Abstract Title:
Characterizing Radiographic Hip Anatomy and Relationship to Hip Range of Motion and Symptoms in National Hockey League (NHL) Players

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Objectives: The objective of this study was to characterize the radiographic proximal femoral and acetabular anatomy for professional (NHL) hockey players, and to correlate with objective assessments of hip range-of-motion and current or prior hip symptoms / surgery.

Methods: One hundred and eighteen hips in 59 professional hockey players with one NHL organization (mean age 24.2, range 18-36) underwent a history and physician examination by two independent orthopedic surgeons for direct flexion, adduction, abduction in extension and flexion, and internal and external rotation at 90 degrees of flexion. A history of current or previous groin / hip pain or prior hip and/or core muscle surgery was noted. Well-positioned anteroposterior (AP) pelvis and bilateral Dunn lateral radiographs were obtained for all players with measurements performed independently by two-fellowship trained, hip preservation surgeons to assess acetabular and proximal femoral morphology. Statistical analysis was performed with linear regression models, Pearson and Spearman correlations, as well as intra-class correlation coefficients to assess inter-rater reliability, with p<0.05 defined as significant.

Results: Good to Very Good reliability of radiographic assessments were revealed (ICC = .749 - .958, p<.01). With regards to acetabular retroversion, 64% of the athletes had a positive-crossover sign (COS), while 86% and 60% had a positive posterior wall (PWS) and prominent ischial spine sign (ISS), respectively. Mean lateral center edge angle (LCEA) was 28.3 ± 4.6°, and mean Tonnis angle 7.0° ± 4.1°. 18% of hips demonstrated borderline dysplasia (LCEA 20°-25°) and 3% frank dysplasia (LCEA<20°). Femoral head asphericity as assessed by AP and lateral alpha angles was 52.2° ± 11.2° and 61.0° ± 10.1°, respectively. Both the mean AP and lateral head-neck offset ratio was 0.14 ± 0.02. 85% and 89% of hips demonstrated cam-type proximal femoral morphology based on increased alpha angle and reduced head-neck offset respectively. Very good reliability was confirmed for all ROM assessment (ICC > 0.80) with the exception of direct adduction, which demonstrated good reliability (ICC = 0.69). Mean hip flexion was 107.4±6.7, abduction and adduction 37.6±8.7 and 20.5±5.2 respectively, and IR and ER in 90 degrees of flexion 26.1±6.6 and 44.2±8.6 respectively. 31.4% percent of hips had current or prior history of hip related pain / surgery. Higher AP, lateral, and maximal alpha angles all correlated with decreased hip internal rotation (p=0.004). Greater AP alpha angle correlated with decreased hip extension /abduction (p=0.025), and
greater lateral and maximal alpha angle correlated with decreased hip flexion / abduction (p=0.001). Acetabular parameters (LCE, COS, ISS, Tonnis angle) did not correlate with hip ROM. Decreased hip ER correlated with an increased risk for current or prior hip related pain / surgery (p < 0.001).

**Conclusion:** Hip anatomy in NHL hockey players is characterized by highly prevalent cam-type morphology (>85%) and acetabular retroversion (> 60%). In addition, dysplasia (21%) was relatively common. Greater cam type morphology (higher alpha angle) correlated with decreased hip IR, Ext / ABD, and Flex / ABD ROM, whereas acetabular parameters did not correlate with hip ROM. Only decreased hip ER was predictive of hip related pain / surgery.