International Journal of Research in Orthopaedics
Serrasqueiro SN et al. Int J Res Orthop. 2024 Nov;10(6):1160-1164
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20243109

Original Research Article

Key-risk factors for fracture-related infection after ankle surgery: a retrospective study

Sebastião N. Serrasqueiro*, Orlando Simões, João Moreno, Vitor Pinheiro, Fernando Fonseca

Unidade Local de Saúde de Coimbra, Coimbra, Portugal

Received: 05 August 2024
Accepted: 09 October 2024

***Correspondence:**
Dr. Sebastião N. Serrasqueiro,
E-mail: sebastiaoserrasqueiro@gmail.com

ABSTRACT

Background: Fracture-related infection (FRI) is a serious complication following ankle fracture surgery, with significant implications for patient outcomes. This study aimed to identify the key risk factors associated with FRI in a cohort of patients undergoing surgical fixation of ankle fractures.
Methods: A retrospective analysis was conducted on 261 patients who underwent open reduction and internal fixation (ORIF) for ankle fractures between 2019 and 2021. Patient demographics, comorbidities, and surgical details were extracted from medical records. The primary outcome was the development of FRI within one year postoperatively. Logistic regression analysis was used to identify independent predictors of infection.
Results: The mean age of the patients was 61.8 years (SD=16.5), with 69.3% being female. The overall infection rate was 8%. Significant predictors of FRI included smoking (OR=13.643, p=0.002), peripheral vascular disease (OR=17.684, p<0.001), and diabetes mellitus (OR=11.309, p=0.002). Gender, congestive heart failure, obesity, and age were not statistically significant predictors of infection.
Conclusion: This study identifies smoking, peripheral vascular disease, and diabetes mellitus as significant risk factors for FRI following ankle fracture surgery. These findings underscore the importance of targeted interventions to manage these comorbidities in high-risk patients to reduce the incidence of postoperative infections**.** Further research is needed to explore the role of other potential factors and to develop effective prevention strategies.

Keywords: Ankle fracture, Fracture-related infection, Risk factors, Surgery, Retrospective study

INTRODUCTION

Ankle fractures are among the most common orthopedic injuries, with surgical fixation often necessary for displaced or unstable fractures. However, one of the most significant complications following ankle fracture surgery is fracture-related infection (FRI).[1,2] The incidence of infection after ankle fracture surgery varies, with rates reported between 1.4% and 9% depending on the population studied, surgical techniques, and definition of infection used.[3] Understanding the risk factors associated with FRI is crucial for optimizing patient outcomes and developing preventative strategies.[4] Moreover The occurrence of surgical site infections (SSIs) is higher in orthopaedic surgery than in general surgeries.[5] Including age and gender other several patient-related factors have been associated with an increased risk of FRI.[6-8] Diabetes mellitus is a well-established risk factor for postoperative infections due to its impact on immune function and wound healing.[9] Patients with poorly controlled blood glucose levels are particularly at risk. Peripheral vascular disease (PVD) compromises blood flow to the extremities, leading to delayed healing and a higher risk of infection. Patients with PVD are more likely to develop FRI following ankle fracture surgery has also been implicated in higher rates of (SSIs), including FRI, due to factors such as increased tissue handling, longer operative times, and impaired wound healing.[10] Smoking impairs tissue

oxygenation and immune response, increasing the risk of infection. Smokers undergoing ankle fracture surgery are at a significantly higher risk of FRI.[11-13.] The characteristics of the fracture itself can also influence the risk of infection. Open fractures are at a higher risk of infection due to the exposure of bone and soft tissue to the external environment. The risk increases with the severity of the soft tissue injury (e.g., Gustilo-Anderson classification). The comminuted and high-energy fractures are associated with greater soft tissue damage, increasing the risk of infection.

These types of fractures often require more extensive surgical intervention, which can also contribute to a higher infection risk. The surgical approach and perioperative management also play critical roles in the risk of developing FRI. Delayed surgical fixation, particularly in the context of open fractures, has been linked to higher infection rates. Early debridement and fixation are crucial to minimize the risk of FRI. Poor surgical technique, including inadequate debridement of devitalized tissue or improper fixation, can lead to an increased risk of infection.

Additionally, prolonged surgery times have been correlated with higher infection rates due to increased exposure to potential contaminants. The use of implants can provide a surface for bacterial adherence and biofilm formation, which is resistant to antibiotics and host immune defenses. Improper placement or selection of implants can exacerbate this risk. Postoperative care is critical in preventing infections.[14,15] Meticulous wound care post-surgery is essential. Early identification and management of superficial wound infections can prevent progression to deeper infections involving the bone and hardware.

