



Maxillofacial Fractures Caused by Falls

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Abstract

Background: Fall-related injuries are sometimes caused by high-energy trauma and show complex clinical conditions that are occasionally difficult to treat. The objective of this study was to clarify the roles of oral and maxillofacial surgeons in fall-related injuries.

Methods: The medical records of patients who were admitted to the Emergency Room of Kyushu University Hospital due to falls from January 2011 to December 2015 were retrospectively reviewed. We evaluated the distribution of age, gender, fall height, mortality, cause of injury, fracture site, duration from injury to treatment, and treatment of maxillofacial fractures.

Results: There were 124 patients (84 males (67.7%) and 40 females (32.3%)) who were admitted to our hospital (average age 36.8 years). The average fall height was 10.1 m, and the mortality was 37.9%. The causes of trauma were unintentional fall in 58 patients (46.8%) and jumping in 66 patients (53.2%). Maxillofacial fractures were found in 37 cases (29.8%). Maxillofacial fractures were more common in the jumping group than in the unintentional fall group. The cases with maxillofacial fractures had more fractures of the pelvis and cranial bone, especially the frontal bone, and fewer fractures of the spine and ribs. For the treatment of maxillofacial fractures, conservative treatment (11 cases) was preferred over open surgery (5 cases). The treatment of 21 patients was not indicated because of an impossibility of survival.

Conclusion: For the treatment of maxillofacial fractures caused by falls, cooperation with specialists from other fields is important to determine the indication and priority of treatment.

Keywords: Maxillofacial fracture; High energy; Suicide

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Background

Fall-related injuries are sometimes caused by high-energy trauma and show complex clinical conditions [1,2]. Maxillofacial fractures caused by falls are often associated with severe deformities and are difficult to treat. In addition, victims of falls sometimes die of brain, chest, or abdominal injuries [3-5], so maxillofacial trauma may not be treated initially.

Therefore, in the case of fall-related trauma, the primary concern is whether the patient survives [6]. Consequently, there have been few detailed reports on the concurrent treatment of maxillofacial fractures.

In the Emergency Room of Kyushu University Hospital, trauma patients are treated using a multidisciplinary approach with not only emergency physicians but also cardiovascular specialists, orthopedic surgeons, plastic surgeons, and oral and maxillofacial surgeons.

The maxillofacial region is important not only aesthetically but also because of functional aspects, such as feeding, swallowing and speech. Prompt treatment after life-saving is therefore important to reduce residual complications.

Here, we report an investigation of maxillofacial fractures caused by falls and discuss how oral and maxillofacial surgeons intervene during fall-related trauma treatment.

Methods

The medical records of patients who were admitted to the Emergency Room of Kyushu University Hospital due to falls from January 2011 to December 2015 were retrospectively reviewed. Three patients who had hit obstacles during their fall were excluded from the analysis. For the remaining 124 patients we evaluated the distribution of age, gender, fall height, mortality, cause of

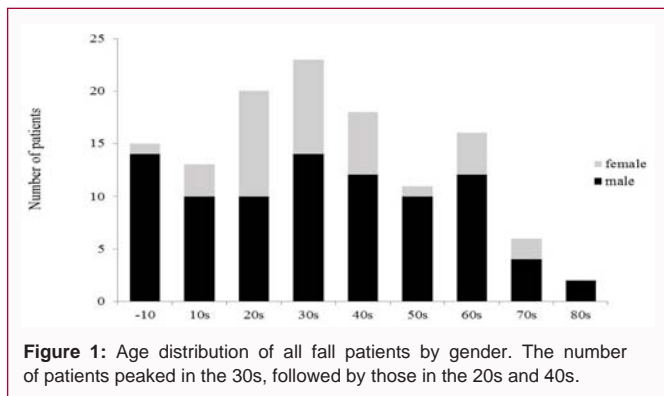


Figure 1: Age distribution of all fall patients by gender. The number of patients peaked in the 30s, followed by those in the 20s and 40s.

