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Diagnosis of medial meniscus posterior root tear on Magnetic resonance imaging using deep learning

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Conflict of interest

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No conflict of interest to disclose regarding the content of this presentation

Background

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Medial meniscus posterior root tear (MMPRT)

Definition

Radial tear located within 10mm from the posterior root insertion of the medial meniscus[1].

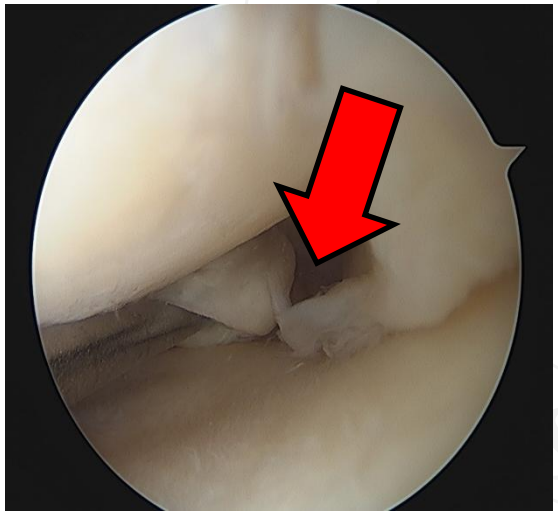

Fig. 1 Arthroscopic view of the posterior root of the medial meniscus. Red arrow indicates a medial meniscus posterior root tear.

Fig. 2 MRI coronal plane of the left knee. Red arrow indicates a medial meniscus posterior root tear.

Background

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Function

Maintains hoop tension of the medial meniscus for efficient transfer of load between the tibiofemoral joint.

Clinical Significance

Disruption of load transfer leads to extrusion of the medial meniscus from the tibial plateau, ultimately contributing to the progression of knee osteoarthritis (OA).

Accurate and **timely** diagnosis + **appropriate** treatment is crucial

Background

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PROBLEM

Diagnosis of MMPRT is usually made by magnetic resonance imaging (MRI).

➡ Associated signal changes may be subtle resulting in misdiagnosis or delayed diagnosis, especially if the reader is not conscious about detection of possible MMPRT[2,3] .

Deep learning technology may assist in timely diagnosis

Purpose

Assess the accuracy and precision of deep learning technology for diagnosing MMPRT on MRI.

Materials/Methods

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Samples

MMPRT group
MRI images
- 100 coronal
- 100 sagittal

→ Training Data
- 80 coronal
- 80 sagittal

→ Test Data
- 20 coronal
- 20 sagittal

Non-MMPRT group
MRI images
- 100 coronal
- 100 sagittal

→ Training Data
- 80 coronal
- 80 sagittal

→ Test Data
- 20 coronal
- 20 sagittal

Materials/Methods

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MRI images

- Preoperative MRI images were obtained for both groups.
- MMPRT group: MRI images from patients with arthroscopically confirmed MMPRTs.
  non-MMPRT group: MRI images from patients arthroscopically confirmed not to have MMPRTs.
- Coronal and sagittal slices for T2 STIR and fat suppression images including the medial meniscus posterior root, were obtained from picture archiving and communication system (PACS) data of patients that underwent arthroscopic knee procedures.

Materials/Methods

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- Transfer learning using efficientNet was conducted[4].
- Model evaluation was performed using confusion matrix and area under the curve (AUC) based on receiver operating characteristic (ROC).
- Occlusion sensitivity was used to visualize important features.
- Model evaluation scores were calculated using confusion matrix table.

