Original Article

Safety of Skeletal Traction through the Distal Femur, Proximal Tibia, and Calcaneus

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Abstract

Introduction: Skeletal traction provides pain relief and temporary stability in patients anticipating surgery for a variety of lower-extremity fractures. Recent literature suggests that distal femoral traction provides pain relief and is safe; however, data regarding proximal tibial and calcaneal pins are primarily historical and limited. The purpose of this study is to document complications associated with distal femur, proximal tibia, and calcaneal traction pin placement. **Materials and Methods:** We identified patients with the distal femur, proximal tibia, and calcaneal traction pin placement from January 2013 to June 2016. Chart review was utilized to identify any complications, including nerve or vascular injuries, need for revision, or infection. **Results:** Five hundred and nineteen traction pins were eligible for review, consisting of 120 calcaneal traction pins, 129 distal femoral pins, and 270 proximal tibia traction pins. Primary diagnosis was defined as 305 femur fractures (58.8%), 60 tibial shaft fractures (11.6%), 60 acetabular fractures (11.6%), 38 pilon fractures (7.3%), 30 pelvic ring injuries (5.8%), 21 tibial plateau fractures (4.0%), and 5 hip dislocations (1.0%). We identified 17 (3.3%) adverse events potentially attributable to traction pin insertion. Pins that became infected were found to have been in place for a significantly longer duration (18.3 days compared to 5.8 days, $P = 0.0001$). **Conclusions:** Traction pin placement for skeletal traction is generally an uncomplicated procedure. Duration of pin placement is significantly related to the likelihood of pin site infection.

Keywords: Complications, fracture care, infection, skeletal traction

Introduction

Skeletal traction provides pain relief and temporary stability in patients anticipating surgery for variety of lower-extremity fractures and is a well-accepted component of treatment for a patient awaiting definitive fixation. Several options for skeletal traction exist, including pin placement in the distal femur, proximal tibia, or calcaneus. Location of pin placement is usually selected based on constellation of injuries, provider choice, and training. Each of these options has theoretical advantages, disadvantages, and potential complications.[1,2]

Theoretical advantages of a distal femoral pin include direct pull on the fractured bone for femoral fractures, as well as avoiding pull through the knee, which may have a concomitant ligamentous injury. Disadvantages include possible contamination of the medullary canal, possible interference during the placement of definitive fixation, specifically with interlocking bolt placement for femoral nails, risk of septic knee joint, heterotopic ossification, and gas gangrene.[3-5] Theoretical advantages of proximal tibial traction pins include avoiding contamination of the femoral medullary canal and avoiding holes that may interfere with distal

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interlocking bolt placement for femoral nails. Disadvantages include pull through the knee and possible peroneal nerve injury or popliteal artery pseudoaneurysm.[6,7] Theoretical advantages of calcaneal fixation include the ability to provide distal traction for fractures of the tibia. Disadvantages include possible sural and medial calcaneal nerve injury.

The majority of data regarding skeletal traction are from historical literature describing long-term skeletal traction for definitive treatment of long bone fractures, rather than for temporary stability. A recent study demonstrated that skeletal traction through the distal femur provides pain relief compared to splinting and is safe.[8] Another study reported low infection rates with distal femoral and proximal tibial pins.[3] However, only 6% of the pins in this series were in the proximal tibia; information regarding proximal tibial, and calcaneal pins is notably lacking in the literature. The purpose of this study is to identify complications associated with distal femur, proximal tibia, and calcaneal traction pin placement. Our hypothesis was that complications among these groups would not differ significantly.