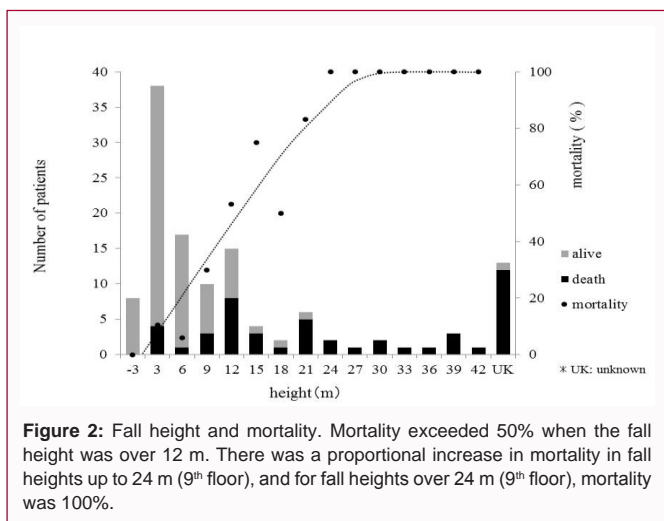


Figure 2: Fall height and mortality. Mortality exceeded 50% when the fall height was over 12 m. There was a proportional increase in mortality in fall heights up to 24 m (9th floor), and for fall heights over 24 m (9th floor), mortality was 100%.

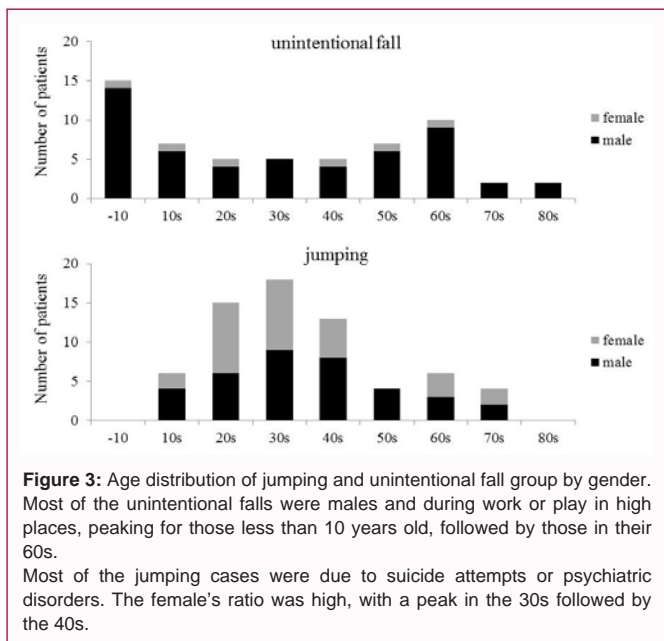


Figure 3: Age distribution of jumping and unintentional fall group by gender. Most of the unintentional falls were males and during work or play in high places, peaking for those less than 10 years old, followed by those in their 60s. Most of the jumping cases were due to suicide attempts or psychiatric disorders. The female's ratio was high, with a peak in the 30s followed by the 40s.

injury, fracture site, period from injury to treatment, and treatment of maxillofacial fractures.

Results

Age and gender distribution

There were 124 patients, 84 males (67.7%) and 40 females (32.3%), with a ratio of 1:0.48. The patients had an average age of 36.7 years, in

which the youngest patient was a 3.5-month-old baby, and the oldest was an 87-year-old man (Figure 1).

Fall height and mortality

The overall average fall height was 10.5 m, and mortality was 37.9%. To assess the relationship between mortality and fall height, one floor was estimated to be 3 m. Mortality exceeded 50% when the fall height was over 12 m (Figure 2). There was a proportional increase in mortality in fall heights up to 24 m (9th floor), and over 24 m (9th floor) mortality was 100%.

Cause of injury

The causes of trauma were unintentional fall in 58 patients (46.8%) and jumping in 66 patients (53.2%) (Figure 3). Most of the unintentional falls were during work or play in high places, while most of the jumping cases were due to suicide attempts or psychiatric disorders. The average fall height was 5.6 m, and mortality was 12.1% in unintentional falls. For jumping, the average fall height was 14.8 m and the mortality was 59.4% (Figure 4). Unintentional falls (53.7%) outnumbered jumping (46.3%) in male patients, while jumping was the main cause in females (81.1%). The peak age of unintentional falls was bimodal, peaking at under 10 years old, followed by those in their 60s (Figure 3). In the jumping group, the peak age was in the 30s, and the female rate was relatively high in the 20s and 40s (Figure 3).

