KANSAS JOURNAL of MEDICINE

Debridement Versus Simple Scrubbing of External Fixator Pin Sites

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Received June 21, 2022; Accepted for publication Sept. 19, 2022; Published online Oct. 24, 2022
https://doi.org/10.17161/kjm.vol15.18219

ABSTRACT

Introduction. Irrigation and debridement of external fixator pin sites are methods utilized by some orthopedic surgeons to minimize the risk of surgical site infections in patients undergoing definitive internal fixation after temporization in an external fixation device. This study aimed to determine if irrigation and debridement of external fixator pin sites leads to fewer deep surgical site infections, compared to simply scrubbing the external fixator pin sites with a chlorhexidine scrub-brush.

Methods. This single center retrospective cohort study was performed at a university level I trauma center. All cases in which a single surgeon removed an external fixator and followed this with definitive open reduction and internal fixation (ORIF) in the same operative setting between October 2007 and October 2018 were reviewed. A total of 313 patients were temporized in 334 external fixators prior to ORIF and were included in the study.

Results. Eighteen of the 179 Irrigation and Debridement cohort (10.0%) and 8 of the 155 Simple Scrubbing cohort (5.2%) had infections that required a return to the operating room. No statistical difference ($p = 0.10$) or meaningful effect size (Cohen's $d = 0.18$) were found between irrigation and debridement and simple scrubbing of external fixator pin sites.

Conclusions. Given no significant differences were found in deep infection rates between debridement of pin sites versus simply scrubbing, it is reasonable to ask whether the time and resources required for debriding external fixator pin sites is worthwhile.

Kans J Med 2022;15:369-372

INTRODUCTION

Infection following open reduction and internal fixation of a fracture can be a devastating complication, resulting in significant morbidity.[1] Furthermore, such infections often are associated with a significant socio-economic burden.[2,3]

One potential source of deep post-operative infection following open reduction and internal fixation of a fracture that has been temporized in an external fixator is inoculation of the surgical site with bacteria from the external fixator pin site. Some studies have demonstrated findings suggestive of this. For instance, Bhandari et al.[4] demonstrated that intramedullary nailing of tibial shaft fractures temporized in an external fixator for 28 days or fewer resulted in an 83% reduced risk of deep infection. This finding suggested that the likely connection between increased risk of infection with increased time in an external fixator was a greater incidence of clinically signicant pin site colonization/infection with greater time in an external fixator.

In another study, an increased rate of deep infection was observed in tibial pilon and plateau fractures, where overlap of plates with external fixator pin sites occurred.[5] From this study, it seemed reasonable to conclude that this increased rate of infection was secondary to colonized/infected external fixator pin sites inoculating the fracture implants, thereby leading to deep infection. However, this spatial relationship was not observed in a similar study that only included tibial plateau fractures.[6] Notable differences between the two studies included time in an external fixator, which was only 10 days in the Laible et al.[6] study, versus 20 days in the Shah et al.[5] study that demonstrated an increased risk of infection with plate overlap. Other substantial differences included the primary surgeons being residents versus attending traumatologists, the manner in which external fixator pins were placed into the bone (i.e., predrilling versus simply driving the pin in on power), and prepping the external fixator pins into the field at the time of definitive internal fixation versus prior removal. Furthermore, neither study made mention of whether the pin sites were debrided at the time of definitive internal fixation. These study differences suggested that there were more factors involved in producing post-operative infection when fractures temporized in an external fixator undergo internal fixation, other than only overlapping pin sites with the fracture implants.[6]

Finally, in an animal model of infected external fixator pin sites in which intramedullary nailing was performed after pin sites were inoculated with staphylococcus, infection was observed in all cases unless debridement of the pin sites occurred prior to internal fixation.[7] Although this was an animal study, it demonstrated a very clear link between infected external fixator pin sites with overlap of fracture implants by the development of subsequent deep infection, with the same bacteria used to inoculate the pin site. In addition, this study also demonstrated a method to prevent clinically significant deep infection when internal fixation is placed in the face of a pin site infection. In this study, pin sites were debrided mechanically and irrigated prior to performing the surgical procedure in addition to the administration of antibiotics. This regimen was found to prevent the development of clinically significant infection following the placement of internal fixation.

Currently, some surgeons will debride external fixator pin sites mechanically when removal of the external fixator is followed by internal fixation of the fracture in the same operative setting. The rationale for performing this mechanical debridement of the external fixator pinsites is to decrease the risk of post-operative infection. However, to our knowledge, this procedure has never been substantiated in a clinical study. In this study, it was hypothesized that sharply debriding (DB) external fixator pin sites compared to simply scrubbing (SS) external fixator pin sites prior to performing definitive internal fixation will result in no significant difference in surgical site infection.

