Structured Abstract:

INTRODUCTION: Diverse wearable sensor technology presents an exciting opportunity for applications in the clinical world for more intelligent and individualized assessment of patients. The timed-up-and-go (TUG) test is a functional test that has been previously demonstrated to be an appropriate clinical tool to assess patient function after total knee replacement (TKR) while only collecting the time to complete the test. With the use of novel wearable sensor technology, we can identify quantitative metrics within the TUG test that may provide insight into the mechanics of patient function post-TKR. We hypothesize that sensor-derived metrics quantifying time segments of specific tasks within the TUG test will significantly correlate with functional patient-reported outcome measures (PROMs).

METHODS: Data were collected for n=33 TKR patients (M/F: 14/19) at 1- or 2-year post-op appointments. Participants completed outcome questionnaires including: SF-12, WOMAC, KSS, and UCLA Activity Score. Subjects were affixed with four inertial measurement units, with one proximal and one distal to the knee joint on the anterior side of both legs. Subjects then underwent a TUG test in which they stood up from a chair, walked 3 meters to a measured goal, turned around, walked back, and sat back down in the chair. Time segments from the tasks within the TUG tests could be obtained from the sensor orientations (ie. total-test, sit-stand, walk-to-goal, turn-at-goal, walk-to-chair, stand-sit). GraphPad Prism 7.00 software was used to obtain Pearson correlations and P values.

RESULTS: Significant correlations were observed between sensor metrics and functional PROMs (SF-12 Physical, WOMAC Function, UCLA Activity, KSS Function), where shorter durations were associated with improved outcome scores. These correlations to the patient reported measures were found for total-test (r>0.49, p<0.01), walk-to-goal (r>0.52, p<0.002), turn-at-goal (r>0.52, p<0.002), and walk-to-chair time segments (r>0.37, p<0.05), but not for the sit-stand or stand-sit sensor time segments.

DISCUSSION: While the sensor-derived total-test, walk-to-goal, turn-at-goal, and walk-to-chair time segments all significantly correlated to functional PROMs, the sit-stand and stand-sit time segments did not. Greater correlations with functional PROMs were observed in the walk-to-goal and turn-at-goal time segments than the TUG total-test time. This highlights the potential for more quantitative metrics derived from wearable sensors than the presently reported total-test time. While only temporal parameters were extracted from these quantitative TUG test data for this report, these novel sensor techniques may provide additional insight into patient function through the identification of gait- or flexion-based parameters. In the future, we will determine the merit of gait- and flexion-based parameters derived from the quantitative TUG test to provide a more complete picture of function in TKR patients.