|			
25 Anos COHEN ORTOPEDIA, SAÚDE E ESPORTE	**EINSTEIN** Hospital Israelita	INTERNATIONAL SOCIETY OF ARTHROSCOPY, KNEE SURGERY & ORTHOPAEDIC SPORTS MEDICINE · 1995 ·	**SBOT** SOCIEDADE BRASILEIRA DE ORTOPEDIA E TRAUMATOLOGIA
FOUNDING DIRECTOR	BOARD OF DIRECTORS	PAST PRESIDENT 2011=13 HONORARY MEMBER	PRESIDENT 2019
FIFA® MEDICAL CENTRE OF EXCELLENCE	**MEDICINA ESPORTIVA** UNIFESP	**CBF BRASIL**	**FPF 75**
FOUNDING DIRECTOR	FOUNDING DIRECTOR	BOARD OF DIRECTORS	MEDICAL COMMITTEE PRESIDENT

UNIFESP UNIVERSIDADE FEDERAL DE SÃO PAULO 1933

UNIVERSIDADE FEDERAL DE SAO PAULO - BRASIL

Moisés Cohen, MD., PhD

Full Professor of Orthopedic and Sports Medicine

Department of the Federal University of São Paulo

ACL study group
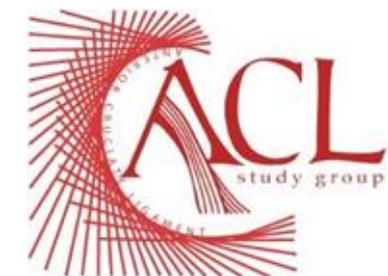
President 2024- 2026

Can We Predict ACL Injury Before It Happens?

Artificial Intelligence–Based 3D MRI Analysis

Meyer O | Amaro JT | Kaleka CC | Debieux P | Gomes Filho N | Cohen M

Automated AI-Based Model for Three-Dimensional Anatomical Risk Factor Analysis and ACL Injury Prediction Using Conventional MRI
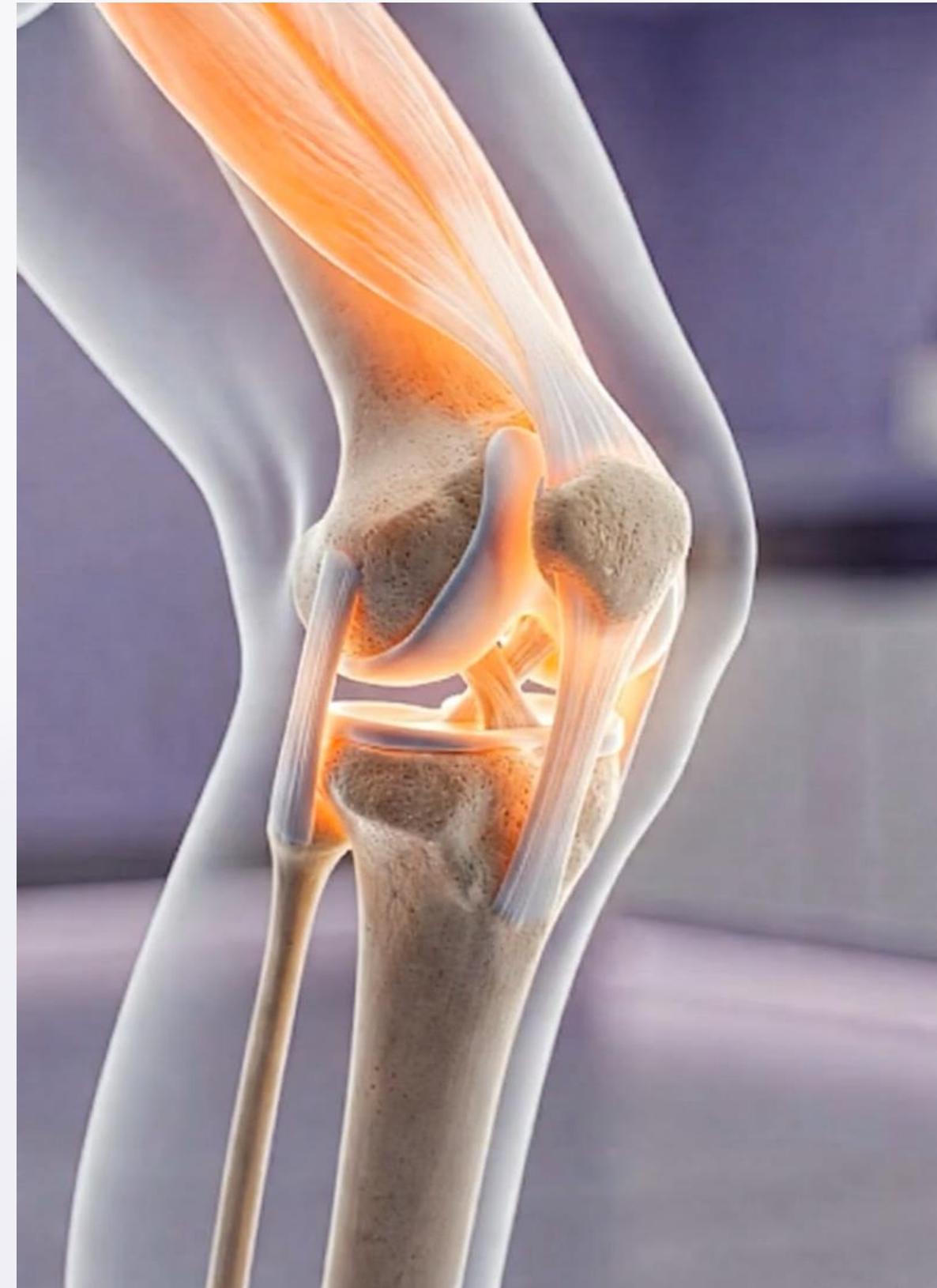
The ACL Injury Challenge: Why Prediction Matters

