

## **Limited protocol MRI knee: An accurate and cost effective technique in evaluation of ligamentous and meniscal injuries.**

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## **Aims and objectives**

To determine the accuracy of limited protocol MRI knee comprising of sagittal PD and coronal STIR in the diagnosis of tears of medial meniscus, lateral meniscus, ACL and PCL in cases of acute knee pain confirmed by full protocol MRI of knee joint.

## Methods and materials

The cross-sectional study was conducted at Radiology department of a tertiary care hospital from Feb 2017 to Apr 2017. A total of 233 patients of any age or gender presenting for routine MRI knee with any complaint were included through non-probability convenient sampling. While patients with MRI claustrophobia or with any contraindication to MRI such as any metallic device or implant was excluded.

MRI was performed on 1.5 Tesla or 0.4 Tesla MRI machines. Axial and sagittal T2 weighted images, sagittal proton density images and coronal STIR images were obtained. Two sets of the images were made. One set labeled limited protocol included sagittal PD and coronal STIR images and other set included complete protocol MRI knee. Two radiologists blinded to each other's result interpreted MRI. One interpreted the full protocol and record findings and other interpreted limited protocol and record findings. The findings of limited protocol were compared with the full protocol for calculation of sensitivity, specificity, PPV, NPV and diagnostic accuracy.

SPSS version 21 was used for statistical analysis. Mean  $\pm$  standard deviation (SD) was calculated for the quantitative variable like the age while frequency and percentages were calculated for qualitative variables like gender, ACL tear, PCL tear, median meniscus tear and lateral meniscus tear on both full protocol MRI and limited protocol MRI. Diagnostic accuracy including sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of limited protocol MRI was calculated using full protocol MRI as the gold standard.

## Results

A total of 233 patients fulfilling the inclusion criteria were included in the study. There were 56 (24%) males and 177 (76%) females. The mean age of the patients was 35.83 ±13.01 years.

Diagnostic accuracy of limited protocol MRI knee for evaluation of injuries of medial meniscus, lateral meniscus, anterior cruciate ligament and posterior cruciate ligament was calculated by comparing it with full protocol MRI knee. Out of 233 patients, true positive cases for anterior cruciate ligament, posterior cruciate ligament, medial meniscus and lateral meniscus was found to be 7, 14, 142, and 52. True negative cases of the anterior cruciate ligament, posterior cruciate ligament, medial meniscus and lateral meniscus were found to be 96, 219, 91 and 181.

The calculated diagnostic accuracy of limited protocol MRI knee was 100% in all cases of medial meniscus, anterior cruciate ligament, posterior cruciate ligament and lateral meniscus injuries.

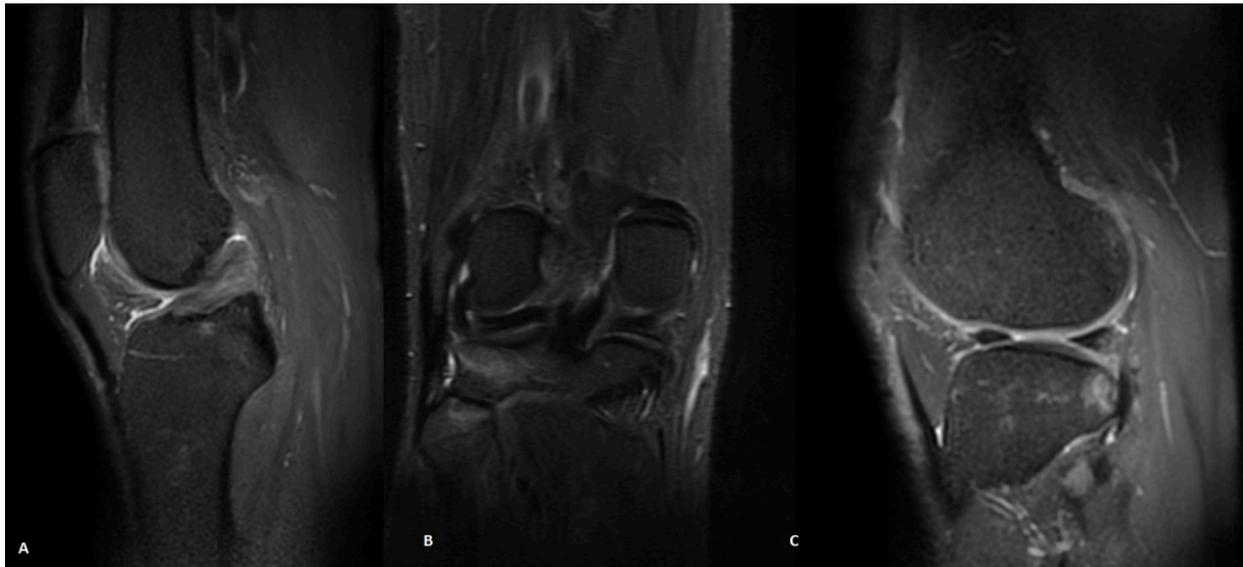
## Images for this section:



**Figure 1:** A 36-year-old female with history of trauma. (A, B) Sagittal PD weighted fat-sat image shows grade II tear of medial meniscus. (C) Sagittal PD weighted image shows tear of posterior cruciate ligament.

