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RESEARCH

Characterization of mandibular fractures using 64-slice multidetector CT

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Objective: The aim of this study was to characterize mandibular fracture locations using 64-slice multidetector CT (MDCT).
Methods: CT scans of 138 patients with mandibular fractures who underwent 64-slice MDCT were studied. Mandibular fractures were classified into five types: median, paramedian, angle, condylar and coronoid process. Statistical analysis for the relationship between multiple fractures and type of mandibular fractures was performed using χ^2 test with Fisher's exact test.
Results: The percentage of multiple mandibular fractures was 80.9% median type, 74.3% paramedian type, 52.9% angle type and 60.9% condylar type. The resultant data showed a significant relationship between multiple fractures and the median type ($p = 0.000$), paramedian type ($p = 0.002$) and condylar type ($p = 0.003$).
Conclusion: The results suggest that multiple fractures are related to the type of mandibular fractures.
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Keywords: multidetector computed tomography; mandibular trauma; multiple fractures

Introduction

CT is being increasingly applied to define the fracture location and the degree of dislocation in fractures accompanying craniomaxillofacial trauma.[1] Multidetector CT (MDCT) allows high-quality multiplanar reformation (MPR) and isotropic viewing, all of which improve the diagnostic power of this imaging modality, thus benefiting facial trauma patients.[2–4] The application of 64-slice MDCT technology to multitrauma imaging affords important advantages in injury detection and characterization.[5] Decreasing slice thickness and the ability to routinely acquire whole body imaging using isotropic data sets have resulted in true multiplanar CT imaging.

Maxillofacial trauma has been investigated worldwide because it affects a significant percentage of trauma patients.[6–11] The mandible is one of the most commonly fractured maxillofacial bones.[6,8–11] Knowledge of the fracture pattern and the aetiology of the injury is important for the management of maxillofacial fractures.[12] Characteristic features of the mandible have been observed in age and gender distributions and the site and severity of fractures according to the cause of trauma.[13–18] However, few studies have been concerned with the evaluation of the craniomaxillofacial trauma using 64-slice MDCT.

The surgical team needs to have an accurate understanding of the facial injuries pre-operatively.[19] The aim of this study was the characterization of mandibular fracture locations using 64-slice MDCT.

Materials and methods

CT scans of 138 patients (101 males, 37 females; age 4–87 years, mean age 35.7 years) with mandibular fractures who underwent 64-slice MDCT in the Department of Radiology at the Nihon University School of Dentistry at Matsudo, Chiba, Japan, from April 2006 to May 2010 were studied. All participants read and signed an informed consent form. This study was approved by the Ethics Committee of the University School of Dentistry (No. EC10–039).

CT imaging was performed with a 64-slice MDCT system (Aquilion 64; Toshiba Medical Systems, Tokyo, Japan). All patients were scanned using the clinically routine protocol for craniomaxillofacial examination at our hospital as follows: tube voltage, 120 kV; tube current, 100 mA; field of view, 240 × 240 mm; and

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Table 1 Number of mandibular fractures in 138 patients

Type of fracture	*Number*	*Percentage (%)*
Condylar	106 (R 55, L 51)	47.1
Median	47 (M 47)	20.9
Paramedian	36 (R 19, L 17)	16.0
Angle	35 (R 16, L 19)	15.6
Coronoid process	1 (R 1, L 0)	0.4
Total	225 (R 91, M 47, L 87)	100

L, left; M, median; R, right.

Table 2 Patient distribution according to type of mandibular fractures in 138 patients

Single fractures		*Multiple fractures*	
Type of fracture	*Patients (%)*	*Type of fracture*	*Patients (%)*
Condylar	34 (24.6)	Median and condylar	17 (12.3)
Angle	16 (11.6)	Paramedian and condylar	14 (10.1)
Median	9 (6.5)	Median and bi-condylar	13 (9.4)
Paramedian	9 (6.5)	Paramedian and angle	9 (6.5)
		Median and angle	5 (3.6)
		Bi-condylar	5 (3.6)
		Angle and condylar	2 (1.4)
		Median and paramedian	1 (0.7)
		Bi-paramedian	1 (0.7)
		Median and bi-angle	1 (0.7)
		Angle, condylar and coronoid process	1 (0.7)
		Median, paramedian and bi-condylar	1 (0.7)
Total	68 (49.3)		70 (50.7)

Bi-, bilateral.

helical pitch, 41. Imaging included axial (0.50 mm), MPR (3.00 mm) and three-dimensional (3D) images. The MDCT images were interpreted using a medical liquid crystal display monitor (RadiForce G31; Eizo Nanami, Ishikawa, Japan). All images were independently evaluated by two oral radiologists and any differences were resolved by forced consensus.

