The Open Orthopaedics Journal
DOI: 10.2174/0118743250464468260318132933, 2026, 20, e18743250464468
ISSN: 1874-3250
1

SUPPLEMENTARY MATERIAL **OPEN ACCESS**

Risk Factors for Early Fracture-related Infection After Surgical Treatment of Ankle Fractures in Patients Aged 50 Years and Older

Molham Najjar[1,2,*], Mario Morgenstern[1], Florian Samuel Halbeisen[3] and Henrik Eckardt[1,4]

[1]*Department of Orthopaedics and Traumatology, University Hospital Basel, University of Basel, Basel, Switzerland*
[2]*Department of Orthopaedics and Trauma Surgery, Hirslanden Klinik Birshof, Basel, Switzerland*
[3]*Basel Institute for Clinical Epidemiology and Biostatistics, University of Basel, Basel, Switzerland*
[4]*Crossklinik, Clinic for Orthopaedic Surgery & Sports Medicine, Basel, Switzerland*

*Address correspondence to this author at the Department of Orthopaedics and Traumatology, University Hospital Basel, University of Basel, Spitalstrasse 21, 4031 Basel, Switzerland and Department of Orthopaedics and Trauma Surgery, Hirslanden Klinik Birshof, Basel, Switzerland; E-mail: dr.molham.najjar@gmail.com

Cite as: Najjar M, Morgenstern M, Halbeisen F, Eckardt M. Risk Factors for Early Fracture-related Infection After Surgical Treatment of Ankle Fractures in Patients Aged 50 Years and Older. Open Orthop J, 2026; 20: e18743250464468. http://dx.doi.org/10.2174/0118743250464468260318132933

Published: April 17, 2026

Sex:

Categorized as male or female.

Age:

Included patients aged 50 years and older who were treated operatively for ankle fractures between 2008 and 2017.

Diabetes (Uncomplicated vs. Complicated):

Complicated diabetes was defined as diabetes with associated end-organ damage, including peripheral neuropathy, nephropathy, and/or peripheral arterial disease (PAD). Uncomplicated diabetes was defined as diabetes without such complications. Only documented cases from discharge summaries or medical histories were included.

Reference: Wukich DK et al. Foot Ankle Int. 2011;32(2):120–130.

Peripheral Artery Disease (PAD):

Included acute or chronic, symptomatic or asymptomatic PAD as documented in discharge summaries or patient histories. Classified according to the ACC/AHA guideline: asymptomatic, claudication, critical limb ischemia, or acute limb ischemia.

Reference: J Am Coll Cardiol. 2013;61(14):1555–1570.

Elixhauser Score:

Calculated based on comorbidities documented in patient records. Higher scores indicate more severe comorbidity burden and higher risk of adverse outcomes.

Reference: Elixhauser A et al. Med Care. 1998;36(1):8–27.

Osteoporosis:

Defined as a T-score ≤ -2.5. Only cases with explicit documentation in medical history or discharge letters were included.

Reference: WHO Scientific Group. 2000.

Smoking:

Defined as any daily tobacco use, regardless of amount. Only documented cases in the medical history or discharge letter were considered.

Reference: Fiore MC et al., 2008.

Renal Failure (Acute/Chronic):

Included cases documented in discharge letters, medical histories, or lab values. No distinction was made between acute vs. chronic or treated vs. untreated renal disease.

References: Ronco C et al., Lancet 2019; NIDDK, 2017.

Operator Level:

Categorized into four levels based on surgical training:

1. Resident Orthopedic Surgeon (Assistenzarzt)
2. Senior Orthopedic Surgeon (Oberarzt)
3. Lead Consultant (Leitender Arzt)
4. Head of Department (Chefarzt)

Hypoalbuminemia:

Defined as serum albumin < 3.5 g/dL, based on preoperative laboratory values.

Reference: Rush University Medical Center Lab Norms.

Anemia:

Severity classified as:

• Mild: Hb 110 g/L to lower normal range

• Moderate: Hb 80–110 g/L

• Severe: Hb < 80 g/L

Blood-loss anemia was identified postoperatively if hemoglobin dropped below normal. Documented cases from discharge letters, histories, or lab results were included.

References: Pomeranz AJ et al., 2016; Guo S et al., 2010.

Open Fracture:

Classified according to the Gustilo-Anderson system.

Syndesmotic Screw:

Presence confirmed by postoperative radiographs.

Intraoperative Difficulties:

Defined as any documented technical difficulty during surgery, e.g., problems with reduction in multifragmentary intra-articular fractures.

Fracture Malreduction:

Included patients who underwent revision surgery due to malreduction, confirmed on postoperative radiographs.

Medication Affecting Wound Healing:

Included use of glucocorticoids, antidepressants, immunosuppressants, or antineoplastic agents, based on documentation in patient history or medication list.

References: J Foot Ankle Surg, 2023; Am Foot Ankle Orthop, 2022; Wound Pract Res, 2024.

Postoperative Non-Compliance:

Defined as failure to follow postoperative care protocols (e.g., not wearing a cast, refusing physiotherapy). Reasons were primarily psychiatric or cognitive (e.g., dementia, delirium, substance abuse). Documentation required in discharge summaries, ward notes, or nursing records.

Psychological Disorders (Combined):

Included any documented diagnosis of substance abuse (alcohol, medication, drugs), affective or anxiety disorders, dementia, personality disorders, PTSD, schizophrenia, sleep disorders, psychosis, or postoperative delirium.

Mechanism of Injury:

• Low Impact: Falls, tripping, sports injuries

• High Impact: Motor vehicle accidents, falls from height, crush injuries

Wound Infection / FRI Diagnosis:

FRI was diagnosed using published consensus criteria:

• *Confirmatory criteria:*

1. Fistula/sinus tract with communication to bone or implant
2. Purulent wound drainage or pus observed intraoperatively
3. Positive cultures from ≥2 deep samples
4. Microorganisms detected histologically in deep tissue

• *Suggestive criteria:*

1. Local signs: redness, swelling, warmth, pain, fever
2. Radiologic signs: lysis, implant loosening, non-union
3. Positive culture from 1 deep sample
4. Elevated ESR/CRP/WBC
5. Persistent drainage
6. New joint effusion

The time frame for classification was set to ≤ 3 months postoperatively.