การศึกษาผลของเครื่องมือไอแพนด้าในการขยายขากรรไกรบนอย่างไม่สมมาตร

Effect of The Indirect Palatal Miniscrew Anchorage and Distalization Appliance (iPanda) for Asymmetric Maxillary Transverse Expansion

ศรีกรุง แกล้วกสิกิจ[1], เอดวาร์โด้ ยูโก้ ซูซูกิ[2], และบุญศิวา ซูซูกิ[3]

Srikrung Klaewkasikij[1], Eduardo Yugo Suzuki[2] and Boonsiva Suzuki[3]

[1]นักศึกษาปริญญาโท [2,3]อาจารย์ คณะทันตแพทยศาสตร์ มหาวิทยาลัยกรุงเทพธนบุรี, โทรศัพท์ 0-5327-4420

e-mail: boonsiva.suz@bkkthon.ac.th

บทคัดย่อ

มินิสกรูได้มีการใช้อย่างแพร่หลายในปัจจุบัน และสามารถนำมาใช้ในการขยายขากรรไกรบนอย่างไม่สมมาตรได้ แต่อย่างไรก็ตามไม่เคยมีการศึกษาถึงผลของมินิสกรูในการขยายขากรรไกรบนอย่างไม่สมมาตร ในการศึกษาย้อนหลัง ได้ทำการศึกษาในผู้ป่วย 17 ราย ที่มีการใช้เครื่องมือขยายขากรรไกรอย่างไม่สมมาตรร่วมกับการใช้มินิสกรู มาวัดระยะการเคลื่อนของฟันหลังระหว่างก่อน และหลังขยายขากรรไกร และนำมาวิเคราะห์หาความแตกต่างระหว่างฟันแต่ละซี่โดยใช้การวิเคราะห์ความแปรปรวนทางเดียวและการวิเคราะห์ของทูกีย์ ผลการศึกษาพบว่าการขยายฟันพลังสอดคล้องกับแผนการรักษาที่วางไว้ การเคลื่อนของฟันหลังที่ให้แรงเป็นการเคลื่อนแบบล้มเอียงไปด้านหน้า ไม่พบการเคลื่อนของฟันในฝั่งที่ไม่ให้แรง จากผลการศึกษาสรุปได้ว่าเครื่องมือไอแพนด้าสามารถควบคุมการขยายขากรรไกรแบบไม่สมมาตรได้อย่างมีประสิทธิภาพ

คำสำคัญ: การขยายขากรรไกรอย่างไม่สมมาตร, มินิสกรู, ความไม่สมมาตร

Abstract

Miniscrew has been widely used in clinical orthodontics and may has potential benefits for asymmetric transverse control. However, the effectiveness of miniscrew in controlling the side effect of asymmetric transverse expansion has never been evaluated. In this retrospective study, seventeen patients needing miniscrew-supported asymmetric maxillary expansion were included. The expander was connected to two midpalatal miniscrews through a self-locking system. 3-dimensional intraoral scans were used to evaluate the distances connected midpalatal miniscrews to premolars and molars each side before and after expansion. The data were analyzed using one-way ANOVA and Tukey post-hoc tests. The results showed that the movement of the posterior teeth occurred only on the affected side in accordance with the treatment plan. The teeth on the loaded side

moved and tipped buccally. No crown movement was observed on the non-loaded side. Therefore, iPanda expander was found to be effective in controlling asymmetric maxillary expansion.

Keywords: Asymmetric Maxillary Expansion, Miniscrew, Asymmetry

Introduction

Posterior crossbite has been defined as any abnormal bucco-lingual relation between opposing molar, premolar or both, in centric occlusion. The incidence of posterior crossbite ranges from 7% to 23%. The most frequent is a unilateral crossbite, with a prevalence of approximately 6-7%, compared to a bilateral crossbite, with a prevalence between 1.5% and 3.5%. The frequency of spontaneous self-correction ranges from 0% to 9%. In addition, the spontaneous development of crossbite that was not present earlier is 7%. A posterior crossbite is believed to be transferred from the primary to the permanent dentition and can have long-term effects on the growth of the jaws. Treatment of unilateral crossbite is more difficult than treatment of bilateral crossbites because dental anchorage always results in unwanted tooth movement.

Determination of the cause of the transverse discrepancy must be an important ingredient in the process of formulation of an appropriate treatment plan. According to Burstone, the classification of transverse discrepancy can be divided into two types according to axial inclination. A dental cause is a transverse discrepancy with unilateral abnormal axial inclination of the molars, whereas a skeletal cause shows normal axial inclination of the molars. A true and functional unilateral crossbite can be classified by the discrepancy of centric relation to centric occlusion; centric relation and centric occlusion are usually discrepant in a functional shift of the mandible toward the crossbite side. The differential diagnosis of transverse discrepancy is critical to formulating a proper treatment plan.

