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Using Risk Factors and Preoperative Inflammatory Markers to Predict 3-Year Mortality in Patients with Unstable Intertrochanteric Femur Fractures

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Purpose: Preoperative biomarkers such as the neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-C-reactive protein ratio (LCR), and albumin have been proposed to predict postoperative outcomes in various conditions. This study investigated their association with 3-year mortality in elderly patients undergoing closed reduction and internal fixation with proximal femoral nail anti-rotation (CRIF with PFNA) for unstable intertrochanteric femur fractures (UIFF).

Materials and Methods: We retrospectively reviewed 306 patients aged ≥65 years who underwent CRIF with PFNA for UIFF between April 2012 and December 2020. Receiver operating characteristic curve analysis determined optimal cutoffs: LCR 0.441 (sensitivity 48.2%, specificity 78.4%), NLR 3.573 (sensitivity 83.2%, specificity 36.3%), and albumin 3.250 g/dL (sensitivity 52.0%, specificity 76.1%). Patients were dichotomized into low versus high groups for each marker. Univariate and multivariate Cox regression analyses assessed associations with 3-year mortality.

Results: At 3 years postoperatively, 76 patients (30.4%) had died. Kaplan–Meier survival analysis revealed that patients with low LCR (<0.441) and low albumin (<3.250 g/dL) had significantly shorter survival compared to those with higher values. In contrast, stratification by NLR did not yield significant differences in survival. Multivariate Cox regression identified both low LCR and low albumin as independent predictors of increased 3-year mortality ($P<0.05$), whereas NLR showed no prognostic significance.

Conclusion: Preoperative LCR and albumin levels are valuable prognostic biomarkers for 3-year survival following CRIF with PFNA in elderly UIFF patients. Incorporating these parameters into preoperative risk assessment may improve clinical decision-making and patient counseling, while NLR appears less predictive.

Keywords: Unstable intertrochanteric femur fracture, Proximal femur nail anti-rotation, Mortality, Lymphocyte-to-C-reactive protein ratio, Neutrophil-to-lymphocyte ratio

INTRODUCTION

Hip fractures represent a significant health concern for the general population. However, while the overall number of incidents increases with age, hip fracture is particularly problematic for women. It is estimated that the incidence of hip fracture will rise from 1.66 million in 1990 to 6.26 million by 2050, which is indicative of its global impact[1,2]. Several factors elevate the incidence risk of hip fracture, including osteoporosis, genetic predisposition, lack of physical activity, and the use of specific medications[3,4]. Epidemiologically, hip fracture occurrence varies worldwide, with some areas witnessing a rise in cases, whereas others report stable

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or declining numbers[5]. This variation could be attributed to lifestyle changes as well as demographic shifts, including an aging populace and alterations in levels of physical engagement[6,7]. Identification and modification of risk factors linked to mortality are essential for mitigation of hip fracture impacts[8].

The value of immune-inflammatory markers, including neutrophil-to-lymphocyte ratio (NLR; odds ratio [OR] 2.24, 95% confidence interval [CI] 1.43-3.51), lymphocyte-to-C-reactive protein ratio (LCR) (area under the curve [AUC] 0.648, 95% CI 0.594-0.701), and the C-reactive protein-to-albumin ratio (OR 2.04, 95% CI 1.31-3.20), for predicting various postoperative mortality rates, including hip fracture repair has been the focus of increasing research interest[9-12]. Recent studies have delved into how immune inflammation indices correlate with mortality in older individuals with fractures of the femoral neck. Specifically, LCR and NLR have been identified as potential indicators of systemic inflammation, as they correlate with lower survival rates in other conditions, such as colorectal cancer[13,14]. Additionally, albumin, an indicator of nutritional status and general health, could influence patient prognosis and outcomes with unstable intertrochanteric femur fractures (UIFF). Due to the association of low albumin levels with higher rates of morbidity and mortality across a range of conditions, including those undergoing orthopedic surgeries, it has been suggested that, in the context of UIFF, diminished albumin could indicate compromised nutritional health and healing abilities, thereby exacerbating negative outcomes[15,16].

Given the variability in treatment modalities and mortality outcomes among hip fracture patients, management of these fractures as a uniform group is challenging. While there is a significant body of literature investigating mortality associated with hip fractures, further clarification and exploration of this topic are warranted. This study, therefore, seeks to underscore the clinical relevance of LCR, NLR, and albumin as predictors of 3-year mortality in patients surgically treated for UIFF with closed reduction and internal fixation (CRIF) with proximal femoral nail anti-rotation (PFNA). A retrospective analysis was conducted on elderly patients who suffered femoral neck fractures to evaluate whether these aforementioned biomarkers can predict mortality and postoperative complications. This research aims to ascertain the predictive accuracy of LCR, NLR, and albumin for mortality and to explore their practical benefits in clinical settings by comparing patients who succumbed within three years post-surgery to survivors.

