Mental health implications of fracture-related infections

a longitudinal quality of life study

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Aims

Fracture-related infections (FRIs) are a major concern for patients and healthcare systems, yet their impact on mental health has been largely overlooked. This study aimed to assess the longitudinal impact of FRI on patients' quality of life.

Methods

A prospective study was conducted at a level 1 trauma centre between January 2020 and December 2022. In total, 56 patients participated, with quality of life assessed at five timepoints: one week preoperatively, and one, three, six, and 12 months postoperatively. Statistical analysis was performed using repeated measures analysis of variance (ANOVA) with adjusted post-hoc analysis.

Results

The preoperative Physical Component Summary score on the 36-Item Short-Form Health Survey questionnaire (SF-36) was 26.71, increasing to 30.40 at one month, remaining stable at three months. A modest increase was observed at six months (32.45, $p = 0.003$), but it decreased to 29.72 at 12 months. The preoperative Mental Component Summary score (SF-36) was 46.48, decreasing to 39.89 at one month ($p = 0.027$) and to 36.03 at three months ($p \leq 0.001$). However, it improved at six (42.74) and 12 months (44.05). Positive changes were seen in EuroQol five-dimension questionnaire (EQ-5D) subdimensions, such as mobility, self-care, usual activities, and pain/discomfort, while anxiety/depression scores decreased over time. The EQ-5D visual analogue scale (VAS) score increased to 62.79 at six months ($p \leq 0.001$) and decreased to 58.2 at 12 months ($p = 0.011$).

Conclusion

FRIs substantially affect mental health and quality of life, particularly during the initial three months of treatment. This study emphasizes the importance of addressing psychological aspects early in FRI management, advocating for holistic care encompassing both physical and psychological aspects of treatment.

Article focus

- Mental health in fracture-related infection (FRI) is often overlooked.
- This article assesses the longitudinal impact of FRI on patients' quality of life.
- It examines the changes in both physical and mental health using 36-Item Short-Form Health Survey questionnaire (SF-36) and EuroQol five-dimension questionnaire (EQ-5D) scores.

Key messages

- FRIs have a substantial negative impact on mental health and quality of life, particularly during the initial three months of treatment.

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- The study highlights the need for early attention to psychological aspects in the management of FRI.

Strengths and limitations

- The study's use of a prospective longitudinal design allows for the assessment of changes in patients' quality of life over time, utilizing a comprehensive set of assessment tools, including SF-36 and EQ-5D scores, to measure both physical and mental aspects of quality of life.
- The study acknowledges that it cannot control for factors unrelated to FRI treatment that may impact quality of life.
- The study's sample size of 56 patients may be relatively small, which could limit the generalizability of the findings.

Introduction

Fracture-related infections (FRIs), which emerge as insidious complications post-fracture fixation surgeries, present substantial hurdles for patients, orthopaedic surgeons, and the broader healthcare ecosystem. As fracture management procedures are expected to increase, the incidence of FRIs has surged, highlighting the pressing need to fully comprehend their multifaceted implications.[1-3] The occurrence of a post-traumatic infection is estimated to be 1% to 2% for closed fractures, and can surpass 30% for Gustilo-Anderson type III open tibia fractures.[4,5] For Germany, an incidence of 11 cases per 100,000 inhabitants has been reported for the year 2018.[1] Beyond their impact on bone healing, FRIs trigger systemic consequences that result in extended hospital stays, recurrent interventions, elevated medical expenses, and the potential for enduring disability.[6]

Clinical indicators hold a pivotal role in evaluating the severity and scope of infection. This encompassing category includes inflammatory markers, identified pathogens, imaging evaluations, and diagnostic criteria, collectively contributing to definitively diagnosing and formulating treatment strategies for FRI cases.[7-9] However, while these clinical markers are indispensable in managing FRIs, they primarily capture the physiological aspects of the infection.

