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Effect of femoroacetabular impingement on hip fractures

Femoroasetabular sıkışmanın kalça kırıkları üzerine etkisi

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ABSTRACT

AIM: The aim of this study is to find out if there is a relationship between femoroacetabular syndrome and the risk of hip fractures that have been known with high morbidity and mortality rates.

MATERIAL AND METHOD: Between January 1st of 2015 and January 1st of 2020, data of 243 patients with intertrochanteric fracture, 126 patients with femoral neck fracture and 250 trauma patients of over 65 years old that had admitted to our hospital's emergency department but had no fracture on both pelvis AP X-ray and pelvis CT, were evaluated retrospectively. While central edge angle, acetabular index and singh index were measured on AP X-ray of pelvis, alfa-angle, anterior offset with anterior offset ratio were calculated on pelvis CT.

RESULTS: No significant differences were found between the groups forming the hip fracture and the control group in terms of gender, age and Singh index, indicating that these factors were homogeneously distributed between the groups and had no effect on the factors investigated ($p>0.05$). The central edge angle, acetabular index, alpha angle, anterior offset and anterior offset ratio were found to be significantly different ($p<0.05$) in both hip fracture group compared to the control group in favor of femoroacetabular impingement.

CONCLUSIONS: The analysis results support our hypothesis and show that femoroacetabular impingement may cause hip fracture. As a result, the relationship of femoroacetabular impingement with hip fractures, which is the cause of high mortality and morbidity should be kept in mind.

Keywords: intertrochanteric fracture, femoral neck fracture, femoroacetabular impingement, femoroacetabular syndrome
Level of evidence: III

ÖZET

AMAÇ: Femoroasetabular sıkışma, asetabulum ve proksimal femurun anormal ilişkisi sonrası meydana gelen periartritik değişikliklerin eşlik ettiği kalça ekleminin ağrılı bir hastalığıdır. Eklem hareketlerinin kısıtlanmasına yol açar ve bu durum kalçanın normal biyomekaniğini bozarak anormal yüklenmelere sebep olur. Bu çalışmanın amacı femoroasetabular sıkışmanın indirekt etki ile yüksek mortalite ve morbidite nedeni olan kalça kırığı riskini artırıp artırmayacağının araştırılmasıdır.

GEREÇ VE YÖNTEM: 1 Ocak 2015 – 1 Ocak 2020 tarihleri arasında hastanemiz acil servisine başvuran ve tarafımıza konsulte edilerek intertrokanterik femur kırığı olan 243 hasta ve femur boyun kırığı olan 126 hasta ile travma nedeniyle acil serviste değerlendirilen aynı yaş grubuna sahip ve yapılan pelvis AP grafi ve pelvis BT tetkiklerinde herhangi bir fraktür saptanmayan 250 bireyin verileri retrospektif olarak incelenmiştir. X-ray görüntülerde merkez kenar açısı, asetabuler indeks, anterior ofset, anterior ofset oranı ve Singh indeksi; pelvis BT kesitlerinde ise alfa açısı ölçüldü.

BULGULAR: Kalça kırığını oluşturan her iki grup ile kontrol grubu arasında cinsiyet, yaş ve Singh indeksi açısından anlamlı bir fark saptanmamış olup bu faktörler için gruplar arası homojen dağılımın gerçekleştiğini ve araştırılan faktörler üzerine etkisinin olmadığını göstermektedir. Merkez kenar açısı, asetabuler indeks, alfa açısı, anterior ofset ve anterior ofset oranının ise kalça kırığı bulunan grupta kontrol grubuna göre femoroasetabular sıkışma lehine anlamlı derecede farklı çıktığı görülmüştür.

SONUÇ: Femoroasetabular sıkışmanın kalça eklem artrozuna neden olduğu ve bunun da kalça eklemi biyomekaniğini bozduğu bilinmektedir. Çalışmamızda bozulan bu biyomekaniğe bağlı olarak indirekt yoldan kalça kırığı oluştuğu araştırılmış olup analiz sonuçları hipotezimizi destekleyerek femoroasetabular sıkışmanın kalça kırığına neden olabileceğini göstermektedir.

