ORIGINAL ARTICLE

Is the preoperative neutrophil-to-lymphocyte ratio a predictive value for postoperative mortality in orthogeriatric patients who underwent proximal femoral nail surgery for pertrochanteric fractures?

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ABSTRACT

BACKGROUND: Hip fractures in the orthogeriatric population are a health problem that causes mortality and morbidity, with an increasing frequency. The present study aims to investigate whether the preoperative neutrophil-to-lymphocyte ratio (NLR) is a predictive value for the postoperative mortality risk in patients who underwent only proximal femoral nail (PFN) surgery due to pertrochanteric fractures (PTF). To our knowledge, there is not any study conducted with a similar population in the litertaure.

METHODS: Fifty-five patients who were operated on by two National Board-certified surgeons with the PFN method were included in our retrospective study. The patients were divided into two groups. Group A included the patients who lost their lives within the postoperative first year (n=13), while Group B included the survivors (n=42). Preoperative NLR data, demographic information, duration of hospitalization, postoperative intensive care requirements (ICU) and comorbid diseases of all patients were recorded.

RESULTS: In our study with a maximum follow-up period of 27 months, no statistically significant difference was found between the groups concerning age, gender, body mass index, preoperative American Society of Anesthesiologists scores (ASA), types of fractures, ICU requirements, duration of hospitalization ($p>0.05$). However, the NLR was significantly higher in Group A ($p<0.01$), with a cut-off value of 5.25, sensitivity of 84.6% and specificity of 78.6%.

CONCLUSION: We believe that the preoperative NLR is a predictive variable for orthopedic surgeons in assessing the postoperative mortality risk in orthogeriatric patients who presented to the emergency room due to PTF and were planned to undergo PFN surgery.

Keywords: Aged; hip fracture; mortality; neutrophil-to-lymphocyte ratio; proximal femoral nail; risk factor.

INTRODUCTION

Hip fractures (HFs) in the orthogeriatric population are a health problem with an increasing prevalence.[1] In the UK, 110,000 cases encounter HFs each year, while the affected patients reach approximately 1.5 million worldwide annually. In 2025, it is estimated that this number will reach 2.6 million patients per year.[2,3] Almost half of the HFs, demonstrating such an increase, consist of extracapsular pertrochanteric fractures (PTF) and need absolute surgical fixation.[4]

Dynamic hip screw (DHS), hemiarthroplasty (HA) and proximal femoral nail (PFN) methods are used in the surgical treatment of PTF, all with almost similar postoperative functional results for the hip.[1,4,5] However, the postoperative complication and mortality risk in the minimally invasive PFN have been reported to be lower than other methods.[1,4] Mortality rates of 7–10% in patients who underwent surgery due to HFs were reported during the first 30 days postoperatively.[2] In addition, the mortality rate during the postoperative first year has been reported to vary between 8.4% and 30%,

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whereas the mortality rate during the first three years was 27.6%.[1–4,6] Diabetes mellitus (DM), dementia and heart disease have been reported as the negative predictors of postoperative mortality risk; however, definite predictors have not been identified.[3]

Recent studies suggested that blood and serum markers may be used as the predictors of postoperative mortality following HFs.[4,6–13] One of these methods, the preoperative neutrophil-to-lymphocyte ratio (NLR) is used as a predictor for the postoperative mortality risk in emergency abdominal, cardiovascular and oncologic surgeries.[12,13] In addition, several other studies suggested that this method can as well be used as a predictor of postoperative mortality following HFs in the orthogeriatric population.[6–11] In almost all studies in the literature, the study groups consist of a heterogeneous patient population that suffers from femoral neck and pertrochanteric hip fractures under "hip fractures", which are usually treated using the DHS, HA and PFN methods. However, the postoperative mortality risk in the minimally invasive PFN method is lower compared to more invasive methods, such as HA and DHS.[1,4]

In our retrospective study, we took the, "Can the NLR be used as a predictive value for mortality during the postoperative first year in PTF patients treated only with the PFN method?" as our guide. The hypothesis of our study was that the NLR was a predictive marker for the postoperative first year mortality risk in patients treated with the minimally invasive PFN method.

MATERIALS AND METHODS

Approval of the Ethics Committee of the Faculty of Medicine at Bozok University was obtained for this study. Informed consent forms were obtained from all patients and our study was conducted in accordance with the Declaration of Helsinki.

