การเปลี่ยนแปลงของฟันจากการใช้จอวส์ในการสบฟันผิดปกติแบบฟันหน้าสบเปิด

Dental changes following the use of JAWs in anterior open bite

รุ่งรวี ไกรสิริเดช[1], บุญศิวา ซูซูกิ[2] และเอดวาร์ดโด้ ยูโก้ ซูซูกิ[3]

Rungrawee Kraisiridej[1], Boonsiva Suzuki[2] and Eduado Yugo Suzuki[3]

[1,-3]สาขาวิชาทันตกรรมจัดฟัน คณะทันตแพทยศาสตร์ มหาวิทยาลัยกรุงเทพธนบุรี โทรศัพท์ 028006800

[1-3]Department of Orthodontics, Faculty of Dentistry, Bangkokthonburi University, Tel. 028006800

[1]e-mail: mm-a-y@hotmail.com

บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อประเมินผลของการเปลี่ยนแปลงในสามมิติของกระดูกขากรรไกรและฟันภายหลังการรักษาด้วยสเปอร์สสำหรับกันลิ้นรูปฟันฉลามในผู้ป่วยกลุ่มผู้ใหญ่ที่มีการสบฟันผิดปกติแบบฟันหน้าสบเปิดร่วมกับมีฟันห่าง ทำการศึกษาโดยการใช้การใช้โมเดลทันตกรรมดิจิทัลสามมิติเปรียบเทียบก่อนและหลังการรักษา ในผู้ป่วยผู้ใหญ่จำนวนสิบห้าคนที่ได้รับการวินิจฉัยว่ามีการสบฟันผิดปกติแบบฟันหน้าสบเปิดและมีฟันห่างอันมีสาเหตุมาจากความผิดปกติของลิ้น โดยผู้ป่วยได้รักษาด้วยสเปอร์สสำหรับกันลิ้นรูปฟันฉลามเป็นเวลาสามเดือน ก่อนการรักษาทางจัดฟันด้วยเครื่องมือจัดฟันแบบติดแน่น หลังจากการเก็บรวบรวมข้อมูล ข้อมูลการเปลี่ยนแปลงของกระดูกและฟันทั้งในทั้งสามมิติจะถูกตรวจสอบโดยใช้วิธีการทดสอบทางสถิติ ผลการศึกษาพบว่าเกิดการเปลี่ยนแปลงของกระดูกขากรรไกรและฟันทั้งหลังการรักษาด้วยสเปอร์สสำหรับกันลิ้นรูปฟันฉลามในสามมิติดังต่อไปนี้ (1) ในทิศทางด้านหน้าและด้านหลัง มีการเคลื่อนถอยหลังของฟันหน้าบนและฟันหน้าล่าง ร่วมกับมีการเอียงตัวของฟันหน้าไปทางด้านเพดานเพิ่มขึ้นโดยในฟันหน้าบนพบการเปลี่ยนแปลงเคลื่อนถอยหลัง 0.6±0.3 มม.เช่นเดียวกับในฟันหน้าล่างที่พบว่ามีการเคลื่อนถอยหลัง 0.8±0.1 มม. (2) ในแนวดิ่ง พบว่ามีการเพิ่มขึ้นของระยะสบในแนวดิ่งในตำแหน่งฟันหน้า 0.8±0.5 มม. การแก้ไขความผิดปกติของลิ้นดันฟันโดยการใช้สเปอร์สสำหรับกันลิ้นรูปฟันฉลาม สามารถทำให้เกิดการเปลี่ยนแปลงชองลิ้น และตำแหน่งของฟันได้

คำสำคัญ: ลิ้น, สบฟันผิดปกติแบบฟันหน้าสบเปิด, แบบจำลองฟันสามมิติ

Abstract

The objective of this study was to evaluate the dental effects of customized bonded tongue spurs in adult patients with AOB. Fifteen patients with AOB were treated with Customized Bonded Shark-Tooth-like Spurs spurs (JAWs). 3D digital dental models were recorded to evaluate and compare the dental changes

before treatment (T0), and three months (T1) after spur placement. The Paired T-tests were used to compare changes over time within groups. The significance level was set at $p < 0.05$. Major Findings: Statistically significant dental changes occurred after spur placement. These changes included increases in overbite (0.8±0.5 mm), in maxillary incisor position (0.6±0.3 mm), and in mandibular incisor position (0.8±0.1 mm) ($p < 0.01$). The use of customized spurs in patients with AOB can induce dental changes. JAWs can be considered as a complement for effective orthodontic treatment in patients with AOB.