MATERIALS AND METHODS

1. Study Design and Setting

The research was designed and carried out in adherence to the Declaration of Helsinki (2013) principles, and conformed to STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines. The study received approval from the Review Board of Busan Medical Center (approval No. #2022-12-001), and the written informed consent was waived by the IRB due to the retrospective nature of the study. It encompassed 306 consecutive elderly patients (age, ≥60 years) from a single orthopedic surgeon who underwent CRIF with PFNA for UIFF between April 2012 and September 2020 at Busan Medical Center. The preference was to opt for hemiarthroplasty or total hip arthroplasty (THA) over CRIF with PFNA in cases involving patients older than 65 years, with multiple comorbidities, severe displacement, or osteoporosis with a T-score below –3.0. This approach was determined by the belief that these patients would derive greater benefit from hemiarthroplasty or THA due to their complex health profiles and the intricate nature of their conditions. Thus, the aim was to improve their quality of life and surgical outcomes.

2. Patient Selection and Study Population

Study eligibility required a diagnosis of UIFF. Patients undergoing surgical CRIF treatment with PFNA within 4 weeks of post-diagnosis were included. Those patients with surgery delayed beyond 4 weeks, significant dementia or psychiatric conditions (which could interfere with accurate symptom reporting and pain assessment), multiple concurrent fractures, pathological fractures, or incomplete follow-up assessments were excluded. These exclusions resulted in a retrospective analysis of 250 patients (Fig. 1).

3. PFNA Approach

The patient is placed in a supine position on a radiolucent operating table, ensuring full access for fluoroscopic examinations. The unaffected leg is abducted to its maximum on a leg support, allowing for unobstructed imaging. This is a necessity which is confirmed

