Characteristic Multidetector CT Findings of Mandibular Fractures: Comparison with Falls and Violence

（下顎骨骨折の特徴的マルチスライス CT 所見：転倒症例と殴打症例との比較）

日本大学松戸歯学部放射線学講座

研究講座員　本多　伊知郎

専任講師　　小椋　一朗

（指導教授：金田　隆）

Abstract

The purpose of this study was to investigate the characteristic multidetector CT (MDCT) findings, especially the prevalence of location, of mandibular fractures resulting from falls and violence. A prospective study was performed in 217 patients with mandibular fractures resulting from falls or violence underwent 64-MDCT. Mandibular fractures were classified into four types: median, paramedian, angle and condyle. Statistical analysis of the relationship between cause and mandibular fracture location was performed using χ^2 test with Fisher's exact test and logistic multivariate regression analysis. The results showed that the percentages of cases resulting from falls and violence were 55.8% and 44.2% of paramedian type ($p = 0.001$), 46.4% and 53.6% of angle type ($p = 0.000$) and 87.8% and 12.2% of condyle type ($p = 0.000$), respectively. This study indicated a significant relationship between cause and condyle type (odds ratio (OR) = 3.303, $p = 0.009$), paramedian type (OR = 0.339, $p = 0.017$) and angle type (OR = 0.313, $p = 0.019$), respectively. In conclusion, the results of the presented study suggest the characteristic MDCT findings, especially the prevalence of location, of mandibular fractures resulting from falls and violence.

Keywords: Computed tomography, Mandibular trauma, Mandibular fracture, Falls, Violence

Introduction

Maxillofacial fractures have various causes, such as falls, violence and others (1). Falls are frequent cause of injury, especially in the elderly, causing disability, morbidity and increased health care utilization (2, 3). Violence can result in various injuries, and the head and neck are regions often the most affected (4). Fracture morphology of facial injury as a result of violence is often complex, the radiologist should be familiar with the imaging findings.

Various radiographic methods have been used for diagnosing maxillofacial trauma. Panoramic tomography is widely used for the screening of orofacial trauma as well as other diseases (5). Cone-beam computed tomography (CBCT) is also used for diagnosing orofacial diseases (6). However, despite a higher radiation dosage compared to radiography, in craniomaxillofacial injuries, CT is the imaging technique of choice to display the multiplicity of fragments, the rotation and dislocation degree, or any skull base involvement (7).

Fractures of the mandible at multiple sites are common and should always be sought radiographically. Unfortunately, many studies of mandibular fractures did not use multidetector CT (MDCT) to confirm the presence of suggested fractures and excluded additional nondisplaced fractures (8). MDCT with multiplanar reformation (MPR) and three-dimensional (3D) images has become a standard part of the

assessment of facial injury because of the exquisite sensitivity of this imaging technique for fracture (9-14). However, to our knowledge, characteristic MDCT findings of mandibular fractures resulting from falls and violence have not been reported in the literature.

The purpose of this study was to investigate the characteristic MDCT findings, especially the prevalence of location, of mandibular fractures resulting from falls and violence.

Materials and Methods

This prospective study was approved by the Ethics Committee of our institution (No. EC10-039). After obtaining written informed consents, 217 patients (149 males, 68 females; age 4-87 years, mean age 37.1 years) with isolated mandibular fractures resulting from falls or violence underwent 64-MDCT within 7 days after injury at our university hospital from April 2006 to September 2012. This study included 103 single fracture patients and 114 multiple fractures patients in the mandible.

