



The Pathologic Role of Preoperative Albumin-to-C-Reactive Protein Ratio in Detecting Early Acute Infection Following Femur Implant Insertion

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ABSTRACT

Introduction: Implant-associated infections after femur surgery are severe, and early diagnosis is challenging due to overlapping postoperative inflammation. While CRP and albumin are commonly used markers, their combined ratio may offer better insight into host reserve and inflammatory burden. This study aims to assess the preoperative albumin-to-C-reactive protein ratio for detecting early acute infection following femur implant insertion.

Material and methods: This descriptive cross-sectional study at Shohada Hospital, Tabriz, enrolled 85 patients undergoing femoral implant surgery using convenience sampling. Preoperative data on demographics, comorbidities, surgical details, and laboratory markers (including serum albumin and CRP to calculate the Alb/CRP ratio) were collected to assess early acute postoperative infection.

Results: Preoperative albumin-to-C-reactive protein ratio was significantly suppressed in infected patients compared with non-infected controls [median 0.22 (IQR:0.15-0.30) vs. 0.50 (IQR:0.36-0.68); $p<0.001$]. Receiver operating characteristic analysis established superior discriminatory performance for Alb/CRP (AUC=0.988; 95% CI:0.82-0.98; cutoff $\leq$ 0.34; sensitivity 100.0%, specificity 95.6%). Multivariable logistic regression identified Alb/CRP $\leq$ 0.34 as an independent predictor of early acute infection (aOR=9.10; 95% CI:3.20-25.80; $p<0.001$) alongside operative duration $\geq$ 120 minutes (aOR=2.45; $p=0.028$).

Conclusion: Preoperative albumin-to-C-reactive protein ratio serves as an outstanding, independent biomarker for early acute infection risk stratification following femur implant placement.

Introduction

Femoral fractures and reconstructive procedures frequently require internal fixation or prosthetic implantation to restore alignment, stability, and early mobilization, yet implant-associated infection remains one of the most devastating complications in orthopedic trauma and elective reconstructive surgery.

Even when incidence appears numerically modest, the absolute burden is substantial because femur implants are common, infections are difficult to eradicate in the presence of foreign material, and clinical consequences include prolonged hospitalization, repeated debridement's, implant failure, nonunion, chronic osteomyelitis, and long-term functional decline.

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From a health-systems perspective, these infections impose high direct costs, increase antimicrobial exposure, and contribute to antimicrobial resistance, while for patients they translate into pain, disability, and loss of independence. The challenge is compounded by the fact that early infection can mimic expected postoperative inflammation, delaying diagnosis until bacterial biofilm matures and the therapeutic window for implant retention narrows. For these reasons, improving early recognition and risk stratification for femur implant insertion is a priority in contemporary orthopedic care [1].

The pathobiology of implant-related infection is distinct from soft-tissue infection because adherence of microorganisms to biomaterial surfaces enables rapid biofilm formation. Within biofilms, bacteria exhibit altered metabolic states, reduced susceptibility to host immunity, and tolerance to antibiotics, making eradication difficult without surgical intervention. Clinically, early acute infection often discussed within the first few weeks after implantation may present with subtle wound changes, disproportionate pain, serous drainage, or low-grade fever, but these signs are neither sensitive nor specific in the immediate postoperative period. Moreover, postoperative analgesics and perioperative antibiotics can blunt symptoms and modify laboratory markers. This diagnostic ambiguity means that clinicians frequently rely on a composite impression derived from clinical examination, imaging, and inflammatory biomarkers, each with limitations. A preoperative biomarker that captures the host's baseline inflammatory and nutritional state could therefore be valuable, both for identifying patients at heightened risk and for contextualizing postoperative trajectories in the critical early phase after femur implant insertion [2].

C-reactive protein (CRP) is among the most widely used inflammatory biomarkers in orthopedics. Synthesized by hepatocytes under interleukin-6 stimulation, CRP rises rapidly during acute-phase responses and is routinely measured around major surgery because it is inexpensive and readily available. However, CRP is inherently nonspecific: it increases after trauma, surgical tissue injury, hematoma, and many noninfectious inflammatory conditions. In femoral fracture patients, the baseline preoperative CRP may already be elevated due to the index injury, associated soft-tissue damage, or concurrent systemic stress. Following surgery, CRP typically rises and then declines over days; deviations from the expected decline can be suggestive of complications, yet there is significant inter-individual variability. Consequently, reliance on CRP alone can lead to false-positive concern and unnecessary interventions, or conversely, false reassurance when CRP is modest despite evolving infection particularly in older or

immunocompromised patients. These limitations underscore the need for complementary markers or composite indices that better reflect clinically meaningful immune dysregulation beyond isolated inflammation [3].