There are many devices to treat bilateral dental transverse discrepancy: removable plates, fixed palatal expanders, cross elastics, etc. For discrepancies of skeletal origin, if the patient's midpalatal suture is not fused, rapid maxillary expansion is an option. However, if the problem is true unilateral transverse discrepancy, with a dental cause, various options, including the modified expander and cross elastics have been suggested. However, orthodontic biomechanics always

produce unwanted tooth movement when dental anchorage is provided by the abovementioned devices; so, pure unilateral expansion is not possible. Similarly, cross elastics may cause the extrusion of teeth and may induce side effects on the normal opposing dentition. Surgical options for the treatment of true unilateral transverse discrepancy place a heavy burden on patients and have a poor cost-to-benefit ratio when the amount of discrepancy is small.

Skeletal anchorage by means of miniscrew implants has been widely used in clinical orthodontics. Such implants provide absolute anchorage and avoid unwanted tooth movement. Miniscrew implantation in the midpalatal area can provide high stability and low failure rates, since this area does not include important anatomic structures, such as major nerves, blood vessels or dental roots. Moreover, the area contains dense cortical bone thickness that is ideal for the primary stability of the miniscrews. There was only a case report about miniscrew-supported asymmetric transverse control.

Recently, the indirect palatal miniscrew anchorage and distalization appliance (iPanda) has been developed. The iPanda is easily connected to and removed from midpalatal miniscrews. The iPanda may have potential benefits for asymmetric transverse control, however, the effectiveness of the midpalatal miniscrews in controlling the side effect of asymmetric transverse expansion has never been evaluated.

Objectives and Hypothesis

The objective of this study was:

1. To evaluate the effect of miniscrew-supported asymmetric maxillary transverse expansion on arch width.

Review of Literatures

Asymmetric maxillary expansion

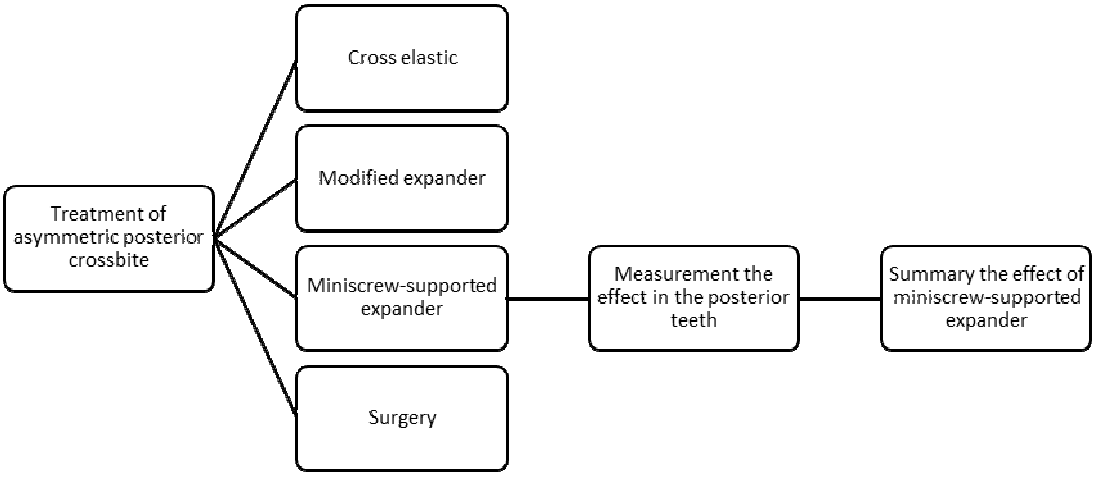
A simple method to treat a true unilateral posterior crossbite is to use a removable appliance incorporated with finger springs. This type of treatment approach might be preferred when the posterior crossbite is unilateral and involves 1 or 2 teeth. Alternatively, a removable appliance with a jackscrew, sectioned asymmetrically, able to usage Perhaps, the low height of the clinical crowns of molars makes retention difficult and lessens the effective force essential to produce

maxillary expansion. Unfortunately, any removable appliance leaves the clinician totally depending on patient cooperation and presents hygiene problems.

