Keywords:
computed tomography, MDCT, maxillofacial trauma, fracture, elderly

Introduction
Maxillofacial fractures in elderly patients are less frequent than young patients and mostly related to age-related changes and systemic pathologic conditions (1–3). However, traumatic injuries in the elderly have been increasing in recent years; this is due to increased active life span with advances in medicine that result in a higher percentage of older people in the population (4, 5). Falls are a frequent cause of trauma, especially in the elderly, due to disability, morbidity and increased health care utilization (6–9). The maxillofacial bones support such functions as respiration, sense of smell, vision, speech, and eating (10). Therefore, maxillofacial fractures require accurate radiologic diagnosis and surgical management to prevent severe functional debilitation and cosmetic deformity. The fracture morphology of maxillofacial trauma is often complex, requiring the clinician to be familiar with imaging findings.

In recent years, multidetector-row computed tomography (MDCT) with multiplanar reformation (MPR) and three-dimensional (3D) imaging has become a standard part of the assessment of facial injury because of the exquisite sensitivity of this imaging technique for fracture (11, 12). MDCT is an effective tool for the detection of maxillofacial fracture location, degree of fragment dislocation, soft tissue edema, and hemorrhage (13–18). Furthermore, trauma encompasses not only ambulatory patients with suspected maxillofacial fractures but also patients with loss of consciousness. In the trauma setting, rapid access to imaging is important to the trauma team in making diagnoses and guiding management decisions. In the acute setting, MDCT is becoming the imaging modality of choice (19). This is one reason for its wide availability at

Abstract
The purpose of this study was to investigate the characteristics of maxillofacial fractures in elderly patients in comparison to young patients. A retrospective study was conducted of 376 patients with maxillofacial fractures who underwent 64 multidetector-row CT (MDCT) procedures. The study patients comprised 81 elderly patients (≥ 60 years) and 295 young patients (< 60 years). Age, sex, cause of injury and fracture location according to MDCT were analyzed using the χ² test with Fisher’s exact test. The proportion of male vs female of elderly patients was 55.6% vs 44.4% and that of young patients was 73.9% vs 26.1% (p = 0.002). The causes of injury in the elderly patients were falls, traffic accidents, assaults, and sports incidents (59.3%, 32.1%, 7.4%, and 1.2%, respectively (p < 0.001)). The percentages of cases with mandibular angle fractures, condylar fractures, and median fractures were 3.7% of elderly patients vs 22.4% of young patients (p < 0.001), 63.0% of elderly patients vs 44.4% of young patients (p = 0.004), and 16.0% of elderly patients vs 30.8% of young patients (p = 0.008), respectively. In conclusion, mandibular condylar fractures dominate maxillofacial fractures in the elderly compared with mandibular median and angle fractures.
most hospitals; another reason is its ability to acquire images rapidly. However, to our knowledge, maxillofacial fractures in the elderly, especially in comparison with young patients, as detected with MDCT have not been previously reported in the literature. The purpose of this study was to analyze the characteristics of maxillofacial fractures in elderly patients compared with young patients.

Materials and Methods

Patient Population

This retrospective study was approved by the ethics committee of our institution (No. EC 10-039). After obtaining written informed consent, 376 patients (263 men, 113 women; age 3–87 years, mean age 39.2 years) with maxillofacial fractures underwent 64-MDCT within 7 days after injury at our university hospital from April 2006 to May 2014 (Fig. 1). The study patients consisted of 81 elderly patients (45 men, 36 women; age 60–87 years, mean age 69.8 years) and 295 young patients (218 men, 77 women; age 3–59 years, mean age 30.8 years).

Image acquisition

CT imaging was performed with a 64-MDCT (Aquilion 64, Toshiba Medical Systems, Otawara, 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. The protocol consisted of axial acquisition (0.50 mm) with axial (3.0 mm), coronal (3.0 mm) and sagittal (3.0 mm) MPR and 3D images.

Image analysis

The MDCT images were independently evaluated by two oral and maxillofacial radiologists, and any discrepancies were resolved by consensus. The maxillofacial fracture locations were classified according to the distribution described by Lieger et al. (20) into eight types: mandibular median, paramedian, angle, condylar, Le Fort (I–III), isolated maxillary, isolated zygomatic arch, and zygomaticomaxillary complex type. The age, sex, cause of injury and fracture location with MDCT were analyzed.