Anahtar kelimeler: İntertrokanterik femur kırığı, femur boyun kırığı, femoroasetabular sıkışma, intertrochanteric fracture, femoral neck fracture, femoroacetabular impingement

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INTRODUCTION

Femoroacetabular impingement (FAI) is caused by a mismatch between the femur and the acetabulum.[1,2] Changes and deterioration in contact stresses due to the disorder in the structure of the hip cause osteoarthritis and related hip-related symptoms.[1,3] FAI may be asymptomatic in some individuals and may remain an anatomical variation.[4] Three types of impingement are defined radiologically as cam, pincer and mixed.[5] Patients diagnosed with FAI usually have decreased internal rotation of the hip, and torsional forces may cause hip fractures, especially in elderly and osteoporotic individuals.[6–8]

It is known that hip biomechanics are impaired in patients with FAI, and it is thought that this may predispose to hip fractures. This relationship has been investigated in a limited number of studies in the literature, our study is the first study in which the relationship between cam and pincer types of femoroacetabular impingement in both hip fracture types over 65 years of age was investigated separately with the control group.

The aim of the study is to investigate the effect of FAI, which causes disruption of hip biomechanics, on the risk of hip fracture.

MATERIAL AND METHOD

Ethical approval was obtained from Ankara Training and Research Hospital. Approval no: 28.01.2021- 528/2020 Between January 1st of 2015 and January 1st of 2020, data of 243 patients with intertrochanteric femur fracture, 126 patients with femoral neck fracture and 250 trauma patients of same age group (over 65 years old) that had admitted to our hospital's emergency department but had no fracture on both pelvis AP x-ray and pelvis CT, were evaluated retrospectively. Since pelvis CT was not performed in all patients, alpha angle, anterior offset and anterior offset ratio were measured in 132 intertrochanteric femoral fractures and 76 femoral neck fractures.

People over 65 years of age were included in the study; patients with pathological fractures, history of fractures in their bilateral lower extremities, and patients who underwent ipsilateral or contralateral total knee or total hip arthroplasty were excluded from the study in terms of probably causing impaired hip biomechanics.

After the lower extremities of the patient in the supine position were internal rotated 15° as standard, the beam was drawn from a distance of 1.2 meters, centralized to the symphisis pubis. The radiographs taken were transferred to the Radiant Dicom Viewer and analyzed.

We analyzed sex, age, singh index and evaluation of the measured angles, distance and ratio.

Central edge angle and acetabular index on the fractured side on X-ray images; determine the level of osteoporosis in the patients, singh index was evaluated from the X-ray images on the non-fractured side; in CT sections, alpha angle, anterior offset with anterior offset ratio were evaluated on the fractured side.

Increased alpha angle and decreased anterior offset and anterior offset ratio on the femoral side were accepted in favor of cam type femoroacetabular impingement.

On the acetabular side, increased central edge angle and decreased acetabular index were accepted in favor of pincer type impingement.

The angle between the vertical axis of the pelvis passing through the center of the femoral head and the line connecting the center of the femoral head and the lateral acetabulum edge was measured as the central margin angle

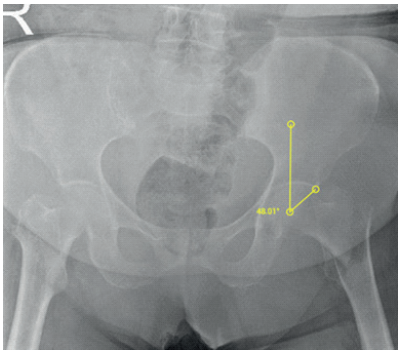

Figure 1. Demonstration of the central edge angle measurement of a patient with an intertrochanteric femur fracture

The angle between the line passing through the medial and lateral edges of the sclerotic region in the acetabulum and the transverse axis of the pelvis was evaluated as the acetabular index