Keywords: Tongue, Open bite, Dental models, Three-dimensional

Introduction

The treatment of anterior open bite (AOB) is highly challenging in orthodontics because of difficulties in determining and addressing etiologic factors and because of the potential for relapse in the vertical dimension after treatment.(Canuto, Janson, de Lima, de Almeida, & Cancado, 2016) Although many treatment options are available, there is limited evidence of their long-term effectiveness and stability. (Greenlee et al., 2011)

Recently, applications of 3D imaging have been widely used in orthodontics. Several studies have evaluated the effectiveness of AOB correction with fixed and removable palatal cribs on the tridimensional changes in dental arches of growing patients, as seen on digital models. (Slaviero et al., 2017)

Although many therapeutic interventions have been used to correct tongue habits, most studies seem to be focused on the effect of treatment in young patients.(Canuto et al., 2016; Garrett, Araujo, & Baker, 2016; Huang, Justus, Kennedy, & Kokich, 1990; Insabralde et al., 2016; Slaviero et al., 2017; Villa & Cisneros, 1997) There were a few previous studies in adult patients who used prefabricated tooth spurs to correct tongue thrusting habits. (Rogers, 1927),(Justus, 2001) Recently a customized shark-tooth-like spur (JAWs) system was introduced to treat patients with AOB (Figure 1). We have a hypothesis that the JAWs might be an important approach to correct tongue thrusting in patients with AOB.

Objective

1) The study aimed to evaluate the dental changes following the use of JAWs in adult patients with AOB.

Literature Review

The term “open bite” was coined by Caravelli in 1842 as a distinct classification of the malocclusion.(Parker, 1971) Subtelney et al.(Subtelny & Sakuda, 1964) defined open bite as the open vertical dimension between the incisal edges of the maxillary and mandibular anterior teeth. Some authors have determined that open bite, or a tendency toward open bite, occurs when overbite is smaller than what is considered normal. Others argue that an open bite is characterized by end-on incisal relationships. Others require that no incisal contact be present before diagnosing an open bite.

AOB and anterior tongue function are frequently associated, but despite many investigations, the relationship between the two is not completely understood. Lowe et al.(Lowe & Johnston, 1979) reported that anterior tongue posture may prevent the eruption of the anterior teeth. On the contrary, Tulley (Tulley, 1969) suggested that tongue-thrust swallowing is an adaptation to open bite, which facilitates an anterior oral seal, rather than being its cause. Dentists and speech therapists often attribute open bite malocclusion to abnormal tongue function.(Ngan & Fields, 1997)

There are different tongue positions at rest.(Artese, Drummond, Nascimento, & Artese, 2011) The position considered normal for the tongue at rest is one in which the tip of the tongue rests on the incisal papilla and its back lies along the palate, keeping the anterior teeth in balance while preserving the transverse dimension of the maxillary arch. (Proffit, 1978) Based on these morphological characteristics some different resting positions of the tongue are suggested(Artese et al., 2011): high; horizontal; low, and very low.

Justus (Justus, 2001) demonstrated the long-term clinical results of closing AOB with intraoral spurs. The spurs force a change in anterior tongue rest posture, which in turn allows incisors to erupt, closing the AOB due to a modified tongue rest posture. The neurophysiologic basis for using the spur appliance involves the form-function concept. The neural pathways that allow a change in anterior tongue rest posture are the lingual nerve, which is afferent or sensory, and the hypoglossal

nerve, which is efferent or motor. The spurs alter orofacial function, resulting in a change in form. In other words, the sensory input to the brain is modified by the spurs. This proprioceptive change leads to an altered motor response, resulting in a new normal tongue rest posture (change in function) that allows the incisors to erupt (change in form).

