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Original Article

ค่าเฉลี่ยความหนาของผนังกระดูกด้านริมฝีปากบริเวณฟันหน้าบนในประชากรไทย จากการวิเคราะห์ด้วยภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์ชนิดโคนบีม

Average thickness of the maxillary labial plate in Thai population using cone beam computed tomography analysis

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บทคัดย่อ **ปัจจุบันความต้องการทดแทนฟันที่สูญเสียไปด้วยรากฟันเทียมมีเพิ่มมากขึ้น โดยผู้ป่วยคาดหวังทั้งในแง่ความสวยงามและการใช้งานอย่างมีประสิทธิภาพในระยะยาว อย่างไรก็ตามในบริเวณกระดูกขากรรไกรบนด้านหน้าเป็นตำแหน่งที่มีข้อจำกัด โดยเฉพาะอย่างยิ่งลักษณะรูปร่างกระดูก ผนังกระดูกด้านริมฝีปากต้องมีความหนาอย่างน้อย 2 มม. จึงจะเพียงพอต่อการรองรับเนื้อเยื่ออ่อน และต้านทานการละลายตัวของกระดูกได้ ภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์ชนิดโคนบีม (โคนบีมซีที) เป็นเครื่องมือที่มีประโยชน์ สามารถแสดงภาพที่ต้องการศึกษาได้ในทั้ง 3 ระนาบ และมีความละเอียด ถูกต้องแม่นยำ**

วัตถุประสงค์: **เพื่อประเมินค่าเฉลี่ยความหนาของผนังกระดูกด้านริมฝีปากบริเวณฟันหน้าบนในประชากรไทย**

***ระเบียบวิธีการวิจัย*:** **ทำการศึกษาจากภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์ (ไอแคต) ของผู้ป่วยที่มารับการรักษา ณ คณะทันตแพทยศาสตร์ มหาวิทยาลัยรังสิต ตั้งแต่ปี พ.ศ.2551-2556 จำนวน 186 ราย ประกอบด้วยฟันทั้ง**

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หมด 723 ซี่ เป็นฟันตัดซี่กลาง 245 ซี่ ฟันตัดซี่ข้าง 240 ซี่ และฟันเขี้ยว 238 ซี่ นำมาวัดความหนากระดูกด้านริมฝีปาก 2 ตำแหน่งในแนวตั้งฉากกับแนวแกนฟันซึ่งได้แก่ ความหนาของผนังกระดูกด้านริมฝีปากระดับ 4 มม. ไปทางปลายรากฟัน จากรอยต่อระหว่างเคลือบฟันกับเคลือบรากฟัน (แอล 1) และบริเวณกึ่งกลางรากฟัน (แอล 2) โดยผู้วิจัย 2 คน นำเสนอข้อมูลโดยใช้สถิติเชิงพรรณนา

ผลการศึกษา : ค่าเฉลี่ยความหนาของผนังกระดูกด้านริมฝีปากในฟันทุกซี่คือ 0.885 มม. ที่ตำแหน่งแอล 1 (ช่วงระหว่าง 0.0-1.97 มม.) และ 0.660 มม. ที่ตำแหน่งแอล 2 (ช่วงระหว่าง 0.0-1.86 มม.) และไม่พบผนังกระดูกด้านริมฝีปากจำนวน 67 ซี่ คิดเป็นร้อยละ 9.3 ที่ตำแหน่งแอล 1 และจำนวน 123 ซี่ คิดเป็นร้อยละ 17.0 ที่ตำแหน่งแอล 2

สรุปผลการศึกษา : ในการศึกษาครั้งนี้ สามารถสรุปได้ว่า การวางแผนการรักษาในบริเวณที่ต้องการความสวยงามก่อนฝังรากเทียม ควรมีการถ่ายภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์ชนิดโคนบีม เพื่อประเมินความหนากระดูกด้านริมฝีปากเพื่อให้ได้ผลลัพธ์ด้านความสวยงามที่ดีในระยะยาว