Materials and Methods

The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation our Institutional Review Board (IRB) and with the Helsinki Declaration of 1975, as revised in 2000. After the IRB approval, we retrospectively identified patients who received skeletal traction in the distal femur, proximal tibia, or calcaneus from January 2013 to June 2016 through the review of departmental databases and by current procedural terminology code (20670). For this type of study formal consent is not required. We excluded patients under the age of 18 years and patients that underwent immediate transfer to alternative hospitals. All individuals screened for our study were patients at our institution's county hospital, which is an academic level-1 trauma center in the United States that primarily cares for patients of a lower socioeconomic status (uninsured, undocumented, low income, etc.). At this hospital, on-call orthopedic residents place traction pins in the Emergency Department, operating room, or intensive care unit using a standard technique and under local anesthesia or conscious sedation. A brace-and-bit drill is used to place 4-mm or 5-mm fully threaded Steinmann pins using aseptic technique. Distal femoral traction pins are placed approximately two fingers breadths above the superior pole of the patella from medial to lateral. Proximal tibial traction pins are placed two fingerbreadths distal and posterior to the tibial tubercle from lateral to medial. In the calcaneus, a centrally-threaded pin is inserted from medial to lateral in the safe zone described by Casey *et al*.[9] Pin placement was verified with postprocedure radiographs.

We identified 526 traction pins placed in the study period in 509 unique patients. Three traction pins were excluded as the patients were under 18 years of age. Four distal tibia pins were also excluded, leaving 519 traction pins in 502 unique patients eligible for review. We reviewed the medical record to identify any immediate complications such as nerve or vascular injuries, need for pin removal and reinsertion, or infection. All available radiographs were reviewed to evaluate the need for revision, accuracy of pin placement, and potential heterotopic ossification. All adverse events were recorded, as was duration traction of pin status. In general, evaluation was made at the patient's first follow-up visit (2 weeks after discharge) and at three and 6 months. Patients without 4 weeks of follow-up were excluded from the evaluation of infection, though all patients with infection were included, regardless of follow-up.

Results

A total of 519 traction pins were eligible for review, consisting of 120 calcaneal traction pins, 129 distal femoral pins, and 270 proximal tibia traction pins. Fourteen patients received bilateral traction pin placement. Traction pins were inserted for the following reasons: 305 femur fractures (58.8%), 60 tibial shaft fractures (11.6%), 60 acetabular fractures (11.6%), 38 pilon fractures (7.3%), 30 pelvic ring injuries (5.8%), 21 tibial plateau fractures (4.0%), and 5 hip dislocations (0.96%). Eighty-two (15.8%) of these fractures were open. The mean length of follow-up was 104.7 days (range: 1–1347 days). Patients' mean age was 44.0 years (range 18–97 years). The population was 69% males. We excluded 170 pins from the evaluation of infection as they had <28 days of follow-up, leaving 349 pins for the analysis (90 calcaneus pins, 92 distal femur pins, and 167 proximal tibia pins).

Of the 519 pins included for analysis, there were 17 complications resulting in an overall complication rate of 3.3%. There were 8 infections resulting in an overall infection rate of 2.3% (out of 349 included for analysis). There were 7 cases of nerve injury resulting in an overall incidence of 1.3%. In addition to infection and nerve palsy, there were two additional complications (0.4%). Findings are summarized in Table 1.

There were 5 (3.9%) complications after distal femoral pin placement. Three patients had infections that were successfully treated with local debridement and antibiotics (3/92, 3.3%). One patient reported diminished lateral foot sensation, and one patient experienced a foot drop. These both resolved without intervention.

Six patients (2.2%) experienced complications after the placement of a proximal tibial traction pin. One patient had an improperly placed pin (too posterior in the tibia) that required removal and reinsertion of the pin. Two patients had infections requiring local debridement and antibiotics (2/167, 1.2%). Two patients reported decreased sensation over the anterior leg. One patient had a deep peroneal nerve palsy, which resolved over several months.

