Postoperative Pain Trajectories in Total Knee Arthroplasty: An Analysis of Patient-Reported Outcomes

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INTRODUCTION: Total knee arthroplasty (TKA) is a widely performed procedure to alleviate pain and improve function in patients suffering from knee disorders such as osteoarthritis. Although TKA has proven to be highly successful, the recovery process demonstrates considerable heterogeneity among patients. This study aimed to investigate whether patients follow distinct pain trajectories following TKA and to identify patient characteristics associated with suboptimal trajectories. In pursuing these objectives, the study seeks to enhance our understanding of TKA pain experiences, ultimately helping to guide realistic patient expectations and optimize personalized pain management strategies.

METHODS:
This retrospective cohort study was conducted at a tertiary multi-center orthopaedic hospital and analyzed all TKA patients who completed PROMIS pain-intensity questionnaires from 2017-2022. These were collected preoperatively and at 1, 3, 6, 12, and 24-month follow-up timepoints. Latent Class Growth Analysis (LCGA) and Growth Mixture Modelling (GMM) were used to model patient's pain trajectories based on their PROMIS Intensity scores. The statistical fit of the model was assessed by the Bayesian Information Criterion (BIC), Vuong-Lo-Mendell-Rubin Likelihood test (VLMR-LRT), class posterior probabilities (>0.7), and entropy values (>0.8). Patients were assigned to the trajectory group where they had the highest posterior probability of membership.

The three-step approach was performed to measure the association between trajectory groups and patient characteristics, using multinomial logistic regression analysis weighted by probability of class membership. The Minimal Clinically Important Difference (MCID) threshold was calculated using the distribution method.
RESULTS: A piecewise GMM model with three distinct patient trajectories was identified as the best fit for the 1,634 eligible patients. The distribution of patients across these trajectories was: 90.5% in Trajectory 1 (T1), 8.1% in Trajectory 2 (T2), and 1.5% in Trajectory 3 (T3). T1, comprising most patients, had a mean baseline score of 54.1 and was identified as the standard patient trajectory, thereby serving as the reference in the logistic regression model. T2 was characterized by high initial pain levels, with a mean baseline score of 66.9 - this was deemed as the suboptimal trajectory in this cohort. However, all patients following this trajectory achieved an MCID by the two-year mark. Conversely, T3 represented a low-pain trajectory, with a mean baseline score of 37.4. At the one-month follow up, all three trajectories showed convergence, and at the two-year follow up, there was marginal differences in their mean scores—T1 at 48.6, T2 at 50.9, and T3 at 49.1.

Logistic regression modelling showed that females were 1.94x more likely to be allocated to the T2, high pain trajectory (p=.004). Furthermore, for each additional hour of hospital stay, there was an associated 1% increase in the odds of allocation to T2 (p=.034). African American patients were also found to have a 2.11 times higher odds of being allocated to T2 (p=.002).
DISCUSSION AND CONCLUSION: This study successfully identified three distinct pain trajectories following TKA, primarily differentiated by their baseline pain scores. Interestingly, despite the pronounced disparities in initial pain levels among these trajectories, the pain scores demonstrated a convergence from the one-month follow up until the two-year follow up, implying a similar short and long-term postoperative pain journey across all patient groups. Although the suboptimal trajectory showed markedly elevated baseline pain, this convergence, as well as the complete attainment of an MCID underlines the potential for substantial pain reduction even in patients with initially severe pain.

The identification of distinct trajectories and their associated risk factors has substantial implications for personalized patient care. Particularly, these results highlight the necessity of a more nuanced approach to preoperative counselling, focusing not only on the anticipated surgical outcomes but also on addressing specific risk factors, such as gender, and race, that may predispose a patient to a higher baseline pain. Such an approach can help in setting realistic recovery expectations for the patients, as well as guide surgeons to customize preoperative management strategies effectively.

These results emphasize the role of individual patient-specific factors in establishing realistic recovery expectations. Encouragingly, this study suggests that even at-risk patients with exceptionally high preoperative pain levels can still expect positive pain outcomes. This insight can foster optimism for significant post-surgical pain relief and provide reassurance to patients dealing with severe preoperative pain.

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