Statistical analysis

The statistical analysis for the comparison between elderly (≥60 years) and young (<60 years) patients was performed using the χ² test with Fisher’s exact test. These analyses were performed with the statistical package IBM SPSS Statistics version 22 (IBM Japan, Tokyo, Japan). A p-value < 0.05 was considered statistically significant.

Results

Table 1 shows the comparison between the elderly and young study patients with maxillofacial fractures. The
The proportion of men vs women was 55.6% (45 cases) vs 44.4% (36 cases) among the 81 elderly patients and 73.9% (218 cases) vs 26.1% (77 cases) among the 295 young patients, respectively \((p = 0.002)\). Regarding cause of injury, the proportions of falls, traffic accidents, assaults, and sports incidents were 59.3% (48 cases), 32.1% (26 cases), 7.4% (6 cases), and 1.2% (1 cases) among the 81 elderly patients, respectively \((p < 0.001)\).

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\text{Table 1 Comparison between elderly and young patients with maxillofacial fractures} \\
\begin{array}{|c|c|c|c|}
\hline
\text{Parameter} & \text{Patients with maxillofacial fractures} & \text{Elderly (≥ 60 years)} & \text{Young (<60 years)} \\
\hline
\text{Number of patients} & 376 (100%) & 81 (21.5%) & 295 (78.5%) \\
\hline
\text{Age (years)} & 39.2 ± 20.6 & 69.8 ± 7.8 & 30.8 ± 13.9 \\
\hline
\text{Gender} & 0.002 & 45 (55.6%) & 218 (73.9%) \\
\hline
\text{Cause of injury} & 263 (69.9%) & 36 (44.4%) & 77 (26.1%) \\
\hline
\text{Fracture location with MDCT} & 113 (30.1%) & 168 (44.7%) & 120 (40.7%) \\
\hline
\text{Mandible} & 168 (44.7%) & 48 (59.3%) & 120 (40.7%) \\
\hline
\text{paramedian} & 111 (29.5%) & 26 (32.1%) & 85 (28.8%) \\
\hline
\text{angle} & 69 (18.4%) & 6 (7.4%) & 45 (15.3%) \\
\hline
\text{condylar} & 182 (48.4%) & 51 (63.0%) & 131 (44.4%) \\
\hline
\text{Midface} & 104 (27.7%) & 13 (16.0%) & 91 (30.8%) \\
\hline
\text{Le Fort I-III} & 61 (16.8%) & 12 (14.8%) & 51 (17.8%) \\
\hline
\text{isolated maxillary} & 69 (18.4%) & 3 (3.7%) & 66 (22.4%) \\
\hline
\text{isolated zygomatic arch} & 182 (48.4%) & 51 (63.0%) & 131 (44.4%) \\
\hline
\text{zygomaticomaxillary complex} & 104 (27.7%) & 13 (16.0%) & 91 (30.8%) \\
\hline
\end{array}
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SD, standard deviation.

MDCT, multidetector CT.

The percentages of cases with angle fractures, condylar fractures, and median fractures were 3.7% (3/81 cases) of elderly patients vs 22.4% (66/295 cases) of young patients \((p < 0.001)\), 63.0% (51/81 cases) of elderly patients vs 44.4% (131/295 cases) of young patients \((p = 0.004)\), and 16.0% (13/81 cases) of elderly patients vs 30.8% (91/295 cases) of young patients \((p = 0.008)\), respectively. Figures 2 and 3 show mandibular fractures and midface fractures, respec-
Maxillofacial fractures in the elderly occur less frequently than in younger people (1–3). The purpose of this study was to investigate the characteristics of maxillofacial fractures in the elderly, especially in comparison with young patients.

Goldschmidt et al. (1) showed that men sustained 56.1% of the craniomaxillofacial fractures in the elderly (60 years of age and older) while women sustained 43.9%. Fasola et al. (3) showed that the male to female ratio was 1.1:1 in patients above 60 years with maxillofacial fractures. On the other hand, Sawazaki et al. (21) indicated a male/female ratio of 3.05:1 and a mean age of 28.4 years among a total of 317 condylar fractures. In the present study, the proportions of men vs women were 55.6% vs 44.4% in the elderly group (≥ 60 years) and 73.9% vs 26.1% in the young group (<60 years), respectively. The incidence of maxillofacial fractures in women was observed to increase in the elderly in the present study. We consider that the age and sex distribution relatively.

