Influence of Acetabular Coverage on Pre- and Post-Operative Patient Reported Outcomes for Hip Arthroscopy

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INTRODUCTION: Acetabular coverage of the femoral head is an important anatomic parameter that has implications on the diagnostic work-up and subsequent surgical indications for patients with femoroacetabular impingement syndrome (FAIS). As such, there is significant interest in further exploration on the role of acetabular coverage in relation to symptom development and post-operative improvement. The use of three-dimensional (3D) models to assess acetabular coverage provides a more accurate and robust mechanism to assess the hip joint. Beyond investigating morphological aspects of the hip joint, there is little data, if any, regarding correlations between acetabular coverage and patient-reported outcomes (PROs). PROs have become important metrics to evaluate success and satisfaction in surgical treatments and can also be used to inform healthcare decision-making. The purpose of this study was to utilize 3D models to assess the role of acetabular coverage on pre- and post-operative functional status and outcomes for patients undergoing hip arthroscopy.

METHODS: Twenty patients (15F/5M, age range 16-60, mean 33 y.o.) who underwent hip arthroscopy for FAIS between 12/2018 – 1/2022 were identified within a prospectively maintained repository that is IRB approved. 3D models of the femur and pelvis were generated from preoperative 1.5T Flash-Dixon sequence magnetic resonance imaging scans (Materialise Mimics v. 25.0, Leuven, Belgium) using well-established methodology [1]. Acetabular coverage was measured by projecting the acetabular rim onto the superior surface of the femoral head following a previously presented method [2] (**Fig. 1**). The superior surface of the femoral head was divided into quadrants based on bony landmarks. Percent coverage was collected globally, by anterior and posterior halves as well as by quadrant using a commercially available CAD program (Materialise 3-matic v. 17.0, Leuven, Belgium). PROs including Hip Outcome Score-Activities of Daily Living (HOS-ADL), HOS-Sports Subscale (HOS-SS), international Hip Outcome Tool - 12 item questionnaire (iHOT-12), and modified Harris Hip Score (mHHS) were collected pre-operatively and at 2 years post-operatively. Unpaired t-tests were used to compare pre-operative to post-operative PROs. Pearson correlations were performed to assess the relationship between acetabular coverage and PROs. Significance level was set at $p < 0.05$.

RESULTS: The relationships between coverage patterns and pre/post-operative PROs are outlined in **Table 1**. Anterior coverage was negatively correlated with preoperative HOS-ADL ($r = -0.647$, $p = 0.009$) and HOS-SS ($r = -0.568$, $p = 0.034$). This was driven primarily by anteromedial coverage, which was also negatively correlated with HOS-ADL ($r = -0.546$, $p = 0.035$) and HOS-SS ($r = -0.571$, $p = -0.033$). Posterior coverage was positively correlated with preoperative HOS-SS ($r = 0.583$, $p = 0.029$) and mHHS ($r = 0.578$, $p = 0.049$). This was driven primarily by posterolateral coverage, which was also positively correlated with HOS-SS ($r = 0.582$, $p = 0.029$) and mHHS ($r = 0.578$, $p = 0.049$). Postoperatively, there was no statistically significant correlation between PROs and acetabular coverage ($-0.010 \leq r \leq 0.033$, $0.418 \leq p \leq 0.971$, for all). All measured PROs showed improvement after surgical intervention, regardless of the preoperative coverage configuration. These preoperative to postoperative comparisons with their p values are as follows: HOS-ADL: 60.8 ± 14.9 vs. 87.2 ± 13.0, $p < 0.001$; HOS-SS: 38.1 ± 19.6 vs. 74.1 ± 29.8, $p < 0.001$; mHHS: 59.1 ± 14.0 vs. 77.0 ± 15.4, $p = 0.002$, and iHOT12: 36.4 ± 18.4 vs. 64.5 ± 30.8, $p < 0.001$, respectively.

DISCUSSION: Identifying the cause of a patient's hip pain can be a nebulous pursuit, where referred pain from pathology at the sacrum, lower back, or abdomen is commonly the culprit. Even within FAIS, several issues at the joint can contribute to symptoms, each managed with particular surgical interventions. The results of our study highlight the role of anterior over coverage of the femoral head as a cause of impingement and posterior under coverage leading to hip joint instability. We demonstrated that these morphologies alter one's ability to engage in daily and recreational activities. Because impingement can be treated with femoroplasty and instability can be improved with capsular plication, surgeons have options on how to best address these variations in acetabular coverage. As demonstrated by the improvement in postoperative PROs, the use of the well-indicated surgical intervention can facilitate significant improvement in patient pain and function.

SIGNIFICANCE/CLINICAL RELEVANCE: Preoperative 3D models of femur and pelvis provide a means to identify the specific causes for hip pain in a patient. This can guide a practitioner's surgical approach to ensure clinical improvement and better quality of life for a patient.

REFERENCES: [1] Malloy P, *et al*. J Orthop Res. 2020 Sep. 38(9): 2050-2056. [2] Larson JH *et al*., Proceedings ORS Annual Meeting vol. 48:1580

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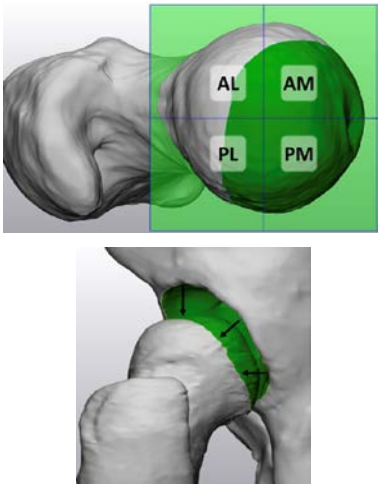

Figure 1: Top 3D model of acetabular coverage split by quadrant. Bottom: projection of the acetabular surface onto the femoral head.

Pre-Operative PROs vs Coverage

	Global	Anterior	Posterior	AM	AL	PM	PL
HOS-ADL							
r	-0.22	-0.65	0.39	-0.55	-0.50	N/A	0.39
p	0.435	**0.009**	0.152	**0.035**	0.057	N/A	0.152
HOS-SS							
r	-0.01	-0.57	0.58	-0.57	-0.33	N/A	0.58
p	0.976	**0.034**	**0.029**	**0.033**	0.252	N/A	**0.029**
mHHS							
r	0.10	-0.39	0.58	-0.54	-0.08	N/A	0.58
p	0.750	0.224	**0.049**	0.067	0.803	N/A	**0.049**
iHOT-12							
r	0.09	-0.24	0.43	-0.36	-0.05	N/A	0.43
p	0.738	0.382	0.108	0.191	0.844	N/A	0.099

Post-Operative PROs vs Coverage

	Global	Anterior	Posterior	AM	AL	PM	PL
HOS-ADL							
r	-0.01	-0.08	0.08	0.08	-0.20	N/A	-0.01
p	0.971	0.791	0.803	0.787	0.505	N/A	0.803
HOS-SS							
r	0.08	-0.05	0.08	0.20	-0.10	N/A	-0.02
p	0.789	0.867	0.970	0.515	0.746	N/A	0.805
mHHS							
r	0.18	0.30	-0.02	0.16	0.33	N/A	0.08
p	0.669	0.474	0.983	0.970	0.418	N/A	0.970
iHOT-12							
r	-0.06	-0.08	-0.01	0.09	-0.21	N/A	0.08
p	0.840	0.790	0.983	0.983	0.482	N/A	0.983

Table 1: Correlation coefficients and *p*-values demonstrating associations between coverage and pre/post-operative PROs. Red shows negative correlations, while blue depicts positive correlations.