Serum albumin, traditionally viewed as a nutritional marker, is also a negative acute-phase reactant that decreases with systemic inflammation, capillary leak, hepatic reprioritization of protein synthesis, and catabolic stress. Hypoalbuminemia has been associated with impaired wound healing, reduced collagen synthesis, edema, altered drug pharmacokinetics, and a higher susceptibility to infection in various surgical populations. In orthopedic settings, low albumin can reflect malnutrition, frailty, chronic disease burden, or acute inflammatory stress from trauma, each of which can compromise host defenses and tissue repair. Importantly, albumin changes are not purely nutritional; they can decline rapidly in inflammatory states, making albumin informative as part of an integrated assessment of the acute-phase response. Nevertheless, albumin alone has limitations as well: it is influenced by hydration status, liver function, nephrotic losses, and other confounders, and its relatively longer half-life can obscure short-lived inflammatory changes. A composite index that incorporates albumin may therefore be more robust than albumin as a standalone parameter when the aim is to characterize perioperative immune-metabolic reserve and susceptibility to infection [4]. Combining an inflammatory positive acute-phase reactant (CRP) with a negative acute-phase reactant (albumin) yields the albumin-to-CRP ratio, a metric that conceptually captures the balance between inflammatory burden and physiological reserve. A low albumin-to-CRP ratio can be interpreted as a state of heightened systemic inflammation coupled with impaired nutritional or metabolic resilience, a biological milieu in which bacterial contamination may be more likely to progress to clinically significant infection. Unlike single markers that move in only one direction, the ratio amplifies clinically relevant divergence CRP rising while albumin falls potentially improving discrimination in settings where either marker alone is equivocal. Additionally, because both components are commonly available in preoperative blood panels, the ratio can be calculated easily without added cost or specialized assays, supporting translation into routine practice. The notion that such composite biomarkers may outperform individual analytes has gained traction across surgical specialties, particularly for postoperative complications, sepsis risk, and prognostication, but its specific utility for early acute infection after femur implant insertion remains incompletely defined [5].

In trauma-related femoral fractures, the diagnostic landscape is especially complex. The initial injury induces a systemic inflammatory response, and

patients may present with polytrauma, transfusion requirements, open wounds, or prolonged preoperative waiting times, all of which can distort inflammatory markers and increase infection risk. Surgical factors such as the type of implant (intramedullary nail, plate fixation, arthroplasty components), operative duration, soft-tissue handling, dead space, and hematoma formation further shape the postoperative inflammatory profile. Early acute infection in this context can be clinically silent until drainage, fever, or rising inflammatory markers become apparent, at which point biofilm maturation may already compromise implant retention strategies. Traditional postoperative monitoring with serial CRP and leukocyte counts often lacks specificity, while imaging may be limited by postoperative changes and metal artifact. Therefore, a preoperative stratification approach that provides a baseline “risk signature” could help clinicians interpret postoperative trends more accurately and prioritize surveillance or early diagnostic work-up in those most susceptible [6].

Several related biomarker frameworks support the plausibility of the albumin-to-CRP ratio as a pathologically meaningful indicator. Protein-energy malnutrition and systemic inflammation interact bidirectionally: inflammation drives catabolism and anorexia, while malnutrition impairs innate and adaptive immunity. In orthopedic implant surgery, host factors such as diabetes, smoking, obesity, chronic kidney disease, and immunosuppressive therapy modulate these pathways and influence infection risk. Albumin integrates aspects of chronic illness, frailty, and acute stress, whereas CRP reflects the magnitude of inflammatory signaling. Their ratio, therefore, may function as an accessible surrogate for the host’s immunometabolism phenotype at the time of implantation, potentially capturing risk not fully represented by comorbidity counts or traditional clinical scoring systems. Importantly, “pathologic role” in this context refers not only to association but to biological plausibility: a low ratio may mark a host environment conducive to microbial persistence, impaired wound sealing, and early colonization of implanted material. Establishing the relationship between this ratio and early infection could also inform targeted perioperative optimization strategies, such as nutritional support, glycemic control, or intensified postoperative surveillance [7].

