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Open Fractures: 6 Hour Rule: Can It Wait Overnight?

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Traditional teaching has emphasized the need to perform irrigation and debridement of open fractures early, with suggested time of six hours. However, there has been little to no literature that has been able to support this claim.

Open fractures are associated with risks of infection and non union secondary to the injury and early debridement may help in decreasing the infection rate by removing the contamination and possibly preventing bacterial colonization.

Charalambous et al studied a cutoff of 6 hours after injury for the timing of initial irrigation and debridement, and no statistically significant difference between early and delayed treatment groups was noted in terms of infection rates.

Patzakis et al reviewed the infection rates of over 1100 patients with open fractures treated with irrigation and debridement within 12 hours from injury or in a delayed fashion (more than 12 hours from injury); the infection rate in both groups was 7% showing no effect of timing of surgery.

Weber et al in a prospective evaluation of 791 open fractures showed that Infection after open fracture was associated with increasing Gustilo grade or tibia/fibula fractures but not time to surgery or antibiotics.

More recently Lack et al attempted to identify factors associated with infection. They found that age, smoking, diabetes, injury severity score, type IIIA versus 3B/C injury, and time to surgical debridement were not associated with infection on univariate analysis. Greater than 5 days to wound coverage ($P < 0.001$) and greater than 66 minutes to antibiotics ($P < 0.01$) were univariate predictors of infection. Multivariate analysis found wound coverage beyond 5 days [odds ratio, 7.39; 95% confidence interval (CI), 2.33-23.45; $P < 0.001$] and antibiotics beyond 66 minutes (odds ratio, 3.78; 95% CI, 1.16-12.31; $P = 0.03$) independently predicted infection. Immediate antibiotics and early coverage limited the infection rate (1 of 36, 2.8%) relative to delay in either factor (6 of 59, 10.2%) or delay in both factors (17 of 42, 40.5%).

Skaggs et al, in their analysis included 554 open fractures in 536 consecutive patients who were eighteen years of age or younger. The overall infection rate was 3% (sixteen of 554). The infection rate was 3% (twelve of 344) for fractures that had been treated within six hours after the injury, compared with 2% (four of 210) for those that had been treated at least seven hours after the injury; this difference was not significant (p = 0.43). When the fractures were separated according to the Gustilo and Anderson classification system, there were no significant differences in the infection rate between those that had been treated within six hours after the injury and those that had been treated at least seven hours after the injury. Specifically, these infection rates were 2% (three of 173) and 2% (two of 129), respectively, for type-I fractures, 3% (three of 110) and 0% (zero of forty-four), respectively, for type-II fractures, and 10% (six of sixty-one) and 2% (two of thirty-seven), respectively, for type-III fractures (p > 0.05 for all three comparisons)

While these studies indicated that some delay in debridement did not affect infection rates, we cannot recommend waiting for significantly contaminated open fractures; Gustillo Types 3B and C injuries and those with mangled extremities

Based on available literature, the timing of surgery for open fractures is variable and it is safe to wait till the morning for debridement; while there is no optimal time for surgery, the sooner the better. This will allow for appropriate staff and facilities for surgical treatment.

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2. British Orthopaedic Association and the British Association of Plastic, Reconstructive and Aesthetic Surgeons (BAPRAS). Working party on the management of open tibial fractures. Br J Plast Surg. 1997; 50:570--583.

3. Patzakis MJ , Wilkins J , . Factors influencing infection rate in open fracture wounds. Clin Orthop Relat Res. 1989; (243):36—40

4. Charalambous CP , Siddique I , Zennios M , Early versus delayed surgical treatment of open tibial fractures: effects on the rates of infection and need of secondary surgical procedures to promote bone union. Injury. 2005; 36(5):656--661.

