

Review of Van earthquakes form an orthopaedic perspective: a multicentre retrospective study

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Abstract

Purpose This is a descriptive analysis, of victims of Turkey's October 23, 2011 and November 21, 2011 Van earthquakes. The goal of this study is investigated the injury profile of the both earthquakes in relation to musculoskeletal trauma.

Methods We retrospectively reviewed medical records of 3,965 patients admitted to in seven hospitals. A large share of these injuries were soft tissue injuries, followed by fractures, crush injuries, crush syndromes, nerve injuries, vascular injuries, compartment syndrome and joint dislocations. A total

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of 73 crush injuries were diagnosed and 31 of them were developed compartment syndrome.

Results The patients with closed undisplaced fractures were treated with casting braces. For closed unstable fractures with good skin and soft-tissue conditions, open reduction and internal fixation was performed. All patients with open fracture had an external fixator applied after adequate debridement. Thirty one of 40 patients with compartment syndrome were treated by fasciotomy. For twelve of them, amputation was necessary. The most common procedure performed was debridement, followed by open reduction and internal fixation and closed reduction-casting, respectively.

Conclusions The results of this study may provide the basis for future development of strategy to optimise attempts at rescue and plan treatment of survivors with musculoskeletal injuries after earthquakes.

Introduction

Earthquakes have killed and injured millions of people in the past. Adequate and well-timed management to reduce mortality and morbidity of the injured in earthquakes is of concern to rescuers and medical-care professionals [1, 2]. In earthquakes, treatment is often delayed by the destruction of roads, inadequate equipment and damage to hospitals [3]. Whilst surgical and anaesthetic care is influenced by infrastructural

constraints, the type of surgical procedures, availability of medication and equipment, and the experience of personnel [4, 5]. The earthquake-related injuries are often caused by falling objects or chronic tissue compression. The role of orthopaedic surgeons is important in earthquakes [5].

On Sunday, 23 October 2011 at 13:41 local time, an earthquake measuring 7.2 on the Richter scale struck the densely populated region of eastern Turkey near the city of Van. Utilities such as electricity, water, gas and telecommunication were interrupted. During the very intense aftershock activity of the Van-centre earthquake, another earthquake occurred at 10 km south of Van, near Edremit province on Wednesday, 09 November 2011 at 21:23 local time. The magnitude of this earthquake was calculated as 5.7 on the Richter scale. According to Disasters and Emergency Situations Directorate (AFAD) of Turkey on 21 November, 644 people were killed in the two earthquakes, in total.

This is a descriptive analysis of the victims of Turkey's October 23, 2011 and November 9, 2011 Van earthquakes. The goal of this study is to investigate the injury profile of both earthquakes in relation to musculoskeletal trauma.

Materials and methods

The local institutional ethical review board approved the study. This multicentre study retrospectively investigated the clinical records of patients admitted to the *Van Research and Education Hospital (Van city)*, *Van Ipekyolu State Hospital (Van city)*, *Bitlis State Hospital (Bitlis city)*, *Mus State Hospital (Mus city)*, *Dicle University Medical School Hospital (Diyarbakir city)*, *Harran University Medical School Hospital (Sanliurfa city)* and *Gaziantep University Medical School Hospital (Gaziantep city)* with earthquake-related musculoskeletal injuries during the seven days that followed the 23 October and 9 November 2011 Van earthquakes.

Five thousand one hundred and seventy three patients with musculoskeletal trauma were treated in the hospitals, 3,965 of them had adequate records for inclusion in our study. We analysed 1,471 patients after the 23 October Van earthquakes and 2,494 patients after the 9 November 2011 incident. Patients were entered in this study according to the following criteria: [1] the aetiology of the injury was associated with the 23 October and 9 November 2011 Van earthquakes; [2] musculoskeletal injuries (soft tissue injury, fracture, dislocation, nerve injury, vascular injury, crush injury, crush syndrome and compartment syndrome) were evaluated by the emergency department. Patients were excluded from the study according to the following criteria: [1] patients who jumped or accidentally fell from heights due to the earthquake; [2] patients who were injured by earthquake-related motor vehicle injury, burn injuries or

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other aetiologies; and [3] patients who received treatment for to non-musculoskeletal injuries.

