

Predicting Return to Sport After Trochleoplasty for Patellar Instability Using Machine Learning

A Feasibility Study

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Introduction

Patellar instability can significantly impair physical function and quality of life. Surgical interventions such as trochleoplasty and medial patellofemoral ligament (MPFL) reconstruction have demonstrated improvements in function and return to sport, particularly in cases of severe trochlear dysplasia. However, the likelihood of returning to sport remains difficult to predict. This study explores the use of supervised machine learning models to predict return to sport following trochleoplasty using clinical and radiographic data.

Methodology

A retrospective dataset of 134 patients who underwent trochleoplasty for symptomatic patellar instability, from 1995 and 2024, were analyzed. Data were collected prospectively preoperatively, at 6 weeks, and at 1-year follow-up. The patients were surveyed retrospectively to determine the clinical and functional outcomes including sports and exercise participation. The primary outcome was whether they returned to sport. Predictive variables included demographic data, preoperative imaging metrics, and intraoperative assessments. Several supervised learning algorithms were then created and evaluated using Python run through Jupyter Notebook via the sklearn ensemble. Models chosen were: linear regression, Random Forest (RF), support vector machine (SVM), and gradient boosting (XGBoost). Model performance was assessed using accuracy, precision, recall, F1 score, and area under the receiver operating characteristic curve (AUC).

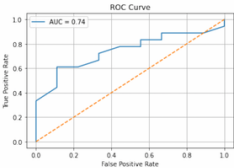
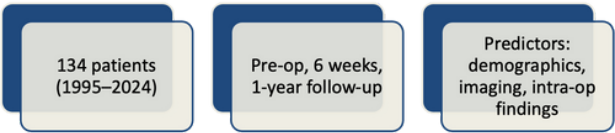


Fig 1: AUC Curve, Random Forst Model

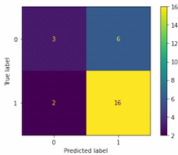


Fig 2: Confusion Matrix, Random Forst Model

Results

Model	Accuracy	Precision	Recall	F1 Score	AUC
SVM	0.67	0.67	1	0.8	0.7
XGBoost	0.67	0.67	1	0.8	0.76
Random Forest	0.7	0.73	0.89	0.8	0.74
Linear Regression	Low	Low	Low	Low	Low

Mean follow-up: 3.8 years
Kujala: PreOp: 60 → PostOp: 87
75% satisfied at 1 year

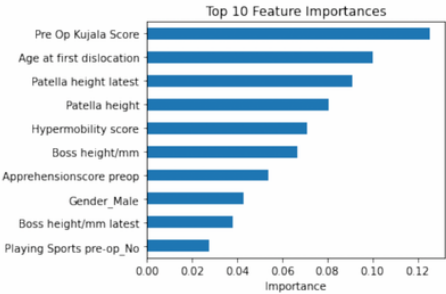


Fig 3: VIMPs For Random Forst Model

Conclusion

This study demonstrates the feasibility of using machine learning models to predict return to sport after trochleoplasty. Despite the limitations of a relatively small dataset and heterogeneity in clinical inputs, the models showed promising performance. These tools could support shared decision-making by providing patients with individualised expectations of recovery and return to sport. However, validation on larger, prospective datasets is required before clinical adoption. Future work should focus on multi-centre data collection, model calibration, and external validation.

CONFLICTS OF INTEREST
No conflicts of interest