

Damage Control Orthopedics in Multitrauma Patients: A Pediatric Case Presentation and Literature Review

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Abstract

Introduction: A multiple long-bone shaft fracture is associated with developing systemic complications and increased morbidity and mortality. Optimal timing for surgery of polytrauma patients according to damage control orthopedics principles is crucial.

Case Presentation: We present a 5-year-old boy referred after a pedestrian car accident with right femoral shaft fractures, a left distal femur fracture, and a left tibial fracture. The patient was classified as a borderline state according to the orthopedic trauma team and was managed accordingly.

Conclusions: An article review is presented that signifies the potential benefits of delays in operative multitrauma fracture fixation, particularly for patients in a borderline state.

Keywords: Damage Control Orthopedics, Multitrauma, Femoral Shaft Fracture

1. Introduction

Patients with multiple long-bone shaft fractures are prone to develop systemic complications with increased morbidity and mortality (1-7). Bilateral traumatic femoral shaft fractures are rare injuries in children and are always a challenge for orthopedic surgeons, not only because the treatment needs expertise but also due to the complications during the early and late postoperative periods. Recent studies have shown that patients with bilateral femoral shaft fractures experience a higher rate of systemic complications compared to patients suffering from unilateral femoral shaft fractures (2, 3, 8, 9).

In recent years, focus has shifted toward trying to identify which patient groups can have their femoral fractures treated early and which should wait. This article presents the report of a child with traumatic bilateral femur fractures and a unilateral tibial fracture who was classified in a borderline state and makes a review of related literature about the best time for fracture fixation in this group of patients.

2. Case Presentation

A 5-year-old boy was brought to the Imam Hossein hospital emergency department (ED) after a pedestrian car accident. Upon arrival, he was evaluated by the trauma surgery and orthopedic teams.

According to trauma team assessments, the patient was classified as advance trauma life support (ATLS) Grade

2. The injury severity score (ISS) parameters of the patient are shown in Table 1 with an ISS of 34. The ISS is an anatomical scoring system that provides an overall estimate of a patient with multiple injuries by considering six body regions (head, face, chest, abdomen, extremities [including pelvis], external). Each injury receives an abbreviated injury scale (AIS) score of 1 - 6 (1. minor, 2. moderate, 3. serious, 4. severe, 5. critical, 6. maximal [currently untreatable]). After distinguishing the highest AIS score in each body region, the square of the scores allocated to the three most severely injured body regions were added together to produce the ISS score.

Table 1. The Injury Severity Score (ISS) Parameters of the Patient

Parameter	Injury Description	Grade
Injury severity score (ISS)	A2 + B2 + C2 (A, B, C are the AIS scores of the three most injured ISS body regions)	34
Head and neck AIS	Subarachnoid hematoma	3
Face AIS	Aches around glob	1
Chest AIS	Chest wall stiffness	1
Abdomen AIS	Mild liver contusion	3
Extremities AIS	Bilateral femoral fracture	4
External AIS	Multiple abrasions	1

Abbreviation: AIS, abbreviated injury scale.

The boy's vital signs were 90/60 mmHg blood pres-

sure with 130/minutes pulse rate and axillary temperature of 35°C. His complete blood count revealed a white blood count of 5400, hemoglobin level of 10.2 g/dL, and platelet count of 100,000. A brain CT-scan revealed a less than 5 cc of subarachnoid hematoma. An abdominal CT-scan was suggestive of mild liver contusion, and chest radiography and arterial blood gas analysis were not remarkable for any abnormalities.

The patient suffered bilateral thigh and left leg deformity with a 2 - 3 cm laceration in the anteromedial surface of the left thigh. A vascular examination of both lower limbs showed them to be intact. The confusion state of the patient made neurologic and orthopedic examinations not appraisable.

Right femoral shaft fractures (OTA classification 32-A3), a left distal femur fracture (OTA classification 33-C3), and a left tibial fracture (OTA classification 42-C3) were determined in radiographs (Figure 1).

The patient was a candidate for emergency surgery. However, according to the orthopedic team's opinion, surgery was performed the second day of admission and after hemodynamic stabilization. During surgery, the orthopedic surgery team placed a spanning external fixator across his comminuted, type C3 left femur fracture. Proximal fixation was within the proximal femur and distal fixation in the distal metaphysis and epiphysis, spanning the comminuted fracture. Close reduction and internal fixation with a titanium elastic nail (TEN) were performed for the left proximal tibial fracture (Figure 2). The right femoral shaft fracture was fixed internally using a pre-bent DCP 3.5 plate. Four units of packed red blood cells and two units of fresh frozen plasma were given to the patient during all procedures.

