Pediatric Trauma Patients with High Energy Musculoskeletal Injuries

Children’s Mercy Hospital
Kansas City, MO
Case 1
• 9 y 6 mo old male restrained front seat passenger in highway speed MVC. Extrication prolonged due to damage to car.
• GCS of 15 upon arrival
• In trauma bay, patient is hypotensive (systolic pressure in 70’s) and tachycardic (HR in 120’s)
• Injuries identified on early assessment include:
  • Pelvic ring injury
  • Right proximal femur frx
  • Left midshaft radius and ulna frxs
  • Bladder rupture
Right iliac wing frx
Left SI joint dislocation
Bilateral sup/inf pubic rami frxs
Right intertrochanteric femur frx
CT angiography with likely extravasation
Pelvic binder placed
Left radial and ulnar shaft frxs
• Initial resuscitation:
  • Pelvic binder
  • 3 liters crystalloid
  • 3 units pRBC
  • Stable enough for interventional radiology

• Angiography shows right internal iliac extravasation
• Right internal iliac artery underwent successful coil embolization
• Received further resuscitation in the angiography suite and was intubated prior to that procedure

• Upon return to the ICU
  • pH 7.16
  • Base deficit -12
  • Hgb 8.0
  • INR 1.3-1.7

• 9 liters fluid positive the day after resuscitation
CXR at the time of admission

CXR in the unit after angiography
CXR the following day after some diuresis (and a chest tube)
• 48 hours after presentation
  • Metabolic acidosis and coagulopathy rectified
  • Pulmonary function improved
  • Taken to OR for operative stabilization of his hip and pelvis
• Large subcutaneous hematoma was drained at the time of surgery
After right femur fixed, the patient became hypotensive requiring dopamine, left SI joint then reduced and stabilized. Surgery was then halted and he was returned to the ICU for further resuscitation.
2 days later, returned to OR for ORIF of right iliac wing frx and left forearm frx.

It was discovered at this time, 5 days post injury, that the left ulna fracture was open, now with active drainage.

Forearm I&D performed.
• 2 days later repeat washout and ORIF performed.
• Cultures from the initial surgery showed no growth
• Discharged from the hospital post injury day #27
• Foley catheter removed 6 weeks post injury, bladder did not require repair
• At 7 weeks, his fractures were healed enough to allow weight bearing
  • Admitted for inpatient rehabilitation
18 months post injury, after Pop Warner football season, at pre-op appointment for femoral plate removal
Hypotensive Pelvic Ring Injury Flowsheet

At Risk Pelvic Ring Injury & Hypotension

Exam for open wounds

Sheet/Binder

Responsive → Continue Work-up

BP unresponsive to sheeting and fluids/blood

Access to Angio

-Undergo Embolization
-Subsequent Stabilization

No Access to Angio

-External Fixation
-C-Clamp

-Anti-shock IS Screw
-Pelvic packing
Case 2
• 13 y 11m old male unrestrained passenger in a van involved in an MVC, ejected from the car
• Diminished consciousness and obvious facial fractures at the scene led to intubation
• Upon arrival to ER, hemodynamically stable
• CT head, cervical spine, abdomen, and pelvis show no traumatic injuries
• CT chest shows lung injuries consistent with pulmonary contusions
• Clinically has notable bilateral lower extremity injuries
Ipsilateral left proximal femur and distal tibia/fibula frxs, with a degloving wound over the proximal tibia
Right proximal fibula fracture with large degloving injury over tibia, right first metacarpal fracture, and a traumatic right elbow arthrotomy.
• Abx given, went to the OR the following morning:
• Debridement, irrigation, and negative pressure dressings applied to both lower extremity wounds
• Debridement and irrigation of traumatic right elbow arthrotomy
• Closed reduction and pinning of right first metacarpal frx
• Closed reduction and external fixation of the left distal tibia/fibula frxs
• Closed reduction and intramedullary nailing of the left proximal femur frx
• Total OR time: 6 hours, 6 minutes
• Notably the patient’s surgeon needed to go on bedrest for the remainder of her pregnancy a couple weeks later!
• Patient requires 7 additional operations to treat the traumatic wounds involving
  • Negative pressure dressing changes
  • Split thickness skin grafts
  • Integra porcine dermal grafts
• Initial hospitalization of 3 weeks
• External fixator removed from left tibia 4 months post injury
10 months post injury