คำสำคัญ : กระดูกขากรรไกรบนส่วนหน้า ถ่ายภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์ชนิดโคนบีม รากฟันเทียม บริเวณที่ต้องการความสวยงาม ผนังกระดูกด้านริมฝีปาก

Abstract

Nowadays, patient's demand in tooth replacements offering nice smile and long-term function is increasing, thus single tooth replacement with implant has become more popular. However, anterior maxilla has some concerns that may compromise the predictability of treatment outcome. The underlying bone structure plays a key role in the establishment of successful esthetic outcome. The labial plate should ideally be at least 2 mm in thickness to ensure proper support for soft tissue and to avoid bone resorption. For analyzing the underlying bony structure, cone beam computed tomography (CBCT) is a preferred equipment as it provides great details and three-dimensional information.

Objective : to investigate average thickness of maxillary labial plate in Thai population.

Methods : CBCT files (in ICAT format) of 186 patients, which were obtained between 2008-2013 in the Faculty of Dental Medicine, Rangsit University were used. The samples consisted of 723 teeth (245 central incisors, 240 lateral incisors and 238 canines). The images were evaluated by measuring the thickness of labial plates perpendicularly to the long axis of the tooth in 2 locations; at 4 mm at apical to CEJ in [location 1 (L1)] and at the middle of the root [location 2 (L2)] by 2 observers. Descriptive analysis was used for statistical analysis.

Result : the average thickness of the labial plate for all teeth that has been analyzed was 0.885 mm (range, 0.0 to 1.97 mm) at L1 and 0.660 mm (range, 0.0 to 1.86 mm) at L2. No existing bone wall was found in 67 teeth (9.3%) at L1 and 123 teeth (17.0%) at L2.

Conclusion : within the limitations of this study, it can be implied that treatment planning in the esthetic zone prior to implant placement should include CBCT examination to evaluate thickness of labial plate for long-term esthetic outcome.

Keywords : anterior maxilla, cone beam computed tomography, dental implant, esthetic zone, labial plate.

Introduction

Nowadays, patients demand more esthetic tooth replacements, which offer nice smile and also long term function. Thus single tooth replacement with an implant-supported crown has become a more interesting treatment option. However, maxillary anterior region often brings a considerable challenge for implant treatment, since various local risk factors have the potential to compromise the predictability of the results. The success of dental implant treatment at the maxillary anterior region is generally associated with five factors[1,2]: (i) implant location, (ii) cause of tooth extraction, (iii) thickness of the labial plate (iv) the dimension of the horizontal labial gap, and (v) soft tissue contour. Therefore, the underlying bone structure plays a key role in the establishment of esthetic soft tissue contours. The thickness of the labial bone crest significantly influences not only the amount of horizontal gap fill but also the amount of vertical crestal resorption. So, the thicker the labial plate, the more successfully esthetic outcome.

After implant site preparation, the labial plate should ideally be measured at least 2 mm in thickness to ensure proper soft tissue support and to avoid labial plate resorption.[3] If this requirement is not met, bone and/or soft tissue grafting procedures are recommended.

To analyze underlying bony structure, computed tomography (CT) and cone beam CT (CBCT) presents many advantages over conventional two-dimensional radiographic techniques by providing detailed, accurate, and reliable three-dimensional information.[4]

On the other hand, high cost of CBCT devices hinder their widespread usage in Thailand. This study evaluates average maxillary labial plate thickness in Thai population, prior to implant placement.

Objective

To investigate average thickness of maxillary labial plate in Thai population.

Materials and method

1. Sample selection

CBCT files (in ICAT format) of patients, which were obtained between 2008-2013 in the Faculty of Dental Medicine, Rangsit University were used. Exclusion criteria were patients who underwent apical surgery or anterior maxillary surgery, severe root resorption, periodontitis and crowding.