Patients

Fifty-five patients who presented to the emergency department of our hospital due to PTFs between January 2017 and March 2018 were included in our study. The inclusion criteria were to be over 65 years of age, underwent PFN surgery due to PTF. The exclusion criteria were to have multiple fractures, have pathologic PTFs or a history of ipsilateral or contralateral hip surgery. The patients were divided into two groups; patients who lost their lives in the postoperative first year comprised Group A (n=13) and patients who survived comprised Group B (n=42).

Surgery and Care

Anteroposterior (AP) and lateral X-rays of the femur were taken, surgical blood tests were performed and 40 mg/0.4 mL of enoxaparin was administered preoperatively. The fractures were classified according to the Evans-Jensen classification based on the preoperative X-rays.[14] The surgery was performed under spinal anesthesia on all patients who were taken to the operating room as soon as they presented at the emergency service. The surgeries were carried out by two different, National Board certified surgeons and without using a traction table. XRBEST (Xinrong Medical, Zhangjiagang, China) PFNs were used via a minimally invasive approach. On postoperative day 1, AP and Lowenstein lateral X-rays of the femur were taken. All patients who did not require postoperative intensive care were encouraged to walk with full weight-bearing with the aid of a walker. The patients were administered 40 mg/0.4 mL of enoxaparin and compression socks for six weeks. Their sutures were removed on the second postoperative week. The patients were followed up on the 2nd week, 6th week and 3rd, 6th and 12th months. X-rays were taken to evaluate any loss of reduction and union at each follow-up visit.

Data

The demographic data, preoperative NLR, body mass index (BMI), comorbid diseases, ASA scores, time from the emergency room to the operating room (ER to OR), postoperative intensive care requirements (ICU) and the duration of hospitalization of all patients were recorded. In addition, the patients who died and had their date of death recorded in the National Death Registry system were identified and noted. These data were evaluated for the comparison of both groups and for the postoperative mortality risk.

Statistical Analysis

The SPSS v.11 software (SPSS Inc., Chicago, IL, USA) was used to analyze the data. The descriptive statistics were given as mean, standard deviation, median, number and percentage. Normality of the numerical data was evaluated using the Kolmogorov-Smirnov test, and the Mann-Whitney U test was used for group comparisons. Categorical data were compared using the chi-square or Fisher's exact test. The ROC curve was utilized in assessing whether the NLR could be used as a marker in predicting mortality. The effects of the NLR on mortality was determined using the Kaplan-Meier analysis. The level of statistical significance was set at $p<0.05$.

RESULTS

A total of 55 patients (29 males, 26 females) aged between 68 and 94 years (mean: 80.76±7.6) who were operated for pertrochanteric hip fractures were included in this study. Thirteen patients died in the first year (Group A), making the overall mortality rate for the postoperative first year 23.6%. The groups had a homogeneous distribution; no statistically significant difference was found between the two groups concerning mean age, gender, BMI, preoperative ASA scores, Evans-Jensen fracture type, time from ER to OR and ICU requirement ($p>0.05$). The comparison of the demographic

and clinical data of the groups is summarized in Table 1. The mean follow-up period of the patients in Group B was 18.5 (range: 13 to 27) months, and no loss of reduction, infection or implant failure that necessitated a revision surgery were observed postoperatively.

No statistically significant correlation was detected between age, gender, BMI, preoperative ASA score and Evans-Jensen fracture type and mortality in the postoperative first year (p>0.05). In addition, no statistically significant correlation was detected between the comorbidities of the patients included in our study (hypertension [n=21], atherosclerosis [n=11], diabetes mellitus [n=8], chronic renal failure [n=8] and cerebrovascular event [n=5]) and mortality (p>0.05). However, there was a statistically significant correlation between the presence of two or more comorbidities and mortality (p<0.05).

There was a statistically significant difference between the NLRs of the two groups (Fig. 1) (p<0.01). In the ROC analysis performed to investigate whether the NLR could be used as a predictive marker for the postoperative first year mortality, the area under the curve was 0.861 (p<0.001; lower bound: 0.761, upper bound: 0.961). When the cut-off value was taken as 5.25, the sensitivity and the specificity of this value for mortality were 84.6% and 78.6% respectively (Fig. 2). According to the ROC curve, when the NLR was divided

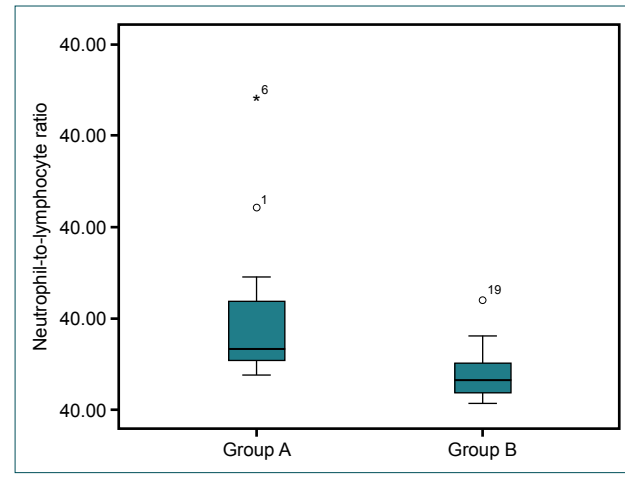

Figure 1. Comparison of the neutrophil-to-lymphocyte ratio in Group A versus Group B.