Fracture site distribution

Maxillofacial fractures were found in 37 cases (29.8%) in overall falls comprising 22 mandible fractures, 19 maxilla fractures, 19 zygomatic fractures, 18 orbital wall fractures and 9 nasal bone fractures. Fourteen patients were not examined because they were pronounced dead on arrival (Figure 5). There was an increase in maxillofacial fractures as the fall height increased up to 12 m, but for fall heights over 12 m, there were many cases where the fracture site was not examined because of death shortly after arrival, so we could not perform statistical comparisons. Maxillofacial fractures were found in 24 jumping cases (36.4%) comprising 19 mandible fractures, 13 maxilla fractures, 14 zygomatic fractures, 12 orbital wall fractures and 7 nasal bone fractures (Figure 6). Maxillofacial fractures were found in 13 cases (22.4%) of unintentional fall comprising 3 mandible fractures, 6 maxilla fractures, 5 zygomatic fractures, 6 orbital wall fractures and 2 nasal bone fractures (Figure 6). There was no correlation between fall height and the incidence of maxillofacial fractures (Figures 5,6). Patients with maxillofacial

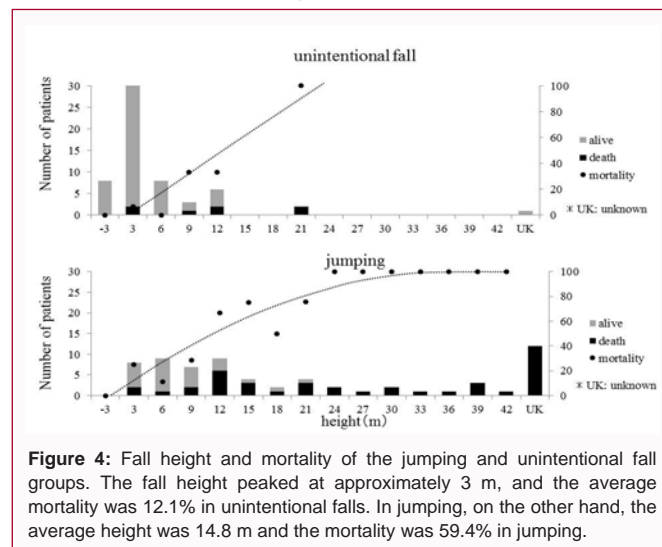
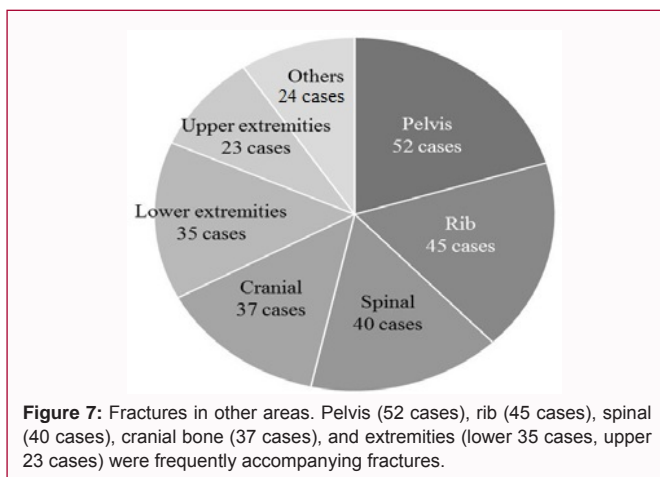
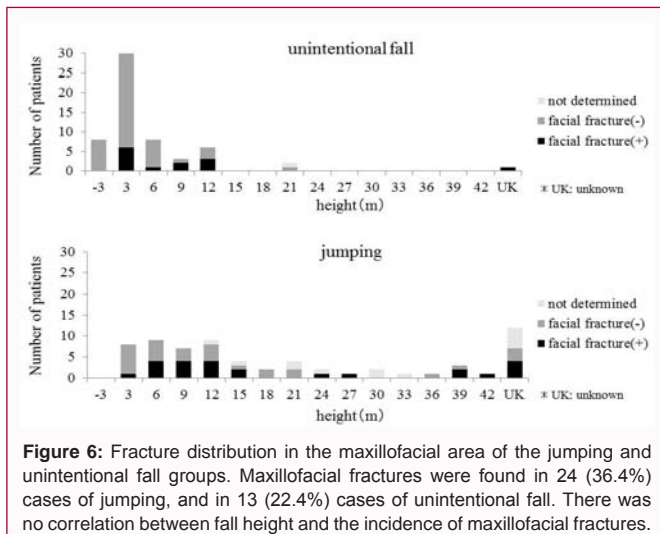
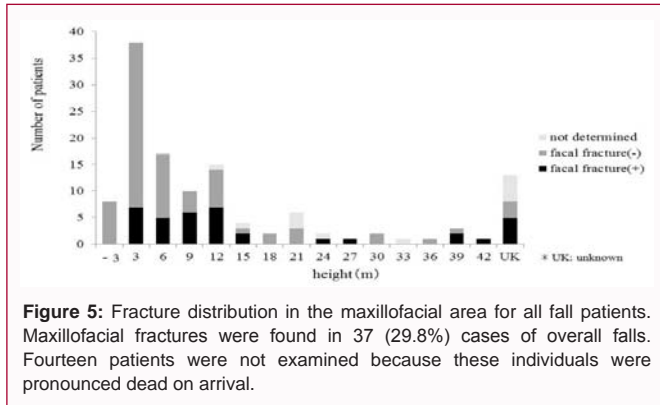


