ORIGINAL ARTICLE

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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 I

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SUMMARY

OBJECTIVE: This study was carried out to evaluate the injuries in pediatric earthquake victims due to the 2023 Turkey-Syria earthquakes with computed tomography and determine the anatomotopographic distribution of injuries.

METHODS: The material of this retrospective study consisted of the computed tomography findings of 257 pediatric cases injured in the 2023 Turkey-Syria earthquakes, and those were divided into subgroups based on their age group, i.e., 0–4, 5–9, 10–14, and 15–18 years, and the type of injury, i.e., head, maxillofacial, thoracic, abdominal, pelvic, and spinal injuries.

RESULTS: Earthquake-related injuries had been detected in 102 (39.6%) patients. Of the 29 patients with multiple injuries, 17, 10, and 2 had injuries in two, three, and four topographic regions, respectively. The most common injury was a head injury, which was detected in 48 (18.7%) cases, followed by thoracic injury, spinal injury, pelvic fracture, abdominal injury, and maxillofacial fracture, which were detected in 40 (15.6%), 22 (8.5%), 19 (7.4%), 10 (3.9%), and 6 (2.3%) patients, respectively. The cranial bone fractures and intracranial injuries were significantly more frequent in the 0–4 years age group compared with other age groups (p=0.028 and p=0.024, respectively). The rib fractures with spinal and pleural injuries were significantly more common in the 15–18 years age group compared with others (p=0.016, p=0.004, and p=0.002, respectively).

CONCLUSION: The head injury was the most common earthquake-related injury in pediatric cases. Herein, it was more common in younger children compared with other age groups, whereas rib, spine, and pleural injuries were more common in older children.

KEYWORDS: Earthquake. Pediatrics. Tomography. Radiology. Surgery.

INTRODUCTION

With regret, on February 6, 2023, at 4:17 a.m., an earthquake with a magnitude of at least 7.7 occurred, deeply affecting the South and East of Turkey and the North and West of Syria. Straight after, 9 hours later the first earthquake, a second earthquake with a magnitude of 7.6 occurred in the same region, triggered by the first earthquake. According to the data released by the Turkish Ministry of Interior Affairs, the death toll in earthquakes rose to 50,096 and the number of injured to 107,204 on March 20, 2023. Children are the most vulnerable population during such a major disaster[1]. According to the data on previous earthquakes, approximately one-third of earthquake victims are children, and the earthquake-related mortality rate is higher in pediatric cases than in adults[2,3].

Multiple traumas such as bone fractures, soft tissue, and organ injuries caused by the collapse of buildings or falling objects constitute the most common reasons for hospital admissions after a major earthquake[4]. Pediatric cases are more likely to suffer serious and multiple injuries in earthquakes as they have less subcutaneous fat and larger head and solid abdominal organs compared with the body[5]. In pediatric trauma cases, X-ray, ultrasonography, and computed tomography (CT) are used in the first place to detect damage quickly. The next-generation CT scan with multiplane reconstruction is an extremely

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valuable diagnostic tool for detecting head, thoracic, spinal, abdominal, and pelvic injuries[6,7].

Patients injured in the earthquakes affecting 11 provinces in Turkey were immediately transferred to neighboring cities for treatment management, where they were evaluated according to trauma guidelines, utilizing CT scans in most. The Teleradiology System of the Ministry of Health is a system that allows accessing the radiological examination records 7 days 24 h on the web, reporting these examinations, performing teleconsultation between radiologists, and evaluating the medical images and reports in terms of quality (https://teleradyoloji.saglik.gov.tr). Under the coordination of the Ministry of Health, the CT examinations performed in hospitals that serve trauma patients after earthquakes began to be reported immediately by radiologists across Turkey through the Teleradiology System. In this way, it was aimed to alleviate the burden of physicians in the regions affected by such a devastating disaster.

In this study, we purposed to evaluate the CT scans of pediatric patients via Teleradiology System in order to assess the characteristics of earthquake-related injuries in these cases based on the relevant age groups.