METHODS

This was a retrospective chart review of all patients who underwent external fixator removal by an individual fellowship-trained traumatologist at an academic level I trauma center. Definitive fracture fixation was performed with plates, screws, intramedullary nails, or a combination of devices. After approval from the associated University Institutional Review Board, all surgical cases for which the CPT® billing code for the removal of external fixation system under anesthesia was billed for were reviewed to ensure they met the inclusion criteria. A manual chart review was performed to collect patient information including age, sex, body mass index (BMI), fracture status, duration in external fixator device, management of external fixator pin sites, and presence of a deep infection requiring return to the operating room for surgical debridement. The HERON data query tool was utilized to cross reference patient medical records of included study participants to collect patient status with regards to diabetes mellitus diagnosis and current smoking status.[8]

The period for this study spanned 11 years, including all cases from October 2007 to October 2018. This period was chosen as it would include all cases performed by one surgeon at this center after he completed his orthopedic trauma fellowship training. The October 2018 stop date was chosen as it allowed for appropriate patient follow-up prior to data collection and analysis. The following pin site care regimen was utilized in the respective time frame to determine whether debridement or scrubbing affected infection:

- Pin site debridement was the mainstay of practice from October 2007 to January 2013.
- From February 2013 to December 2014, there was a similar number of cases of both debridement and simple scrubbing.
- From January 2015 to October 2018, when the study was concluded scrubbing had become the treatment of choice.

Inclusion criteria included all patients over the age 12 where an external fixator was removed immediately prior to definitive internal fixation of a fracture in the same operative setting. Patients with the following fractures were included in this study: radius, ulna, humerus, pelvis, femur, tibia, fibula. For a patient to be included in this study, the infection required a return to the operating room for treatment.

Exclusion criteria included known bone or deep tissue infection prior to external fixator placement, age under 12 years old, those not receiving definitive internal fixation at the time of external fixator removal, the treatment of non-unions and mal-unions, and inadequate follow-up. Reasons for not receiving definitive internal fixation at time of external fixator removal included risk to patient, patient refusal of definitive surgery, a fracture that had healed satisfactorily in the external fixator, amputation, death, and external fixator use in the treatment of vascular, soft tissue, and other ligamentous injury not requiring reconstruction of a fracture. All patients that were included in the study were followed for at least 12 months after the removal of their external fixator and performance of definitive internal fixation.

Surgical Technique. For both sharp debridement and simple scrubbing of external fixator pin sites protocols were developed as described below.

The removal of the external fixator was performed the same for each technique. The patient's limb was marked prior to entering the operating room. Once in the operating room, anesthesia was induced and patients were administered perioperative antibiotics within 30 minutes of incision. The external fixator was removed by cutting the pins with a bolt cutter or deconstructing the external fixator with wrenches. The external fixator pins within the bone were removed with a t-handle chuck. From this point, the external fixator pin sites were managed in one of two ways: sharp debridement or scrubbing.

Sharp Debridement. The patient's limb was scrubbed with chlorhexidine and rinsed with sterile normal saline. Next, a sterile curette was used to sharply debride the pin tracts. The skin, subcutaneous tissue, muscle, and bone were debrided until only healthy bleeding tissue remained. The tracts were irrigated using a 60 cc syringe of sterile normal saline with an 18 guage angiocatheter attached to the end that was inserted into the depth of the external fixator pin sites. After at least 1 L of normal saline had been placed through the external fixator pin sites, the limb was prepped and draped in sterile fashion for definitive internal fixation.

Scrubbing. The limb and skin over the pin sites were scrubbed with a chlorhexidine scrub-brush and rinsed with sterile saline. Then, the limb was prepped and draped in sterile fashion, followed by open reduction and internal fixation of the fracture.

Statistical Analysis. All statistical analyses were calculated and/or confirmed by a consulting statistician. Patient demographics between the two pin site management techniques were described with means and standard deviation. Student t-tests were used to compare contiguous variables including age, BMI, and duration in an external fixator. Categorical variables including patient sex, smoking status, diabetes mellitus, and whether a fracture was open or closed were compared with a chi-square test. Sex, age, open versus closed nature of fracture, BMI, smoking status, diabetes mellitus, and duration of time in external fixation were considered as possible confounders between the techniques. To isolate the impact of pin site management on the outcome of interest, which was deep post-operative surgical site infections that required surgical debridement, the previously stated demographics were compared using a chi-squared test to determine if there was a statistically significant difference between the interventions, and a Cohen's d effect size was calculated to determine if the magnitude of the difference was meaningful for analysis purposes. A statistical difference was a p value < 0.05. The Cohen's d effect size was interpreted using the traditional stratification of Small 0.2, Medium 0.5, and Large 0.8.