CT imaging was performed with a 64-MDCT (Aquilion 64, Toshiba Medical Systems, Tokyo, Japan) using the maxillofacial trauma protocol at our hospital: tube voltage, 120kV; tube current, 100mA; field of view, 240mm×240mm; rotation time, 1.0s. The protocol consisted of axial acquisition (0.50mm) with axial (3.0 mm), coronal

(3.0 mm) and sagittal (3.0 mm) MPR and 3D images. The MDCT images were independently evaluated by two oral and maxillofacial radiologists and any discrepancies were resolved by consensus. The relationship between cause and age, gender, number and location of mandibular fractures was analyzed. Regarding the age, we compared ＞30 years and ≦30 years, because 33.0 years was median age in this study. Mandibular fractures were classified according to the distribution described by Lieger et al. (15) into four types: median, paramedian, angle and condyle. The cause of injury was recorded as falls or violence.

Statistical analysis of the relationship between cause and variables was performed using χ^2 test with Fisher's exact test. Odds ratio of falls was performed using logistic multivariate regression analysis. These analyses were performed with the statistical package SPSS version 14.0 (SPSS Japan, Tokyo, Japan). A p value less than 0.05 was considered statistically significant.

Results

Table 1 showed patient characteristics according to cause of mandibular fractures in 217 patients. The results using χ^2 test with Fisher's exact test showed a significant relationship between cause and age ($p = 0.000$), gender ($p = 0.000$), respectively.

Condyle type was most frequent in mandibular fractures resulting from falls,

followed by median type (Fig. 1). Angle type was most frequent in mandibular fractures resulting from violence, followed by paramedian type (Fig. 2). The percentages of cases resulting from falls and violence were 78.9% and 21.1% of median type (p = 0.258), 55.8% and 44.2% of paramedian type (p = 0.001), 46.4% and 53.6% of angle type (p = 0.000) and 87.8% and 12.2% of condyle type (p = 0.000), respectively (Table 2).

The results using logistic multivariate regression analysis showed a significant relationship between cause and condyle type (odds ratio (OR) = 3.303, p = 0.009), paramedian type (OR = 0.339, p = 0.017) and angle type (OR = 0.313, p = 0.019), respectively (Table 3).

Discussion

MDCT can detect the non-displaced fractures and also provides valuable 3D morphology of the more complex injuries in facial trauma (2-4). Escott et al. (8) showed that CT was more sensitive than panoramic tomography, particularly for fractures of the angle, ramus, or condyle. Despite a higher radiation dosage compared to radiography, in craniomaxillofacial injuries, CT is the imaging technique of choice to display the multiplicity of fragments, the rotation and dislocation degree, or any skull base involvement (7). Furthermore, Ogura et al. (10, 12) reported that MDCT is an effective tool to assess craniomaxillofacial trauma, especially the multiple fracture locations, the

degree of dislocation, soft tissue edema and hemorrhage. However, to our knowledge, characteristic MDCT findings of mandibular fractures resulting from falls and violence have not been reported in the literature. This study investigated the characteristic MDCT findings, especially the prevalence of location, of mandibular fractures resulting from falls and violence.

Falling accidents are a common cause of injury. CT is the imaging method of choice for these injuries, enabling fast and accurate diagnosis, thus leading to better treatment (3). Salonen et al. (2, 3) reported that the mandibular condylar fractures were most frequently in falling accidents. This study indicated that condyle type was most frequent in mandibular fractures resulting from falls, followed by median type. Sawazaki et al. (16) reported that median fractures were significantly associated with both unilateral and bilateral fractures of the mandibular condyle. Ogura et al. (10) indicated that the median and condyle type in the multiple fracture patients was the most frequent, followed by the paramedian and condyle type, and the median and bilateral condyle type. We consider that trauma force was applied in the median region, causing indirect fractures of the condyle with or without fractures in the median region.

Violence is a very common cause of facial injury. Salonen et al. (4) showed that violence was involved in 30% of all suspected facial injury. This study indicated that the percentages of cases resulting from falls and violence were 73.7% and 26.3% of all

mandibular fracture patients, respectively. Iida et al. (17) reported that fractures of the mandibular angle were observed most commonly due to violence. In our study, angle type was most frequent in mandibular fractures resulting from violence, followed by paramedian type. The most common form of interpersonal violence is a hit with a fist, but high-energy means, such as use of brass knuckles or kicking, are increasing. We consider that the high-energy resulting from violence was applied in the facial region, causing direct fractures of the paramedian and angle type.