2. Materials and Instruments

2.1 Cone beam computed tomography
2.2 External hard drive for collecting data
2.3 Program i-CATVisionTM
2.4 Program Microsoft excel
2.5 Program SPSS

3. Method

All images were assessed under standardized conditions at the same examination workplace. Observers allowed to adjust brightness and contrast of the images and zoom. Two observers, one experienced oral radiologist, analyzed images separately. The thickness of the labial plate in each image was measured in particular in two different points perpendicularly to the long axis of the tooth. One observer measured at 4 mm at apical to CEJ [location 1(L1)] while the other measured at the middle of the root [location 2(L2)] (Fig.1). Both observers measured each image twice (second measurement are performed after completion of the first round).

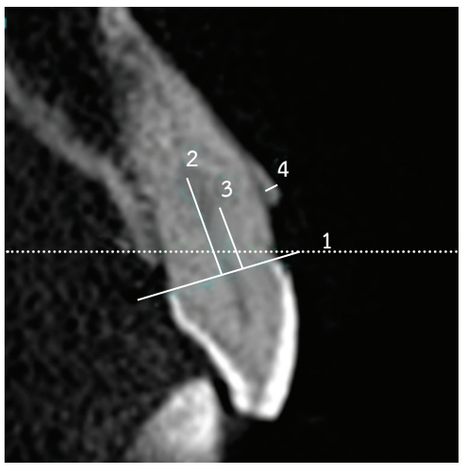

Fig. 1 *Measurement of each image : 1 = cementoenamel junction, 2 = distance at middle root length, 3 = distance at 4 mm apical to cementoenamel junction, and 4 = thickness of labial plate.*

4. Data analysis

Descriptive statistical analysis was complemented with inferential statistics. To detect significant differences in the data set for the left and right side of the maxilla, Wilcoxon Signed Ranks Test for paired data (paired by left and right teeth of the same patient and position) were used using exact *p* values. Since there were no significant difference between the data set, the measurements for the two locations in all teeth were grouped into the following categories for descriptive analysis : missing bone wall (thickness = 0 mm), bone wall thickness < 1 mm, and bone wall thickness >1 mm. Wilcoxon Signed Ranks test were performed by using SPSS program.

Results

This sample consists of 723 subjects. The CBCT images were taken between the years of 2008-2013 in patients with ages ≥25 years old. The distribution of the analyzed teeth is presented in Table 1.

The average thickness of the labial plate for all teeth that has been analyzed was 0.885 mm (range, 0.0 to 1.97 mm) at L1 and 0.660 mm (range, 0.0 to 1.86 mm) at L2. No existing labial plate was found in 9.3% (67 teeth) at L1 and 17.0% (123 teeth) at L2 (Table 2 and 3).

Table 1 The distribution of the analyzed teeth.

	Distribution of analyzed teeth			
	Central incisor	Lateral incisor	Canine	Total
No.	245	240	238	723

Table 2 Frequency distribution (%) of examined teeth according to thickness of the labial plates at L1.

	Missing labial plate	Labial plate thickness <1 mm	Labial plate thickness ≥1 mm
Central incisor	14.6%	52.3%	33.1%
Lateral incisor	6.7%	55.0%	38.3%
Canine	14.6%	43.1%	42.3%
Total	**9.3%**	**52.9%**	**37.8%**

Table 3 Frequency distribution (%) of examined teeth according to thickness of the labial plates at L2.

	Missing labial plate	Labial plate thickness <1 mm	Labial plate thickness ≥1 mm
Central incisor	8.6%	70.6%	20.8%
Lateral incisor	16.7%	66.7%	16.7%
Canine	25.9%	49.8%	24.3%
Total	**17.0%**	**62.4%**	**20.6%**

The majority of the examined teeth exhibited a thin labial plate (<1 mm; 52.9% (383 teeth) at L1; Table 2, 62.4% (452 teeth) at L2; Table 3). Further analysis is to distinguish between the three groups of teeth. The results were shown in Table 2 and 3 and Fig.2 and 3.

