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Proximal femoral nail causes lower systemic immunoinflammatory response compared to hemiarthroplasty in the treatment of unstable intertrochanteric fractures

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Abstract

Aim: This study aimed to compare the surgical stress and immunoinflammatory response caused by proximal femoral nail (PFN) and hemiarthroplasty (HA) in patients with unstable intertrochanteric fractures.

Materials and Methods: We retrospectively evaluated 344 patients who had undergone surgery for intertrochanteric fractures. Inclusion criteria were defined as being between the ages of 65 and 80, having an ASA score of 3, and the time between fracture formation and surgery being less than 72 hours. PFN was performed in 42 of the patients whereas HA was performed in 40 patients. In the two groups, data such as age, gender, pre-operative waiting and operation times, length of hospital stay, change in hemoglobin levels, and erythrocyte suspension (ES) need were recorded. Venous blood samples were collected from all the patients at the first admission to the emergency department after fracture, 6 hours after the operation, and 3 days after the operation. neutrophil-lymphocyte ratio (NLR) and systemic immune-inflammation index (SII) were compared between the two procedures at three different time points.

Results: The age, gender distribution, and preoperative wait duration did not differ significantly ($p>0.05$) between the two groups. The operation duration, hospitalization duration, and number of ES use were significantly higher ($p<0.05$) in the HA group than in the PFN group. In both groups, NLR and SII values increased significantly ($p<0.05$) between the day 0 and the 3rd postoperative day. The postoperative day 0 NLR and SII values in the HA group were significantly higher than those in the PFN group ($p<0.05$).

Conclusion: We conclude that the PFN procedure causes less surgical stress than HA; therefore, it is a safer procedure.

Introduction

The incidence of hip fractures has dramatically increased due to factors such as longer life expectancy, reduced physical activity, smoking, and malnutrition, all of which cause a reduction in muscle mass and function, thus leading to osteoporosis [1]. In a recent retrospective cohort study, it was stated that the mortality rate during the first year after a hip fracture is as high as 33% [2]. The same study showed that the mortality rate increased at a statistically significant rate when aged 75 years or older, being a male, and by suffering from other medical conditions including diabetes, moderate or severe liver problems, chronic kidney disease, dementia, chronic obstructive pulmonary disease, heart failure, and impairments to vision and hearing problems [3]. A hip fracture creates stress for the patient due to the trauma of the fracture itself and this stress increases by undergoing surgery. This is especially significant for elderly patients with comorbid medical problems, which may increase the mortality rate in this patient group.

Neutrophil-lymphocyte ratio (NLR) and systemic immune-inflammation index (SII) are known to be reliable quantitative parameters to evaluate stress levels on admission and also during early and late postoperative periods [3-6].

Fractures of the intertrochanteric region of the femur are the second most common type of hip fracture, following fractures of the femoral neck [7]. As it is extra-capsular, this area has good blood supply and thus, has good potential for fracture healing if proper fixation is performed. In elderly patients, the treatment choice for unstable in-

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tertrochanteric fractures with comminution of the posteromedial cortex remains controversial. The most popular surgical techniques, proximal femoral nailing (PFN) and hemiarthroplasty (HA), have been compared in many aspects [8-10]. In these studies, the key differences are that the PFN group experienced comparatively shorter surgeries and less blood loss, while the HA group experienced earlier mobilization [11]. We believe that proximal femoral nailing creates lesser surgical stress because of smaller incisions and shorter surgery time. No clinical study has compared the stress and inflammatory responses caused by the two surgical techniques used for the treatment of unstable intertrochanteric fractures in the elderly patient group.

This study aimed to compare the surgical stress and immunoinflammatory responses caused by PFN and HA surgical procedures in patients with unstable intertrochanteric fractures.

Materials and Methods

This clinical study was approved by the Ethical Committee of Dr. Burhan Nalbantoğlu State Hospital. (Date: 26.06.2020 / No: YTK.1.01), and all participating researchers signed the Helsinki Declaration. This retrospective study included 344 patients who underwent operations for intertrochanteric fractures of the femur between March 2018 and September 2019, all of whom signed informed consent forms to participate in the study.