Amid the focus on somatic indicators, one often underestimated dimension pertains to the profound impact of FRIs on mental health and overall wellbeing. Beyond the physical realm, FRIs exact an emotional toll that reverberates across the psychological and social spheres of patients' lives. Emotional challenges such as anxiety and depression are among the experiences that individuals grappling with FRIs may confront.[10] The journey from diagnosis to recovery is rife with uncertainties, eliciting feelings of helplessness and distress. Additionally, disruptions to daily routines, functional limitations, and the looming possibility of recurrent infections can contribute to a decline in mental wellbeing.[11]

Despite the considerable implications of FRIs for both physical and psychological wellbeing, the exploration of their mental health ramifications remains largely uncharted territory.[12] The existing body of literature primarily focuses on clinical indicators and functional outcomes, often neglecting the intricate interplay between FRIs and mental health. Although there has been a surge of interest in mental health among orthopaedic surgical patients in general, comprehensive studies that explore the full range of challenges faced by individuals affected by FRIs are scarce.[10,13] For instance, a recent review on FRI outcome found only three out of 93 studies, which included quality of life measures.[6] Thus, only a few studies shed light on the quality of life of FRI patients, however these are either retrospectively designed with inherent limitations or conducted with small sample sizes.[10,14,15] Therefore, to understand the mental health impact throughout the treatment and recovery process, the aim of this study was a longitudinal evaluation of quality of life in patients without any known psychological disorders.

Methods

Design, setting, and participants

A prospective, longitudinal study of patients treated for FRI was conducted in a level 1 trauma centre in Germany. The inclusion period was defined from January 2020 to December 2022. FRI was verified in all cases according to the consensus definition.[9] FRI was verified through the fulfillment of at least one of the subsequent confirmatory criteria: 1) the presence of fistula, sinus tract, or wound breakdown; 2) observation of purulent drainage or pus during the surgical procedure; 3) identification of phenotypically indistinguishable microorganisms through culture in at least two distinct deep tissue/implant samples (inclusive of sonication fluid); and 4) histopathological discoveries such as microorganism presence in deep tissue samples or the identification of more than five polymorphonuclear cells (PMNs) per high-power field (HPF).[8] To ensure comparability, it was verified that all patients remained infection-free during the 12-month follow-up period. In the event that a patient exhibited confirmatory symptoms of FRI requiring additional treatment within that time frame, the follow-up period was reset to the initial point.

In total, 56 patients were included in the study. More patients were male than female (67.9% vs 32.1%). The average age of the patients was 56.2 years (SD 15.2). Anatomically, the majority of infections were localized at the tibia for 30 patients (53.6%) followed by the ankle (16.1%). In 20 cases (35.7%) the initial fracture was open (Table I). All patients remained infection-free in the 12 months' follow-up interval, and bone consolidation was achieved in 51 (91.1%) patients. Three patients underwent an amputation (5.4%) and two patients (3.6%) required a total knee arthroplasty in the follow-up time due to severe gonarthritis.

The exclusion criteria included patients with multiple fractures, pathological fractures, a known comorbid psychological disorder according to chapter F of the ICD-10,[16] malignancy, or antibiotic therapy due to any other infectious disease. Additionally, to address missing values, only patients who had completed all questionnaires in full were considered, which led to the exclusion of two patients. Eligible patients aged 18 years or older were consecutively enrolled. Patients were enrolled regardless of whether they presented with primary infection or reinfection and whether the initial fracture was open or closed.

Informed consent was obtained from all individual participants included. The study was approved by the institutional ethics committee of University Hospital Regensburg according to the Helsinki Declaration (file number 20-1680-101).[17] This study was registered at the German Clinical Trials Register (DRKS; file number: 00025492).

Table I. Patient characteristics.