Rising Incidence

ACL tears affect 1 in 3,500 people annually, with young athletes at highest risk for career-altering injuries

Long-Term Impact

High risk of progressive joint degeneration and early-onset osteoarthritis following ACL rupture

Reactive Approach

Current diagnosis relies on MRI and clinical exams only after injury has already occurred

Can we shift from reactive diagnosis to **proactive prediction?**

How AI Predicts ACL Injury: Key Morphological Features

Anatomical Metrics Analysis

Machine learning models analyze comprehensive knee anatomy: tibial slope angles, meniscal height measurements, and precise bone geometry parameters

Risk Factor Identification

Increased lateral bone slope and elevated meniscal slope measurements have been directly linked to significantly higher ACL injury risk profiles
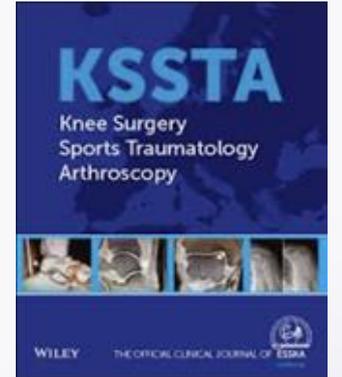
Multi-Feature Integration

Combining multiple anatomical features substantially improves prediction accuracy beyond single-factor analysis approaches

> Testing Accuracy

Gaussian naïve Bayes model achieved >90% testing accuracy in predicting primary ACL injury (Meyer et al., 2021)

KSSTA
Knee Surgery
Sports Traumatology
Arthroscopy

WILEY   THE OFFICIAL CLINICAL JOURNAL OF ESSKA

2026

Purpose

- To assess whether **combined tibial and meniscal parameters** improve ACL rupture risk

MRI-based measurements (medial & lateral compartments):

- Tibial slope
- Meniscal slope
- Meniscal–bone angle (MBA)

Clinical Implications

- ACL injury risk reflects **bone–meniscus interaction**, not a single parameter

The Question is…

Can AI automatically differentiate these patients based solely on the morphology of intra-articular structures on MRI?

Arthroscopy
The Journal of Arthroscopic and Related Surgery
Volume 39 · Issue 5 · May 2023

Infographic: In-Office Needle Arthroscopy
by Domos, Azari, Bullan Weiss, and Kennedy

Ervision, Hurley, Mojica, Joynson, and The Ulna Collateral Ligament Delphi Consensus Group on Elbow UCL Tears
…with Commentary by Hofmann

Davis, Lee, Bohlen, Downs, Jimenez, Solomon, and Montgomery for *Hip Arthroscopy With Microfracture*
…with Commentary by Marques-Laia and Budde

Li, Hong, Zhang, Hong, Fong, Yong, and Tran on *Meditation Using a Mobile App Improves Trainee Performance*
…with Commentary by Smithsonian

Horchman, Song, Higgenbottom, Para, and Montgomery Jia on *PRP Versus Steroid for Shoulder Adhesive Capsulitis*

AANA

2026

Distinct 3D Anatomic Patterns Including Flatter Surfaces and Greater Sagittal Inclinations of Intra-Articular Structures Are Reliably Identified Through an Artificial Intelligence-Based Pipeline in ACL Injured Knees.

Oliver Meyer[1,2] MD; Joicemar Tarouco Amaro[1,3] MD, PHD; Camila Kaleca[1,3] MD, PHD; Pedro Debieux[1,3] MD, PHD; Nilton Gomes Filho[1,3] MD; Moises Cohen[1,3] MD, PHD

Purpose:

- To evaluate whether an AI model can identify morphological features associated with ACL rupture and enable risk prediction

Study Methodology: ACL Rupture & Control Analysis

Study Design & Participants

- Retrospective case-control study
- 100 patients total
- 50 ACL rupture, 50 controls
- Matched by age and sex

Imaging & Analysis

- Sagittal T2-weighted MRis processed
- 3D reconstruction: femoral/tibial cartilage, menisci, tibial bone
- Computed surface curvature & anguar inciinations (sagittal, coronal, axial planes)
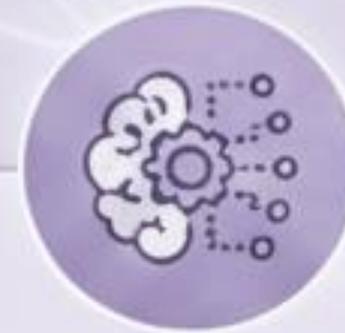
Machine Learning Model

- Supervised prediction model trained on significant variables
- Training set: 80 patients
- Testing set: 20 unseen cases (10 cases, 10 controls)

Comprehensive analysis combining advanced imaging and machine learning for ACL research.

