

DİZ OSTEOARTRİTİNİN ŞİDDETİ YAŞLI POPÜLASYONDA PROKSİMAL FEMUR KIRIĞI TİPİNİ ETKİLER Mİ: RETROSPEKTİF KOHORT ÇALIŞMASI

DOES THE SEVERITY OF KNEE OSTEOARTHRITIS AFFECT THE TYPE OF PROXIMAL FEMUR FRACTURE IN THE ELDERLY POPULATION: A RETROSPECTIVE COHORT STUDY

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ÖZET

AMAÇ: Yaygın bir dejeneratif eklem rahatsızlığı olan Diz Osteoartriti, önemli bir küresel yük oluşturunken, proksimal femur kırıkları geriatric popülasyonda giderek daha yaygın hale geliyor. Bu durumlar arasındaki ilişkiyi anlamak, etkili klinik yönetim için hayati öneme sahip olmaya devam ediyor. Bu çalışma, intertrokanterik femoral kırıkları için proksimal femoral çivileme geçiren geriatric hastalarda diz osteoartriti şiddeti ve proksimal femur kırıklarının doğası arasındaki ilişkiyi araştırmayı amaçlamaktadır.

GEREÇ VE YÖNTEM: 2016-2021 yılları arasında femoral kırık nedeniyle proksimal femoral çivileme (PFN) uygulanan 420 geriatric hastada retrospektif bir kohort çalışması yürütüldü. Demografik özellikler, osteoartrit şiddeti (Kellgren-Lawrence sınıflandırması), kırık türü (AO/OTA sınıflandırması) ve klinik sonuçlarla ilgili veriler toplandı. Kalça kırığı türünün hafif (Kellgren-Lawrence derece I/II) ve şiddetli (derece III/IV) diz osteoartriti ile korelasyonunu değerlendirmek için istatistiksel analiz yapıldı.

BULGULAR: Osteoartrit şiddeti ile kırık tipi arasında anlamlı ilişkiler gözlemlendi ($p = 0,001$). Hafif osteoartritli hastalarda ağırlıklı olarak AO/OTA-tip 1 kırıkları (%74,7) görülürken, şiddetli osteoartritli hastalarda AO/OTA tip-2 (%67,9) ve AO/OTA tip 3 (%18,6) kırıklarının daha yüksek prevalansı vardı. Ancak, hafif ve şiddetli osteoartritli hastalar arasında genel sağ kalım ($p = 0,138$) veya revizyon oranlarında ($p = 0,978$) anlamlı bir fark bulunmadı.

SONUÇ: Osteoartrit şiddeti arttıkça kırık tipi değişti ve daha parçalı instabil kırık paterni ile birlikteliği görüldü.

ANAHTAR KELİMELE: Osteoartrit, Diz, Femur, Kırık sabitlenmesi, Intramedüller.

ABSTRACT

OBJECTIVE: Knee Osteoarthritis, a prevalent degenerative joint condition, poses a significant global burden, while proximal femur fractures are increasingly common among the geriatric population. Understanding the relationship between these entities remains crucial for effective clinical management. This study aims to investigate the association between knee osteoarthritis severity and the nature of proximal femur fractures in geriatric patients undergoing proximal femoral nailing for intertrochanteric femoral fractures.

MATERIAL AND METHODS: A retrospective cohort study was conducted on 420 geriatric patients who underwent proximal femoral nailing (PFN) for femoral fracture between 2016 and 2021. Data on demographic characteristics, osteoarthritis severity (Kellgren-Lawrence classification), fracture type (AO/OTA classification), and clinical outcomes were collected. Statistical analysis was performed to evaluate the correlation of the hip fracture type with mild (Kellgren-Lawrence grades I/II) and severe (grades III/IV) knee osteoarthritis.

RESULTS: Significant associations were observed between osteoarthritis severity and fracture type ($p = 0.001$). Patients with mild osteoarthritis predominantly exhibited AO/OTA type 1 fracture (74.7%), whereas those with severe osteoarthritis had a higher prevalence of AO/OTA type-2 (67.9%) and AO/OTA type 3 (18.6%) fractures. However, no significant difference was found in overall survival ($p = 0.138$) or revision rates ($p = 0.978$) between patients with mild and severe osteoarthritis.

