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Incidence and Risk Factors for Pin Site Infection of Exposed Kirschner Wires Following Elective Forefoot Surgery

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Abstract

Background: Kirschner wires (K-wires) are commonly utilized for temporary metatarsal and phalangeal fixation following forefoot procedures. K-wires can remain in place for up to 6 weeks postoperatively and are at risk for complications. This study investigated the incidence of infectious complications of exposed K-wires after forefoot surgery and identifies risk factors for these complications.

Methods: A single-surgeon retrospective chart review of forefoot surgeries from 2007 to 2017 was undertaken. Inclusion criteria were adult patients (≥18 years) undergoing elective forefoot surgery with the use of exposed K-wires. Incidence of pin site infectious complication, defined as cellulitis, or pin site drainage and/or migration/loosening of the pin was noted. Patient demographic and perioperative data were analyzed, along with the number of K-wires placed per procedure. Mann-Whitney U and chi-square tests were performed to determine predictive factors related to pin site infection rates, with a multivariable model with significant factors subsequently performed. Two-thousand seventeen K-wires in 1237 patients were analyzed.

Results: There were 35 pin site infections for a rate of 1.74%. Combined forefoot procedures (507 pins in 229 patients) had a pin site infection rate of 4.93% (N = 25), followed by lesser metatarsal osteotomies (667 pins in 446 patients) at 1.05% (N = 7), then hammertoe corrections (694 pins in 421 patients) at 0.43% (N = 3), and no pin site infections with chevron osteotomies (149 pins in 141 patients). Male sex, body mass index (BMI), current smoker, and number of pins were significant risk factors ($P \leq .05$). Additionally, there were 23 non–infection-related K-wire complications. No long-term sequelae were encountered based on any complications.

Conclusion: K-wires are commonly used for temporary immobilization of the smaller bones of the forefoot following deformity correction. Male sex, BMI, current smoker, and number of pins were significant risk factors for pin site infection, with a higher rate of infection with 2 or more pins placed.

Level of Evidence: Level IV, case series.

Keywords: Kirschner wire, K-wire, infections, complications, forefoot, osteotomy, chevron, hammertoe, lesser metatarsal

Introduction

The Kirschner wire (K-wire) is a device commonly used for temporary fixation in the forefoot. Primarily due to their smaller size, complex articulations, and anatomic location, phalanges and metatarsals often require K-wire fixation when plate and screw fixation is not feasible or optimal. With proper placement and alignment, K-wires can reliably remain in place for up to 6 weeks, allowing the bony correction to heal in the desired position.[2]

In order to be removed on an outpatient basis, K-wire ends are left external to the skin, which creates a direct conduit between the intraosseous and outside environment and introduces a risk of infection.[3] Infection may require early removal, antibiotic treatment, and surgical debridement that can

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significantly impact overall outcomes. Similarly, exposed K-wires are at risk for migration and/or bending if there is premature weightbearing on the foot by the patient or direct trauma to the K-wires in place.[4] Failure of fixation may occur as well, leading to costly and more difficult revision procedures.

Analogous to distal forefoot procedures, the repair of metacarpal and phalangeal injuries of the upper extremity often involves K-wires as the primary temporary fixation. The incidence of complications with K-wire use in the hand literature has been well described. Ranging from 10% to 16%,[6,10,11] wound complications in exposed K-wires in the phalangeal, metacarpal, and carpal bones of the upper extremity represent a significant risk to the overall success of the procedure. Furthermore, these complications can necessitate antibiotic treatment, multiple outpatient visits, and a possible return to the operating room for surgical debridement, all of which can increase the cost of care.[9] While there is no consensus on the risk factors leading to wound infection, location and number of K-wires, along with local pin site care, were the most oft-cited factors.[6,9,11]

There is a relative paucity in the literature on the incidence of pin site infection of exposed K-wires in forefoot procedures and little to no data on the risk factors for infection. The relatively ubiquitous use of exposed K-wires in corrective forefoot procedures and somewhat high complication rate in the upper extremity suggest that this information is vital to the treating physician. Ideally, the identification of modifiable risk factors can provide opportunity to optimize these factors and reduce complications in forefoot procedures in which exposed K-wires will be used. The aim of this study was to identify the incidence of pin site complication and patient or perioperative risk factors following common forefoot procedures, such as chevron osteotomy, lesser metatarsal osteotomy, hammertoe correction, and/or their combination with exposed K-wires.