Patients with intertrochanteric femoral fractures who had undergone PFN or HA surgery were selected from the patient database for inclusion in the study. The inclusion and exclusion criteria were carefully chosen in order to obtain more reliable NLR and SII values, since they are known to be very sensitive to many factors. The inclusion criteria were as follows: (1) age between 65 and 80 years old; (2) have an American Society of Anesthesiology physical status classification system (ASA) score of 3; and (3) have undergone surgery within the first 72 hours of the initial fracture trauma. The exclusion criteria were as follows: (1) fractures additional to the intertrochanteric fracture; (2) had pathologic fractures, including fractures resulting from metabolic or oncological problems; (3) had previous surgeries on either hip, (4) had any malignant tumors, surgery, or infection within the last month; (5) had been taking any immunosuppressive drugs, including corticosteroids; (6) was admitted to the intensive care unit post-operation; (7) had postoperative superficial or deep wound infections; and (8) died within the first 12 months of surgery.

As there was no obvious difference in the clinical outcomes of the two types of surgical procedures, the type of surgery was decided according to the fracture type and the clinical experience of the four participating surgeons. As a result, PFN was performed in 42 patients, and HA was performed in 40 patients. Spinal anesthesia was administered to all the patients. In the PFN group, all operations were performed on a fracture table, whereas in the HA group, all the surgeries were performed in the lateral decubitus position with a lateral incision applying cemented prosthesis. In the HA group, a trochanteric grip plate was also used to fix the greater trochanteric fracture in 12 patients. All patients were administered cephazoline sodium 3 x 1 gram intravenously for 1 day and low-molecular-weight heparin 4000 IU 1 x 1 subcutaneously for 6 weeks. The patients were mobilized on the day after surgery. The HA group patients were allowed full weight-bearing, and the PFN group patients were allowed to bear weight as tolerated without exceeding 50% in the first 6 weeks.

For both patient groups, age, sex, preoperative waiting time, length of surgery, length of hospital stay, changes in the hemoglobin (HGB) levels, and the need for blood transfusion (erythrocyte suspension (ES)) were recorded and compared. Venous blood samples were collected from all patients at three points: upon admission to the ER, 6 hours postoperatively, and 3 days postoperatively, and each sample was analyzed to measure complete blood cell count (CBC) using an automated blood cell counter (Beckman Coulter LH 780, California, USA). NLR was calculated by dividing the neutrophil count by the lymphocyte count and SII was calculated by multiplying the thrombocyte count with the neutrophil count and dividing the result by the lymphocyte count.

Statistical analysis

All statistical analyses were conducted using IBM SPSS 27.0, including descriptive statistics (mean, standard deviation, median, minimum and maximum values, frequency, and percentages), the Kolmogorov-Smirnov test for the distribution of variables, the independent samples test and Mann-Whitney U test for the comparison of quantitative data, the paired samples t test for repeated measurement analysis, and the chi-square test for the comparison of qualitative data.

Results

In both groups, there were no significant differences in age, sex and waiting time before surgery ($p>0.05$). In the HA group, there was an obvious difference in surgery time, hospital stay, and the need for transfusion compared with the PFN group ($p<0.05$)(Table 1). Preoperative and postoperative HGB levels and changes in HGB levels after treatment were not found to be significant in either group ($p>0.05$). In both groups, the HGB levels after treatment were found to be significantly low ($p<0.05$) (Table 2). In both the HA and PFN groups, the NLR and SII values were not statistically different on the third postoperative day ($p>0.05$), whereas postoperative day 0 values of NLR and SII were significantly higher in the HA group than in the PFN group ($p<0.05$). In both groups, there was a statistically significant increase in postoperative NLR and SII values on both days 0 and 3 ($p<0.05$) (Table 2).

Discussion

Most significantly, this study demonstrated that the PFN application produces lower levels of immunoinflammatory stress than those seen in HA patients with similar fracture types.

