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Orthopaedic Triage and Management of Earthquake Victims

Güzelali Özdemir, Olgun Bingöl, Enver Kılıç

Ankara Bilkent City Hospital, Clinic of Orthopaedics and Traumatology, Ankara, Turkey

ABSTRACT

Major earthquakes can cause crush injuries. Damage to buildings is a major cause of death and injury in earthquakes, especially when solid building materials such as concrete are used. The most common injuries following earthquakes are fractures, compartment syndromes, major soft tissue injuries, and crush injuries. This highlights the importance of planning at the national level before natural disasters occur. The aim of this study was to review what needs to be done in orthopedic and trauma services in the field, during transfer, and in advanced treatment centers after an earthquake disaster in our country, where high-intensity earthquakes occur. In conclusion, strategic planning in the field, during transfer, and in advanced treatment centers can reduce the pressure on the health system in similar mass disasters.

Keywords: Orthopaedic triage, earthquake, victims, management

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Introduction

The region in which Turkey is located is one of the most active tectonic regions on earth. Many large and small earthquakes have occurred in our country throughout history. New earthquakes are expected to occur in our region in the future. Measures should be taken against the destructive effects of these earthquakes. However, rescue and health services should also be organized after an earthquake.

Major earthquakes can cause crush injuries. Damage to buildings is a major cause of death and injury in earthquakes, especially when solid building materials such as concrete are used. Earthquakes also cause damage to infrastructure, health facilities, and transport (1).

The most common injuries following earthquakes are fractures, compartment syndromes, major soft tissue injuries, and crush injuries (2). Therefore, patients admitted to healthcare facilities are more likely to have extremity injuries than non-orthopaedic injuries (3). Most orthopedic injuries are fractures, and most fractures after the earthquake occurred in the diaphyseal region of the tibia and femur (1). The high number of orthopedic cases observed in previous studies emphasizes the need for orthopedic surgery in natural disaster and conflict settings (2,3,4).

Previous studies have confirmed the existence of organizational and educational barriers to quality surgical care following the Haiti earthquake (5,6,7). This highlights the importance of national planning before natural disasters to prevent patient overload and provide advanced life support.

Address for Correspondence: Assoc. Prof. Güzelali Özdemir, Ankara Bilkent City Hospital, Clinic of Orthopaedics and Traumatology, Ankara, Turkey
Phone: +90 532 584 36 11 **E-mail:** drguzelali@yahoo.com **ORCID ID:** orcid.org/0000-0003-4279-0955
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The aim of this study was to review what needs to be done in orthopedic and traumatological services in the field, during transfer, and in advanced treatment centers after an earthquake disaster in our country, where high-intensity earthquakes occur.

In the Field

After an earthquake, the work capacity of health workers should be assessed quickly. Healthcare workers may also be disaster victims because of physical and psychological losses (8). In this case, the authorities should be informed quickly, and backup staff should be available if needed. Several emergency teams should be formed before the disaster, and they should be prepared in advance for their roles in disaster response scenarios.

Healthcare workers should ensure their own safety before rescuing survivors from the rubble of the disaster site. This is because the loss of healthcare workers will adversely affect the response. The removal of survivors should therefore be left to specialist rescue teams (9).

The maximum survival time in a trap is an important issue for rescuers. After reviewing the literature, Macintyre et al. (9) concluded that numerous survivors have survived entrapments for more than 48 hours, with a few successfully surviving entrapments for 13-14 days.

Assessment of casualties should be performed using the Advanced Trauma Life Support System, with a two-stage assessment recommended. The primary approach is to quickly identify life-threatening injuries. A detailed secondary approach is required for a more accurate assessment. Survival of casualties recovered from under the rubble depends on early medical intervention by emergency teams at the scene. Treatment of casualties trapped under the rubble should begin as soon as communication is established (10). Early intervention should include basic life support, prevention of blood loss, stabilization of fractures, prevention of hypothermia, and fluid therapy.