Table 1. Demographic and clinical data of the patients

Variables	Group A (n=13)		Group B (n=42)		p
	Mean±SD	Median	Mean±SD	Median	
Age (years)	83.54±7.3	84.0	79.90±7.6	78.0	0.156
Sex, n (%)					
Male	8 (61.5)		21 (50)		0.467
Female	5 (38.5)		21 (50)		
Body mass index (kg/m^2)	25.47±2.5	25.54	26.94±5.4	25.76	0.620
Body mass index, n (%)					
Underweight	0		1 (2.4)		0.264
Normal	6 (46.2)		15 (35.7)		
Overweight	7 (53.8)		13 (31)		
Obese	0		10 (23.8)		
Extremely obese	0		3 (7.1)		
ASA score, n (%)					
3	8 (61.5)		21 (50)		0.537
4	5 (61.5)		21 (50)		
Time from ER to OR (hours)	44.8±31.5	24.0	34.7±20.5	24.0	0.356
ICU requirement, n (%)					
Yes	3 (23.1)		11 (26.2)		0.822
No	10 (76.9)		31 (73.8)		
Time in ICU (days)	0.84±1.9	0	0.47±0.9	0	0.979
Duration of hospitalization (days)	5.07± 3.5	4.0	5.69±4.0	5.0	0.611
NLR	10.41±8.7	6.70	3.75±2.3	3.20	<0.001

ASA: American Society of Anesthesiologists; ER: Emergency room; ICU: Intensive care unit; NLR: Neutrophil-to-lymphocyte ratio; OR: Operating room; SD: Standard deviation.

