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A needful, unique, and in-place evaluation of the injuries in earthquake victims with computed tomography, in catastrophic disasters! The 2023 Turkey-Syria earthquakes: part II

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SUMMARY

OBJECTIVE: This study aimed to determine the computed tomography findings associated with very recent catastrophic 2023 Turkey-Syria earthquake-related injuries and their anatomotopographic distribution in the adult population.

METHODS: The incorporated computed tomography scans of 768 adult cases who had been admitted to the hospital and had undergone computed tomography imaging after these tragic disasters had been examined on the Teleradiology Reporting System of the Turkish Ministry of Health. To this end, the injuries were classified into six categories: head, thoracic, spinal, pelvic, extremity, and abdominal injury, with three age groups (18–34, 35–64, and ≥65 years) and four different imaging intervals (<24, 24–48, 49–72, and >72 h).

RESULTS: This study incorporated 316 (41.1%) cases on the first day, 57 (7.5%) on the second day, 219 (28.5%) on the third day, and 176 (22.9%) on the fourth day after the earthquake or later. Of the 768 cases, 109 (14.2%) had a head injury, 100 (13.0%) had a thoracic injury, 99 (12.9%) had a spinal injury, 51 (6.6%) had a pelvic injury, 41 (5.4%) had an extremity injury, and 11 (1.4%) had an abdominal injury.

CONCLUSION: In these regrettable earthquake disasters, we determined a high ratio of head injuries, which was closely followed by thoracic and spinal injuries, in our preliminary outcomes for the pediatric population, Part I. The frequency of abdominal injuries was low among individuals who experienced the earthquake. Last but not least, we have noticed a higher likelihood of spinal injury in individuals older than 65 years in the studied population.

KEYWORDS: Earthquake. Adult. Tomography. Radiology. Surgery.

INTRODUCTION

Ab imo pectore, a regrettable and catastrophic earthquake with a magnitude of at least 7.8 on February 6, 2023, at 4:17 a.m., deeply affecting the south and east of Turkey and the northern and western parts of Syria. Straight after, 9 h after the first earthquake, a second tragic earthquake with a magnitude of 7.6 occurred in the same geographic regions. Official reports state that the earthquake left more than 50,000 people dead and tens of thousands more wounded[1]. The earthquake, *per se*, is estimated to have caused $84.1 billion US dollars' worth of damage, making it one of the costliest natural disasters ever recorded. In the aftermath of such an unpredictable, huge, and wide-ranging disaster, with regret, thousands of houses collapsed, dozens of hospitals became unusable, tens of thousands of people died, and hundreds of thousands were injured.

After a massive earthquake, multiple traumas such as bone fractures, soft tissue injuries, and organ injuries due to the collapse of buildings or damage by falling objects are the most common reasons for hospital admission[2-4]. In trauma cases, X-rays and computed tomography (CT) are used in the first place to detect damage quickly[5,6]. After the disaster affected 11 cities in Turkey, patients were transferred to neighboring

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cities immediately for treatment management. Patients evaluated according to trauma guidelines were frequently examined via CT scan.

The Teleradiology Reporting System (TRS) of the Ministry of Health is a system that allows accessing images of radiological examinations on the web 7×24, reporting these images, conducting teleconsultations between radiologists, and evaluating medical images and reports in terms of quality (https://teleradyoloji.saglik.gov.tr). After the earthquakes, with the coordination of the Ministry of Health, CT examinations carried out in hospitals serving trauma patients in earthquakes began to be reported immediately by radiologists all over Turkey via the TRS. Thus, it was aimed to alleviate the burden on physicians in the regions affected by such a painful disaster.

Herein, we purposed to investigate CT imaging features seen in adult individuals from areas damaged by this massive earthquake based on images carried out by the TRS.

METHODS

Study design

This present study included patients aged 18 years or older who had a history of trauma associated with the 2023 Turkey-Syria Earthquake and had undergone CT scan imaging between February 6 and February 11, 2023, according to the TRS of the Ministry of Health. Of note, two cases who underwent surgical treatment before CT examination and six who underwent CT imaging for non-earthquake-related causes were excluded from the present study design.

Image analysis

The CT images of the cases consisting of axial sections, multiplanar reconstruction, coronal, and sagittal sections had been evaluated by two authors using the TRS of the Ministry of Health. As such, the injuries were classified into six categories: (i) head injury, (ii) thoracic injury, (iii) abdominal injury, (iv) spinal injury, (v) pelvic injury, and (vi) extremity injury. Moreover, patient demographic data concerning age, gender, anatomotopographic distribution, and types of injuries had been recorded. Herein, the differences in interpretation have been resolved with the consensus on the relevant issues. To this end, the cranial subcutaneous soft tissue, bones, and brain parenchyma had been examined for head injuries, while the bones, pulmonary parenchyma, and pleura for thoracic; the solid organs, retroperitoneal and intraperitoneal spaces for abdominal; the pelvic bones fractures for pelvic; and the vertebral bodies, the transverse and spinous processes, had been examined for spinal injuries.

