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ArthroPredict: A Machine Learning Approach To Predict 5-Year Total Joint Replacement In Patients With Osteoarthritis Using Routine Clinical Data

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- None to declare

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Introduction

- Osteoarthritis (OA) is the most common degenerative joint disease, significantly impacting physical function, quality of life, and posing a substantial global socioeconomic burden.

- As OA prevalence increases due to aging populations and obesity, the need for total joint replacement (TJR) is projected to rise sharply, particularly in the UK, where surgeries are expected to grow from 70,000 to 119,000 annually by 2035.

- Despite the effectiveness of TJR, accurately predicting which patients will progress to needing joint replacement within a specific timeframe remains a challenge in clinical practice.

Objectives

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Addressing this need, OsteoFuture is a novel machine learning (ML)-powered platform designed to predict the likelihood of TJR within five years of diagnosis using baseline clinical data.

Dataset

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- Data of 4,796 patients (12,813 knees) were retrieved from the Osteoarthritis Initiative (OAI) dataset, who were followed for at least five years.

- A wide range of 45 demographic and clinical variables (such as age, body mass index, functional scores, and 12-Item Short Form Survey) were selected.

Preprocessing and Development

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Model	Precision	Accuracy	Recall	F1 Score	AUC
Logistic Regression	0.2069	0.6323	0.5909	0.3065	0.6625
Kernel SVM	0.2269	0.7271	0.4091	0.2919	0.6369
Decision Tree	0.2099	0.7531	0.2879	0.2428	0.5576
Random Forest	0.2785	0.8260	0.1667	0.2085	0.6498
Naïve Bayes	0.2193	0.6625	0.5682	0.3165	0.6689
XGBoost	0.2941	0.8406	0.1136	0.1639	0.6482
NGBoost	0.2154	0.7469	0.3182	0.2569	0.6289
LightGBM	0.3200	0.8438	0.1212	0.1758	0.6578
CatBoost	0.2391	0.8375	0.0833	0.1236	0.6437

Conclusion

- Our results demonstrated that the ML-powered OsteoFuture tool can accurately predict the risk of TJR in OA patients using baseline clinical data.

- The models, particularly RF and XGBoost, achieved clinically acceptable levels of accuracy, showing potential to assist clinicians in identifying high-risk patients early in their disease course.

- By early identification of high-risk patients using data from routine clinical practice, OsteoFuture enables timely, personalized interventions, potentially delaying surgery and alleviating the burden on healthcare systems.

Conclusion

- However, limitations include the potential lack of generalizability beyond the OAI dataset and the use of only baseline data without accounting for longitudinal changes.

- Despite these limitations, ML-powered prediction tools could play a significant role in optimizing OA patient management and delaying surgery through timely interventions. Further validation in diverse populations is necessary to confirm these findings.

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