METHODS

Ethical aspects

This study was conducted according to the declaration of Helsinki and approved by the Clinical Research and Ethics Committee linked to the Ministry of Health-Giresun University Education and Research Hospital, under the approval number 210227920/10.KAEK-44/2023.

Study design

The study population consisted of pediatric cases aged 0–18 years who had undergone CT scans due to injuries related to the 2023 Turkey-Syria earthquakes. Patients' demographic characteristics, including age and gender data, had been recorded. Ten patients with insufficient CT image quality due to motion artifacts and five who underwent surgery before CT examination were excluded from the study.

Data collection

The CT scans' axial and multiplanar reformatted sagittal and coronal images that had been preserved in the Ministry of Health Teleradiology System (https://teleradyoloji.saglik.gov.tr) were independently evaluated by two experienced radiologists, and inconsistencies between their evaluations were resolved by consensus. Accordingly, the patients were divided into six subgroups based on the type of injury, i.e., the head, maxillofacial, thoracic, abdominal, pelvic, and spinal injury groups. In the head and maxillofacial injuries, craniomaxillofacial soft tissue, bones, and brain had been reviewed, and anatomical distributions or types of injuries were recorded. Furthermore, in the thoracic injuries, the thoracic cage, pulmonary parenchyma, and pleura had been evaluated, whereas in the abdominal and pelvic ones, the abdomen was classified as retroperitoneal and intraperitoneal spaces and the pelvis had been interpreted for pelvic fractures. Finally, in the spinal injuries, the presence of vertebral corpus, transverse process, spinous process, and articular process fractures in each vertebral region, as well as the degree of narrowing of the spinal canal, had been interpreted.

Statistical analysis

All the patients' data were entered into a Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) spreadsheet. Afterward, the statistical analyses of these data were performed comparatively according to the subgroups created based on the age groups, i.e., 0–4, 5–9, 10–14, and 15–18 years, using SPSS 13.0 (SPSS 13.0 for Windows, SPSS Inc., Chicago, IL, USA). The Pearson χ^2 test was used to identify the differences between age groups in the respective anatomical regions. As such, the data were presented as n (%), and the probability (p) statistics of ≤0.05 were deemed to indicate statistical significance.

RESULTS

A total of 257 pediatric patients with earthquake-related injuries who had undergone CT examinations between February 6 and 11, 2023, had been included in this study. The mean age of the study group was 9.7±5.1 (0–17) years, and earthquake-related injuries were detected in 102 (39.6%) patients. Of the 29 patients with multiple injuries, 17, 10, and 2 had injuries in two, three, and four anatomical regions, respectively. The most common injury was a head injury, which was detected in 48 (18.7%) patients, followed by thoracic injury, spinal injury, pelvic fracture, abdominal injury, and maxillofacial fracture, which were detected in 40 (15.6%), 22 (8.5%), 19 (7.4%), 10 (3.9%), and 6 (2.3%) patients, respectively. In the anatomotopographic distribution of injuries between the age groups, head injuries were more common in the 0–4 years age group, while spine injuries were in the 15–18 years age group (p=0.028 and p=0.004, respectively) (Table 1 and Figure 1).

Head and maxillofacial injuries

Cranial bone fractures and intracranial injuries were significantly more common in the 0–4 years age group compared with other

Table 1. Distribution of earthquake-related injuries according to age groups.