A rehabilitation program was started immediately after surgery. The patient was discharged 12 days after the operation. Weight bearing was allowed six weeks after surgery for both sides.

3. Discussion

One of the most important aspects in the management of patients with bilateral femoral fractures deciding whether surgery is needed and if so when. In the last 10 years, focus has shifted toward trying to identify which patient groups can have their femoral fractures treated early and which should wait.

Any fracture caused by injury could activate the inflammatory cascade and cause a degree of systemic inflammatory response syndrome (SIRS). This condition is considered to be the first hit to the patient's systemic inflammatory system. After the first hit, any surgical intervention subsequently is considered the second hit. The second hit

leads to worsening SIRS and ultimately multi-organ dysfunction syndrome (MODS) (10).

In the last decades, early total care (ETC) was achieved at the index operation, typically within the first 24 hours after injury. During the 2000s, increased appreciation and understanding of the physiology of trauma patients saw a shift towards damage control orthopedics (DCO) (11).

Optimal timing for surgery of polytrauma patients is decided according to DCO principles (12). According to DCO, definitive treatment is delayed until resuscitation of the patient has been achieved adequately (11-16).

Three patient groups now are considered: those who can have their fractures treated early (ETC), those who must wait (DCO), and those who fall in between, the "borderline patient."

For the first time, Pape et al. have described the term borderline for the situation in which a patient is in an apparently stable condition preoperatively but deteriorates subsequently and may develop organ dysfunction (12).

The borderline patient must be looked at closely. These patients typically have femoral fractures, single or bilateral, with pulmonary injury but no other major system injury (17).

The optimal timing of the long-bone fracture fixation in patients with multisystem trauma is controversial. Several studies suggested that early stabilization of major long-bone fractures is associated with clinical features of patients.

Three large studies have assessed the effect of the timing of the internal fixation of the femoral shaft fracture in adult patients with multisystem trauma (ISS > 15) (16-19). Fakhry et al. have found a significant decrease in mortality among groups that were treated later, but they only adjusted for the ISS (19). Morshed et al. showed that waiting just 12 hours before fixation in patients with an ISS > 15 reduced mortality by 50% (16).

However, Brundage et al. did not report significant differences in mortality rate association with treatment time but did find significant increases in complications such as pneumonia, acute respiratory distress syndrome, and the length of hospital stay among patients who were managed between two and five days after the injury (18). In the present case, the patient fully recovered from his abdominal trauma and, despite a suspicious acute respiratory distress syndrome, recovered rapidly after a few days of hospital stay.

Another study showed that multisystem (head or chest) trauma along with femoral fracture could influence the timing of fracture fixation.

Pape et al. reported a significant increase in the incidence of acute respiratory distress syndrome among 106 patients with femoral shaft fractures (ISS > 18) with



Figure 1. Right Femoral Shaft Fractures (OTA Classification 32-A3), a Left Distal Femur Fracture (OTA Classification 33-C3), and a Left Tibial Fracture (OTA Classification 42-C3)