Methods

After institutional board review approval was obtained, a retrospective review of elective forefoot procedures with exposed K-wires from 2007 to 2017 was undertaken. This was a single-surgeon case series. The forefoot procedures included chevron osteotomies/bunionectomies, distal lesser metatarsal osteotomies, and crossover deformity correction with trans-metatarsophalangeal joint pinning, hammertoe corrections, or a combination of the aforementioned procedures. With the exception of utilizing a headless screw for fixation of the lesser metatarsal osteotomies, no additional fixation was utilized for the chevron bunionectomies or hammertoe corrections. Pin site infection was defined as postoperative cellulitis, or pin site drainage that required antibiotic treatment with or without early K-wire removal. These complications were calculated based on the review of outpatient dictated notes along with the prescription history of antibiotics in the patient chart.

The standard protocol for the single surgeon for exposed K-wire management includes allowing heel weightbearing in a postoperative shoe starting immediately after surgery unless additional concomitant procedures required non-weightbearing. Strict elevation of the operative foot was suggested for the first 2 weeks following surgery. Immediate postoperative dressings were left on and no pin care was initiated for the first 2 weeks. At 2 weeks postoperatively, sutures were removed and at this point patients were allowed to get their foot wet in a shower. Patients were provided detailed pin site care instructions, which include keeping the pin sites clean, dry, and avoiding any twisting, bending, or contact with the pin. The K-wires were removed in the office without additional anesthesia in all cases. Time to planned removal was dependent on the surgical indication. As per the senior author's (S.M.R.) protocol, chevron first metatarsal osteotomies and isolated hammertoe corrections underwent routine K-wire removal at 2 weeks postoperatively, while lesser metatarsal osteotomies and trans-metatarsophalangeal joint fixation had the K-wires removed at 6 weeks postoperatively.

The inclusion criteria were all patients age 18 or older undergoing forefoot corrective surgery during which temporary exposed K-wire fixation was used. Patients undergoing revision surgery, simultaneous midfoot or hindfoot procedures, or surgery on a nonelective basis (for acute trauma or infections) were excluded from the study, as were patients for which there were incomplete office notes available. The data collected included preoperative patient demographic data such as age, sex, body mass index (BMI), smoking status, history of diabetes mellitus (DM), and history of rheumatoid arthritis (RA). Perioperative data were also collected, such as tourniquet time, type of anesthesia utilized, and type of prophylactic antibiotic treatment. Subgroup analysis based on the type of forefoot procedure (chevron/lesser metatarsal osteotomy, hammertoe correction, or combined procedures) was also performed. The number of K-wire pins utilized during the procedure was measured and compared with a cutoff of 2 or more for comparison.

Two-thousand seventeen K-wires in 1237 patients were analyzed. The median age of the overall cohort was 58 (interquartile range [IQR], 49-65) years and the median BMI was 26.2 (IQR, 23.3-30.2) kg/m^2. One-thousand forty-four patients were female, representing 84.4% of the study population. Two-hundred sixty-nine patients (21.7%) were current smokers, 48 (3.9%) had DM, and 57 (4.6%) had RA. Seventy-four (6.0%) patients received only regional anesthesia, while 1163 (94.0%) had a combination of general and regional anesthesia.

The infectious complication rate was calculated as the percentage of K-wires that required treatment for infection

Table 1. Overall Pin Site Infection Rate and by Forefoot Procedure.

	No. of Pins	No. of Patients	No. of Pin Site Infections	Pin Site Complication Rate, %
Overall	2017	1237	35	1.74
Chevron osteotomy	149	141	0	0
Lesser MT osteotomy	667	446	7	1.05
Hammertoe correction	694	421	3	0.43
Combined forefoot procedures	507	229	25	4.93

Abbreviations: MT, metatarsal.

Table 2. Analysis of Patient Risk Factors for Pin Site Infection.

		Overall Cohort	No Pin Site Infection	Pin Site Infection	*P* Value[a]
Age, mean (IQR), y		58 (49-65)	58 (49-65)	56 (50-67)	.939
BMI, mean (IQR), kg/m^2		26.2 (23.3-30.2)	26.0 (23.2-30.1)	30.0 (25.5-34.1)	**.012**
No. of pins, mean (IQR)		1 (1-2)	1 (1-2)	2 (1-3)	**.001**
Tourniquet time, mean (IQR), min		45 (33-59)	45 (32-59)	50 (34-63)	.295
Sex, n	Female	1044	1027	17	**.045**
	Male	193	185	8	
Smoking, n	Nonsmoker	968	953	15	**.047**
	Current smoker	269	259	10	
DM, n	No	1189	1166	23	.253
	Yes	48	46	2	
RA, n	No	1180	1157	23	.322
	Yes	57	55	2	
Anesthesia, n	Regional	74	74	0	.395
	General	1163	1138	25	

Abbreviations: BMI, body mass index; DM, diabetes mellitus; IQR, interquartile range; RA, rheumatoid arthritis.
[a]Boldface type indicates statistical significance.

including antibiotic management, early K-wire removal, or surgical debridement in the operating room. The sample data for age, BMI, and tourniquet time did not have a normal distribution; therefore, Mann-Whitney U tests were used to test for differences between patients with or without pin site infections. Categorical variables were evaluated using chi-square tests of independence or Fisher's exact test, as appropriate. From the univariable models, variables observed to have a significant ($P \leq .05$) association to pin site infection were entered into a multivariable model to determine predictive factors of pin site infections. Odds ratios (ORs) and 95% confidence intervals were reported for the multivariable regression. Model fit was evaluated by the Hosmer-Lemeshow goodness-of-fit test.