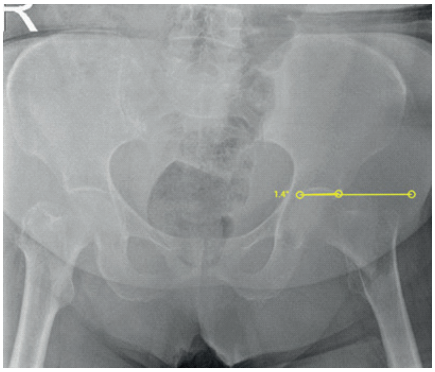

Figure 2. Demonstration of acetabular index measurement of a patient with intertrochanteric femur fracture

The angle between the line drawn parallel to the femoral neck and the line drawn from the center of the femoral head to the starting point of the femoral head aspheric was measured as the alpha angle

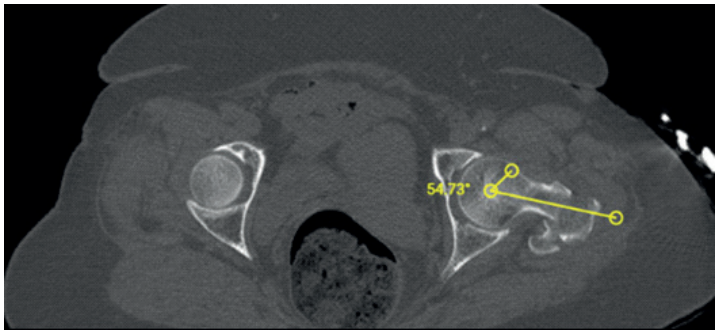

Figure 3. Demonstration of alpha angle measurement of a patient with intertrochanteric femur fracture

The distance between the line passing through the anterior of the femoral neck and drawn parallel to the axis of the femoral neck and the line parallel to this line and passing tangentially to the femoral head anteriorly was evaluated as the anterior offset

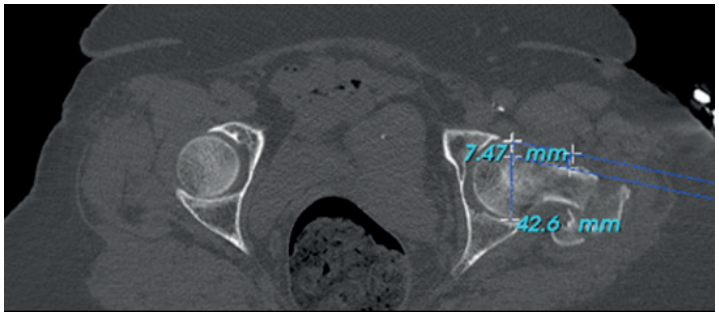

Figure 4. Demonstration of anterior offset and anterior offset ratio measurement of a patient with intertrochanteric femur fracture.

Anterior offset ratio was calculated by dividing the anterior offset to the diameter of the femoral head

The statistical data obtained were evaluated with the program called İBM SPSS Statistics. Whether the distribution was homogeneous between the groups was evaluated with the Kolmogorov-Smirnov test. The mean values between groups were analyzed with the Independent-Samples T-test at a

significance level of 0.05.

RESULTS

Of the 619 individuals included in the study, 243 patients with intertrochanteric femur fractures (98 male and 145 female), 126 patients with femoral neck fractures (42 male and 84 female) and 250 of them the control group without any fracture (89 male and 161 female). 229 of the individuals are male and 390 are female.

When the group of patients with intertrochanteric femur fracture and the control group were analyzed in terms of the central edge angle (p<0.001), acetabular index (p=0.002), alpha angel (p<0.001), anterior offset (p<0.001) and anterior offset ratio (p<0.001) significant differences was found between the two groups (Table 1). When the group of patients with intertrochanteric femur fractures and the control group were analyzed in terms of gender (p=0.280), age (p=0.118) and Singh index (p=0.411) no significant differences were found between the two groups

Table 1. Comparison of intertrochanteric femur fracture and control group in terms of central edge angle, acetabular index, alpha angle, anterior offset, anterior offset ratio, gender, age and singh index variable

