Original Article

Evaluation of pelvic fractures by radiographical and multi-detector computed tomography following the 2011 Van earthquake in Turkey

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Abstract. Pelvic fracture that is frequently encountered in the setting of a multi-trauma patient is major and serious trauma with potentially life-threatening consequences. The aim of this study was to evaluate the radiographical and multidetector computed tomography (MDCT) images of 47 patients injured during the 2011 earthquake in the city of Van, and to define the characteristics of earthquake-related pelvic fractures. Study data were analyzed according to the anatomic localizations of pelvic fractures and classified based on the Tile classification of pelvic ring fractures. The pubic bone was determined as the most frequent localization of pelvic fractures. Type C fractures and Type C2 sub-types were more frequently observed than the other types according to the Tile classification system.

Key words: Earthquake, pelvic trauma, computed tomography

1. Introduction

Earthquakes are one of the most destructive natural disasters and the most important cause of mass deaths throughout the world, second only to wars (1). An earthquake occurred in the city of Van, Turkey in October 23, 2011 at 01:47 PM local time. The earthquake had an intensity of 7.2 according to Richter's scale and lasted 29 seconds. One hundred and four people died during this earthquake.

The Van Training and Research Hospital admitted 1582 injured patients until October 30, 2011, assuming the role of the most important rescue center during this disaster (2). Some of these had pelvic crush fractures after the collapse of mostly concrete buildings as a result of high energy trauma. Pelvic fractures are one of mortal traumas, with mortality rate of 10-50% depending on the severity of bleeding and concomitant brain, thorax or abdomen injuries (3-6). Based on our knowledge, there are only three studies in literature investigating the radiographical and multi-detector computed tomography evaluation of earthquake-related pelvic fractures (7-9). In this study, we aimed to retrospectively evaluate the radiographical and multi-detector computed tomography (MDCT) findings for 47 patients with pelvic fractures.

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2. Materials and method

This study was performed retrospectively, including the first seven days following the earthquake.

This study included patients with earthquake-related pelvic traumas who were evaluated according to radiographical and MDCT findings. Patients with a history of pelvic fracture-related surgical treatment were excluded.

Table 1. Tile classification system

Type A:	Stable fractures
A1:	Avulsion fractures that are not related to the pelvic ring
A2:	Mild displacement fractures where the pelvic ring is stable
A3:	Transverse sacrum and coccyx fractures that are not related to the pelvic ring
Type B:	Partially stable fractures
B1:	Unilateral rotational instable, vertical and posterior stable fractures
B2:	Internal rotation instability; lateral compression injury
B3:	Bilateral rotational instability
Type C:	Rotational, posterior, vertical instable fractures
C1:	Unilateral fractures
C2:	Bilateral fractures (one side being rotational and the other side being vertical instable)
C3:	Bilateral vertical and rotational instable fractures

All 47 patients were screened in standard antero-posterior (AP) position via the conventional radiography system (Toshiba Rotanode E7252, Spain). The radiographic screening parameters were 80 kV, 8 mAs, and the active screening interval was 43x43 cm.

Pelvic screening was performed by Somatom Sensation 16-sectioned MDCT (Siemens Medical Systems, Forchheim, Germany) for eight patients considered as having severe pelvic trauma. The MDCT imaging parameters were determined as 130 kV, 121 mAs, 6 mm collimation, 380 mm imaging interval and 512x512 mm matrix. In addition, 'volume-rendering' and 'multiplanar reconstruction' techniques were used for detailed evaluation of pelvic fractures.

Images were analyzed retrospectively according to anatomic localizations, the number of fractures in pelvic bones and the classifications of pelvic ring fractures. Classification of pelvic ring fractures was performed based on the Tile classification system, according to pelvic ring stability (10,11) (Table 1).

3. Results

A total of 47 patients (21 males, 26 females, mean age: 44.2 years, age range: 10-79 years) admitted to our hospital with earthquake-related pelvic fractures between October 23 and 30 and who satisfied the inclusion criteria were included in our study. Eleven of the patients had other concomitant injuries in different anatomical regions. These injuries were thoracical in four, abdominal in two, spinal in three and cranial in two patients.