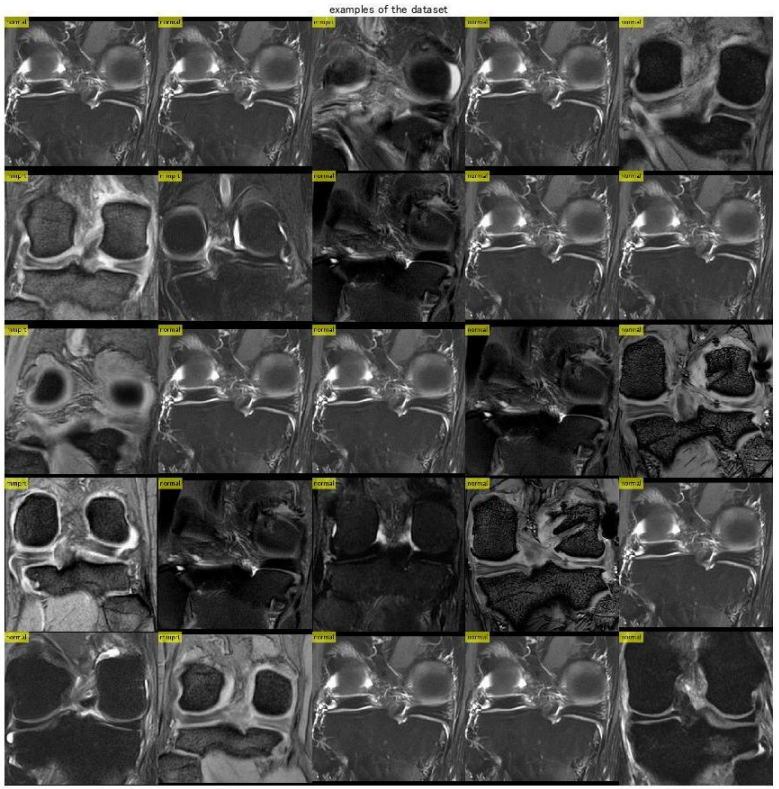

Fig. 3 Example of data set

Results

- MMPRT images from 22 patients (7 males, 15 females; mean 60.2 years)
  non-MMPRT images from 23 patients (12 males, 11 females; mean 48.7 years)
- The deep learning model focused on the posterior horn and root of the medial meniscus.

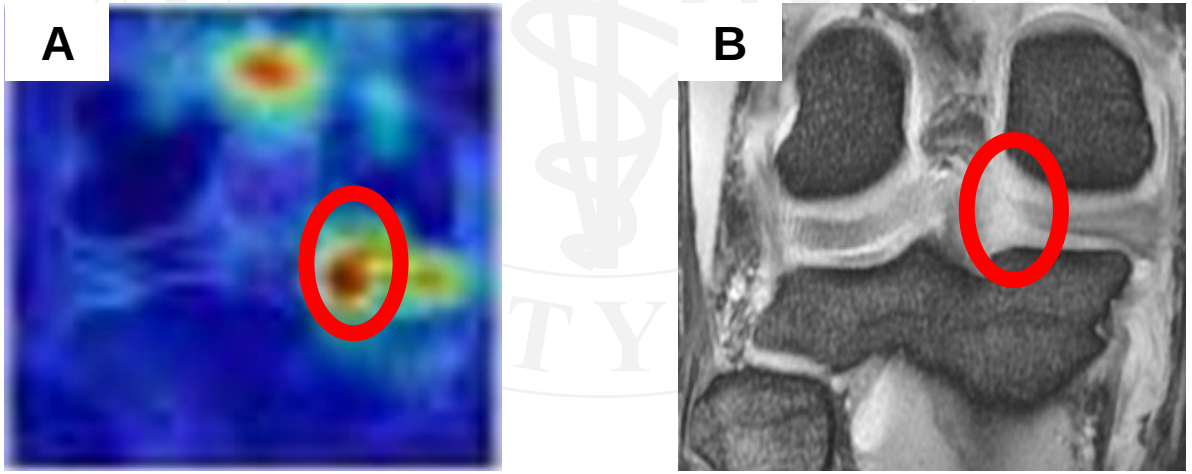

Fig. 4 Occlusion sensitivity shows regions of interest. The heat map shows interest in area of the MMPRT (fig 5A.), as seen on the MRI image (fig 5B.)