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is closely related to the circumstances of injury, because the life span is different between men and women.

Velayutham et al. (5) showed that the most common cause of facial injuries among older people was falls, whereas among younger people it was interpersonal violence. Sasaki et al. (22) indicated that 31% of maxillofacial fractures were due to traffic accidents, 29% to accidental falls, 23% to violence and 14% to sports. The authors found that the percentage of cases with maxillofacial fractures resulting from falls was 59.3% in the elderly group vs 40.7% in the young group underwent MDCT at Nihon University School of Dentistry at Matsudo. Therefore, we consider that falls are the most common cause of maxillofacial fracture in the elderly.

Regarding midface fractures, Yamamoto et al. (23) showed that zygomaticomaxillary complex fractures were most frequently involved in falls. Salonen et al. (6, 7) reported that the zygomaticomaxillary complex was the most common fracture in facial trauma resulting from falling accidents. The present study indicated that the zygomaticomaxillary

Fig. 3 A 74-year-old man with midface fractures resulting from falls. Axial soft-tissue algorithm CT (a) demonstrates a zygomatic arch fracture with soft tissue edema (arrow). Axial bone algorithm CT (b) demonstrates a zygomatic arch fracture (arrow). Axial soft-tissue algorithm CT (c) demonstrates maxillary fractures with soft tissue edema (arrow). Axial bone algorithm CT (d) demonstrates maxillary fractures (arrows). Three-dimensional imaging (e, f) shows zygomaticomaxillary complex fractures (arrowheads) to better advantage.
complex fracture was most frequent among midfacial fractures in the elderly. Injuries to the zygomatic bone or arch usually result from a forceful blow to the cheek or side of the face. We believe that trauma force resulting from falls applied in the facial region causes direct fractures of the zygomaticomaxillary complex.

The present study found that mandibular condylar fracture was most frequent type of maxillofacial fractures in the elderly; the percentage of cases with mandibular condylar fractures was 63.0% in the elderly group vs 44.4% in the young group. Salonen et al.(6, 7) reported that mandibular condylar fractures were the most frequently occurring type of maxillofacial fractures in falling accidents. Sawazaki et al.(21) reported that mandibular median fractures were significantly associated with both unilateral and bilateral fractures of the mandibular condyle. We believe that trauma force from falling applied to the mandibular median, paramedian and angle regions causes indirect fractures of the mandibular condyle with or without fractures in the mandibular median, paramedian or angle region. Furthermore, among the elderly population, the present study indicated that maxillofacial fractures occurred more frequently in women, and that the percentage of cases with mandibular median fractures and mandibular angle fractures was 16.0% in the elderly group vs 30.8% in the young group and 3.7% in the elderly group vs 22.4% in the young group, respectively. The mandibular condylar bone in elderly women may be weak because of low bone density, physical status, and systemic disease such as osteoporosis. Therefore, we believe that the incidence of mandibular condylar fractures is the highest among the types of maxillofacial fractures in the elderly.

The limitation of the present study was that it did not analyze the relationship between medical conditions and maxillofacial fractures in the elderly. Velayutham et al.(5) reported coexisting medical conditions and polypharmacy in elderly patients with maxillofacial trauma, and observed that cardiovascular disease was the most frequent, followed by musculoskeletal disease including osteoporosis. Therefore, we believe that the relationship between medical conditions and maxillofacial fractures in the elderly is an important topic for future studies.

Conclusions
The present study showed that the percentage of cases with mandibular angle fractures, condylar fractures, and median fractures was 3.7% in the elderly vs 22.4% in young patients, 63.0% in the elderly vs 44.4% in young patients, and 16.0% in the elderly vs 30.8% in young patients, respectively. Mandibular condylar fractures dominate maxillofacial fractures in the elderly compared with mandibular median and angle fractures.

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Conflict of interest: All authors declare that they have no conflict of interest.

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