Automated Pipeline

- 3D reconstruction of articular surfaces
- Automatic calculation of curvature and inclinations in : Sagittal, Coronal, and Axial planes
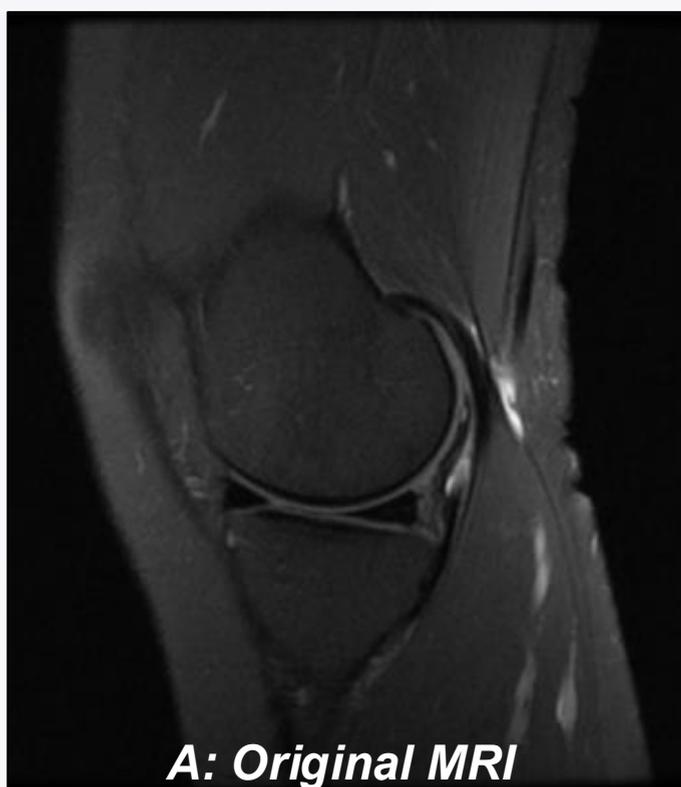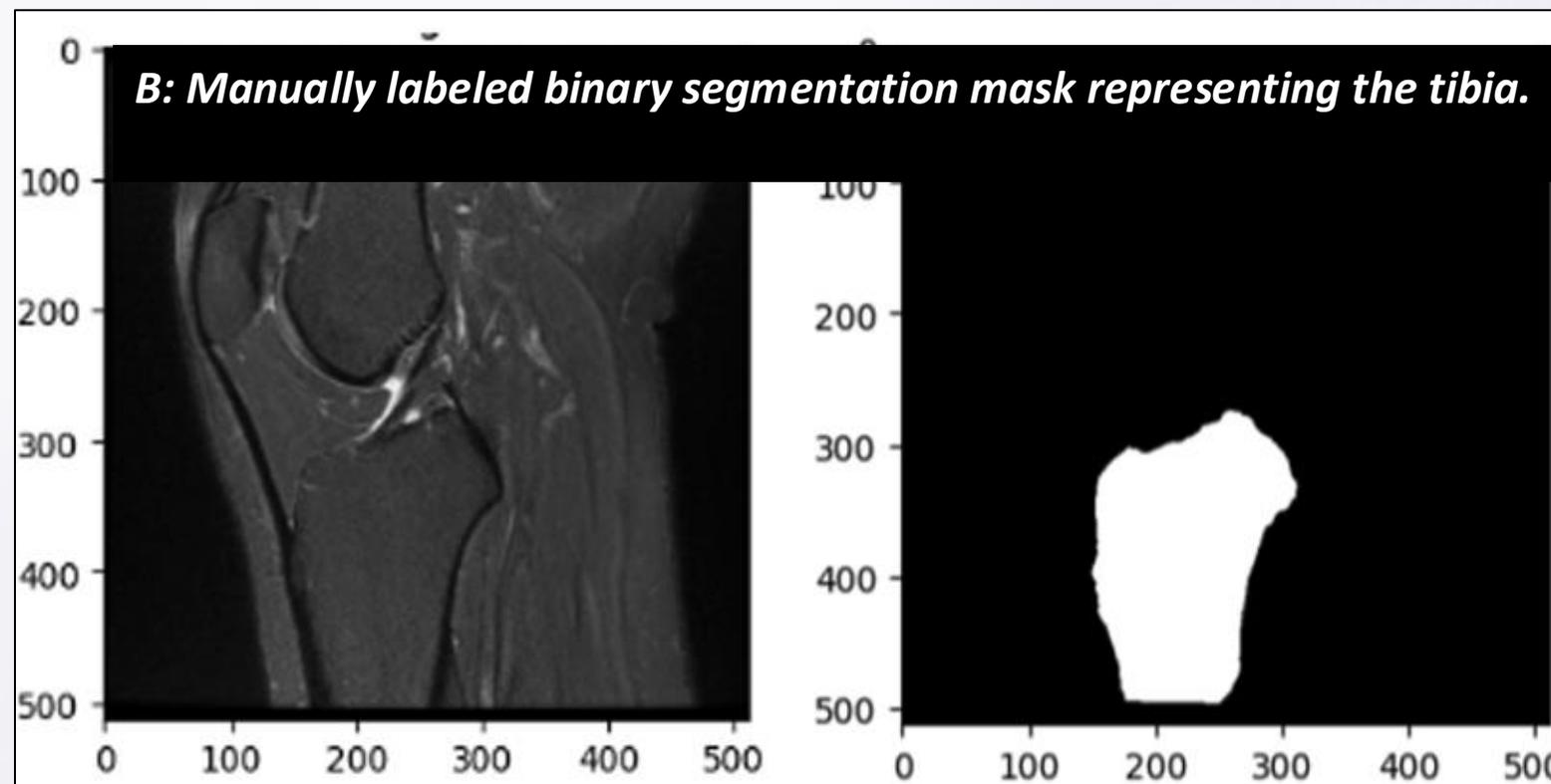