It is recommended that isotonic sodium chloride (NaCl) be used as the most readily available liquid in the field. Potassium-containing solutions should be strictly avoided. Inappropriate fluid replacement increases the risk of developing acute kidney injury after crush injury (11). Non-steroidal anti-inflammatory drugs should not be preferred for pain relief. Narcotics should also be used for pain relief.

In cases of mass casualties, the injured should be reached as soon as possible and the most appropriate intervention should be made. In such cases, institutions and individual critical care providers must use a moral framework to allocate available resources efficiently and fairly. Therefore, guidelines for the triage of critically ill patients are presented (12,13,14,15). The importance of field triage in the scene of an incident has been demonstrated previously. In a mass casualty incident, field triage should be performed by the first medical team arriving at the scene. Subsequent healthcare teams should provide medical interventions to the casualties. Conveniently, there are five classifications with corresponding colors (Table 1) (16).

Alvarado et al. (4) described seven basic requirements for surgical care in the field (Table 2). Basic orthopedic procedures could be performed in these settings. However, more demanding procedures, such as internal fixation, can only be performed at certain sites. These requirements are increased when internal fixation procedures are performed; 1) improved air quality with filters; 2) availability of water supply in quantity and quality; 3) special orthopaedic accessories table, C-arm, and disposable gowns and drapes; 4) enforced dress code and procedures, use of hydro-alcoholic solutions and surface disinfectants; 5) clearly defined and dirty circuits in sterilization, autoclave, and instrument disinfectants; 6) qualified orthopaedic surgeons, nurses and infection control

Table 1. **Triage classification by color**

1	Black/expectant	They are so badly injured that they will die from their injuries, possibly within hours. Treatment is usually palliative, such as administering painkillers to reduce suffering.
2	Red/immediate	Immediate surgery or other life-saving intervention. Priority for surgical teams or transport to advanced facilities. Likely to survive with immediate treatment.
3	Yellow/observation	The condition is stable for the moment but requires observation by trained staff and frequent reassessment. Requires hospital care.
4	Green/wait	May need medical attention in a few hours, but not immediately. Can wait several hours. Broken bones without compound fractures and many soft tissue injuries.
5	White/dismiss	Minor injuries: first aid and home care are sufficient. Medical attention is not required.

Table 2. Basic requirements for surgical care in the field

1	Adequate infrastructure, including protection from the external environment and appropriate electricity and lighting
2	Adequate provision of water and sanitation facilities
3	The availability of all essential disposable items, drugs, and equipment
4	Strict adherence to the requirements of hygiene and the universal precautionary principle
5	Mandatory use of sterile equipment for surgical and anaesthetic procedures
6	Blood transfusion capability
7	Adequate human resources in terms of quantity and quality

officers, physiotherapists; and 7) availability of antibiotic culture and susceptibility (4).

In some natural disasters, this organization may not be fully in place. In this case, more limited interventions, such as external fixation and referral of the injured, may be required (17,18,19). The focus of medical care should be on hemorrhage management, wound debridement, infection control, and soft tissue stabilization (2).

Great care must be taken when deciding whether to perform fasciotomy in patients who have been removed from the rubble. These patients are predisposed to acute renal failure due to rhabdomyolysis, infection, and bleeding due to Crush syndrome. Therefore, fasciotomy should not be routinely performed. Each patient should be assessed individually, and a decision should be made accordingly.

The later fasciotomy is performed, the less beneficial it is. When performed early, the need for subsequent amputation and the risk of long-term damage are lower (20,21). Delayed fasciotomy performed after 45.5 hours increase the need for amputation by 28.48 times (22).

Amputation can be lifesaving in some cases. Amputation is not a routine procedure. In the presence of crushed limbs, severe infection, and life-threatening sepsis, amputation should be performed to save the patient's life. Each patient should be assessed individually. After the 2023 Kahramanmaraş earthquakes, Bingol et al. (22) concluded that patients with extrication times longer than 23 hours were associated with an 8.8 times higher risk of amputation.