Since hip fractures are associated with high mortality rates in elderly patients with comorbid medical problems, this study shows that PFN application causes less surgical stress than HA and is thus a safer surgical procedure.

Table 1. Patients demographics, operation and hospitalization time and required ES number between PFN and HA groups.

	HA Group		PFN Group		
	Mean±sd /n-%	Median	Mean±sd /n-%	Median	p
Age	72.6 ± 4.8	72.0	73.3 ± 4.7	73.0	0.509[m]
Gender					
Female	26 65.0%		27 64.3%		0.946[x^2]
Male	14 35.0%		15 35.7%		
Preop Wait Duration	2.2 ± 0.8	2.0	2.2 ± 0.7	2.0	0.771[m]
Operation Duration	110.9 ± 20.2	105.0	77.7 ± 17.4	75.0	0.000[m]
Hospitalization Duration	9.7 ± 2.3	10.0	6.7 ± 1.3	7.0	0.000[m]
ES Number	2.1 ± 1.2	2.0	1.4 ± 1.2	1.0	0.012[m]

HA: Hemiarthroplasty, PFN: Proximal Femoral Nailing, ES: Erythrocyte Suspension, sd: Standart Deviation [m]: Mann-Whitney u test / [X^2] : Chi-square test.

Table 2. Comparison of the HGB, NLR and SII levels of the groups.

	HA Group		PFN Group		
	Mean±sd	Median	Mean±sd	Median	p
HGB					
Before Treatment (BT)	11.8 ± 1.3	11.8	11.6 ± 1.7	11.6	0.566[t]
After Treatment (AT)	10.3 ± 0.8	10.2	10.4 ± 1.1	10.4	0.781[t]
BT/AT Difference	-1.5 ± 1.2	-1.5	-1.3 ± 1.7	-1.3	0.448[t]
Intra Group p	0.000[P]		0.000[P]		
NLR					
Before Treatment	3.9 ± 2.3	3.5	3.8 ± 2.2	3.7	0.930[m]
After Treatment 0 th Day	10.7 ± 6.5	9.4	7.4 ± 4.6	6.9	0.016[m]
After Treatment 3 rd Day	6.2 ± 4.3	4.8	4.6 ± 2.4	4.1	0.134[m]
BT/AT 0 th Day Difference	6.9 ± 5.2	5.8	3.6 ± 2.7	3.3	0.001[m]
Intra Group p	0.000[w]		0.000[w]		
BT/AT 3 rd Day Difference	2.4 ± 3.8	1.7	0.8 ± 2.3	1.1	0.044[m]
Intra Group p	0.000[w]		0.021[w]		
SII					
Before Treatment	881 ± 572	751	891 ± 590	809	0.985[m]
After Treatment 0 th Day	2958 ± 2496	2302	1991 ± 1531	1760	0.027[m]
After Treatment 3 rd Day	1586 ± 1098	1344	1204 ± 702	1252	0.112[m]
BT/AT 0 th Day Difference	2077 ± 2145	1422	1100 ± 1159	939	0.009[m]
Intra Group p	0.000[w]		0.000[w]		
BT/AT 3 rd Day Difference	704 ± 1004	490	313 ± 660	255	0.044[m]
Intra Group p	0.000[w]		0.004[w]		

HGB: Hemoglobin NLR: Neutrophil-Lymphocyte ratio SII: Systemic Immune-Inflammation Index BT/AT: Before Treatment /After Treatment sd: Standard Deviation /[t]: Independent Samples t test / [m]: Mann-Whitney u test
[P]: Paired Samples t test / [w]: Wilcoxon test.