The age and gender distribution is closely related to the circumstance of injury. Regarding to elderly patients, Ohki et al. (14) showed that the condylar type was considered more frequency in female with maxillofacial fractures resulting from falls. This study showed that the falls were commonly observed in elderly patients, especially in female patients, and the violence were commonly observed in younger patients, especially in male patients. These results were in line with those of the previous studies (1-3, 18). Domestic violence (DV) has been identified as a cause of maxillofacial fractures especially among women (19). However, the diagnosis of DV is difficult because of a lack of clearly defined signs and symptoms (20). This study showed that characteristic MDCT findings of mandibular fractures resulting from falls was condyle type, and those from violence were paramedian and angle type. We consider that paramedian and angle type with unknown cause may be mandible fractures resulting

from violence, although we did not analyzed relationship between DV and mandibular fractures, because the number of DV was small in this study.

In conclusion, the results of the presented study suggest the characteristic MDCT findings, especially the prevalence of location, of mandibular fractures resulting from falls and violence. MDCT findings are useful for the appropriate treatment in patients with mandibular fracture, especially in disclosing the hidden violence.

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Figure Legends

Fig. 1 A 34-year-old male with mandibular fracture resulting from falls. Axial (A), sagittal (B), and coronal (D) bone-algorithm CT (A) demonstrate that the condylar fracture fragment is dislocated mesioanteriorly (arrow). Coronal soft-tissue algorithm CT (C) demonstrates the condylar fracture with soft tissue edema (arrow). 3D images (E, F) to better advantage show the condylar displaced fracture (arrow).

Fig. 2 A 36-year-old male with mandibular fracture resulting from violence. Axial (A) and coronal (C) soft-tissue algorithm CT demonstrate the angle fracture with soft tissue edema (arrow). Axial (B) and coronal (D) bone-algorithm CT demonstrate that the angle fracture fragment is dislocated (arrow). Coronal soft-tissue algorithm CT (C) demonstrates the angle fracture with soft tissue edema (arrow). 3D images (E, F) to better advantage show the angle displaced fracture (arrow).