Six patients (5.0%) with calcaneal pins had complications. Three patients had infections requiring local debridement and/or antibiotics (3/90, 3.3%). One patient had an equinus

Table 1: Complications identified with traction pin placement

Patient	Pin site	Age	Diagnosis	Follow-up (days)	Complication
1	Proximal tibia	79	Acetabulum fracture	85	Local pin site infection treated with irrigation and debridement and IV antibiotics
2	Proximal tibia	92	Acetabulum fracture	41	Local pin site infection treated with irrigation and debridement and IV antibiotics
3	Proximal tibia	45	Femur fracture	26	Decreased anteriolateral leg sensation-resolved
4	Proximal tibia	25	Femur fracture	94	Decreased anteriolateral leg sensation-resolved
5	Proximal tibia	61	Femur fracture	61	Pin too posterior-removed and replaced in correct position
6	Proximal tibia	32	Femur fracture	186	Deep peroneal nerve palsy
7	Distal femur	34	Femur fracture	52	Local pin site infection treated with irrigation and debridement and IV antibiotics
8	Distal femur	65	Acetabulum fracture	448	Local pin site infection treated with irrigation and debridement and IV antibiotics
9	Distal femur	47	Pelvic ring fracture	350	Slight decreased sensation over lateral foot
10	Distal femur	86	Femur fracture	208	Superficial cellulitis around pin-treated with IV antibiotics
11	Distal femur	53	Femur fracture	225	Foot drop requiring AFO-resolved
12	Calcaneus	33	Pilon fracture	72	Local pin site infection treated with irrigation and debridement and IV antibiotics
13	Calcaneus	61	Pilon fracture	53	Local pin site infection treated with irrigation and debridement and IV antibiotics
14	Calcaneus	31	Tibial plateau fracture	341	Superficial cellulitis around pin-treated with IV antibiotics
15	Calcaneus	50	Tibial shaft fracture	129	Equinus contracture (no tibialis anterior function)
16	Calcaneus	24	Pilon fracture	211	Decreased plantar foot sensation
17	Calcaneus	37	Pilon fracture	107	Decreased first dorsal webspace sensation

IV: Intravenous, AFO: Ankle foot orthosis

contracture, one patient had decreased plantar sensation, and one patient experienced decreased first dorsal web space sensation.

There was no significant difference between pin placement location categories with regard to the overall complication rate or infection rate. In addition, there was no significant difference in complication rate based on age or sex [Table 2]. The average duration of pin placement in patients with subsequent pin infection was 18.3 days (range 1–42 days), compared to the average duration of pin placement in noninfected pins, 5.8 days (range 1–83 days) ($P = 0.0001$). No vascular injuries, unrecognized ligamentous injuries, or cases of osteomyelitis were identified. Within the cohort of patients, we also identified 16 inpatient hospital deaths, six patients with pulmonary embolus, and six patients with deep-vein thrombosis.

Discussion

Skeletal traction is commonly used to provide provisional stability and pain relief for patients with fractures of the lower extremity. While it is a routinely performed procedure, the majority of the current literature on skeletal traction is regarding its use as definitive fixation, or cadaveric studies regarding safe zones of traction pin placement. There remains a paucity of data regarding complications associated with traction pin placement in the clinical setting. The incidence of these events remains largely unknown. Duration of traction pin status has been thought to correlate with the likelihood of infection, but this has not been shown in a large sample size. Prior publications attempting to provide data characterizing the complications have been limited by small sample size and therefore unreliable. To our knowledge, this study provides the largest series of traction pin placement and related complications in the literature to date.

Placement of skeletal traction pins can be associated with an array of complications including damage to neurovascular structures, ligamentous injury, fracture, and infection.[1] Several authors have published their experience with long-term traction reporting a major infection rate of up to 9.5%.[3,4,10-17] Kirby and Fitts reported on 305 transfixion pins observed over an average of 6 weeks. Complications occurred in 12 patients (3.93%) and included 7 loose pins/wires, 1 broken wire, 1 bow failure, 1 infection, and 2 transient peroneal nerve palsies.[16] Nigam *et al*. performed a prospective case–control of 60 patients with long-term proximal tibial pins comparing the use of local antibiotics in preventing pin site morbidity. The infection rate among the control group was 30%, with only a 3% infection rate among cases.[18] A Cochrane database study by Lethaby *et al*. reviewed the pin site infection associated skeletal traction and external fixators to elucidate whether different methods of cleansing/dressing the pin sites had an effect on infection rates. They concluded that there was insufficient evidence in the literature to identify a strategy of pin site care to minimize infection rates.[19]

In the study by Bumpass *et al*., examiners performed a prospective cohort study evaluating the safety profile and functional outcome of patients with femoral shaft, acetabular, and unstable pelvic fractures immobilized with skeletal traction versus splinting before definitive fixation.