- Wounds all healed
- No functional limitations
• 2.5 years post injury
  • Wounds all healed
  • No functional limitations
  • Mild left greater trochanteric pain
Case #3
• 9 y 9 mo old female riding on a tractor with her father. Fell off and was run over by a brush hog being towed behind the tractor.

• Injuries to bilateral lower extremities, left more severe than right

• Father applied belt tourniquet in the field and child transported to Bates County Hospital (75 minutes by car from CMH). Non-pneumatic field tourniquet applied.

• At Bates County she received fluid resuscitation and had a SBP in the 130’s

• Transported by air ambulance to CMH
• She becomes hypotensive during the transfer. Upon arrival in trauma bay:
  • BP 62/37
  • HR 145
  • O2 sat 88%
  • Hgb/Hct: 3.9/11.2

• “Massive transfusion protocol” initiated prior to arrival
  • 3 units of non-cross matched blood
  • 1 unit platelets
  • 2 units FFP
  • Intubated
  • Antibiotics (Ancef, gent, then Zosyn)
  • Taken to OR for further management
**Left leg**

- Tourniquet replaced with an uninflated pneumatic tourniquet
- Left popliteal pulse palpable
- Some perfusion of mid leg, absent perfusion of foot
- Extensor mechanism disrupted
- Wounds heavily contaminated

**Right foot**

- Near complete amputation of hallux but perfused
- Deep laceration to heel with exposed calcaneus but well perfused foot
- Wounds heavily contaminated
Left leg

- I&D
- Guillotine amputation through the proximal tibia and fibula frxs, revised to a knee disarticulation when perfusion still appeared compromised
- Wound left open and covered with a negative pressure dressing

Right foot

- I&D
- Debridement/primary closure of 1\textsuperscript{st} and 2\textsuperscript{nd} toe wounds
- Debridement/primary closure of traumatic calcaneal wound
• In the OR, she received 6 more units pRBC, 2 units of FFP, 250 mL Albumin, 2L of Normal Saline
• Also received 5 units of cryoprecipitate. Shortly after the last dose of cryoprecipitate, she became acutely hypotensive, hypoxic, and developed a diffuse erythematous rash, which rapidly recovered after treatment with benedryl and steroids.
• Brought to the unit on pressor support
• Subsequently brought back to the OR six more times for wound vac changes and subsequent skin grafting

2 weeks post injury

2.5 weeks post injury

5 days after STSG placed
2 months post injury
- R foot healed
- Started weight bearing
- LLE wounds healed
- Prosthetic fitting
• 15 months post injury
  • Doing well with prosthesis
  • Has returned to school full time
  • Participating in adaptive sports and dance
  • Some sensitivity over skin grafted areas of amputation, but otherwise pain free
Bibliography


Case #4
• 21 mo old female run over by SUV. Her mother was backing out of driveway, felt a bump, then pulled forward and ran over her daughter again. Tire marks on chest. No loss of consciousness.

• Taken to CMH ED by EMS. GCS 14. Child crying, HR 200+, BP stable en route.

• Respiratory distress in ED, intubated (aspirated during intubation)

• Found to have b/l pulmonary contusions, grade I splenic lac, grade 3 left renal lac. CT head/neck normal

• Orthopaedics placed pelvic sheet
- Bilateral sacroiliac frx-dislocations
- Left iliac wing frx
- Bilateral pubic rami frxs
- Left intertrochanteric frx

- Post pelvic sheet
- Bilateral sacroiliac frx-dislocations
- Left iliac wing frx
- Bilateral pubic rami frxs
- Left intertrochanteric frx

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- Post pelvic sheet
- Bilateral sacroiliac frx-dislocations
- Left iliac wing frx
- Bilateral pubic rami frxs
- Left intertrochanteric frx