We conducted an injury profile of all patients with musculoskeletal trauma, and recorded hospital distribution of the patients, admission time of the patients, age and gender, profile of injury, infections, and treatments. The patients were classified according to their primary injuries.

This study was approved by the Ethical Committee of the Yuzuncu Yil University Medical School Hospital of Van city. No informed consent was necessary as this study used existing data.

Statistical analysis

The patients' age, sex and the cause of injury for the earthquake victims were recorded. The numbers of patients with soft tissue injuries, fractures, crush injury, crush syndrome, and compartment syndrome were enumerated. The continuous variables were expressed as means±standard deviation, and the categorical variables were expressed as numbers and percentages.

Results

Hospital distribution of the patients

One thousand six hundred and thirty nine earthquake victims admitted to Van Research and Education Hospital, 2001 earthquake victims admitted to Van Ipekyolu State Hospital, 237 earthquake victims admitted to Bitlis State Hospital, 30 earthquake victims admitted to Mus State Hospital, 55 earthquake victims admitted to Dicle University Medical School Hospital, two earthquake victims admitted to Sutcu Imam University Medical School Hospital and one earthquake victim admitted to Gaziantep University Medical School Hospital formed the hospital distribution of the patients. Two thousand seven hundred and fifty nine patients (69.6 %) were admitted to hospital over the first three days after the Van earthquakes (Fig. 1).

Admission time of the patients and follow up

The average length of hospital stay of the earthquake victims after admission to hospitals was 4.1 ± 2.8 days for all of the patients, 3.1 ± 2.7 for those with soft tissue injury, 5.2 ± 2.6 for those with fractures.

The mean follow up period in the hospital was 13 days (Range: 2–24 days). Definitive operations were performed after 52.3 hours on average (range: 1–157 hours) after admission.

Age and gender distribution

Two thousand four hundred and seventy eight patients (62.5 %) were male and 1,487 (37.5 %) were female. Patients between 20 and 30 years of age accounted for the majority (1,063, 26.8 %) of the patients, followed by those between 30 and 40 years of age (722, 18.2 %). The mean age was 23.5 (range 0–94). The age distribution of victims is shown in Fig. 2.

Profile of Injuries

A large share of these injuries were soft tissue injuries (3,292 victims, 83.0 %), followed by fractures (442 victims, 11.1 %), crush injuries (72 victims, 1.8 %), crush syndromes (41 victims, 1.0 %), nerve injuries (34 victims, 0.9 %), vascular injuries (26 victims, 0.7 %), compartment syndrome (40 victims, 1.0 %) and joint dislocations (18 victims, 0.5 %), respectively (Fig. 3). A total of 73 crush injuries were diagnosed and 31 of them developed compartment syndrome.

Soft tissue injury and fracture were the most common types of injuries. The soft tissue injuries were mostly caused by contusion and lacerations, which accounted for more than 70 % of the soft tissue injuries. Twenty four patients had major soft tissue loss.

Fractures were mostly frequently found in the lower limbs (46.4 %), including tibial-fibular fractures in 100 cases and femoral fractures in 36 cases, followed by upper limb fractures (31.2 %), including radius-ulna fractures in 70 cases and humeral fractures in 23 cases, followed by spine fractures (8.6 %). Thirty seven patients had open fractures, 56 multiple fractures and 19 comminuted fractures. Table 1 shows the distribution of fractures based on anatomical site.

The most common peripheral nerve injury was to the sciatic nerve (12 cases). The sciatic nerve injuries were associated with lower limb fractures or dislocations. Eight patients had spinal injuries, which were all associated with vertebral fractures. Radial nerve injury was seen in four cases. All of the radial nerve injuries were associated with fractures. Other peripheral nerve injuries (axillary, ulnar, femoral, tibial and peroneal) were seen in 11 cases.