Figure 4: Fall height and mortality of the jumping and unintentional fall groups. The fall height peaked at approximately 3 m, and the average mortality was 12.1% in unintentional falls. In jumping, on the other hand, the average height was 14.8 m and the mortality was 59.4% in jumping.



fractures had a much higher rate of mortality (56.8%) than those without maxillofacial fractures (31.0%).

Regarding fractures that accompanied maxillofacial fractures, there was only one case with maxillofacial fractures without fractures in other regions. Pelvis (52 cases), rib (45 cases), spinal (40 cases), cranial bone (37 cases), and extremities (upper 23 cases, lower 35 cases) were frequently accompanying fractures (Figure 7). Fractures of the ribs, spine, and upper extremities predominated in cases without maxillofacial fractures. Occipital bone fractures were also more common. On the other hand, fractures of the pelvis and cranial bone, especially the frontal bone, were more frequent, and those of

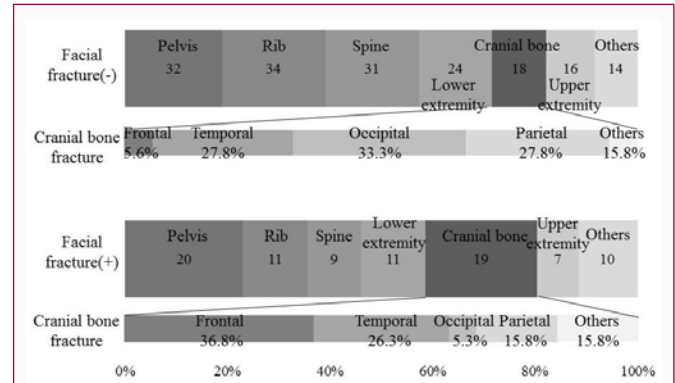
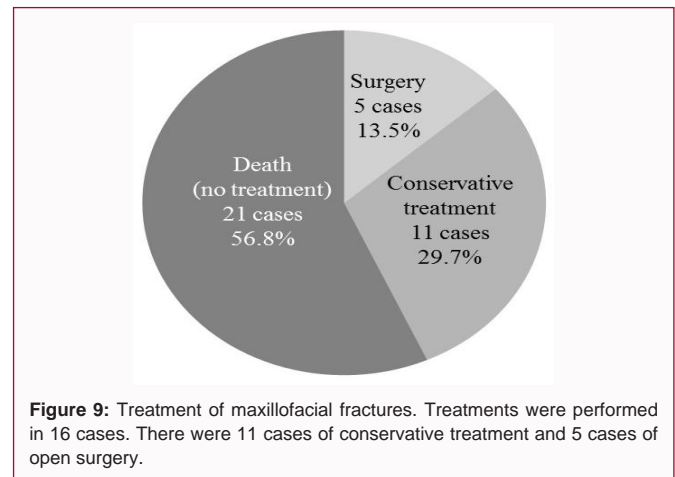


