Wound Complications and How to Prevent Them
Mark J. Berkowitz, MD
Cleveland, Ohio

Disclosure:
(n)

Wound Complications after ORIF of Calcaneus Fractures and How to Prevent Them

I. Scope of the problem
   • The most common complication of surgical treatment of calcaneus fractures involves the surgical wound and surrounding soft-tissues
   • Text books cite an incidence of wound complications in up to 30% of cases for closed fractures
   • However, the numbers at the high end of this range frequently come from smaller, less prominent studies
       ○ 18.1% of 33 fractures
     ▪ Abidi, et al. FAI, 1998
       ○ 33% of 63 fractures with wound complications
   • Larger studies from prominent authors document a much lower incidence
     ▪ Benirshke, et al. JOT, 2004—341 closed fractures
       ○ 1.6% serious infection closed fractures
     ▪ Harvey, et al. FAI, 2001—218 fractures
       ○ 3.2% infection
       ○ 8.2% wound complications
       ○ 6.7% wound necrosis
       ○ 4.7% hematoma
       ○ 4.3% soft tissue infection
       ○ 2.2% bone infection
     ▪ Canadian study, JOT, 2003—226 fractures
       ○ 16% superficial wound slough
       ○ 4.4% deep infection
     ▪ Sanders, et al. CORR, 1993—120 fractures
       ○ 5 wound dehiscence/infection in 89 Type II fractures
       ○ 2/30 Type III fractures
       ○ 2/11 Type IV with deep infections
     ▪ Incidence of wound complication in open fractures definitively higher, 19-31%
       ▪ Mehta, et al. JOT, 2010—14 open fractures
         ○ 7% osteomyelitis
         ○ 7% superficial infection
       ▪ Heier, et al. JBJS, 2003—43 open fractures
         ○ 37% infection
         ○ 19% osteomyelitis
   • Must accurately characterize the nature of the wound complication
     ▪ Dehiscence vs. infection
II. Definition and types of soft-tissue complications

- **Pre-operative**
  - Skin necrosis
    - Tongue-type fractures
  - Blisters
    - Clear (partial thickness)
    - Hemorrhagic (full thickness)
  - Wounds from open fractures

- **Post-operative**
  - Surgical wound dehiscence
    - Superficial/partial-thickness dehiscence
      - Apical wound necrosis
    - Full-thickness dehiscence
      - Exposed bone and/or hardware
  - Infection
    - "Non-Serious" (Benirschke, et al. JOT, 2004)
      - Managed with oral antibiotics
    - "Serious"
      - Requiring intravenous antibiotics, surgery, admission, etc.
      - Superficial infection (osteitis)
      - Deep infection (osteomyelitis)

III. Risk factors

- Smoking
- Noncompliance
- Diabetes
- Obesity
- Change in Bohler's angle
- Open fractures
- Timing of surgery
- Prolonged surgical time
- Prolonged tourniquet time
- Single layer closure

V. Prevention

- **Patient selection (non-operative treatment)**
  - Non-surgical treatment eliminates wound complications but creates other complications
    - Canadian study, JOT, 2003
      - 25% major complications in surgical group
      - 18% major complications in non-surgical group
    - Radnay, et al. JBJS, 2006
      - 11% wound complication for ST fusion with prior ORIF
      - 28% wound complication for ST fusion without ORIF
  - **Delay in surgical treatment**
    - 10-21 days
• Wrinkle test
• Optimization of risk factors
  ▪ Smoking cessation
  ▪ Glucose control
• Staged surgical treatment
  ▪ Initial external fixation (Attinger, Cooper. OCNA, 2001)
  ▪ Initial I and D and K-wires for open fractures (Mehta, et al. JOT, 2010)
  ▪ Prevents contraction of soft-tissue envelope
• Edema resolution
  ▪ Cryotherapy
  ▪ Pulsed-intermittent compression
  ▪ Elevation
• Blister treatment
  ▪ Observation vs. unroofing with Silvadene (Strauss, et al. JOT, 2006)
• Surgical technique
  ▪ Extensile lateral incision
    ▪ Incision should be between angiosomes of flap (lateral calcaneal artery) and heel pad (medial calcaneal artery)
    ▪ No-touch technique
    ▪ Double-layered closure
    ▪ Suture material (absorbable vs. nonabsorbable)
    ▪ Suturing technique
      ▪ Allgower-Donati least strangulating (Sagi, et al. JOT, 2008)
  ▪ Alternative incisions / approaches
    ▪ Sinus tarsi
    ▪ Modified Palmer
    ▪ Percutaneous / minimally invasive osteosynthesis
    ▪ External fixation
• Post-surgical
  ▪ Immobilization vs. early mobilization
  ▪ Suture retention
  ▪ Drain
  ▪ VAC

VI. Treatment
• Most cases of wound complication are “non-serious”
• Basic wound care
• Cessation of motion
• Dressing changes
• Whirlpool therapy
• Oral antibiotics
• VAC for more extensive dehiscence
• Serious infections usually require surgical treatment
  ▪ Osteitis
    ▪ Irrigation/debridement
    ▪ IV antibiotics
    ▪ Hardware retention
    ▪ DPC, VAC, or free flap for closure
- Osteomyelitis
  - Radical debridement
  - Hardware removal
  - Antibiotic cement
  - Free flap
  - Possible staged fusion
  - Amputation

REFERENCES:

Wound-healing risk factors after open reduction and internal fixation of calcaneal fractures.
Abidi NA. Dhawan S. Gruen GS. Vogt MT. Conti SF.

Soft tissue reconstruction for calcaneal fractures or osteomyelitis.
Attinger C. Cooper P.

Wound healing complications in closed and open calcaneal fractures.
Benirschke SK. Kramer PA.

Vascularity of the lateral calcaneal flap: a cadaveric injection study.
Borrelli J Jr. Lashgari C.

Early wound complications of operative treatment of calcaneus fractures: analysis of 190 fractures.
Folk JW. Starr AJ. Early JS.

Morbidity associated with ORIF of intra-articular calcaneus fractures using a lateral approach.
Harvey EJ. Grujic L. Early JS. Benirschke SK. Sangeorzan BJ.

Open fractures of the calcaneus: soft-tissue injury determines outcome.
Heier KA. Infante AF. Walling AK. Sanders RW.
A staged treatment plan for the management of Type II and Type IIIA open calcaneus fractures.
Mehta S. Mirza AJ. Dunbar RP. Barei DP. Benirschke SK.

Subtalar fusion after displaced intra-articular calcaneal fractures: does initial operative treatment matter?
Radnay CS. Clare MP. Sanders RW.

The effect of suture pattern and tension on cutaneous blood flow as assessed by laser flowmetry in a pig model
Sagi HC, Papp S, DiPasquale T.

Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification.
Sanders R. Fortin P. DiPasquale T. Walling A.

Negative-pressure wound therapy to treat hematomas and surgical incisions following high-energy trauma.
Injury. 60(6), 1301-1306, 2006 June

Blisters associated with lower-extremity fracture: results of a prospective treatment protocol.
Strauss EJ. Petrucelli G. Bong M. Koval KJ. Egol KA.

Calcaneal fractures—open reduction and internal fixation (ORIF)
Zwipp H, Rammelt S, Barthel S.