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Knee Injury Detection Using Unsupervised Machine Learning Model

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Faculty Disclosure Information

- The authors have nothing to disclosure

Objectives

- Develop an unsupervised machine learning model for the automated diagnosis of knee injuries in MRI images.
- Evaluate accuracy, precision, and discrimination capabilities in detecting ACL and meniscus injuries.
- Identify model limitations and improvements opportunities

Introduction

- AI: A key tool in medical diagnostics
- Opportunity to standardize and accelerate clinical decisions
- Machine learning: Algoritms that learns from larga data base

Machine Learning Types

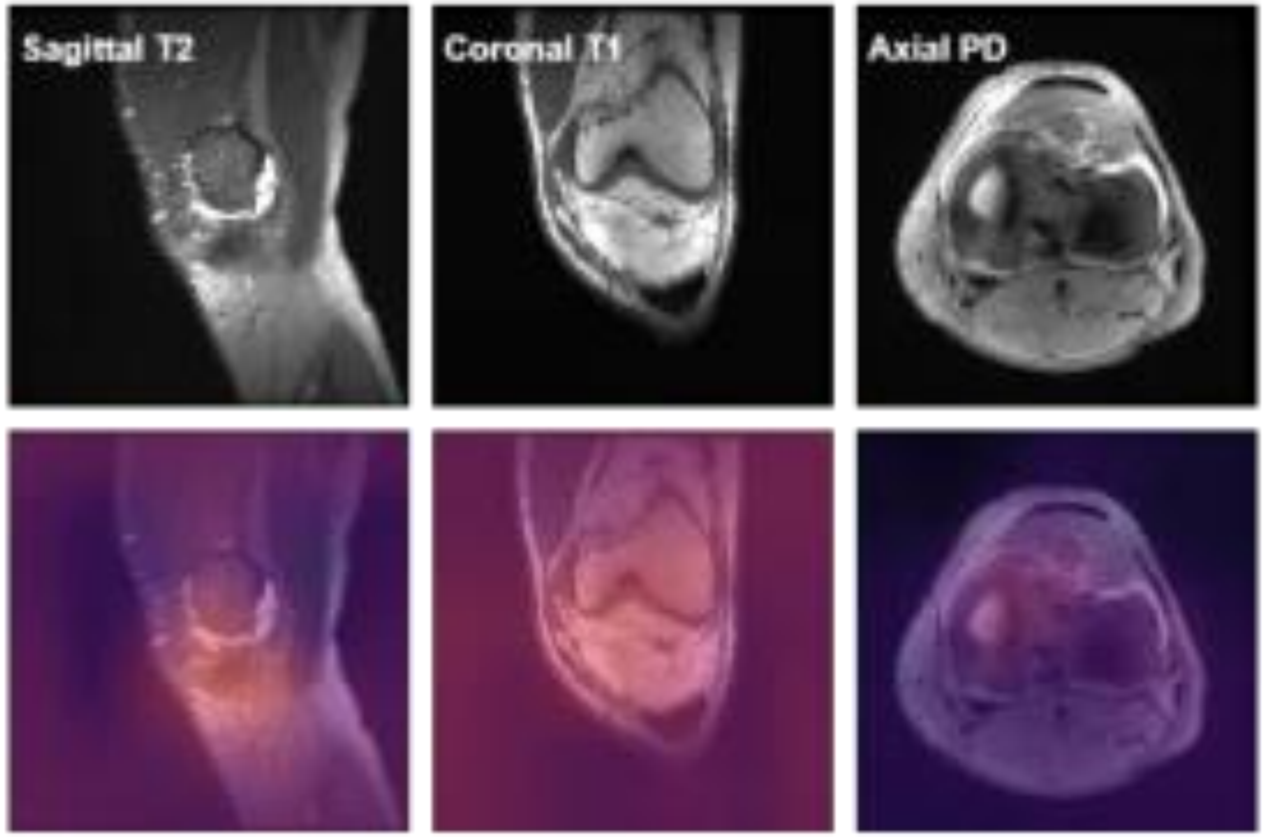
	Supervised Model	**Unsupervised Model**
Definition	Training with labeled data	Label-free training
Main Task	Classification, prediction	Identify patterns and group them
Advantages	High presicion	Explore unknown data
Limitations	Expensive	Moderate precision
Examples	Detect meniscal injuries	**Group injuries with similar patterns and classify them**

