Management of musculoskeletal injuries after the 2009 western Sumatra earthquake

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ABSTRACT

Purpose. To report injury patterns and management of musculoskeletal injuries after an earthquake.

Methods. 94 male and 161 female patients aged 17 to 90 (mean, 53) years underwent surgery for musculoskeletal injuries. Their injury patterns, anaesthesia administered, surgeries undertaken, and development of postoperative complications were reviewed.

Results. Of the 255 patients, 155 sustained superficial lacerations with minor soft-tissue contusion, whereas 100 sustained injuries that necessitated surgery under anaesthesia. The injuries involved the tibia/ankle (n=90), the hand (n=48), the pelvis/femur (n=41), the radius/ulnar (n=36), the foot (n=20), the humerus (n=10), and the spine (n=10). 30 (12%) of the patients had multiple injuries. The most common procedure performed was debridement (n=58), followed by open reduction and internal fixation with plates and screws for closed fractures (n=20), Kirschner wiring (n=11), external fixation (n=8), and general surgery and others (n=6). Repeated debridements were performed for 19 open fractures; 10 involved the distal tibia. 63 procedures were carried out under anaesthesia or sedation. General anaesthesia involved 2 patients; one had a right hemi-colectomy for an ischaemic bowel and another had an appendicectomy. Regional anaesthesia included sub-arachnoid block for lower-limb surgeries (n=21), axillary brachial plexus block for upper-limb surgeries (n=11), and femoral and sciatic nerve blocks for a lower-limb surgery (n=1). The remaining 28 procedures involved conscious sedation. The mean number of debridements for open fractures was 2.8 (range, 2–5). The mean follow-up duration was 10.4 (range, 7–14) days. Only one patient developed a postoperative wound infection.

Conclusion. Our team was effective in managing orthopaedic injuries after an earthquake. The postoperative complication rate was low. Regional and spinal anaesthesia are relatively safe alternatives to general anaesthesia when carried out under such austere circumstances. The success of the mission depended on collaboration with the local health care workers and external agencies.

Key words: anesthesia; disasters; earthquakes; Indonesia; orthopedic equipment; orthopedic procedures

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INTRODUCTION

On 30 September 2009, an earthquake struck 45 km northwest of Padang, Sumatra, Indonesia. There were 1115 deaths, 1214 serious injuries, and 1688 light injuries; most were reported in the areas of Padang, Agam and Pariaman.1 135 000 houses were destroyed and 144 000 houses damaged, including 2 regional hospitals.1 The Singapore Armed Forces deployed a 54-man team to set up an outpatient and surgical facility in the damaged hospital, as roads leading out of the region were also damaged.

Tsunamis and floods tend to result in a higher proportion of fatalities than injuries, whereas earthquakes inflict more injuries (commonly by entrapment2) than deaths, and they are predominantly orthopaedic.3–5 Nonetheless, landslides can cause a large number of fatalities when villages are buried.

Acute treatment is often hampered by the destruction of roads, lack of equipment, and damage to hospital facilities,4 as is surgical and anaesthetic care by infrastructural constraints, type of surgical procedures, availability of drugs and equipment, and the experience of staff.6,7 The role of orthopaedic surgeons during combat6 and peace support operations9 is important.

We report the injury pattern and management of musculoskeletal injuries after an earthquake.

MATERIALS AND METHODS

1117 earthquake victims were treated by our medical team. 614 were for musculoskeletal problems. Of whom, 94 male and 161 female patients aged 17 to 90 (mean, 53) years underwent surgery; their injury patterns, anaesthesia administered, surgeries undertaken, and development of postoperative complications were reviewed.

Medical team

The team was formed immediately after the earthquake by civilians (from a tertiary hospital) and military personnel (from a field hospital) and comprised 2 general surgeons, 2 orthopaedic surgeons, 2 anaesthetists, 9 nurses and supporting staff. This configuration was based on our capability to perform 10 operations a day in 2 shifts during a 2-week deployment. The team was deployed to a partially damaged operating theatre of the Pariaman Hospital, which had an emergency department, polyclinic, radiological service, and limited operating theatre facilities. However, it lacked intensive-care or high-dependency facilities. There was a good supply of well water but no theatre light. The team brought in surgical and anaesthetic equipment to set up an operating environment that resembled a field hospital. The inventory included drills, large/small fragment fixation sets, Kirschner-wiring sets, external fixators, and Pulsavacs (Zimmer, Swindon, UK).