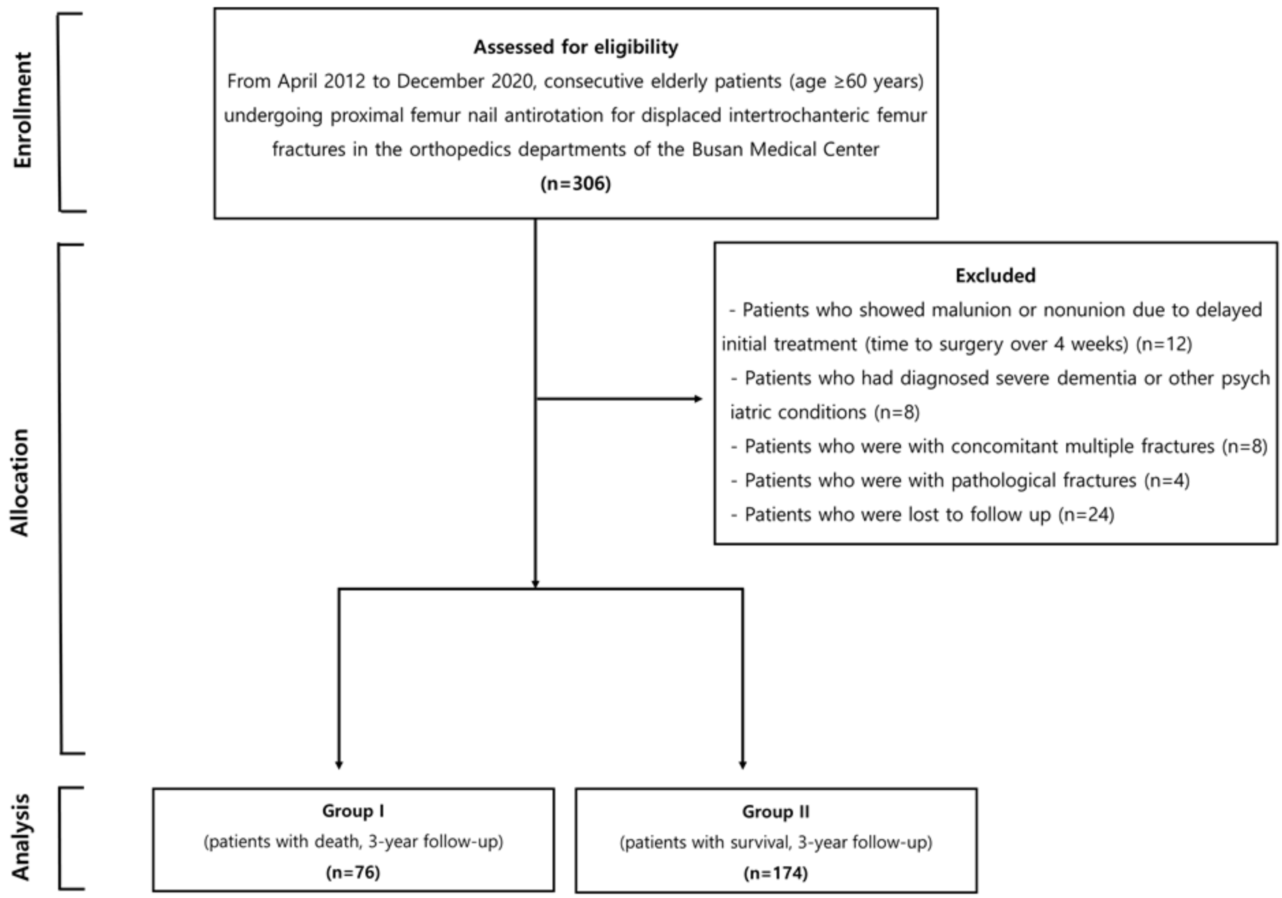

Fig. 1. Flowchart of patient selection process.

before surgery. The patient's upper body is slightly abducted (10°-15°) away from the affected side for optimal medullary cavity access.

Fracture reduction is attempted using a closed method under fluoroscopic guidance. If the alignment is unsatisfactory, the surgery is switched to an open approach. Once aligned, the femur is measured for nail length using a C-arm and a radiographic ruler placed alongside the thigh. Accurate placement is ensured by marking the skin at the proximal end of the ruler.

The incision is made about 5 cm proximally from the tip of the greater trochanter, with careful dissection through the fasciae and gluteal muscles to reach the femoral entry point. Using anteroposterior and lateral fluoroscopic views, a guide wire is inserted and ideally positioned within the medullary cavity. Subsequent steps involve securing the guide wire, expanding the femoral canal using graduated reaming, and preparing the insertion site with a bi-directional awl. The PFNA-II nail is then carefully inserted, with rotational alignment verified and corrected as needed.

Nail locking involves precise positioning of guide wires and the PFNA blade under fluoroscopic guidance which ensures optimal placement within the femoral head. From wire insertion to reaming and locking, each step is performed with meticulous attention to maintain bone integrity and alignment. The procedure concludes with a thorough irrigation, layer-by-layer suturing, and application of a compressive dressing to support healing.

4. PFNA Procedure and Rehabilitation

All eligible patients underwent CRIF with PFNA surgery under spinal anesthesia using 0.2 mL/kg of bupivacaine (Heavy Marcaine™; AstraZeneca). To facilitate post-surgical recovery, preoperative patient education included exercises like straight leg raises and knee flexion/extension. Posture education and the use of medical compression stockings throughout the hospital stay were included as preventative measures against postoperative complications.

At the two-week postoperative follow-up, a consultation was initiated to customize the rehabilitation protocol. Initial rehabilitation focused on bed-bound exercises to maintain joint mobility and muscle strength without bearing weight for patients who could not stand or walk. The non-weight-bearing period was determined based on the posteromedial cortex approximation. If approximation was achieved, a four-week non-weight-bearing protocol was followed; otherwise, it extended to six weeks. Once patients were capable of walking, assisted walking exercises were introduced to gradually restore weight-bearing capabilities. Our rehabilitation protocol did not include continuous passive motion and tilt table exercises. Patients who could not walk were those with a preoperative Koval grade of 3 or higher. To prevent thromboembolic events, all study patients were given compression stockings to wear.

5. Outcome Measures and Data Collection

Monitoring, including a telephone-based mortality check, was conducted over a three-year period. The data collected was comprised of surgery dates, demographics, medical history, anesthesia type, AAACCIS (Adjusted Age-adjusted Charlson Comorbidity Index Score), ASA (American Society of Anesthesiologists) score, and preoperative lab results (white blood cell count, red blood cell count, haemoglobin, platelets, neutrophil, lymphocyte, monocyte, basophil counts, absolute neutrophil count, glomerular filtration rate, albumin, C-reactive protein [CRP], and erythrocyte sedimentation rate). Focusing on variables like LCR, NLR, and albumin levels, a two-stage analysis identified significant laboratory predictors of 3-year mortality post-CRIF with PFNA for UIFF. At the time of hospital admission, the levels of NLR, LCR, and albumin were measured, reflecting biomarker status immediately after injury and preoperatively.