Methods

- Database
  - Stanford University Open Source
  - 1250 Knee MRI images
    - Healthy Knees
    - Isolated Lesions
    - Combined Lesions
- Data Tabulation
  - Knee surgeon in training
  - Senior Knee Surgeon

Stanford University

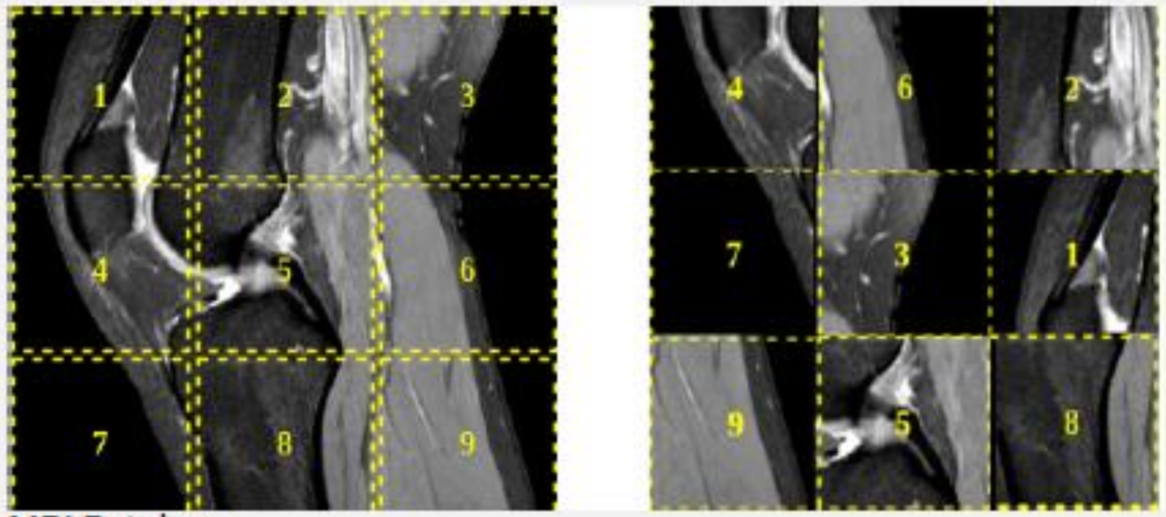
Center for Artificial Intelligence in Medicine & Imaging



Methods

- **SKID** (Self-Supervised Learning for Knee Injury Diagnosis from MRI Data)

- Stage 1 **(Upstream):** The model learns to identify normal vs abnormal patterns without labeled data
- Stage 2 **(Downstream):** Learned patterns are used to classify images based on similar features