During Transfer

Patients should be taken to the hospital as soon as their general condition has stabilized in the field. In cases where advanced interventions and medical care cannot be continued, casualties should be immediately transferred to advanced treatment centers. All available air, land, and sea vehicles should be used to transport casualties. Patients for whom loss of time increases the risk of loss of life and organs should be transported by air or helicopter for rapid transfer. At this point, national coordination must ensure that the casualties receive definitive treatment. Special transport and coordination teams should be established.

Medical care should continue while the casualties are being transported. It is essential that patients continue to receive adequate fluid replacement during transport.

At Advanced Treatment Centers

From the moment the earthquake struck, hospitals with referral centers should have started preparations. All elective patients in stable condition should be discharged, and rooms should be opened for patients expected to be referred. All trauma teams should be activated in a coordinated manner. By informing medical companies, the necessary implants for emergency treatment, such as external fixators, were made available.

In the aftermath of the earthquake, the services of many clinics are needed because of the large number of injured and polytrauma cases involving many systems. The effectiveness of the multidisciplinary approach has been demonstrated in military treatment, and coordination of these teams is also important in earthquakes (23,24).

Rigal (25), in a study of disaster situations, reported that when several casualties are transferred at the same time, the treatment of patients can be delayed. It may be better to divide orthopedic and trauma surgeons into several teams and work in shifts (24). In this way, delays for treating casualties could be avoided.

Triage should be performed both in the hospital emergency department (ED) and in the field. All fractures that do not require emergency surgical treatment should be splinted, or cast, and patients with Crush syndrome should be given priority. All patients with Crush syndrome should be managed by a dedicated team of internal medicine specialists from admission to the ED until discharge (24).

During this period, the use of social networks plays a crucial role in facilitating communication (26). However, in many major disasters, communication failures have led to

inadequate management (27). Precautions should be taken and preparations made. The use of social networks has several advantages. Faster treatment of patients, pre-operative and intraoperative communication between different trauma teams, and easy documentation of patient information have been achieved. In addition, patients requiring urgent intervention should not be delayed in reaching operating theatres or intensive care units (ICU) (24).

Hadary et al. (28) concluded that most of the workload in general surgery shifts from the operating room to the ED, while orthopedic procedures and ICU beds become bottlenecks in patient flow during war. In the 2023 Kahramanmaraş earthquakes, the most injured body regions were the extremities; therefore, the workload of the orthopedic and traumatology clinic was very high.

Human and material resources were limited during peak hours. Early reinforcement of the surgical staff has improved outcomes (26). Departments with high workloads, such as orthopedics and traumatology, should be augmented by health professionals from other departments (24).

Hyperbaric oxygen therapy (HBOT) is used in patients with crush injuries. However, the effectiveness of HBOT remains controversial. While some claim that it is beneficial, there are also those who report that it has no effect on clinical outcomes (29,30). Therefore, larger studies are needed to evaluate the effect of HBOT in high-energy trauma, such as earthquakes, with more muscle necrosis (30).

Different types of wounds can occur after earthquakes, and chronic wound care is also very important. Methods such as negative pressure wound therapy, debridement, collagenase creams, antiseptics, and HBOT can provide satisfactory short-term results (29).

Patients with amputations and/or completed definitive treatment should be transferred to the physical medicine and rehabilitation department. In addition, the psychiatric team should provide therapy to all patients throughout the process. This phase of treatment can take a long time. They are also very important.

Conclusion

Strategic planning in the field, during transfer, and at the advanced treatment center can reduce the burden on the health system in similar mass casualty events in the future.

An appropriate management plan should be developed and planned using a multidisciplinary approach to prevent limb loss and reduce the risk to patient life.

Ethics

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: G.Ö., Design: G.Ö., Data Collection or Processing: O.B., Analysis or Interpretation: E.K., Literature Search: O.B., Writing: G.Ö., O.B., E.K.

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