6. Postoperative Assessment

Evaluation of post-surgical pain was completed using the visual analogue scale at various intervals up to 72 hours postoperation. Additional data collected included patient controlled analgesia doses, rescue analgesics, nausea, incidence of vomiting, Koval grade, T-cane usage, general complications, and duration of hospital stay.

7. Statistical Analysis

Our study used IBM SPSS (ver. 22.0; IBM Corp.) and R software (ver. 3.6.5) to perform statistical evaluations. While continuous variables were expressed as mean±standard deviation, categorical variables were expressed as counts and percentages. To compare groups based on LCR, NLR, and albumin levels, we applied independent Student *t*-tests and chi-square or Fisher's exact tests[17]. Receiver operating characteristic (ROC) curve analysis determined optimal variable cutoff values, assessing AUC significance at $P<0.05$. Cox proportional hazard models were used to analyze 3-year mortality, with Kaplan–Meier curves and the Tarone–Ware test estimating patient survival. For all tests, significance was set at $P<0.05$[18].

RESULTS

1. Study Population Characteristics

This study included a total of 250 participants. As demonstrated in Fig. 1, 97 were males and 153 were females, spanning from 65 to 99 years, with an average age of 75.73 years. Although no deaths were recorded during the perioperative phase, there was a study cohort mortality rate of 30.4% (76 patients) during the 3-year postoperative follow-up period.

2. Determination of Optimal Biomarker Cutoff Values

Through ROC curve analysis aimed at maximizing the Youden index, optimal cutoff points for albumin, NLR, and LCR were identified as 3.250, 3.573, and 0.441, respectively. The AUC for LCR, NLR, and albumin were calculated as 0.650, 0.570, and 0.670, respectively, thus indicating a fair level of predictive accuracy. The statistical significance of these biomarkers was substantiated by *P*-values <0.05. Specific *P*-values for albumin, NLR, and LCR were 0.001, 0.161, and 0.002, respectively (Table 1). ROC curves for these markers are depicted in Fig. 2.

3. Patient Data and Preoperative Biomarker Levels

The association between patient demographics and preoperative levels of LCR and NLR, encompassing all 250 participants, is presented in Table 2. Categorization by age showed that 137 patients (54.8%) were younger than 75 years, while 113 patients (45.2%) were older. Significant disparities were observed across various parameters, such as age, gender, albumin, neutrophil,

Table 1. Optimal Cutoff Values for LCR, NLR, and Albumin (Sensitivity, Specificity, 95% CI, and *P*-value)

Variable	AUC (cutoff value)	Sensitivity	Specificity	95% CI	*P*-value
Albumin	0.670 (3.250)	0.520	0.761	0.578-0.758	0.001*
NLR	0.570 (3.573)	0.832	0.363	0.472-0.668	0.161
LCR	0.650 (0.441)	0.482	0.784	0.560-0.747	0.002*

LCR: lymphocyte-to-C-reactive protein ratio, NLR: neutrophil-to-lymphocyte ratio, CI: confidence interval, AUC: area under the curve.
*P<0.05.