A: Original MRI slice.
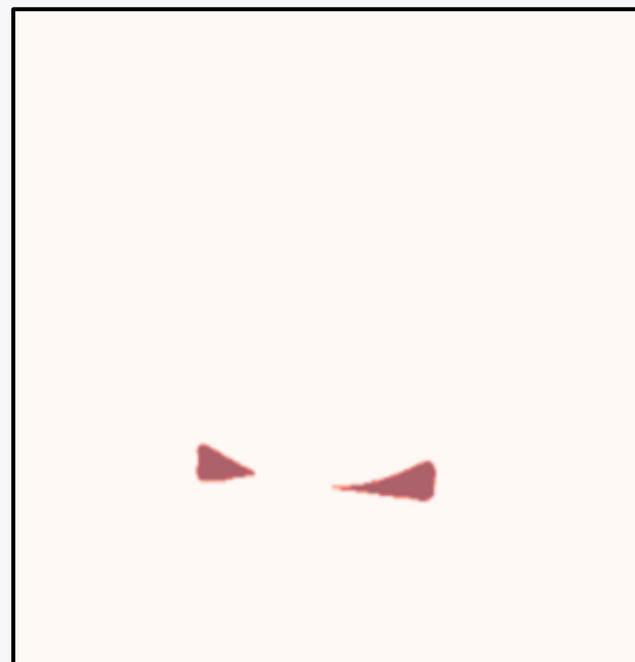
B: Meniscus automatically segmented by SKM-TEA

B: Manually labeled binary segmentation mask representing the tibia.

