Effects on The Alveolar Bone Change Following Decortications-Facilitated Orthodontics for Mandibular Molar Protraction: A Clinical Study

Supang Samansukumal

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Oral Health Sciences Prince of Songkla University

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บทคัดย่อ

บทนำ ปัญหาที่พบได้บ่อยในผู้ป่วยที่มีการรักษาทางทันตกรรมจัดพันถึง การสูญเสียฟันเครื่องกำลังที่ไปทรงจากสันพุ หลังออกจากกระดูกของกระพันจะต้องลด การเคลื่อนพัน ผ่านกระดูกลิ้นที่อยู่ในหลุมข้อ ทำให้ระดับการรักษาที่ต่ำ โดยเฉพาะอย่างยิ่งในกระดูกชั้นโครงสร้างซึ่งมีกระดูกที่ยืดหยุ่น นักวิจัยได้ทำการเปรียบเทียบผลของการกระดูกตามการเคลื่อนที่ของฟันเพื่อความได้ชัยชนะ การเคลื่อนพันที่มีระดับการรักษาที่ต่ำ 0.5 มิลลิเมตรต่อเดือน นอกจากนี้การเคลื่อนพันฟันตามที่ยาวขึ้นได้ค้นหาและเกิดขึ้นอย่างมากสูงกระดูกอย่างรวดเร็ว วิจัยที่นี้มีวัตถุประสงค์เพื่อศึกษาการเปลี่ยนแปลงของกระดูกของกระพัน และอธิบายเกี่ยวกับการเคลื่อนพัน ภูมิลักษณะทางด้านเดิมท้ายล่างจากการกระดูกที่ร่วมกับการจัดพัน วัตถุดีเป็น กรุ่น ตัวอย่างประกอบด้วยผู้ป่วยที่มีการจัดพันจัดพันจานมานาน 13 ราย อายุยังต่ำ 27.46 ปี อัตราการเคลื่อน ฟันเกิดขึ้นอุปกรณ์เทียมกับการศึกษาที่ผ่านมา วิธีการศึกษาที่ศึกษากำลังเคลื่อนพันฟันกว่าช่วงที่ 2 มีวิธีการในว้าไว้ถูกทางด้านที่ผ่านมาตั้งอย่างที่มีการศึกษาโดยใช้ผลิตภัณฑ์ แต่ที่มีข้อมูลการเปลี่ยนแปลงความหนาของกระดุกเป็นพัน ระดับออกจากกระดูก และความสูงของยอด กระดูกเป็นพันเกินและระดับหลังการเคลื่อนพันความจากภาพถ่ายโดยเป็นคอมพิวเตอร์ทางภาพ ฟิวิวาร์ะจัดการเคลื่อนพันฟันแต่ข้างจากการถ่ายรูปวัดค่าบาทด้านข้างเกินและหลังการเคลื่อนพัน ผลการศึกษา พบว่า ความหนาของกระดูกเป็นพันพื้นที่มิได้มีความสำคัญทางสถิติ (p < .05) ในขณะที่ระดับของกระดูก และความสูงของยอดกระดูกเป็นพัน แตกต่างกันอย่างมีนัยสำคัญทางสถิติ (p < .05) เนื่องจากยอดขึ้นในระดับบกปิดพันได้ในการเคลื่อนพันทางทันตกรรมจัดพันแบบปกติ
สรุป การกระจายลูกศักดิ์รวมกับการจัดพื้นสามารถเคลื่อนฟิล์มกระท่อมล่างชั้นที่ 2 ผ่านช่องว่างตอนที่
ติดลิบมากทางด้านหน้าพร้อมกับกระจายองรีพื้น และมีอัตราการเคลื่อนพื้นที่เร็วขึ้นกว่า 3เท่า
Effects on The Alveolar Bone Change Following Decortications-Facilitated Orthodontics for Mandibular Molar Protraction: A Clinical Study

Miss Supang Samansukumal

Oral Health Sciences

2011

ABSTRACT

Introduction: A common clinical finding in adult orthodontic patient had loss of mandibular first molar due to caries. After extraction of mandibular first molar, alveolar portion starts to atrophy. Orthodontic tooth movement through atrophic extraction area is difficult and prolonged treatment time; especially in mandible that predominately cortical bone. The modeling/remodeling of alveolar bone was difficult and delayed. Mesial movement of mandibular second molar to close the mandibular first molar extraction space was limited by the rate of cortical bone remodeling which about 0.5 mm/mth. Moreover, mandibular second molar protraction through atrophic first molar extraction site took the risks including root resorption, dehiscence, fenestration, loss of alveolar bone support, anchorage loss, devitalization and no formation of new bone. Objectives: The aims of this study were to evaluate the alveolar bone changes and the rate of mandibular molar protraction following decortication-facilitated orthodontics. Materials and methods: 13 patients with the mean age of 27.46 years were included in this study. The rate of mandibular molar protraction was compared with 7 previous studied which mandibular first molar area were closed orthodontically in adult patients. Changes of alveolar bone thickness, marginal bone level and crestal bone height were assessed from pre-protraction ($T_0$) and 3 months post-protraction ($T_3$) cone beam computed tomography images. Rate of molar protraction was analyzed from pre-protraction ($T_0$) and post-protraction ($T_3$) lateral cephalometric radiographs. Results: The alveolar bone thickness of edentulous ridge was statistically significant increased ($p < .05$), while the marginal bone level and the crestal bone height were statistically significant decreased ($p < .05$). However, this is a normal situation of orthodontic tooth movement. Conclusion: Decortication-facilitated orthodontics
assisted mandibular molar protraction could be move the mandibular second molar forward through the atrophic edentulous area with the bone and the rate of protraction was increased over 3-time.
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<tr>
<td>mm</td>
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<td>et al.</td>
<td>and others</td>
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<td>g</td>
<td>gram</td>
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<td>CBCT</td>
<td>cone-beam computed tomography</td>
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<td>NSIADs</td>
<td>non steroidal anti-inflammatory drugs</td>
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<td>RAP</td>
<td>regional acceleratory phenomenon</td>
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<td>PAOO</td>
<td>periodontally accelerated osteogenic orthodontics</td>
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<td>NiTi</td>
<td>nickel titanium</td>
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<tr>
<td>TMA</td>
<td>titanium molybdenum</td>
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<td>figure</td>
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<td>CEJ</td>
<td>cemento-enamel junction</td>
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<td>OP</td>
<td>occlusal plane</td>
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<td>OPP</td>
<td>occlusal plane perpendicular</td>
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CHAPTER 1

INTRODUCTION

Background and rationale

A common clinical finding in the adult orthodontic patient was posterior spacing due to missing mandibular teeth. Excluding the third molars, the mandibular second premolar is the most common congenitally absent tooth\(^1\) while the mandibular first molar is the most frequently lost tooth in adults\(^1\)\(^-\)\(^3\). When the first molar was lost, the second molar usually tips mesially\(^3\)\(^-\)\(^5\), the second premolar drifts distally\(^3\), altered gingival form\(^4\),\(^5\) and constriction of the edentulous ridge\(^2\),\(^3\),\(^6\)\(^-\)\(^9\). Under most circumstances, there are three clinical options for management of missing mandibular first molars:

1. Alignment of the abutment teeth as needed, followed by placement of a fixed partial denture (FPD).
2. Fabrication of an implant-supported crown as a single tooth replacement (STR).
3. Orthodontic space closure.

Disadvantages of a fixed partial denture and implant-supported crown are mean life span often 10 to 15 years, increases risk of caries and periodontal disease, damage to health teeth and high cost\(^10\).