	İntertrochanteric Fracture	Control	*p-value*
Number of hips	243	250	
Central Edge Angle, mean	48.36±6.49	45.37±6.26	<0.001
Acetabular index, mean	2.31±5.73	3.91±5.81	0.002
Alpha angle, mean	55.05±8.16	43.87±5.01	<0.001
Anterior offset, mean	6.55±2.21	9.01±1.46	<0.001
Anterior offset ratio, mean	0.11±0.04	0.17±0.02	<0.001
Gender, male:female	98:145	89:161	0.280
Age (years), mean	83.9±7.8	82.7±9.1	0.118
Singh index, mean	3.83±0.69	3.78±0.68	0.411

When the group of patients with femoral neck fracture and the control group were analyzed in terms of the central edge angle (p<0.001), acetabular index (p=0.033), alpha angel (p<0.001), anterior offset (p<0.001) and anterior offset ratio (p<0.001) significant differences was found between the two groups

Table 2. Comparison of femoral neck fracture and control group in terms of central edge angle, acetabular index, alpha angle, anterior offset, anterior offset ratio, gender, age and singh index variable

	Femoral Neck Fracture	Control	*p-value*
Number of hips	126	250	
Central Edge Angle, mean	47.82±7.04	45.37±6.26	<0.001
Acetabular index, mean	2.52±6.21	3.91±5.81	0.033
Alpha angle, mean	52.37±7.13	43.87±5	<0.001
Anterior offset, mean	6.38±1.65	9.01±1.46	<0.001
Anterior offset ratio, mean	0.11±0.03	0.17±0.02	<0.001
Gender, male:female	42:84	89:161	0.664
Age (years), mean	83.09±7.99	82.7±9.1	0.686
Singh index, mean	3.79±0.71	3.78±0.68	0.858

When the group of patients with femoral neck fractures and the control group were analyzed in terms of gender (p=0.664), age (p=0.686) and Singh index (p=0.858) no significant differences were found between the two groups

DISCUSSION

In our study, when the groups with hip fractures were compared with the control group, no significant difference was found between the groups in terms of age, gender, and Singh index at a significance level of 0.05. This shows us that the groups are homogeneously distributed in terms of these factors and will not affect the result. The alpha angle used in the diagnosis of cam type femoral impingement was significantly higher in both the intertrochanteric femoral fracture group and the femoral neck fracture group compared to the control group. The anterior offset with anterior offset ratio used in the diagnosis were found to be significantly lower than the control group. This shows us that cam type femoral impingement is seen at a higher rate in patients with hip fractures compared to normal population in the same age group. The central edge angle used in the diagnosis of pincer type acetabular impingement was found to be significantly higher in both the intertrochanteric femoral fracture group and the femoral neck fracture group compared to the control group. The acetabular index used in the diagnosis is found to be lower than the control group. This shows us that acetabular covering is more in patients with hip fracture compared to the normal population in the same age group and a significantly higher rate of pincer type acetabular impingement is observed. We think that this situation leads to hip fracture indirectly by disrupting the biomechanics of the hip.

It is known that femoroacetabular impingement leads to the development of osteoarthritis as a result of the biomechanical change of the loads on the hip joint and its surroundings.9 In arthrosis and similar conditions, joint movements are restricted and the loads on the bone change and concentrate on certain points. Hip joint movements, especially abduction and internal rotation are restricted. This may indirectly facilitate hip fracture.

The aim of this study is to investigate whether hip biomechanics deteriorated due to femoroacetabular impingement has an effect on hip fracture formation, which causes high mortality and morbidity. Our hypothesis is that impaired hip biomechanics due to femoroacetabular impingement may increase the risk of hip fracture. This is the first study in which the relationship between cam and pincer types of femoroacetabular impingement in both hip fracture types over 65 years of age was investigated separately with the control group.