RESULTS

There were 472 external fixators removed from 444 patients during the date range of our chart review. A total of 335 external fixators on 316 patients met the inclusion criteria of our review and are presented in the results. Polytrauma patients with more than one injury requiring external fixation were included in this study. Furthermore, all infections recorded in this study were deep tissue infections. To account for them accurately, all external fixation devices were considered independent cases, as they were managed as separate injuries. Sharp debridement of pin sites to the bone was performed for 179 external fixators on 171 patients. Scrubbing of the surgical site with chlorhexidine was performed for 156 external fixators on 145 patients. Table 1 compares general demographics of the populations, including some comorbid conditions between the two groups that are known to increase the risk of infection.[9]

Table 1. Demographics of all included patients.

Variable	DB (n = 179)	SS (n = 155)	p Value
Age, Years, Mean (Range, SD)	45.2 (16-87, 14.3)	45.0 (14-84, 16.0)	0.93
BMI, kg/m², Mean (Range, SD)	30.2 (19-55, 7.5)	29.9 (16.7-66.7, 8.9)	0.71
Diabetes Mellitus, %	16.2%	14.2%	0.61
Duration in external fixator, days, Mean (Range, SD)	17.6 (1-74, 11.5)	18.8 (1-64, 11.9)	0.34
Open fracture, %	32.4%	25.8%	0.19
Sex, Female, %	38.5%	38.1%	0.93
Smoking history, %	55.9%	45.8%	0.22

When comparing the demographics of the two groups of patients, no statistical differences were detected in the age of participants, sex of participant, BMI, open versus closed, or duration in external fixator. This lack of statistical difference supported the assumption that the two groups were composed of comparable populations and eliminated some sources of confounding. Table 2 displays the frequency of deep infections that required return to the operating room. Table 3 shows infection information.

Table 2. Outcome of interest and timeline.

	DB (n = 179)	SS (n = 155)	p Value[a]	Cohen's d[b]
Deep surgical site infection requiring re-operation, n (%)	18 (10.0%)	8 (5.2%)	0.10	0.18
Total patients with external fixator for 0 - 10 days	53	40		
Patients with external fixator for 0 - 10 days with deep surgical site infection requiring re-operation, n (%)	5 (9.4%)	1 (2.5%)		
Total patients with external fixator for 11 - 20 days	57	32		
Patients with external fixator for 11 - 20 days with deep surgical site infection requiring re-operation, n (%)	6 (10.5%)	3 (9.3%)		
Total patients with external fixator for > 20 days	69	83		
Patients with external fixator for > 20 days with deep surgical site infection requiring re-operation, n (%)	7 (10.1%)	4 (4.8%)		

Abbreviations: DB, Irrigation and Debridement; SS, Simple Scrubbing
[a]p value < 0.05 considered statistically significant.
[b]Cohen's d effect size traditional stratification of Small 0.2, Medium 0.5, and Large 0.8.

A statistical difference was not detected in post-operative infections requiring return to the operating room between the two groups ($p = 0.10$). With a p value of 0.1, the data suggested there might be a difference in rates of deep post-operative infection requiring re-operation, but that the rate was higher in the debridement group. A Cohen's d effect size of 0.18 for deep post-operative infection between the two groups correlated to a very small effect size.

Table 3. Infection information.

	DB (n = 18)	SS (n = 8)
Sex at birth, Males/Females	11/9	6/2
Age of patients in years, Mean (SD)	42.4 (14.1)	47.1 (13.4)
Duration of external fixator prior to infection in days, Mean (SD)	21.1 (16.8)	21.5 (11.8)
Status of fracture, Open/Closed	7/11	3/5
Body Mass Index in kg/m², Mean (SD)	30.3 (7.9)	27.7 (2.5)
Methicillin Sensitive *Staphylococcus Aureus* (MSSA), n (%)	1 (5.6%)	1 (12.5%)
Methicillin Resistant *Staphylococcus Aureus* (MRSA), n (%)	0	2 (25%)
Coagulase Negative *Stapylococcus species*, n (%)	7 (38.8%)	2 (25%)
Multiple bacteria grew on culture, n (%)	5 (27.8%)	1 (12.5%)
No growth appreciated on culture, n (%)	5 (27.8%)	2 (25%)

Abbreviations: DB, Irrigation and Debridement; SS, Simple Scrubbing; SD, Standard Deviation

DISCUSSION

In this retrospective cohort study, cases performed by an individual, fellowship trained, orthopedic traumatologist over more than a decade were reviewed. After data analysis, no significant difference in the rate of deep surgical site infection requiring return to the operating room was found between the two groups.