	0–4 years (n=57)	5–9 years (n=57)	10–14 years (n=83)	15–18 years (n=60)	Total (n=257)	p
Male	30 (52.6)	28 (49.1)	48 (57.8)	28 (46.7)	134 (52.1)	0.570
Female	27 (47.4)	29 (50.9)	35 (42.2)	32 (53.3)	123 (47.9)	
Head injury	17 (29.8)	13 (15.6)	13 (15.6)	5 (8.3)	48 (18.7)	**0.028**
Scalp hematoma	10 (17.5)	10 (17.5)	11 (13.2)	3 (5)	34 (13.2)	0.145
Bone fractures	8 (14)	5 (8.7)	3 (3.6)	1 (1.7)	17 (6.6)	**0.028**
Frontal	3 (5.3)	2 (3.5)	2 (2.4)	0 (0)	7 (2.7)	0.357
Parietal	3 (5.3)	2 (3.5)	2 (2.4)	0 (0)	7 (2.7)	0.357
Temporal	2 (3.5)	1 (1.8)	1 (1.2)	0 (0)	4 (1.6)	0.485
Occipital	1 (1.8)	1 (1.8)	1 (1.2)	0 (0)	3 (1.2)	0.789
Intracranial injury	9 (15.8)	4 (7)	3 (3.6)	2 (3.3)	18 (7)	**0.024**
SAH	1 (1.8)	1 (1.8)	0 (0)	0 (0)	2 (0.8)	0.470
EDH	1 (1.8)	1 (1.8)	1 (1.2)	0 (0)	3 (1.2)	0.789
SDH	5 (8.8)	2 (3.5)	2 (2.4)	1 (1.7)	10 (3.9)	0.177
Cerebral edema	2 (3.5)	1 (1.8)	0 (0)	1 (1.7)	4 (1.6)	0.432
Contusion	4 (7)	0 (0)	0 (0)	1 (1.6)	5 (1.9)	**0.015**
Maxillofacial injury	0 (0)	2 (3.5)	3 (3.6)	1 (1.7)	6 (2.3)	0.490
Spine injury	0 (0)	3 (5.2)	8 (9.6)	11 (15)	22 (8.5)	**0.004**
Cervical	0 (0)	0 (0)	1 (1.2)	1 (1.7)	2 (0.8)	0.636
Thoracal	0 (0)	0 (0)	1 (1.2)	3 (5)	4 (1.6)	0.089
Lumbar	0 (0)	1 (1.8)	2 (2.4)	7 (11.7)	10 (3.9)	**0.004**
Sacral	0 (0)	2 (3.5)	4 (4.8)	4 (6.7)	10 (3.9)	0.289
Thorax injury	7 (12.2)	8 (14)	9 (10.8)	16 (26.7)	40 (15.6)	0.055
Bone fractures	1 (1.8)	2 (3.5)	3 (3.6)	6 (10)	12 (4.7)	0.151
Rib	0 (0)	1 (1.8)	3 (3.6)	6 (10)	9 (3.5)	**0.016**
Clavicula	1 (1.8)	1 (1.8)	0 (0)	0 (0)	2 (0.8)	0.470
Scapula	0 (0)	0 (0)	0 (0)	1 (1.7)	1 (0.4)	0.348
Pulmonary parenchyma	7 (12.3)	5 (8.8)	8 (9.6)	7 (11.7)	27 (10.5)	0.913
Contusion	7 (12.3)	5 (8.8)	8 (9.6)	7 (11.7)	27 (10.5)	0.913
Laceration	0 (0)	1 (1.8)	0 (0)	2 (3.3)	3 (1.2)	0.234
Pleura	2 (3.5)	4 (7)	5 (6)	13 (21.7)	24 (9.3)	**0.002**
Pneumothorax	1 (1.8)	1 (1.8)	4 (4.8)	7 (11.7)	13 (5.1)	**0.045**
Hemothorax	0 (0)	2 (3.5)	1 (1.2)	3 (5)	6 (2.3)	0.257
Hemo-pneumothorax	1 (1.8)	1 (1.8)	0 (0)	3 (5)	5 (1.9)	0.203
Abdomen injury	2 (3.5)	3 (5.2)	4 (4.8)	1 (1.7)	10 (3.9)	0.730
Liver	1 (1.8)	0 (0)	1 (1.2)	1 (1.7)	3 (1.2)	0.807
Renal	0 (0)	2 (3.5)	0 (0)	0 (0)	2 (0.8)	0.070
Hemoperitoneum	1 (1.8)	3 (5.3)	1 (1.2)	1 (1.7)	6 (2.3)	0.422
Pneumoperitoneum	0 (0)	0 (0)	1 (1.2)	0 (0)	1 (0.4)	0.551
Pelvic injury	1 (1.8)	4 (7)	7 (8.4)	7 (11.7)	19 (7.4)	0.222

SAH: subarachnoid hemorrhage; EDH: epidural hemorrhage; SDH: subdural hemorrhage.

