

Original Article: There is a Relationship between CRP Levels and Lower limb Swelling in Patients with Lower Limb Fractures: Cross-Sectional Study

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ABSTRACT

Introduction: this study will investigate the relationship between CRP levels and lower limb swelling in patients with lower limb fractures, aiming to provide valuable insights into the inflammatory dynamics associated with such injuries.

Material and Methods: Blood samples were collected from each participant within 24 hours of admission. Serum CRP levels were measured using a high-sensitivity CRP assay (hs-CRP) performed in the hospital's central laboratory. The results were expressed in milligrams per liter (mg/L).

Results: The relationship between CRP levels and lower limb swelling was assessed using Pearson's correlation coefficient. The results indicate a significant positive correlation between CRP levels and the degree of swelling ($r = 0.76$, $p < 0.001$).

Conclusion: this study demonstrates a significant relationship between CRP levels and lower limb swelling in patients with lower limb fractures. Elevated CRP levels are associated with greater swelling, highlighting the potential of CRP as a biomarker for assessing and managing post-fracture inflammation.

Introduction

C-orectal C-reactive protein (CRP) is a well-known biomarker of inflammation that is commonly used in clinical practice to assess the presence and intensity of inflammatory processes within the body [1-3]. Elevated CRP levels are indicative of

acute inflammation and can result from various conditions, including infections, autoimmune diseases, and trauma. Lower limb fractures, which often lead to significant tissue damage and subsequent inflammatory response, are a prevalent cause of acute inflammation. One of the clinical manifestations of this inflammatory response is swelling in the affected limb, which

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can complicate patient recovery and management [4].

Swelling following a lower limb fracture is not merely a symptom but a complex physiological response involving vascular changes, fluid accumulation, and cellular activity at the injury site. The extent of swelling can impact pain levels, mobility, and overall recovery outcomes, making it a critical factor to monitor and manage. However, the relationship between CRP levels and the degree of swelling in patients with lower limb fractures remains an area of active investigation. Understanding this relationship could provide valuable insights into the inflammatory processes at play and potentially inform more effective management strategies for these patients [5].

This cross-sectional study aims to explore the correlation between CRP levels and lower limb swelling in patients who have sustained lower limb fractures. By investigating this relationship, the study seeks to enhance the understanding of the inflammatory response associated with such fractures and identify potential markers for predicting and monitoring swelling [6].

This could ultimately lead to improved patient outcomes through more targeted and timely interventions.

Lower limb fractures, encompassing fractures of the femur, tibia, fibula, and associated structures, are among the most common injuries seen in orthopedic practice. They are frequently associated with significant morbidity, prolonged recovery periods, and, in some cases, complications such as compartment syndrome. The inflammatory response, as evidenced by elevated CRP levels, is a natural part of the healing process, yet excessive inflammation can exacerbate swelling and delay recovery. Hence, elucidating the relationship between CRP levels and swelling could have important clinical implications [7].

Previous research has established CRP as a reliable marker for systemic inflammation, but

its specific role and predictive value in the context of post-fracture swelling have not been fully delineated [8].

This study will address this gap by systematically measuring CRP levels and quantifying swelling in a cohort of patients with lower limb fractures. The findings are expected to provide a clearer picture of how CRP levels correspond to the severity of swelling and whether CRP can serve as a useful biomarker for monitoring and managing post-fracture inflammation.

In conclusion, this study will investigate the relationship between CRP levels and lower limb swelling in patients with lower limb fractures, aiming to provide valuable insights into the inflammatory dynamics associated with such injuries. By enhancing our understanding of this relationship, the study seeks to contribute to improved clinical practices and patient care in the management of lower limb fractures [9].

Materials and Methods

Study Design and Setting

This cross-sectional study was conducted at the Orthopedic Department of Shohada Hospital, a tertiary care hospital, over a period of six months from 2019 to 2021. The study protocol was approved by the Institutional Review Board (IRB) of Tabriz University of Medical Sciences, and all participants provided informed consent prior to enrollment.

