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ORIGINAL ARTICLE

A CBCT measurement of the mandibular buccal bone thickness in dentate adults

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Abstract

Aim: This study aims to measure the mandibular cortical bone thickness and the proximity of the tooth roots and the inferior alveolar canal to the outer cortex using cone-beam computed tomography (CBCT).
Materials and methods: Eighty CBCT scans were analysed. Buccal cortical plate and trabecular bone thickness were measured. Measurements of canine, first premolar, second premolar, first molar and second molar regions were taken at following levels: cortical plate thickness at the level of the midpoint of the midapical third of the root and at the level of apex, cortical plate and trabecular bone thickness at the level of the midpoint of the midapical third of the root, at the level of apex and at the level of inferior alveolar canal.
Results: Cortical bone thickness was greatest at the second molar region with 2.66 ± 0.72 at the root's midapical third, 3.27 ± 0.52 at the apex and 3.12 ± 0.64 at the level of the canal. Cortical plate and trabecular bone thickness was greatest at the second molar region with 4.72 ± 0.86 at the midapical third, 6.49 ± 0.8 at the apex and 5.3 ± 0.6 at the level of the canal.
Conclusions: Thickness of the outer cortex as well as the distance from cortex to canal and root is greatest at the second molar region, allowing placement of 4 mm monocortical screws safely and providing better implant stability and a thicker bone graft.

Clinical relevance

Scientific rationale for study

Different surgical procedures in the mandible may risk injury to the inferior alveolar canal and tooth roots.

Principal findings

The second molar region provides the thickest outer cortex in the posterior mandible minimising the risk of injury to tooth roots or inferior alveolar canal.

Practical implications

The article provides valuable information about the thickness of the outer cortex in the posterior mandible and its clinical significances during the treatment planning for bone grafting, mandibular fractures and dental implants.

Introduction

Dexterity in different surgical procedures in the mandible demands accurate pre-operative assessment and measurements of key areas in the working field. The mandibular cortical bone thickness, the distance from the outer bony cortex to the roots and the distance from the bony cortex to the mandibular canal are of special importance. The fixation of mandibular fractures with miniplates and monocortical screws requires knowledge of the average buccal cortical bone thickness. Champy *et al.*[1,2] extensively researched the use of miniplates with a high level of elasticity and malleability in treatment of mandibular fractures. Since then, miniplate fixation of the mandible fractures along the 'ideal lines of osteosynthesis' has become the standard and most widely used technique by maxillofacial surgeons. Monocortical fixation in the outer cortical plate is sufficient to support the strains resulting from the masticatory muscles[3]. Different types of dental root trauma caused by monocortical screws have been reported[4]. Knowledge of the buccal cortical bone thickness is critical during the pre-operative planning for mandibular fracture treatment. Also during implant therapy, the knowledge of the thickness of the cortical bone is important. Implant stability is necessary for osseointegration and is aided largely by cortical bone. Patients with an adequate amount of cortical bone thickness surrounding a cancellous region are best suited for implant therapy[5]. The knowledge of cortical bone thickness is also critical during harvesting a ramus graft. Many types of bone grafts can be used in various augmentation procedures. Autogenous bone grafts are still considered the 'gold standard' in alveolar ridge augmentation[6]. The choice of a secondary surgical site is often based on the quantity of desired bone and the type of desired graft. The ramus graft usually provides a graft that is longer in length but not as thick as a symphysis graft due to the proximity of the inferior alveolar canal to the buccal surface of the external oblique ridge[7]. The purpose of this study was to measure the cortical bone thickness of the mandible and the proximity of the tooth roots and the inferior alveolar canal to the outer cortex in dentate adults using cone-beam computed tomography (CBCT).