Fig. 1

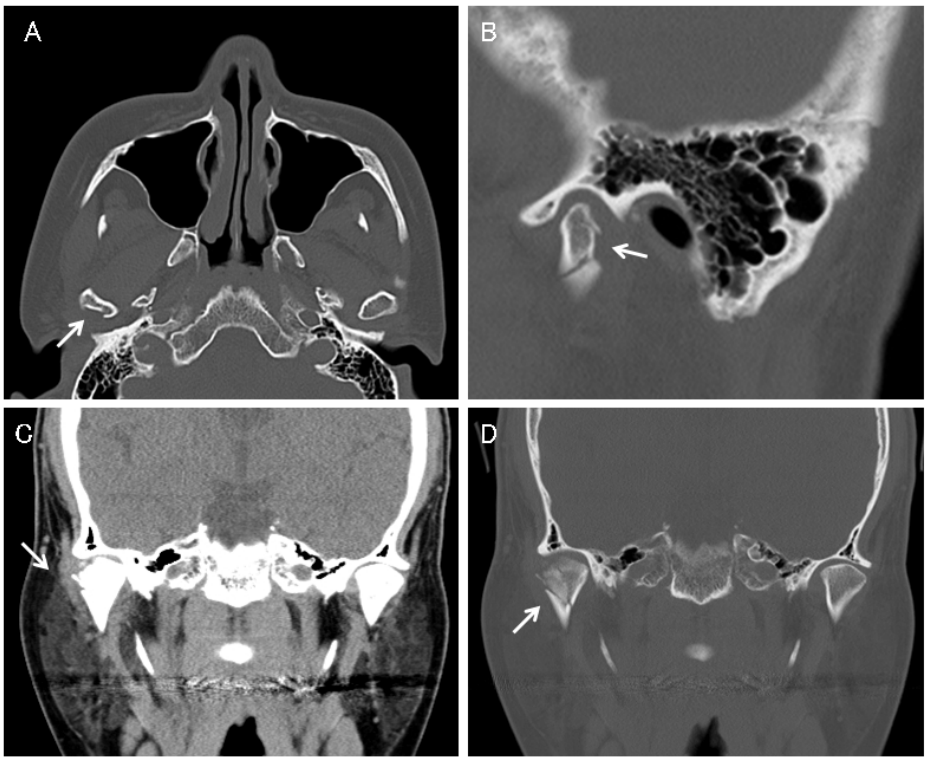

Fig. 1

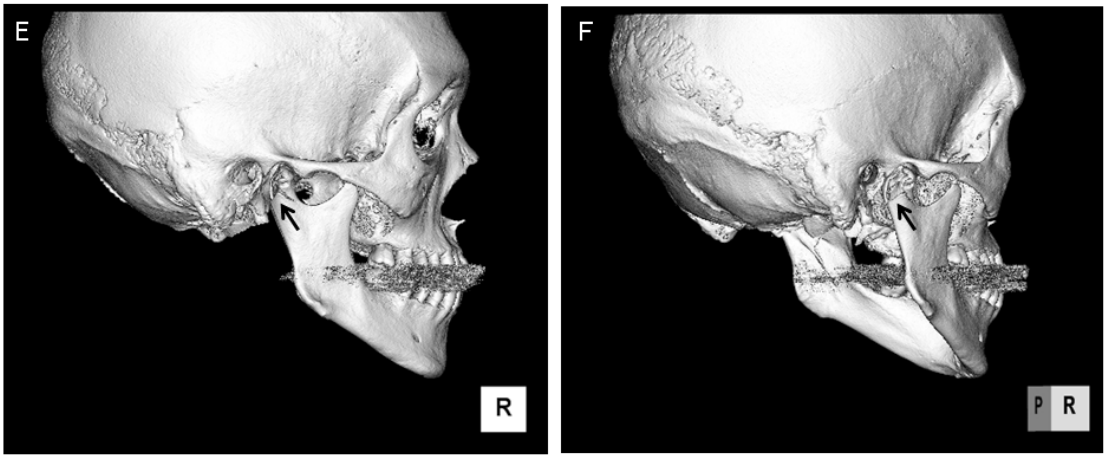

Fig. 2

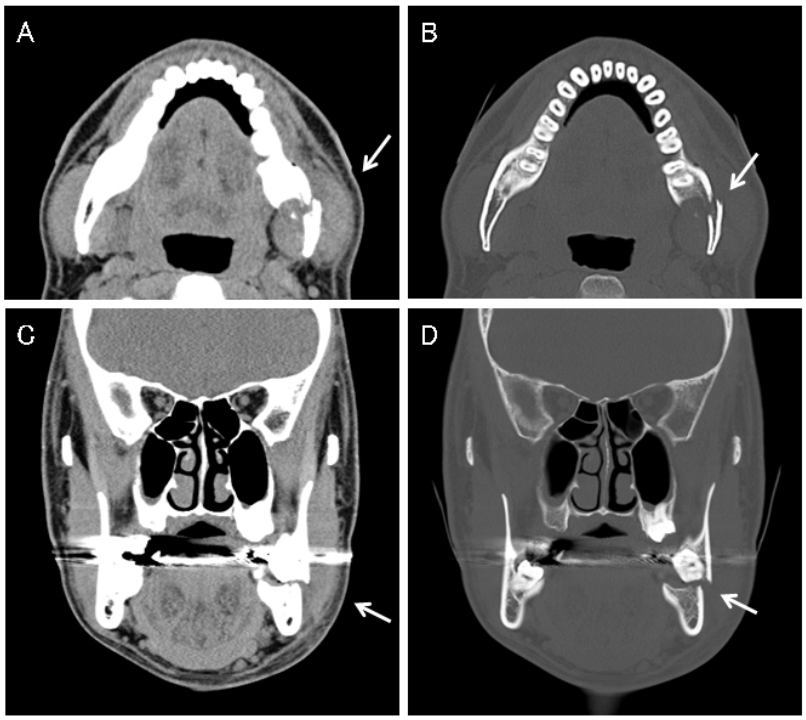

Fig. 2

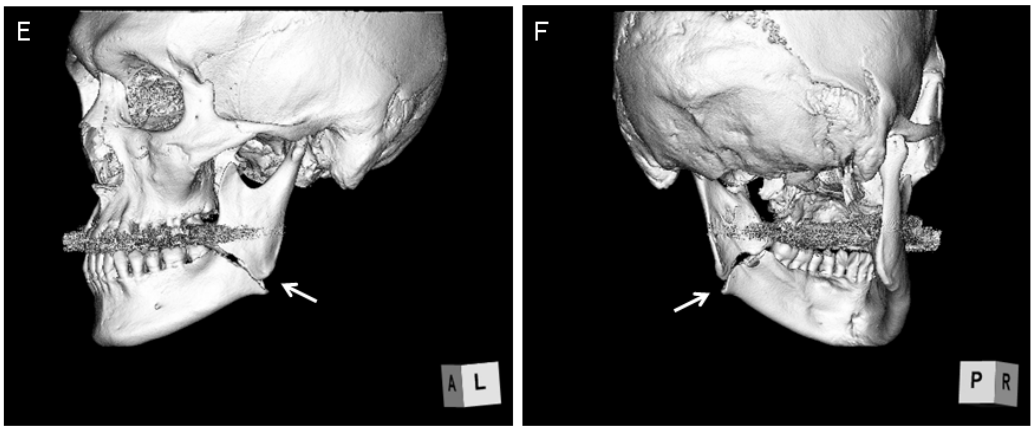

Table 1 Patient characteristics according to cause of mandibular fractures in 217 patients

	Cause			
	Falls	Violence	Total	
Variables	160 (73.7%)	57 (26.3%)	217 (100%)	p-value
Age (years)				0.000
＞ 30	98 (85.2%)	17 (14.8%)	115 (53.0%)	
≦ 30	62 (60.8%)	40 (39.2%)	102 (47.0%)	
Gender				0.000
male	98 (65.8%)	51 (34.2%)	149 (68.7%)	
female	62 (91.2%)	6 (8.8%)	68 (31.3%)	

Table 2 Characteristic multidetector CT findings of mandibular fractures resulting from falls and violence

	Cause			
	Falls	Violence	Total	
Variables	160 (73.7%)	57 (26.3%)	217 (100%)	p-value
Number of mandibular fractures				0.760
single	77 (74.8%)	26 (25.2%)	103 (47.5%)	
multiple	83 (72.8%)	31 (27.2%)	114 (52.5%)	
Location of mandibular fractures				
median	60 (78.9%)	16 (21.1%)	76 (35.0%)	0.258
paramedian	29 (55.8%)	23 (44.2%)	52 (24.0%)	0.001
angle	26 (46.4%)	30 (53.6%)	56 (25.8%)	0.000
condyle	122 (87.8%)	17 (12.2%)	139 (64.1%)	0.000

Table 3 Logistic multivariate regression analysis in characteristic CT findings of mandibular fractures resulting from falls and violence

Location of mandibular fractures	Odds ratio	95% CI	p-value
Median	0.831	0.357－1.934	0.668
Paramedian	0.339	0.140－0.822	0.017
Angle	0.313	0.118－0.829	0.019
Condyle	3.303	1.349－8.090	0.009

CI confidence interval