1st Step: Segmentation of knee structures

The AI model overlayed the two images to learn how to segment the tibia. The model received 563 pairs of binary masks and their respective original slices for training.
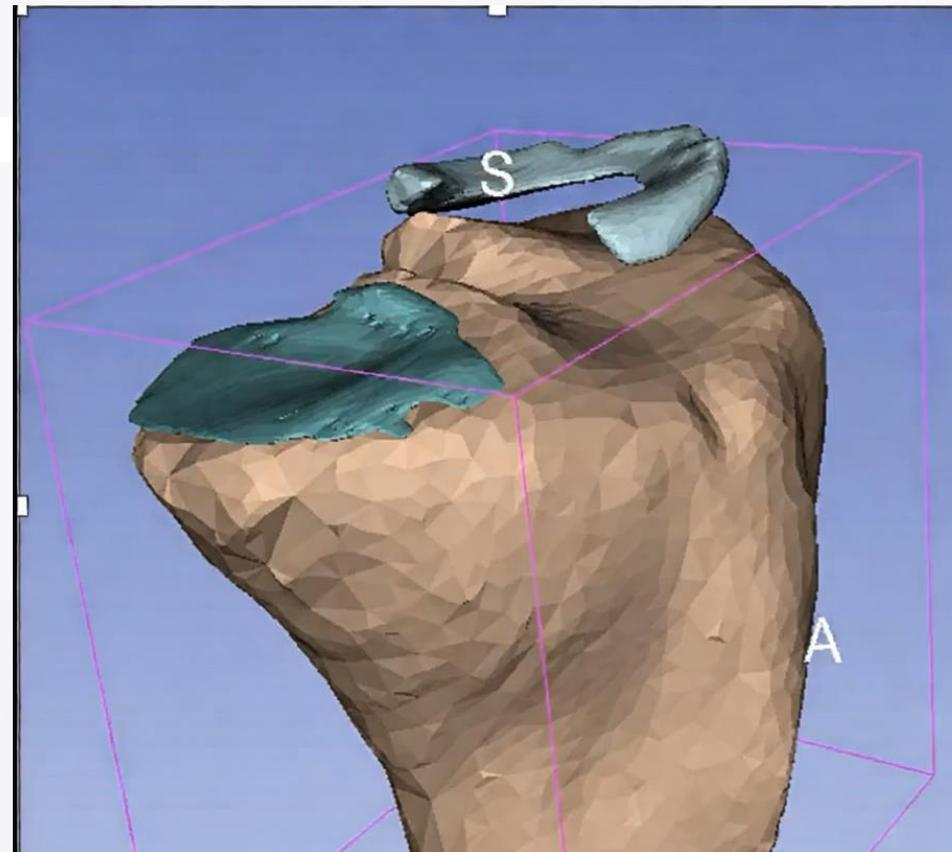
Visualization of the three-dimensional models
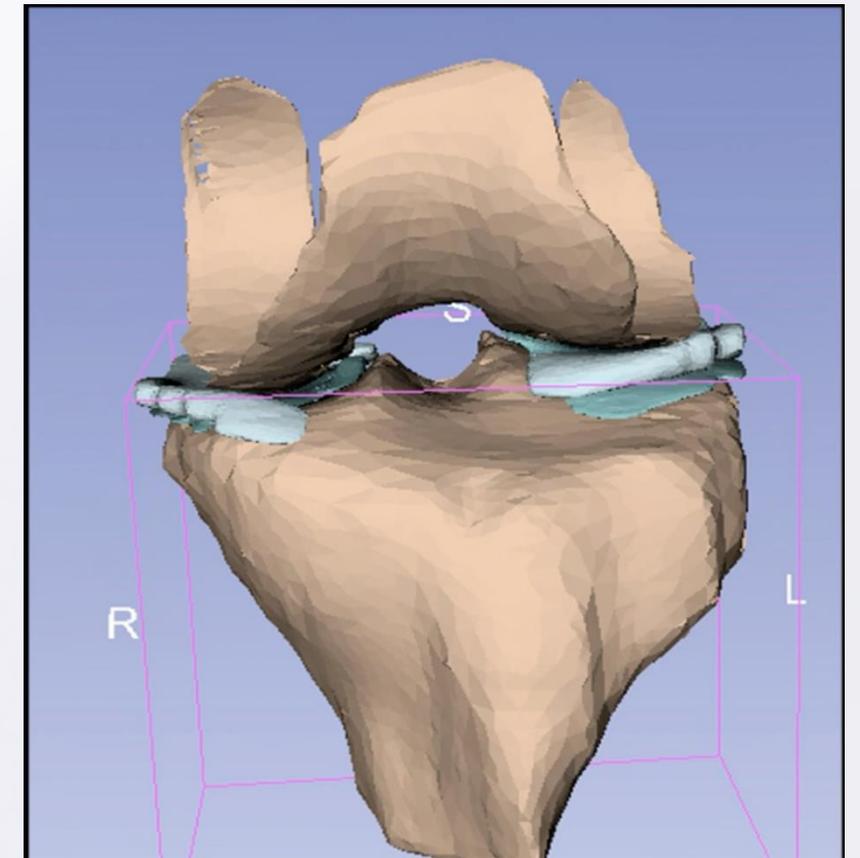
2nd Step- Knee 3D Reconstruction

- Multiple views femur, tibia, menisci
- Long axis of the tibia defined by a point cloud
- Meniscus-plateau and plateau-tibial axis angles automatically computed
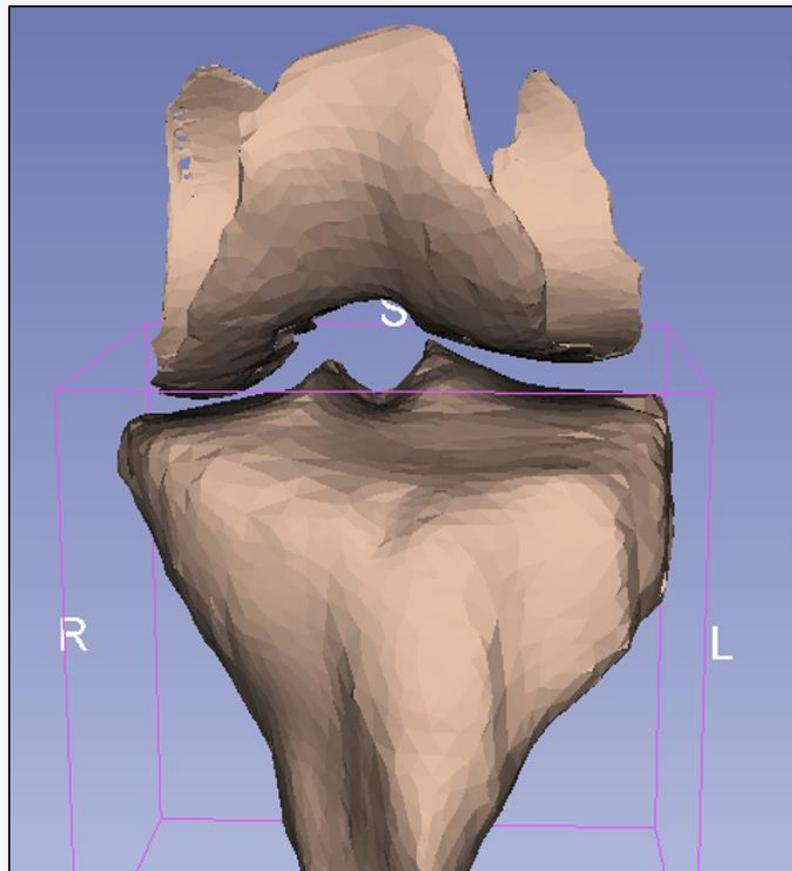
A: Frontal view of the femur and tibia

