

**The Effect of Acetabular Retroversion on Ipsilateral Injuries During Traumatic Hip
Dislocation**

Jessica L. Koshinski BS ^a, Carly J. Deter MD ^a, C. Logan SanCraint MD ^a, Taikhoom Dahodwala
MD ^b, James E. Murphy MD MBA ^c

^a Geisinger Commonwealth School of Medicine, Scranton, PA, 18510 United States of America

^b Geisinger Musculoskeletal Institute, Danville, PA, 17822 United States of America

^c Geisinger Health System, Department of Orthopaedic Surgery, Wilkes Barre, PA, 18702 United
States of America

Corresponding Author: James E. Murphy MD MBA, 1175 E. Mountain Blvd, Wilkes Barre,
PA, 18702, E-mail: jemurphy@geisinger.edu

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ABSTRACT

Background: Determine whether native acetabular anteversion angle increased the risk of
ipsilateral limb injuries in patients with traumatic hip dislocations.

Methods: Retrospective clinical series completed at a large, tertiary health care system between
February 2016-November 2021. Patients with a native traumatic hip dislocation requiring a
closed reduction in the operating room or open reduction internal fixation (ORIF) of an

associated fracture were included, identified using current provider terminology (CPT) codes 27250 and 27252. Standard acetabular version angles were measured on CT images.

Results: 121 cases were included in the analysis. The average age of our population was 37.5 years and 72% were male. The median acetabular version was 14.7° ($2-27^{\circ}$). Of the 121 cases of dislocations, 28 experienced a knee injury (23%, $p = 0.89$) and 40 had a femoral head injury (33%, $p = 0.88$). The most common knee injuries were patellar fractures (29%, $n = 8$), tibial plateau fractures (29%, $n = 8$), meniscal injuries (25%, $n = 7$) and ligamentous knee injuries (21%, $n = 6$). Median version angle was not associated with an increase in predisposition to femoral head injury or knee injury for patients with a native hip dislocation ($p = 0.13$).

Conclusion: These findings demonstrate that native acetabular anteversion does not predispose, nor protect, patients from experiencing an ipsilateral limb injury in the setting of a traumatic hip dislocation. Future studies should investigate other factors that may influence the occurrence of ipsilateral limb injuries in these settings.

Key Words: traumatic hip dislocation, trauma, acetabular version

Level of Evidence: Level IV – Therapeutic (Retrospective Clinical Series)

MANUSCRIPT

INTRODUCTION

Traumatic hip dislocations are common injuries in orthopaedic trauma settings, accounting for 5.2% of all lower extremity dislocations.¹⁻³ These dislocations typically occur from high-energy mechanisms, such as motor vehicle accidents in younger populations and falls in older populations, with increasing incidences reported.^{1,3} This bimodal distribution tends to affect

males more commonly than females, especially in earlier years.⁴ Several studies have investigated these gender differences in hip dislocations, with findings suggesting that women tend to have a more stable hip joint that is able to withstand various forces and is less likely to dislocate with trauma because of their increased acetabular depth and smaller femoral head diameters.⁵

Aside from gender differences, individual native pelvic and acetabular anatomy may increase risk for traumatic dislocation. The femoral head sits in the acetabulum of the pelvis, within the anterior and posterior columns and is secured by fibrocartilage and ligamentous structures, including the acetabular labrum and the ligamentum teres. Additionally, the femoral head is further stabilized in the acetabulum by the gluteal muscles, which provide hip and pelvis stabilization. While these structures inherently create stability for the femoral head, if there is more coverage anteriorly or posteriorly, there may be a predisposition for the femoral head to shift in the setting of trauma. A recent study by Regenbogen et al demonstrated that acetabular retroversion and limited posterior coverage by the acetabulum were risk factors for posterior hip dislocation in high-energy trauma mechanisms.⁶ Klasan et al demonstrated an average version angle of $17.3^{\circ} \pm 4.8^{\circ}$ in their patient population, and previous studies have defined normal acetabular version angle to be between 15° - 20° .^{7,8}

The mechanism of injury and position of the hip at the time of injury are crucial to guiding work-up and treatment options. The hip can dislocate in either an anterior or posterior position depending on the direction of the force and the position of the leg at time of impact. Anterior dislocation occurs less frequently (10%) than posterior dislocation (90%) because of the amount

and direction of force required to dislodge the hip from the acetabulum.⁹ Posterior dislocations often occur in the setting of “dashboard injuries,” which are injuries occurring from excessive anterior force with the knee and hip in a flexed position, such as sitting in a car. This position allows force to travel through the femur, potentially pushing the femoral head posterior to the acetabulum, resulting in a simple posterior location of the hip.