- Post pelvic sheet
- Right distal femur frx
- Left intertrochanteric frx
1 day post injury –

- Hgb 8 (10), CK 7600
- Required pressors overnight
- Pelvis externally fixated
- Continues intubated
5 days post injury -
- ORIF bilateral femurs

6 days post injury -
- Hgb 10.3 (8)
- CK 911 (7600)

7 days post injury -
- Extubated
7 days post injury –
- CT shows wide left SI joint and penetration of b/l SI joints

12 days post injury –
- Ex fix revised

14 days post injury –
- Discharged home
- 7 days post injury –
  - CT shows wide left SI joint and penetration of b/l SI joints
- 12 days post injury –
  - Ex fix revised
- 14 days post injury –
  - Discharged home
7 days post injury –
- CT shows wide left SI joint and penetration of b/l SI joints

12 days post injury –
- Ex fix revised

14 days post injury –
- Discharged home
2 weeks post discharge -
  ▶ Doing well
  ▶ Using wheelchair

7 weeks post discharge -
  ▶ Pin site infection treated with Keflex

8 weeks post discharge -
  ▶ Ex fix removed

10 weeks post discharge -
  ▶ Doing well
  ▶ Standing

Last seen 1 year post discharge –
  ▶ Normal ROM, no pain
  ▶ Running, jumping, playing
Case 5
• 2 y 3 mo old male run over by car. Mother was driving sedan and didn’t see son in driveway.
• No loss of consciousness
• Taken to OSH, found to be HD stable, A&O, transferred to CMH
• Multiple abrasions over left back/flank and left leg
• CT head & neck normal
• CT chest showed right pulmonary contusion
- Right iliac wing frx
- Left sacroiliac vertical shear fracture-dislocation
Left closed distal tibia and proximal fibula fractures
Taken to OR 2 days after presentation for left distal femur traction pin, ~5 lbs
3 weeks post op
- Traction removed
- Placement of 1½ spica cast

6 weeks post op
- Spica removed and started weight bearing (no x-ray)

9 weeks post op
- Doing well
- Walking with limp
- Leg lengths equal clinically
3 months post op
- No limp
- Leg lengths equal clinically

9 months post op
- No limp
- Leg lengths equal clinically
- Planned follow up for 2 years but never came
• 12 y 8 m old female struck in the bilateral lower extremities by a vehicle at 40 mph
• Momentary loss of consciousness
• Taken to OSH, given 2 units pRBC, Ancef
• GCS 15 on arrival
• Hemodynamically stable
• Bilateral leg deformities with wounds
• Left frontal bone nondisplaced fracture, no intracranial pathology on CT head
- Right grade IIIB open tibial shaft fx
- Right closed distal fibula fx
- Right SH1 distal femur fx
- Left closed tibial shaft frx
- Left SH1 proximal fibula frx
- Proximal leg wound
- Right proximal femur?
- Right inferior pubic ramus frx
• Emergently to OR for bilateral LE I&Ds, external fixators and NPWT
- CRPP right distal femur
ORPP left open
great toe IP
dislocation
• Extubated evening of surgery
  ▶ Post injury day 5 – ORIF left tibia
  ▶ Post injury day 7 – Right leg STSG (320 square cm) and left leg STSG (148 square cm) with NPWT
  ▶ Post injury day 10 - I&D right necrotic calf wound
  ▶ Post injury day 15 – Conversion of RLE ex-fix to circular frame
  ▶ Post injury day 19 – Discharged home after 9 surgeries
• 6 weeks post injury –
  • LLE healing nicely, great toe pin pulled
  • Right leg with wound drainage, right femur pins pulled

► 7 weeks post injury – RLE femoral ring removed

► 3 months post injury –
  ► Left tibia healing
  ► Right tibia delayed union – Plan to return to OR for debridement with placement of allograft with iliac marrow aspirate
4 months post injury – Right leg superficial infection, Keflex started


7 months post injury – Right tibia not healing

8 months post injury – Right tibia still not healing
8.5 months post injury – Debridement of right tibia non-union site, iliac crest bone graft, IMN fixation, fibular osteotomy

