A Smart Implantable Device Able to Remotely Identify TKA Patients with Limited Knee ROM

John Dundon, MD[1], Patrick M. Aubin, PhD[2], Charles DeCook, MD2[3], Daniel Gerscovich, MD[4], Jacob Sams, MD[5], Jeffrey Yergler, MD[6]

(1) Othopedic Research Institute of NJ, Chester, New Jersey, (2) Canary Medical Inc., Vancouver, British Columbia; (3) Arthritis and Total Joint Specialists, Northside Hospital Forsyth, Cumming, Georgia; (4) Carolina Hip and Knee, Spartenburg, South Carolina; (5) Decatur Orthopedic Center, Mt. Zion, Illinois; (6) South Bend Orthopaedics, South Bend, Indiana

Introduction

Success rates following total knee arthroplasty (TKA) are variable depending on the outcome metric used. Patient reported outcomes are periodic and subjective. Range of motion (ROM) is a quantifiable outcome, and limited ROM can lead to patient dissatisfaction, disability, and further intervention and procedures. Detecting limited ROM early can potentially help mitigate some of these complications. This study uses a smart implantable device (SID) to identify limited ROM remotely using sensor-derived gait data.

Methods

A machine learning model to predict limited knee ROM (defined as under 110 degrees) was trained with data from 370 patients from two high-volume TKA clinics, using clinically measured ROM and gait data derived from an SID at 1 to 12 weeks post-surgery. The model performance was tested on 95 patients enrolled in a prospective, multi-center, IRB-approved clinical trial with patient evaluation at 4 to 8 weeks. There was no significant difference in demographics between the two patient populations. The area under the receiver operating characteristic curve (AUC) with 95% confidence intervals (CI) was calculated.

Results

The mean model AUC on test patients was 0.79 (95% CI: 0.68 to 0.90). Using a threshold of 0.2, meaning patients with a model score > 0.2 are predicted to have limited ROM (AKA, positive test results), the positive predictive value (PPV) is 33%. The negative predictive value (NPV) is 97%.

Conclusion

The machine learning algorithm developed in this study may be applied to sensor-derived gait data from an SID and used to predict limited ROM in the early postoperative period. Gait data captured remotely during activities of daily living may be used to triage patients at higher risk of limited knee ROM earlier than routine follow-up care, enabling earlier intervention and potentially improving patient outcomes.