CONCLUSIONS: As the severity of osteoarthritis increased, the fracture type changed and was associated with a more comminuted fracture pattern.

KEYWORDS: Osteoarthritis, Knee, Femur, Fracture fixation, Intramedullary.

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INTRODUCTION

Knee osteoarthritis, a condition of which prevalence escalates with advancing age, has emerged as a widespread health concern affecting approximately one hundred million adults globally (1). Apart from its detrimental impact on functional capabilities, knee osteoarthritis also affects patients socio-psychologically, disrupting the biomechanics and anatomical positioning of the knee joint during movement (2). This compromised biomechanical alignment renders patients more susceptible to falls, a phenomenon substantiated by numerous clinical studies (3-4). Furthermore, knee osteoarthritis predisposes individuals to hip fractures, a subset of fractures notorious for their high mortality rates and prevalence among the geriatric population.

Among hip fractures, intertrochanteric (IT) hip fractures rank among the most frequently encountered in orthopedic practice. Proximal femoral nailing (PFN) is the preferred and efficacious surgical intervention for these fractures. Classified under the Orthopedic Trauma Association (OTA) classification system as AO/OTA 31-A, these fractures are further stratified into types A1, A2, and A3. A1 fractures manifest as two-piece configurations, A2 fractures involve multiple fragments, while A3 fractures encompass reverse oblique and transverse fracture patterns (5). Of particular concern are A2 and A3 fractures, known to result from high-energy trauma and associated with challenging healing processes and relatively poorer clinical outcomes due to their unstable nature (5). It is hypothesized that in knees afflicted with impaired kinematics due to osteoarthritis, fractures may occur with greater energy expenditure, given the increased physical stress and load on the hip joint. However, existing literature lacks substantial evidence of this correlation. Our study seeks to investigate the potential relationship between osteoarthritis severity and fracture types.

MATERIAL AND METHODS

This study received approval from the Institutional Review Board. In this study, we employed a retrospective cohort design to explore the potential correlation between knee osteoarthritis

in the geriatric population and the type of proximal femur fractures among patients undergoing PFN. The primary objective was to ascertain whether the severity of knee osteoarthritis, classified according to the Kellgren and Lawrence system (6), was linked to proximal femur fractures. Additionally, secondary objectives aimed to discern any variations in outcomes across different grades of knee osteoarthritis.

The study cohort comprised 420 patients who underwent PFN for femoral fracture correction at the hospital between 2016 and 2021. Inclusion criteria included geriatric patients with intertrochanteric femoral fractures. Demographic characteristics, including age, gender, and comorbidities, were collected from electronic health records and imaging databases. Data collection was conducted using a structured electronic database, facilitating the systematic extraction of relevant clinical and radiological information. Variables were extracted from patient records and imaging reports. Data collectors included two academic orthopedic surgeons. Regular quality checks were performed to verify data integrity and completeness. Standardized protocols were followed for image acquisition and interpretation to ensure consistency across assessments. Any discrepancies in interpretation were resolved through a consensus review by the authors.

We used the AO/OTA system to evaluate the fractures (5): The AO/OTA classification system stands as one of the most extensively utilized frameworks for categorizing proximal femoral fractures or fractures at the end segment of the proximal femur. These fractures, akin to others, are categorized into three main groups based on the severity and complexity of the respective injury. Type A fractures encompass trochanteric fractures situated below the intertrochanteric line and above the inferior border of the lesser trochanter. Within this category, fractures are further delineated into subtypes, such as simple perthrochanteric fractures (A1), multifragmentary perthrochanteric fractures (A2), and intertrochanteric or reverse oblique fractures (A3). Type B fractures comprise femoral neck or subcapital fractures, including subtypes like subcapital fractures (B1) and transcervical fractures (B2). Lastly, type C fractures involve

femoral head fractures, characterized by split fractures (C1) or depression fractures (C2), each with its specific subtypes delineated by the nature and severity of the injury. The classification system's precision allows for a comprehensive understanding of the diverse presentations of proximal femoral fractures, aiding clinicians in treatment planning and prognostication.

The Kellgren and Lawrence system (6) serves as a widely utilized method for assessing the severity of osteoarthritis employing five grades for classification. The severity increases from grade I to grade IV. Grade I and II were defined as mild and III and IV as severe osteoarthritis to ease the statistical analyses.