Despite growing interest in composite inflammatory-nutritional indices, there remains a practical evidence gap in orthopedics regarding preoperative albumin-to-CRP ratio specifically for early acute infection after femur implant insertion. Many studies on implant-associated infection focus on postoperative diagnostic criteria, synovial markers (more applicable to arthroplasty), or late complications, while trauma populations are often

underrepresented or analyzed together with heterogeneous fracture sites and implant types. Additionally, published biomarker thresholds vary across institutions due to differences in laboratory assays, case mix, and timing of sampling relative to injury and surgery. Even when associations are reported, it is frequently unclear whether the ratio adds incremental diagnostic value beyond CRP alone, whether it remains predictive after adjusting for confounders such as open fracture status or operative duration, and how it performs in the clinically challenging “early” window when postoperative inflammation overlaps with infection. Furthermore, clinicians need interpretable, actionable cutoffs and an understanding of how preoperative values relate to early postoperative presentation, rather than solely long-term outcomes. Addressing these uncertainties is essential before the albumin-to-CRP ratio can be recommended as a routine tool in perioperative decision-making for femur implants [8]. Accordingly, the present study was designed to evaluate the clinical and pathologic utility of the preoperative albumin-to-C-reactive protein ratio as an accessible biomarker for identifying early acute infection following femur implant insertion, with the goal of clarifying its diagnostic performance and potential role in perioperative risk stratification.

Material and methods

Study Design:

This descriptive cross-sectional study was conducted at Shohada Hospital, Tabriz, Iran. The study assessed the association between the preoperative albumin-to-C-reactive protein (Alb/CRP) ratio and the occurrence of early acute postoperative infection following femoral implant insertion, using routinely collected perioperative clinical and laboratory data from eligible patients during the study period.

Sampling and Sample Size:

Participants were recruited using convenience (available) sampling from patients undergoing femoral implant insertion at Shohada Hospital, Tabriz. The required sample size was calculated using Cochran’s sample size formula for a single proportion:

$$n = Z^2 \times p \times (1 - p) / d^2$$

Assuming a 95% confidence level ($Z=1.96$), an expected proportion of early acute postoperative infection of $p=0.10$ based on prior clinical estimates, and an absolute precision of $d=0.064$, the calculated sample size was approximately 85 patients. Accordingly, a total of 85 patients were enrolled in the study to provide adequate precision for estimating the outcome frequency and evaluating the predictive value of the preoperative albumin-to-CRP ratio.

Inclusion and Exclusion Criteria:

Eligible participants were adult patients undergoing femoral implant insertion (including internal fixation and/or femoral implant-based reconstruction as per the treating orthopedic team) who had preoperative laboratory measurements of serum albumin and CRP available within the defined preoperative window and who were clinically stable for surgery. Patients were excluded if they had evidence of active infection before surgery (e.g., established systemic infection, local infection at the operative site, or documented sepsis), chronic inflammatory or autoimmune disease likely to distort CRP, severe hepatic dysfunction or nephrotic-range protein loss affecting albumin interpretation, malignancy under active treatment, long-term corticosteroid or immunosuppressive therapy, incomplete or missing key clinical/laboratory data, revision surgery for a previously infected implant, or refusal/inability to provide informed consent (where applicable). Additionally, patients receiving prolonged preoperative therapeutic antibiotics for reasons other than standard prophylaxis were excluded to reduce misclassification of early postoperative infection.

Procedures:

After enrollment, baseline demographic and clinical characteristics were recorded, including age, sex, body mass index, smoking status, relevant comorbidities (e.g., diabetes mellitus, chronic kidney disease), mechanism of injury (when trauma-related), and perioperative risk factors documented in the medical record. Preoperative laboratory values included serum albumin and CRP, from which the Alb/CRP ratio was calculated. Additional routinely available laboratory markers were also collected when present in the chart, such as white blood cell count and hemoglobin, to allow clinical contextualization of inflammatory status and perioperative condition.

Perioperative and postoperative variables were captured to characterize surgical exposure and early outcomes, including implant type and surgical approach, operative duration, intraoperative blood loss (when recorded), timing and type of antibiotic prophylaxis, and length of hospital stay. The primary outcome was early acute postoperative infection after femur implant insertion, identified based on documented clinical diagnosis by the treating team and compatible clinical findings in the early postoperative period (e.g., wound erythema, warmth, increasing pain disproportionate to expected recovery, purulent drainage, wound dehiscence), supplemented when available by supportive evidence such as positive culture results, imaging consistent with infection, or initiation of targeted antimicrobial therapy due to suspected implant-related infection. Postoperative CRP trends, fever recordings, wound status, need for

reoperation/debridement, and any early implant-related complications were also extracted to support outcome classification and to explore clinical correlates of the biomarker findings.

