Objective Assessment of Functional Recovery after Hip Preservation Surgery: Use of a novel cell-phone application to collect gait metrics

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INTRODUCTION: Objective assessment of functional recovery after orthopaedic surgery can be challenging. Traditional methods rely on patient-reported outcome measures (PROMs) which are subject to recall bias, irregular collection, limitations in capturing daily functional changes, and ceiling effects limiting their validity.[1-3] Passively collected smart phone data may have the potential surpass these limitations and offer a more detailed, accurate, and descriptive picture of functional recovery after surgery. The Apple® Health App is a validated tool that passively collects step count, walking speed, step length, double support percentage, and asymmetry percentage—providing a potentially innovative approach to objectively measure postoperative recovery.[4, 5] The aim of this study was to evaluate recovery across these gait metrics following hip preservation surgery and define timelines for return to baseline activity.

METHODS: This study was approved by the IRB. Adolescents and young adults (aged 10-25 years old) that underwent hip preservation surgery (hip arthroscopy, periacetabular osteotomy (PAO), and/or femoral osteotomy) to treat femoroacetabular impingement (FAI) and/or hip dysplasia were enrolled in this study and signed an informed consent. Subjects were eligible if they had a personal smart phone capable of downloading applications and were familiar with using phone-based applications. A custom smartphone app was developed and made available on the iTunes App Store for IOS devices. The subjects downloaded the app, created a profile, and granted the app permission to access their Apple® Health data from a range of one month preoperatively to six months postoperatively. Within the cohort, five gait metrics were analyzed: step count, walking speed, step length, double support percentage, and asymmetry percentage. Baseline values were defined as the median of data collected between 30 and 15 days prior to surgery. Postoperative values were summarized in 2-week intervals up to 6 months after surgery. Return to baseline was defined as the first time the postoperative median value was greater than or equal to baseline for step count, walking speed, and step length, or less than or equal to baseline for double support percentage and asymmetry percentage, where lower values indicate improvement. Recovery trajectories and the proportion of patients returning to baseline over time were evaluated for each metric. Data are presented as median (Q1 - Q3) for numeric variables due to skewed and/or non-normal distributions, and as count (%) for categorical variables. All statistical analyses were performed using R version 4.5.0.

RESULTS: Sixty participants were enrolled in the study. For patients undergoing only hip arthroscopy (n=18), over 50% of patients had returned to baseline for step count by postoperative week 10. By postoperative week 14, over 50% of patients had returned to baseline for walking step length. Asymmetry percentage reached 50% return to baseline by postoperative week 16, while double support percentage and walking speed reached this threshold by postoperative week 18. By 6 months (week 26) postoperatively, all five metrics had reached their maximum observed rates of return to baseline: 88.9% for step count (week 24), 72.2% for walking step length (week 24), 64.7% for double support percentage (week 24), 76.5% for walking speed (week 24), and 64.7% for asymmetry (week 18). For patients undergoing PAO +/- hip arthroscopy (n=34), over 50% of patients had returned to baseline for walking step length by postoperative week 14. Step count reached 50% return to baseline at postoperative week 16, while walking speed and double support percentage reached this threshold by postoperative week 18. Walking asymmetry percentage did not reach 50% return to baseline during the 6-month period. By 6 months (week 26) postoperatively, four of the five metrics had reached their maximum observed rates of return to baseline: 57.6% for step count (week 20), 61.8% walking step length (week 20), 54.5% for walking speed (week 18), and 47.1% for walking asymmetry (week 18), while double support percentage reached a maximum rate of return to baseline of 57.7% at week 28. These findings suggest that most patients regained core walking function between weeks 14 and 18, with continued recovery through month 6.

DISCUSSION: We found that recovery timelines vary across gait domains, but most patients can expect to reach baseline walking function for key metrics between 14 and 18 weeks after hip preservation surgery. Importantly, these objective measures provide a continuous, patient-specific recovery trajectory that may supplement traditional function-based PROMs and improve postoperative counseling. Integrating smartphone-based data with PROM collection could enhance precision rehabilitation strategies and shared decision-making in young, active patients undergoing hip preservation surgery. Limitations for this study include smartphone use between patients not being standardized and the variability of patients having a smartwatch, effecting the results obtained by the study. Future studies correlating these metrics with PROMIS and other validated outcome measures will further refine clinical utility.

SIGNIFICANCE/CLINICAL RELEVANCE: This study used passively collected, objective data from smartphones to monitor postoperative activity and recovery following hip preservation surgery. This data, combined with PROMs, can be used to provide a more patient-specific approach to monitor and counsel postoperative patients, enhancing rehabilitation strategies and decision making.

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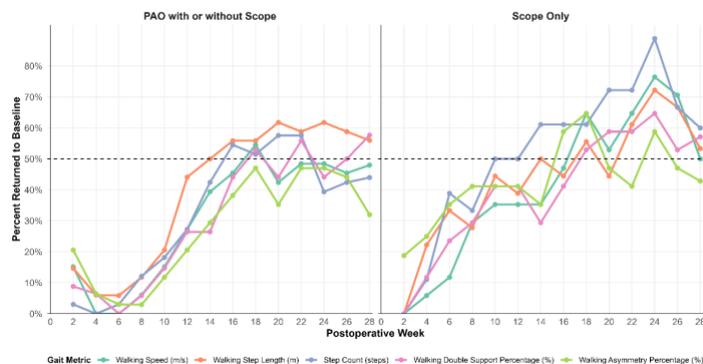
Figure 1. Proportion of patients returning to baseline function by gait metric, comparing PAO with or without scope and scope only. Each line represents a distinct gait metric. The horizontal black dashed line marks the 50% return threshold.