After extraction of the mandibular first molar, the alveolar portion of the jaws starts to atrophy\(^6\),\(^11\) because lost of bucco-lingual cortical plate, clot retraction, resorption of alveolar bone during the healing process or mastication impairment. Displacement of teeth into substantial atrophy of the alveolar ridge has considered a major limitation; especially in the posterior part of the mandibular arch, because of predominately cortical bone, less trabecular bone, less cellular, less vascular and the mandibular molar roots are extremely wide buccolingually\(^4\),\(^9\),\(^12\)\(^-\)\(^13\). Orthodontic tooth movement is a process whereby the application of a force induces bone resorption on the pressure side and bone apposition on the tension side\(^14\)\(^-\)\(^15\). Classically, the rate of orthodontic tooth movement depends on the magnitude and duration of the force\(^14\), the number and shape of the roots\(^16\), the quality of the bony trabeculae\(^17\)\(^-\)\(^20\),
the patient’s response, and the patient’s compliance. Orthodontic translation through cortical bone was limited by the linear rate of osteoclastic resorption, which is about 0.5 millimeter per month\textsuperscript{21}. Therefore, to close the mandibular first molar extraction space that about 10-12 millimeters, mesial movement of the mandibular molar usually take long treatment time about 2 years and demand substantial anchorage\textsuperscript{2, 3, 21}. Moreover, the longer orthodontic treatment duration takes, the more risks for the patient. Risks in orthodontic treatment include enamel demineralization, caries, periodontal disease and root resorption\textsuperscript{22}. And the duration of orthodontic treatment is one of the things that orthodontic patients complain about most—especially adult patients\textsuperscript{23}.

Previously, parameter use clinically to evaluation of interdental bone was bitewing or periapical film\textsuperscript{24}. This conventional dental radiograph was limited to identifying anatomic and pathologic structures of intraoral hard tissues\textsuperscript{25} and cause of an underestimation of interdental alveolar bone loss\textsuperscript{24, 26}. With low-dose cone-beam computed tomography (CBCT) technology, it is possible to obtain accurate radiographic images that allow clinicians and researchers to quantitatively evaluate hard-tissue changes in 3 dimensions\textsuperscript{27-29}.

**Review of literatures**

Some orthodontists prefer to open the atrophic extraction space by uprighting the molar and stabilized with prosthesis, fixed partial denture or implant-supported crown. For instance, Graber (1972)\textsuperscript{12} stated that space closure of the molar area was seldom possible or desirable. Movement of molar teeth was often difficult because of the greater root surface area, the increased tissue resistance, and the anchorage needs involved. He advocated uprighting the second molar to its normal position and stabilizing it with a fixed or removable prosthesis. Kessler (1976)\textsuperscript{4} suggested that if the buccolingual width of the second molar alveolus was wider than the adjacent edentulous ridge; the tooth should not be moved mesially because resulted in loss of the bone support, especially in adults. Because of alveolar bone surface adjacent to adult teeth were frequently aplastic that there had delayed in the formation and mobilization of osteoblasts, osteoid and bone formation in adults. Orthodontic tooth movement over long distances in adults might produce unavoidable loss of alveolar bone particularly at the alveolar crest.
While the studies of Brown (1973) and Roberts (1982) informed that though the tooth movement through cortical plate or atrophic extraction site was possible, the disadvantages of root resorption, dehiscence, and prolonged treatment time generally outweigh the advantages. Creation of pontic space by correction of molar inclination and stabilization improved the health of the molar periodontium, protected the inflammatory periodontal diseases and occlusal traumatism because this therapy produced significant reduction in the depth of existing periodontal defects and highly desirable changes in the gingival architecture.

Roberts, et al. (1994) considered the long-term consequences and the total cost of conventional prosthodontics compare with orthodontic space closed, suggested that although the conventional fixed partial denture has a high rate of success initially, it had limitations relative to prosthetic longevity. Furthermore, undesirable side effects or complications could occurred, including loss of pulpal vitality, mechanical failure (fracture, loss of retention, etc.), secondary caries, and periodontal disease. It is more likely that the prosthetic options will require additional treatment (as endodontic treatment following placement of fixed partial denture) with added expense. Therefore, orthodontic space closure might proved to be the most cost-effective option overall, particularly for adolescents and young adults who usually required at least five decades of longevity. They mentioned that no prosthetic device is equivalent to a natural tooth.

**Protraction of mandibular molar for close the extraction site:**

Generally, there were two methods to close the extraction site; conventional orthodontic treatment or conventional orthodontic together with skeletal anchorage reinforcement (rigid endosseous implant, bicortical microimplant, or miniscrew). Stepovich (1979) studied the changes in the edentulous ridge and adjacent teeth before and after closure of first molar spaces in the mandible using rectangular wire Bull loop retraction in an .022 slot. It was found that spaces of 10 millimeters or more in posterior mandible could closed in young adults (average treatment time was 27.8 months) as well as adults (average treatment time was 32.3 months). But the half the adult patients resisted forming any new bone during space closure. The other half developed only small amounts of new bone. The young adults had four times more bone to the width of the alveolar ridge during space closure. Loss of crestal bone height and gingival recession were seen in both groups but more evident in the adult patients.
Hom and Turley (1984) studied the dental and periodontal changes occurred when mandibular first molar areas were closed orthodontically in 14 adult patients, using closing loops on rectangular wires. The treatment time ranged from 23 to 52 months. He found that every case had significant space closure (a mean of 6.2 millimeters), but only 5 of 19 quadrants had complete space closure on post-treatment models. Nine patients had crestal bone loss mesial to the second molars; however five patients showed bone addition. Half the patients showed increasing the width of alveolar ridge buccolingually 1.1 millimeters as the second molar moved forward. The other half showed narrower alveolar ridges after treatment. There was no correlation between ridge width and changed in vertical bone height. This study is in agreement with the finding of Cacciafesta and Melsen (2001) which was showed that second mandibular molars can be moved forward through atrophic alveolar ridge by use of superelastic Ni-Ti springs.

A case report of Robert, et al (1990), endosseous implant was placed in the retromolar area of the mandible as a rigid anchorage to translate mandibular molars mesially into an atrophic edentulous ridge. They claimed that a rigid endosseous implant was successfully used as the principle anchorage to intrude and mesially translate second and third molars into an atrophic first molar extraction site. However, the results showed that there was a possibility that mandibular molars could be devitalized when they were moved in great distances. And 10-12 millimeters of space closure through dense cortical bone was required approximately two years, because the rate of cortical bone remodeling was about 0.5 millimeters per months. They informed that not all atrophic ridges are candidates for space closure. In this case, there was no evidence upon on periodontal and radiographic examinations of fenestration or dehiscence. The overall mechanic approach to space closure was designed to lessen the possibility of creating a fenestration or dehiscence during space closure. Robert, et al. (1996) used of osseointegrated retromolar anchorage to close large spaces (8 millimeters or more) for studying steady state skeletal physiology during a period of sustained tooth movement. They suggested that orthodontic translation was a physiologic manifestation of bone modeling and remodeling throughout the adjacent alveolar process and the rate of mandibular molar translation was inversely related to the apparent radiographic density of the resisting alveolar bone. During the last year of space closure, radiolucent foci were noted ahead of the distal root.
A study of Wu, et al. (2007) performed in beagle dog, using a newly designed bicortical microimplant for mesial movement of posterior teeth in the mandibles. Because of microimplants and microscrews have advantages over conventional implants; they could placed not only in edentulous alveolar and midpalatal areas but also at alveolar segments and even around root apices. And bilateral orthodontic force system applied to the center of resistance of the molar was preferred to mesiodistal displacement of teeth. The disadvantages might including complicated placement of the bicortical microimplant and a possible intense tongue reaction.

A case report of Kyung, et al. (2003), both mandibular second molars were moved into first molar extraction sites by two miniscrews, inserted into the lingual alveolar bone between the premolar roots and connected to a lower lingual arch with elastic chain. In this case, reported the difficult to place the screws precisely because of poor visibility and access. Superimpositions of pre- and post-treatment cephalometric tracing showed mandibular second molars translated about 9mm mesially with no appreciable retraction of anterior teeth. This study was likely with the finding of Nagaraj, et al. (2008) which was performed by placed the titanium screws in the buccal alveolar bone between the roots of the first and second premolars and Ni-Ti coil spring were stretched between the molar hook and the titanium screw head.

Kravitz and Jolley (2008) stated that anterior dental anchorage is often inadequate to protract even a single first molar without reciprocal retraction of the incisors or movement of the dental midline. Furthermore, if the buccal and lingual cortical plates in the edentulous region have collapsed, safe and effective protraction may be impossible. Potential risks of molar protraction with temporary anchorage devices through an atrophic ridge include loss of attachment (particularly in the presence of plaque), mobility, ankylosis, root resorption, devitalization, tooth morbidity, dehiscence and fenestration.