Depending on the circumstances of dislocation, the degree of impact, as well as deceleration forces, can lead to blunt trauma injuries or fracture of the acetabulum, femoral head or femoral neck due to excessive shear forces.¹⁰ These complex dislocations require more intensive management, such as prompt surgical fixation, to prevent further injury and limit long-term functional impairments. Along with these fractures associated with posterior hip dislocation, other common injuries include knee injuries, injury to the sciatic nerve, avascular necrosis of the femoral head, labral tears and bone contusions.^{1,9,11} A recent study investigating outcomes of patients with traumatic hip dislocation found that 29% of patients had a comorbid knee injury, 27.5% sustained a sciatic nerve injury and 13% of patients experienced osteonecrosis.¹² When considering the risks of acetabular anteversion, it has been suggested that may increase the risk of ipsilateral knee injury because of the altered knee alignment in the setting of anteverted hip angle.¹³

The purpose of this investigation was to determine whether native acetabular anteversion increased the risk of ipsilateral limb injuries, such as femoral head and knee injuries, in patients with traumatic hip dislocations. We hypothesize that patients with native acetabular anteversion,

as measured on radiographic imaging, are less likely to experience ipsilateral limb injuries than patients without acetabular anteversion.

METHODS

This study was a retrospective electronic medical record review, approved by the Institutional Review Board (Geisinger, Danville, PA, USA). Patients eligible for this study were evaluated at a large, tertiary health care center, with three trauma hospitals, including Level 1 and Level 2, between February 2016-November 2021. All patients with a native traumatic hip dislocation requiring a closed reduction in the operating room or open reduction internal fixation (ORIF) of an associated fracture were identified using current provider terminology (CPT) codes 27250 and 27252.

Patients were reviewed to confirm they were not miscoded and for presence of any exclusion criteria. Exclusion criteria were patients with non-native dislocations or those with previous total hip arthroplasty (THA) of the affected limb, patients without computer tomography (CT) scans, or patients with a history of hip surgery. Additionally, patients greater than 60 years old were excluded to minimize osteophyte measurement interference.

A standard median acetabular anteversion angle measurements on the post-reduction pelvic CT scan were used to determine acetabular version.¹⁴ Axial images positioned at the level of the mid-femoral head were used. The angle formed by a single line connecting the anterior and posterior acetabular ridge and a reference line positioned perpendicular to a single line drawn between the greater sciatic notches, forming the posterior pelvic margins, were used to define the

angle of anteversion.¹⁴ For patients with injuries that interfered with this measurement, the contralateral hip was measured.

Statistics:

Mann-Whitney test done for comparison between the knee injury and femoral head injury groups. Subgroup analysis was also performed, using one standard deviation above and below our median angle.

RESULTS

A total of 121 cases of native hip dislocations were included in the analysis. The average age of our population was 37.5 years old. Male patients accounted for 72% of our cases and the average BMI of our population was 33.10 kg/m². The median acetabular version was 14.7°, ranging from 2-27°. Of the 121 cases of dislocations, 28 experienced a knee injury (23%, $p = 0.89$) and 40 had a femoral head injury (33%, $p = 0.88$). The most common knee injuries were patellar fractures (29%, $n = 8$), tibial plateau fractures (29%, $n = 8$), meniscal injuries (25%, $n = 7$) and ligamentous knee injuries 21%, $n = 6$).

In cases of dislocation without a knee injury, the median version angle was 15.3 degrees, while those cases with a concurrent knee injury had a median version angle of 14.5 degrees. For cases without a femoral head injury, median version angle was 15.3 degrees and those that sustained a femoral head injury had a median version angle of 14.3 degrees. Our subgroup analysis used a range one standard deviation above and below our measured median version angle, making the high version angle greater than 18.6 degrees and the low version angle less than 9.7 degrees. Median version angle was not associated with an increase in predisposition to femoral head

injury for patients with a native hip dislocation ($p = 0.13$). An association between median version angle and knee injury in patients with native hip dislocation was not seen ($p > 0.99$).