Patients were first triaged at the accident and emergency department and then referred to our team. The management plan was decided jointly by the surgeon and anaesthetist. The patient then underwent preoperative investigation. Four patients with previously undiagnosed diabetes mellitus were picked up in this manner. They were started on strict glycaemic control and monitoring before surgery, and long-term glycaemic control was established after surgery. Patients with critical injuries were sent directly to the operating theatre.

Anaesthesia

The anaesthesia team comprised one attending and one resident anaesthetist. The major anaesthetic equipment deployed included a Propaq LT patient monitor, an Oxford miniature vapouriser, a Pneupac compPAC ventilator with battery pack, VisionAire oxygen concentrators, a Medela Dominant 50 medical suction device, a LifePak 12 defibrillator, a B Braun Perfusor Space infusion pump, and a Sonosite Micromaxx portable ultrasound machine with HFL38 linear and C60e curved array transducer probes. Owing to the unreliable power supply and lack of a scavenging system, regional anaesthesia was preferred whenever possible. Sub-arachnoid blocks were performed with 25- or 27-gauge spinal needles using 0.5% bupivacaine. Peripheral nerve blocks included axillary brachial plexus block for upper-limb surgeries and femoral and sciatic nerve blocks for lower-limb surgeries. These blocks were performed under ultrasound guidance with 22-gauge insulated needles using 20–30 ml of local anaesthetics (10–15 ml of 2% lignocaine and 10–15 ml of 0.5% bupivacaine with a 1:200 000 dilution of adrenalin). For general anaesthesia, a propofol total-intravenous anaesthesia technique was applied. For conscious sedation, low-dose intra-venous ketamin (0.1–0.5 mg/kg/hr) and fentanyl (0.5–1 mg/kg) were titrated to obtain the desired effect.

Surgery

All patients received a single preoperative prophylactic dose10 of intravenous cefazolin 2g. For closed fractures with good skin and soft-tissue
conditions, open reduction and internal fixation was performed. Open fractures were irrigated with sterile saline to remove any gross superficial contaminants and stabilised with plaster splints. Intravenous antibiotics were started, and tetanus prophylaxis updated. The antibiotic regimen consisted of cefazolin (1 g every 8 hours); gentamicin was added for severe soil contamination. Wounds were fully explored and all devitalised tissues excised. The wounds were irrigated with 12 litres of pulse lavage. After adequate debridement, external fixators were applied. Antibiotics were continued for 3 days after surgery.

**Postoperative care**

Open fracture wounds were inspected on day 2. Debridements were repeated for infected wounds. Primary closure of clean wounds with soft-tissues in good condition was delayed. Simple analgesia (paracetamol and non-steroidal anti-inflammatory drugs) was prescribed to discharged patients. Ambulatory aids from Handicap International were given to selected patients. Postoperative care was continued by the local trauma surgeons. Patients requiring further specialist care were evacuated by air to tertiary hospitals in the neighbourhood.

**RESULTS**

Of the 255 patients, 155 sustained superficial lacerations with minor soft-tissue contusion, whereas 100 sustained injuries necessitated surgery under anaesthesia. Injuries involved the tibia/ankle (n=90), the hand (n=48), the pelvis/femur (n=41), the radius/ulnar (n=36), the foot (n=20), the humerus (n=10), and the spine (n=10). Most spinal injuries were stable wedge compression fractures of <25% (n=5) and stable transverse process fractures (n=4); one patient with a T10 fracture-dislocation and paraplegia was transferred to a tertiary hospital. 30 (12%) of the patients had multiple injuries.

The most common procedure performed was debridement (n=58), followed by open reduction and internal fixation with plates and screws for closed fractures (n=20), Kirschner wiring (n=11), external fixation (n=8), and general surgery and others (n=6). Repeated debridements were performed for 19 open fractures; 10 involved the distal tibia, for which an A-frame external fixator was used.

63 procedures were carried out under anaesthesia or sedation. General anaesthesia involved 2 patients; one had a right hemi-colectomy for an ischaemic bowel and another had an appendicectomy. Regional anaesthesia included sub-arachnoid block for lower-limb surgeries (n=21), axillary brachial plexus block for upper-limb surgeries (n=11) and femoral and sciatic nerve blocks for a lower-limb surgery (n=1). The remaining 28 procedures involved conscious sedation.

The mean number of debridements for open fractures was 2.8 (range, 2–5). Two patients underwent amputation. One had a severely mangled left foot and underwent first and second ray amputations. The other had poorly controlled diabetes and wet gangrene of her right middle finger and underwent ray amputation.