Statistical analysis

The data from each patient were input into a Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) chart, and data analysis was conducted on a personal computer using statistics software (SPSS for Windows, version 23.0; SPSS, Chicago). The relevant injuries in six categories were examined with regard to three age groups (18–34, 35–64, and 65 years and older) and four different imaging intervals (<24, 24–48, 49–72, and >72 h) (Figure 1). The Pearson χ^2 test was used in order to determine the differences associated with the age groups and imaging intervals in the involved body parts. The data were presented as n (%), and p-value lower than 0.05 were considered statistically significant.

RESULTS

This study included 768 patients aged 18 or older who had a tragic earthquake-related history of trauma and had undergone CT scans between February 6 and February 11, 2023, according to the TRS of the Ministry of Health. The anatomical distribution of the injuries was evaluated regarding the four different imaging intervals and three age groups (Table 1), and the injuries were detected in 300 of these 768 cases. Of the 300 patients with injuries, 222 (74%) had injuries in a single anatomical region, 61 (20.3%) had injuries in two anatomical regions, and 17 (5.6%) had injuries in three or more anatomotopographic regions.

This study included 316 (41.1%) patients examined on the first day, 57 (7.5%) patients examined on the second day, 219 (28.5%) patients examined on the third day, and 176 (22.9%) patients examined on the fourth day after the earthquake or later. A total of 425 female and 343 male patients were included in the study with an age range of 18–95 years and a mean age of 46.1 years. The present study included 262 (34.2%) cases

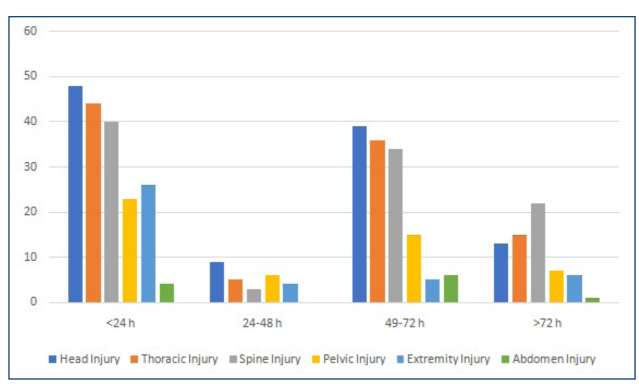

Figure 1. The cluster bar graph shows the distribution of earthquake-related injuries by imaging intervals.

aged between 18 and 34 years, 355 (46.2%) aged between 35 and 64 years, and 151 (19.6%) aged 65 years or older. There was no significant difference between male and female patients in terms of the anatomic location of the injury.

Of the 768 patients included in the present study, 109 (14.2%) had a head injury, while 100 (13.0%) had a thoracic injury, 99 (12.9%) had a spinal injury, 51 (6.6%) had a pelvic injury, 41 (5.4%) had an extremity injury, and 11 (1.4%) had an abdominal injury. The most common types of injury across the six anatomical localizations were, in descending order of frequency, scalp hematoma in 75 patients (7.60%), calvarial bone fracture in 52 (7.60%), and rib fracture in 47 (7.60%). In patients with head injuries, the most common finding was Scalp Hematoma, found in 75 patients, and the most common fracture was a parietal bone fracture. We determined the calvarial bone fractures in 52 cases, the intraparenchymal hematoma in 9, the subdural hematoma in 9, the subarachnoid hemorrhage in 8, the cephalic contusion in 8, the pneumocephalus in 4, the cephalic edema in 3, and the epidural hematoma in 1 patient. Eleven cases had parietal, 10 had frontal, 8 had temporal, 7 had nasal, 5 had zygomatic, 4 had occipital, 3 had maxillary, 2 had ethmoid, and 2 had mandibular fractures. Of these, 62.1% were linear, whereas 22.9% were depressed, and 15% were mixed fractures (Table 2).

The most common finding detected in patients with thoracic injuries was a rib fracture, which affected 47 cases. In addition, 36 cases had lung contusions, 36 hemothorax, 19 pneumothorax, 13 scapular fractures, 5 clavicular fractures, 3 pneumomediastinums, 1 sternal fracture, and 1 lung laceration.