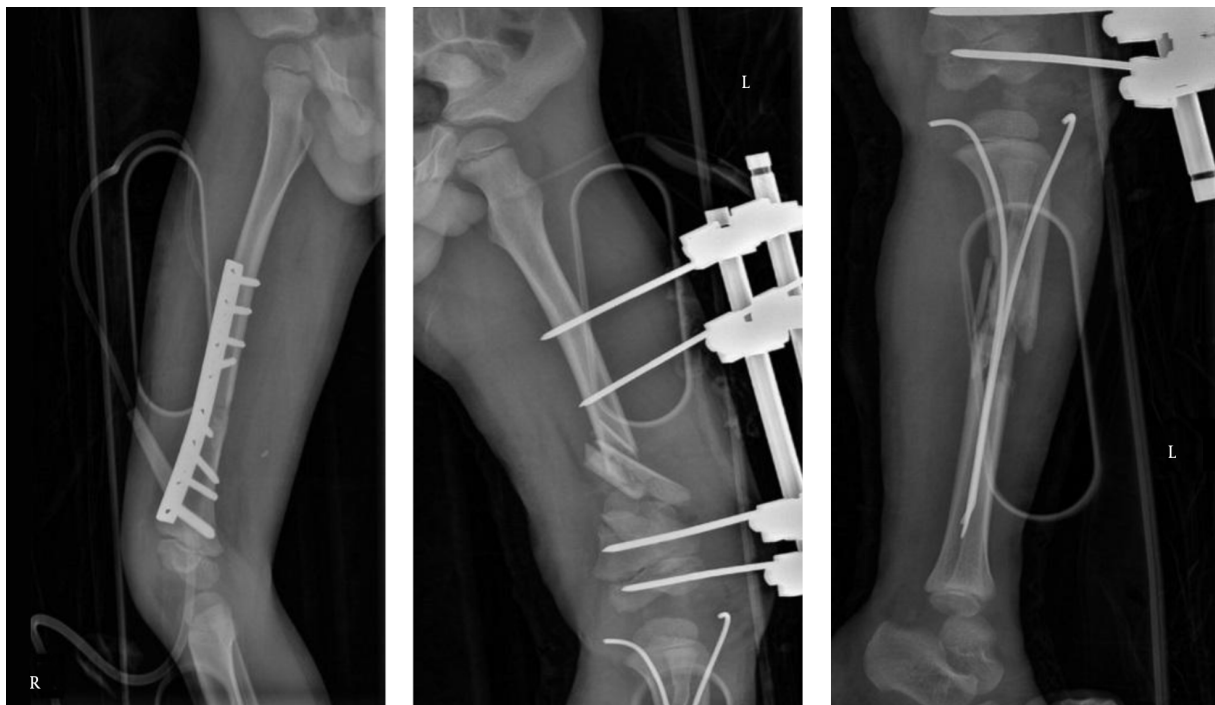


Figure 2. The Postoperative Radiograph the Second Day After Surgery

chest injuries who were managed with intramedullary nailing early (less than 24 hours after admission) as compared with those without chest injuries (33% compared to 7.7%). This finding suggest that patients with chest injuries might benefit from delayed treatment (14).

Serious abdominal injury also could be an important risk factor for mortality and morbidity in the patient with multisystem trauma (16, 20, 21).

Morshed et al. also reported that, in patients with serious abdominal injuries, undergoing delayed treatment was associated with an estimated mortality risk that was 36% that of early treatment. This relative risk was significantly lower than that of patients without such injuries (16).

On the other hand, physiological parameters such as rising lactate and interleukin-6 (IL-6), falling temperature, coagulopathy, and respiratory function failure have all been shown to be useful in guiding this decision-making process (20, 21).

Another factor that can influence treatment approaches in patients with multisystem trauma who have a femoral shaft fracture is post-traumatic hypo-perfusion that may stimulate the immune system for an inflammatory response. In this situation, any surgical treatment prior to adequate resuscitation can lead to substantial end-organ injury (22, 23). The patient discussed here was resuscitated during surgery by receiving a total of 1450 cc of normal saline (50 cc/h as maintenance, 375 cc as deficit, 75 cc as continuous mechanical ventilation deficit, 600 cc for blood loss during surgery, and 250 cc of urine output). The patient was then hydrated by 1250 cc/24 h fluid and oral fluid of 800 cc during the first day, with urine output of 250 cc per day.

The literature mostly is related to femoral fractures and its management in adults. There are a few papers reporting bilateral femur fractures and optimal fixation time in children. The risk for femoral shaft fracture caused by motor vehicle crashes was considerably higher in children than in adults (24, 25). Its peak incidences were at 2 and 12 years, and most children with femoral fracture need to be admitted to the hospital (26).

As discussed above, there are many factors that could influence the timing of surgery; therefore, assessing these factors and making the appropriate decision play an important role in managing patients in these situations.

Our patient's ISS was 34 according to trauma team assessments (Table 1) and was classified as borderline.

The patient was operated on two days after trauma. This delay brought the patient the optimal level for surgery. Surgery for patients in a borderline state can be delayed, as it is acceptable for multiple trauma patients with hemodynamic stability to be operated early, but oper-

ations of patients in a borderline state (like our case), unstable, and extremis group should be delayed (12).

Our case is consistent with the DCO approach and signifies the potential benefits that may be realized with delays in operative multitrauma fracture fixation, particularly for patients in a borderline state.

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