After a hip fracture, inflammatory indicators increase at different rates due to comorbid medical problems and the patient's immune system. Among these indicators, are IL-6, TNF-@, Neoprotein, NLR and SII [3-6,12-15]. NLR and SII can easily be calculated by obtaining a simple CBC and are current indicators. In elderly patients with hip fractures, high NLR and SII levels prior to surgery have been shown to be related to high mortality rates [3-6]. The pre-surgery levels of NLR and SII reflect the immunoinflammatory response after trauma and fracture, which are also affected by factors such as the patient's comorbid medical problems and immune system. The standardization of these variable parameters is therefore important in order to be able to correctly calculate the NLR and SII levels and compare the immunoinflammatory response of different surgical techniques in patient groups with similar NLR and SII levels. By doing so, we have shown that the NLR levels increased by 1.9 times in the PFN group and by

2.7 times in the HA group which was statistically significant. As different surgical procedures differ in terms of the length of surgery, amount of bleeding, and size of incision, they will produce different immunoinflammatory responses. This was shown in a study in which five different surgical techniques were used in 349 patients with proximal femoral fractures (percutaneous cancelous screw, dynamic hip screw, PFN, HA, total hip arthroplasty) where CRP values were found to be 8.7, 12, 14, 16 and 16 mg/dl, respectively, on the second postoperative day [16]. In this study, the difference between PFN and HA was not found to be statistically significant. The reason for this may be that CRP alone is insufficient to show the immunoinflammatory response.

Although increased NLR and SII levels before surgery are known to be related to early and late postoperative mortality rates in patients with hip fractures, no studies have been conducted on the changes in postoperative NLR and SII levels. However, in patients who underwent surgeries for gastric or colorectal cancer, it has been shown that postoperative prognosis can be determined more accurately with NLR and SII levels calculated in the postoperative period rather than in the preoperative period [17,18]. These studies show that the dynamic changes in the NLR and SII values can be used to determine both the immunoinflammatory response of the surgical intervention and the postoperative prognosis.

In a recent meta-analysis, it has been shown that low lymphocyte levels after hip fracture are related to increased mortality [19]. Also, increased platelet/lymphocyte ratio (PLR) is known to be related to increased mortality after hip fracture [20]. Therefore, we can conclude that an increase in the SII levels, which indicates an increase in the neutrophil and platelet numbers and a decrease in lymphocyte numbers, can be related to an increase in mortality in patients with hip fractures.

This study had some limitations. Most importantly, it was a retrospective study conducted in only one department. Therefore, the number of cases was limited which is important for statistical calculations. The preoperative venous blood samples were obtained on the day of the fracture but at different time periods after the initial trauma. Despite these limitations, obtaining similar preoperative NLR and SII values shows that standardization was achieved.

Conclusion

Hip fractures are a common health problem, with high mortality rates, especially in elderly patients. In this patient group with multiple comorbid medical problems, any additional surgical trauma exacerbates fracture trauma and increases the mortality risk. Having shown that PFN causes less surgical stress than HA, it is clear that PFN is a safer procedure than HA.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Dr. Burhan Nalbantoğlu State Hospital. (Date: 26.06.2020 / No: YTK.1.01)