Ethical Committee

This study received approval from the Institutional Review Board (IRB) at Umraniye Education and Research Hospital (ID: E-54132726-000-1397/21). All research procedures were conducted by the ethical standards outlined in the Declaration of Helsinki. Informed consent was waived due to the retrospective nature of the study and the use of de-identified patient data. Measures were taken to ensure patient confidentiality and data security throughout the research process.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0. Descriptive statistics were used to summarize patient characteristics and study variables. Continuous variables were reported as means $\pm$ standard deviations or medians with interquartile ranges, while categorical variables were presented as frequencies and percentages. Inferential analyses, including chi-square and one-way ANOVA tests, were conducted to examine associations. Sensitivity analyses and subgroup analyses were performed to assess the robustness of the findings and explore potential effect modifiers. A significance level of $\alpha = 0.05$ was used for all statistical tests.

RESULTS

In terms of gender distribution, females constituted the majority, accounting for 61.1% (256 individuals). The mean age of the cohort was

76.7 years. Regarding the American Society of Anesthesiologists (ASA) classification, 49.4% (207) of patients fell into the II-I category, while 50.6% (213) were classified as III-IV. Kellgren-Lawrence grading revealed that 23.8% (100) of individuals had mild, whereas the majority, 67.2% (320), had severe knee osteoarthritis. 27.8% (117) of the hip fractures were categorized as AO/OTA-1, 57.1% (240) as AO/OTA-2, and 14.5% (61) as AO/OTA-3 (**Table 1**).

Table 1: General overview of the cohort

Cohort	means	frequency (n%)
Gender (female)		61.1(256)
Age	76.7 $\pm$ 3.8	
BMI	29.3 $\pm$ 5.1	
ASA		
II-I		49.4 (207)
III-IV		50.6 (213)
Kellgren-Lawrence		
I-II		23.8 (100)
III-IV		67.2 (320)
<i>Orthopedic Fracture:</i>		
AO fracture Classification:		
AO-1		27.8 (117)
AO-2		57.1 (240)
AO-3		14.5 (61)

A comprehensive comparison between patients with Mild and Severe Osteoarthritis (**Table 2**).

Table 2: General comparison between Mildly osteoarthritis (KL I/II patients) patients and Severe osteoarthritis patients (KL III/IV patients)

	KL I/II patients	KL III/IV patients	P-value
Gender (female)	60.6 (61)	61.3 (195)	0.942
Age	76.2 $\pm$ 3.4	76.7 $\pm$ 3.8	0.670
BMI	29.0 $\pm$ 4.8	29.5 $\pm$ 5.1	0.562
ASA			0.820
II-I	49.5 (50)	49.1 (156)	
III-IV	50.5 (50)	51.9 (163)	
<i>Orthopedic Fracture:</i>			
AO fracture Classification:			0.001
AO-1	74.7 (75)	13.5 (43)	
AO-2	24.3 (24)	67.9 (211)	
AO-3	1.0 (1)	18.6 (60)	

Gender distribution demonstrated no significant difference between the two groups ($p = 0.942$). The age for hip fracture was similar for the patients having mild and severe osteoarthritis. Body mass index (BMI) showed no substantial difference between the two groups ($p = 0.562$). The American Society of Anesthesiologists (ASA) classification revealed no significant disparity in distribution ($p = 0.820$). Notably, in terms of orthopedic background, AO/OTA fracture classification showed a significant association with the severity of osteoarthritis ($p = 0.001$). AO/OTA-1 fractures were predominantly detected in Mild Osteoarthritis patients

(74.7%), while AO-2 and AO-3 fractures were more prevalent in Severe Osteoarthritis patients (67.9% and 18.6%, respectively) (**Figure 1**).

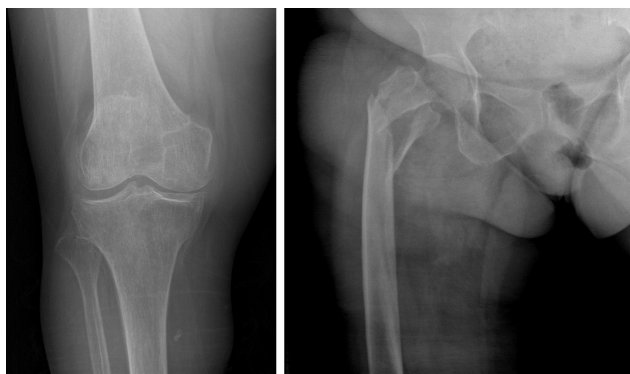


Figure 1: 79 years old female patient. Weight-bearing knee frontal image taken 3 years before the fracture and fracture frontal image