Statistical Analysis:

Because the data were normally distributed, continuous variables were summarized as mean $\pm$ standard deviation and compared using the independent-samples t test between patients with and without early acute infection. Categorical variables were reported as frequency (percentage) and compared using the chi-square test (or Fisher's exact test when expected cell counts were small). The diagnostic/predictive performance of the preoperative Alb/CRP ratio for early acute infection was assessed using receiver operating characteristic (ROC) curve analysis, including calculation of the area under the curve (AUC) and determination of an optimal cutoff value based on the Youden index. To quantify the association between the Alb/CRP ratio and infection, binary logistic regression was performed and reported as odds ratios with 95% confidence intervals; clinically relevant covariates were entered to adjust for potential confounding. All tests were two-sided, and a p value <0.05 was considered statistically significant. Analyses were performed using standard statistical software.

Ethical Considerations:

The study protocol was reviewed and approved by the Ethics Committee of Tabriz University of Medical Sciences (Ethics code: IR.TBZMED.REC.1404.008).

Patient confidentiality was maintained by anonymizing data prior to analysis and restricting access to the research dataset to the study team. All procedures were conducted in accordance with the Declaration of Helsinki and relevant national guidelines; informed consent was obtained when required by the institutional regulations for the study design and data-collection approach.

Results

Baseline characteristics and univariate comparisons between patients with and without early acute postoperative infection are summarized in Table 1. Overall, demographic profiles, medical comorbidities, and surgical variables including age, sex distribution, body mass index, operative duration, and implant modality demonstrated no statistically significant differences between the two cohorts (all $p>0.05$). In contrast, preoperative systemic inflammatory and nutritional indices differed markedly. Patients who subsequently developed early acute infection exhibited significantly lower preoperative serum albumin levels (3.4 ± 0.5 g/dL vs. 4.0 ± 0.4 g/dL; $p<0.001$) and markedly higher serum C-reactive protein concentrations [median 16.5 mg/L (IQR 11.9-22.8)]

vs. 8.9 mg/L (IQR:5.8-13.6); $p < 0.001$] compared with the non-infection cohort. Consequently, the preoperative albumin-to-C-reactive protein ratio was significantly suppressed in the infection cohort [median 0.22 (IQR:0.15-0.30) vs. 0.50 (IQR:0.36-

0.68); $p < 0.001$], identifying it as a prominent laboratory marker associated with postoperative infectious complications.

Table 1. Baseline demographic, clinical, surgical, and preoperative laboratory characteristics of the study population, stratified by early acute postoperative infection status.

Variable	All patients (n=85)	Non-infection group (n=68)	Infection group (n=17)	p value
Demographic and clinical variables	-	-	-	-
Age, years	43.6 ± 16.8	42.9 ± 16.5	46.4 ± 18.0	0.478
Male sex	58 (68.2)	46 (67.6)	12 (70.6)	0.795
Body mass index, kg/m ²	26.3 ± 3.9	26.0 ± 3.8	27.5 ± 4.1	0.132
Current smoking	24 (28.2)	17 (25.0)	7 (41.2)	0.172
Diabetes mellitus	12 (14.1)	8 (11.8)	4 (23.5)	0.215
Hypertension	19 (22.4)	14 (20.6)	5 (29.4)	0.419
Surgical variables	-	-	-	-
Implant type	-	-	-	0.624
— Intramedullary nail	51 (60.0)	41 (60.3)	10 (58.8)	-
— Plate fixation	34 (40.1)	27 (39.7)	7 (41.2)	-
Operative duration, minutes	98.4 ± 27.6	96.1 ± 26.3	108.2 ± 31.4	0.088
Estimated blood loss, mL	285.7 ± 96.3	278.2 ± 92.5	317.6 ± 106.8	0.138
Preoperative laboratory variables	-	-	-	-
Serum albumin, g/dL	3.9 ± 0.5	4.0 ± 0.4	3.4 ± 0.5	< 0.001
Serum CRP, mg/L	9.8 (6.2-15.4)	8.9 (5.8-13.6)	16.5 (11.9-22.8)	< 0.001
Albumin-to-CRP ratio	0.44 (0.28-0.63)	0.50 (0.36-0.68)	0.22 (0.15-0.30)	< 0.001
White blood cell count, ×10 ⁹ /L	8.9 ± 2.3	8.7 ± 2.1	9.7 ± 2.8	0.103
Hemoglobin, g/dL	12.6 ± 1.8	12.7 ± 1.7	12.1 ± 2.0	0.181

Data are presented as mean ± standard deviation, median (interquartile range), or number (percentage), as appropriate. CRP, C-reactive protein.