Results

There were 35 pin site infections for a complication rate of 1.74% (35/2017). Combined forefoot procedures (507 pins in 229 patients) had a pin site infection rate of 4.93% (N = 25); hammertoe corrections (694 pins in 421 patients), 0.43% (N = 3); and lesser metatarsal osteotomies (667 pins in 446 patients), 1.05% (N = 7), while there were no pin site infections with chevron osteotomies (149 pins in 141 patients). Table 1 summarizes this information. The median tourniquet time was 45 (IQR, 32-59) minutes for patients without pin site infections and 50 (IQR, 34-63) minutes for those with postoperative pin site infections, which was not significantly different (P = .295). All K-wire–related infections were managed with oral antibiotics and local pin site care.

Univariable analysis of patient demographics and perioperative data yielded 4 statistically significant risk factors associated with pin site infection. BMI (P = .012), 2 or more pins placed during a single procedure (P = .001), male sex (P = .045), and smoking (P = .047) all were statistically significant. Age, history of DM, history of RA, tourniquet time, and anesthesia type were not significant risk factors for pin site infection (Table 2).

Multivariable regression including BMI, male sex, number of pins, and smoking history showed that the number of pins placed during the procedure remained statistically significant (P = .012) with a 1.56 times (95% CI, 1.089, 2.186) increased risk of pin site

Table 3. Multivariable Regression Model for Pin Site Infection.

	Odds Ratio	Confidence Interval [2.5-97.5%]	*P* Value[a]
Number of pins placed	1.560	1.089-2.186	**.012**
Smoking history	2.053	0.871-4.636	.088
BMI	1.053	0.984-1.119	.113
Male sex	1.871	0.735-4.387	.164

Abbreviations: BMI, body mass index.
[a]Boldface type indicates statistical significance.

infection with each subsequent pin placed per single procedure. This was based on a cutoff of 2 or more pins in comparison to a single pin utilized for a procedure. Smoking and BMI were both approaching significance, with smoking conferring an OR of 2.05 (95% CI, 0.871, 4.636) for pin site infection, which was the highest of the 4 variables analyzed (Table 3). Variable inflation factor values were less than 1.015, suggesting little collinearity between the explanatory variables. The Hosmer-Lemeshow statistic (P = .719) did not suggest adequate model calibration.

Out of the 2017 implanted K-wires, 23 (1.14%) had non–infection-related complications. Twelve K-wires (0.59%) were removed before the planned removal time. In the combined procedure group (N = 507 K-wires), 7 K-wires backed out prematurely, while 3 patients fell, resulting in severe bending to their K-wires that could not be acceptably corrected, all requiring early removal. This resulted in an early removal rate of 1.97% in the combined forefoot procedure group. Additionally, 5 K-wires (0.98%) were found to be broken and 3 more (0.59%) were found to be bent at the time of planned removal at 6 weeks, but none of these required any additional treatment or deviation from the subsequent postoperative protocol. Premature K-wire removal was managed with plantarflexion taping of the toe until the planned 6-week K-wire removal visit.

In the isolated hammertoe correction group (N = 694 K-wires), 2 patients, each with 1 K-wire (0.29%), caught their K-wires on something, resulting in them pulling out prematurely, while another 2 K-wires were found to be bent at the time of planned removal but were still able to be removed in the office without anesthesia and without need for additional treatment. One K-wire was found to be broken at the time of removal in the isolated metatarsal osteotomy group (N = 667 K-wires; 0.15%), while there were no complications related to the K-wires in the chevron bunionectomy group. No patients returned to the operating room for broken K-wires, and no infections required surgical debridement. There were no long-term sequelae related to any of the K-wire complications in this study, and no patients required any type of revision surgery related to broken pins or premature removal.