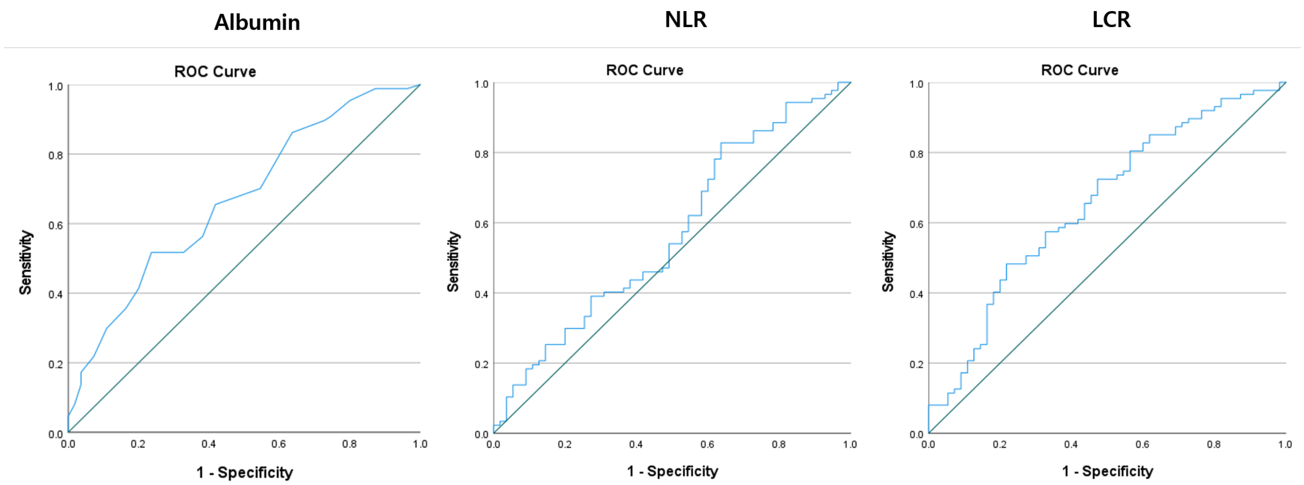

Fig. 2. Receiver operating characteristic curve (receiver operating characteristic [ROC] curve) of albumin, neutrophil-to-lymphocyte ratio (NLR), and lymphocyte-to-C-reactive protein ratio (LCR).

lymphocyte, CRP, LCR, and NLR. All of these parameters showed significant differences when analyzed against the established cutoff values. Notably, factors such as females of increased age (>75 years), presenting with hypoalbuminemia, elevated neutrophils, reduced lymphocytes, higher CRP, and lower LCR were all significantly associated with higher mortality rates.

4. Survival Analysis Based on Clinical Variables

Kaplan–Meier survival analysis revealed distinct median survival times contingent upon the biomarker levels. In contrast to a median survival of 30±3.46 months for those patients with lower LCR levels, patients with an LCR above 0.441 had a median survival of 38±1.56 months. A lower NLR value (<3.573) corresponded to a median survival of 37±2.88 months, only marginally surpassing the 36±3.85 months for individuals with a higher NLR (≥3.573). Albumin levels were also indicative of survival outcomes. As illustrated in Fig. 3, patients with levels above the 3.250 threshold had a median survival of 39 months versus 29 months for those below it.

5. Comparison of Postoperative Outcomes

Focusing on aspects such as pain levels, mobility, and surgical results, postoperative metrics were analyzed to compare outcomes between the surviving and deceased groups, as detailed in Table 3. The Koval classification was uniquely significant among these factors, showing a notable difference with a *P*-value of 0.013. Additionally, general postoperative complications, length of hospital stay, and ambulatory functions after surgery were examined in Table 4. Therefore, significant differences were revealed in the incidences of postoperative nausea and vomiting and delirium, with *P*-values of 0.043 and 0.011, respectively, underscoring their impact on patient outcomes.

DISCUSSION

1. Introduction to Study Findings and Predictive Markers

Discovering a survival rate of 69.6%, our retrospective examination inquired into 3-year patient mortality rates following CRIF with PFNA for UIFF The analysis identified low LCR and hypoalbuminemia as

Table 2. Relationships between Patient Characteristics and Preoperative LCR and NLR Values

Characteristic	Total (n=250)	Low LCR (n=145)	High LCR (n=105)	*P*-value	High NLR (n=175)	Low NLR (n=75)	*P*-value
Age (yr)							
≤75	137 (54.8)	41 (28.3)	68 (64.8)	0.018*	54 (30.9)	37 (49.3)	0.021*
>75	113 (45.2)	104 (71.7)	37 (35.2)		121 (69.1)	38 (50.7)	
Sex							
Female	153 (61.2)	86 (59.3)	63 (60.0)	0.025*	92 (52.6)	40 (53.3)	0.037*
Male	97 (38.8)	59 (40.7)	42 (40.0)		83 (47.4)	35 (46.7)	
Affected side				0.165			0.255
Left	117 (46.8)	74 (51.0)	60 (57.1)		86 (49.1)	34 (45.3)	
Right	133 (53.2)	71 (49.0)	45 (42.9)		89 (50.9)	41 (54.7)	
Anemia (Hb <12 g/dL for male, Hb <11 g/dL for female)				0.189			0.239
Yes	73 (29.2)	43 (29.7)	31 (29.5)		66 (37.7)	30 (40.0)	
No	177 (70.8)	102 (70.3)	74 (70.5)		109 (62.3)	45 (60.0)	
Hypoalbuminemia (<3.250 g/dL)				<0.001*			<0.001*
Yes	95 (38.0)	70 (48.3)	28 (26.7)		80 (45.7)	30 (40.0)	
No	155 (62.0)	75 (51.7)	77 (73.3)		95 (54.3)	45 (60.0)	
AACCIS				0.228			0.112
AAC=1-3	68 (27.2)	40 (27.6)	25 (23.8)		30 (17.1)	19 (25.3)	
AAC=4-5	107 (42.8)	55 (37.9)	31 (29.5)		62 (35.4)	24 (32.0)	
AAC≥6	75 (30.0)	50 (34.5)	49 (46.7)		83 (47.4)	32 (42.7)	
ASA class				0.201			0.178
I-II	178 (71.2)	102 (70.3)	62 (59.0)		54 (30.9)	48 (64.0)	
III-IV	72 (28.8)	43 (29.7)	43 (41.0)		121 (69.1)	27 (36.0)	
Neutrophil (50%-70%)	64.23	67.38	61.92	<0.001*	69.89	59.97	<0.001*
Lymphocyte ($\times 10^9$/L)	1.70	1.14	2.59	<0.001*	1.31	2.29	<0.001*
CRP (mg/dL)	4.64	7.82	2.15	<0.001*	6.36	2.76	<0.001*
LCR	0.560	-	-	-	0.421	0.892	<0.001*
NLR	3.74	4.18	3.22	0.161	-	-	0.161
3-Year mortality							
Yes	76 (30.4)	52/135 (38.5)†	24 (22.9)	<0.001*	40 (22.9)	36 (48.0)	0.093
No	174 (69.6)	83/135 (61.5)†	81 (77.1)	0.028*	135 (77.1)	39 (52.0)	0.071