In those with spinal injuries, fractures in levels L1, L3, and L2 were the top three most frequent fractures. The most frequently affected level was the lumbar level, while the least commonly affected level was the cervical level. Of these cases, 16 had bursts, one had translations and one had distraction-type unstable vertebral fractures. These fractures were found in the thoracolumbar levels. Of note, 92 of them are compression fractures in the anterior column of the vertebral corpus and the other vertebral fractures are stable fractures located in the transverse and spinous processes. The levels of spinal fractures are indicated in Table 2.

Of the 40 patients with pelvic injuries, 24 had pubic, 24 had sacral, 11 had acetabular, 6 had iliac, and 2 cases each had coccyx and ischial fractures. Among patients with extremity injuries, the upper extremities were injured in 37, while the lower extremities were injured in 10, involving femur fractures in 21, tibia fractures in 8, and talus fractures in 5. The levels of the other fractures are presented in Table 2. Eight patients with abdominal injuries had hemoperitoneum, two had liver lacerations, and one had a renal laceration.

DISCUSSION

Natural disasters are ecological phenomena that dramatically disrupt the normal order of life in a population. In comparison to other natural disasters such as floods, landslides, and avalanches, earthquakes can impact a greater area within a short time, resulting in the loss of both life and property[7]. Minimizing their effects requires urgent and organized aid, and the burden of loss associated with a major earthquake is also major[8]. The 1999 Marmara earthquake in Turkey resulted in more than 17,000 casualties. Meanwhile, for this earthquake, a death toll exceeding

Table 1. Distribution of earthquake-related injuries by age, gender, and imaging intervals.

	<24 h (n=316)	24–48 h (n=57)	49–72 h (n=219)	>72 h (n=176)	Total (n=768)
Male	169 (53.5)	28 (49.1)	82 (37.4)	64 (36.4)	343 (44.7)
Female	147 (46.5)	29 (50.9)	137 (62.6)	112 (63.6)	425 (55.3)
Head injury	48 (15.1)	9 (15.8)	39 (17.8)	13 (7.4)	109 (14.2)
Thoracic injury	44 (13.9)	5 (8.8)	36 (16.4)	15 (8.5)	100 (13)
Spinal injury	40 (12.7)	3 (5.3)	34 (15.5)	22 (12.5)	99 (12.9)
Pelvic injury	23 (7.3)	6 (10.5)	15 (6.8)	7 (4)	51 (6.6)
Extremity injury	26 (8.2)	4 (7)	5 (2.3)	6 (3.4)	41 (5.4)
Abdominal injury	4 (1.3)	0 (0)	6 (2.7)	1 (0.6)	11 (1.4)
18–34 years	106 (33.5)	29 (50.9)	79 (36.1)	48 (27.3)	262 (34.1)
35–64 years	145 (45.9)	21 (36.8)	104 (47.5)	85 (48.3)	355 (46.2)
>65 years	65 (20.6)	7 (12.3)	36 (16.4)	43 (24.4)	151 (19.7)

Table 2. Distribution of earthquake-related injury types.

Injury	n	%
Head injury types		
SCALP hematoma	75	68.8
Parietal fracture	11	10
Frontal fracture	10	9.2
Intraparenchymal hemorrhage	9	8.2
Subdural hematoma	9	8.2
Temporal fracture	8	7.3
Subarachnoid hemorrhage	8	7.3
Cephalic contusion	8	7.3
Nasal fracture	7	6.4
Zygoma fracture	5	4.5
Pneumocephalus	4	3.6
Occipital fracture	4	3.6
Maxilla fracture	3	2.7
Cephal oedema	3	2.7
Ethmoid fracture	2	1.8
Mandibular fracture	2	1.8
Epidural hematoma	1	0.9
Thoracic injury types		
Rib fracture	47	47
Pulmonary contusion	36	36
Hemothorax	36	31
Pneumothorax	19	19
Scapula	13	13
Clavicular fracture	5	5
Pneumomediastinum	3	3
Sternum fracture	1	1
Laceration	1	1
Spinal injury types		
L1	37	37.4
L3	34	34.3
L2	30	30.3
T12	19	19.2
T11	14	14.1
L4	13	13.1

Continue...

Table 2. Continuation.

Injury	n	%
L5	8	8.1
T5	7	7.1
T10	6	6.1
T4	5	5.1
T6	5	5.1
T3	5	5.1
C6	5	5.1
T9	4	4
C7	4	4
T1	3	3
T8	3	3
T2	2	2
C1	2	2
T7	2	2
Pelvic injury types		
Pubic fracture	40	78.4
Sacrum fracture	24	47.1
Acetabulum fracture	11	21.6
Iliac fracture	6	11.8
Coccyx fracture	2	3.9
Ischium fracture	2	3.9
Extremity injury types		
Femur fracture	21	51.2
Tibia fracture	8	19.5
Talus fracture	5	12.2
Humerus fracture	4	9.7
Radius fracture	3	7.3
Ulna fracture	2	4.8
Patella fracture	2	4.8
Fibula fracture	1	2.4
Carpal fracture	1	2.4
Abdominal injury types		
Hemoperitoneum	8	72.7
Liver	2	18.2
Renal	1	9.1

