The Windshield Wiper Sign: A Radiographic Finding of Hip Instability

N.G. Girardi BA[1], J. Lee MD[1], M.J. Kraeutler MD[1], M.K. Jesse MD[1], J. Genuario MD[1], O. Mei-Dan MD[1]

[1]University of Colorado Anschutz Medical Campus, Aurora, CO

Introduction

The pathogenesis of hip instability is multifactorial and often results in significant functional debilitation.[1,2] Beginning with deficiency of bony and/or soft tissue stabilizers, instability is characterized by excessive femoral head movement in relation to the socket, which elevates the risk for intraarticular injury and early onset osteoarthritis.[1,2] Multiple variables can contribute to hip instability including deficient acetabular coverage of the femoral head, femoral antetorsion, disruption of the labral suction seal, and/or soft tissue laxity.[1,2,3] Markers of hip instability can aid surgeons in the decision-making process for patients whose primary hip pathology is unclear. However, there are few independently reliable diagnostic measures.

Purpose

The purpose of this study was to introduce a new radiographic sign of hip instability that often results in acetabular suction seal disruption in the native hip, coined the "windshield wiper" (WSW) sign.

Methods

A retrospective review was performed of patients who underwent or had a scheduled periacetabular osteotomy (PAO) with the senior author between March 2021 and September 2023. All patients with the characteristic radiographic WSW sign in a native hip were identified and included in the analysis. A WSW sign was identified radiographically on plain films as a concave or flat osteochondral defect on anterolateral femoral head extending medial to the head-neck-junction with resultant loss of femoral head sphericity (Figure 1). All patients underwent arthroscopy prior to PAO to address intra-articular pathology, as well as other indicated procedures. The osteochondral defect and resultant suction seal disruption were verified during arthroscopy (Figure 2).

Patho-Mechanism

We theorize the patho-mechansim of the WSW sign begins with superolateral subluxation of the femoral head due to instability, resulting in chronic friction stress between the hip joint capsule and femoral head. We coined this the WSW sign, because with chronic instability, the capsule wipes back and forth over the femoral head/neck, as the head moves internally and externally in the subluxated position, like a windshield wiper, resulting in chronic attrition of the osteochondral surface (Figure 3).

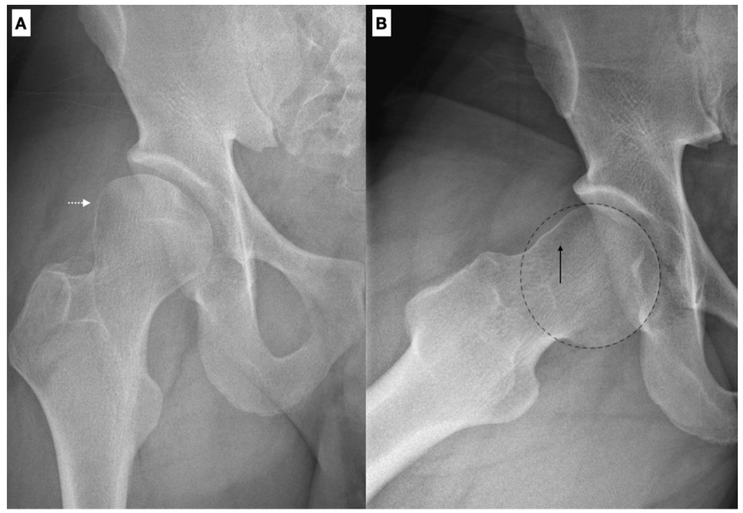

Figure 1. Preoperative anteroposterior (AP) and frog leg lateral radiographs demonstrating a WSW sign of the right hip in a patient with no prior surgical history. A) AP radiograph with a white arrow pointing toward a flattened area over the anterolateral femoral head. B) Frog leg lateral radiograph demonstrating a localized linear flattening of the anterolateral femoral head-neck junction resulting in a focal divergence from the normal femoral head sphericity (black arrow).