The innovative orthodontic method that offers the short treatment times and the ability to simultaneously reshaped and increased the buccolinguval thickness of the supporting alveolar bone was first described in 2001 by Wilcko and Wilcko. This technique performed buccal and lingual full-thickness flaps, selective alveolar decortication of the cortical plates (extended just barely reaches into medullary bone) on the teeth to be moved orthodontically, concomitant bone augmentation, and primary flap closure. After the surgery, orthodontic adjustments were made approximately every 2 weeks. They patented and trademarked their
technique as Periodontally Accelerated Osteogenic Orthodontics (PAOO) or “Wilckodontics”. They claimed that the incorporation of the bone augmentation into the corticotomies site because this made it possible to complete the orthodontic treatment with a more intact periodontium, created greater alveolar bone volume which eliminated bony dehiscences and fenestrations, and enhanced the stability of the orthodontic treatment result.

Several authors had described rapid tooth movement in conjunction with corticotomy surgery as movement by bony “block”. Köle (1959) reported combining orthodontics with corticotomy surgery and completed the active tooth movement in adult orthodontic cases in 6 to 12 weeks. The interproximal corticotomy cuts were extended through the entire thickness of the cortical layer, just barely penetrating into the medullary bone. These vertical cuts were connected beyond the apices of the teeth with a horizontal osteotomy cut extending through the entire thickness of the alveolus, essentially creating blocks of bone in which one or more teeth were embedded. Using the crowns of the teeth as handles, Köle believed that he was able to move the blocks of bone somewhat independently of each other because they were only connected by the less-dense medullary bone. He found no incidence of root resorption, no loss of tooth vitality, and no pocket formation. Similarly to finding of Suya (1991) which believed that tooth movements were made by moving blocks of bone using the crowns of the teeth as handles. But Suya’s surgical technique differed from Köle’s with the substitution of a supraapical horizontal corticotomy cut in place of the horizontal osteotomy cut beyond the apices of the teeth.

On the other hand, Wilcko and Wilcko (2001) believed that the concept on rapid tooth movement after corticotomy was supported by the “regional acceleratory phenomenon (RAP)”. Orthopedist Harold Frost recognized that surgical wounding of osseous hard tissue results in striking reorganizing activity adjacent to the site of injury in osseous and/or soft tissue surgery. He collectively termed this cascade of physiologic healing events the regional acceleratory phenomenon (RAP). RAP healing is a complex physiologic process with dominating features involving accelerated bone turnover and decreases in regional bone densities. Trauma to cortical bone, osteotomy, bone grafting, or even flap operation have been shown to be a potentiating factor in producing a localized osteoporosis. For alveolar bone, this transient osteoporosis would facilitate more rapid tooth movement. Osteoporosis provides a favorable environment for increasing the rate of tooth movement without increasing the risk of root
resorption in rats. Moreover, it has been demonstrated that the residual soft tissue matrix has the ability to induce remineralization after the cessation of tooth movement. All of this suggests that the dynamics of the physiologic tooth movement after osteotomy might be more appropriately described as a demineralization/remineralization process, rather than bony block movement or resorption/apposition. This perspective is substantiated by the fact that there is a growth protein component in the soft tissue matrix of bone. Following cessation of the active tooth movement, this growth protein component may assist in stimulating an increase in osteoblastic activity, resulting in remineralization of the soft tissue matrix. Yaffe et al. suggested that RAP in humans begins within a few days of surgery, typically peaks at 1 to 2 months, and may take from 6 to more than 24 months to subside. During RAP, extensive regional intra-cortical bone remodeling occurs, recruiting cellular activity necessary for activation of the subsequent healing process. Cho et al. found that in the periodontal tissue with corticotomy, an increasing number of osteoclasts, osteoblasts, fibroblasts, cementoblasts with developed organelles were noted. The rate of tooth movement with corticotomy was 4 times greater than without corticotomy. However, 6 months after corticotomy, these cells were severely decreased in number and cellular activity.

Ferguson, et al. (2007) suggested that the clinical technique involving selective alveolar decortications was a form of periodontal tissue engineering. There were three tissue engineering principles associated with the selective alveolar decortications technique.

1. Decortications surgery initiates the local tissue repair and the production of osteoprogenitor cells (signaling and angiogenesis) and osteoinductive agents (mostly from the hemorrhage)
2. Low turnover tissues were replaced with high turnover tissues that functionally normal, a reversible condition often referred to as osteopenia (diminished bone density but not bone volume)
3. High tissue turnover was promoted in a precise anatomic area; that was, immediately adjacent to the area of desired tooth movement. The tissue was formed in the alveolus surrounding the area of desired tooth movement respond effectively to biomechanical forces, and teeth move rapidly.

In summary, the contributions of periodontal therapy to orthodontic treatment via Periodontally Accelerated Osteogenic Orthodontics was increased alveolar volume and enhanced
the periodontium, enhanced the stability of orthodontic clinical outcomes (less relapse), increased the scope of malocclusion treatable without orthognathic surgery, and reduced active orthodontic treatment time over 3-fold. These benefits were realized for two reasons:

1. Tissues lose memory due to high hard and soft tissue turnover induced by the periodontal decortications.

2. Augmentation bone grafting increased alveolar volume and thickness of the alveolar cortices.

Up until now, the studies regarding mandibular molar protraction through the atrophic edentulous ridge had stay in place, which used conventional orthodontic methods (closing loops, closed coil spring) or reinforced anchorage for mesialized mandibular molar by endosseous implant, bicortical microimplant and miniscrews. There were not rescue to reduced the complications or increased the rate of mandibular molar protraction through the atrophic edentulous ridge. Therefore, it was interesting to search a new orthodontic method that could assist protraction of the mandibular molar with surrounding periodontium, reduce the complications and the treatment time.

**Objectives**

1. To evaluate the alveolar bone changes of the mandibular first molar extraction site and the mandibular second molar following decortication-facilitated orthodontics for mandibular molar protraction.

2. To evaluate rate of mandibular molar protraction following decortication-facilitated orthodontics.

**Hypotheses**

1. The bucco-lingual width of alveolar bone of the mandibular first molar extraction site will increase while maintain alveolar bone support of mandibular second molar following decortication-facilitated orthodontics for mandibular molar protraction.

2. The rate of mandibular molar protraction following decortication-facilitated orthodontics will faster than previous studies.
Significances of the study

1. Decortication-facilitated orthodontics can present a viable alternative solution in a treatment of mandibular molar protraction.
2. Decortication-facilitated orthodontics can reduce some problems of mandibular molar protraction.

The limitations of the study

This study was performed under the limitation of time, thus the long-term effect from this technique, such as pulpal vitality, periodontal condition, or root resorption could not be investigated.
CHAPTER 2

RESEARCH METHODOLOGY

Samples

The population for this study was defined as adult patients who intend to receive orthodontic treatment in the Orthodontic clinic, Dental hospital, Faculty of Dentistry, Prince of Songkla University. The 13 samples were selected from the new patient pool base on the inclusion criteria.

Sample size was calculated from the equation following Kittika, 1999

\[
\text{Sample size (n)} = \frac{(z_{(1-\alpha)} + z_{(1-\beta)})^2 \cdot \text{SD}^2 \cdot \text{diff}}{(X_2 - X_1)^2}
\]

SD diff: difference standard deviation between group = 0.5 (Saikaya et al, 2002)

\(\alpha\): significant level 0.05

1-\(\beta\): power of test = 80%

The inclusion criteria were:

1. Age 18-35 years old.
2. Loss of mandibular first molar that bucco-lingual width of medullary bone was less than bucco-lingual width of cervical1/3 of mesial root of the mandibular second molar; assessed from cone-beam computed tomography (CBCT), Fig. 1
3. After mandibular second molar was protracted, the lastest tooth in maxillary arch had occluded.
4. The patients could come to follow up and activation of appliance every 2 weeks until space closed.
5. No long term use of Corticosteroid, NSIADs, Bisphosthanate.46
6. No sign and symptom of periodontal disease
Each patient was informed about the study and the consent form was signed prior to the study. The patients received repeated oral hygiene instructions for the use of toothbrush and dental floss during the study.