Treatment

After admission, all of the patients were uniformly given injections of tetanus immunoglobulin and routine systemic physical examination was done. Patients with closed fractures who underwent operative treatment received a single preoperative prophylactic dose of intravenous cefazolin 2 g. All patients with open fractures were irrigated with sterile saline to remove any gross superficial contaminants and



Fig. 1 The earthquake victims were admitted to in seven hospitals. Van Research and Education Hospital (Van city), Van Ipekyolu State Hospital (Van city), Bitlis State Hospital (Bitlis city), Mus State

Hospital (Mus city), Dicle University Medical School Hospital (Diyarbakir city), Harran University Medical School Hospital (Sanliurfa city) and Gaziantep University Medical School Hospital (Gaziantep city)

stabilised with plaster splints. Intravenous antibiotics were started. The antibiotic regimen consisted of cefazolin (1 g every eight hours); gentamicin and metronidazole were added for severe soil contamination. Wounds were fully explored and all devitalised tissues excised. The wounds were irrigated with pulse lavage. Antibiotics were continued for three days after surgery. Dressings were applied after debridement.

The treatment of earthquake survivors with musculoskeletal trauma included medical treatment, debridement, fasciotomy, closed reduction, open reduction and amputation. The operations were performed under general anaesthesia in all patients. The method of fracture fixation was divided into internal and external fixation. The external fixation approach also included casting braces. The presence of multiple fractures and comminution of fractures were identified.

The patients with closed undisplaced fractures had a casting brace applied. For closed unstable fractures with good skin and soft-tissue condition, open reduction and internal fixation was performed. All patients with open fractures had an external fixator applied after adequate debridement. Thirty one of 40 patients with compartment syndrome were treated by fasciotomy. Twelve required amputation. The most common procedure performed was debridement ($n=166$), followed by open reduction and internal fixation ($n=117$) and closed reduction-casting ($n=91$) respectively. Table 2 shows the number of procedures performed for patients.

Discussion

A major earthquake frequently causes numerous victims with a wide variety injuries [6–9]. Most orthopaedic injuries during earthquakes involve the extremities [6, 7]. The injuries typically seen in earthquakes are often caused by falling masonry etc. leading to chronic tissue compression.

In our study, 55.6 % of victims were between 0 and 30 years. This differs greatly from the findings of other studies on the victims of other earthquakes [8, 9]. Probably, young age of earthquake survivors is associated to some factors, such as the high percentage of young population in Van, and the high intensity of the disaster leaving elderly unable to escape from the scene immediately and thus dying before rescue.