Figure 8: Fractures in other areas for the 'with maxillofacial fracture' and 'without maxillofacial fracture' groups. Fractures of the ribs, spine, and upper extremities predominated in cases without maxillofacial fractures. On the other hand, fractures of the pelvis and cranial bone, especially the frontal bone, were more frequent, and those of the ribs and spine were less frequent in cases with maxillofacial fractures.



the ribs and spine were less frequent in the cases with maxillofacial fractures (Figure 8).

Period from injury to treatment

As for treatment of maxillofacial fractures, treatments were given in 16 cases. Conservative treatment was used in 11 cases and open surgery in 5 cases (Figure 9). All patients who could be treated for maxillofacial fractures had fallen from a height of less than 12 m (Figure 10). The treatment for 21 patients was not indicated because of an impossibility of survival. Conservative treatments, such as Maxillo Mandibular Fixation (MMF) or limitation of mouth opening, were performed in 6 cases, concurrently with other aspects of trauma treatment. Surgical treatments, such as Open Reduction and Internal Fixation (ORIF), were performed in 4 cases. Time from injury to treatment showed a distribution from on the day to 1 year because treatment for cerebrospinal fluid rhinorrhea, brain hemorrhage or edema, lung contusion, hemorrhagic shock, fracture of the pelvis or femur were performed in the acute stage. Oral surgeons only performed manipulative reduction, extraction of loose teeth, suture laceration to achieve hemostasis in the acute stage, and treatment of cosmetic disturbance or malocclusion after confirmation of the stability of general conditions.

Discussion

Falls are the cause of between 1 and 32.5% of all maxillofacial

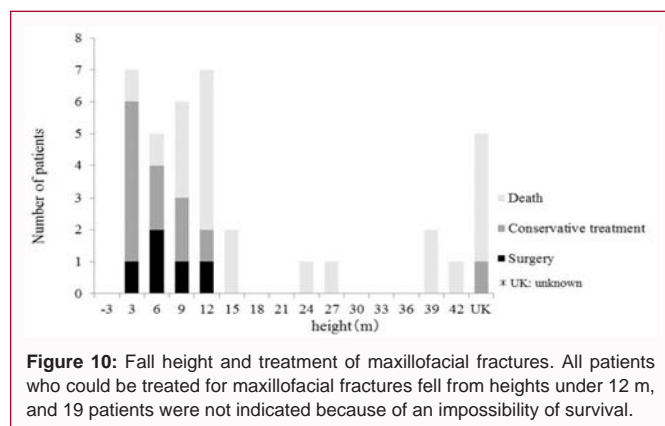


Figure 10: Fall height and treatment of maxillofacial fractures. All patients who could be treated for maxillofacial fractures fell from heights under 12 m, and 19 patients were not indicated because of an impossibility of survival.

fractures [7-9]. In this study, maxillofacial fractures were found in 37 cases (29.8%), similar to these studies. Men are more likely to fall for a variety of work-related and other reasons. The male-to-female ratio is different from that in previous studies [1,2]. This difference is attributed to probable social, economic, conventional, cultural and regional differences. Trauma caused by falls occurs at work [1,2], and most patients are concentrated in the 10s to 40s [10]. In this study, there were a relatively high number of female cases, especially suicide attempts in the 20s to 40s, despite fall accident cases being predominantly males in other countries. Today, suicides are increasing, so young female patients who have maxillofacial fractures may increase.

