Preoperative Gait Variables and Harris Hip Scores Predict Clinical Recovery After Total Hip Replacement

Kharma Foucher, MD, PhD.
University of Illinois at Chicago, Chicago, IL, USA.

Disclosures:
K. Foucher: None.

Introduction: Patient satisfaction after total hip replacement (THR) surgery is strongly determined by the extent to which preoperative expectations are met. Clinicians can modify patient expectations through preoperative education, but their ability to do so accurately is limited by our incomplete understanding of the factors that can predict and/or influence THR outcomes. Preoperative clinical scores and some sociodemographic patient characteristics (e.g. age, sex, income) have been associated with THR outcomes, but it is not yet clear how this knowledge should be used. Moreover, these predictors cannot easily be modified in order to improve the likelihood of a good response. Objective preoperative predictors of THR outcomes, that could also suggest better interventions to improve outcomes, are still needed. Gait analysis can be used to objectively characterize patient function before or after THR, and could also point to specific, modifiable advantages or deficits that could be associated with a good or poor outcome. The goal of this study was to evaluate the relationship between preoperative gait and THR clinical outcomes. The two hypotheses tested were (1) that preoperative gait variables can predict postoperative improvement in clinical scores, and (2) that clinical improvement can be better predicted by preoperative gait variables and clinical scores, than by preoperative clinical scores alone.

Methods: An IRB-approved data repository was used to identify subjects who had participated in gait analysis studies before undergoing primary unilateral THR. Subjects were included if both preoperative gait data and pre- and 1-year postoperative clinical data were available in the repository. Gait analysis was conducted using standard published methods. Sagittal plane dynamic range of motion (peak flexion-peak extension during walking), and peak external moments in the sagittal, frontal, and transverse planes, averaged from trials collected at each subject’s self-selected normal walking speed, were of interest here. The Harris Hip Score (HHS) was administered at the time of each gait evaluation to characterize clinical status. Pre-to-post change in HHS (ΔHHS) was calculated to represent postoperative clinical recovery. Linear regression analysis was used to identify predictors of ΔHHS. Preoperative HHS, age, BMI, and the gait variables listed above were considered predictor variables. Sex was included as a dummy variable (female=1). To test the first hypothesis, forward and backwards regression procedures were used to determine whether any statistically significant models could be identified using preoperative gait variables but excluding preoperative HHS terms from the analyses. The second hypothesis was tested in two steps. The first step was to identify the best model in which only preoperative HHS, age, sex, and BMI were considered. Next, forward and backwards regression procedures were used to determine whether or not any gait variables could be added to the model and significantly improve the prediction of ΔHHS.

Results: 128 subjects satisfied inclusion/exclusion criteria (Age 61 ± 11 yrs; BMI 29 ± 5; 66 women). As a group, patients experienced significant clinical improvement after THR (preoperative HHS = 57 ± 14, range 32-69; postoperative HHS = 92 ± 11, range 46-100) but individual ΔHHS varied considerably. The first hypothesis was supported, as gait variables alone were able to predict ΔHHS in two regression models: i. ΔHHS = 52.523 - 1.080 Range of motion (R²=0.162, p<0.001); ii. ΔHHS = 30.112 + 34.637 Sex - 1.137 Range of motion + 6.071 Adduction moment - 9.042 Adduction moment x Sex (R²=0.266, p<0.001).

Notably, higher preoperative hip adduction moments were associated with more HHS improvement in HHS in men, but with less HHS improvement in women (Figure 1.) The best regression model that included preoperative HHS but excluded gait variables was: iii. ΔHHS = 89.693 - 0.746 Preoperative HHS - 0.379 BMI + 17.414 Sex - 0.372 Preoperative HHS x Sex (R²=0.605, p<0.001). Two gait variables were added to this model during forward stepwise regression:
iv. ΔHHS = 92.791 - 0.663 Preoperative HHS - 0.423 BMI + 17.285 Sex - 0.435 PreopHHS x Sex - 0.451 Range of motion +18.848 Internal rotation moment x Sex (R²= 0.635, p < 0.001).

The contribution of each these variables was statistically significant based on partial Ftests (p = 0.034, p = 0.033), thus the second hypothesis was also supported.

Discussion: The most important new finding of this study was that preoperative gait variables alone predicted 16 to 27% of the
variation in postoperative change in HHS. Including gait variables, in regression models, significantly improved the predictive ability of preoperative HHS to predict HHS improvement. While this increase was small, the understanding of specific biomechanical factors that are associated with THR prognosis could be useful clinically. Lower preoperative HHS (as expected) and lower range of motion were associated with more postoperative improvement in HHS. However, results suggested that there are different associations between dynamic hip abductor function and clinical recovery in men and women. It is important to note that the regression strategies used here were not designed to identify the absolute best set of predictors among all considered, and that a causal relationship between preoperative status and clinical improvement cannot be inferred from these results or this study design. More detailed longitudinal studies are needed to validate these predictions. Despite these limitations, this study demonstrates that preoperative function, as measured objectively through gait analysis, is associated with clinical outcomes of THR, and suggests avenues through which altering preoperative gait mechanics could improve postoperative recovery. A better understanding of the sex differences in the relationship between gait and clinical outcomes may also be helpful in reducing gender disparities in THR utilization and outcomes.6

Significance: As the demand for total hip replacement increases, patients and surgeons are in need of better tools to help predict and improve surgical outcomes. Gait analysis may provide an objective way to improve outcomes predictions, help determine appropriateness for surgery, and point to beneficial new perioperative physical interventions.

Acknowledgments: Gary Farkas, Robert Trombley, Markus Wimmer. Rush University Medical Center Motion Analysis Laboratory


Figure 1. Higher preoperative hip adduction moments during gait were associated with more HHS improvement in men, but less in women (p=0.001).