Participants:

The study included 100 patients aged 18 years and older who presented with acute lower limb fractures. The inclusion criteria were:

1. Patients with confirmed lower limb fractures (femur, tibia, fibula, ankle).
2. Patients who presented within 48 hours of injury.

Exclusion criteria were

1. Patients with a history of chronic inflammatory diseases (e.g., rheumatoid arthritis, inflammatory bowel disease).
2. Patients on long-term corticosteroid or immunosuppressive therapy [10].
3. Patients with concurrent infections.
4. Patients with known malignancies.
5. Pregnant women.

Clinical Assessment

Upon admission, each patient underwent a comprehensive clinical assessment. Data collected included demographic information (age, sex, BMI), medical history, and details of the fracture (type, location, mechanism of injury). The extent of lower limb swelling was measured using circumferential measurements at predefined anatomical landmarks (e.g., mid-thigh, mid-calf) with a standard measuring tape. Swelling was quantified as the difference in circumference between the injured and uninjured limbs [11].

Laboratory Analysis

Blood samples were collected from each participant within 24 hours of admission. Serum CRP levels were measured using a high-sensitivity CRP assay (hs-CRP) performed in the hospital's central laboratory. The results were expressed in milligrams per liter (mg/L) [12].

Imaging Studies

Standard radiographs of the injured limb were obtained to confirm the diagnosis and classify the type and severity of the fracture. Additional imaging studies, such as MRI or CT scans, were performed if clinically indicated to assess associated injuries [13].

Statistical Analysis

Data were analyzed using SPSS software version [Version Number]. Continuous variables were expressed as mean $\pm$ standard deviation (SD) and categorical variables as frequencies and percentages. The relationship between CRP levels and the degree of lower limb swelling was assessed using Pearson's correlation coefficient. Multivariate linear regression analysis was performed to adjust for potential confounders such as age, sex, BMI, and fracture severity. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

The study adhered to the ethical principles outlined in the Declaration of Helsinki. Participants were informed about the purpose of the study, the procedures involved, and their right to withdraw at any time without any impact on their medical care. Confidentiality of participant data was strictly maintained throughout the study. Ethic NO: IR.TBZMED.REC.1397.690

Limitations

Potential limitations of this study include its single-center design, which may limit the generalizability of the findings. Additionally, the exclusion of patients with certain comorbidities may affect the applicability of the results to a broader patient population. By rigorously following this methodology, the study aims to provide robust data on the relationship between CRP levels and lower limb swelling in patients with lower limb fractures, thereby contributing valuable insights to clinical practice [14].

Results

Participant Characteristics

A total of 100 patients with acute lower limb fractures were enrolled in the study. The demographic and clinical characteristics of the study population are summarized in Table 1.

Table 1: Demographic and Clinical Characteristics of Study Participants (N=100)

Characteristic	Value
Age (years), mean $\pm$ SD	45.8 $\pm$ 16.2
Gender, n (%)	
- Male	62 (62%)
- Female	38 (38%)
Body Mass Index (BMI), mean $\pm$ SD	26.7 $\pm$ 4.9
Fracture Location, n (%)	
- Femur	28 (28%)
- Tibia	36 (36%)
- Fibula	20 (20%)
- Ankle	16 (16%)
Mechanism of Injury, n (%)	
- Motor Vehicle Accident	40 (40%)
- Fall	34 (34%)
- Sports Injury	26 (26%)

CRP Levels and Limb Swelling

CRP levels and the extent of lower limb swelling were measured for all participants. The results are presented in Table 2.

Table 2: CRP Levels and Lower Limb Swelling (N=100)

CRP Level (mg/L)	Patients (n)	Mean Swelling (cm) $\pm$ SD
< 10	35	2.1 $\pm$ 0.8
10 - 20	30	3.4 $\pm$ 1.1
21 - 30	20	4.6 $\pm$ 1.3
> 30	15	5.8 $\pm$ 1.5

Correlation Between CRP Levels and Limb Swelling

The relationship between CRP levels and lower limb swelling was assessed using Pearson's correlation coefficient. The results indicate a significant positive correlation between CRP

levels and the degree of swelling ($r = 0.76$, $p < 0.001$) [15].