Discussion

K-wire fixation following distal forefoot procedures remains a valuable tool in the foot and ankle surgeon's armamentarium. The use of temporary K-wires requires their exposure to the outside environment, which puts the operated extremity at risk for wound complications and damage to the K-wire itself. These complications can jeopardize the success of the forefoot bony correction, particularly if the K-wire requires early removal. Superficial pin site infections represent the most common complication when utilizing K-wire fixation in any foot and ankle procedure.[5,12]

The current literature on K-wire fixation and its impact on outcomes comes mainly from hammertoe correction. Kramer et al[8] reviewed 876 patients, citing a complication rate of 11.1% (124/1115) of superficial pin site infections that went on to require postoperative antibiotics. Of these 124 superficial infections, 11.3% (14/124) required additional surgery involving irrigation and debridement with subsequent intravenous antibiotics, or early removal due to pin-track infection. In a case series, Coughlin et al[2] studied the charts of 63 patients undergoing hammertoe correction, citing a 10% complication rate in 6 patients. Three of the patients had superficial pin site infections requiring antibiotic treatment, 2 patients had vascular impairment of the toe requiring early removal, and 2 patients experienced a hyperextension deformity, one of which had a simultaneous pin site infection.

Other studies evaluating the duration and impact of K-wire fixation in distal forefoot corrections also show a relatively high complication rate, albeit with limited overall study populations. Klammer et al[7] performed a prospective, randomized trial of 46 patients leaving K-wire fixation in the lesser toes for 3 or 6 weeks, respectively. In this study, there were no significant differences in outcomes based on the duration of K-wire fixation. Baig et al[1] reported on 20 patients undergoing chevron osteotomies with K-wire fixation for hallux valgus deformity and noted a 20% complication rate with 2 patients having K-wire migration greater

than 1.5 cm and 2 patients with pin site infections requiring a 5-day course of antibiotics.

To the best of our knowledge, this is the first study to evaluate pin site infection rate following K-wire fixation for multiple distal forefoot procedures. Our results show a considerably smaller pin site infection rate in comparison to similar literature. This could be due to a number of factors, including how the study personnel classified complications such as a pin site infection or whether intervention (ie, early removal, antibiotic prescription) was necessary to include a patient within that cohort. Lesser metatarsal osteotomy had the highest infectious complication rate as an isolated procedure and was the only single procedure that had an infection rate of greater than 1% (1.05%). Combined procedures had the highest rate of infection, which logically follows both the increased number of pins and different sites of pin placement leading to an increased number of potential sites of infection. Interestingly, tourniquet time, though higher in those with pin site infections, was not significantly longer, which could be due to the limited overall number of patients experiencing infections in our cohort.

Male sex, BMI, smoking, and 2 or more pins placed per procedure represented the risk factors that were associated with pin site infection. There is no clear explanation for the increased rate of infectious complications in male patients. This may be related to increased complexity of forefoot procedures in male patients or simply due to the relatively small number of male patients in the overall cohort. The correlation of BMI with complications is not unexpected, as elevated BMI is often cited as a risk factor for wound complication with other foot and ankle procedures.[3,4] Smoking also represents a likely risk factor for pin site infection due to the chronic microvascular injury caused by regular nicotine use. Increased number of pins placed per procedure was the most important risk factor for pin site infection, which suggests that more involved procedures increase the risk for contamination of the K-wire or environment around the K-wire, even with maintenance of a strict sterile technique.

The strengths of the study include the large number of patients evaluated and a comparison performed between 3 common distal forefoot corrective procedures. This is also a consecutive case series over the past 10 years, thus limiting the risk of selection bias. The study defines pin site complication based on common postoperative findings in the outpatient setting with the requirement of antibiotics helping to bolster our definition, which helps standardize data collection. We limited the scope of our analysis to pin site infections as this is a complication that likely occurs without patient noncompliance such as early weightbearing, which is a variable that is out of the surgeon's direct control.

Our study has limitations that affect the interpretation of our results. First, the study is retrospective in nature, which puts the data at risk for information bias as they rely on the accuracy of the postoperative dictated clinical notes. However, the definition of complication followed a strict protocol developed by the single surgeon in the study, helping standardize the evaluation of the clinical notes. The study also comes from a single surgeon, which may impact the generalizability of the results, particularly if different operative techniques are utilized, although the placement of K-wires themselves during these procedures is largely standardized among most foot and ankle surgeons. We also did not determine how many complications were the result of early weightbearing due to the lack of patient compliance as this is difficult to quantify, particularly given the retrospective study design. Lastly, K-wires were removed in chevron osteotomies at 2 weeks postoperatively, which may be an earlier time of removal than most surgeons perform. However, no patients reviewed in this study returned for a recurrence of hallux valgus.

Conclusion

In conclusion, K-wire fixation for the correction of forefoot deformities had a 1.74% pin site infection rate. Male patients, high BMI, current smokers, and patients undergoing procedures with 2 or more pins placed per single procedure were risk factors for pin site infections following K-wire fixation. Two or more pins placed per single procedure was the most significant risk factor for K-wire infectious complications. Additionally, a diagnosis of DM and/or RA was a not risk factor for postoperative complications. Further studies with prospective evaluation of postoperative complications are needed to better elucidate these and other potential risk factors when utilizing K-wire fixation.

Declaration of Conflicting Interests

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