Predicting 60-day Recovery Outcomes After ACL Surgery Using Machine Learning

P. Liuzzi [a], E. Nesi [a], S. Campagnini [a], F. Mari [b], I. Dimauro [b], N. Carta [c], J. Rocchi [c], E. Bergamini [d], A. Mannini [a], P.P. Mariani [c]

[a] *IRCCS Fondazione Don Carlo Gnocchi, Firenze, Italy*
[b] *University of Roma Foro Italico, Department of Movement, Human and Health Sciences, Roma, Italy*
[c] *Villa Stuart, Roma, Italy*
[d] *University of Bergamo, Department of Management, Information and Production Engineering, Bergamo, Italy*

Introduction

Anterior Cruciate Ligament (ACL) surgery is a common procedure to repair or reconstruct the ACL after injury. Postoperative rehabilitation plays a crucial role in returning ACL-reconstructed (ACLR) patients to sports activities as safely as possible. Predicting outcomes of ACL surgery and rehabilitation programs using machine learning (ML) models could enhance patient care by providing personalized recovery forecasts and optimizing treatment plans [1,2]. In this work, we cross-validated and tested ML models targeting the 60-days recovery of ACLR patients, using the knee circumference (CircK) and the knee flexion Range of Motion (RoMflex) as recovery metrics.

Methods

Data from 431 patients admitted to Casa di Cura Villa Stuart (Rome, IT) after a severe ACL injury were enrolled in this prospective study. Independent variables included etiology data (lesion and sport characteristics, severity levels), pre-surgery examinations (e.g., lower limb/joint circumferences and/or laxity), and surgery-related data (type of interventions, graft, and fMRI data), for a total of 101 features. The pre-processing pipeline included removal of variables with low standard-deviation (less than 0.01 after normalization) and of mutual correlated variables (retaining the most correlated with outcome). Then, feature transforms as PCA and univariate feature selection (mutual information-based) were derived from the train set (80%) and applied to the test set (stratified by recovered percentage). Model optimization (XGBoost) was performed using Optuna [3] by maximizing 10-fold (from the train set) cross-validation accuracy. CircK and RoMflex were selected as recovery metrics and the patient's status was defined as recovered if the difference healthy-injured for these two metrics was, respectively, less than 1 cm and equal to 0°.

Results

Four-hundred thirty-one patients were enrolled (311 males, median age of 25 years [IQR = 15]), of which 148 were professional athletes. The initial screening reduced the dataset to 62 variables, before entering PCA (N = 18) and cross-validated feature selection (N = 10). The best performing solution reached a test accuracy of 70% for CircK and 65% for flexion RoMflex (Figure 1) where corresponding cross-validation accuracy was of 76% and of 73%. Computing the area under the RoC (AuRoC) on the test-set predicted posteriors resulted an AuRoC of 0.73 on CircK and of 0.70 on RoMflex.

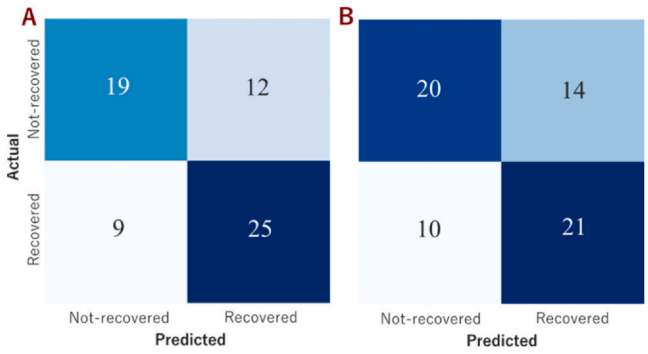

Figure 1.

Discussion

In this study, we aimed to enhance the prediction of recovery outcomes following ACL surgery by applying rigorous data preprocessing and model optimization techniques on a comprehensive dataset taken before and after the surgery. Future works should aim to refine these models by including mid-term evaluations and externally validating the deployed models.

REFERENCES

[1] de Mille P, Osmak J. *Curr Rev Musculoskelet Med.* 2017;10(3):297-306.
[2] de Jong SN, et al. *Arthroscopy* 2007;23(1):21.e1-21.e11.
[3] Akiba T, et al. *Proceedings of the 25th ACM SIGKDD international conference on KDD* 2019.

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A graph-based approach to study motor coordination in Parkinson's Disease gait: a longitudinal study to assess the effectiveness of Deep Brain Stimulation neurosurgery

L. Locoratolo [a], M. Ghislieri [a], F. Sciscenti [a], M. Lanotte [b], L. Rizzi [b], V. Agostini [a]

[a] *PolitoBIOMed Lab, Dept. of Electronics and Telecommunications, Politecnico di Torino, Turin, Italy*
[b] *Department of Neuroscience "Rita Levi Montalcini", University of Turin, Turin, Italy*

Introduction

Graph theory is emerging as a promising technique in different contexts [1], and it can be used to extract a network of muscles based on their coordinated activity during gait. This work aims to investigate the motor control strategies of Parkinson's Disease (PD) patients through graph theory and Louvain clustering and to