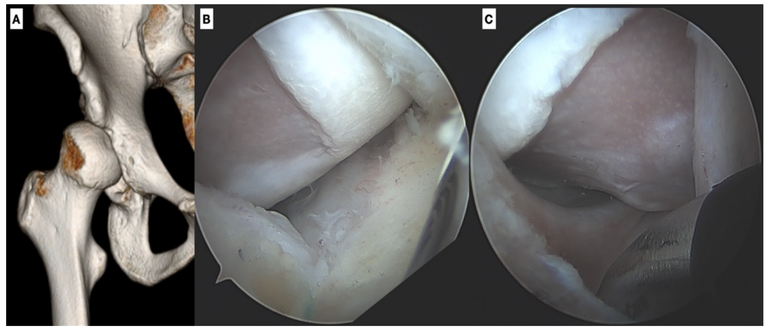

Figure 2. Images showing a right hip WSW sign in a patient with no prior surgical history. A) 3D computed tomography (CT) reconstruction of the right hip demonstrating the extent and location of the WSW sign defect. B) Arthroscopic image corresponding with the same lesion seen on 3D CT. C) Arthroscopic image in extension, off traction, demonstrating the compromise of the labral suction seal with gapping between the labrum and femoral head.

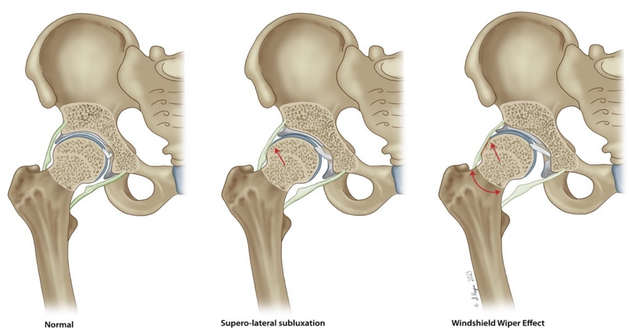

Figure 3. The patho-mechanism behind a WSW sign. The windshield wiper effect is thought to be created by longstanding hip laxity with abnormal superolateral subluxation and subsequent chronic capsular friction stress against the femoral head.

Results

The WSW sign was identified in 22 hips (17 patients), with a prevalence of 8.5% of PAO patients reviewed. Each patient with a WSW sign had severe symptomatic hip instability. Descriptive statistics and mean radiographic measures for the WSW cohort are displayed in tables 1 and 2, respectively. Fourteen hips (63.6%) had frank dysplasia, 6 (27.3%) had borderline dysplasia, and 2 (9.1%) had a normal acetabular coverage. Of the hips identified, 17 had undergone surgical management. Of this cohort, 3 (17.6%) required labral reconstruction and the rest underwent labral repair during arthroscopy. Femoroplasty and capsular plication were performed in all 17 hips. Every patient with a WSW sign had arthroscopic confirmation of a dysfunctional labral suction seal.

Table 1

Variable (N=17)	Value
Average Age (±SD), yrs	31.2 (±9.14)
Sex (Male/Female)	7/10
% with bilateral WSW sign	27.8% (n=5)
% With Joint Hypermobility	55.6% (n=10)
Average BMI (±SD), kg/m^2	23.1 (±3.52)

Table 2

Measure	Mean Value (±SD); [Range]
Sourcil Angle	13.9° (±5.6°); [0°]- [28°]
Lateral Center Edge Angle	14.9° (±8.8°); [-4°]- [28°]
Alpha Angle	58.8° (±8.8°); [44°]- [82°]
Femoral Torsion	27.9° (±18.8°); [-8°]- [69°]
Acetabular Version	24.3° (±7.1°); [15°]- [47°]

Conclusions

The WSW sign is an uncommon radiographic finding in patients with severe hip instability. When identified, it is highly predictive of significant instability which may be of value for patient prognosis and counseling as well as preoperative evaluation, diagnosis, and surgical planning, especially in cases which are otherwise considered borderline dysplasia or normal based on lateral center edge angle.

References

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