Characteristic	Data (n = 56)
Sex, n (%)	
Male	38 (67.9)
Female	18 (32.1)
Mean age, yrs (SD)	56.2 (15.2)
Open fractures, n (%)	20 (35.7)
GAII	7 (12.5)
GAIIIa	5 (8.9)
GAIIIb	5 (8.9)
GAIIIc	3 (5.4)
Anatomical localization, n (%)	
Humerus	3 (5.4)
Femur	7 (12.5)
Tibia	30 (53.6)
Ankle	9 (16.1)
Foot	7 (12.5)
Reinfection cases, n (%)	5 (8.9)
Mean number of surgeries (range)	2.1 (1 to 5)
Surgical procedure, n (%)	
DAIR	3 (5.4)
External fixation	8 (14.3)
One-stage exchange	19 (33.9)
Two-stage exchange	18 (32.1)
Arthrodesis	5 (5.4)
Amputation	3 (5.4)

DAIR, debridement, antibiotics, and implant retention; GA, Gustilo-Anderson.

Outcome measures

The following patient-reported outcome measures (PROMs) were assessed at five different timepoints, specifically one week preoperatively before the consultation, one month postoperatively, and after three, six, and 12 months, respectively. The questionnaires were administered by the study team (NW, MR) in person during inpatient treatment and ambulatory visits. Additionally, at each timepoint clinical data were collected including site of infection, radiographs, and treatment procedure. Open fractures were classified according to the Gustilo-Anderson classification.[18] Revision rates were defined as required surgeries between infection occurrence and infection eradication. Achieved bone consolidation was determined with an evaluated RUST score > 10.[19]

German 36-Item Short-Form Health Survey questionnaire (SF-36): The extensively employed SF-36 health survey assesses overall health status through 36 questions across eight functional domains, which include physical function, role physical, bodily pain, general health, vitality, social function, emotional role, and mental health.[20] Summary scores for the physical and mental components were derived using normative data from a 1998 German national health interview and examination survey involving 7,124 participants.[21]

EuroQol five-dimension questionnaire (EQ-5D): The EQ-5D stands as a widely recognized and extensively used generic quality of life assessment tool, developed by the EuroQol group.[22] This instrument encompasses five distinct dimensions that probe into various functional domains: mobility, self-care, everyday life activities, pain/discomfort, and anxiety/depression. Furthermore, the efficacy of the EQ-5D was gauged through the implementation of the visual analogue scale (VAS) methodology.[23]

Statistical analysis

The analysis of the data was conducted using SPSS Statistics version 28.0 (IBM, USA). Descriptive measures were calculated for all the variables. Mean and SD were used to express continuous variables. To compare continuous variables, a repeated measures analysis of variance (ANOVA) with a Bonferroni-adjusted post-hoc analysis to control for inflated type I errors was calculated, following confirmation of suitable distribution for parametric testing through Levene's test. There were no violations of the assumption of homogeneity of variances. Significance was set at $p < 0.05$.

Results

Participants' quality of life was assessed using the SF-36 questionnaire, from which the Physical Component Summary (PCS) and Mental Component Summary (MCS) scores were calculated. The preoperative PCS score was 26.71. At one month postoperatively, the PCS score increased to 30.40, and remained stable with 30.43 at three months. Notably, the six-month evaluation demonstrated a modest increase in PCS score to 32.45. The improvement was statistically significant compared to the preoperative value ($p = 0.003$). At 12 months' follow-up the score decreased to 29.72. On the other hand, the preoperative MCS score was 46.48. Postoperatively, the MCS score decreased to 39.89 at one month ($p = 0.027$), and slightly further to 36.03 at three months ($p \leq 0.001$). Subsequently, this declining trend reversed, with the MCS score increasing to 42.74 at the six-month assessment. The 12-month follow-up showed a slight improvement to 44.05 (Figure 1).