The patients were instructed to avoid non-steroidal anti-inflammatory agents in the month before appliance placement and during the study. In case of toothache due to orthodontic procedure, the patients were instructed to take acetaminophen.

**Materials and methods**

This study was certified by the ethic committee of Faculty of Dentistry, Prince of Songkla University. Pre-adjusted edgewise appliances (Roth prescription) with 0.018”-slot in anterior teeth and 0.022”-slot in posterior teeth were used for full arch. The teeth were aligned and leveled until complete on 0.018”x0.025” stainless steel archwire. Upper and lower impressions, lateral cephalograph, and CBCT were taken for pre-operation records. From initial CBCT found that the mesial root of mandibular second molar (according to the treatment plan) was moved out off alveolar bone housing (Fig.2). Before the surgical procedure (T0), buccolingual width of edentulous ridge at the narrowest, bucco-lingual width of edentulous ridge that the mesial root of mandibular second molar would be moved according to the treatment plan, height of crestal bone mesial to mandibular second molar, buccal and lingual marginal bone level of mandibular second molar were assessed by CBCT. Position of mandibular second molar,
position of mandibular second premolar and inclination of mandibular second premolar were assessed by lateral cephalograph. Then, Periodontally Accelerated Osteogenic Orthodontics was performed.

**Fig. 2** CBCT before alveolar decortication, the mesial root of mandibular second molar following to the treatment plan was moved out off alveolar bone housing

**Surgical procedure**

The surgical procedure was performed on the edentulous area to the mandibular second molar by 1 surgeon, following these steps:

1. Local anesthesia with inferior alveolar nerve block.
2. Buccal and lingual full-thickness flaps.
3. The alveolar decortications of the buccal and lingual cortical plates (Fig. 3) were done.

**Fig. 3** The selective alveolar decortications of buccal and lingual cortical plates
4. Bone grafting of allograft mixed with cortical autograft (from decortications) were applied to the corticotomy site. (Fig. 4)

5. Primary flap closure was done.

![Fig. 4](image)

**Fig. 4** A: Mixed of allograft and cortical autograft. B: Mixed of allograft and cortical autograft was applied to the corticotomy site.

Two weeks later, segmented L-loop was used to protract the mandibular second molar and activated every 2 weeks until space closed (Fig. 5A). Mandibular teeth were divided into two units, which were anchorage unit (from the second premolar of surgical side to the second molar of another side) and movement unit (the second molar distal to edentulous area). The 0.018”x0.025” stainless steel wire was engaged in anchorage unit and the 0.017”x0.025” titanium molybdenum segmented L-loop wire was overlayed on the first and second premolar and engaged to the second molar. To eliminate the occlusal interference between the upper and the lower molars during mandibular molar protraction, which might be a confounding factor to the rate of tooth movement, the segmented L-loop has step down about 1 millimeter at the distal arm (Fig. 5B). To create mesial root torque and to prevent mesio-lingual rotation of the mandibular second molar during protraction, a tipback bend and toe in were applied on distal arm of the segmented L-loop. The impressions were taken every month. The intra-oral photographs were taken every 2 weeks. After space closed, lateral cephalometric radiograph was taken (T1) to assess the rate of mandibular molar protraction, amount and inclination of anchorage loss. CBCT was taken at 3 months after space closed (T2) to evaluate alveolar bone changes.
Fig. 5 A: Mechanic was used for mandibular molar protraction. B: The 0.017”x0.025” TMA segmented L-loop wire with step down about 1 mm.

**Records and data analysis**

Parameters measured in this study included bucco-lingual width of edentulous ridge, height of crestal bone, buccal and lingual marginal bone level of mandibular second molar which were analyzed from CBCT. Mandibular molar movement was analyzed from lateral cephalograms.

**Cephalometric analysis**

To evaluate the rate of mandibular second molar protraction, the amount and inclination of anchorage loss, the lateral cephalometric radiographies were taken before alveolar decortication and after edentulous space closed. The occlusal plane (OP), occlusal plane perpendicular (OPp) and mandibular plane (MP) from the first lateral cephalometric radiograph were used as a reference grid. The grid was transferred from the first tracing to the following tracings by superimposition of the tracing on the nasion-sella plane (NSP) with sella (S) as registering point. The mandibular second molar position was measured from the most anterior contour of the mandibular second molar parallel to OP, to OPp. The mandibular second premolar position was measured from the most posterior contour of the mandibular second premolar parallel to OP, to OPp (Fig.6A). The inclination of mandibular second premolar (IP) was measured from angle between long axis and mandibular plane (Fig.6B). Rate of mandibular
second molar protraction (mm/mth) was calculated from the distance of mandibular second molar movement from T0 and T1 divided with treatment time. Anchorage loss (amount and inclination) were analyzed by the changes of position and inclination of mandibular second premolar between T0 and T1.

**Fig. 6** The lateral cephalographs were assessed mandibular second molar position, mandibular second premolar position (A), and inclination of mandibular second premolar (B).

**Computed Tomographic analysis**

The changes of alveolar bone was evaluated from CT scan (Veraviewepocs J Morita MPG (80 kv, 5mA)) according to study of Fuhrmann RAW et al. To evaluate the bucco-lingual width, CBCT sections were perpendicular to occlusal plane. To evaluate the height of crestal bone and buccal-lingual marginal bone level, CBCT sections were parallel to the mandibular second molar.

The bucco-lingual width of edentulous ridge was measured two areas (Fig. 7A),
at the most narrow and at the point that mesial root of mandibular second molar was moved following the treatment plan. Measurement between the outer surface of buccal and lingual plates at the level of 2mm, 4mm, 6mm and 8mm below to cement-enamel junction (CEJ) of mandibular second premolar (Fig. 7B) because the root was taper from coronal to apical while the alveolar bone support was wider apically. The bucco-lingual width of edentulous ridge at 8mm below to CEJ of all subject in our studied had wider than the width of molar roots, then we were measured until 8mm below to CEJ. The first CBCT section perpendicular to the occlusal plane was at distal surface of mandibular second premolar and sectioning every 1.5 mm to mandibular second molar.

Fig. 7 CBCT section at the narrowest of edentulous ridge and at the area that mesial root of mandibular second molar was moved following the treatment plan (A). The bucco-lingual width of alveolar ridge was measured at 4mm, 6mm and 8mm below CEJ (B).

The bucco-lingual width of mesial root of mandibular second molar was measured at the level of 2mm, 4mm, 6mm and 8mm below to cement-enamel junction (CEJ) of mandibular second molar (Fig. 8).

The buccal and lingual marginal bone level at mid-mesial root and mid-distal root of mandibular second molar (Fig. 9) were measured from CEJ to the apical limit of the bone defect (Fig 8).
Fig. 8 The bucco-lingual width of mesial root of mandibular second molar was measured from buccal to lingual borders, C2. The marginal bone level was measured from CEJ to the apical limit of the bone, C3.

Fig. 9 CBCT were assessed the buccal and lingual marginal bone level at mid-mesial root (A) and at mid-distal root (B).

The height of crestal bone mesial to mandibular second molar was measured from CEJ to highest point of crestal bone (Fig. 10) according to study of Baxter DH49 (Fig. 11).
Fig. 10 CBCT (sagittal section) assessed the height of crestal bone mesial to mandibular second molar, from CEJ to highest point of crestal bone.

Fig. 11 Schematic drawing of structures studied in intraoral bitewing roentgenograph. Alveolar crest is the most occlusal edge of the alveolar bone proper, as point Z⁹⁹.

