Risk Assessment of Jawbone Fracture by Mandibular Cortical Bone Width Using Computed Tomography

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Abstract: Maxillofacial trauma is a serious health problem because of the significant negative impact on an individual of the physical and psychological health. There are few studies reported that risk assessment of jawbone fracture by mandibular cortical bone width. The purpose of this study was to evaluate the mandibular cortical bone width using CT and to assess of the risk of jawbone fracture. This study included 381 patients (181 women and 200 men; 20-95 years of age, mean age 50.5 years) with suspected jawbone fractures due to falling who underwent CT at our hospital from April 2008 to March 2015. Mandibular cortical bone width was measured from distal to the mental foramen on both sides of the mandible using CT coronal images. All images were independently evaluated by two of oral radiologists. Each of the two groups were then compared about average of mandibular cortical bone width. Of the 381 patients, jawbone fractures were seen in 243 patients (63.8%). The average mandibular cortical bone width in patients with jawbone fractures was 2.40±0.64 mm. In contrast, the average mandibular cortical bone width in patients without jawbone fracture was 2.76±0.61 mm (p<0.01). The interobserver agreement for MCW was good (ICC=0.795). The present study found that the MCW with fracture group was significant thinner than without fracture group. Our results suggested that the MCW on CT provide a risk assessment of jawbone fractures.

Key words: Risk assessment, Jaw, Cortical bone, Trauma

Introduction
Maxillofacial trauma is a serious health problem because of the significant negative impact on an individual of the physical and psychological health. Especially, maxillofacial fracture is confronted with several problems that may have a significant impact on their health-related quality of life including changes in facial appearance. Victims of maxillofacial fracture can sustain scars or disfigurements, with their resultant emotional and psychological impact. Psychological impairment such as posttraumatic stress syndrome and depression are common after sustaining facial injuries. Maxillofacial injury is also associated with high socioeconomic cost due to the increasing cost of hospital resource as well as time lost to work. Maxillofacial fracture is common in seriously injured and this is can be life threatening occurs in serious case.

Computed tomography (CT) is applied to diagnosis the location and the dislocation in fractures accompanying cranio maxillofacial trauma. CT is capable of high-quality multiplanar reformation (MPR) and isotropic viewing, as a result, these improve the diagnostic capabilities of this modality, thus benefiting facial trauma patients. The application of CT technology to multitrauma imaging affords important advantages in injury detection and characterization. Recently, advance of high-resolution CT imaging has provided marked improvement in bone imaging. Degrees of fracture, previously grossly underestimated by conventional complex facial fractures, especially those associated with craniocerebral or spinal injuries, are better and more safely assessed by CT. Many studies have reported that there was a high correlation between the mandibular cortical bone and fracture. However, there are few studies the risk assessment of jawbone fracture by mandibular cortical bone width (MCW) using CT. The purpose of this study was to evaluate the risk assessment of jawbone fracture by MCW using CT.

Materials and Methods
This was a retrospective cohort study, approved by the ethics committee, Nihon University School of Dentistry at Matsudo (No. EC19-010) and conducted in accordance with the 1975 Declaration of Helsinki (2013 revision). The requirement to obtain written informed consent was waived for this retrospective study. This study included 381 patients (181 women and 200 men; 20-95 years of age, mean age 50.5 years) with suspected jawbone fractures due to falling who underwent CT at our hospital from April 2008 to March 2015. Patient with prior history of radiotherapy, jawbone tumor or cyst, medication history of bisphosphonate and under 20 years old patients were excluded from this study.

Data acquisition
CT was performed with a 64 multi-detector-row CT (MDCT) (Aquilion64, Toshiba Medical Systems, Tokyo, Japan) using the maxillofacial trauma protocol at our hospital: tube voltage, 120 kV; tube current, 100...
mA; field of view, 240 mm×240 mm; rotation time, 1.0 s; mean effective dose, 1.6 mSv; mean CTDI vol value, 37.3 mGy; mean DLP value, 520.3 mGy·cm. In this study, the k-factor used is the head neck factor 0.0031 mSv/(mGy·cm). The protocol consisted of axial acquisition (0.50 mm) with axial (3.0 mm) and sagittal (1.0 mm) MPR and 3D images. The CT images were interpreted using a medical liquid crystal display monitor (RadiForce G31; Eizo Nanami, Isikawa, Japan). MCW was measured in the axial direction of the mandible using a CT coronal slice corresponding to the mental foramen (Fig. 1). All images were independently evaluated by two of oral radiologists. Cases were subdivided into those with and those without a fracture group.