Regarding the EQ-5D subdimension, a positive outcome was observed. For mobility, participants showed an initial severe limitation (n = 11, 20.0%) preoperatively, which notably improved by the 12-month assessment, with no patient reporting severe limitations. A decreasing trend in limitations was also observed in self-care, as severe limitations decreased from 25.7% (n = 14) preoperatively to 2.6% (n = 2) at 12 months. The trend in usual activities demonstrated a reduction in severe limitations from 40.0% (n = 22) preoperatively to 10.3% (n = 6) at 12 months. Additionally, the percentage of participants reporting no problems increased from 14.3% (n = 8) to 38.5% (n = 21), indicating a gradual improvement in performing everyday activities. While pain and discomfort limitations fluctuated, with improvements at three months, preoperative scores and scores at the 12-month follow-up were identical. Anxiety/depression limitations showed fluctuations with an overall decreasing trend. Preoperatively, 71.4% (n = 40) of patients reported no problems with regard to psychological symptoms, while at 12 months only 51.3% (n = 29) stated that they had no

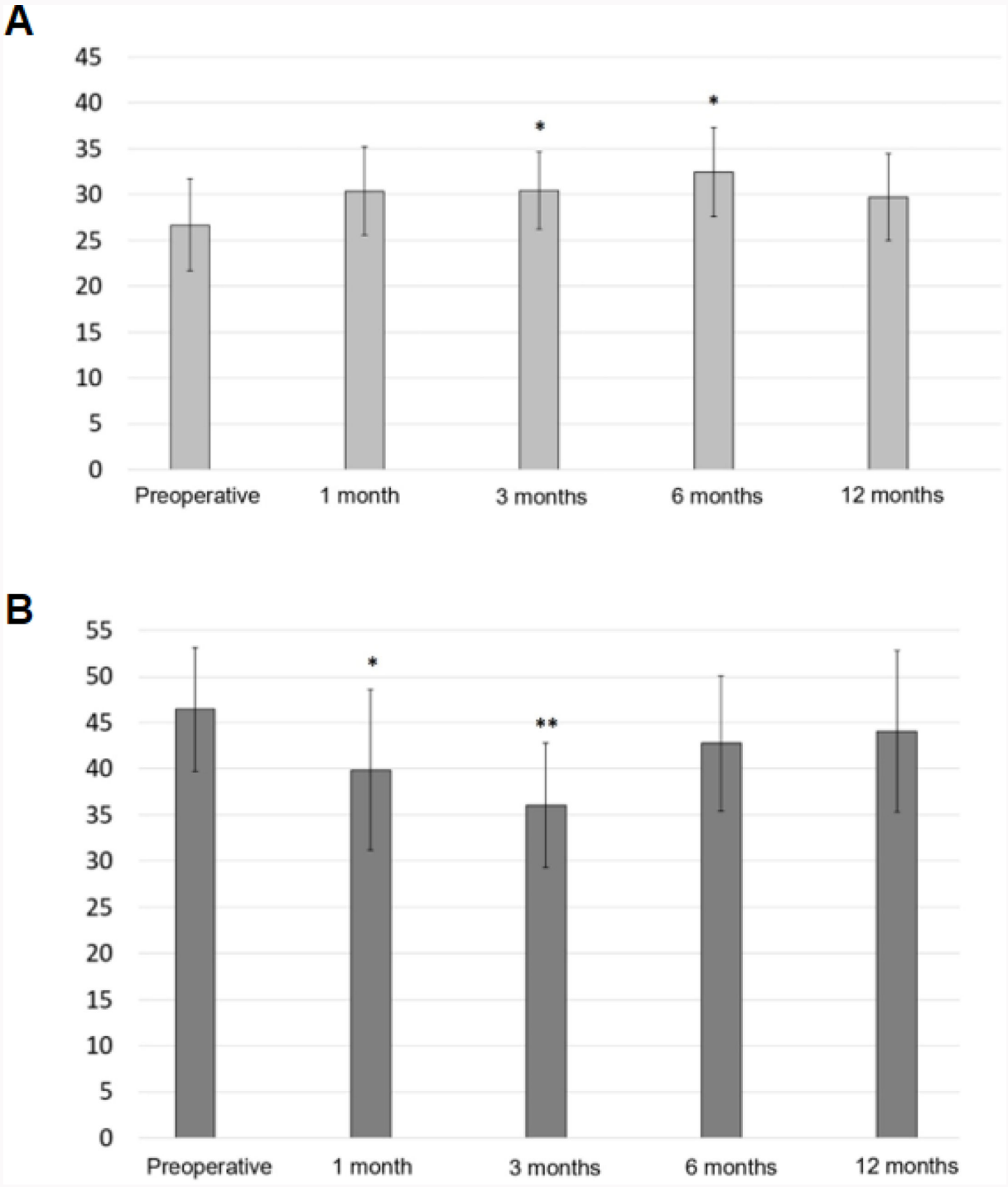

Fig. 1

a) Mean Physical Component Summary (PCS) scores and b) mean Mental Component Summary (MCS) scores assessed with the 36-Item Short-Form Health Survey questionnaire (SF-36). Lower scores are interpretated as declined quality of life. Statistical comparison of each follow-up timepoint with the preoperative baseline score was done using a repeated measures analysis of variance with a Bonferroni-adjusted post-hoc analysis. *p ≤ 0.05, **p ≤ 0.001.

problems. The EQ-5D VAS score showed an increase over time, with values of 48.3 before surgery, 53.5 at one month, 58.3 at three months ($p = 0.004$), 62.79 at six months ($p \leq 0.001$), and 58.2 at 12 months postoperation ($p = 0.011$) (Figure 2).

Discussion

This longitudinal study explored the quality of life of patients undergoing treatment for FRI. The findings revealed a statistically significant improvement in patients' physical health. However, a decline in Mental Component Summary (MCS) scores within the initial three months postoperatively pointed towards the challenges posed by FRIs on psychological health.

Aligned with our findings, a recent retrospective analysis showed that FRI patients report significantly lower quality of life in comparison to normative data, even after a mean 4.2 years after successful treatment with achieved infection eradication and bone consolidation.[10] The authors