Statistical analysis

The measurements of all samples were repeated twice and averaged. Paired t-test and Dahlberg’s formula were used to determine the intraobserver reliability. Shapiro-Wilk normality test was used to test normal distributed population. Unpaired t-test was used to compare the rate of mandibular molar protraction between this study and 7 previous studies which had age of subjects and mechanic close to this study. While paired t-test was used to compare the alveolar
bone changes (bucco-lingual width, buccal marginal bone level, and crestal height) of subject between before molar protraction and 3 months after space closed. The values of $p < .05$ were evaluated as statistically significant.
CHAPTER 3

RESULTS

The 13 samples in this study included 9 females and 4 male. Their mean age at the start of the treatment was 27.46 ± 5.59 years, range from 22-35 years. Mean extraction space was 5.88 ± 2.01 millimeters, range from 3.5-11.5 millimeters. Mean mandibular second molar movement was 5.04 ± 1.97 millimeters, range from 3.5-10.5 millimeters. Mean treatment time was 4.00 ± 1.37 months, range from 3-6.5 months. Mean rate of mandibular molar protraction was 1.21 ± 0.29 millimeters/month, range from 0.71-1.66 millimeters/month. (Table 1)

Measurement error analysis

All measurements were repeated 2 weeks apart and calculated to determine the intraobserver reliability. Dahlberg’s error was calculated from equation;

\[
ME = \sqrt{\frac{\sum D^2}{2N}}
\]

Where ME is the error of measurement, D is the difference between repeated measurement and N is the number of double measurements. The error in this study was 0.24 mm, ranging from 0.00 to 0.35 mm for the distance measurement from computed tomography, 0.10 mm, ranging from 0.00 to 0.20 mm for the distance measurement from lateral cephalometric radiographs. Paired t-test showed no significant difference between two series of measurements.
Table 1 Gender, age, extraction space, mandibular second molar movement, treatment duration and rate of molar protraction of each subject in this study.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Gender (Male / Female)</th>
<th>Age (Year)</th>
<th>Extraction space (mm.)</th>
<th>Mandibular molar movement (mm.)</th>
<th>Treatment duration (mth)</th>
<th>Rate of molar protraction (mm./mth)</th>
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<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>22</td>
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<td>Mean ±SD</td>
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<td>27.46 ± 5.59</td>
<td>5.88 ± 2.01</td>
<td>5.04 ± 1.97</td>
<td>4.00 ± 1.37</td>
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</tbody>
</table>

The bucco-lingual width of edentulous ridge

When mandibular molar was extracted, the alveolar ridge became atrophy both bucco-lingual and occluso-gingival dimensions. The CBCT data of every subject were shown that shape of edentulous ridge was concavity from second molar to second premolar (axial section; fig.12A) and gradually decreased occlusally (coronal section; fig. 12B).
Before decortications-facilitated mandibular molar protraction was performed, the bucco-lingual width at the narrowest of edentulous ridge and the bucco-lingual width of edentulous ridge that the mesial root of mandibular second molar would moved following the treatment plan were defined and measured. The bucco-lingual width of edentulous ridge in both area of each subjects found that no alveolar bone support at 2 mm below to CEJ. The means of bucco-lingual width at the most narrowest of edentulous ridge at 4, 6 and 8 mm below to CEJ were $5.03 \pm 1.59$ mm, $6.49 \pm 1.87$ mm and $7.68 \pm 1.71$ mm respectively. Three months after extraction space closed, measured the bucco-lingual width of alveolar ridge at the same point, found that also no alveolar bone support at 2 mm below to CEJ. The means of width of alveolar ridge at 4, 6 and 8 mm below CEJ were $6.82 \pm 1.75$ mm, $8.09 \pm 1.99$ mm and $9.36 \pm 1.85$ mm respectively (Table 2). There was a statistically significant difference between the means of bucco-lingual width at the narrowest of alveolar ridge before decortications and 3 months after extraction space closed as shown in Table 3 and Fig. 13.

The means of bucco-lingual width of alveolar ridge in the area that the mesial root of mandibular second molar would moved following the treatment plan at 4, 6 and 8 mm below to CEJ were $5.47 \pm 1.29$ mm, $6.58 \pm 1.17$ mm and $8.11 \pm 1.18$ mm respectively. Three months after extraction space closed, measured the bucco-lingual width of alveolar ridge at the same point, found that also no alveolar bone support at 2 mm below to CEJ. The means of width

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**Fig. 12** Shape of alveolar ridge when mandibular molar was extracted; concavity from second molar to second premolar (A) and bucco-lingual width gradually decreased occlusally (B).
of alveolar ridge at 4, 6 and 8 mm below CEJ were 7.21 ± 0.99 mm, 8.05 ± 1.16 mm and 9.08 ± 1.46 mm respectively (Table 4). There was a statistically significant difference between the means of bucco-lingual width of alveolar ridge in the area of mesial root of mandibular second molar before decortications and 3 months after extraction space closed as shown in Table 5 and Fig. 13.

Table 2 The bucco-lingual width at the narrowest of edentulous ridge of each subject in this study.

<table>
<thead>
<tr>
<th>Subject</th>
<th>The B-Li width at the narrowest of edentulous ridge</th>
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<tbody>
<tr>
<td></td>
<td>At 4 mm below CEJ</td>
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</tbody>
</table>

Note: At 2mm below CEJ, all subjects were no alveolar bone both before and after decortications-facilitated mandibular molar protraction.
Table 3 Comparision of means of the bucco-lingual width of alveolar ridge at the narrowest between before decortications and 3 months after extraction space closed.

<table>
<thead>
<tr>
<th>B-Li width of ridge</th>
<th>Before</th>
<th>After</th>
<th>Paired t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 4 mm below CEJ</td>
<td>5.03 ± 1.59</td>
<td>6.82 ± 1.75</td>
<td>**</td>
</tr>
<tr>
<td>At 6 mm below CEJ</td>
<td>6.49 ± 1.87</td>
<td>8.09 ± 1.99</td>
<td>**</td>
</tr>
<tr>
<td>At 8 mm below CEJ</td>
<td>7.68 ± 1.71</td>
<td>9.36 ± 1.85</td>
<td>**</td>
</tr>
</tbody>
</table>

** Statistically significant, p < 0.01

Table 4 The bucco-lingual width of alveolar ridge in the area of mesial root of mandibular second molar of each subject in this study.

<table>
<thead>
<tr>
<th>Subject</th>
<th>The B-Li width in the area of mesial root of mandibular second molar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At 4 mm below CEJ</td>
</tr>
<tr>
<td></td>
<td>Before</td>
</tr>
<tr>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>5.25</td>
</tr>
<tr>
<td>3</td>
<td>4.38</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>5.50</td>
</tr>
<tr>
<td>6</td>
<td>8.38</td>
</tr>
<tr>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>5.00</td>
</tr>
<tr>
<td>9</td>
<td>5.50</td>
</tr>
<tr>
<td>10</td>
<td>7.25</td>
</tr>
<tr>
<td>11</td>
<td>3.88</td>
</tr>
<tr>
<td>12</td>
<td>6.00</td>
</tr>
<tr>
<td>13</td>
<td>4.88</td>
</tr>
</tbody>
</table>
Table 5 Comparision of means of the bucco-lingual width of alveolar ridge in the area of mesial root of mandibular second molar between before decortications and 3 months after extraction space closed.

<table>
<thead>
<tr>
<th>B-Li width of ridge</th>
<th>Before</th>
<th>After</th>
<th>Paired t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 4 mm below CEJ</td>
<td>5.52 ± 1.29</td>
<td>7.25 ± 0.99</td>
<td>**</td>
</tr>
<tr>
<td>At 6 mm below CEJ</td>
<td>6.61 ± 1.17</td>
<td>8.10 ± 1.16</td>
<td>**</td>
</tr>
<tr>
<td>At 8 mm below CEJ</td>
<td>8.33 ± 1.18</td>
<td>9.40 ± 1.46</td>
<td>**</td>
</tr>
</tbody>
</table>

** Statistically significant, \( p < 0.01 \)

Fig. 13 CBCT (axial section) was used to compare the bucco-lingual width of edentulous ridge before decortications (A) and 3 months after extraction space closed (B), at the narrowest (red line) and at the mesial root of mandibular second molar (yellow line).

The bucco-lingual width of edentulous ridge VS the width of mesial root of mandibular second molar

The means width of mesial root of mandibular second molar at 2, 4, 6 and 8 mm below to CEJ were \(8.07 ± 0.73 \) mm, \(7.15 ± 0.66 \) mm and \(8.11 ± 1.18 \) mm respectively (Fig. 14). Before decortications-facilitated mandibular molar protraction, the bucco-lingual width of
alveolar bone in the area that the mesial root of mandibular second molar would be moved following the treatment plan at 2, 4 and 6 mm below to CEJ were narrower than width of mesial root of mandibular second molar (Fig. 15). Three months after extraction space closed found that the bucco-lingual width of alveolar bone at 4 and 6 mm below to CEJ were increased and wider than width of mesial root of mandibular second molar (Fig. 16).