Steppacher et al.,[10] the relationship between posterior hip dislocation developing after high energy trauma and femoroacetabular impingement was investigated in the study conducted by. In the study, 53 hips of 53 patients with posterior hip dislocation after trauma and 85 hips of 44 healthy individuals were compared in terms of cam type deformity and acetabular retroversion. For this, pelvis AP and cross-table lateral radiographs were used, and alpha angle was used for cam type deformity and crossover sign, ischial spine sign, posterior wall sign, retroversion index, and anterior and posterior acetabular coverage were evaluated for the evaluation of acetabular retroversion. As a result, it was reported that cam type deformity and acetabular retroversion were significantly higher in the posterior hip dislocation group compared to the normal population. In our study, CT was also used in the measurements, and instead of the qualitative factors used in this study to determine the morphological difference, quantitative data such as the central edge angle and acetabular index for acetabular coverage, and the anterior offset with anterior offset ratio in addition to the alpha angle for cam type deformity were evaluated.

Carey et al.,[11] in a study by military personnel, the relationship between femoral neck stress fracture and femoroacetabular impingement was evaluated. Radiologic measurements of femoroacetabular impingement were performed on MRI sections of 53 patients with femoral neck stress fractures. Crossover sign was detected in 27 patients (51%). The central edge angle was measured above 40° in 25 patients (47%), and the alpha angle was evaluated above 50° in 29 patients (55%). As a result, changes in favor of femoroacetabular impingement have been reported in patients with femoral neck stress fractures. However, the lack of a control group and the small number of evaluated parameters are the limitations of the study. In our study, there was a control group with the same age group, and in addition, important parameters were evaluated in the assessment of femoroacetabular impingement, such as the acetabular index and anterior offset and anterior offset ratio.

Kuhn et al.,[12] in a study by military personnel, the relationship between acetabular retroversion and femoral neck stress fracture was investigated. Pelvis AP radiographs of 54 patients were retrospectively compared with the control group of 54 patients. Crossover sign, femoral neck anomalies and femoral neck-shaft angle were evaluated. There was a finding of crossover in 31 of the patients in the group with a femoral neck stress fracture, whe-

reas this finding was positive in 17 people in the control group. The femoral neck-shaft angle was 132 on average in the group with femoral neck stress fracture, whereas the average of this angle was 135 in the control group. In the detection of femoral neck anomaly, the femoral head-neck offset was used, and it was evaluated as positive in 7 patients in the femoral neck stress fracture group and in 6 patients in the control group. In our study, in addition to pelvis AP X-ray, pelvis CT sections were also used in order to evaluate more parameters, and acetabular index and central edge angle were used as more objective data to evaluate acetabular coverage, and alpha angle and anterior offset and anterior offset ratio were used to evaluate femoral impingement.

Busato et al.,[13] in this study, the relationship between proximal femur fracture and femoroacetabular impingement over 60 years of age was investigated. Pelvis AP and lateral radiographs of 100 patients were compared retrospectively with a control group of 66 people. Alpha angle, lateral central edge angle and Tönnis angle were evaluated. Alpha angle, lateral central edge angle and Tönnis angle were found to differ significantly in favor of femoroacetabular impingement in the group with proximal femur fracture compared to the control group. In our study, hip fracture types were compared separately with the control group, and the number of cases was higher. In addition, the measurement of anterior offset and anterior offset ratio is the plus of our study.

The retrospective planning of our study and the lack of evaluation of comorbidities other than osteoporosis are limitations of the study. The presence of a control group, the presence of a high number of patients compared to other studies in the literature, and the high sensitivity, specificity and number of the evaluated parameters are important advantages of the study. In the future, patients with a diagnosis of femoroacetabular impingement can be followed prospectively to investigate the risk of fracture development.

CONCLUSION

Our study reveals the relationship between femoroacetabular impingement and hip fracture. The correlation we have shown between femoroacetabular impingement and hip fracture can be accepted as a hypothesis for biomechanical studies. This relationship can be more clearly demonstrated in future cohort studies that are better separated according to other comorbidities and factors that may lead to fracture.

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Patient consent: There is no information of patient in the submitted manuscript.

Author contributions: Concept and design: HY, ZG, CNA; Supervision: HY, ZG, CNA; Materials: HY, ZG, CNA; Data collection and/or processing: HY, ZG, CNA; Analysis and interpretation: HY, ZG, CNA; Writing: HY, ZG, CNA

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