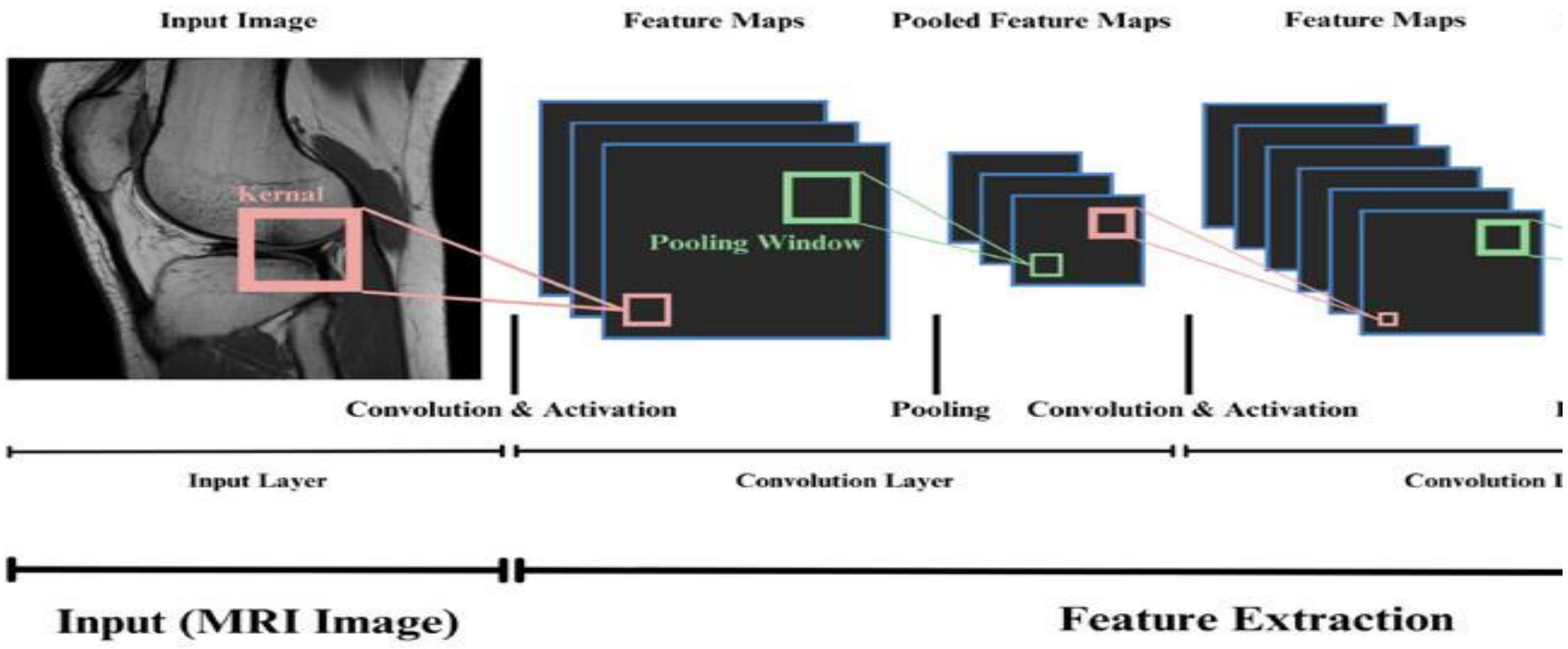
MRI Patches

Fuente: Manna, S., Bhattacharya, S., & Pal, U. (2020). SKID: Self-Supervised Learning for Knee Injury Diagnosis from MRI Data. IEEE Transactions on Artificial Intelligence.