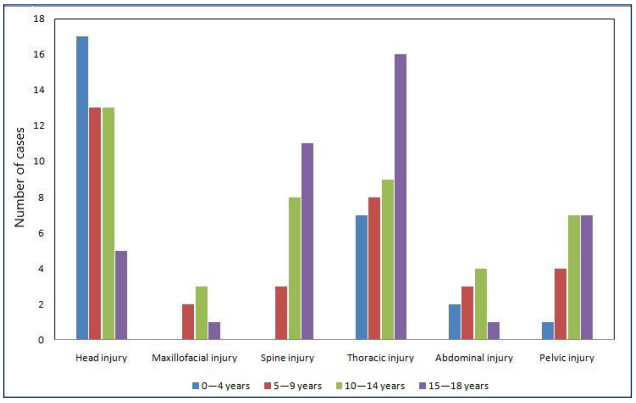

Figure 1. The cluster bar graphs exhibit the different anatomotopographic injuries recognized in the different pediatric earthquake victims' age groups.

age groups (p=0.028 and p=0.024, respectively). No statistically significant difference between age groups in maxillofacial injury (p=0.490) has been recognized. The intracranial injuries were present in one (16.6%) of the six cases with maxillofacial fractures, ten (71.4%) of the 14 with cranial bone fractures, and five (13.8%) of the 36 with scalp hematoma without fractures.

Thoracic injuries

The rib fractures were significantly more common in the 15–18 years age group compared with other age groups (p=0.016). No significant difference between age groups in terms of pulmonary parenchymal injuries (p=0.913) has been observed. Among pleural injuries, pneumothorax was significantly more common in the 15–18 years age group compared with other age groups (p=0.045).

Abdominal and pelvic injuries

Of the two cases with retroperitoneal injury, one had a renal subcapsular hematoma, and the other had a renal laceration. The liver laceration was present in three cases with intraperitoneal solid organ injuries, whereas no significant difference between age groups in terms of abdominal and pelvic injuries (p=0.730 and p=0.222, respectively) has been exhibited.

Spinal injuries

Among spinal injuries, the most and the least affected were the vertebras, the lumbar and sacral (45.4%), and the cervical (9%), respectively. Of the four (18.1%) cases, two had burst, one had a translation, and one had an unstable vertebral fracture in the form of distraction, all of which fractures were observed at the lumbar levels, accompanied by a narrow spinal canal. Other vertebral fractures were stable fractures such as transverse and spinous process fractures, corpus anterior column fractures, and non-displaced sacral fractures.

DISCUSSION

The most common earthquake-related injury in the study group was head injury (18.7%), followed by chest injury (15.6%), spinal injury (8.5%), pelvic fracture (7.4%), abdominal injury (3.9%), and maxillofacial fracture (2.3%). Head injuries were more common in the 0–4 years age group, whereas rib fractures and spine and pleural injuries were more common in the 15–18 years age group. Of note, the types and localization of injuries in pediatric cases differ from those of adults due to physiological and anatomical differences[5]. As such, CT imaging provides systematic and rapid diagnosis in pediatric earthquake victims, shortening the time to initiate lifesaving treatment[8].