5. Penn-Barwell JG , Murray CK , Wenke JC , . Early antibiotics and debridement independently reduce infection in an open fracture model. J Bone Joint Surg Br. 2012; 94(1):107--112. Basic science studies support the common thought that thoroughness of debridement is more important than its timing: a well-done debridement by an experienced surgeon is better than an inadequate debridement performed within 6 hours

6. Schlitzkus L , Goettler C , Waibel B , Open fractures: it doesn't come out in the wash. Surg Infect. 2011; 12(5):359—363. identified that fracture grade, revised trauma score, and male sex were all independent predictors of wound complications but timing of initial debridement was not.

7. Weber D1, Dulai SK, Bergman J, Buckley R, Beaupre LA. Time to initial operative treatment following open fracture does not impact development of deep infection: a prospective cohort study of 736 subjects. J Orthop Trauma. 2014 Nov;28(11):613-9.
8. Lack WD, Karunakar MA, Angerame MR, Seymour RB, Sims S, Kellam JF, Bosse MJ. Type III open tibia fractures: immediate antibiotic prophylaxis minimizes infection. J Orthop Trauma. 2015 Jan;29(1):1-6.

Talus Fractures: Timing of Surgery

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Fractures of the talar neck and body are relatively uncommon injuries that are typically the result of high energy trauma. The goals of treatment include an accurate anatomical restoration of the entire talus to allow joint mobilization, revascularization, and the minimization of complications. The most commonly observed and/or concerning complications of the injury and the treatment include subtalar and tibiotalar joint arthritis, avascular necrosis with or without collapse, infection, and soft tissue wound healing complications. The urgency and timing of surgical treatment in talar neck fractures and its effect on outcomes has been debated for decades.

The blood supply to the talus has been studied with both injection studies and Gadolinium-enhanced magnetic resonance imaging (Miller et al, JBJS 2011). These studies have demonstrated that all three of the main arteries of the leg (anterior tibial, posterior tibial, and peroneal) have contributions to the talus in an anastomotic network, with the posterior tibial artery providing the majority of talar blood flow. Interestingly, the posterior tibial artery provides a combination of retrograde flow into the talar body via the branches at the tarsal canal, as well as antegrade flow from the posterior tubercle (Miller et al, JBJS 2011). Displaced talar neck fractures certainly disrupt portions of the talar blood supply, and the amount of disruption appears to be related to the displacement of the talar body. Preservation of the contributions of these vessels are logically considered important to minimize the risk of avascular necrosis. What is less clear is the impact of timing of definitive fixation on the incidence of avascular necrosis and talar body revascularization.

A number of previous studies have failed to demonstrate an impact on the timing of fixation and the development of avascular necrosis (Bellamy et al, 2011; Vallier et al, 2004; Lindvall et al, JBJS 2004, Vallier et al, JBJS 2014). All of these series are retrospective and may be too small to detect small differences in the incidence of avascular necrosis based on time from injury to definitive operative fixation. However, the consistency of the data is compelling. In non-displaced or minimally displaced talar neck fractures without subtalar dislocation, the incidence of avascular necrosis is virtually non-existent despite reported variations in time from injury to surgery. Given the typical lack of soft tissue compromise in these injuries combined with the expected good results with regards to blood flow to the talus, operative stabilization can proceed when the soft tissues are favorable and an experienced surgical team is available. However, in displaced fractures with an associated dislocation of the subtalar, tibiotalar or talonavicular joints, the incidence of avascular necrosis is significant. Early operative intervention has been hypothesized to relieve blood flow embarrassment on the vessels that supply the talar body and are in an unfavorable anatomical position. Further, early fixation may allow for revascularization of the talar body across a well-reduced fracture. However, in a study by Vallier et al who reviewed the results of 65 patients treated operatively for talar neck and body fractures, avascular necrosis was observed in only 25% and this was not related to the time of definitive fixation (Vallier et al, JBJS 2014). This series stratified patients based on the amount of the Hawkins type and further divided patients with type II fractures into IIA and IIB patterns (those without and with associated dislocation of the subtalar joint). The incidence of avascular necrosis was 0 in the Hawkins I and IIA patters, 25% in the IIB patterns, and 41% in the III patterns. The majority of patients were treated with urgent open reduction and definitive fixation at an average of 10 hours from injury, largely because of associated open injuries or dislocations which put the soft tissues at risk. However, in the remaining 43% of patients, definitive fixation was delayed fixation at an average of 10.1 days. Despite these large differences in timing to fixation, there was no association found with the development of avascular necrosis (Vallier et al, JBJS 2014). This lack of association between timing of fixation and the development of avascular necrosis has been identified in several other large retrospective reviews (Lindvall et al, JBJS 2004, Vallier et al, JBJS 2004), as well as a Systematic review and meta-analysis (Dodd et al, JOT, 2015).