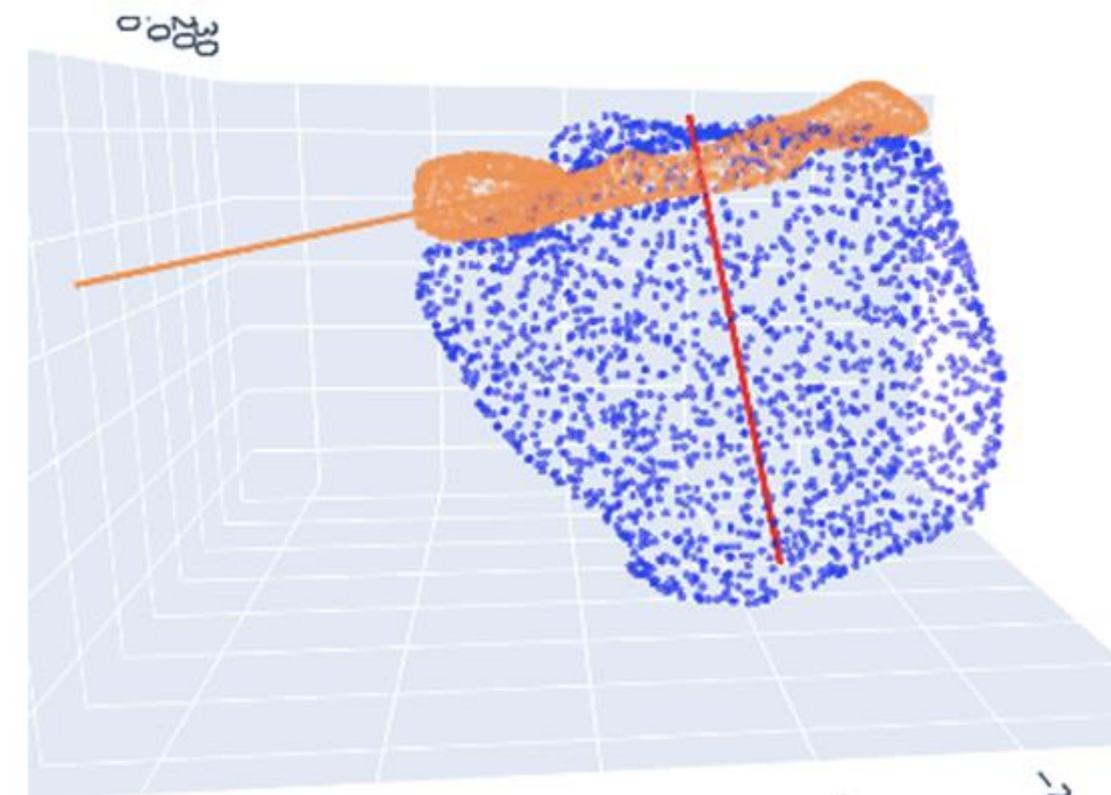*B: Oblique view of the tibia, lateral plateau, and medial meniscus.*

C: Complete three-dimensional model (tibia, femur, medial and lateral plateau, and medial and lateral meniscus)
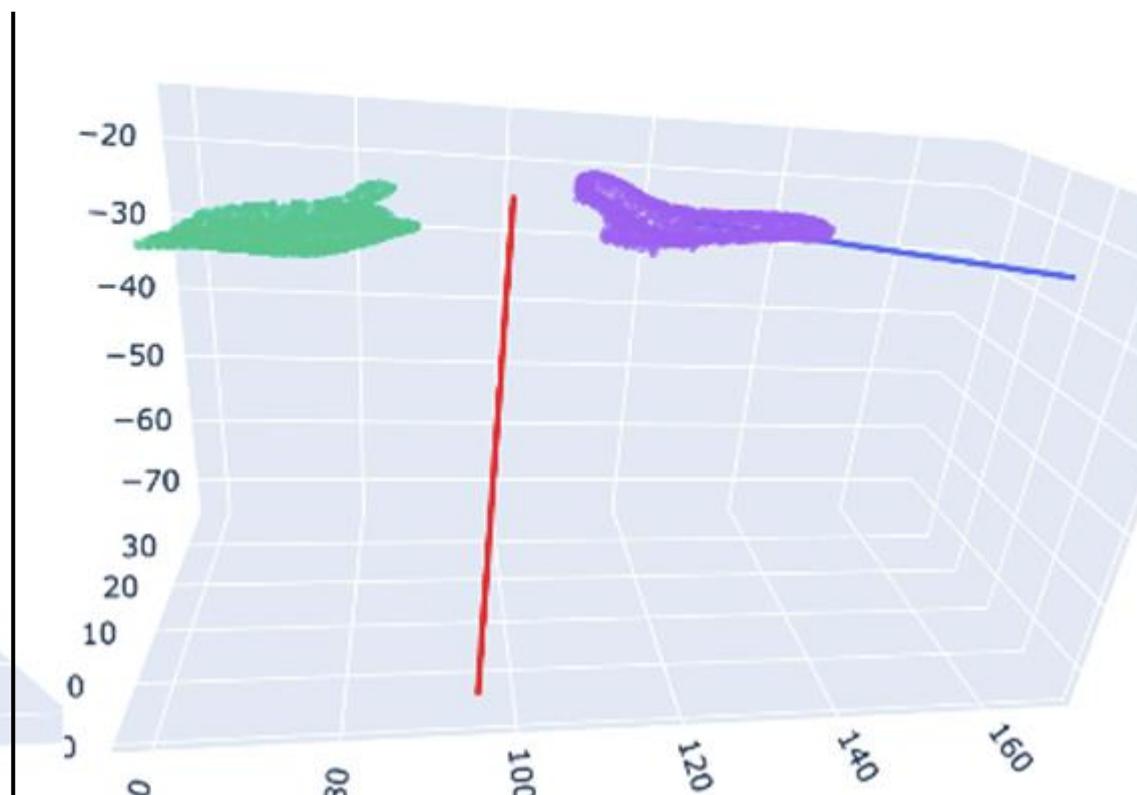
3D Reconstruction and Metrics
## *Relative inclinations of the structures*