Table 2: Complications by age and sex

Sex	Male (n=363), n (%)	Female (n=156), n (%)	P*
All complications	13 (3.6)	4 (2.6)	0.48
Infection	6 (1.7)	2 (1.3)	1
Nerve injury	5 (1.4)	2 (1.3)	1
Other	2 (0.6)	0 (0.0)	1
Age	**Age <50 (n=328), n (%)**	**Age ≥50 (n=191), n (%)**	**P***
All complications	9 (2.7)	8 (4.2)	0.13
Infection	3 (0.9)	5 (2.6)	1
Nerve injury	6 (1.8)	1 (0.5)	0.43
Other	0 (0.0)	2 (1.0)	0.14

*P-value determined by Chi-square or Fisher's exact test (expected value of <5)

No complications were observed of the 6-month follow-up period. Visual analog scale scores were significantly lower in patients placed in skeletal traction; moreover, there were no significant differences in 6-month Lysholm scores between the immobilization groups.[8] A similar study by Austin *et al.* quantified the infection risks of lower extremity skeletal traction in 157 patients. They reported a single infection, a septic knee joint, following placement of distal femoral skeletal traction. The authors concluded that skeletal traction can be safely performed at bedside with low infection rates.[3] Weaknesses of this study that limits its utility include the lack of analysis of other complication including neurovascular injury or unrecognized ligamentous injury. In addition, the cohort in this study only included 9 proximal tibia skeletal traction, making its findings less generalizable for this anatomic site.

This study showed a low complication rate of 2%–5% associated with transient skeletal traction. Traction pins can be placed in the distal femur, proximal tibia, and calcaneus with minimal risk of infection, osteomyelitis, vascular injury, ligament injury, and fracture. In the absence of significant differences in complication rates between groups, our results do not help guide selection of pin location but do reinforce that traction pin placement for skeletal traction is a safe procedure. These pins can be placed safely after appropriate training and are an important treatment modality in high-volume trauma centers.

Our study has several strengths. The cohort in this study provides analysis of the largest series of traction pin placement in the literature to date. In addition, there is a relatively even distribution of anatomical sites (distal femur, proximal tibia, calcaneus), which allows for stratified analysis of outcomes. Finally, the skeletal traction pins were placed by a large number of residents with varying years of experience adding to the validity of the study. We believe that this is representative of the experience at many high-volume trauma centers and lends itself to increasing the applicability of this study for many institutions.

Weaknesses of this study include the large number of patients with under 28 days of follow-up. These patients were included in the evaluation of any immediate complications but as some infections may present in a delayed fashion, we opted to exclude these patients from the assessment of infection. Several potential immediate complications were counted in this study based on chart review but may not have been due to pin placement and were more likely to be associated with patient's other injuries, resulting in overestimation of the total complication rate.

Conclusions

The placement of lower-extremity skeletal traction pins is an effective means to provide provisional stability in lower-extremity long bone and pelvic fractures with a relatively low complication rate. The current literature suggests the benefits associated with temporary skeletal traction (pain control, soft-tissue length, and mid-term function) outweigh the risks. Minimizing duration of traction pin use may help to decrease the rate of infection, which is already generally low. Further, randomized prospective studies to compare differences in functional outcome following skeletal traction at the proximal tibia, distal femur, and calcaneus in the setting of various fractures are warranted.

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Conflicts of interest

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