**Fig. 14** The means width of mesial root of mandibular second molar at 2, 4, 6 and 8 mm below to CEJ of mandibular second molar.

**Fig. 15** Comparision of the bucco-lingual width of alveolar bone before decortications and the width of mesial root of mandibular second molar.
The buccal and lingual marginal bone level

Before decortications-facilitated mandibular molar protraction was performed, the buccal and lingual marginal bone level of each subject was measured (Table 6). Means of the buccal marginal bone level at mid-mesial root was 4.01 ± 1.43 mm and at mid-distal root was 3.35 ± 1.32 mm. Means of the lingual marginal bone level at mid-mesial root was 2.18 ± 0.65 mm and at mid-distal root was 1.97 ± 0.55 mm. Three months after extraction space closed found that means of the buccal marginal bone level at mid-mesial root was 3.90 ± 1.53 mm and at mid-distal root was 3.40 ± 1.51 mm. While means of the lingual marginal bone level at mid-mesial root was 2.58 ± 0.58 mm and at mid-distal root was 2.36 ± 0.50 mm. No statistically significant difference between means of the buccal marginal bone level at mid-mesial root and mid-distal root before decortications and 3 months after extraction space closed but there were a statistically significant difference between means of the lingual marginal bone level at mid-mesial root and mid-distal root before decortications and 3 months after extraction space closed as shown in Table 7 and Fig 17.
Table 6 The buccal and lingual marginal bone level of mandibular second molar of each subject.

<table>
<thead>
<tr>
<th>Subject</th>
<th>The buccal marginal bone level (mm)</th>
<th>The lingual marginal bone level (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At mid-mesial root</td>
<td>At mid-distal root</td>
</tr>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>1</td>
<td>1.95</td>
<td>1.67</td>
</tr>
<tr>
<td>2</td>
<td>2.51</td>
<td>2.21</td>
</tr>
<tr>
<td>3</td>
<td>4.46</td>
<td>4.73</td>
</tr>
<tr>
<td>4</td>
<td>5.01</td>
<td>4.85</td>
</tr>
<tr>
<td>5</td>
<td>4.80</td>
<td>4.46</td>
</tr>
<tr>
<td>6</td>
<td>2.51</td>
<td>2.20</td>
</tr>
<tr>
<td>7</td>
<td>5.84</td>
<td>5.29</td>
</tr>
<tr>
<td>8</td>
<td>4.46</td>
<td>3.90</td>
</tr>
<tr>
<td>9</td>
<td>6.41</td>
<td>6.68</td>
</tr>
<tr>
<td>10</td>
<td>2.23</td>
<td>1.95</td>
</tr>
<tr>
<td>11</td>
<td>5.02</td>
<td>5.29</td>
</tr>
<tr>
<td>12</td>
<td>3.34</td>
<td>3.50</td>
</tr>
<tr>
<td>13</td>
<td>3.61</td>
<td>4.00</td>
</tr>
</tbody>
</table>

Table 7 Comparision of means of the buccal and lingual marginal bone level between before decortications and 3 months after extraction space closed.

<table>
<thead>
<tr>
<th>Marginal bone level</th>
<th>Before</th>
<th>After</th>
<th>Paired t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buccal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At mid-mesial root</td>
<td>4.01 ± 1.43</td>
<td>3.90 ± 1.53</td>
<td>NS</td>
</tr>
<tr>
<td>At mid-distal root</td>
<td>3.35 ± 1.32</td>
<td>3.40 ± 1.51</td>
<td>NS</td>
</tr>
<tr>
<td>Lingual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At mid-mesial root</td>
<td>2.18 ± 0.65</td>
<td>2.58 ± 0.58</td>
<td>**</td>
</tr>
<tr>
<td>At mid-distal root</td>
<td>1.97 ± 0.55</td>
<td>2.36 ± 0.50</td>
<td>**</td>
</tr>
</tbody>
</table>

NS, no statistically significant,

** Statistically significant, \( p < 0.01 \)
Fig. 17 CBCT (coronal section) was used to compare the buccal and lingual marginal bone level before decortications (A) and 3 months after extraction space closed (B).

**The height of crestal bone**

Before decortications-facilitated mandibular molar protraction was performed, the height of crestal bone mesial to mandibular second molar of each subject was measured (Table 8). Mean of the height of crestal bone was $2.00 \pm 0.15$ mm. Three months after extraction space closed, mean was $2.24 \pm 0.24$ mm. There was a statistically significant difference between before decortications and 3 months after extraction space closed as shown in Table 9 and Fig. 18.
Table 8 The height of crestal bone mesial to mandibular second molar of each subject.

<table>
<thead>
<tr>
<th>Subject</th>
<th>The height of crestal bone (mm)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>1</td>
<td>1.89</td>
<td>2.18</td>
</tr>
<tr>
<td>2</td>
<td>1.88</td>
<td>2.39</td>
</tr>
<tr>
<td>3</td>
<td>2.00</td>
<td>2.23</td>
</tr>
<tr>
<td>4</td>
<td>2.00</td>
<td>2.28</td>
</tr>
<tr>
<td>5</td>
<td>2.20</td>
<td>2.50</td>
</tr>
<tr>
<td>6</td>
<td>1.77</td>
<td>1.95</td>
</tr>
<tr>
<td>7</td>
<td>1.88</td>
<td>2.01</td>
</tr>
<tr>
<td>8</td>
<td>1.88</td>
<td>2.00</td>
</tr>
<tr>
<td>9</td>
<td>1.97</td>
<td>2.23</td>
</tr>
<tr>
<td>10</td>
<td>2.13</td>
<td>2.25</td>
</tr>
<tr>
<td>11</td>
<td>1.91</td>
<td>1.94</td>
</tr>
<tr>
<td>12</td>
<td>2.20</td>
<td>2.79</td>
</tr>
<tr>
<td>13</td>
<td>2.23</td>
<td>2.38</td>
</tr>
</tbody>
</table>

Table 9 Comparision of the means of height of crestal bone mesial to mandibular second molar between before decortications and 3 months after extraction space closed.

<table>
<thead>
<tr>
<th>Height of crestal bone (mm.)</th>
<th>Before</th>
<th>After</th>
<th>Paired t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.00 ± 0.15</td>
<td>2.24 ± 0.24</td>
<td>**</td>
</tr>
</tbody>
</table>

** Statistically significant, \( p < 0.01 \)
Fig. 18 CBCT (axial section) was used to compare the height of crestal bone between before
decortications (A) and 3 months after extraction space closed (B).
CHAPTER 4

DISCUSSION

The findings in this study indicate that mandibular second molar could be protracted through mandibular first molar extraction site with conventional orthodontic appliance (segmented L-loop). Similarly, many previous studies also showed that second molars can be moved forward through edentulous areas but mostly required TADs for anchorage reinforcement. This is in contrast to Graber and Kessler, suggested that space closure of the mandibular first molar area is seldom possible, especially in adults. In this study, edentulous space of all subjects could be closed completely (Fig. 19) with a mean of 5.88 mm (3.5-11.5 mm).

![A. B.](image)

**Fig. 19** Subject no.1, extraction space of 11.5 mm. could be closed completely. A; Before alveolar decortications, B; After extraction space was closed.

The rate of mandibular molar protration in this study was about 4 times greater than previous studies, 1.21 mm/mth and 0.37 mm/mth respectively (Fig. 20). Because previous studies without dentoalveolar surgery, the rate of mandibular molar protration was consistent with the rate of resorption for osteocloasts during cortical bone remodeling that was about 0.5 mm/mth. This study was incorporate dentoalveolar surgery including selective alveolar decortications and bone graft augmentation according to Wilcko and Wilcko 2001. The mechanism of rapid tooth movement facilitated with dentoalveolar surgery has been explained by regional acceleratory phenomenon (RAP) after bone injury (periodontally accelerated
osteogenic orthodontics) \(^{35}\). RAP is a complex physiologic process with dominating features involving accelerated bone turnover and decreases in regional bone densities (as transient osteopenia) \(^{38}\). This transient osteoporosis provides a favorable environment for increasing the rate of tooth movement without increasing the risk of root resorption \(^{39}\). During RAP, extensive regional intra-cortical bone remodeling occurs, recruiting cellular activity necessary for activation of the subsequent healing process. The range of rate of molar protraction in this study was 0.71-1.66 mm/mth. The slowest rate (subject no.6, table 1) was faster than the previous studies (0.37 mm/mth) but slower than normal orthodontic tooth movement (1 mm/mth) because of the maxillary molar, opposite to protracted tooth, was distalized. Cuspal interference during maxillary and mandibular molar movement might cause of slow rate of mandibular molar protraction in this case.