Even without consensus the use of prophylactic antibiotics is standard in ankle fracture surgery to reduce the risk of infection.[16] However, the choice, timing, and duration of antibiotic therapy are areas of ongoing research and debate. Recent studies have identified other potential risk factors for FRI. Emerging evidence suggests that vitamin D deficiency may impair immune function and wound healing, contributing to a higher risk of infections.[17] Research is beginning to explore the role of genetic factors in susceptibility to infection, which could explain the variability in infection rates among different populations. The present study aims of to analyze patient related risk factors and determine their influence on infection rates following ankle surgery.

METHODS

Study design

This retrospective cohort study was conducted to evaluate the risk factors associated with FRI following ankle fracture surgery. A total of 261 patients who underwent surgical fixation of ankle fractures.

Study place

The study was conducted at Centro Hospitalar Universitário de Coimbra.

Study duration

The study duration was between 2019 and 2021 were included in the study.

Inclusion criteria

The inclusion criteria were patients aged 18 years or older who had undergone open reduction and internal fixation (ORIF) for ankle fractures.

Exclusion criteria

Patients with insufficient medical records or those who did not complete the required follow-up were excluded from the study.

Data collection

Data were collected from electronic medical records (EMRs) and operative reports. The following patient-related variables were extracted: age, sex, body mass index (BMI), smoking status, presence of diabetes mellitus, peripheral vascular disease (PVD), and other comorbidities. Injury-related variables included fracture type (e.g., Weber classification), presence of open fractures, and mechanism of injury (low vs. high energy). Surgery-related variables included the time to surgery, duration of the surgical procedure, surgical approach, type of fixation, and use of prophylactic antibiotics.

Outcome measures

The primary outcome was the development of fracture-related infection (FRI) within one year postoperatively. FRI was defined according to the criteria established by the Musculoskeletal Infection Society (MSIS), which includes clinical signs of infection (e.g., erythema, swelling, purulent discharge), positive microbiological culture from the wound or hardware, and radiological evidence of infection.

Statistical analysis

Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. Continuous variables were reported as mean ± standard deviation (SD) Categorical variables were presented as frequencies and percentages. Univariate analyses were conducted using chi-square tests for categorical variables and t-tests tests for continuous variables to identify potential risk factors associated with FRI. Variables with a p value<0.10 in the univariate analysis were included in a multivariate logistic regression model to identify independent predictors of FRI. Odds

ratios (ORs) with 95% confidence intervals (CIs) were calculated. All statistical analyses were performed using the statistical software SPSS, version 29. A p value<0,05 was considered statistically significant.

Ethical considerations

As this was a retrospective study using de-identified data, the requirement for informed consent was waived. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000.

RESULTS

As reported in Table 1 the majority of the study population was female, accounting for 69.3% of the patients and the mean age was 61.8 years, with a standard deviation of 16.5 years The information provided suggests a fairly wide age range within the sample. Regarding the comorbidities, about 13,8% of patients had a history of congestive heart failure, 7.3% of the were smokers and 25,3% were classified as obese. Of the patients 23,4% had Diabetes Mellitus. About 8% of the sample was diagnosed with infection after surgery.

Univariate analysis

Univariate analyses were conducted to identify potential risk factors associated with FRI, using chi-square for the categorical variables and the T-test for continuous variables.

Table 1: Descriptive characteristics of the sample.

Variables		
Gender	69.3% (F)	
Age	61.75 (Mean)	16.5 (SD)
Congestive heart failure (ICHF)	13.8%	
Smoker	7.3%	
Peripheral vasculae disease (PVD)	9.2%	
Obesity	25.3%	
Diabetes mellitus (DM)	23.4%	
Infection	8%	

Table 2: Univariate analysis.

Variables	Test	
Gender	**Chi Square**	
	39.084	p<0.001
Age	T Test	
	-3.537	p<0.001
Congestive heart failure (CHF)	Chi Square	
	136.862	p<0.001
Smoking	Chi Square	
	190.539	p<0.001
Peripheric vascular disease	Chi Square	
	173.828	p<0.001
Obesity	Chi Square	
	63.759	p<0.001
Diabetes mellitus	Chi Square	
	74.027	p<0.001

Table 3: Logistic regression.