Values are presented as number (%) or mean only.
LCR: lymphocyte-to-C-reactive protein ratio, NLR: neutrophil-to-lymphocyte ratio, Hb: haemoglobin, AACCIS: Adjusted Age-adjusted Charlson Comorbidity Index Score, AAC: Ambulatory Anesthesia Care, ASA: American Society of Anesthesiologists, CRP: C-reactive protein.
*P<0.05.
†In the course of data collection, discrepancies in the records of certain cases resulted in temporary omissions; these missing data were subsequently supplemented during the final review.

pivotal predictors for complications and mortality post-operation. These markers highlight the significant role of LCR and albumin levels in the predictive assessment of in-hospital mortality. Biomarker clinical utility is emphasized in the prognoses and management of patients subjected to CRIF with PFNA for UIFF.

2. LCR and Albumin as Essential Indicators for Prognosis

LCR and NLR have emerged as systemic inflammation indicators. LCR offers early detection capabilities through its inverse relation to CRP levels[19,20]. This study highlights LCR's utility in risk assessment of in-hospital complications. Findings suggest low LCR (<0.441) and low albumin as markers are significantly associated with increased in-hospital mortality. This study posits the enhanced sensitivity of LCR in early inflammation stages, making it, alongside hypoalbuminemia's indication of increased overall mortality risk, a superior predictor of in-hospital complications