3rd Step: Generating a point cloud representing structures

The tibial point cloud (blue) is seen in profile Sagittal slope of the lateral meniscus (orange) with the long axis of the tibia (red)

Anterior view of the point clouds of the medial plateau (purple), lateral plateau (green), tibial long axis (red line), and coronal slope of the medial plateau (blue line).
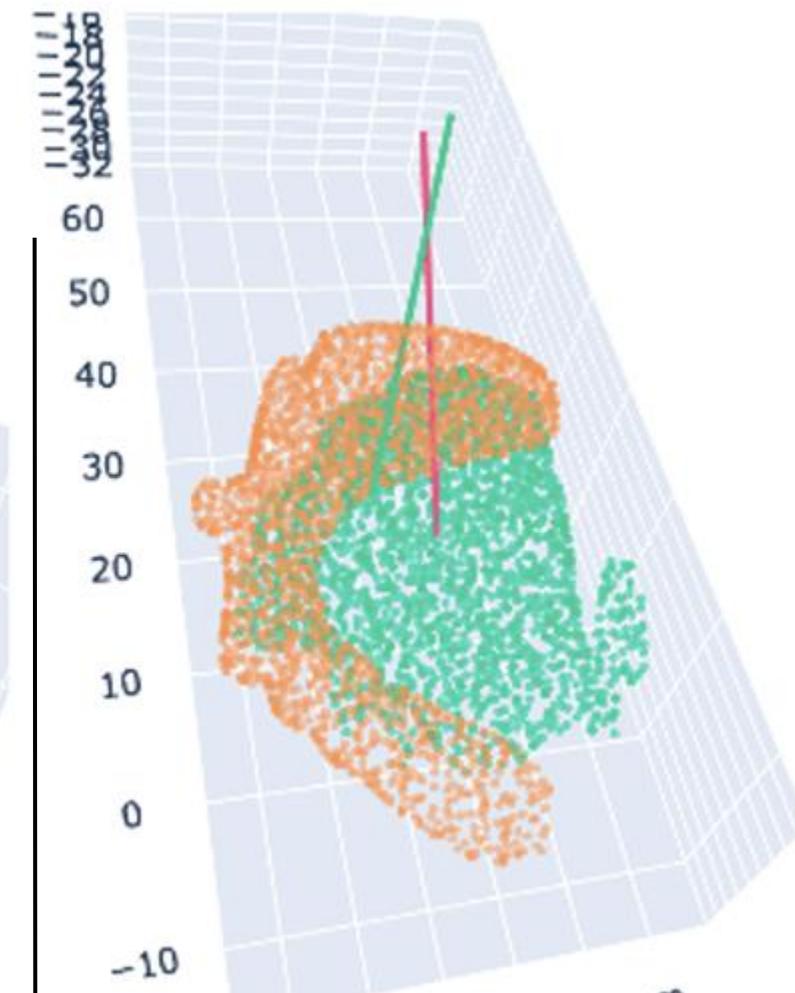
Superior view of the point clouds of the lateral meniscus (orange) and lateral plateau (green). The orientations relative to the axial axis are represented by the green (lateral meniscus) and red (lateral plateau) lines

3D Reconstruction and Metrics

4th Step: Extracting variables (3D curvature, relative angles)

- *Anterior, lateral, and top views of the point cloud representing the surface of the tibia.*