Elastics can be attached from the buccal attachments of the maxillary teeth to the lingual attachments of the mandibular teeth. Being an appropriate treatment approach only when the mandibular teeth have erupted with buccal inclination. Otherwise, a mandibular lingual arch must be inserted to avoid lingual tipping and constriction of the mandibular arch. Elastics, as a removable appliance, require patient compliance and might extrude the involved teeth with the vertical component of force. This extrusion effect is undesirable in vertical growers and in patients with limited overbite.

Treatment for a true unilateral posterior crossbite for usage in fixed lingual maxillary expansion appliances. W-arches and quad helix appliances can be modified by changing the length of the arms to include more teeth in the anchorage unit. Fixed lingual arches have been shown to require less overall treatment time and to be cost-effective and compared with other removable appliances.

Conceptual Framework



Research Methodology

Subjects were recruited from patients at the Orthodontic Clinic at the Bangkokthonburi University in Chiang Mai, Thailand. All 17 patients (4 male and 13 female), the mean age was 20.5 ± 4.7 years, had a dental unilateral posterior crossbite with no functional displacement of mandible. The inclusion criteria were permanent dentition, absence of cleft lip and palate, no sign and symptom of TMD, completed data collection.

The miniscrew-supported maxillary expander was constructed by modifying the iPanda appliance proposed by Suzuki and Suzuki. The appliance composed of two miniscrews (length, 6 mm; diameter, 1.6 mm) (Dual top JB; Jeil Medical Corporation, Seoul, Korea) and the expander wire was modified for asymmetric expansion, as shown in Figure 1.

Fig 1. Unilateral expansion of the maxillary posterior teeth: Right side was expanded and left side was maintained

Generating forces to expand the posterior teeth were accomplished by parallel widening of the expander arm before insertion. Two hundred grams expansion force was delivered to the posterior teeth on the side to be expanded. The amount of expansion was based on the orthodontic treatment plan and the clinical circumstances.

3-dimensional (3D) dental model was fabricated using a TRIOS intraoral scanner (3Shape, Copenhagen, Denmark) and the OrthoAnalyzer program (3Shape). Transverse distance was measured in millimeters (mm) from the midpalatal miniscrews to premolars and molars each side as shown in Fig 2. Differences in distance before and after expansion were evaluated. One-way analysis of variance (ANOVA) and Tukey post-hoc tests were used to compare the results between each tooth. Statistical analyses were performed by using the statistical software (SPSS for Windows, version 17.0 (IBM Corporation, Armonk, NY). The level of significance was set at 0.01.

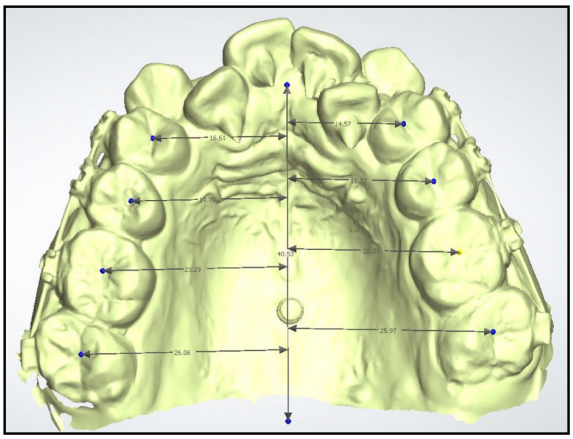


Fig 2. Measurement on the 3D model.

Research Results

Transverse discrepancy was corrected in all cases (Fig 3) in 4.2 ± 1.1 months. Of the seventeen cases, four cases were treated with unilateral maxillary expansion and thirteen cases with asymmetric maxillary expansion. The amount of expansion was different in each case based on the amount of discrepancy which was planned before the treatment (Table 1).

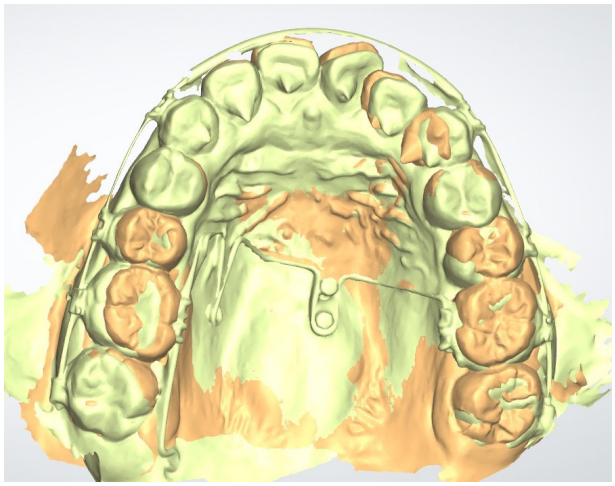


Fig 3. Superimposition of 3D models before and after treatment of unilateral expansion.