Results

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Accuracy: % of correct answers for all data
(TP+TN)/(TP+FP+FN+TN)
Precision: % of AI correctly judging MMPRT
TP/(TP+FP)
Recall: % of data correctly judged by AI as MMPRT
TP/(TP+FN)
Specificity: % of data correctly judged by AI as non-MMPRT
TN/(FP+TN)
F-measure: Harmonic mean of precision and recall
2*(precision*recall)/precision + recall

*TP: true positive, TN: true negative, FP: false positive
FN: false negative

Accuracy 86.2%
Precision = 89.7
Recall = 81.4%
Specificity = 90.9%
F-measure =85.3%

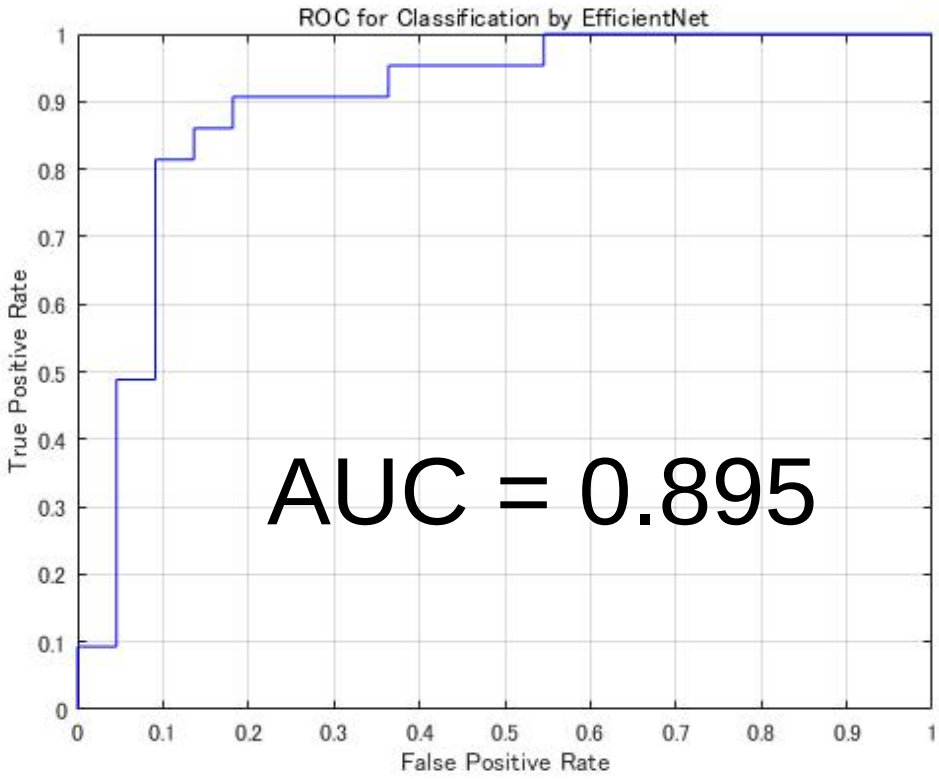

Fig. 5 Receiver operating characteristic curve for efficientNET

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Discussion

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- The most important finding of this preliminary study is that diagnosis of MMPRT on MRI using efficientNET produced accurate and precise results.

- Misdiagnosis of MMPRT on MRI is not uncommon. Previous studies have shown preoperative MRI only detected 72.9% of arthroscopically confirmed MMPRT[5] and 32.7% of cases failed to confirm MMPRT on preoperative MRI[2].

- Deep learning applied to detect different anterior cruciate ligament tear statuses on MRI has shown a high sensitivity of 97% and specificity of 97%[6]. There may be potential for application of this technology to diagnosis of MMPRT on MRI.

Conclusion

Diagnosis of MMPRT on MRI using deep learning is accurate and precise based on the current model and may potentially be used in assisting diagnosis of MMPRT

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