- *The "x" markings represent the centers of the "horizontal slices," allowing the calculation of the long axis of the tibia (red line).*
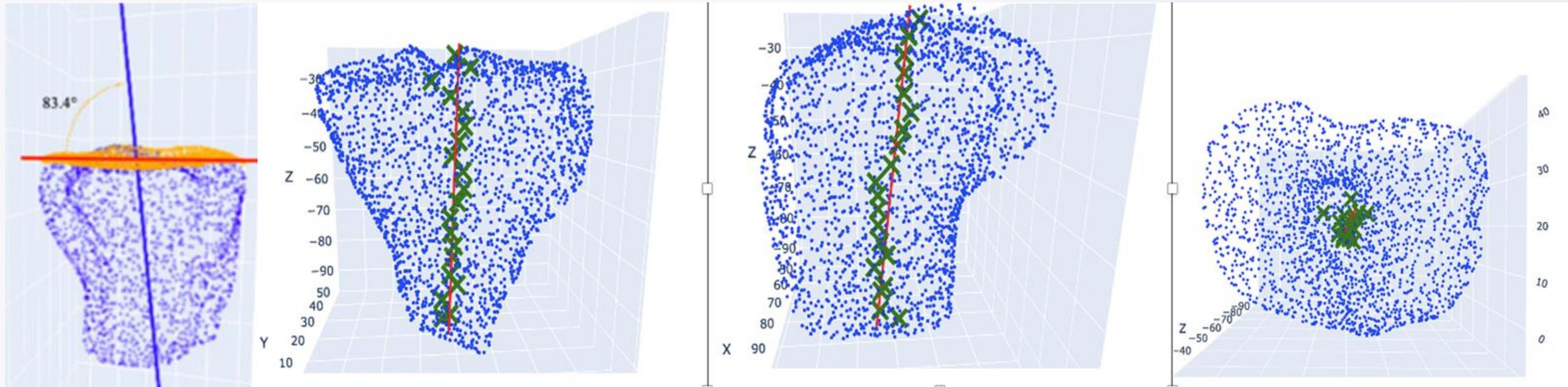
Results

The trained AI model demonstrated high predictive performance: 80% sensitivity, 70% specificity and an AUC of 0.81 when applied to the independent test set.

AUC = 0.81 refers to the area under the ROC (Receiver Operating Characteristic) curve. ➡ good discrimination ability

From 2D Scans to 3D Insights: The AI Reconstruction Pipeline

INPUT: STANDARD 2D MRI SLICES

AI PROCESSING (CNN / Deep Learning)

OUTPUT: 3D VOLUMETRIC ANATOMICAL MODEL

Standard clinical DICOM files, which are stacks of 2D images.

A Convolutional Neural Network (CNN) analyzes each slice to automatically identify and segment anatomical structures.

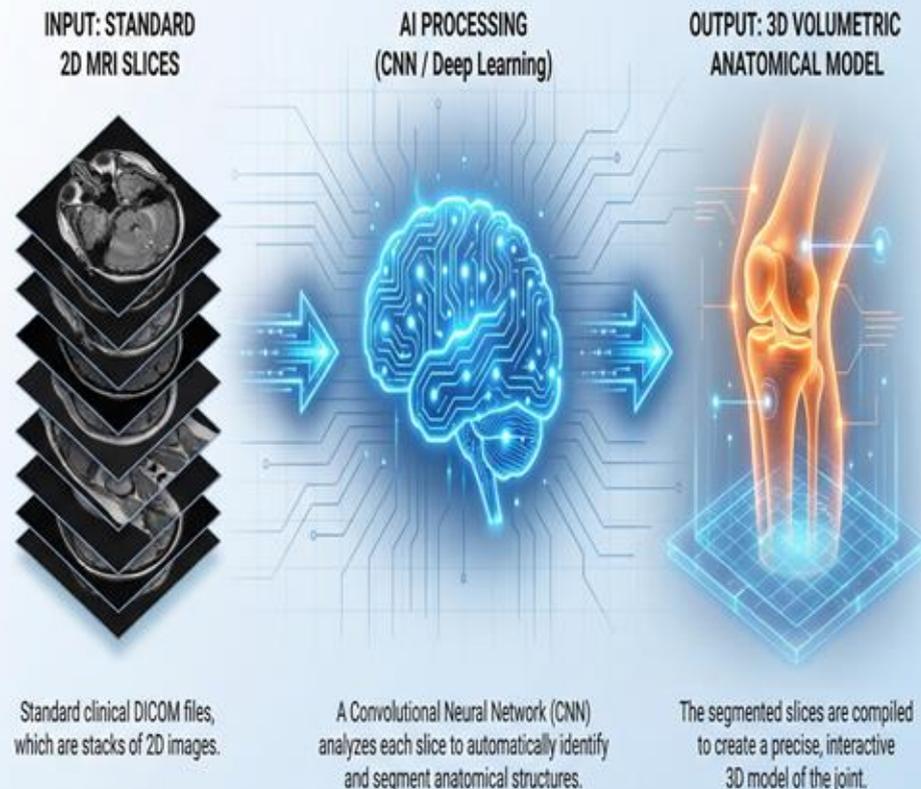The segmented slices are compiled to create a precise, interactive 3D model of the joint.

Clinical relevance

- Automatic program to Predict high risk from routine MRI
- Potential for personalized preventive intervention
- Potential integration into radiology workflows and sports screening

Study Limitations

- Retrospective, single-center design
- Relatively small sample size
- Dependence on MRI quality
- **Need for multicenter external validation**

EINSTEIN
Hospital   Israelita

drmoisescohen@gmail.com

@DrMoisésCohen

T h a n k   Y o u