Methods

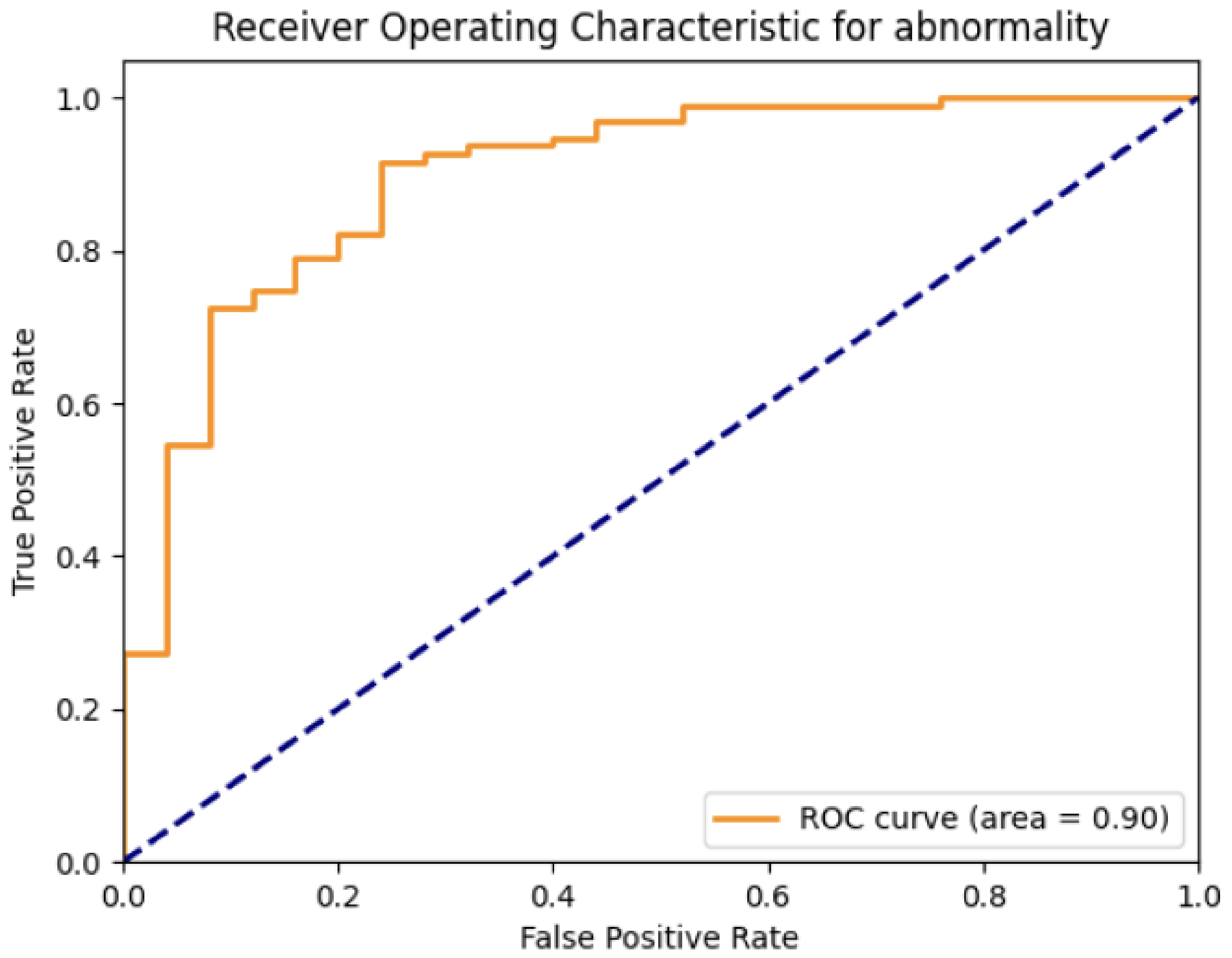
CNNs: Convolutional Neural Networks

- Mathematical operation used to extract image features.
- Applies filters to pixel grids to detect relevant patterns.
- Performs calculations and assigns values to highlight features.
- Produces feature maps refined through iterative processing.