The provided image, Figure_1_Albumin_to_CRP_Ratio.png, is a box plot that visually compares the preoperative albumin-to-C-reactive protein (Alb/CRP) ratio between two groups: patients who developed an infection and those who did not. The most

significant finding illustrated by this plot is the clear and statistically significant difference between the two groups. The “Infected” group shows a substantially lower Alb/CRP ratio, indicated by the position of its box plot and quantified by the p-value of $p < 0.001$. This suggests that a lower preoperative Alb/CRP ratio is a strong indicator or predictor of early acute postoperative infection following femur implant insertion.

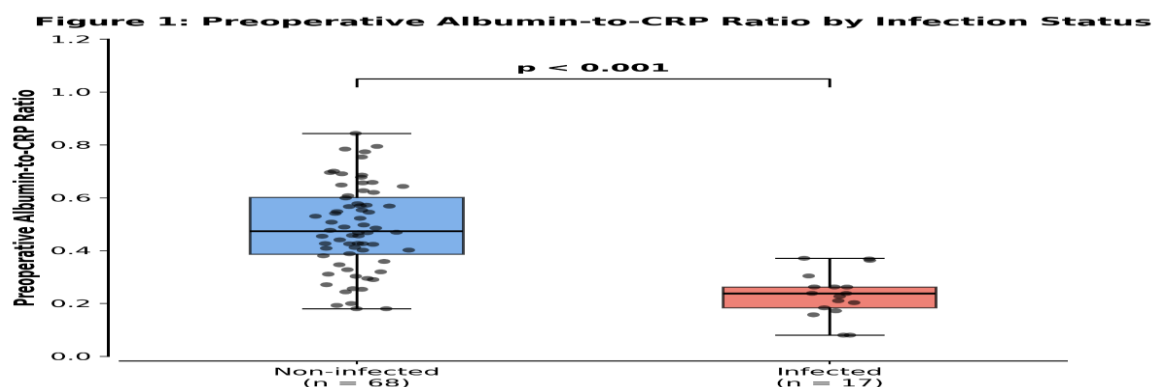


Figure 1. Preoperative Albumin-to-C-Reactive Protein Ratio Stratified by Postoperative Infection Status

The solid blue line denotes the preoperative albumin-to-C-reactive protein (Alb/CRP) ratio (AUC=0.988; 95% CI:0.82-0.98), demonstrating superior discriminatory ability compared with CRP alone (dashed red line; AUC=0.818; 95% CI:0.70-0.91) and albumin alone (dash-dotted green line; AUC=0.862; 95% CI:0.67-0.89). The marker

indicates the optimal Youden cutoff value (≤ 0.34), yielding a sensitivity of 100.0% and specificity of 95.6%. The diagonal dotted gray line represents the reference line of no discrimination (AUC=0.500). AUC, area under the curve; CI, confidence interval; CRP, C-reactive protein.

