Remote, Automated Limping Detection Model Agrees with in-Person Clinical Assessment Following TKA

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Introduction

Total Knee Arthroplasty (TKA) is a successful procedure that helps improve patient pain and improve activities of daily living. Currently, outcome evaluation is limited to periodic patient surveys, x-ray review, range of motion (ROM), and physical examination. This study proposes using sensor-derived gait information from a smart implantable device (SID) to evaluate limping.

Methods

A machine learning model was trained to quantify patient limp using features extracted from an SID. 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. Demographics included a mean age of 64.8 years (range: 45 to 82, SD ±9.0), mean BMI of 32.0 (range: 19.1 to 42.8, SD ±5.3), and 53.7% women. Clinicians reported that 50.5% of patients had a mild/moderate or severe limp. 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 0.73 (95% CI: 0.64 to 0.81). Using a threshold of 0.5, meaning patients with a model score > 0.5 are predicted to have mild to severe limp, the positive predictive value (PPV), or probability that subjects with a model value > 0.5 have a limp, is 73%. The negative predictive value (NPV), or probability that subjects with a model value under 0.5 have gait without a limp, is 67%.

Conclusion

The proposed machine learning algorithm applied to sensor-derived gait data from an SID may be used as a screening tool to identify patients with a higher likelihood of having a limp after TKA. Gait data captured remotely during activities of daily living may be used to triage patients at higher risk of gait abnormalities earlier than routine follow-up care, enabling earlier intervention and potentially improving patient outcomes.