![Graph](image)

**Fig. 20** The rate of mandibular molar protraction (mm/mth) in this study was compared with 7 previous studies.

Allograft, demineralized freeze dried bone was used in this study. Its advantage was less toxicity (less infection and rejection) while its disadvantages include weaker mechanical properties and lack of rich osteoinductive potential \(^{51, 52}\). However, osteoinductive property has important to stimulate new bone production in bone-forming cells and promote cell growth by hinding to specific receptors. This property obtained by blood-borne proteins, peptides, growth factors and cytokines from decortications surgery (mostly from the hemorrhage) \(^{44, 51}\). In addition
to allograft, cortical autograft from bone collector (Fig. 21) during decortication surgery was transplanted. Thus, decortications surgery incorporate with augmentation bone grafting performed in this study could produce osteoconduction (scaffold from allograft), osteoinduction (growth factors, cytokines from surgical procedure) and osteogenesis (osteoblast and osteoclast precursors from cortical autograft) cause of modeling/remodeling of alveolar bone, the results was increased bucco-lingual width of alveolar bone during orthodontic tooth movement through edentulous ridge. This is in contrast to studies of Stepovich, Hom, Robert, Kravitz and Jolley which not had surgical intervention and augmentation bone grafting, found that the half the adult patients resisted forming any new bone during orthodontic space closure while the other half developed only small amounts of new bone and had potential risks of dehiscence and fenestration after molar protraction through atrophic ridge.

Fig. 21 A; Bone collector B; Cortical autograft from bone collector

Three months after extraction space closed, the lingual marginal bone level of mandibular second molar was decreased 0.1-0.4 mm. Because the mandibular second molar moved into decreased alveolar bone housing (both width and height) and the pressure from tongue, cause of less bone modeling and remodeling. Moreover, the marginal bone level decreased due to “bone matrix transformation” phase of alveolar bone housing. The demineralization of the alveolar housing over the root surfaces apparently leaves the collagenous soft tissue matrix of the bone, which can not detected from CT scan. Similarly to study of Wilcko et al. which use 3D CT scan, found that the bony dehiscence and fenestration were increased after 2.5 months of orthodontic treatment but fully reversible alveolus after 2 years of retention.

Three months after extraction space closed, the crestal bone height mesial to mandibular second molar was decreased 0.24 mm because the mandibular second molar was
tipping movement during protracted. Tipping movement created maximum pressure to alveolar crest which less cellular and less vascular, hyalinization and undermining resorption arised that cause of creastal bone lost. Similarly to study of Stepovish\(^2\) and Hom\(^3\), found that crestal bone height loss was seen after mandibular molar protraction. Proffit\(^54\) stated that lost of alveolar crest height less than 0.5 mm are observed on orthodontic patients.

The first clinical observation, extraction spaces were closed and mandibular second molar could be protracted with less tipping and rotation because we could applied the tipback bend, step down or toe in at distal arm of segmented L-loop to control tipping and rotation of mandibular second molar. The second clinical observation was the mandibular third molar could be translate following the second molar without apply orthodontic force to it (Fig. 22). Possible causes were RAP from alveolar decortications produce transient osteoporosis and decreased the bony resistance\(^55\). And protraction force from transeptal fibers was occured mesial to the third molar.

Fig. 22 Subject no.2, the mandibular second molar was protracted 6 mm and the third molar was mesialized about 3 mm. A; Initial, edentulous space of 6mm B; After extraction space was closed, remaining space between second and third molar about 3mm.

In order to assess dentoalveolar morphology in both sagittal and vertical dimensions, orthodontists often use cephalometric tracings. However, this fails to assess bone thickness. Compared with conventional dental radiograph, CBCT permits accurate identification and measurement in multiple plane\(^56\). Fuhrmann et al\(^48\) recently showed that quantitative evaluation of alveolar bone plates is accurate to a minimum bone thickness of 0.25 mm. Lascala
et al.\textsuperscript{57} found that, although the CBCT image underestimated the real distances between skull sites, the differences were significant only for the skull base; therefore, it was reliable for linear evaluation measurements of other structures more closely associated with dental and maxillofacial imaging. Lagravere \textit{et al.}\textsuperscript{58} evaluated the accuracy of measurements made on CBCT images compared with measurements made on a coordinate measuring machine; they found no significant statistical differences between the linear and angular measurements from the coordinate measuring machine and the NewTom 3G (Aperio Services, Verona, Italy) images. Hence, they concluded that the NewTom 3G produces a 1-to-1 image-to-reality ratio. CBCT findings have proven to be statistically similar to histologic measurements. Moreover, accuracy and reliability of CBCT measurements are not affected by changing the skull orientation.\textsuperscript{59-60} Therefore, this study was designed to use CT measurements to more accurately evaluate bone thickness changes.

The limitations of this study were the mandibular second premolar that used as reference might be moved and could not defined the movement of mandibular second molar, tipping or bodily movement.
CHAPTER 5

CONCLUSION

Decortication-facilitated orthodontics assisted mandibular molar protraction could be move the mandibular second molar forward through the atrophic edentulous area, the following concluded were

1. The rate of mandibular molar protraction (1.21 mm/mth) was a statistically significant faster than previous studied (0.37 mm/mth) and normal orthodontic tooth movement through cortical bone (0.5 mm/mth) over 2-time.

2. Three months after mandibular first molar areas were closed, a statistically significant increased in the bucco-lingual width of atrophic alveolar ridge.

3. The marginal bone levels of mandibular second molar after protracted were decreased about 0.1-0.4 mm.

4. The crestal bone height of mandibular second molar after protracted were decreased about 0.24 mm, which can be observed in orthodontic tooth movement.
REFERENCES


45. กิตติ์กิจ ภูษิติคมกิจ. การฟื้นฟูกระดูกด้วยยาและกำลังของการกระดอนใน: ขั้นประ วัติวิจัยนิพนธ์รุเสถียรภาพ. กิตติ์กิจ ภูษิติคมกิจ (บรรณาธิการ) วิจัยทางการแพทย์ (Medical research) โครงการด้านการแพทย์ศาสตร์ มหาวิทยาลัยเชียงใหม่ 2542 หน้า 183-205.


APPENDICES
ใบข้อมูล

ขอข้อมูลข้างต้นโครงการวิจัยเรื่องการศึกษาอัตราการเคลื่อนพื้นและผลต่อกระดูกตรงรับพื้นจากวิธีการรักษาโดยการกระดูกที่รับมันกับการจัดพื้นเพื่อเคลื่อนพื้นกระดูกไปทางด้านใกล้กระดูก

เริ่ม	ท่านผู้อ่านที่ยี่หนึ่ง

จากที่เรา ทพุ.ศุภาลัย สามารถสุขภาพ ก่อให้เกิดการระดับปริญญาโท สาขาพันธุกรรมจัดพื้น ภาควิชาพันธุกรรมป้องกัน คณะพันธุศาสตร์ มหาวิทยาลัยสงขลานครินทร์ ใครขอโลก ถึงโครงการวิจัยที่กล่าวท้ายสุด และขอข้อมูลข้างต้นรวมกับโครงการดังนี้ โครงการวิจัยนี้จะที่ทำการศึกษาอัตราการเคลื่อนพื้นกระดูกล่าง และศึกษาการเปลี่ยนแปลงของกระดูกตรงรับพื้นหลังจากการยอมกระดูกที่รับมันกับการจัดพื้นเพื่อเคลื่อนพื้นกระดูกไปทางด้านใกล้กระดูกด้วยวิธีการตามปกติ หลังจากสุทธิการวิจัยแล้วผู้เข้าร่วมการวิจัยจะได้รับการรักษาทางพันธุกรรมจัดพื้นด้วยวิธีการตามปกติ