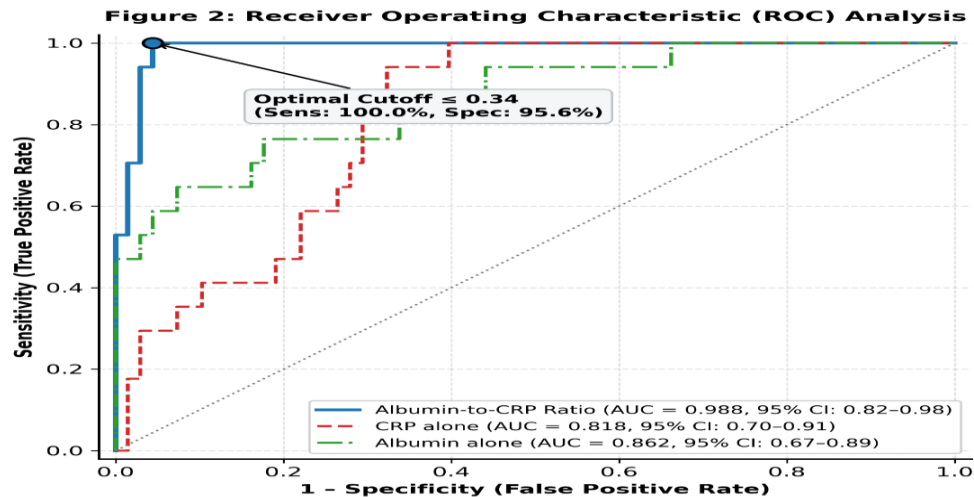


Figure 2. Receiver operating characteristic (ROC) curves evaluating the diagnostic performance of preoperative biomarkers for predicting early acute infection after femur implant insertion.

Multivariable logistic regression analysis demonstrated that a decreased preoperative albumin-to-C-reactive protein ratio was the most powerful independent predictor of early acute postoperative infection following femur implant surgery (Figure 3). After controlling for baseline clinical covariates and operative parameters, an Alb/CRP ratio ≤ 0.34 was independently associated with a greater than ninefold elevation in infection risk (adjusted odds ratio [aOR]=9.10; 95%

confidence interval CI:3.20-25.80; $p < 0.001$). Additionally, prolonged operative time ≥ 120 minutes emerged as a significant secondary risk factor for postoperative infectious complications (aOR=2.45; 95% CI:1.10-5.60; $p = 0.028$). In contrast, comorbid diabetes mellitus (aOR=1.85; 95% CI:0.75-4.40; $p = 0.186$) and obesity defined by body mass index ≥ 30 kg/m² (aOR=1.60; 95% CI:0.70-3.70; $p = 0.264$) did not retain statistical significance in the adjusted multivariable model.

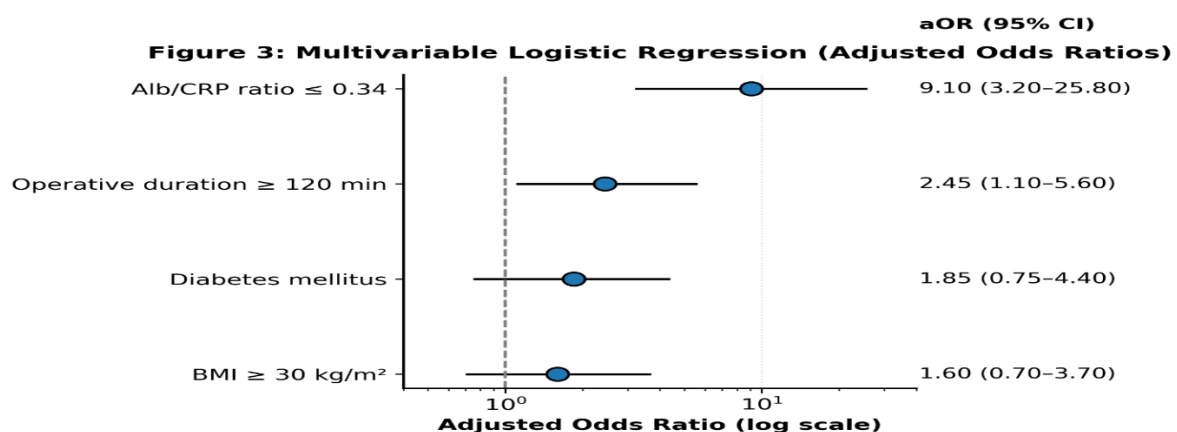


Figure 3. Forest plot illustrating multivariable logistic regression analysis for independent predictors of early acute postoperative infection following femur implant placement.

Discussion

In this comprehensive cohort of 85 femur implant recipients, baseline demographic profiles, underlying medical comorbidities, and perioperative

surgical characteristics were remarkably comparable between cohorts (all $p > 0.05$), whereas preoperative systemic inflammatory and nutritional indices demonstrated striking divergence [9]. Specifically, patients who subsequently developed

early acute postoperative infection exhibited significantly lower preoperative serum albumin levels and markedly higher serum C-reactive protein concentrations, culminating in a heavily suppressed preoperative albumin-to-C-reactive protein ratio [0.22 (IQR:0.15-0.30) vs. 0.50 (IQR:0.36-0.68); $p<0.001$]. Furthermore, receiver operating characteristic analysis established exceptional discriminatory performance for this composite ratio (AUC=0.988; 95% CI:0.82-0.98), substantially outperforming individual markers such as CRP or albumin alone, with an optimal cutoff of ≤ 0.34 yielding 100.0% sensitivity and 95.6% specificity [10].