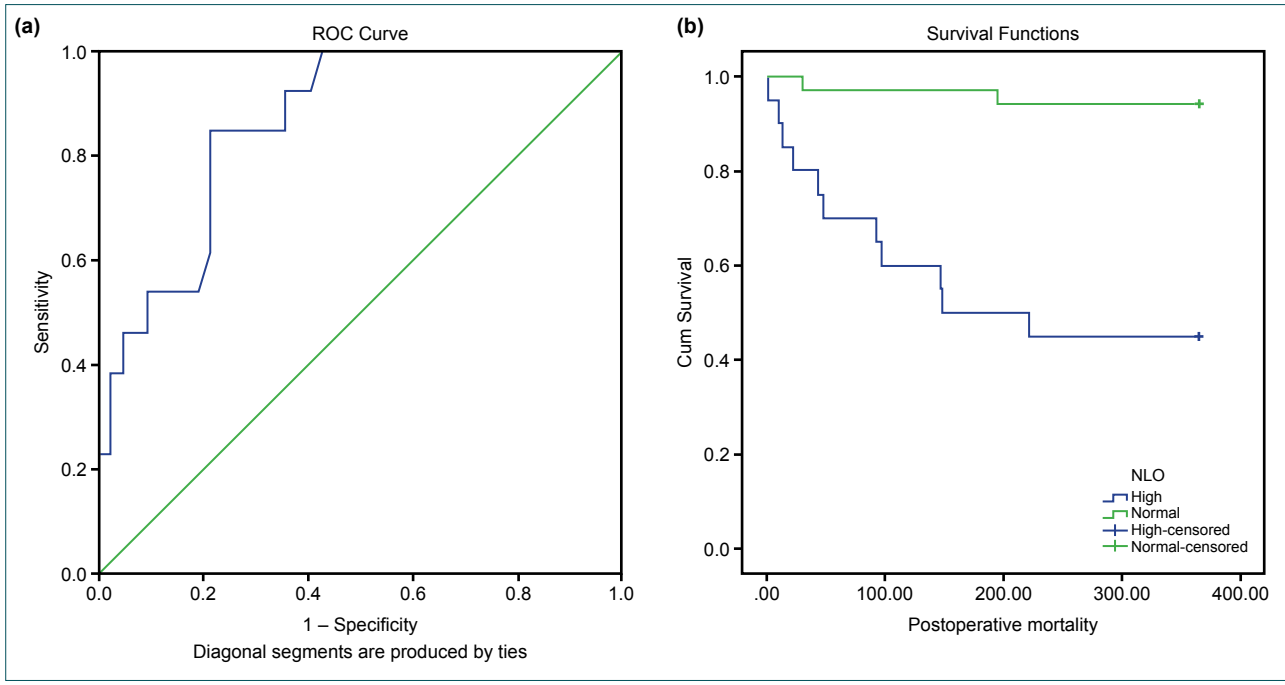

Figure 2. (a) The ROC curve for NLR and **(b)** the Kaplan-Meier survival analysis.

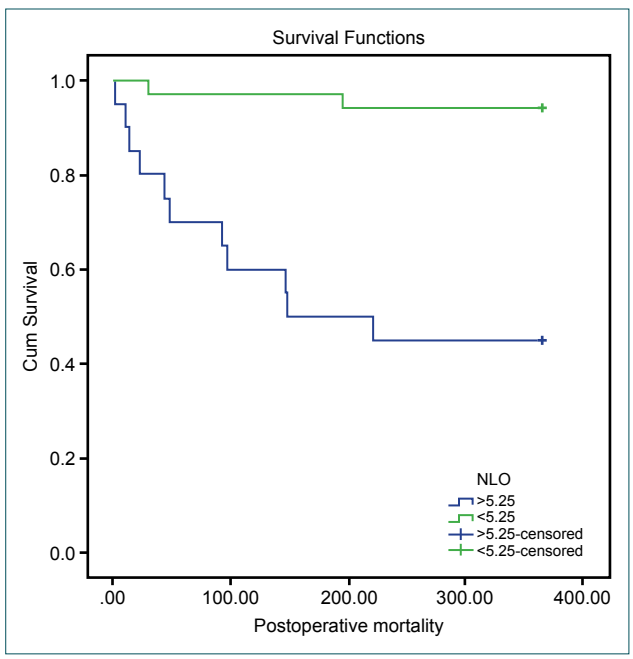

Figure 3. The Kaplan-Meier curve showing the effect of high neutrophil-to-lymphocyte ratio on postoperative mortality.

into two groups as 'high' (>5.25) and 'normal' (<5.25), the postoperative surveillance period had significantly decreased in patients with a high NLR (Fig. 3).

DISCUSSION

The prevalence of HFs in the orthogeriatric population has increased threefold from the early 2000s to the present day, with PTFs constituting the majority of these fractures with 55.5%.[15] The mortality rate in the patient population undergoing surgery for PTF may reach 30% at the postoperative first year.[16] However, this rate varies depending on the type of surgery performed; the mortality risk after PFN surgery was reported as 16%.[16,17] Nevertheless, HA, PFN and DHS methods were used heterogeneously in the postoperative first year mortality studies following PTF surgery in the orthogeriatric population and the predictive values for mortality were defined. Our study, on the other hand, was carried out in an orthogeriatric population from two homogeneous groups of patients who underwent PFN surgery due to PTFs and our results suggested that the NLR could be used as a predictor of mortality in the postoperative first year with a cut-off value of 5.25. This cut-off value is similar to the cut-off value from other studies in the literature.[6–11] In their study that included 50 patients who underwent HA, Temiz and Ersozlu reported a cut-off value of 5.34.[12] Forget et al.[6] reported a postoperative NLR cutoff value of 4.9 (sensitivity: 62.9%, specificity: 57.6%) as an outcome of their study that included 237 patients with an intracapsular or extracapsular hip fracture. In our study, the sensitivity for the NLR cut-off value was 84.6% and the specificity was 78.6%. However, we found no other study planned with a similar patient population in our review of the literature.

Various patient-related factors have been reported to be correlated with mortality in the postoperative first year, including advanced age, high preoperative ASA score, obesity, comorbid diseases and postoperative intensive care requirement.[18–23] In parallel with the literature, the findings of our study suggested that having two or more comorbidities was a risk factor for mortality in the first year postoperative. On the other hand, no significant correlation was established be-

tween age, preoperative ASA score, postoperative intensive care requirement, obesity and duration of hospitalization and mortality in our study. We concluded that this was due to that our study included two groups with a homogeneous distribution for these variables and other studies related to this subject contained different types of fractures and treatments under 'hip fracture' topic.