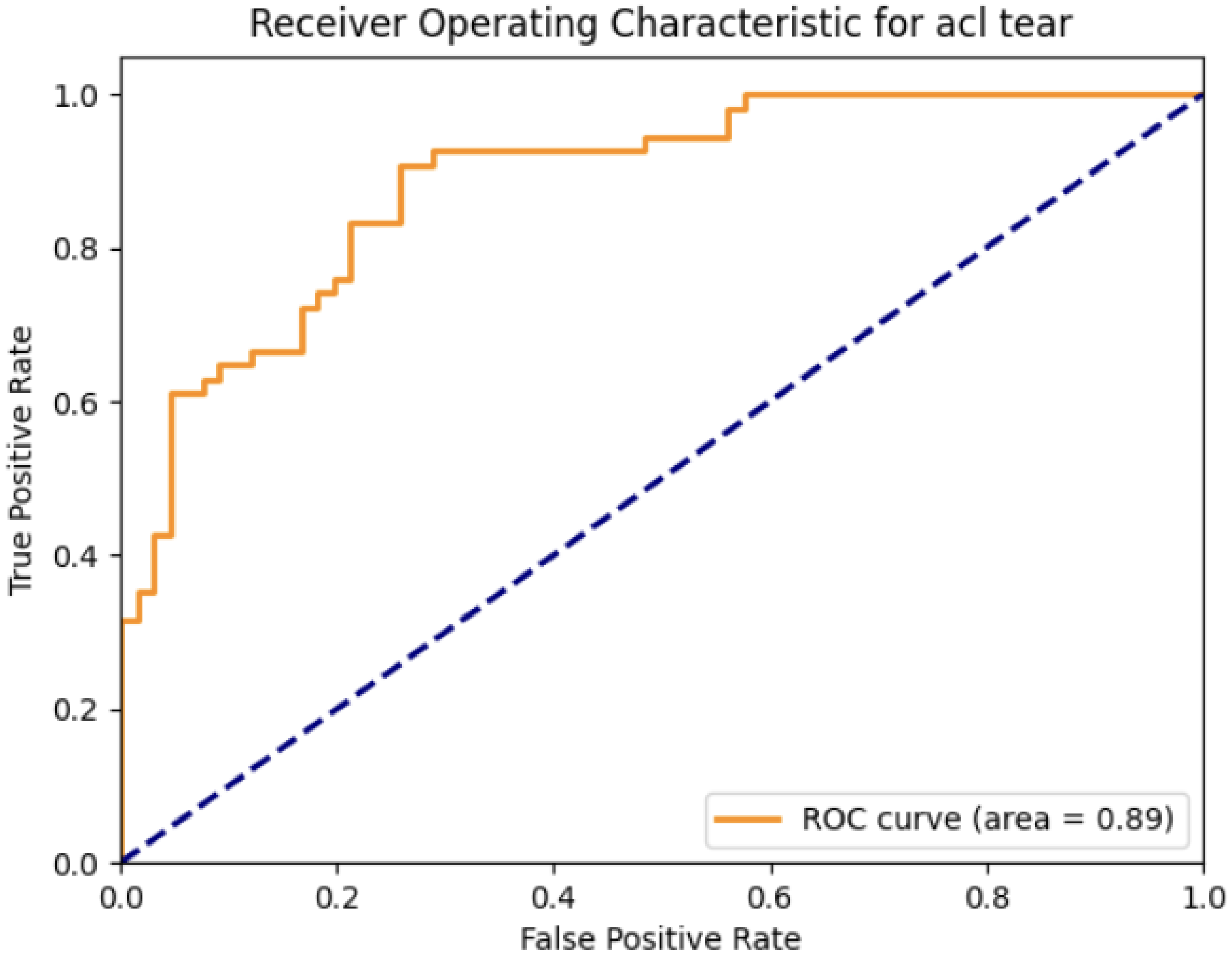
Results

- **Anormal images**
  - Precision: 87,62%
  - Sensitivity: 96,84%
  - ROC Curve: 0.90



