

Machine-Learning MRI-Based Model for Early Detection of Knee Osteoarthritis

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Background

Magnetic Resonance Imaging of knee joint has been described as a sensitive tool for detection of early osteoarthritis in knee joint before it is detectable on radiograph. Early detection provides time of intervention which may prevent or retard the cartilage loss needing joint replacement at a much later date, thus effective both clinically and in utilization of resources including finances. In this study, we evaluated how the addition of machine-learning (ML) based models can affect the overall performance of MRI in determination of osteoarthritis in knee joint.

Methods and materials

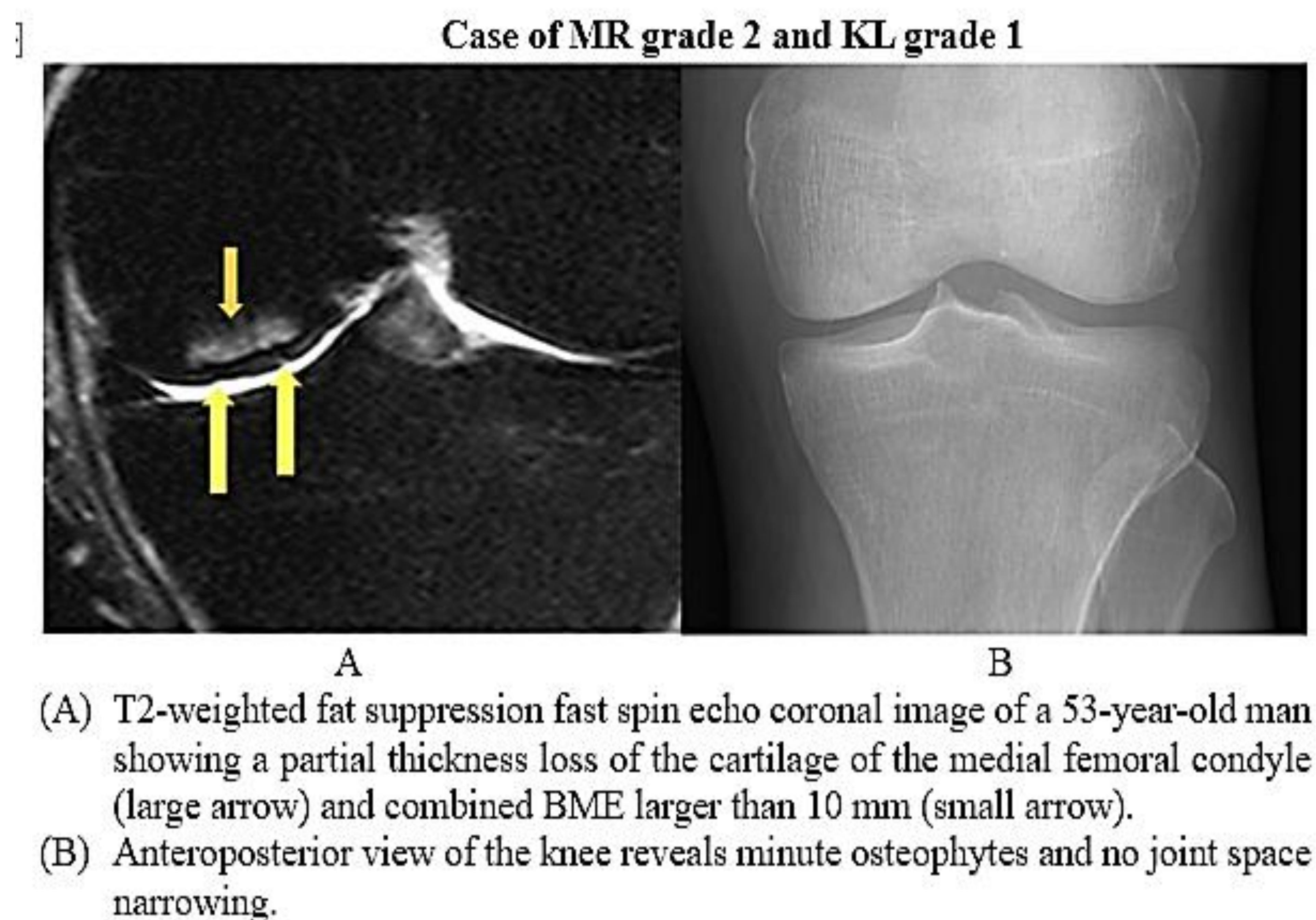
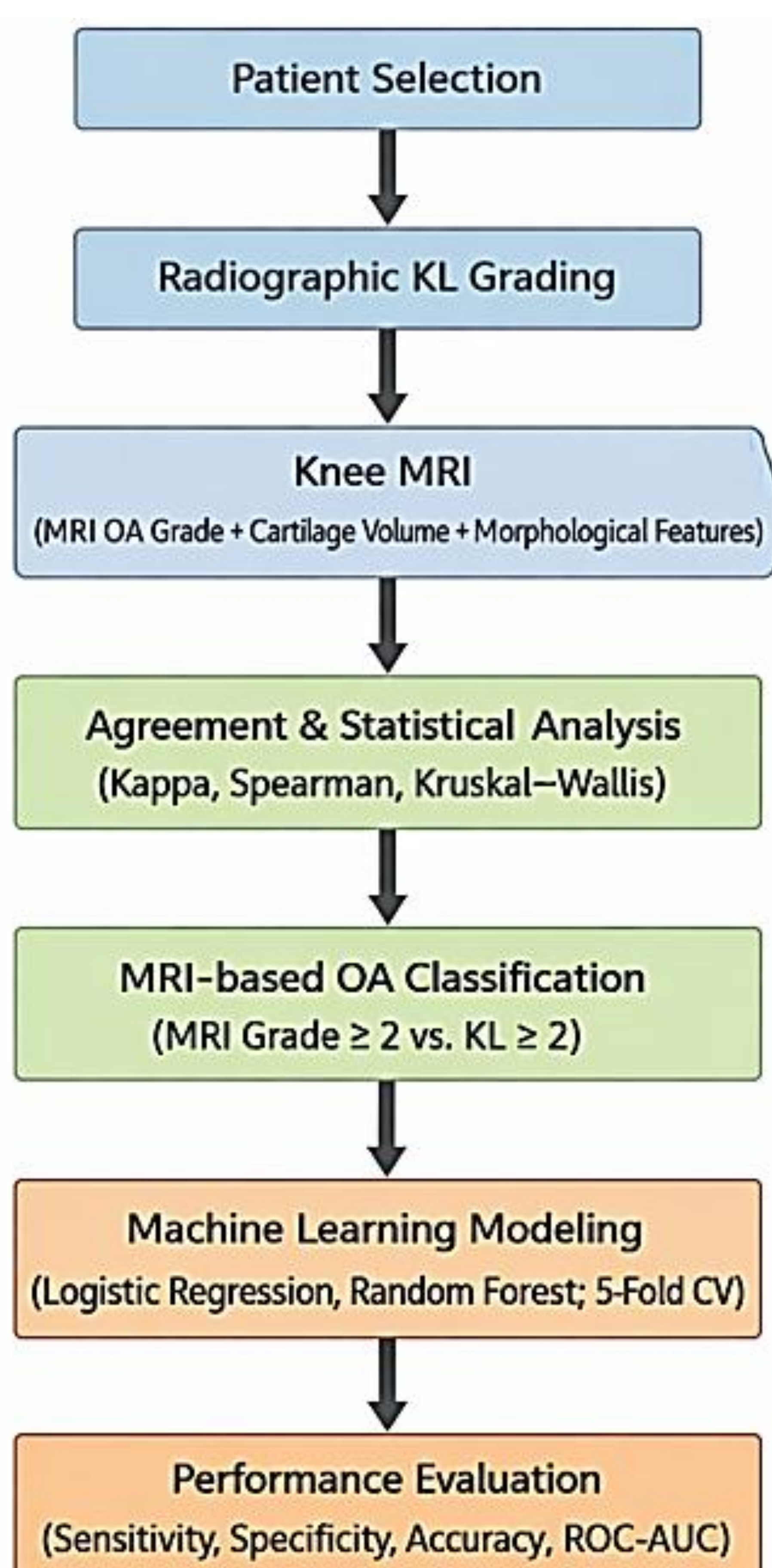
Sixty-six patients undergoing knee MRI and radiography were retrospectively analysed. Radiographic KL grade, proposed MRI grade, cartilage volume, and MRI morphological features (bone marrow edema, cartilage injury, subchondral cysts) were assessed. Agreement between MRI and KL grading was evaluated using weighted Cohen's kappa, confusion matrix, and Spearman correlation. Differences in cartilage volume across KL grades were tested using the Kruskal-Wallis test with pairwise Mann-Whitney post-hoc comparisons. Diagnostic accuracy for identifying radiographic OA (KL ≥ 2) was computed. ML-based logistic regression and random forest classifiers with stratified 5-fold cross-validation were used to predict OA, and performance was evaluated using sensitivity, specificity, and ROC-AUC.

Results

MRI grading showed excellent agreement with KL grading (quadratic weighted kappa = 0.94; Spearman $r = 0.95$, $p < 0.001$). Cartilage volume decreased significantly with increasing KL grade (Kruskal-Wallis $p < 0.001$). The diagnostic performance of MRI grading for detecting radiographic OA (KL ≥ 2) was excellent, demonstrating sensitivity above 90% and specificity exceeding 95% across tested thresholds. Furthermore, machine learning classifier models incorporating MRI features achieved an overall accuracy of 98.50%, highlighting the strong predictive value of MRI in identifying osteoarthritis.

Conclusion

MRI demonstrates excellent agreement with early radiographic KL grading. MRI-based, Machine-learning classifiers reliably identified OA, supporting MRI as a sensitive tool for early diagnosis and staging of knee OA. Larger studies are, however, required to determine the generalizability of the results of our study.



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