Multivariate Analysis

Multivariate linear regression analysis was performed to adjust for potential confounders such as age, sex, BMI, and fracture severity. The results are summarized in Table 3.

Table 3: Multivariate Linear Regression Analysis of Factors Associated with Limb Swelling

Predictor	Coefficient (B)	95% Confidence Interval (CI)	p-value
CRP Level (mg/L)	0.15	0.12 - 0.18	<0.001
Age (years)	0.02	-0.01 - 0.05	0.15
BMI	0.04	-0.02 - 0.10	0.21

Fracture Severity (mild/moderate/severe)	0.50	0.30 - 0.70	<0.001
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These results indicate that higher CRP levels are significantly associated with greater lower limb swelling, even after adjusting for age, sex, BMI, and fracture severity. Fracture severity also emerged as a significant predictor of swelling. In conclusion, the data demonstrate a clear relationship between CRP levels and the extent of lower limb swelling in patients with lower limb fractures, highlighting the potential of CRP as a marker for inflammation and swelling in this patient population [16-18].

Discussion

The findings of this cross-sectional study demonstrate a significant relationship between C-reactive protein (CRP) levels and lower limb swelling in patients with lower limb fractures. Elevated CRP levels were strongly correlated with increased swelling, suggesting that CRP can serve as a useful biomarker for inflammation and subsequent swelling in this patient population [19-21].

The positive correlation ($r = 0.76$, $p < 0.001$) between CRP levels and the extent of lower limb swelling indicates that as CRP levels rise, so does the degree of swelling. This correlation is consistent with the role of CRP as an acute-phase reactant, which increases in response to tissue injury and inflammation. In the context of lower limb fractures, the inflammatory response is a critical component of the healing process, but excessive inflammation can lead to complications such as increased swelling, pain, and delayed recovery [22].

The results of the multivariate linear regression analysis further support the association between CRP levels and swelling, even after adjusting for potential confounders such as age, sex, BMI, and fracture severity.

This suggests that CRP is an independent predictor of swelling in patients with lower limb

fractures. The significant coefficient for CRP levels ($B = 0.15$, $p < 0.001$) underscores the strength of this relationship [23-25].

The findings of this study have important clinical implications. First, monitoring CRP levels in patients with lower limb fractures could provide valuable information about the inflammatory status and potential for swelling.

Early identification of patients at risk for significant swelling could facilitate more proactive management strategies, such as the use of anti-inflammatory medications or other interventions to control inflammation and minimize swelling.

Second, the significant association between fracture severity and swelling highlights the need for tailored treatment approaches based on the severity of the fracture.

Severe fractures are likely to provoke a more robust inflammatory response, leading to greater swelling. Therefore, clinicians should be particularly vigilant in managing inflammation and swelling in patients with more severe fractures [26].

Previous research has established CRP as a reliable marker for systemic inflammation, but its specific role in predicting swelling in the context of lower limb fractures has been less well explored.

The results of this study align with earlier findings that elevated CRP levels are associated with increased inflammatory activity and tissue damage. However, this study adds to the existing literature by specifically quantifying the relationship between CRP levels and lower limb swelling, providing a clearer understanding of how CRP can be used to assess and manage post-fracture inflammation [27].

Despite the robust findings, this study has several limitations. The single-center design may limit the generalizability of the results to other settings.

Additionally, the exclusion of patients with certain comorbidities, such as chronic inflammatory diseases or concurrent infections, may affect the applicability of the findings to a broader patient population.

Future research should consider multi-center studies with larger sample sizes to validate these findings and enhance their generalizability. Additionally, longitudinal studies that track CRP levels and swelling over time could provide insights into the temporal relationship between inflammation and swelling, and how these factors influence long-term outcomes in patients with lower limb fractures.

Conclusion

In conclusion, this study demonstrates a significant relationship between CRP levels and lower limb swelling in patients with lower limb fractures. Elevated CRP levels are associated with greater swelling, highlighting the potential of CRP as a biomarker for assessing and managing post-fracture inflammation. These findings underscore the importance of incorporating CRP level monitoring into the clinical management of lower limb fractures to improve patient outcomes through timely and targeted interventions.

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