Historically, the height at which 50% mortality occurs for injuries sustained from free falls has been the 4th floor (48 ft, 14.6 m), and falls from higher than 60 ft (18.3 m) are almost always lethal [3]. In our study, mortality exceeded 50% when the fall height was over 12 m (Figure 2), which was lower than that in the previous study. Other components that play a critical role impacting injury severity are the age of the patients, landing surface, fall orientation, elasticity and viscosity [4,5], but these factors could not be researched in our retrospective study. We propose that the mortality exceeded 50% at a lower height in our study because half of our cohort was suicide victims who have little protection for their faces and either fall headfirst or jump from a building to a concrete floor. The jumping group patients had a predominantly higher mortality rate with more maxillofacial fractures and fractures of the cranial bone, especially frontal bone, and fewer fractures of the upper extremities than the unintentional fall group. These ideas support our finding of a lower height for 50% mortality. Cases with maxillofacial fractures have a higher mortality rate, suggesting that brain injury close to the maxillofacial area is more likely to be fatal. Despite advances in trauma care, the overall death rate remains unchanged [6]. There was a proportional increase in mortality in fall heights up to 24 m (9th floor), and for fall heights over 24 m (9th floor), mortality was 100% which suggests that falls from over 24 m cause fatal injury to the brain, chest and abdomen, irrespective of fall condition.

Kyong et al. reported that the most common causes of maxillofacial fractures were falls, especially for condyle fractures [10], but in our study, the cases of maxillofacial fracture were 22 mandible (11 body, 2 angle, 2 ramus, 9 condyle), 19 maxilla, 19 zygoma, 18 orbital wall and 9 nasal bone cases. The face has bones clustered in a relatively small area, and some suggest that the facial skeleton cushions the brain [11], but in falls from over 24 m, there is no cushioning effect, and the brain injury is fatal.

Pelvis (52 cases), rib (45 cases), spinal (40 cases), cranial bone (37 cases), and extremities (upper 23 cases, lower 35 cases) were frequently accompanying fractures. This is different from the results of other studies where the incidence of spinal fractures remains high with high-level falls and commonly occurs at the thoracolumbar junction [12,13]. The cases with maxillofacial fractures had more fractures of the pelvis and cranial bone, especially frontal bone, and fewer fractures of the spine and ribs. Therefore, those with maxillofacial fractures may often have collided from a frontal or lateral direction caused by jumping off for suicide purposes.

The Emergency Room of Kyushu University Hospital is a tertiary medical center and many patients with severe multiple injuries are admitted to our hospital. Fourteen patients were not examined because they were pronounced dead on arrival and 19 patients were not treated because of early death upon arrival. Oral and maxillofacial surgeons need to treat maxillofacial fractures within the context of the patient's general condition. Even patients with treatment indications tend to be treated concurrently or secondary to other sites of fractures or vital organs. For patients with non displaced or minimally displaced fractures, conservative treatments were performed concurrently with other aspects of trauma treatment. During the secondary healing process after bone fracture, a hard callus starts forming approximately 3 weeks after injury [14], so it is optimal to reduce fractures within 2 weeks after injury for adequate reduction without intentional osteotomy. However, we should treat the other vital organs in priority to maxillofacial fractures. We only performed suture of lacerations, extraction of loose teeth, manipulative reduction in the acute phase, and treatment of cosmetic disturbance or malocclusion after confirmation of the stability of the patient's general condition. The face is aesthetically crucial and controls important functions, such as mastication, pronunciation, and breathing. Injury to the face can cause functional and cosmetic disturbances, which may lead to a subsequent suicide attempt. Therefore, oral and maxillofacial surgeons who first encounter facial injury by falls should effectively manage emergencies and achieve adequate aesthetic and functional restoration to minimize post fracture sequelae.

The roles of the oral and maxillofacial surgeon in a tertiary emergency medical facility include the management of intraoral bleeding, handling injured teeth, manipulative reduction and cooperation with specialists from other fields in initial treatment. Then, maxillofacial fractures should be treated promptly to minimize post fracture sequelae.

Conclusion

For the treatment of maxillofacial fractures caused by falls, cooperation with specialists from other fields is important to decide the indication and priority of treatment.

Authors' Contributions

II, TY, and KI contributed to the conception, design, and acquisition of data of the study. TS and YM contributed to the coordination of the study. TA, KM, and KK made the literature research for the study. All authors read and approved the final manuscript and take responsibility for the integrity and accuracy of any part of the study.

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