Radiographical screening was performed to thirty nine patients with suspected pelvic fractures whose clinical findings did not indicate any severe clinical trauma. MDCT imaging was performed to eight patients with suspected pelvic fractures whose clinical findings indicated a severe trauma. Six patients underwent open reduction-internal fixation surgeries, and two

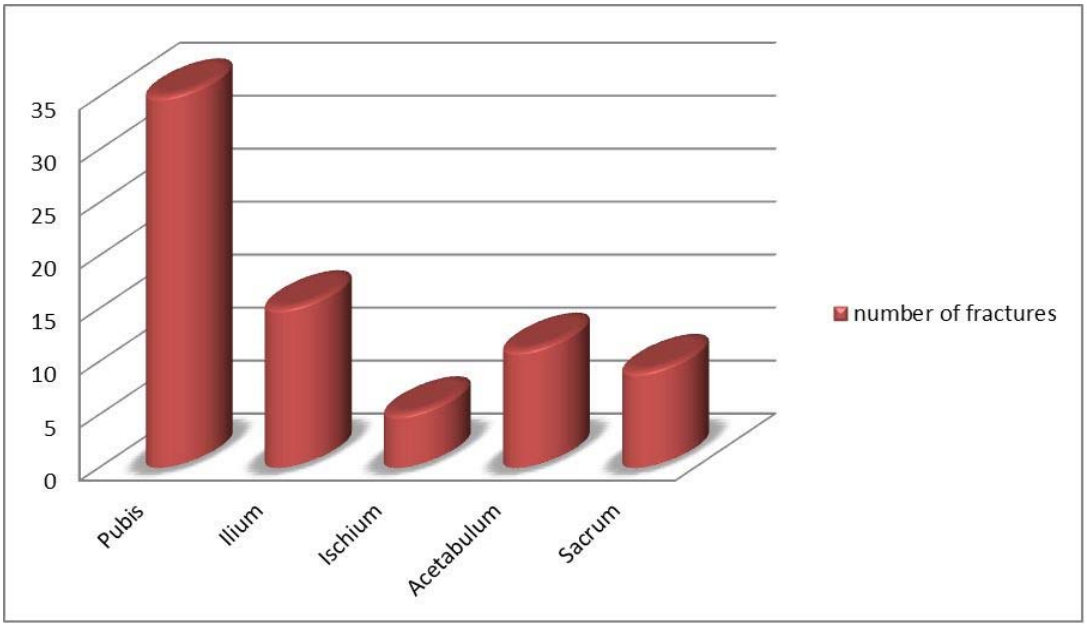

Fig. 1. Anatomic distribution of pelvic fractures.