Variables that were not related to patients but possessed a risk for postoperative mortality were the surgical treatment method of the fracture, time from ER to OR and the anesthesia method used during surgery.[16,17,20,21] In their study of 136 patients, Aydin et al.[16] reported that PFN surgery for PTFs caused less mortality compared to HA and allowed patients to return to daily life activities earlier. Ergun at al.[17] stated that the PFN method was a better method than the HA method in terms of postoperative functional results. In our study, all patients were operated with the PFN method and under spinal anesthesia, and our postoperative mortality and complication rates were in parallel with the literature. However, in our study, there was no correlation between the time from ER to OR and mortality, and we concluded that this was due to the nature of the studies from the literature which were carried out with heterogeneous groups.[21]

Our study had some limitations. The low number of patients included in our study was one of the major weaknesses. Tha the surgical treatments were performed by two different surgeons was another weakness. However, both of these surgeons were certified by the National Board and both possessed an orthopedic surgery experience of more than five years. Another weakness of our study was the lack of NLR data on the fifth day postoperative contrary to other studies from the literature that reported the NLR as a risk factor for postoperative mortality and included this data.[6,12] The majority of the patients included in these studies were treated with HA and the mean duration of hospitalization was longer than five days. In our study, the mean duration of hospitalization times were 5.07 and 5.69 days for the two groups, thus patients with a hospitalization duration of less than five days were also included in our study. However, the hypothesis of our study was designed to identify the predictive postoperative values for postoperative mortality.

Despite these limitations, we believe the NLR data we attained in our study will be one of the preoperative predictive variables for the postoperative mortality risk in orthogeriatric patients who were admitted to the emergency department for PTFs and planned to undergo PFN surgery. Nevertheless, we think that the variables not related to patients will be re-evaluated in line with these predictive values by orthopedic surgeons in multicenter studies with a larger population in the future.

Each author certifies that he has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements) that may pose a conflict of interest in connection with the submitted article.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Ameliyat öncesi nötrofil-lenfosit oranı pertrokanterik kırık nedeniyle proksimal femoral çivi planlanan ortogeriatrik popülasyon için ameliyat sonrası mortaliteyi belirlemede kullanılabilecek ameliyat öncesi bir değer midir?

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AMAÇ: Ortogeriatrik popülasyonda kalça kırığı mortalite ve morbiditeye neden olan ve giderek sıklığı artan bir sağlık problemidir. Çalışmamızın amacı pertrokanterik kırık nedeniyle sadece proksimal femur çivi (PFÇ) cerrahi yöntemi ile tedavi edilmiş hastalarda; ameliyat öncesi nötrofil-lenfosit oranının (NLO) ameliyat sonrası mortalite riski için preditif bir değer olup olmadığını irdelemektir. Literatürde benzer popülasyonda planmış başka bir çalışma tespit edilememiştir.

GEREÇ VE YÖNTEM: Geriye dönük olarak planlanan çalışmamıza ulusal ortopedi kurul sertifikalı iki cerrah tarafından PFÇ yöntemi ile ameliyatı gerçekleştirmiş 55 hasta alındı. Hastalar ameliyat sonrası ilk bir yıl hayatını kaybedenler (Grup A [n=13]) ve hayatta kalanlar (Grup B [n=42]) olarak iki gruba ayrıldı. Tüm hastaların ameliyat öncesi NLO değerleri, demografik bilgileri, hastanede kalış süreleri, ameliyat sonrası yoğun bakım (POYB) ihtiyaçları ve komorbid hastalıkları kayıt altına alındı.

BULGULAR: En uzun hasta takip süresi 27 ay olan çalışmamız sonucunda her iki grup arasında; yaş, cinsiyet, vücut kitle indeksi, ameliyat öncesi American Society of Anesthesiologist (ASA) skorları, kırık tipleri, POYB ihtiyaçları, hastanede kalış süreleri ve hastaların acil servis başvurusundan ameliyathaneye alınmasına kadar geçen süre açısından anlamlı fark saptanmadı (p>0.05). Bununla birlikte anlamlı şekilde grup A hastalarında NLO değeri daha yüksek gözlenmiş (p<0.01), kestirim değer 5.25, sensitivitesi %84.6, spesifitesi %78.6 idi.

TARTIŞMA: Ameliyat öncesi NLO değerinin ortopedik cerrahlar açısından; pertrokanterik kırık nedeniyle acil servise başvuran ve PFÇ cerrahisi planlanan ortogeriatrik hastaların ameliyat sonrası mortalite riski için prediktif değişkenlerden olacağını düşünmekteyiz.

Anahtar sözcükler: Kalça kırığı; mortalite; nötrofil-lenfosit oranı; ortogeriatri; risk faktörleri.

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