Variables in the equation						
	B	**S.E**	**Wald**	**df**	**Sig.**	**Exp (B)**
Gender	1.272	0.793	2.569	1	0.109	3.566
Age	0.031	0.028	1.226	1	0.268	1.031
Congestive heart failure CHF)	-1.704	0.955	3.184	1	0.074	0.182
Smoker	2.613	0.842	9.628	1	0.002*	13.643
Peripheral vascular disease (PVD)	2.873	0.801	12.863	1	<0.001*	17.684
Diabetes mellitus (DM)	2.426	0.784	9.566	1	0.002*	11.309
Obesity	0.251	0.739	0.116	1	0.734	1.286
Constant	-7.105	2.087	11.587	1	<0.001	0.001

Logistic regression

The logistic regression analysis (Table 3) was conducted to identify the predictors of FRI following ankle fracture surgery. All the collected variables identified as risk factors entered the model as they revealed a strong significant statistical relationship in the univariate analysis (Table 2). However, in the logistic regression, only smoking, PVD and DM remain statistically significant predictors after adjusting for other variables. The constant term is significant, reflecting the baseline log-odds of infection when all predictors are set to zero. Regarding demographic variables, Gender is not statistically significant (p>0.05) in predicting FRI when other variables are considered. However, if gender were significant, the odds of FRI would be approximately 3,6 times higher for

one gender over the other. Age is also not statistically significant (p>0.05). The odds ratio of 1.031 indicates a slight increase in the odds of the outcome with increasing age, but this effect is not significant.

CHF is not statistically significant (p>0.05), though it shows a trend towards reducing the likelihood of the outcome. The odds ratio of 0.182 suggests that CHF may decrease the odds of the outcome, but this finding isn't statistically conclusive. Smoking is statistically significant (p<0.05). The odds ratio of 13.643 indicates that smokers are about 13, 6 times more likely to experience FRI compared to non-smokers. PVD is statistically significant (p<0.05). The odds ratio of 17,684 suggests a very strong association, with individuals having PVD being about 17,7 times more likely to experience the outcome. DM is statistically significant (p<0.05). The odds ratio of 11.309 indicates that diabetics are about 11, 3 times more likely to experience the outcome compared to non-diabetics. Obesity is not statistically significant (p>0.05). The odds ratio of 1.286 suggests a slight increase in the likelihood of the outcome, but this effect is not significant.

The constant represents the log odds of the outcome when all predictors are set to zero. The highly significant p value and very low odds ratio suggest that the baseline probability of FRIis extremely low when none of the risk factors are present.

In summary, significant predictors like Smoking, PVD, and DM are significant predictors of FRI, with substantial increases in odds. Non-significant predictors like Gender, CHF, Obesity, and Age do not significantly predict FRI in the logistic regression model, even though some showed significance in univariate analysis. These results suggest that while many factors are associated with FRI individually, only certain variables (like smoking, PVD, and DM) remain influential when considering multiple factors simultaneously

DISCUSSION

Fracture-related infection after ankle fracture surgery is a multifactorial problem influenced by patient characteristics, injury specifics, surgical technique, and postoperative care. While some risk factors are non-modifiable, others, such as smoking cessation, glycemic control, and meticulous surgical technique, offer opportunities for intervention. Ongoing research is necessary to further elucidate these risk factors and develop evidence-based strategies for the prevention and management of FRI. Recent research presented a new definition of FRI to improve diagnosis and treatment after fracture surgery.[18,19]

The 8% infection rate falls within the higher range of reported rates for fracture-related infections after ankle surgery, which typically range from 1.4% to 9%.[3] The relatively high prevalence of DM (23.4%), obesity (25.3%), and CHF (13.8%) among the patients highlights the significant burden of risk factors comorbidities in this population as it was found in other previous studies.[3,12] These factors suggest that the cohort may have had a higher baseline risk of infection given their known associations with impaired wound healing and increased susceptibility to infection. Gender and age reflect demographic trends in ankle fractures, where older women, particularly those with osteoporosis, are at increased risk.[6]

Gender appears to influence the risk of infection, with females potentially being more at risk. However, this result is not statistically significant (p=0.109). Also, age does not significantly impact the risk of infection in this cohort (p=0.268), despite a small positive coefficient indicating a slight increase in risk with age.

The presence of CHF could influence both the surgical risk and postoperative recovery, potentially affecting the likelihood of complications such as infection. Despite appearing to have a protective effect against FRI, it was not a statistically significant finding. This could be due to confounding factors or a small sample size within the CHF subgroup. Smoking is a known risk factor for impaired healing and infection.[13] This reflects on the results, which highlight it as a major risk factor for FRI. However, its relatively low prevalence in this cohort may limit its overall impact on the study's findings. Given that PVD can impair blood flow to the extremities, this condition may predispose these patients to a higher risk of infection following surgery.[3]

It was shown to be a significant predictor of FRI in this cohort. This strong association underscores the importance of vascular health in postoperative outcomes. Obesity is associated with various complications in orthopedic surgery, including a higher risk of surgical site infections.[10] However, it does not significantly predict FRI in this study. The odds ratio (1.286) suggests a minor increase in risk, but this finding is not statistically meaningful. Diabetes is a significant risk factor for postoperative infections due to its effects on wound healing and immune function.[14] It was shown to be a significant predictor of FRI in this cohort which emphasizes the role of glycemic control in surgical care.

