Risk Assessment for Condylar Fracture Using Classification of the Mandibular Inferior Cortical Shape by Pantomography

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Abstract
The purpose of this study was to assess condylar fracture risk according to the classification of the mandibular inferior cortical shape using pantomography.

This retrospective study was approved by the Institutional Review Board (EC15–12–009–1). 254 patients with suspected condylar fractures who underwent both pantomography and MDCT from April 2006 to December 2016 were included in this study. The mandibular inferior cortical shape was evaluated by pantomography on both sides of the mandible, distal to the mental foramen by specialist of two oral and maxillofacial radiologists, and classified into three types as follows: Type I: normal cortex, Type 2: mildly to moderately eroded cortex and Type 3: severely eroded cortex. Moreover, the patients were divided into two groups; Group I: normal bone mineral density (Type 1) and Group II: low bone mineral density (Types 2 and 3).

Of the 254 patients, condylar fractures were seen in 158 patients (62.2%). Of the 158 patients with condylar fractures, 27 patients were in Group I (17.1%) and 131 patients were in Group II (82.9%). Of the 96 patients without mandibular fracture, 57 patients were in Group I (59.4%) and 39 patients were in Group II (40.6%). There was a statistically significant difference between Group I and Group II in the prevalence of condylar fractures (p < 0.05).

Our results suggest that classification of the mandibular inferior cortical shape on pantomography may provide a risk assessment of condylar fractures.

Keywords:
condylar fracture risk, pantomography, mandibular inferior cortical shape

Introduction
Facial trauma is a huge public health problem because of the significant negative impact on an individual’s overall physical and psychological health (1, 2). A fracture of the mandible is a common trauma presentation and represents one of the most frequently encountered fractured bones within the viscerocranium (3). Patients suffering from mandibular fractures are confronted with several problems that may have a significant impact on their health-related quality of life including changes in facial appearance, impaired oral and masticatory functions, sensory disturbances, obstacles in daily routines, and interruption of social and working life due to convalescence (4).

Fractures of mandibular condyle process are the most common fractures of the mandible area (5, 6). Of all mandibular fractures, 25–35% are fractures of the mandibular condyle (7). This can be explained by the fact that the mandible is similar to a hunting bow in shape—strongest in the midline (symphysis) and weakest at the ends (condyles) (8). This area has a great clinical value due to important components such as the facial nerve and temporomandibular joint (9). Deranged occlusion, inability to masticate food, difficulty in opening mouth, haemotympanum and pain in preauricular region are some of the complaints of patients (10).

Despite having a higher radiation dosage than that associated with radiography, computed tomography (CT) is
the imaging technique of choice for evaluating craniomaxillofacial injuries as it can display the multiplicity of fragments, degrees of rotation and dislocation, and any skull base involvement (11). Conversely, pantomography is widely used to assess orofacial trauma and other disorders (12). Some investigators have suggested that classification of the mandibular inferior cortical shape detected on pantomography (13, 14).

However, there have been few studies evaluating the risk of condylar fracture by classification of the mandibular inferior cortical shape using pantomography.

The purpose of this study was to assess condylar fracture risk according to the classification of the mandibular inferior cortical shape using pantomography.

Materials and Methods

Study subjects

This retrospective study was approved by the Institutional Review Board (EC15–12–009–1). 254 patients (131 men, 123 women; age 20–91 years, mean age 56.2 years) with suspected condylar fractures who underwent both pantomography and multi-detector-row CT (MDCT) from April 2006 to December 2016 were included in this study. All patients read and signed an informed consent form.

CT and pantomography protocol

CT imaging was performed with a 64MDCT (Aquilion 64, Toshiba Medical Systems, Tokyo, Japan) using the maxillofacial trauma protocol at our hospital: tube voltage:120 kV; tube current: 100 mAs; field of view: 240 mm × 240 mm; rotation time: 1.0 s; mean effective dose: 1.6 mSv; mean CTDIvol 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 reference for the used conversion factor is International Commission on Radiological Protection (ICRP) publication102 (15). The protocol consisted of axial acquisition (0.50 mm) with axial (3.0 mm), coronal (3.0 mm) and sagittal (1.0 mm): MPR and 3D images.

The mandibular inferior cortical shape was assessed on digital pantomography (Veraviewepocs; J. Morita, Kyoto, Japan) at 1 to 10 mA and peak kV between 60 and 80, depending on the subject’s jaw size.

The MDCT images and pantomography images were interpreted using a medical liquid crystal display monitor (RadiForce G31; Eizo Nanami, Ishikawa, Japan).

Image analysis

The mandibular inferior cortical shape was evaluated on both sides of the mandible, distal to the mental foramen on pantomography by specialist two oral and maxillofacial radiologists, and classified into three types (Fig. 1) (14):

Type I. Normal cortex: the endosteal margin of the cortex was even and sharp on both sides. Type 2. Mildly to moderately eroded cortex: the endosteal margin shows semilunar defects (lacunar resorption) or appears to form endosteal cortical residues (arrowheads). Type 3. Severely eroded cortex: the cortical layer forms heavy endosteal cortical residues and is clearly porous (arrowheads).