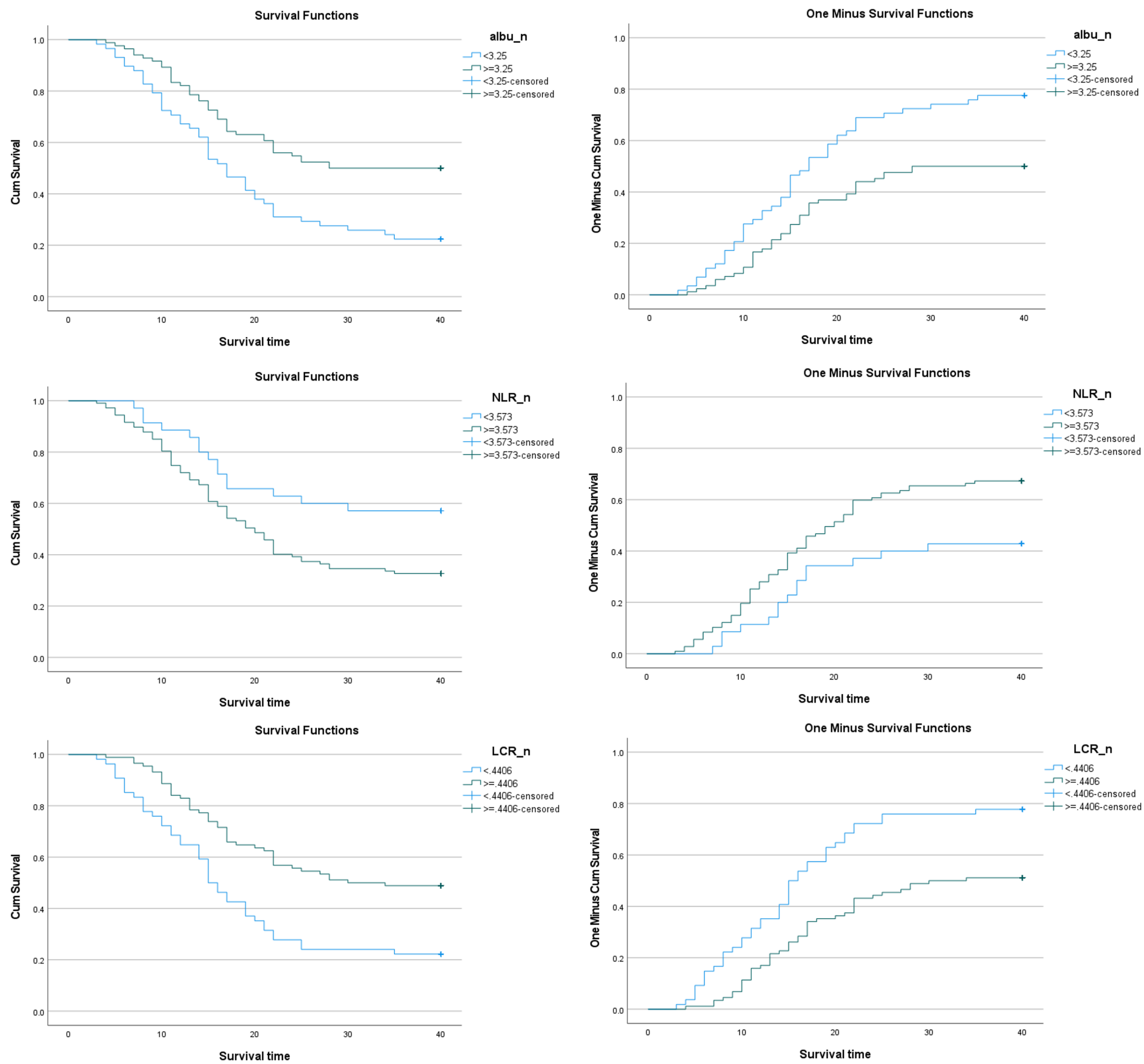

Fig. 3. Kaplan–Meier curve of lymphocyte-to-C-reactive protein ratio (LCR), neutrophil-to-lymphocyte ratio (NLR), and albumin (albu).

and mortality.

3. Predictive Value of Preoperative LCR and Albumin Levels

Preoperative LCR level analysis revealed <0.441 as a threshold predicting increased postoperative complications and extended hospital stays. Corroborating literature identifies age, female gender, and hypoalbuminemia as independent mortality risk factors over three-year postoperative period. With allogeneic transfusions previously noted as a 1-year mortality predictor in similar surgical contexts, this association suggests a compromised physiological state among these demographics[21]. To ameliorate patient outcomes, our findings advocate for these markers' inclusion in preoperative assessments.

4. The Role of NLR in Orthogeriatric Patient Management

High NLR (≥3.573) upon admission correlates with negative outcomes in orthogeriatric patients. Elevated NLR is linked to systemic inflammatory responses to osteoporotic fractures and comorbid age-related conditions[10,12]. Despite the lack of statistical significance, this

Table 3. Preoperative Patient Characteristics on the Day of Admission and Intraoperative Volume Loss

	Survival group (n=176)	Mortality group (n=74)	*P*-value
Mean age (yr)	73.84	78.29	0.065
Sex			0.119
Male	74 (42.0)	23 (31.1)	
Female	102 (58.0)	51 (68.9)	
Mean BMI (kg/m^2)	23.15	22.91	0.105
Koval classification (grade)			0.013*
I	91	41	
II	36	17	
III	18	9	
IV	9	3	
V	7	2	
VI	9	1	
VII	6	1	
Mean operation time (min)	67.57	69.15	0.098
Mean blood loss (mL)	183	186	0.205
Mean urine output (mL)	260.12	267.57	0.089

Values are presented as mean only, number (%), or number only.
BMI: body mass index.
*P<0.05.

Table 4. Complications, Length of Stay and Ambulatory Function of Survival and Mortality Groups

	Survival group (n=174)	Mortality group (n=76)	*P*-value
General complication			
Pressure sore	4	2	0.071
Pneumonia	3	4	0.091
DVT	0	0	-
Postoperative nausea and vomiting	4	6	0.043*
Delirium	6	12	0.011*
Local complication	0	-	-
Mean length of stay (day)	29.26	31.54	0.082
Mean crutch walking (day)	11.72	12.37	0.219

Values are presented as number only or mean only.
DVT: deep vein thrombosis.
*P<0.05.

study proposes the potential of NLR as a biomarker for therapeutic and preventive interventions, as well as suggesting the benefits of preoperative cardiovascular or antibiotic treatments in patients with elevated NLR levels[11,19].