For central incisors; at L1, labial plates in most of cases (52.3%) were less than 1 mm followed by group with labial plate thickness ≥1 mm (33.1%). At L2, labial plates in most of cases (70.6%) were less

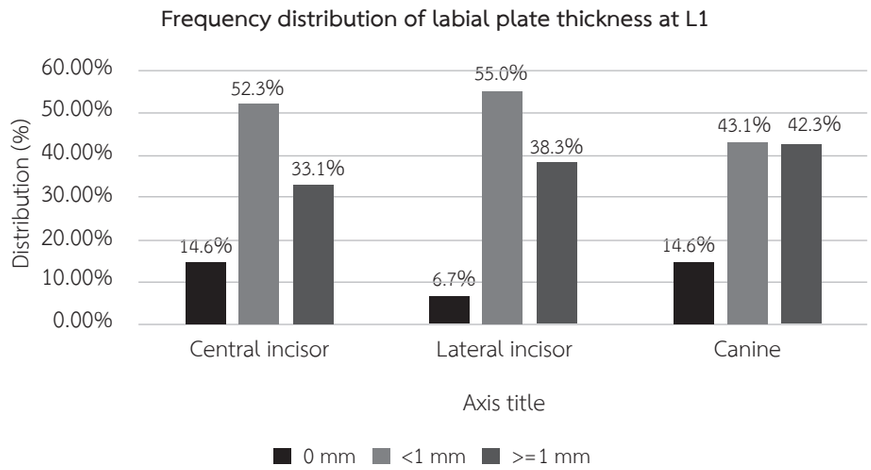

Fig. 2 *Represent the frequency distribution of the labial plate thickness for paired groups of teeth at L1.*

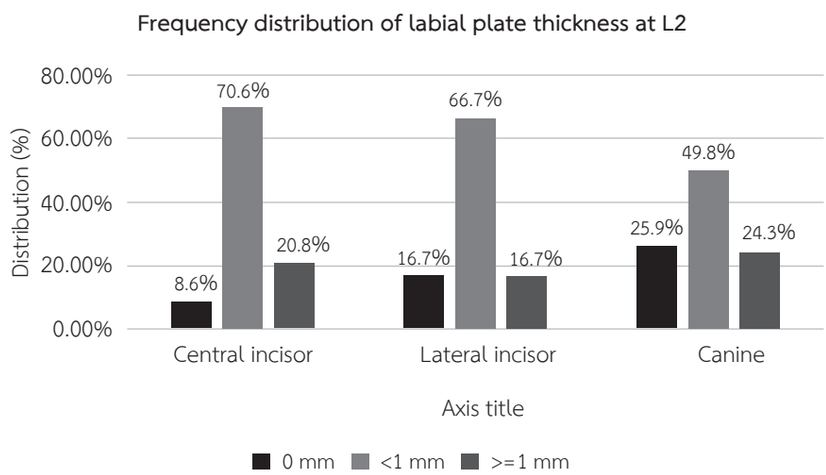

Fig. 3 *Represent the frequency distribution of the labial plate thickness for paired groups of teeth at L2.*

than 1 mm followed by group with labial plate thickness ≥1 mm (20.8%).

For lateral incisors; at L1, labial plates in most of cases (55.0%) were less than 1 mm followed by group with labial plate thickness ≥1 mm (38.3%). At L2, labial plates in most of cases (66.7%) were less than 1 mm.

For canines; at L1, labial plates in most of cases (43.1%) were less than 1 mm followed by group with labial plate thickness ≥1 mm (42.3%). At L2, labial plates in most of cases (49.8%) were less than 1 mm followed by group with missing labial plate (25.9%).

Discussion

Nowadays dental implants are frequently popular for single tooth replacements due to their significant benefits, both promoting function and esthetic. Several experimental and clinical studies over the years have shown that underlying bone support plays a vital role in the establishment and maintenance of esthetic soft tissue contour. For the best esthetic outcome especially in the esthetic zone, one should gather all the information to achieve a good treatment plan and a good long-term result. The labial plate height and thickness play important roles for

the long-term stability of surrounding gingival margin around dental implant restoration. Therefore, it is crucial to determine the labial plate dimension of the teeth to be extracted and replaced with an implant.