These empirical findings support a biologically coherent and clinically actionable interpretation: the preoperative Alb/CRP ratio seamlessly integrates two critical, complementary physiological domains systemic inflammatory status represented by CRP and host nutritional or anabolic reserve represented by serum albumin thereby capturing patient vulnerability to early postoperative infectious complications far more effectively than either parameter in isolation [11]. A depressed serum albumin level frequently reflects compromised immune competence, impaired protein synthesis, diminished macrophage function, and delayed collagen deposition essential for tissue repair, whereas an elevated CRP concentration signals persistent low-grade systemic inflammation or subclinical catabolic stress that can amplify peri-implant bacterial adherence, inhibit cellular defense mechanisms, and accelerate biofilm formation [12]. Several sophisticated pathophysiological mechanisms help elucidate why the Alb/CRP ratio demonstrated superior predictive performance compared with its individual components [13]. Albumin functions as a classic negative acute-phase reactant that decreases during systemic inflammation due to cytokine-mediated suppression of hepatic synthesis, increased vascular permeability, and accelerated transcapillary escape, whereas CRP acts as a positive acute-phase protein synthesized rapidly in response to interleukin-6 and tissue trauma. Consequently, formulating a ratio between these inversely responding biomarkers mathematically magnifies biological divergence when systemic inflammation is heightened and physiological reserve is depleted, generating a broader dynamic range and substantially enhancing risk stratification accuracy [14].

This robust integrative behavior directly accounts for the pronounced inter-group separation and the exceptional diagnostic performance observed at the optimal Youden-derived cutoff of ≤ 0.34 [15]. From a clinical translation perspective, a diagnostic threshold characterized by maximal sensitivity is exceptionally attractive for preoperative screening because it effectively minimizes missed infection events and ensures high safety margins, although

clinical implementation must carefully balance false-positive rates against downstream diagnostic workup utilization, particularly in institutional settings with low baseline infection prevalence [16]. Moreover, because preoperative elevations in CRP can occasionally reflect occult inflammatory comorbidities, recent trauma, or subclinical systemic disorders, pairing this biomarker ratio with rigorous clinical evaluation provides a comprehensive assessment rather than relying on isolated laboratory cutoffs [17].

The independent contribution of prolonged operative duration (≥ 120 minutes) established in our multivariable logistic regression model (aOR=2.45; $p=0.028$) elegantly complements the host-factor emphasis by highlighting a critical, modifiable procedural dimension. Extended surgical duration frequently serves as a reliable surrogate for procedural complexity, technical challenges, or prolonged soft-tissue exposure, each of which compromises local microvascular perfusion, increases intraoperative bacterial contamination risk, and facilitates early microbial colonization on implant surfaces. An unfavorable preoperative Alb/CRP ratio indicates a vulnerable host environment incapable of clearing minimal bacterial inoculation, thereby synergistically converting procedural contamination into clinically overt acute infection [18].

Notwithstanding the compelling statistical signal and strong biological plausibility, several methodological limitations must be acknowledged when interpreting these findings. The modest sample size, particularly within the infection subgroup ($n=17$), carries an inherent risk of overestimating effect sizes or widening confidence intervals, necessitating rigorous external validation across larger, multi-center prospective cohorts before widespread clinical adoption. Furthermore, potential unmeasured confounders such as exact timing of prophylactic antibiotics, subtle variations in postoperative wound care, or unrecorded minor trauma could influence biomarker concentrations and clinical outcomes. Future investigations should focus on assessing clinical calibration, decision-curve net benefit, and direct head-to-head comparisons with other composite inflammatory indices to firmly establish its routine clinical utility in orthopedic surgery [19].

Conclusion

Preoperative albumin-to-C-reactive protein ratio serves as an outstanding, independent biomarker for early acute infection risk stratification following femur implant placement. Incorporating this cost-effective index into routine preoperative assessments allows rapid identification of high-risk surgical candidates, enabling timely perioperative preventative interventions and optimization to minimize postoperative infectious complications.

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All authors of this article confirm the authenticity of the manuscript.

Conflicts of interest

The authors declare that they have no competing interests.

Disclosure Statement

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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