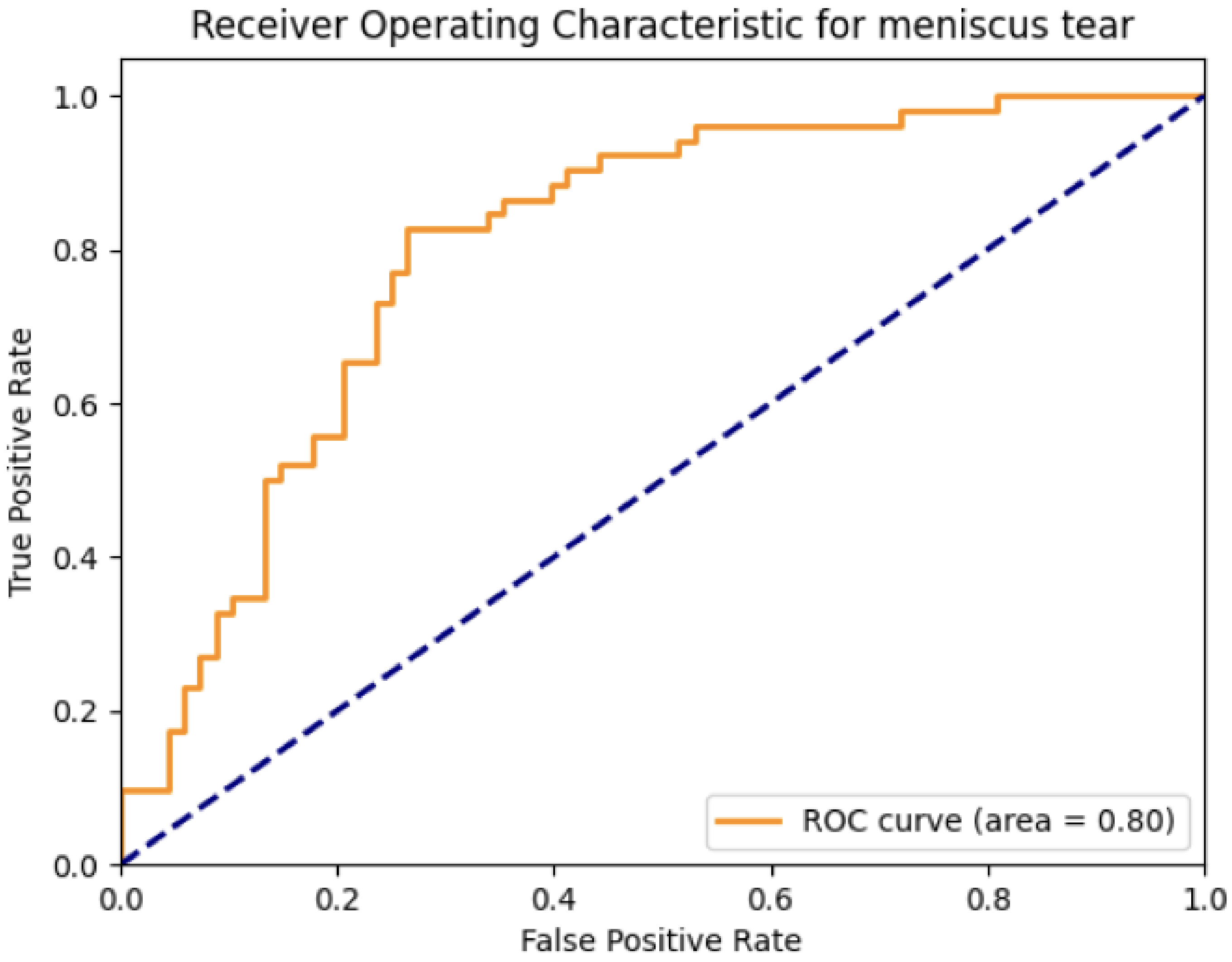
Results

- **ACL Injuries**
  - Precisión: 78%
  - Sensibilidad: 84%
  - ROC Curve:0.89



Results

- **Meniscal injuries**
  - Exactitud: 86.67%
  - Precisión78%
  - Sensibilidad: 90%
  - AUC: 0.80



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Discussion

- Strong performance in detecting abnormalities.
- High accuracy for ACL injuries.
- Slightly lower results for meniscal injuries due to pattern complexity.
- Findings align with existing literature.
- **Clinically promising**: may help reduce diagnostic time and standardize decisions.

Conclusions

- The SKID model demonstrates high accuracy in detecting ACL and meniscal injuries.
- Effectively distinguishes between normal and pathological knees.
- Its unsupervised learning capability makes it a strong candidate for clinical deployment.
- Findings support developing a predictive model integrating clinical variables for real-world application.

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