In this study, CBCT was used to evaluate labial plates thickness of maxillary anterior teeth as it provides great accuracy in measurements and great image quality compared to conventional CT. The thickness of the labial plate was measured in 2 locations: L1 (4 mm apically to CEJ) and L2 (middle of root) in 723 teeth (245 central incisors, 240 lateral incisors, 238 canines).

For a good esthetic outcome, the locations of the labial plate at L1 and L2 play important role in different aspects. In terms of supporting gingival margin and contour of the alveolar process, L1 represents the bone apically to CEJ 4 mm. Since the bone in the crestal area is first affected in the presence of chronic local infection or following extraction, bone loss can occur in either labial-lingual or apical-coronal dimensions or in both as much as 3 to 4 mm apically[5,6] especially in the first 3 months after tooth extraction. L2 location represents the alveolar bone at the middle of the root, which covers the most prominent parts of the root. Thin labial plate at this area can lead to bone dehiscence after extraction. One should be aware that when placing implant at this area, the apical part of the fixture may expose through bone housing. Subsequently, the supporting bone structure in time will resorb and gingival margins may have recession and lead to implant metal exposure, which refers as esthetic failure.

The results of this study showed that at the L1 location of canine; the labial plate was absent in 14.6% of cases, the thickness was less than 1 mm 43.1% of cases and more or equal to 1 mm in 42.3% of cases. For lateral incisor; the labial plate was absent in 6.7% of the cases, the thickness was less than 1 mm in 55.0% and more or equal to 1 mm in 38.3% of cases, while for central incisor; the labial plate was absent in 14.6%, less than 1 mm in 52.3% and more or equal to 1 mm in 33.1% of cases.

For L2 location, canine teeth had absence of labial plate in 25.9% of the cases, less than 1 mm in 49.8% and more or equal to 1 mm in 24.3%. Lateral incisor revealed absence of labial plate in 16.7% of the cases, less than 1 mm in 66.7% and more or equal to 1 mm in 16.7%, while for the central incisors; absence of labial plate in 8.6%, less than 1 mm in 70.6% and more or equal to 1 mm in 20.8%.

Some previous studies evaluated the labial plate thickness using CBCT measurements. A study conducted in a Italian population showed that the thickness at 3 mm apical from CEJ ranges from 1.41 to 1.73 mm.[7] A similar study performed in a Swiss population found that average thickness of the maxillary labial plate at 4 mm below CEJ was 0.5 mm and at midroot was 0.6 mm.[8] The study conducted in a Korean population showed, that the thickness of maxillary labial plate at 3 mm below CEJ of central incisor was 0.68 mm, for lateral incisor 0.76 mm and for canine 1.07 mm.[9] Another study performed in a Chinese population found that the thickness of maxillary labial plate at 3 mm below CEJ of central incisor was 0.98 ± 0.32 mm, lateral incisor was 0.87 ± 0.36 mm and canine was 1.26 ± 0.62 mm. The thickness at the midroot of central incisor was 0.96 ± 0.24 mm, of lateral incisor was 0.59 ± 0.30 mm and of canine was 0.74 ± 0.24 mm.[10]

From these studies, it can be implied that the mean anterior labial plate thicknesses in Asian or European populations are in the range of no bone to less than 2 mm. In the present study, canines have the most variations in bone thickness; this may be due

to anatomical features of the tooth and varied localization in the dental arch. This study also found that in Thai population the thickness of the labial plate never exceeds 2 mm.

Dental implant placement in the anterior maxillary region requires careful preoperative clinical and radiographic evaluations. If there is a missing or thin labial plate, bone augmentation procedure should be considered to obtain the best esthetic outcome.

Conclusions

This study evaluated the average labial plate thickness of 723 anterior teeth with ICAT program using CBCT images. The result showed that the thickness of maxillary labial plate was no more than 2 mm in any individual subjects. It can be concluded that prior to implant placement, without enough information the treatment can be more risky especially in the anterior regions. Thus, clinician should be more careful when performing immediate or early implant placement in the esthetic zone. However, the collected data were only limited in Rangsit University and the distribution might not represent Thai population. Increase in numbers of sample and data from various source are recommended.

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