Early Post-operative Improvement in Biomechanical Function following Total Hip Arthroplasty is Predicted by Muscle Quality Adjacent to the Affected Joint

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INTRODUCTION: While total hip arthroplasty (THA) alleviates pain by replacing the affected joint, biomechanical recovery is complex. Identifying pre-operative predictors for post-operative biomechanical recovery would inform patient-specific care plans for optimizing long-term functional outcomes. Diminished hip muscle quality (higher fat infiltration) can coincide with advanced hip osteoarthritis and may be a risk factor for poor post-operative biomechanical recovery following THA. We assessed pre-operative hip muscle quality and joint degeneration using advanced MRI sequences and associated with patient-specific changes in kinematic movement quality at 6-weeks following THA. We hypothesized that patients with better hip muscle quality (less fat infiltration) would have greater biomechanical improvement at early post-operative timepoints. Better muscle quality and faster post-operative biomechanical improvement may associate with better long-term outcomes.

METHODS: Adults undergoing primary THA at our institution were recruited (Figure 1). Preoperative MRI was obtained and evaluated via Scoring Hip Osteoarthritis with MRI Scores (SHOMRI), a comprehensive measure of joint degeneration (Lee, 2015). Muscle quality of gluteus medius, gluteus minimus, and tensor fascia lata (TFL) were assessed by measuring fat fraction (FF) from advanced water-fat sequences. Biomechanics were assessed preoperatively and at six weeks postoperatively during a staggered stance sit-to-stand using the Kinematic Deviation Index (KDI), a biomechanical outcome metric of movement quality derived from three-dimensional posture analysis (Halvorson, 2022). Symptomatic improvement was assessed using the Hip Osteoarthritis and Outcome Score (HOOS). Spearman's rho assesses correlations as negligible (0.00-0.20), weak (0.21-0.40), moderate (0.41-0.60), strong (0.61-0.80), or very strong (0.81-1.00).

RESULTS: Ten adults (5M, 5F) were recruited (average age: 60.1, BMI: 23.79, SHOMRI: 40.6, KDI: 2.96). Nine underwent a direct anterior approach and one a posterior approach (Table 1). Patient symptoms significantly improved following surgery (mean HOOS difference 7.8, p < 0.001, Figure 2). There was a trend towards improved biomechanics postoperatively, but this was not observed in all patients (mean KDI improvement 0.81, p = 0.22). Preoperatively, better biomechanical function was very strongly correlated with lower gluteus medius FF (rho=0.89), strongly correlated with lower gluteus minimus FF (rho=0.75) and TFL FF (rho=0.70), and weakly correlated with SHOMRI (rho=0.29). At six weeks, greater biomechanical improvement (change in KDI) was strongly correlated with lower minimus FF (rho=0.63), moderately correlated with medius FF (rho=0.59), and weakly correlated with TFL FF (rho=0.26) and SHOMRI (rho=0.39). Lastly, medius FF was moderately correlated with SHOMRI (rho=0.42) with negligible correlations between SHOMRI and FF in the minimus and TFL. Symptomatic improvement (HOOS) was also correlated with medius (rho=.39), minimus (rho=.32), and TFL (rho=.20) FF.

DISCUSSION: These findings suggest adjacent muscle quality may be a key predictor of early postoperative function, as well as symptomatic improvement, following THA. While all patients experienced symptomatic improvement by six weeks, not all patients had experienced biomechanical improvement. Future work will examine relationships between muscle quality and long-term biomechanical recovery.

SIGNIFICANCE/CLINICAL RELEVANCE: Understanding how preoperative hip muscle quality may affect postoperative recovery may support specialized rehabilitation or regeneration therapy to improve outcomes.

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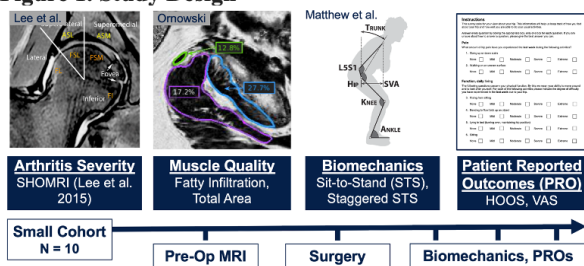
Figure 1. Study Design

Figure 2. Change in Patient Symptoms and Biomechanics from Preoperatively to Six Weeks Postoperatively
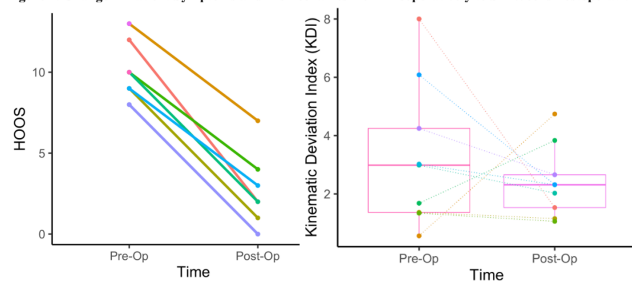
Table 1. Patient Demographics and Baseline Muscle Quality

Demographics		Fatty Infiltration (FI) and Area	
	N (%)	**Muscle**	
Sex	5 M, 5 F	**Medius**	14.3% FI
Age	60.1 years		33915.8 cm^2
BMI	23.79 kg/m2	**Minimus**	20.4% FI
Approach	9 DA 1 Posterior		10781.2 cm^2
		TFL	12.3% FI
			2261.6 cm^2