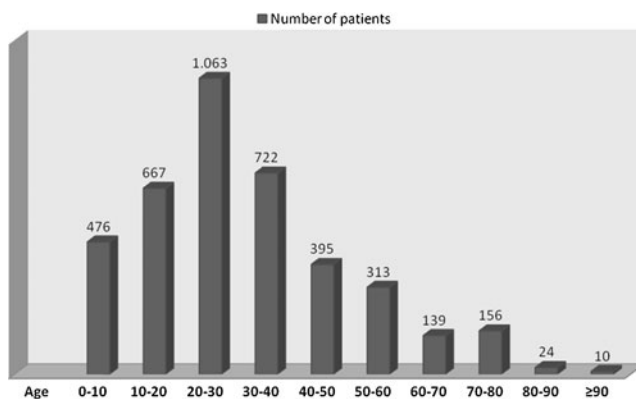


Fig. 2 Age distribution of patients admitted to the hospitals

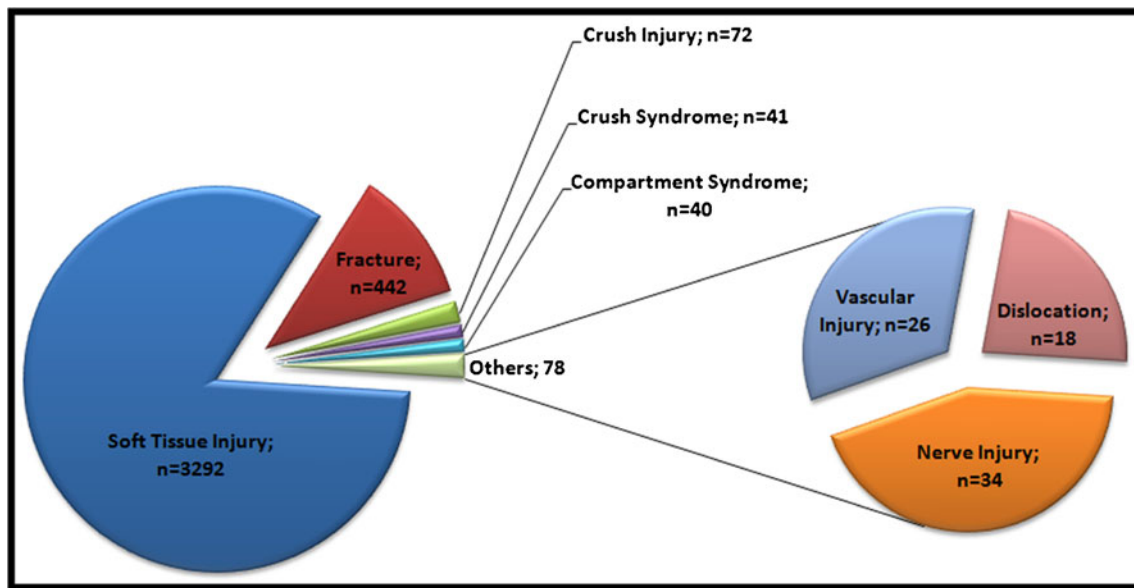


Fig. 3 Profile of musculoskeletal injuries in the earthquake of Van, Turkey

Mulvey et al. [6] reported that the most common types of injury associated with the 2005 Kashmir earthquake were soft tissue injuries and fractures. In our study also the most common types of injury were soft tissue injury and fracture. The 23 October Van earthquake occurred in the afternoon and the 9 November Van earthquake occurred in the early evening. Most earthquake victims were injured while escaping falling debris. When the earthquake occurs in the early morning and most victims are asleep, proximal bones are more commonly involved [10]. The Van earthquakes occurred in the afternoon and evening, so distal bones were commonly involved. The number of lower limb fractures was greater than upper limb extremity fractures as seen in 2009 Western Sumatra earthquake [11]. Limb extremity

fractures were also seen most commonly in our study. To reduce severe injuries in areas at high risk of earthquake, self-rescue education programs should be performed.

In the early period following a catastrophe, the most urgently needed orthopaedic protocols are external fixation, amputation, and debridement; and often there is no facility or equipment to perform more complex procedures [12]. Amputation is a frequently performed procedure during earthquakes and mass casualties related to industrial accidents and military conflicts where large civilian populations are subjected to severe musculoskeletal trauma [13]. The decision to perform an amputation is always difficult [14–16]. We observed in our study; the most frequently performed operation was debridement (33.1 %). Amputations were required in 12 patients. A post-amputation rehabilitation program is often considered to be more important than the amputation (the surgical act) itself and its cornerstone is the fitting of a prosthetic device [17]. In 2005

Table 1 Distribution of fractures based on anatomical site

Fracture location	Frequency	Percent (%)
Upper extremity fracture	138	31.2
Scapula and clavicle	22	5.0
Humerus	23	5.2
Radius and ulna	70	15.8
Carpus, metacarpus and phalangeal	23	5.2
Pelvic fracture	54	12.2
Acetabulum fracture	7	1.6
Lower extremity fracture	205	46.4
Femur	36	8.2
Patella	5	1.1
Tibia and fibula	100	22.6
Tarsal, metatarsal and phalangeal	64	14.5
Vertebra fracture	38	8.6
Total	442	100

Table 2 The table shows the number of procedures performed for patients

Treatment types	Number of patients	Percent
Debridement	166	33.1
Closed reduction and casting	91	18.2
Closed reduction and internal fixation	47	9.4
External fixation	37	7.4
Open reduction and internal fixation	117	23.4
Fasciotomy	31	6.2
Amputation	12	2.4
Total	501	100

earthquake in Pakistan, they managed 112 amputees and placed them in a rehabilitation program [18]. We also established a rehabilitation program for our patients who were amputees.

The most common causes of amputation were serious crush injuries and compartment syndrome. They had lead to vascular damage and eventual infection, a condition that could have been preventable by early fasciotomy operation. In addition, the initiation of early therapy to prevent acute tubular necrosis due to crush syndrome is well shown by the relation between time elapsed since injury to first medical aid and incidence of renal failure. If sepsis and renal insufficiency were controllable and responsive to conservative measures, we avoided amputation operations.

In conclusion, it is clearly not possible at present to prevent an earthquake or to estimate the time, location and severity of earthquake damage and injury. On the other hand, investigation of the injuries profile of patients associated with earthquake will have a positive effect on rescue attempts and treatment planning for musculoskeletal injuries caused by future disasters.

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