Conceptual Framework

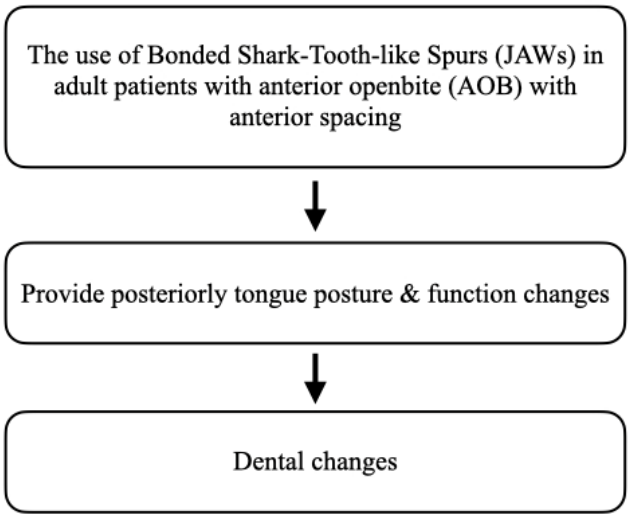

Figure 1. A conceptual framework of the study

Research Methodology

Subjects

15 patients, at the Graduate Clinic, Department of Orthodontics, Faculty of Dentistry, Bangkokthonburi University (BTU), who were diagnosed with AOB with spacing due to a tongue-thrusting swallowing habit, from October 2016 to December 2018. This study was approved by the human ethics committee of Bangkokthonburi University (approval number: 6/2561).

For the subject selection process, the inclusion criteria of the subjects included the following: (1) had identified AOB defined as one or more incisors that do not have vertical overlap with teeth in the opposing arch with anterior spacing; (2) an anterior resting tongue posture and a tongue-thrusting swallowing pattern according to BTU criteria for tongue-thrust assessment; (3) a healthy natural dentition and periodontal tissue, no missing teeth except for possibly the third molar; (4) completed data collection on l 3D digital dental models.

Customized Bonded Shark Tooth-like Spurs (JAWs) procedure

All participants received tongue reeducation with JAWs for three months before orthodontic treatment. The JAWs were placed on the middle of the lingual surfaces of the maxillary and mandibular anterior teeth, canine to canine. Compomer cement (Ultra Band-Lok™ push syringe in blue shade from Reliance Orthodontic Products, Inc., Itasca, Illinois, USA) was used to fabricate JAWs (3 mm length) with sharp conical shape tips (**Figure 2**). No other therapeutic appliances nor myofunctional therapy were used during the observation period.

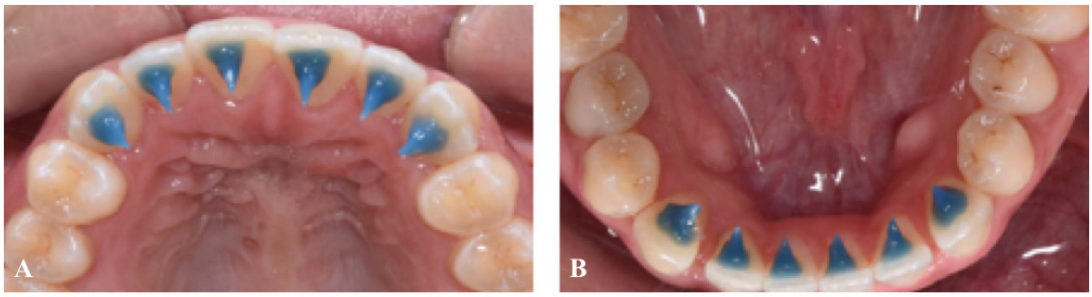

Figure 2. JAWs

3D Digital Dental Model Measurements

3D digital dental models were obtained from a 3D scanner (3Shape R700, 3Shape A/S, Copenhagen, Denmark) at baseline (T0) and three months (T1) after tongue reeducation with the JAWs. The following measurements were performed; overbite and overjet, Maxillary and mandibular anterior teeth position and inclination using OrthoAnalyzer™ 3D software, 2013 version (3Shape A/S) for the 3D digital dental model analysis

Measurement Reliability

To test the measurement reliability, the same investigator (R.K.) repeated the measurement of ten patients after three weeks. The intraclass correlation coefficient (ICC) for the angular measurements ranged from 0.92 to 0.99, and that for the linear measurements ranged from 0.93 to 0.99 (95% confidence interval). The reliability of measurement was considered excellent. The values obtained from the angular and linear measurements in the first and second measurements were tested using the t-test to study the systematic error.

Statistical analysis

Statistical analysis was conducted using SPSS Version 23.0.0 software. (SPSS Inc. Chicago, IL, USA). Data normality was assessed using the Shapiro-Wilk test. The data present normal distributions. Therefore, parametric statistical analysis was used in the present study. The Paired T-tests were used to compare changes over time (T0-T1) within groups. The significance level was set at $p<0.05$.