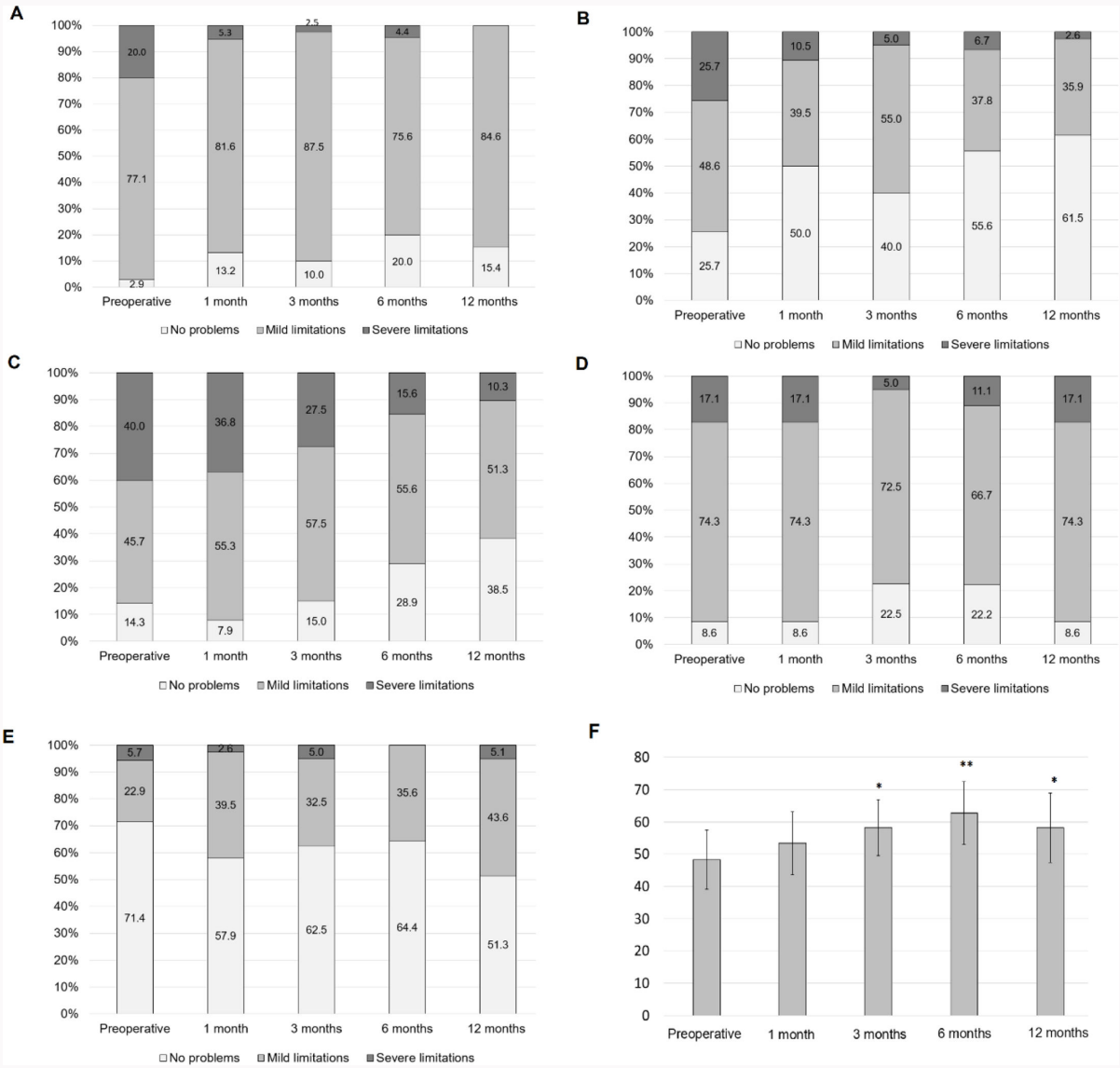

Fig. 2
Results of the EuroQol five-dimension questionnaire (EQ-5D) subdimensions given in percentages for a) mobility, b) self-care, c) usual activities, d) pain/discomfort, and e) anxiety/depression. f) EQ-5D visual analogue scale (VAS) scores. *p ≤ 0.05, **p ≤ 0.001.

reported a mean PCS score of 40.1 (SD 14.6), a mean MCS score of 48.7 (SD 5.1), and a mean EQ-5D VAS score of 65.7 (SD 22.7), which also indicates the potential of restoring patients' quality of life. The same study additionally demonstrated that 32.4% of the patients (n = 12/37) exceeded the clinically relevant threshold for depression symptom burden.[10] Comparable long-term quality of life results with a mean 3.0 years' follow-up were shown for patients with a FRI of the foot (mean PCS: 35.6 (SD 12.3), mean MCS: 41.3 (SD 12.9), mean EQ-5D VAS: 62.1 (SD 18.6)).[24]

Hotchen et al[25] reported a notable increase in EQ-VAS from 58.2 to 78.9 ($p < 0.001$) and an improvement in EQ-5D index scores from 0.284 to 0.740 ($p < 0.001$) over a year in a cohort of patients with long bone osteomyelitis. Applying the BACH classification, cases were divided into "uncomplicated" and "complex" categories, with patients classified as "uncomplicated" generally demonstrating better postoperative QoL outcomes.[25] Such classification tools considering the extent of bone damage, the severity of infection, and the patient's overall health status are particularly relevant in understanding the differential impacts on QoL in osteomyelitis, and a similar framework for stratification could potentially be applied to FRI patients.