5. Hypoalbuminemia's Impact on Postoperative Outcomes

The association of hypoalbuminemia with higher mortality, sepsis rates, and unplanned intubation emphasizes the critical need for early preventive interventions and strict adherence to postoperative rehabilitation guidelines[15,16]. This association underscores the importance of establishing and implementing preventive protocols early to mitigate postoperative complications and enhance the quality of life. These preventive protocols have the potential to reduce mortality rates in this high-risk group.

6. Comparative Insights and Novel Contributions

Our investigation augments existing literature by focusing on CRIF with PFNA for UIFF LCR is also introduced as a less commonly studied yet significant inflammatory marker in this surgical subset[13,14]. The study corroborates the prognostic significance of inflammatory markers and albumin levels in hip fracture surgeries. It also extends the understanding of these biomarkers, particularly LCR, as independent predictors of patient outcomes.

7. Clinical Implications of Inflammatory Markers and Albumin Levels

The study's observed associations between inflammatory markers, albumin levels, and mortality can be attributed to detrimental effects of systemic inflammation on healing processes and increased risk of complication. Albumin serves as a health and nutritional status marker, influencing immune function and the body's response to surgical stress. With the aim to enhance patient care and surgical outcomes, recognizing these markers as mortality predictors accentuates the need for their consideration in preoperative evaluations.

Our comprehensive analysis reiterates the importance of LCR, NLR, and albumin levels as prognostic markers in patients undergoing CRIF with PFNA for UIFF. Our study has found significant correlations between these markers and patient survival, thus supporting biomarker integration into clinical practice for risk stratification, informed treatment decision-making, and optimized postoperative care. Although the predictive power of NLR alone may be limited, the combined use of LCR and albumin enhances overall predictive accuracy. The identification of optimal cutoff points further facilitates timely identification of at-risk patients, and guides the allocation of healthcare resources and the adoption of targeted therapeutic measures to significantly improve orthopedic patient outcomes.

8. Limitations

Acknowledgement of study limitations is crucial for a comprehensive interpretation of its outcomes. Our investigation does not support causal inferences given its retrospective and non-randomized design. The study cohort, comprising 250 patients over a three-year timeframe, underscores the necessity for further studies to enhance the robustness of our findings. In addition, the relatively low AUC values (0.6) indicate limited predictive power of the individual parameters studied, reflecting a potential constraint in their clinical applicability. Potential unmeasured confounders such as the initiation of complementary therapies remained outside our analysis scope despite adjusting for various covariates, including comorbidities and medication use.

Although there are recognized benefits of performing surgery within 48 hours, factors such as neglected femur neck fractures and delayed consultations from other specialties can lead to surgical delays beyond this timeframe. These delays may impact the generalizability of our findings. While this study does take into account intraoperative bleeding volume, it does not extensively consider other critical factors that may influence mortality outcomes, such as the severity of the fracture, the time elapsed from injury to operation, and the duration of the surgery. To provide a more comprehensive understanding of the factors affecting recovery and mortality following hip fractures, future research needs to address these gaps.

The lack of statistically significant associations between the examined biomarkers and other considered risk factors is a notable limitation. Our exhaustive analysis efforts failed to identify significant correlations, suggesting the need for future research endeavors. To delve deeper into the complex relationships between these biomarkers and additional factors, future work should potentially involve larger sample sizes or different methodological approaches. Moreover, as our data originated from an Asian cohort at a single institution, demographic specificity, introduces a potential bias that merits consideration in the interpretation of our results.

As highlighted above, the inherent challenges in conducting retrospective analyses underscore the importance of cautious extrapolation of our findings. These challenges also emphasize the imperative for ongoing research to validate and expand upon our initial observations, ideally through studies that encompass broader and more diverse populations. This approach will be vital in mitigating single center study limitations as well as in elucidating the nuanced dynamics between biomarkers, patient characteristics, and clinical outcomes in the context of CRIF with PFNA for UIFF.

CONCLUSION

In elderly patients undergoing CRIF with PFNA for UIFF, the prediction of three-year mortality and postoperative complications can be efficiently accomplished by evaluating preoperative levels of LCR and albumin. Individuals presenting with reduced LCR and albumin are identified as high-risk and could benefit from enhanced monitoring and stringent postoperative management.

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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