Materials and methods

A radiologic anatomical study was conducted on dentate adult patients who had undergone CBCT scan of the head and neck region from the College of Dental Medicine, University of Sharjah, UAE. These patients were retrospectively selected from the college's database from those who underwent a CBCT scan for evaluation of lower wisdom teeth prior to surgery. Exclusion criteria included any abnormality that would alter the bone thickness as mandibular fractures, tumours, bone disease, tooth loss or growth alterations. A total of 80 individuals (63.75% men and 36.25% women) aged 24–53 (mean 37.04 years) were analysed. A written consent was obtained from all patients to perform CBCT while each medical record contained another signed consent for possibility of data usage in research purposes. Buccal cortical plate and trabecular bone thickness were measured using CBCT (version 10.5, Dolphin Imaging System, Chatsworth, CA, USA). Thickness measurements were obtained at the following locations: canine (C), first premolar (PM1), second premolar (PM2), first molar (M1) and second molar (M2). Measurements of the buccal cortical plate and the distance from the outer cortex to the tooth root or the inferior alveolar canal (cortical plate and trabecular bone thickness) were taken for the locations C, PM1 and PM2 at following levels: cortical plate thickness at the level of the midpoint of the midapical third of the root, cortical plate thickness at the level of apex, cortical plate and trabecular bone thickness at the level of the midpoint of the midapical third of the root and cortical plate and trabecular bone thickness at the level of apex. In addition, for locations M1 and M2, the following levels were also measured: cortical plate and trabecular bone thickness at the level of inferior alveolar canal (Fig. 1). Measurements of the bone thickness at the desired levels were done by the viewing software using a digital ruler aligned perpendicular to the cortex in coronal views. All measurements were performed by one investigator. Statistical package for social sciences (version 18; SPSS Inc., Chicago, IL, USA) was used to analyse the data. Ethical approval for this study was obtained from the Oral and Craniofacial Health Sciences Department Board, as well as from the medical

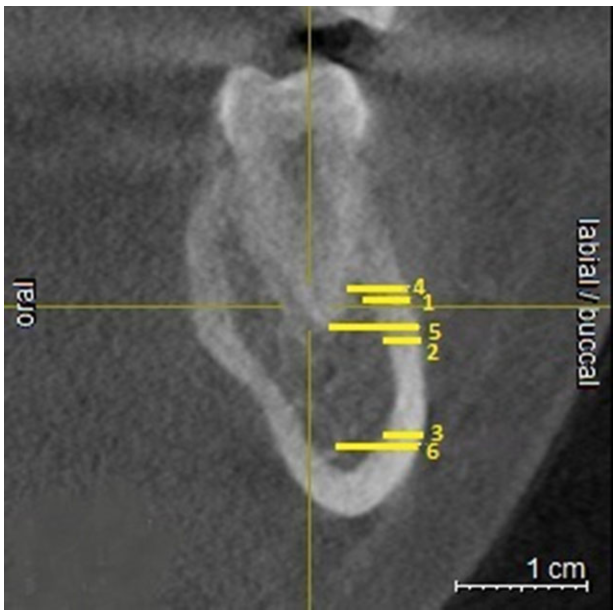

Figure 1 (1) Cortical plate thickness at the level of midapical third. (2) Cortical plate thickness at the level of apex. (3) Cortical plate thickness at the level of inferior alveolar canal. (4) Cortical plate and trabecular bone thickness at the level of midapical third. (5) Cortical plate and trabecular bone thickness at the level of apex. (6) Cortical plate and trabecular bone thickness at the level of inferior alveolar canal.

records department, College of Dentistry, University of Sharjah. SPSS version 18 was used for statistical analysis. The data were presented as mean and standard deviations.

Results

As listed in Table 1, the area of the mandible that had the thickest cortical and trabecular bone thickness was the second molar region.

Cortical bone thickness

In all measured areas, the cortical plate was thickest at the second molar region with 2.66 ± 0.72 at the level of midapical third, 3.27 ± 0.52 at the level of the apex and (3.12 ± 0.64) at the level of the inferior alveolar canal (Table 1).

Thickness of the cortical plate and trabecular bone (distance from the outer cortex to the root and inferior alveolar canal)

In all measured areas, thickness was the most at the second molar region with 4.72 ± 0.86 at the level of midapical third of the tooth root, 6.49 ± 0.8 at the level of root apex and 5.3 ± 0.6 at the level of the inferior alveolar canal (Table 1).