Table 1 Data collection

Case No.	Treatment	Amount of expansion need		Amount of expansion gain	
		Left side	Right side	Left side	Right side
1.	Asymmetric	2.5	1	2.6	1.1
2.	Asymmetric	3	2.5	3.1	2.5
3.	Unilateral	2.5	0	2.7	0
4.	Asymmetric	1	3	1.4	3.3
5.	Asymmetric	2	2	2.5	2.3
6.	Asymmetric	1.5	1.5	2.2	2.3
7.	Asymmetric	3	2.5	3.7	3.1
8.	Unilateral	0	1.5	0	1.8
9.	Asymmetric	3.5	2.5	3.5	3
10.	Asymmetric	2.5	2	2.6	2.4
11.	Asymmetric	2	2.5	2	2.4
12.	Asymmetric	1	3	1.3	3.2
13.	Asymmetric	2	2.5	2.2	2.7
14.	Asymmetric	3	1	3.5	1.2
15	Unilateral	0	2.5	0	2.8
16.	Asymmetric	1	2	1.2	2.5
17.	Unilateral	0	2.5	0	2.7

A statistically significant difference was detected between the groups ($F = 15.84$; $P < 0.01$). Table 2 shows the means and standard deviations of the changes in movement after expansion for each tooth. The means in the movement ranged from 1.54 ± 0.76 to 2.57 ± 0.75 mm. The Tukey post-hoc test subsequently showed a statistically significant difference between the first premolar and the second premolar, the first premolar and the first molar, the second premolar and the second molar, and the first molar and the second molar (Table 3). The other paired comparisons showed no statistically significant differences.

Table 2 Means, standard deviation of transverse crown changes (mm)

	First Premolar	Second Premolar	First molar	Second molar
Mean	1.54	2.57	2.48	1.61
SD	0.76	0.75	0.77	0.71

Table 3 Tukey test results

Groups	Means difference	Significance
First premolar vs Second premolar	1.03	0.000
First premolar vs First molar	0.95	0.00003
First premolar vs Second molar	0.07	NS
Second premolar vs First molar	0.08	NS
Second premolar vs Second molar	0.96	0.00002
First molar vs Second molar	0.88	0.0001

NS, Not significant

Conclusions, Discussion and Recommendations

In conventional orthodontics, expansion of the dental arch is usually obtained using a transpalatal or lingual arch. These devices produce successful results for bilateral expansion. Regardless of how much the clinician deliberately controls the anchorage, unwanted expansion of the contralateral part of the dentition is generally inevitable with conventional orthodontic biomechanics, as evidenced by other studies in which unilateral expansion had some buccal tipping on the non-affected side. To obtain the absolute unilateral or asymmetric maxillary expansion, palatal miniscrew-supported maxillary expansion should be considered.

Buccal crown tipping movement was found in the posterior teeth, which is in agreement with other studies. Those studies founded that buccal tipping usually occurs with the use of slow expansion appliances. Buccal tipping results from a force applied to the crowns superior their center of rotation. The centers of rotation are located in the middle to apical areas of the roots in the premolars and in the apical areas of the buccal roots in the molars. The locations of these centers of rotation make the buccal crowns tipping around the centers of rotation. The greatest

transverse movement of the crowns occurred at the level of the second premolar and first molar because of the expander design. These teeth are located in the middle areas of the expander. Therefre, difference in expander design will affect the stress distribution in the posterior teeth.

Transverse discrepancy was corrected in all cases. The four cases of unilateral expansion were corrected without side effects on the non-loaded side and the thirteen cases of asymmetric expansion were corrected in accordance with the plan. No problems or complications were observed during the maxillary expansion. All miniscrews were stable at the end of the maxillary expansion. These findings show that the antero-posterior positions of the miniscrews to each other, allowed for force control in the transverse expansion, resulting in the absence of displacement of the non-loaded teeth. However, further studies are needed to evaluate the biomechanical effect in the minsicrew in the miniscrew-supported asymmetric maxillary transverse expansion.

The iPanda can be used as an effective appliance to distalize the posterior teeth or anchor the maxillary molars when maximum anchorage is required. However, its clinical application is not limited to the distalization of the posterior teeth; the opposite side can also be expanded. The results show that midpalatal miniscrews can control the force from the expansion without side effects on the non-loaded side. Additionally, the miniscrews are located in the palatal area, far from the dental roots and, consequently, do not interfere with the dental movement.

iPanda expander was found to be effective in controlling asymmetric maxillary expansion and is recommended for unilateral and for asymmetric maxillary transverse expansion.