Although retrospective studies have failed to detect an association between timing of fixation and the development of complications related to talar blood supply, there are a number of surgical urgencies and emergencies in talar neck fractures. Open talus fractures should be treated similar to other open injuries and require early debridement and irrigation. More concerning are irreducible talar fracture dislocations. In Hawkins III patterns, the talar body is typically dislocated posteromedially. At risk are the posteromedial soft tissue structures including the posterior tibial artery, the tibial nerve, and the posteromedial skin. Urgent reduction of the talar body into the ankle mortise should be performed. On occasion (although uncommon), a closed reduction may be successful. This requires several sets of hands, and a combination of pharmacological paralysis, knee flexion, hindfoot distraction, and hindfoot valgus. Direct pressure is then applied to the dislocated posteromedial talar body to reduce the talus back into the ankle mortise. If unsuccessful, operative intervention is indicated. An attempt can be made using the same basic reduction maneuvers after placement of a trans-calcaneal Schanz pin that facilitates improved distraction and hindfoot control. If closed reduction is unsuccessful, open reduction is indicated. Since the majority of talar neck fractures are optimally fixed through two surgical approaches (anteromedial and anterolateral), these can be used for both reduction of the dislocated talar body and for definitive fixation. Frequently, 2.5 mm terminally threaded Schanz pins placed through the surgical approach(es) and into the cancellous surface of the dislocated talar body will assist in reduction. If the talar body remains irreducible or if there is concern about further damage to the important posteromedial structures, a medial malleolar osteotomy should be performed and will allow for atraumatic reduction of the talar body. Obviously in fractures with an associated medial malleolar fracture, the medial malleolar injury can be exploited to facilitate reduction.

Talar neck fractures are associated with a number of challenges, and long term results are optimized by avoidance of early and late complications. The overall goals of surgery include an accurate reduction of the entire talus, reduction of any associated dislocations and subluxations, and treatment of any associated injuries. Two surgical approaches are recommended in the majority of talar neck fractures. The most common complication is subtalar joint arthritis and this complication is unrelated to the surgical timing. The incidence of avascular necrosis can be lessened by good surgical techniques that minimizes any additional insult to the blood supply; there is no data suggesting that two approaches increases the risk of AVN. The incidence of AVN appears to be more related to the injury pattern as previous studies have failed to demonstrate an association with even open injuries. Irreducible fracture dislocations require a sequential strategy for reduction and an open approach is frequently required.

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Femoral Neck Fractures in the 30 Year Old: Tonight?

Philip Wolinsky, MD

Biomechanics of Femoral Neck Fractures and Implications for Fixation
Augat P, Bliven E, Hackl S,
JOT 33(1), Suppl Jan 2019: S27-S32

Femoral Neck Fractures in Young Patients: State of the Art
Chan DS
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Fractures of the femoral neck in patients between the ages of 12 and 49 years
Swiontkowski MF, Winquist RA, Hansen ST Jr
JBJS(A) 66, 1984: 837-846

Reduction techniques for young femoral neck fractures
Halvorson J
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Surgical Treatment of femoral neck fractures after 24 hours in patient between the ages of 18 and 49 is associated with poor patient outcomes: an analysis of 1361 patient in the National Trauma Data Bank
Samuel AM, Russo GF, et al
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Treatment of young femoral neck fractures: is there a consensus?
Slobogean GP, Sprague SA, et al
Injury 46, 2015: 435-330