Interestingly, a recent longitudinal study on another comparable indication – periprosthetic joint infections (PJIs) – revealed comparable scores, with preoperative MCS scores of 44.58, which decreased postoperatively to 40.93 at one month and slightly further to 38.93 at three months. However, in contrast to the FRI cohort, in which the scores increased at six-month follow-up, the scores declined further with time in the case of PJI patients.[26]

Whereas here patients with a pre-existing psychological comorbidity were excluded, notably a nationwide analysis for Germany showed that more than one-quarter of all FRI patients (1,893/7,158) exhibited comorbidities in the realm of mental and behavioural disorders, with the number of patients with psychological comorbidities rising by 24% in the last decade.[27] The finding of a decline in MCS scores

within the initial three months postoperatively introduces a critical dimension to our understanding of patient recovery following surgical interventions for FRI. This phase may be particularly challenging for patients with several factors potentially contributing to mental health decline. This may include persistence of pain and discomfort, as well as physical limitations such as restrictions on mobility, including no weightbearing and disruption of daily life. Patients may face substantial lifestyle adjustments and financial strain due to medical expenses, rehabilitation costs, and potential loss of income during the recovery period.[28] These stressors can contribute to the reported lower mental health scores.

While it is firmly acknowledged that mental state plays a crucial role and notably influences surgical treatment outcomes,[29–31] the mental welfare of patients with bone and joint infections has received limited attention within the realm of trauma surgery. To date, despite clear indications from FRI patients about their requirement for psychological assistance, no randomized controlled trials examining the impact of psychological interventions on treatment outcomes have been carried out, underscoring the deficiency of effective approaches to alleviate the psychological strain associated with musculoskeletal infections.[11] As a result, it becomes crucial to direct future research efforts towards comprehending the psychological welfare of orthopaedic patient groups.[32] Whereas disciplines like oncology have long embraced and demonstrated the advantages of tumour boards, the incorporation of multidisciplinary teams for the management of FRI has only recently received scientific attention.[33] The findings presented here underscore the justification for including a psychologist as an integral member of the treatment team. In a recent qualitative study, patients reported that meditation and yoga exercises were a resource, which helped them to keep calm with a positive mindset during recovery.[11] Beneficial effects of mind-body interventions, and especially mindfulness meditations, are widely reported for a range of diseases.[34] While the effect of such an adjunct therapy approach has still to be evidenced in FRI patients, such an approach would be easily and cost-effectively implemented in clinical practice. A screening for mental health such as the one presented in this study could be useful for identifying vulnerable patients who would benefit from additional, complementary interventions.

Interpreting the findings of this study necessitates acknowledgment of its inherent limitations. First, the study's scope may be constrained by its modest sample size and single-centre design, potentially limiting the generalizability of the results. Additionally, the relatively small cohort size precludes detailed subgroup analysis concerning fracture localizations and treatment strategies. The absence of a control group further complicates the ability to draw definitive causal conclusions regarding observed trends in psychological burden, quality of life, and expectations. Although alternative study designs were considered, such as incorporating fracture patients or a control group of unsuccessful treatments, the unique nature of fracture management rendered the inclusion of a comparable control group unfeasible, thus leading to the adoption of an uncontrolled case series. Furthermore, while the longitudinal design offers insights into temporal changes, it does not establish causality or address potential fluctuations in patients' psychological and physical wellbeing unrelated to FRI treatment. Finally, reliance on PROMs introduces potential response bias and subjectivity, further emphasizing the need for cautious interpretation of the results.

In conclusion, FRI patients reported physical improvement over time, while their mental health notably decreased in the first three months after surgery. The findings indicate the potential of implementing adjunct psychological interventions in the treatment of FRI in order to restore the mental domain of quality of life and enhance overall patient outcomes.

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T. Loew: Conceptualization, Methodology, Validation, Writing – review & editing.
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Data sharing

The data that support the findings for this study are available to other researchers from the corresponding author upon reasonable request.

Ethical review statement

Informed consent was obtained from all individual participants included. The study was approved by the institutional ethics committee of the University Clinic of Regensburg according to the Helsinki Convention (file number 20-1680-101). This study was registered at the German Clinical Trials Register (DRKS, file number: 00025492).

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