

Identifying Risk Factors for Systemic Complications Following Fracture-Related Infection

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INTRODUCTION:

Fracture-related infection (FRI) is a serious complication of orthopaedic trauma that can result in poor outcomes, including systemic complications affecting multiple organ systems. While recent consensus criteria have improved diagnostic consistency, predictors of systemic complications among patients undergoing operative treatment for FRI remain poorly understood. In this study, we aimed to evaluate patient and injury-related factors associated with the development of systemic complications following operative management of FRI.

METHODS:

We conducted a retrospective cohort study at a single Level I trauma center between 2013 and 2021. Adult patients who had previously undergone fracture fixation and were subsequently diagnosed with FRI requiring hospitalization and surgical management were included. FRI was defined according to the 2018 international consensus criteria. Patients were eligible if they had either a minimum of six months of follow-up after FRI diagnosis or experienced a systemic complication prior to the six-month timepoint. The primary outcomes were rates of systemic complications, including cerebrovascular accident (CVA), myocardial infarction (MI), acute respiratory distress syndrome (ARDS), deep vein thrombosis or pulmonary embolism (DVT/PE), acute kidney injury (AKI), sepsis, and mortality. Demographics, comorbidities, injury characteristics, perioperative laboratory values, and operative details were compared between patients with and without complications using univariate and multivariate analyses to identify independent risk factors.

RESULTS:

A total of 281 patients with FRI were included, with 70 (24.9%) experiencing systemic complications. The mean age of patients with complications was significantly higher (51.7 years) compared to those without (43.8 years, $p < 0.001$). Patients with complications had higher body mass index (BMI) (31.6 kg/m² vs. 29.5 kg/m², $p = 0.054$), a greater prevalence of diabetes (30.0% vs. 16.1%, $p = 0.011$), cardiovascular disease (CVD) (42.9% vs. 23.2%, $p = 0.002$), chronic obstructive pulmonary disease (COPD) (20.0% vs. 4.7%, $p < 0.001$), prior CVA (11.4% vs. 1.4%, $p < 0.001$), chronic kidney disease (CKD) (18.6% vs. 3.3%, $p < 0.001$), and higher Charlson comorbidity index (CCI) (2.2 vs. 1.0, $p < 0.001$) (Table 1).

Systemic complications included sepsis (11.7%), AKI (8.2%), DVT/PE (5.0%), and mortality (2.5%) (Table 2).

No significant differences were observed in fracture characteristics, operative details, or preoperative laboratory values (white blood cell [WBC] count, erythrocyte sedimentation rate [ESR], c-reactive protein [CRP], albumin, prealbumin) between the groups. Multivariate analysis identified higher CCI as an independent risk factor for systemic complications (OR 1.83, 95% CI 1.31-2.57; $p = 0.001$) (Table 3).

DISCUSSION AND CONCLUSION:

Patient characteristics such as age, diabetes, CVD, COPD, CVA, CKD, and CCI differed significantly in patients with FRI who experienced systemic complications from those without. However, no significant differences were observed in fracture characteristics, operative details, or laboratory values (albumin, prealbumin, WBC, CRP, ESR). CCI was as an independent risk factor for systemic complications following FRI. Further research is needed to assess how the burden of comorbidities influences systemic complications after FRI reoperation.

Table 1. Comparison of patient characteristics between FRI patients with and without systemic complications.

Patient Characteristics	Complication (n=70)	No Complications (n=211)	p-value
Age, mean (SD)	51.7 (16.8)	43.8 (15.4)	<0.001
Sex, n (%)			
Male	43 (61.4)	134 (63.5)	0.755
Female	27 (38.6)	77 (36.5)	
Race/Ethnicity, n (%)			
White	30 (71.4)	156 (73.9)	0.412
Black	29 (28.6)	31 (28.2)	
Other	0	4 (1.9)	
Injury up (days), mean (SD)	12.6 (2078.0)	160.5 (1401.1)	0.294
BMI (kg/m ²), mean (SD)	31.6 (9.9)	29.5 (6.5)	0.054
Diabetes, n (%)	21 (30.0)	24 (16.1)	0.011
DKD, n (%)	6 (8.6)	8 (3.8)	0.121
CVD, n (%)	30 (42.9)	49 (23.2)	0.002
Tobacco use, n (%)	37 (52.9)	107 (50.7)	0.756
COPD, n (%)	14 (20.0)	10 (4.7)	<0.001
Vascular insufficiency, n (%)	9 (12.9)	7 (3.3)	0.006
Previous CVA, n (%)	8 (11.4)	3 (1.4)	<0.001
CKD, n (%)	13 (18.6)	7 (3.3)	<0.001
CCI, mean (SD)	2.2 (2.0)	1.0 (1.4)	<0.001

FRI = fracture-related infection, SD = standard deviation, BMI = body mass index, kg/m² = kilograms per meter squared, DKD = dialysis-related kidney disease, CVD = cardiovascular disease, COPD = chronic obstructive pulmonary disease, CVA = cerebrovascular accident, CKD = chronic kidney disease, CCI = Charlson comorbidity index

Table 2. Incidence of systemic complications among 281 patients with fracture-related infection.*

Complication	n (%)
Sepsis	33 (11.7)
Acute kidney injury (AKI)	23 (8.2)
Deep vein thrombosis/pulmonary embolism (DVT/PE)	14 (5.0)
Mortality	7 (2.5)
Acute respiratory distress syndrome (ARDS)	5 (1.8)
Myocardial infarction (MI)	4 (1.4)
Cerebrovascular accident (CVA)	3 (1.1)

*Some patients experienced more than one complication.

Table 3. Multivariate analysis of risk factors for systemic complications among FRI patients.

Variable	OR (95% CI)	p-value
Age	0.98 (0.94-1.03)	0.219
BMI	1.02 (0.97-1.08)	0.556
CCI	1.83 (1.31-2.57)	<0.001
Preoperative WBC*	1.08 (0.98-1.19)	0.113
Preoperative ESR*	1.00 (0.99-1.01)	0.982
Preoperative CRP*	1.00 (1.00-1.01)	0.862

FRI = fracture-related infection, OR = odds ratio, CI = confidence interval, CCI = Charlson comorbidity index, WBC = white blood cell count, ESR = erythrocyte sedimentation rate, CRP = c-reactive protein.

*Odds ratio represents per 1,000 K⁺/μL increase in WBC.

*Odds ratio represents per 40-mm/hr increase in ESR. Value derived from SD.

*Odds ratio represents per 100-mg/L increase in CRP. Value derived from SD.