Patient Characteristics and Pre-Operative Gait Speed as Useful Factors to Separate Recovery Curves Generated by a Smart Implant

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INTRODUCTION:

Patients desire feedback to benchmark their recovery progress following joint arthroplasty procedures, requiring creation of similar cohorts of patients for accurate comparisons. Technological advances including smartphones and implantable sensors within the tibial stem that utilize accelerometers and gyroscopes for passive collection of data have the potential to give insight into a patient's progress following total knee arthroplasty (TKA). This analysis aimed to determine which patient characteristics can be used to separate recovery curves generated by the sensors within a tibial stem extension implanted during TKA.

METHODS:

Anonymized data from a commercial database were analyzed to investigate the ability to separate 2,472 patients into cohorts based on age, sex, body mass index (BMI, kg/m2), and pre-operative gait speed, as well as combinations of these factors. Gait metrics collected through 60-days post-operative by the tibial stem extension included knee range of motion (ROM), tibial ROM, cadence, gait speed, stride length, step counts, and average distance. Separation of these metrics by cohorts was measured by Kolmogorov-Smirnov test to investigate which defined cohorts could be best used to stratify patient recovery curves.

RESULTS:

Considering average knee ROM, the most impactful single cohort factor was sex, with the age/sex as the strongest cohort pair to separate ROM recovery over time ($p < 0.001$) and was not affected by the addition of pre-operative gait speed. Tibial ROM was well stratified by sex and BMI as separate factors for cohort creation, with age/sex pairing as the strongest significant cohort definer. Cohort pairs using sex/BMI and sex/age conferred similar results to separate cadence over time, however, were not significant for comparisons at most timepoints evaluated. Post-operative gait speed and stride length were both easily separated by all cohort factors alone, as well as all pairings ($p < 0.001$), with pre-operative gait speed providing a stronger impact than any other characteristic. Pre-operative gait speed was also the most impactful factor in separation of patients into cohorts considering recovery curves for cadence, step counts, and average distance walked.

DISCUSSION AND CONCLUSION:

Patient gait recovery curves can be stratified based on demographic variables, which is strengthened by the addition of pre-operative gait speed considering post-operative cadence, gait speed, stride length, step counts, and average distance walked. Importantly, this analysis demonstrates the feasibility of collecting data from wearable devices in tandem with implanted sensors to better evaluate recovery following TKA, which may allow for improved patient progress feedback to clinicians and patients.