Earthquake-related head injuries are often caused by building collapses and falling objects. Bai and Liu[9] reported that children are more vulnerable to head injuries. In studies conducted with pediatric patients on earthquake-related head injuries, Farfel et al.[10] reported that 3.2% of the 155 cases had head injuries, whereas Zhao et al.[11] reported that 12% of the 192 cases had head injuries. However, to the best of our knowledge, no study in the literature describes in detail the types of earthquake-related head injuries in pediatric cases. The most common type of earthquake-related injury observed in pediatric cases included in this study was head injury (18.7%). As the age of the patients decreased, the incidence of craniofacial fracture and intracranial injury increased. This finding might be attributed to the bigger head size compared with the body in early childhood. Moreover, most (71.4%) cases with cranial bone fractures had accompanying intracranial injuries, the most common being subdural hemorrhage. As such, this finding is in line with the relevant literature data, which indicates that the most common intracranial hemorrhage among blunt head traumas is subdural hemorrhage[12].

The incidence of earthquake-related thoracic injury in pediatric patients reported in the English-language literature varies between 2 and 9.4%[5]. In this study, the thoracic injury was the most common injury after head trauma, 15.6%. As the thorax ossifies with children's age, the incidence of rib fractures increases[6]. Similarly, in this study, rib fracture incidence had been significantly augmented with age. Pulmonary contusion was the most common CT finding among earthquake-related thoracic injuries in this cohort. On the contrary, the incidence of pulmonary laceration was low, which might be attributed to persistent heavy compression being more likely to result in pulmonary contusion than a pulmonary laceration. Some authors reported the incidence of pneumothorax in earthquake-related thoracic injuries as 3.2 and 51.9%, respectively[13,14]. In this study, the rate of pneumothorax among thoracic injuries was 32.5% and this rate was significantly higher in advanced pediatric age groups.

Given this sudden surge of patients in the emergency services after the earthquake, difficulties have arisen in delivering diagnostic and treatment services. An earthquake-related abdominal injury has been associated with high mortality[15-18]. In the retroperitoneal space, kidney or perirenal injury might occur more frequently than injuries of other retroperitoneal organs in the event of an earthquake. Liver injuries in the peritoneal cavity were reportedly more frequent than injuries in other intraperitoneal organs[19]. In our study, the abdomen was the least injured anatomical region due to earthquakes after maxillofacial injuries (3.9%). In line with the incidence of earthquake-related abdominal injuries in adult cases reported in the literature, the most common intraperitoneal and retroperitoneal organ injuries in this study were observed in the liver and kidney, respectively.

Spinal fractures were detected in 8.5% of pediatric cases, mainly at the lumbosacral level. Spinal injuries were the most frequent (50%) in the 15–18 years age group. Conversely, no spinal injury in the 0–4 years age groups had been recognized. As reported in the literature, most victims fall to the ground when an earthquake occurs and are trapped in the prone fetal position[20]. The high incidence of lumbosacral fractures can be explained by the higher probability of objects falling with high force and hitting the lower back. In addition, spinal cord injuries may emerge in 4.9–9.0% of patients in the early post-fracture period[21]. Unstable fractures, in particular, are the types of fractures that should be paid attention to in terms of spinal cord injury. As a matter of fact, unstable fractures constituted 18.1% of the vertebral fractures in this study.

Limitations

First, given that this study was an imaging study based on teleradiology data, the trauma scores of the cases assessed at admission were not available. Second, considering that earthquake-related extremity injuries are evaluated mainly by direct radiography, extremity injuries had been not assessed in this CT study. Finally, the patient's morbidity and mortality data had not been available.

CONCLUSION

The types of earthquake-related injuries in pediatric patients differed between age groups due to anatomical differences and different mechanisms of injury. Head injuries were more frequent in younger children, while rib fractures with spinal and pleural injuries were more common in older children. The characteristics of pediatric earthquake-related injuries detected by CT imaging in this study may help to accurately diagnose and treat earthquake-related trauma cases in the future. With its ability to provide detailed and accurate images of the anatomic internal structures, CT helps physicians to identify injuries of pediatric earthquake victims that may not be visible on their physical examinations or X-rays.

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AUTHORS' CONTRIBUTIONS

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

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