Research surrounding the management of external fixators and the care of patients temporized in an external fixator for the purpose of eventually performing internal fixation was incomplete. Ideal pin site dressings, pin care, management of pin crusts, types of pins implanted, and location of pins in relation to likely locations where definitive internal fixation will be placed have been studied.[10,11] The information yielded was beneficial to the decision making process in managing patients with external fixators.

To our knowledge, there are no studies in humans examining the best method to prepare external fixator pin sites when internal fixation is performed in the same operative setting as removal of the external fixator. This conclusion was reached after a thorough review of the literature.

As mentioned, an animal study by Clasper et al.[7] demonstrated a decreased rate of infection when debridement was performed on infected external fixator pin sites prior to intramedullary nailing. In this study, *Staphylococcus aureus* was used to infect the external fixator pin sites two weeks prior to intramedullary nailing of a tibia in an ovine model. This resulted in widespread infection in the control group, while the treatment group with debrided pin sites and administered antibiotics, for the most part, healed without clinical infection. It was difficult to conclude from this study how much debridement of the external fixator pin sites contributed to the lack of clinical infection because local and systemic antibiotics also were administered to the treatment group but not in the control group.

In this current study, we attempted to determine if the debridement technique used to decrease surgical site infection in the Clasper et al.[7] ovine model could be repeated in humans. Debridement of external fixator pin sites prior to definitive internal fixation is practiced by a number of orthopedic surgeons, with some of the rationale for doing so based upon extrapolations from the ovine model. Indeed, when the senior surgeon (AH) inquired in his trauma fellowship why external fixator pin sites were debrided prior to placement of internal fixation, he was referred to the Clasper study. There were some major differences between the Clasper et al.[7] model and our study. However, it was reasonable to conduct this study, because the manner in which external fixator pin sites were debrided, prior to internal fixation, in our study, was the manner in which the Clasper study has been translated into clinical practice by a number of surgeons.

In this study, the null hypothesis that there would be no difference in deep infection rates between patients that had debrided pin sites versus simple scrubbing was upheld. However, because this was a retrospective study that evaluated a limited number of parameters, there are a number of factors which could have resulted in a type 2 statistical error, which needs to be discussed.

The lack of statistically significant infection rates between the two groups may be explained by the relatively small sample size of this study. Therefore, caution must be applied when interpreting these study results. In addition, the patients were all treated by an independent surgeon spanning the course of his career from immediately after graduating trauma fellowship to 11 years into his career. Surgeon experience has been demonstrated to effect a number of parameters in orthopedic surgery.[12-14] It was possible the effect of gained experience by this surgeon could have resulted in a decrease in surgical site infection rate over time. This possible decrease in infection rate due to experience could have negated any small increased risk of infection that may have been present with simply scrubbing the external fixator pin sites, as this was the method of pin site preparation during the surgeons most experienced years of this study.

In light of this, a more appropriate conclusion to this study would be that simple scrubbing of external fixator pin sites, prior to performing definitive internal fixation, performed by an experienced traumatologist (i.e., greater than six years of experience) demonstrated no difference in deep post-operative infection rates when compared to patients treated by sharp debridement of their external fixator pin sites, prior to definitive internal fixation, performed by a less experienced traumatologist (i.e., less than six years). One might conclude from this study that if the difference of post-operative deep infection between simple scrubbing versus debridement was so small that it can be overcome by experience, it would be better to invest time and resources in training that more quickly brings junior surgeons up to an experienced level.

Other issues that could have affected the outcome of this study that were not analyzed included the socioeconomic status of the patient, education level, race, workers compensation status, discharge home versus to a rehabilitation or skilled nursing facility, presence of active psychiatric issues, and whether the initial external fixator was placed by the surgeon performing definitive internal fixation.

CONCLUSIONS

Based on these results, irrigation and debridement of external fixator pin sites prior to definitive internal fixation in the same operative setting did not result in a decreased rate of deep surgical site infection requiring re-operation compared to simply scrubbing with a chlorhexidine scrub brush. Surgeons should decide based upon this information, if it is worth the extra time, expense, and effort to perform debridement of external fixator pin sites prior to definitive internal fixation.

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Keywords: bone fracture, external fixation device, surgical site infection, orthopedics