9 months post injury – Starting to weight bear

11 months post injury – Boney bridging

15 months post injury – Doing well. RLE 1 inch shorter then LLE, treated with heel lift
21 months post-injury – 2.8 cm shorter right tibia, 0.8 cm shorter right femur

Returned to cheerleading
2 years 9 months post-injury – Right distal tibial interlock screw removed for pain
Case 7
• 15 y 10 m old male unrestrained back-middle seat passenger in MVC, hit a tree at highway speed. Fatality at scene.
• Presented at OSH, reported to have sternal fracture, pulmonary contusions, L1/L2 fractures, and right acetabular fracture
• Alert and hemodynamically stable on arrival
• Urethrogram shows intact bladder/urethra
• Able to move BLEs, 2+ symmetric pulses
- Right transverse acetabular fx, transtectal
- Right superior & inferior pubic rami frxs
L1 burst frx
L2 burst frx
• Transferred to PICU for monitoring
• A few hours after transfer experienced acute respiratory failure requiring intubation

► Taken to OR later that evening for T12-L4 PSIF & interbody fusion L1-L3
  ► 2 L blood loss
  ► Traumatic durotomy
  ► Multiple rootlet avulsions
  ► Post op on 2 pressors to maintain cord perfusion MAP >60
  ► Continued intubated post operatively
Post-injury day 2 – ORIF right acetabulum
- EBL 600 ml
- Extubated
- TDWB RLE
- SCDs for DVT ppx
- 2 weeks of Celebrex for HO ppx
• 3 weeks post-op – discharge home
  ▶ TDWB RLE
  ▶ AFO LLE for partial foot drop
• 4 weeks post-op
  ▶ Doing well, incision healed
• 9 weeks post-op
  ▶ Right hip doing well, WBAT
  ▶ Left external snapping hip, PT
• 15 weeks post-op
  ▶ Right hip doing well, WBAT
  ▶ Left hip doing well
  ▶ Left ankle dorsiflexion 3+/5, AFO
• 6 months post-op - spine
  ▶ Doing well, continues to have left ankle weakness
Case 8
14 y 9 m old male tackled during football in central Kansas 5 months prior, sustaining a grade IIIA open right tibial shaft fracture. ~2 hour delay to get to hospital where he received IV Abx and underwent I&D with reamed IMN fixation.

Inpatient for 10 days, persistent wound drainage cultured, growing group D enterococcus and Serratia marcescens. Treated with gentamicin, ceftriaxone, and vancomycin. Outpatient Abx since the time of his injury.

3 months after index surgery, distal interlock screw bent and was removed. Intra-op cultures grew group D enterococcus.

Persistent drainage

Numbness on the dorsum of his foot. Able to ambulate with discomfort.

Presents for second opinion
Grade IIIA open tibia and fibula frxs (outside films 5 months prior)
- Post op IMN fixation (outside films – no xray showing bent screw)
5 months post IMN
- Nail removed, canal reamed
- I&D of sinus and non-union site
- Abx-impregnated PMMA beads
- Cx Enterococcus faecalis – zosyn, amoxicillin
- CRP 1.1  ESR 7
4 days later –
- Repeat I&D
- Replaced Abx beads
- Medial soleus flap by Plastics
- Taylor spatial frame

6 weeks later –
- Repeat I&D
- Replaced Abx beads
- Cx coag (-) Staph
- Continues amoxicillin
11 wks post IMN removal –
- Wound appears healthy
- Bone grafted with cancellous iliac crest
- Continues amoxicillin (total 6 months)

4 months post IMN removal –
- Doing well
- Plan to remove frame
16 months post IMN removal –
- Slight LLD
- Right ankle pain with laxity
- Playing baseball, has difficulty with basketball

20 months post IMN removal –
- Pain improved
- Continues baseball, avoiding collision sports
2 y 6 mo post IMN removal –

- Doing well, continues baseball
- ¾ inch LLD (right shorter)
- Prefers no heel lift