Statistical analysis

Statistical analysis was performed using χ2 test with Fisher’s exact test. These analyses were performed with the
statistical package SPSS version 21.0 (SPSS Japan, Tokyo, Japan). $P$-values < 0.05 considered statistically significant.

**Results**

Of the 254 patients, condylar fractures were seen in 158 patients (62.2%). Of the 158 patients with condylar fractures, 27 patients were in Group I (17.1%) and 131 patients were in Group II (82.9%). Of the 96 patients without mandibular fracture, 57 patients were in Group I (59.4%) and 39 patients were in Group II (40.6%). There was a statistically significant difference between Group I and Group II in the prevalence of condylar fractures ($p < 0.05$) (Fig. 2).

Of the 131 men with fracture, 27 patients were in Group I (20.6%) and 104 patients were in Group II (79.4%). Of the 123 women with fracture, 24 patients were in Group I (19.5%) and 99 patients were in Group II (80.5%).

Unilateral fractures occurred in 93 of 158 (58.8%) patients and bilateral fractures were seen in 65 of 158 (41.1%) patients. Of the Group I patients with condylar fractures, 88.9% (24/27) demonstrated unilateral fracture patterns and 11.1% (3/27) demonstrated bilateral fracture patterns. 52.7% (69/131) of the Group II patients demonstrated unilateral fracture patterns and 47.3% (62/131) demonstrated bilateral fracture patterns. There was a statistically significant difference between Group I and Group II in the prevalence of unilateral or bilateral fractures ($p < 0.05$) (Fig. 3).

Of the 93 patients with unilateral fractures, 49 patients were right condylar fractures (52.7%) and 44 patients were left condylar fractures (47.3%). Of the Group I patients with unilateral fractures, 41.7% (10/24) demonstrated right condylar fractures and 58.3% (14/24) demonstrated left condylar fractures. Of the Group II patients with unilateral fractures, 56.5% (39/69) demonstrated right condylar fractures and 43.5% (30/69) demonstrated left condylar fractures (Table 1).

**Discussion**

Our study showed that patients with Group II mandibular inferior cortical shape more frequently sustained condylar fractures compared to patients with Group I morphology. Patients with Group II mandibular inferior cortical shape have a higher risk of the condylar fracture compared to patients with Group I morphology. The mandibular condyle is frequently fractured owing to the small cross-sectional area of the condylar neck that extends spiral upwards. The anatomic configuration of the mandible transmits the kinetic energy from a blow along the mandible to the condylar neck, where the compressive strength of the bone is exceeded and fracturing occurs (16).

Unilateral mandibular condylar fractures occur approxi-
Fig. 3. Bilateral condylar fractures in a 75-year-old woman in Group II (A) Pantomography shows that the cortical layer forms heavy endosteal cortical residues and is clearly porous. (B–D) Axial (B), sagittal (C) and coronal (D) images show bilateral condylar fractures (arrows). The most common site of fracture in Group II was at the condylar location.

Table 1. The frequency and sites of condylar fractures based on the mandibular inferior cortical shape

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral condylar fractures</td>
<td>3 (11.1%)</td>
<td>62 (47.3%)*</td>
</tr>
<tr>
<td>Unilateral condylar fractures</td>
<td>24 (88.9%)</td>
<td>69 (52.7%)</td>
</tr>
<tr>
<td>Right condylar fractures</td>
<td>10 (41.7%)</td>
<td>39 (56.5%)</td>
</tr>
<tr>
<td>Left condylar fractures</td>
<td>14 (58.3%)</td>
<td>30 (43.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>131</td>
</tr>
</tbody>
</table>

*p < 0.05

mately two times more frequently than bilateral fractures (17). Iida et al. (18) reported that 201 patients were unilateral condylar fractures and 86 patients were bilateral condylar fractures. In our study, the case of Group I unilateral condylar fractures were 88.9% and bilateral condylar fractures were 11.1%. The case of Group II, unilateral condylar fractures were 52.7% and bilateral condylar fractures were 47.3%. We considered patients with Group II have a higher risk of the bilateral condylar fracture compared to patients with Group I. The mandibular condyle is frequently fractured owing to the small cross-sectional area of the condylar neck that extends spiral upwards. The anatomic configuration of the mandible transmits the kinetic energy from a blow along the mandible to the condylar neck including unilateral or bilateral, where the compressive strength of the bone is exceeded and fracturing occurs (16).
Given the unique geometry of the mandible and temporomandibular joints, these fractures can result in marked pain, dysfunction, and deformity if not recognized and treated appropriately (19). Complications related to the condylar fracture are ranged from tympanic bone fracture, fracture of mandibular fossa of temporal bone with or without dislocation of the condylar segment into the middle cranial fossa, injury to the cranial nerves, vascular damage and bleeding, growth inhibition and arteriovenous fistula (20, 21). Therefore, the understanding of condylar fracture risk according to classification of the mandibular inferior cortical shape is essential in diagnosis and treating fractures of the condylar region.

Conclusion

Patients with Group II mandibular inferior cortical shape have a higher prevalence of condylar fractures compared to patients with Group I mandibular cortical shape. Our results suggest that classification of the mandibular inferior cortical shape on pantomography may provide a risk assessment of condylar fractures.

References