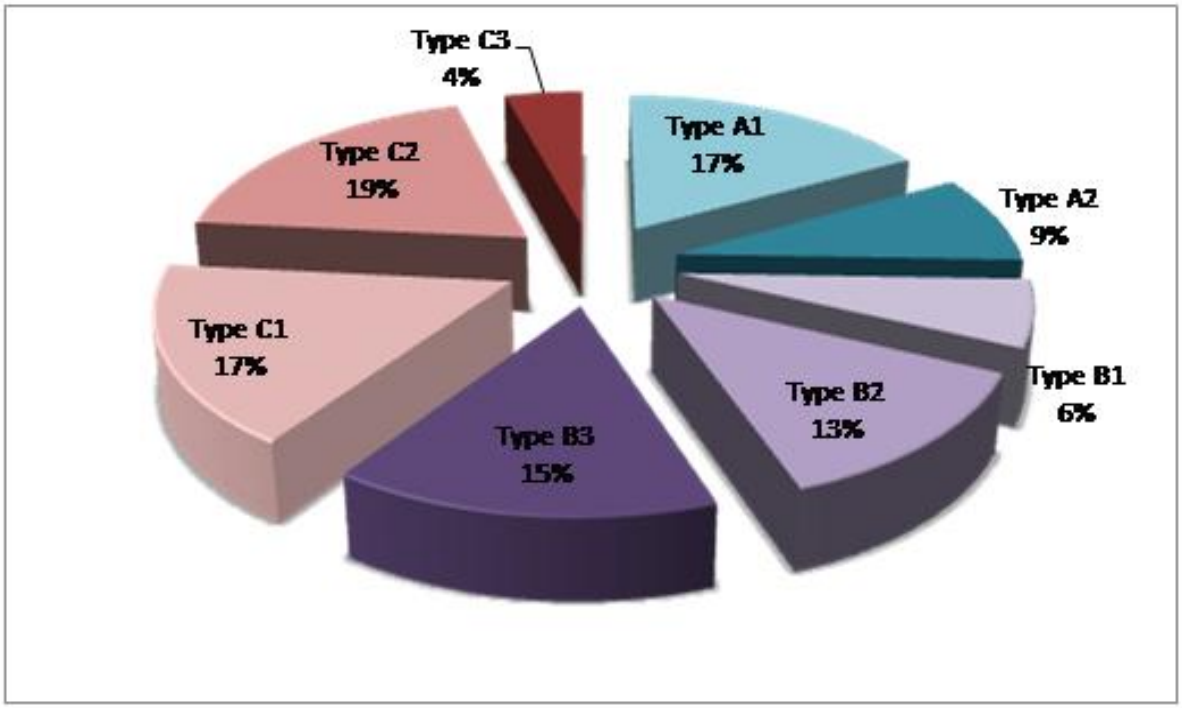

Fig. 2. Distribution of pelvic ring fractures according to Tile classification system.

patients underwent external fixation surgeries depending on the screening reports. All patients treated in our hospital recovered; with no postoperative deaths related injuries were observed. Seven of the patients were transferred to regional hospitals outside the earthquake area following external fixation, and eleven were stabilized and transferred under emergency conditions.

According to the MDCT and radiographical findings, the pelvic fractures of patients were 74% (35/47) pubic, 31.9% (15/47) iliac, 10.6% (5/47) ischial, 23.4% (11/47) acetabular and 19.1% (9/47) sacral (Figure 1). Pubic fractures were most common among other pelvic fractures. According to Tile classification system, 12 patients (25.5%) had Type A, 16 (34.1%) had Type B and 19 (40.4%) had Type C pelvic ring fractures.

Detailed evaluation of the fractures showed on Figure 2.

4. Discussion

More than three million people have lost their lives because of natural disasters in the past 20 years (12). The most devastating of natural disasters with regards to their death toll is the earthquake (13).

Pelvic fractures are serious traumas that generally accompany life-threatening traumas (14). The most common type of injury that results in pelvic fractures are internal car accidents. The second and third most common injuries are external car accidents and motorbike accidents respectively (15-18). Associated with the high energy traumas observed in earthquakes, earthquake-related pelvic fractures may lead to injuries that are more serious than other types of pelvic fractures (8). Radiography and computed tomography have an important role in assessing pelvic fractures and determining their classification (Figure 3-4).

Fig. 3. Bilateral ramus pubis fracture of a 51-year old-man; and on the left a Type C3 fracture caused by acetabulum fracture.

Fig. 4. On the right side, Type C1 fracture caused by ramus pubis, acetabulum and iliac wing fractures on a 36-year old-man.

In this study we aimed to provide a reference for the evaluation of possible earthquake-related pelvic fractures in the future. Within the 7 days following the Van earthquake, The Van Training and Research Hospital received 1582 injured patients (2). Pelvic fracture was determined in 2.9% (47/1582) of all patients. The rate of pelvic fractures are higher among earthquake-related injuries in the literature (1,9). The lower pelvic fracture rates following Van earthquake may be due to the daytime occurrence of the earthquake, when many people were outside the single-story buildings that are common in the region.

Pubic fractures were determined in most of the pelvic fractures in our study (74%). Pubic fractures were also the most common fractures among pelvic fractures in 2008 Sichuan earthquake (52.7%) (9). High pubic fracture rates observed following earthquake-related high energy traumas may be explained by its characteristic as the being the weakest region of the pelvis (19).

In study evaluating car accident-related pelvic fractures, 22% of the fractures were determined as Type A, 50% were Type B, and 28% were Type C (20). In another study, the rates were determined as 21% Type A, 38% Type B and 41% Type C. The mortality ratio was 12% (21). According to the Tile classification system, 19 (40.4%) of the patients included in our study had Type C pelvic ring fractures, while 16 (34.1%) had Type B and 12 (25.5%) had Type A fractures. Most of the fractures were unstable pelvic ring injuries. According to their sub-types, Type C2 fractures were the most frequent fractures, with an occurrence of 19.1%. Type C2 fractures are bilateral fractures in which one side remains vertical while the other side becomes rotationally unstable. The high rates of unstable fractures observed in our study compared to the pelvic fractures observed in car accidents may be explained by earthquake-related high energy traumas. No deaths were observed in patients treated at our hospital. This may be explained by the rapid detection of life-threatening conditions after resolving the triage problem and the timely execution of necessary treatments (2).

In conclusion, pelvic fracture detection with radiographical screening and computed tomography imaging was used successfully in determining the treatment approach to be followed during the earthquake in Van, with the most frequent pelvic fracture type being Type C according to the Tile classification system.

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