Results

A significant 3D dental changes in both anteroposterior and vertical positions were observed. In the vertical dimension, a significant increase in the overbite (0.8±0.5 mm) was observed. In the anteroposterior direction, an increase in overjet (0.2±0.3 mm) was found. Dental changes after tongue therapy with JAWs were reported in **Table 1**.

Table 1. Dental changes in 3D digital dental model variables from baseline (T0) and 3 months (T1) after using JAWs

Variables	T0		T1		Treatment changes (ΔT1-T0)		t	p
	Mean	SD	Mean	SD	Mean	SD		
Linear								
OB (mm)	-1.3	1.2	-0.5	1.3	0.8	0.5	-3.299	*
OJ (mm)	2.2	2.1	2.5	1.9	0.2	0.3	-4.434	**
U1 position (mm)	27.6	2.2	26.9	2.1	-0.6	0.3	13.488	**
L1 position (mm)	23.2	2.2	22.4	2.2	-0.8	0.1	29.974	**

Values are presented as mean ± standard deviation (SD) or p-value Paired t-test, t: p-value significant at *p<0.01; **p<0.001

Discussions

Several previous studies have reported dental changes resulting from various AOB treatment modalities in growing patients due to the effect of the treatment combined with the growth potential.(Canuto et al., 2016; Cassis, de Almeida, Janson, de Almeida-Pedrin, & de Almeida, 2012; Garrett et al., 2016; Huang et al., 1990; Insabralde et al., 2016; Slaviero et al., 2017; Villa & Cisneros, 1997) Furthermore, numerous literature reviews have emphasized that the correction of a functional habit during AOB treatment leads to increased long-term stability.(Cozza, Mucedero, Baccetti, & Franchi, 2007; Huang et al., 1990; Justus, 2001) However, there have been

only a few case reports of the usage of tongue spurs in adult patients,(Justus, 2001) and none of them provided information on the dental effects of spurs. Therefore, the dental changes after tongue therapy in adult AOB patients are unknown.

In the present study, the analysis of dental changes followed by the correction of tongue habits with JAWs in adult patients was performed. Improvement in the inclination of both maxillary and mandibular anterior teeth was observed. These changes resulted in significant changes in the overjet and overbite. These results are in agreement with previous studies that investigate the effectiveness of tongue reeducation appliances in growing patients during early treatment.(Canuto et al., 2016; Insabralde et al., 2016; Philipp Meyer-Marcotty, Kochel, & Stellzig-Eisenhauer, 2013) These results indicated that the use of JAWs has the potential to change the tongue-thrusting habits in adult patients, therefore changing the effects of tongue position on the dentition. The therapeutic mechanism of the spurs therapy to correct tongue-thrusting has been described by Meyer-Marcotty et al.(P. Meyer-Marcotty, Hartmann, & Stellzig-Eisenhauer, 2007)

Improvement of the inclination of both maxillary and mandibular anterior teeth was observed. A similar amount of the palatal inclination of both maxillary incisors and mandibular incisors resulted in slightly overjet changes. On the contrary to Meyer-Marcotty et al(P. Meyer-Marcotty et al., 2007) represented increases in the overjet after treatment with fixed palatal spurs resulted from significant upright of the mandibular incisor.

After tongue therapy with JAWs for a few days, most patients reported initial discomfort, such as initial pain, difficulty speaking, eating, and swallowing. However, these symptoms were solved within two weeks. Canuto et al.(Canuto et al., 2016) showed that 92.5% of their patients had adjusted to the spurs after a week or less of treatment. These results indicate that in adults, adaptation to spur appliances tends to occur in a longer time than children. Also, the patients should be advised to pay attention to their oral hygiene in the spur areas, especially on the palatal aspect of the maxillary and the lingual aspect mandibular anterior teeth.

In the present study, the dental changes followed by the correction of tongue habits with JAWs in adult patients were performed. The use of JAWs is a tailored treatment for individual tongue-thrusting patients. This appliance has many advantages, such as simple intervention, especially can be adjustable size, shape, and direction, can install even in crowding teeth that have no space, can adjustable

rely on the tolerance of the patient, and also no need for additional laboratory preparation. Additionally, JAWs can be used during all treatment times of orthodontic treatment, including at the pre-orthodontic phase, along with orthodontic treatment without interfering with orthodontic tooth movement, and also during the retention phase for preventing relapse tendency.

In conclusion, the use of customized JAWs is an effective therapy in patients with AOB and tongue dysfunction.

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