**Statistical analysis**

Statistical analysis were analyzed using the Mann-Whitney U test and Spearman’s rank correlation coefficient and Tukey’s test. This analysis was performed with the statistical package SPSS version 21.0 (SPSS Japan, Tokyo, Japan). P-values < 0.05 were considered statistically significant. The intraclass correlation coefficient (ICC) were used to assess the interobserver agreement of MCW. ICC were classified as poor (0.0-0.19), fair (0.2-0.39), moderate (0.4-0.59), good (0.6-0.79) and excellent (0.8-1.00).

Each of the two groups were compared about average of MCW using Mann-Whitney U test. Spearman’s rank correlation coefficient was used to the correlation between age and MCW.

Receiver operating characteristic (ROC) curve analysis was performed to assess the ability of MCW to predict jaw bone fracture and area under the curve (AUC) was calculated.

**Results**

Table 1 shows a comparison of patients with and without jaw fractures using the Mann Whitney U test. Among the 381 patients, jawbone fractures were seen in 243 patients (63.8%). The average MCW in patients with jawbone fractures was 2.40±0.64 mm. In contrast, the average MCW in patients without jawbone fracture was 2.76±0.61 mm (p < 0.01).

Table 2 shows a performances of imaging findings to predict jawbone fractures. The cutoff value was determined using the Youden index. Cortical mandibular bone width at the cutoff value of <2.38 had

![Figure 1. Measurement of mandibular cortical bone width.](image-url)
Discussion

The average MCW in patients with jawbone fractures was 2.40±0.64 mm in our results. In contrast, the average MCW in patients without jawbone fracture was 2.76±0.61 mm. This study found that the without fractures group had significantly thicker mandibular cortical bone than the fractures group.

Osteoporosis is a most common bone disease in humans, representing a major public health problem that is characterized by low bone mass, deterioration of bone tissue, and disruption of bone microarchitecture: it can lead to compromised bone strength and an increase in the risk of fractures\(^3,14\). In our results, MCW less than 2.38 mm was a risk factor for jawbone fracture. Hastar et, al. reported that MCW on panoramic radiograph of less than 3 mm is a risk factor for osteoporosis\(^15\). Devlin et, al. reported that the molar regions are magnified about 1.25 times on the panoramic radiograph\(^16\). Therefore, 3 mm of the mandibular cortical bone width on the panoramic radiograph corresponds to 2.4 mm of the MCW on CT. Gomez-Roman et, al. reported that the vertical enlargement ratio varied between 1.21 and 1.29 on optimal orthograde adjusted tomographs, depending on the measured area\(^17\). Although this study excludes patients taking bisphosphonate, patients with MCW less than 2.38 mm may be osteoporosis.

This study excludes causes of injury other than falls. Therefore,
since the external force at the time of injury is the same, it is thought that the thinner the cortical bone easily causes bone fracture. Previous studies have reported that young males have the high risk of fractures[8-22]. The most common causes of fractures in men are in order of traffic accident, violence, and falls. Since factors other than falls were excluded from this study, it is considered that there was no gender difference in the incidence of fractures.

The most frequent fracture caused by a fall was the mandibular fracture. This result is consistent with previous reports. There was no significant difference in MCW between fracture sites. There was no significant difference in CT values between the groups with and without fractures in this study. This suggests that MCW, not CT values, is a risk factor for bone fracture. In this study, a negative correlation was found between age and MCW, with MCW peaks at ages 20-29. However, previous studies have shown that MCW peaks at ages 40 to 49 and decreases thereafter23. Since this study targets Asians, it suggests that differences from previous studies may be due to racial differences.

In conclusion the present study found that the MCW with fracture group was significant thinner than without fracture group. MCW less than 2.38 mm suggested a higher risk of fracture. Our results suggested that the MCW on CT provide a risk assessment of jawbone fractures.

Conflict of Interests

The authors have declared that no COI exists.

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