DISCUSSION

This study reveals the intricate biomechanical interplay between the knee and hip joints, with fractures serving as a pivotal clinical parameter. Our results revealed that the more severe the knee osteoarthritis is the more unstable the intertrochanteric fractures are. This finding should alarm both surgeons and caretakers of the elderly population to prevent those fragile populations with severe knee OA from falling. Degenerative changes in the knee joint due to osteoarthritis are known to disrupt gait kinematics, often leading to limping in advanced stages (7-9). An abnormal gait pattern, referred to as "varus thrust," emerges due to ligament imbalance, varus alignment, and quadriceps weakness. It has been demonstrated that increasing severity of osteoarthritis leads to decreased extensor strength and increased flexor isokinetic strength (9). This progression exacerbates gait abnormalities and can result in limping. Arden et al. (10) have shown that patients with osteoarthritis are at a higher risk of hip fractures. This study provides significant insights into the biomechanical interaction between the knee and hip joints, suggesting that knee degeneration may alter hip fracture patterns.

Furthermore, even though there was no difference between groups by the means of age that fracture was sustained, an early onset of the knee OA may have exacerbated the weakness of tight muscles which have crucial func-

tions in core-body balance during balance. As support for this claim, sarcopenia is a very wide factor among elders having proximal femur fragility fracture (11, 12). Our results may provide insight into the occurrence of more unstable fractures in the severe osteoarthritis group.

Proximal femur fractures present a major health concern in the elderly population, with an annual incidence projected to reach nearly 21 million cases by 2050 (13, 14). This demographic group is further complicated by frailty and a high prevalence of osteoarthritis, with 40-60% of cases experiencing permanent disability even one-year post-treatment (15). Understanding the etiology and configuration of these fractures is vital for developing effective management strategies. Osteoarthritis predisposes individuals to traumatic events, and our study reveals a complex spectrum of trauma types. Notably, AO-2 and AO-3 fractures, triggered by high stress and energy, predominate in 75% of advanced osteoarthritis cases. In contrast, milder osteoarthritic conditions are generally associated with 75% of AO 1 fractures. This distinction highlights the intricate interaction between the severity of osteoarthritis and fracture types. Changes in knee joint biomechanics due to osteoarthritis can shift load distribution to the hip joints, thereby increasing trauma energy. These biomechanical changes provide valuable insights into the pathophysiology of femoral head fractures in osteoarthritic conditions. Such information not only enhances our understanding of osteoarthritis-related fracture patterns but also informs the development of perioperative management strategies (16).

Our study demonstrates that the severity of osteoarthritis impacts the severity of intertrochanteric fractures as well. Increased osteoarthritis severity leads to more fragmented fracture patterns, suggesting that the altered gait patterns and resultant muscle imbalance in osteoarthritic patients contribute to higher energy transfer to the hip. Further studies and research are needed in this area. Our study is the first to show a statistically significant increase in AO/OTA 31A-1 fractures in the moderate osteoarthritis group and AO/OTA 31A-2 fractures in the severe group.

While acknowledging the inherent limitations of retrospective and single-center studies, it is important to highlight the significant strengths of our research. Our study employs a meticulously designed comprehensive methodology to address key research questions. Crucially, the inclusion of a large patient cohort enhances the robustness of our findings. Additionally, achieving a 100% power analysis score underscores the statistical rigor and reliability of our study. Despite its limitations, our research offers valuable insights into the complex interplay of factors influencing proximal femur fractures, making a significant contribution to guiding future research efforts.

In conclusion, our study sheds light on the complex interaction between biomechanics, osteoarthritis, and fracture dynamics in the geriatric population. As osteoarthritis severity increases, the resulting varus thrust force results in changes in gait pattern. As a result of this change, muscle groups are affected and a more uncontrolled force distribution occurs at the time of trauma. This affects the type of proximal femur fracture that occurs and it has been shown that the resulting proximal femur fracture becomes fragmented and unstable. Moving forward, further research is needed to develop perioperative management strategies and improve overall patient care in this challenging clinical scenario.

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