Reference

Moyers R. (1966). ***Handbook of orthodontics***. 2nd ed. Chicago: Year Book Medical Publishers, Inc, p. 332–41.

Thilander B, Lennartsson B. (2002). A study of children with unilateral posterior crossbite, treated and untreated, in the deciduous dentition — occlusal and skeletal characteristics of significance in predicting the long-term outcome. ***J Orofacial Orthop***, 63(5):371–83.

Infante PF. (1976). An epidemiologic study of finger habits in preschool children as related to malocclusion, socioeconomic status, race, sex and size of community. ***ASDC J Dent Child***, 43(1):33–8.

Kurol J, Bergland L. (1992). Longitudinal study and cost–benefit analysis of the effect of early treatment of posterior crossbites in the primary dentition. ***Eur J Orthod***, 14(3):173–9.

Thilander B, Wahlund S, Lennartsson B. (1984). The effect of early interceptive treatment in children with posterior crossbite. ***Eur J Orthod***, 6(1):25–34.

Kutin G, Hawes RR. (1969). Posterior cross-bites in the deciduous and mixed dentitions. ***Am J Orthod,*** 56(5):491–504.

Sofia Petrén, Lars Bondemark, and Björn Söderfeldt. (2003). A Systematic Review Concerning Early Orthodontic Treatment of Unilateral Posterior Crossbite. ***The Angle Orthodontist***: September, Vol. 73, No. 5, pp. 588-596.

Burstone CJ. (1998). Diagnosis and treatment planning of patients with asymmetries. ***Semin Orthod***, 4:153–164.

David B. Kennedy, Matthew Osepchook. (2005). Unilateral Posterior Crossbite With Mandibular Shift: A Review. ***J Can Dent Assoc***, 71(8):569-73.

Anhoury PS. (2009). Nonsurgical treatment of an adult with mandibular asymmetry and unilateral posterior crossbite. ***Am J Orthod Dentofacial Orthop***, 135:118–126.

Rebellato J. (1995). Two-couple orthodontic appliance systems: transpalatal arches. ***Semin Orthod***, 1:44–54.

Suri L, Taneja P. (2008) Surgically assisted rapid palatal expansion: a literature review. ***Am J Orthod Dentofacial Orthop***, 133:290–302.

Hassan AH, AlGhamdi AT, Al-Fraidi AA, Al-Hubail A, Hajrassy MK. (2010). Unilateral cross bite treated by corticotomy-assisted expansion: two case reports. ***Head Face Med***, 6:6.

Hye-Young Kwon, Su-Jung Mah, and Yoon-Goo Kang. (2015). Asymmetric transverse control of maxillary dentition with two midpalatal orthodontic miniscrews. ***The Angle Orthodontist,*** Vol. 85, No. 3, pp. 525-534.

Karagkiolidou A, Ludwig B, Pazera P, Gkantidis N, Pandis N, Katsaros C. (2013). Survival of palatal miniscrews used for orthodontic appliance anchorage: a retrospective cohort study. ***Am J Orthod Dentofacial Orthop***, 143:767-772

Gracco A, Lombardo L, Cozzani M, Siciliani G. (2008) Quantitative cone-beam computed tomography evaluation of palatal bone thickness for orthodontic miniscrew placement. ***Am J Orthod Dentofacial Orthop,*** 134:361-369

Park J, Cho HJ. Three-dimensional evaluation of interradicular spaces and cortical bone thickness for the placement and initial stability of microimplants in adults. Am J Orthod Dentofacial Orthop. 2009;136:314.e1-12; discussion 314-315.

Suzuki EY, Suzuki B. (2013). Maxillary molar distalization with the indirect palatal miniscrew for anchorage and distalization appliance(iPanda). ***Orthod Clin***, 14:e228-e241

Ingervall B, Göllner P, Gebauer U, Fröhlich K. (1995). A clinical investigation of the correction of unilateral first molar crossbite with a transpalatal arch. ***Am J Orthod Dentofacial Orthop***, Apr;107(4):418–25.

Enacar A, O¨zgen M. (1993). Asymmetric maxillary expansion appliance (ABHE). ***Cleft Palate Craniofac J***, 30:416-7.

Langlade M. (1986). ***Therapeutique Orthodontique***. Paris: Maloine S.A. Editeur;

Hicks EP. (1978). Slow maxillary expansion. A clinical study of the skeletal versus dental response to low-magnitude force. ***Am J Orthod***, Feb;73(2):121–141.

Bell RA, LeCompte EJ. (1981). The effects of maxillary expansion using a quad-helix appliance during the deciduous and mixed dentitions. ***Am J Orthod***, Feb;79(2):152–161.