกี่ยวกับความเข้าใจดังนี้ และมีความเข้าใจถูกบัญญัติ จึงได้ลงนามในยินยอมนี้ด้วยความเต็มใจไว้เป็นหลักฐาน

ลงชื่อ……………………………………………...ผู้ยินยอม

(..........................................................)

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

(..........................................................)

ลงชื่อ……………………………………………...มารดา

(..........................................................)

ลงชื่อ……………………………………………...หัวหน้าโครงการ

(..........................................................)

ลงชื่อ……………………………………………...พยาบาล

(..........................................................)

ลงชื่อ……………………………………………...พยาบาล

(..........................................................)
VITAE

Name: Miss Jintarat Chaengsrisuk

Student ID: 4862008

Education Attainment

<table>
<thead>
<tr>
<th>Degree</th>
<th>Name of Institution</th>
<th>Year of Graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor of Dental Surgery</td>
<td>Mahidol University</td>
<td>2003</td>
</tr>
</tbody>
</table>

Work-Position and Address

Dental Department, Chaoprayayomraj Hospital, Suphanburi, Thailand