DISCUSSION

Our study investigated the incidence of ipsilateral knee injuries and femoral head injuries in cases of traumatic hip dislocations to understand the potential role of acetabular morphology in predisposing patients to these injuries. We found 23% of patients experienced an ipsilateral knee injury and 33% experienced an ipsilateral femoral head injury. We did not find any significant associations with risk or protective factors of femoral head or knee injuries in patients with increased or decreased acetabular version angles. Given the anatomic proximity of the femoral head and the anatomic association of the hip and knee, it is important to understand potential predispositions to these injuries in cases of traumatic hip dislocations to guide work-up and treatment, while preventing delayed treatment of comorbid injuries.

Our patient cohort was predominantly male, which was discussed previously and coincides with previous literature regarding gender predisposition to traumatic hip dislocation.⁴ Our study findings of 23% of patients sustaining an ipsilateral knee injury with native hip dislocation was also consistent with previous studies. One study reported that 25% of patients treated at their institution for a hip fracture or dislocation experienced a knee injury.¹⁵ Other studies have reported rates of 25-40%, describing the most common knee injuries as effusions, bone contusions, meniscal tears and ligamentous injuries.^{16,17} Our most common knee injuries were patellar fractures, tibial plateau fractures, meniscal and ligamentous injuries, which is similar to these previous findings.

Comorbid knee injuries in patients with traumatic posterior hip dislocation often occurs in the setting of trauma that dislocated the hip, such as a motor vehicle accident causing patellar or ligamentous injury from direct trauma. Our findings of patellar fractures and ligamentous injury are consistent with the blunt force associated with dashboard injuries, where a large axial force is exerted on the knee as both the knee and hip are in flexion. Femoral head injuries were more common, occurring in 33% of cases, which is higher than previously reported studies 6.5% to 15%.^{18,19} Femoral head injuries, specifically fractures, occurs from the shearing force of the femoral head on the posterior wall of the acetabulum as it exits its anatomic position in the setting of high-energy trauma along the femoral axis.²⁰

Few studies have investigated the role of acetabular version angles on predisposition risks to femoral head and knee injuries in the setting of traumatic posterior hip fractures. Some studies have reported that femoral anteversion and decreased posterior coverage of the acetabulum predisposed patients to traumatic posterior hip dislocation, with one study also suggesting that in these cases, posterior hip serves to prevent injuries to the femoral shaft, knee or tibia.^{21,22}

However, given the clinical acuity of hip dislocation and need for reduction, evaluation for concurrent knee or femoral head injuries may be limited. Interestingly, Tabuenca et al found that seven patients had ligamentous injury at the time of location, but were overlooked during initial examination, given the immediate concern to reduce the traumatic hip dislocation.¹⁵ Completing a thorough examination of the bilateral lower extremities in the setting of hip dislocation is essential to prevent early closure and subsequent delayed treatment for these patients.

There are limitations of this study that need to be considered. This was a retrospective chart review, meaning that documentation in the electronic medical record may have been incomplete or missing. Another is that these cases were from a single health system, serving a rural part of the Mid-Atlantic United States with a relatively homogenous population, which may limit the external validity of these findings. To limit measurement bias, three different authors reviewed and measured acetabular version; however, in cases where the injured hip distorted the native acetabular version, the contralateral hip was measured, which may have impacted version measurements. Additionally, cases of traumatic hip dislocation that were reduced in the emergency room without admission were excluded from the study, which may introduce selection bias in our study sample.

Our findings demonstrate that the degree of native acetabular version during traumatic hip dislocation, does not predispose, nor protect, the patient from associated femoral head or knee injuries. This suggests that mechanism of injury and or other factors may play a more significant role in predicting predispositions to these injuries in the setting of traumatic hip dislocation.

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JLK– Data curation, formal analysis, writing-original draft, writing-review and editing

CJD – Data curation, writing-original draft, writing-review and editing

CLS- Data curation, writing-original draft, writing-review and editing

TD- Data curation, formal analysis, writing-original draft, writing-review and editing

JEM- Conceptualization, Formal analysis, investigation, supervision, writing-original draft, writing-review and editing

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