References

1. Atik OŞ. There is an association between sarcopenia, osteoporosis, and the risk of hip fracture. Joint Diseases and Related Surgery 2019;30(1):1.
2. Guzon-Illescas O, Perez Fernandez E, Crespí Villarias N, Quirós Donate FJ, Peña M, Alonso-Blas C, et al. Mortality after osteoporotic hip fracture: incidence, trends, and associated factors. J Orthop Surg Res. 2019 Jul 4;14(1):203.
3. Bingol O, Ozdemir G, Kulakoglu B, Keskin OH, Korkmaz I, Kilic E. Admission neutrophil-to-lymphocyte ratio and monocyte-to-lymphocyte ratio to predict 30-day and 1-year mortality in geriatric hip fractures. Injury. 2020 Nov;51(11):2663-2667.
4. Wang ZC, Jiang W, Chen X, Yang L, Wang H, Liu YH. Systemic immune-inflammation index independently predicts poor survival of older adults with hip fracture: a prospective cohort study. BMC Geriatr. 2021 Mar 4;21(1):155. doi: 10.1186/s12877-021-02102-3.
5. Temiz A, Ersözlü S. Admission neutrophil-to-lymphocyte ratio and postoperative mortality in elderly patients with hip fracture. Turkish Journal of Trauma and Emergency Surgery 2019;25(1):71-74.
6. Atlas A, Duran E, Pehlivan B, Pehlivan VF, Erol MK, Altay N. The Effect of Increased Neutrophil Lymphocyte Ratio on Mortality in Patients Operated on Due to Hip Fracture. Cureus 2020;12(1):e6543.
7. Bjørgul K, Reikerås O. Incidence of hip fracture in southeastern Norway: a study of 1,730 cervical and trochanteric fractures. Int Orthop 2007;31(5):665-669.
8. Esen E, Dur H, Ataoğlu MB, Ayanoğlu T, Turanlı S. Evaluation of proximal femoral nail-antirotation and cemented, bipolar hemiarthroplasty with calcar replacement in treatment of intertrochanteric femoral fractures in terms of mortality and morbidity ratios. Joint Diseases and Related Surgery 2017;28(1):35-40.
9. Desteli EE, İmren Y, Erdoğan M, Aydagün Ö. Quality of Life Following Treatment of Trochanteric Fractures with Proximal Femoral Nail versus Cementless Bipolar Hemiarthroplasty in Elderly. Clin Invest Med 2015;38(2):E63-E72.
10. Sevimli R, Ö Bilal. Applications of proximal femoral nail treatment for femoral neck fractures. Van Medical Journal 20.4 (2013): 207-211.
11. Zhou S, Liu J, Zhen P, Shen W, Chang Y, Zhang H, et al. Proximal femoral nail anti-rotation versus cementless bipolar hemiarthroplasty for unstable femoral intertrochanteric fracture in the elderly: a retrospective study. BMC Musculoskelet Disord 2019;20(1):500.
12. Sedlár M, Kudrnová Z, Trca S, Mazoch J, Malíková I, Kvasnicka J, et al. Inflammatory response in patients undergoing hip surgery due to osteoarthrosis or different types of hip fractures. Osteoarthritis Cartilage 2008;16(1):26-33.
13. Sedlár M, Kudrnová Z, Erhart D, Trca S, Kvasnicka J, Krska Z, et al. Older age and type of surgery predict the early inflammatory response to hip trauma mediated by interleukin-6 (IL-6). Arch Gerontol Geriatr 2010;51(1):e1-e6.
14. Sun T, Wang X, Liu Z, Chen X, Zhang J. Plasma concentrations of pro- and anti-inflammatory cytokines and outcome prediction in elderly hip fracture patients. Injury 2011;42(7):707-713.
15. Larsen M, Bayard C, Lepetitcorps H, Cohen-Bittan J, Appay V, Boddaert J, et al. Elevated Neopterin Levels Predict Early Death in Older Hip-fracture Patients. EBioMedicine 2017;26:157-164.
16. Neumaier M, Metak G, Scherer MA. C-reactive protein as a parameter of surgical trauma: CRP response after different types of surgery in 349 hip fractures. Acta Orthop 2006;77(5):788-790.
17. Zhou ZQ, Pang S, Yu XC, Xue Q, Jiang HY, Liang XJ, et al. Predictive Values of Postoperative and Dynamic Changes of Inflammation Indexes in Survival of Patients with Resected Colorectal Cancer. Curr Med Sci 2018;38(5):798-808.
18. Min KW, Kwon MJ, Kim DH, Son BK, Kim EK, Oh YH, et al. Persistent elevation of postoperative neutrophil-to-lymphocyte ratio: A better predictor of survival in gastric cancer than elevated preoperative neutrophil-to-lymphocyte ratio. Sci Rep 2017;7(1):13967.
19. Li S, Zhang J, Zheng H, Wang X, Liu Z, Sun T. Prognostic Role of Serum Albumin, Total Lymphocyte Count, and Mini Nutritional Assessment on Outcomes After Geriatric Hip Fracture Surgery: A Meta-Analysis and Systematic Review. J Arthroplasty 2019;34(6):1287-1296.

20. Wang Z, Wang H, Yang L, Jiang W, Chen X, Liu Y. High platelet-to-lymphocyte ratio predicts poor survival of elderly patients with hip fracture. Int Orthop 2021;45(1):13-21.