CONCLUSION

The results provide evidence that older adults, particularly women, with significant comorbidities such as diabetes, obesity, and CHF are at an elevated risk of developing fracture-related infections after ankle surgery. These findings suggest that patients with these conditions should be closely monitored and managed to reduce the risk of postoperative infections. Gender, CHF, obesity, and age were not statistically significant predictors, although their effects warrant further investigation in larger studies. These findings underscore the importance of comprehensive preoperative assessment and targeted

strategies to mitigate infection risk in high-risk populations.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Juto HH, Nilsson, Morberg P. Epidemiology of adult ankle fractures: 1756 cases identified in norrbotten county during 2009-2013 and classified according to AO/OTA. BMC Musculoskelet Disord, 2018;19(1):441.
2. Meng J, Zhu Y, Li Yansen, Sun T, Zhang F, Qin S, et al. Incidence and risk factors for surgical site infection following elective foot and ankle surgery: a retrospective study. J Orthop Surg Res. 2020;15(1):449.
3. Pilskog K, Hovding P, Fenstad AM, Inderhaug E. Risk factors for fracture-related infection after ankle fracture surgery. Injury. 2023;54(10):1110-11.
4. Allegranzi B. New WHO recommendations on preoperative measures for surgical site infection prevention: an evidence-based global perspective. Lancet Infect Dis. 2016;16(12):276-87.
5. Koyagura B, Koramutla HK, Ravindran Bijju. Surgical site infections in orthopaedic surgeries: incidence and risk factors at tertiary care hospital of South India. Int J Res Ortho. 2018;4(4)269-76.
6. Bergh C, Wennergren D, Moller M, Brisby H. Fracture incidence in adults in relation to age and gender: A study of 27,169 fractures in the Swedish fracture register in a well-defined catchment area. PLoS One. 2020;15(12):244-91.
7. Cheng J. Prevalence of surgical site infection and risk factors in patients after foot and ankle surgery: A systematic review and meta-analysis. Int Wound J. 2024;21(1):14350.
8. Liang Z. Surgical site infection following elective orthopaedic surgeries in geriatric patients: Incidence and associated risk factors. Int Wound J. 2019;16(3):773-80.
9. Huang N. Postoperative infection and revision surgery rates in foot and ankle surgery without routine prescription of prophylactic antibiotics. J Am Acad Orthop Surg Glob Res Rev. 2023;7(3).
10. Stewart M. Obesity in Elective Foot and Ankle Surgery. Orthop Clin North Am. 2018;49(3):371-9.
11. Olsen LL. The impact of lifestyle risk factors on the rate of infection after surgery for a fracture of the ankle. Bone Joint J. 2017;99(2):225-30.
12. Richardson, NG. Comparison study of patient demographics and risk factors for surgical site infections following open reduction and internal fixation for lateral malleolar ankle fractures within the medicare population. Foot Ankle Surg, 2021;27(8):879-83.
13. Durand F.Smoking is a risk factor of organ/space surgical site infection in orthopaedic surgery with implant materials. Int Orthop. 2013;37(4):723-7.
14. Uçkay I. Prevention of surgical site infections in orthopaedic surgery and bone trauma: state-of-the-art update. J Hosp Infect. 2013;84(1):5-12.
15. Berríos-Torres SI. Centers for disease control and prevention guideline for the prevention of surgical site infection. JAMA Surg. 2017;152(8):784-91.
16. Baranek ES. Time to diagnosis and treatment of surgical site infections in foot and ankle surgery. Foot Ankle Int. 2018;39(9):1070-5.
17. Zargaran AD, Zargaran, Trompeter AJ. The role of Vitamin D in orthopaedic infection: a systematic literature review. Bone Jt Open, 2021;2(9):721-7.
18. Metsemakers WJ. Fracture-related infection: A consensus on definition from an international expert group. Injury. 2018;49(3):505-10.
19. Govaert GAM. Diagnosing fracture-related infection: current concepts and recommendations. J Orthopaed Trauma. 2020;34(1):8-17.

Cite this article as: Serrasqueiro SN, Simões O, Moreno J, Pinheiro V, Fonseca. Key-risk factors for fracture-related infection after ankle surgery: a retrospective study. F. Int J Res Orthop 2024;10:1160-4.