45,000 was reported within the borders of Turkey at the time of the present study. For earthquake victims that can be rescued with injuries, a systematic and rapid assessment of the extent of the injury is important. Of note, CT is one of the most frequently employed imaging methods in the evaluation of earthquake-related injuries, in accordance with the current evidence in light of the studies in the literature[9-12]. Therefore, we selected CT as the imaging modality in order to be utilized for the determination of earthquake-related injury profiles in the present study.

The most common injuries occurring in earthquake-related trauma patients were reported as extremity injuries[13-15]. However, due to the distribution of anatomical regions in our study, which is not compatible with the English-language literature, we encountered head trauma cases, similar to the very recent study our group conducted with pediatric cases[12]. Of note, the lower rate of extremity injuries in adults compared to the literature is attributable to the exclusion of patients who underwent direct radiography but not CT for the diagnosis of isolated extremity injuries, which affected the representation of extremity injuries in the present study.

In the present study, the majority of the cases underwent imaging within 72 h, which is parallel to the study on the 1999 Marmara earthquake in this regard[13]. In this study, head injury, spinal injury, and thoracic injury were the most common injuries encountered within the first 72 h, in descending order of frequency. However, after 72 h, spinal injury, thoracic injury, and head injury were encountered the most frequently, which leads to the conclusion that physicians would have a greater responsibility for patient intervention after a natural disaster.

Determining the treatment priority for patients with injuries in multiple anatomical regions is of vital importance for the patient[11]. In the present study, approximately 25.9% of earthquake-related trauma cases had injuries affecting two or more regions of the body. Multiple injuries are higher than the 5% reported after the 2008 Sichuan earthquake and the 15% reported after the 1995 South Hyogo and 2005 Kashmir earthquakes[16,17].

We also specified the topographic sites of injury according to age groups. The most affected anatomical regions in cases aged 18–34, patients aged 35–64, and patients aged 65 or older were the head, the thorax, and the spine, respectively. The ratio of spinal injury was slightly higher above the age of 65, which may be explained by the reduced bone density in those older than 65. As such, the TRS of the Ministry of Health collects CT scans in a pool, and these scans can be interpreted by radiologists approved by the ministry in a very short period of time. Considering that the high number of patient scans would further increase the workload of the radiologists living in the earthquake zone in trauma cases and emergency conditions[18-21], who are also victims, and that they might at times experience delays in reporting the scans, the use of the TRS of the Ministry of Health in disasters such as earthquakes offers great benefit in terms of the workload and access to CT reports. On the other hand, potential interruptions to infrastructure, including the Internet, during disasters such as earthquakes may pose a disadvantage for the TRS.

Limitations

Our study has the following three limitations: (i) as a retrospective study, we did not have trauma score data or patient outcomes such as mortality, (ii) only patients with CT images were included in the present study, and (iii) the exclusion of earthquake victims who did not undergo CT scans but were diagnosed using imaging methods such as direct radiography, sonography, or MRI.

CONCLUSION

In these regrettable earthquake disasters of extreme severity, with a magnitude of at least 7.8 and 9 h after the first earthquake, a second earthquake with a magnitude of 7.6 affecting the southern and eastern parts of Turkey and the northern and western parts of Syria, we determined a high ratio of head injuries, which was closely followed by thoracic and spinal injuries in the adults, which is similar to the preliminary results of our former study in the pediatric population, Part I. Herein, a low ratio of abdominal injuries among those who experienced the earthquake has been recognized. In addition, those older than 65 years were noticed to have a greater likelihood of experiencing a spinal injury. Herewith, we might hope our results will be useful in the development of protocols, even guidelines, and disaster preparedness for future high-magnitude earthquakes. This issue merits further investigation.

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AUTHORS' CONTRIBUTIONS

GT: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization. **DS:** Investigation, Methodology, Resources, Software, Supervision, Visualization, Writing – original draft, Writing – review & editing. **TB:** Investigation, Methodology, Project administration, Resources, Validation, Visualization. **IS:** Investigation, Methodology, Resources, Software, Supervision, Visualization, Writing – review & editing. **IMC:** Investigation, Resources, Validation, Visualization. **ROO:** Investigation, Validation, Visualization. **DET:** Investigation, Validation, Visualization. **UE:** Validation, Visualization. **IA:** Formal Analysis, Validation. **ECAV:** Investigation, Software, Supervision, Visualization, Writing – review & editing. **SA:** Formal Analysis, Validation.

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