The mean follow-up duration was 10.4 (range, 7–14) days. Only one patient developed a postoperative wound infection. The patient was diabetic and underwent open reduction and plating for closed fractures of the femoral shaft and distal tibia. On day 5, a purulent discharge was noted in her thigh wound, though the distal tibial wound remained clean. She underwent 4 debridements before delayed primary closure.

There was one equipment failure when the ventilator malfunctioned during general anaesthesia. This was promptly rectified with a replacement and resulted in no morbidity or mortality. The cause of failure was attributed to a loose power connector pin. Two episodes of power failure (lasting about 20 minutes) were encountered; each resulted in temporary failure of theatre lighting and ventilation. Surgery continued with the use of battery-operated light-emitting diode lights.

**DISCUSSION**

Most orthopaedic injuries during earthquakes involve the extremities. A greater proportion of fractures involve proximal bones (femur and humerus), but in our study more injuries involved distal bones (tibia, radius/ulna). When the earthquake occurs in the early morning and most victims are asleep, proximal bones are more commonly involved. The western Sumatra earthquake occurred in the afternoon and most victims were injured while escaping falling debris. Crush injuries were not as common as in reports from elsewhere. As most village houses were constructed of timber, it could be removed with manual effort. Victims buried under masonry were often inaccessible owing to damaged roads and lack of excavation equipment. The small number of pelvic injuries could be because such patients had died before they could be rescued and never reached
the hospital. The disaster response was inevitably delayed beyond 72 hours, owing to the isolation and ruggedness of the local terrain. During our deployment, we treated 4 neglected fractures with non-union after failed treatment by the local bone-setters. Good history taking is therefore imperative.

In the initial period following a disaster, the most urgently needed orthopaedic procedures are external fixation, amputation, and debridement; and often there is no facility or equipment to perform more complex procedures such as internal fixation. The timely arrival of the surgical team 72 hours after the earthquake brought the much needed equipment and instruments to the local hospital. Damaged facilities in the aftermath of earthquakes pose challenges for surgery owing to increased risks of infection. Postoperative infection rates can be as high as 14.8% to 19%. Our team enforced discipline in maintaining sterility in the field environment and adhered strictly to the principles of managing open fractures (tetanus update, aggressive debridement and copious irrigation with pulsavac) using skeletal stabilisation with external fixators. All patients received perioperative antibiotics and were discharged only after the wounds were clean. Strict glycaemic control was commenced for patients with previously undiagnosed diabetes mellitus. These measures achieved a low rate of wound infection (one case). Our team did not encounter any urgent need for blood transfusion. In addition, there was no facility for the storage of blood products. It is recommended that patients deemed to require complex surgery and blood transfusion be evacuated by air for further treatment after preliminary stabilisation in the field.

It is a challenge to provide anaesthesia in the environment with infrastructural and equipment constraints. Regional anaesthesia is thus preferred after the disaster, because of lower overheads, minimal side-effects, availability of profound analgesia, and as the patients were haemodynamically stable. It is also less subjected to power and equipment failure, and thus has high success rates. Ultrasound-guided nerve blocks have become popular, with emerging evidence about their clinical efficacy and safety. They may be the most viable option when operating on injured limbs or performing amputations in the field.

Humanitarian medical missions require clinical ingenuity, and flexibility to adapt to and use available resources. This highlights the multi-faceted role of military doctors—as commanders, logisticians, trainers, and liaison officers. The high work tempo often results in staff fatigue, and thus appropriate work-rest cycles and shift systems should be implemented. This is necessary to maintain morale and keep up the mental and physical strength of the medics for a sustained mission. As logisticians, they must secure adequate supplies and be prepared to replenish them in a timely manner. Military doctors should also be involved in the teaching of medical personnel of the host nation, and in the establishment of an appropriate medical infrastructure. Our team worked with the local doctors and nurses to set up a work-flow that enabled transfer of patients from the emergency department to the operating theatre and the ward. This resulted in shorter waiting times, and better optimisation of patients scheduled for surgery.

Liaisons play an important role in the collective effort of multinational undertakings. Interaction with orthopaedic, non-orthopaedic, and non-medical colleagues from other countries helps achieve a consensus regarding evaluation, management and aftercare of patients. Orthopaedic surgeons should assume an active role, as most cases involve musculoskeletal injuries. Our team conducted daily ward rounds and preoperative discussions with local doctors and other volunteer doctors to align patient care and ensure continuity of care when the team leaves. Collaboration with the civilian medical team enabled sharing of their expertise with the surgical team in managing earthquake-related orthopaedic injuries in the field. Success of a mission depends on preparation and training as well as collaboration with local health care workers and other external agencies.

REFERENCES