ผู้เข้าร่วมการวิจัยจะได้รับการเก็บข้อมูลข้างต้นตามปกติ ได้แก่ การพิมพ์พื้นเพื่อท่านผู้อับเจริญพื้น ถ้าตกตกในข้อข้อ ถ้าเกิดการกระดูกสั้นเพื่อวางแผนการรักษาหลังจากนั้นจะได้รับการเก็บข้อมูลเมื่อจัดพื้นชนิดเต็มและปรับปลีกเมื่อพื้นทุกๆ เดือนจนกระทั่งพื้นอยู่ในตำแหน่งที่เหมาะสม ถ้าการกระดูกแข็งแรงขึ้นผู้เข้าร่วมการวิจัยจะได้รับการถ่ายทอดรังสีโทหลักและนักเขตครอบพิบัติจริงเพื่อประเมินตำแหน่งของพื้นกระดูกและรูปร่างของกระดูกบางพื้น จนถึงเมื่อผู้เข้าร่วมการวิจัยจะได้รับการกระดูกแข็งแรงขึ้นผู้เข้าร่วมการวิจัยจะต้องมีการเปลี่ยนเมื่อพื้นทุกๆ อาทิตย์เป็นเวลา 6 เดือน หรือเจาะข้อมูลข้องกระดูก และจะได้รับการถ่ายภาพรังสีโฟล์คลีย์และนักเขตครอบพิบัติจริงเพื่อประเมินตำแหน่งของพื้นกระดูกและรูปร่างของกระดูกบางพื้นอีกครั้งสุดสุดการวิจัย

ดังท่านผู้อ่านที่เข้าร่วมโครงการนี้จะมีข้อมูลของกรดวิจัยที่เพิ่มเติมขึ้นมาจากจากการจัดพื้นตามปกติคือ

1. พื้นพื้นเต็มเดิม ได้แก่ ก่อนกระดูกละกระดูกที่ซึ่งระหว่างการกระดูกพื้นกระดูกเป็นเวลา 1 ครั้ง

2. ถ้าสภาพรังสีของกระดูกต้านด้านจักรพื้นเต็มเดิม ได้แก่ ก่อนกระดูกละกระดูกที่ซึ่งเมื่อสุทธิสุดสุดการเคลื่อนพื้นกระดูก

3. ถ้าตลอดสมองพิบัติจริงพื้นเต็มเดิม ได้แก่ ก่อนกระดูกละกระดูกที่ซึ่ง 3 เดือนหลังสุดสุดการเคลื่อนพื้นกระดูก
แบบยืนยันเข้าร่วมการศึกษา

โครงการวิจัยเรื่อง การศึกษาอัตราการเกิดลูกแฝงและผลต่อระดับชีวิตการรักษาโดยการกระดูกที่มีเกิดอุบัติเหตุจากการจัดพื้นที่กรมเหลี่ยมไปทางส่วนใกล้ช้าง

วันที่______เดือน______________พ.ศ.______

ชื่อเจ้า………………………………………อาญา………………………………………ปี

อายุผู้บันทึก……………หน่วย………ถนน……………………………………ตระกูล

อำเภอ………………………………….จังหวัด…………………………………..ได้รับการรับมือชั่ววัตถุประสงค์

ของการวิจัย วิสัยทัศน์วิจัย อันตราท่าที่ต้องต้องจากภัย รวมทั้งประโยชน์ที่จะเกิดขึ้นจากการวิจัย

องค์การและมีความเข้าใจต่อว่า

หากเจ้าบ่าวมีข้อสงสัยในการใด หรือเกิดผลข้างเคียงจากการวิจัยสามารถติดต่อได้ที่ หมายเลขโทรศัพท์เลขที่ 074-429876 หรือเมื่อได้ไม่แน่ใจให้ติดต่อ

เนื่องจากการทำการวิจัยในเรื่องนี้ ข้าพเจ้าสามารถเรียนได้ที่กรมบัณฑิต คณะบัณฑิตศาสตร์

มหาวิทยาลัยสงเคราะห์บริการ ถนนพระราม 9 ตรง 112 หมายเลขโทรศัพท์ 074-287510

หากผู้วิจัยมีข้อมูลเพิ่มเติมที่อาจต้องการประโยชน์และไม่อาจต่อไปข้างต้นการวิจัยนี้ ผู้วิจัยจะแจ้งให้ข้าพเจ้าทราบอย่างรวดเร็วโดยไม่ช้าใด

เจ้าบ่าวมีหน้าที่จะให้การเข้าร่วมโครงการวิจัย ใดจะแจ้งให้ทราบว่าหากใด

โดยการครบกำหนดวันเริ่มวิจัยนี้ไม่มีผลต่อการให้รับบริการหรือการรักษาที่ข้าพเจ้าจะได้รับแต่

องค์การ

ผู้วิจัยรับรองว่าจะเก็บข้อมูลเฉพาะที่เกี่ยวกับเจ้าบ่าวเป็นความลับ จะไม่นำไปสู่

ข้อมูลหรือผลการวิจัยของข้าพเจ้าเป็นรายบุคคลต่อสาธารณะ จะเปิดเผยได้ในรูปที่เป็นสูญ

ผลการวิจัย หรือการเปิดเผยข้อมูลต่อผู้ที่ไม่เกี่ยวข้องกับการสำนักงานและกับบุคคลทางวิจัย

ข้าพเจ้าได้เข้ารับข้อความข้างต้นแล้ว และมีความเข้าใจต่อทุกประการ จึงได้แนบมาใน

ใบยืนยันนี้ด้วยความเต็มใจ โดยผู้วิจัยได้ให้สำเนาแบบยืนยันที่แนบแล้วกับข้าพเจ้าเพื่อเก็บไว้

เป็นหลักฐานจำนวน 1 ชุด

ลงชื่อ……………………………………………………………ผู้ยืนยัน

( )
นางชอ………………………………………………………ผู้รับผิดชอบโครงการวิจัย
( หัสดะพรหมหญิวภัฏ สมานสุขมาล )
นางชอ………………………………………………………บิดา/แม่/ผู้ใช้อานาจปกครอง
( )
นางชอ………………………………………………………มารดา/แม่/ผู้ใช้อานาจปกครอง
( )
นางชอ………………………………………………………พาน
( )
นางชอ………………………………………………………พาน
( )
หนังสือฉบับนี้ให้ใช้เพื่อสำนักงาน

โครงการวิจัยเรื่อง “การศึกษาผลของการจัดการบริหารยุทธวิธีการบริหารโดยการตรวจดูที่ร่วมกับการจัดตั้งเพื่อเพิ่มประสิทธิภาพการดำเนินงาน”

หัวหน้าโครงการ

ท่านแพทย์หญิงศุภกิจ ธนาธนสุระบุรี

สังกัดหน่วยงาน

นักวิชาการส่งเสริมญาติ ภาคีหัวหน้าการกรมป้องกัน คอมมุนิตี้แพทย์ศาสตร์ มหาวิทยาลัยหอสมุดรัตนนครินทร์

ได้รับการพิจารณาและได้รับความเห็นชอบจากคณะกรรมการจริยธรรมในการวิจัย (Ethics Committee) ซึ่งเป็นคณะกรรมการพิจารณาในการวิจัยในครอบครัวแพทย์ศาสตร์ มหาวิทยาลัยหอสมุดรัตนนครินทร์ และในระยะระยะเวลาที่ 1/9561 เมื่อวันที่ 15 ธันวาคม 2543

ให้ไว้ ณ วันที่ 15 ธันวาคม 2543

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(อาจารย์อุไรย์ สงเคราะห์)

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(อาจารย์บุญศิริ ชุณห์สิน)//
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Name   Miss. Supang Samansukumal

Student ID   5310820024

Educational Attainment

<table>
<thead>
<tr>
<th>Degree</th>
<th>Name of Institution</th>
<th>Year of Graduation</th>
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<tr>
<td>Doctor of Dental Surgery</td>
<td>Prince of Songkla University</td>
<td>2004</td>
</tr>
</tbody>
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