The relationship between multiple fractures and type of mandibular fractures was analysed. Mandibular fractures were classified according to the distribution described by Lieger et al[20] into five types: median, paramedian, angle, condylar and coronoid process. Statistical analysis for the relationship between number of fractures, such as single and multiple fractures, and type of mandibular fractures was performed using χ^2 test with Fisher's exact test. These analyses were performed with the statistical package SPSS version 14.0 (SPSS Japan, Tokyo, Japan). p-values <0.05 were considered to indicate statistical significance.

Results

Table 1 shows the number of mandibular fractures in 138 patients. The condylar type was most frequent (47.1%), followed by the median (20.9%) and the paramedian types (16.0%).

The percentage of multiple fractures was 50.7% of all mandibular fracture patients (Table 2). In all multiple fractures patients, the median and condylar types were the most frequent, followed by the paramedian and condylar and median and bilateral condylar types. Figure 1 shows MDCT images of median and condylar type.

Table 3 shows the relationship between multiple fractures and type of mandibular fractures in 138 patients. The percentage of multiple fractures was 80.9% of the median type, 74.3% of the paramedian type, 52.9% of the angle type and 60.9% of the condylar type. The resultant data showed a significant relationship between multiple fractures and the median type ($p = 0.000$), the paramedian type ($p = 0.002$) and the condylar type ($p = 0.003$).

a b c

Figure 1 A 40-year-old male after a fall on the chin at home. (a) Axial image demonstrates a median fracture (arrow). (b) Coronal image demonstrates a condylar fracture (arrow). (c) Three-dimensional image to better advantage depicts median and condylar fractures (arrows)

Table 3 Relationship between multiple fractures and type of mandibular fractures in 138 patients

	Number of fractures			
Type of fracture	*Single*	*Multiple*	*Total*	p-*value*[a]
Median	9 (19.1%)	38 (80.9%)	47 (100%)	0.000
Paramedian	9 (25.7%)	26 (74.3%)	3s (100%)	0.002
Angle	16 (47.1%)	18 (52.9%)	34 (100%)	0.844
Condylar	34 (39.1%)	53 (60.9%)	87 (100%)	0.003

[a]Single *vs* multiple.

Discussion

MDCT can easily detect and characterize injuries not only of the body and spine, but also of intracranial and maxillofacial injuries.[21,22] Salonen et al[2–4] showed that MDCT can detect the non-displaced fractures and also provides valuable 3D morphology of the more complex injuries in facial trauma using 4-slice MDCT. However, few studies have been concerned with the evaluation of craniomaxillofacial trauma using 64-slice MDCT. In our experience, 64-slice MDCT with reformatted images and 3D reconstructions helps to interpret mandibular fractures, especially the fracture location, the degree of dislocation and the relationship between multiple fractures and type of mandibular fractures.

Iida et al[6] reported that the most common mandibular fracture site was the condyle (33.6%), followed by the angle (21.7%). Ahmed et al[9] indicated that regarding the distribution of mandibular fractures, the majority (25.0%) occurred in the condyle and 23.0% in the angle. On the other hand, Yamamoto et al[12] showed that the condyle (38.2%) and median (27.0%) were most frequently involved in the mandible. This study demonstrated that the condylar type was most common (47.1%), followed by the median type (20.9%). The results were in line with previous studies given that these parts of the face are prone to injury for anatomical reasons.

In this study, the percentage of multiple fractures was 50.7% of all mandibular fracture patients. Iida et al[6] reported that multiple fractures of the mandible were present in 48.6% of patients. Yamamoto et al[18] showed that fracture lines were multiple in 44.4% of all mandibular fracture patients. These reports suggest no difference of percentage in mandibular fractures between single and multiple fractures.

Sawazaki et al[17] indicated that median fractures were significantly associated with both unilateral and bilateral fractures of the mandibular condyle. This study showed that the median and condylar types were most frequent, followed by the paramedian and condylar types and the median and bilateral condylar types in multiple mandibular fractures. Our resultant data also indicated a significant relationship between multiple fractures and type of mandibular fractures, such as median, paramedian and condylar. These results suggest that the mandible distributes the force of impact and fractures frequently occur in the condylar region. We consider that if a force applied to the mandible is distributed, it affects the weakest point in the mandibular arch and causes extreme bending and tensile failure at that point. Therefore, condylar fractures may be tension failures in response to bending of the mandibular neck.

Regarding radiation dose of CT, Mah et al[23] showed that the effective dose for the imaging of the maxillomandibular volume with cone beam CT (CBCT) is significantly lower than that with CT imaging methods. Ilguy et al[24] reported that more detailed information was obtained about dentoalveolar fractures with CBCT compared with CT and conventional radiography. However, we consider that 64-slice MDCT is an effective tool to assess craniomaxillofacial trauma, especially the fracture location and the degree of dislocation, oedema and haemorrhage.

In conclusion, this study suggests that multiple fractures are related to the type of mandibular fractures.

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