Discussion

The ideal sites for placement of the screws during miniplate fixation of mandibular fractures may risk the tooth roots and the inferior alveolar canal. In our population, there is no enough information about the cortical bone thickness of the mandible as well as the distance from the outer cortex to the tooth root and inferior alveolar canal. Miniplate osteosysthesis has become the treatment of choice for mandibular fractures within the past two decades. Miniplates are manufactured in varying standard lengths but with a uniform thickness of 0.9–1.0 mm[8,9]. To obtain good fixation in the outer cortex of the mandible, 5 to 7 mm long screws have been recommended[10,11]. However, according to Heidemann and Gerlach[12], the length of the screws should be 4–7 mm, depending on the thickness of the cortical bone. A subapical monocortical malleable four-hole plate should be used in the horizontal ramus, following the course of the line of tension at the base of the alveolar process (ideal line of osteosynthesis)[13]. Knowledge of the cortical bone thickness and the distance to the root and inferior alveolar canal is mandatory during treatment planning for mandibular fractures. In implant therapy, achieving primary stability requires the availability of thick cortical bone plates. The knowledge of the average cortical bone thickness in the mandible is of primary importance during treatment planning in dental implant therapy as CBCT or conventional CT machines are not readily available in each clinic. Also the knowledge of the cortical bone thickness is of great importance when planning for bone grafts from the body of the mandible (external oblique ridge). In this study, buccal cortical plate and trabecular bone thickness were measured using CBCT. Measurements were obtained at the C, PM1, PM2, M1 and M2 in both sides. In addition, measurements of the buccal cortical plate and trabecular bone were taken at the same locations. Our results had shown that at the C, PM1, PM2 and M1, the cortical plate thickness measured at different vertical levels as well as the distance to the tooth root and inferior alveolar canal may predict the risk of injury to the roots and the canal. The results of our study are similar to the results found by Kataranji *et al.*[14]; however, in two other studies[15,16] where the mean cortical thickness in the mandible at the mental foramen was measured, the results were slightly higher than the

Table 1 Measurements of the bone thickness at different locations

Measured areas	Canine	First premolar	Second premolar	First molar	Second molar
Cortical plate thickness at the level of midapical third	1.64 ± 0.46	1.59 ± 0.48	1.80 ± 0.63	2.3 ± 0.64	2.66 ± 0.72
Cortical plate thickness at the level of apex	1.91 ± 0.6	2.51 ± 0.49	1.74 ± 0.5	2.47 ± 0.45	3..27 ± 0.52
Cortical plate and trabecular bone thickness at the level of midapical third	2.3 ± 0.64	2.74 ± 0.8	3.0 ± 0.62	2.73 ± 0.55	4.72 ± 0.86
Cortical plate and trabecular bone thickness at the level of apex	3.7 ± 0.91	3.56 ± 0.72	3.34 ± 0.82	3.4 ± 0.75	6.49 ± 0.8
Cortical plate thickness at the level of inferior alveolar canal				2.92 ± 0.51	3.12 ± 0.64
Cortical plate and trabecular bone thickness at the level of inferior alveolar canal				4.1 ± 0.8	5.3 ± 0.6

results of the present study. Our results are similar to Carter *et al.*[17], who measured the mean thickness of segments sectioned during sagittal split osteotomies, the thickness ranged from 0.91 to 2.28 mm. Deguchi *et al.*[18] studied the mean thickness of the cortical plate using CT scans for miniscrews used for anchorage in orthodontic treatment. The cortical thickness ranged from 1.3 to 2.0 mm in the premolar and molar, which was similar to our results. Also Al-Jandan *et al.*[19] have found that the risk of injury to the tooth roots and inferior alveolar canal is minimal at the second molar area when using 4 mm screws and miniplates for fixation of mandibular fractures while the risk increases anterior to the second molar. In conclusion, the buccal bone thickness of the mandible at the second molar region provides the safest zone for placement of 4 mm monocortical screws and provide a thicker bone graft.

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