## Fig. 1

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**Figure 2:** A 45-year-old male with road traffic accident. (A) Sagittal PD weighted image shows complete tear of anterior cruciate ligament. (B) Coronal STIR shows bone contusion in lateral tibial condyle and fibular head. (C) Sagittal PD shows grade II tear in posterior horn of lateral meniscus.

## Fig. 2

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**Figure 3** Sagittal PD image of a 23-year-old male with history of road traffic accident shows complex tear of posterior horn of medial meniscus also extending to involve the body

**Fig. 3**

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## Conclusion

Acute traumatic knee injuries may limit full movement of knee (6) and MRI has become a reliable tool for evaluation of internal derangement of the knee resulting from trauma (7). This study was an attempt to study the use of sagittal proton density (PD) and coronal short tau inversion recovery (STIR) sequences together as a limited protocol for evaluation of knee trauma in a country where majority of population belong from socioeconomic status of lower or lower middle class (8). In evaluating the two stated sequences for the limited protocol, we found that in comparison to routine full protocol, the findings were visible without the loss of information. A high diagnostic accuracy of our limited protocol was demonstrated in the diagnosis of the anterior cruciate ligament, posterior cruciate ligament, medial meniscus and lateral meniscus. The STIR sequence had quality regarding homogeneity of the field along with suppression of fat. PD sequence had a high resolution of ligaments and cartilage.

The findings of this study report a high diagnostic accuracy for diagnosing meniscal tears. These findings are comparable to those reported by other authors. PD sequence with or without fat suppression has been used for evaluation of menisci. Different studies have shown relatively high diagnostic capabilities of PD sequence for evaluation of meniscal injuries (9, 10). Most of the injuries were evaluated in sagittal planes, however in cases of difficulty or ambiguity, the coronal plane was helpful in depicting the tears. Such observation has been reported previously (11). This technique had the comparable diagnostic capability with routine T1 and T2 weighted sequences of our full protocol and had high sensitivity and specificity. The superiority of PD sequences for meniscal injuries has also been reported by other authors (12). A possible explanation for this could be related to the high precision of PD sequence for locating the lesions at the medial and lateral parts of the meniscus leading to a high sensitivity and specificity. Another study comparing PD sequence with T1 sequence also concluded that PD may be superior for detection of meniscal tears (13).

Our study results show that the stated limited protocol was highly accurate for diagnosis of cruciate ligament tears. Limited reports exist regarding the evaluation of anterior and posterior cruciate ligaments by the limited protocol. A study reported that for evaluation of tears of cruciate ligament tears utilization of fat-suppressed PD was comparable to other routine sequences (14). Similarly, another study assessing the posterior cruciate ligament tears demonstrated the superior performance of PD in comparison to T2 weighted image (15). In our limited protocol most of the cruciate ligament tears were picked on PD sequence, however, in few cases, STIR was also helpful. Torn ligaments usually have edema and may contain proteinaceous content as well giving them high signal thus improving the sensitivity of detection.

Different studies have utilized a different combination of MRI sequences to formulate the limited protocol for evaluation of knee joint. Schafer et al (9) utilized coronal and

sagittal fat-suppressed PD sequences and yielded comparable results when compared with coronal T1 and sagittal PD. Other authors have also yielded comparable results utilizing PD sequences (16). Moreover, the comparison between PD sequences acquired by conventional spin echo and fast spin echo had found no difference between the two (17).

Time efficient and cost-saving MRI protocols have a great value in musculoskeletal radiology and in developing countries like Pakistan, such limited MR imaging protocols can help improve patient care by limiting the cost and saving time. Limited protocol lumbosacral spine protocol has yielded accurate results (18). Similarly, different authors have utilized the limited protocol for evaluation of hip joints (19, 20) and for cervical spine (21). To the best of our knowledge, we have few studies focusing on limited protocol MRI of the knee joint and only one study utilizing STIR and PD sequences (22). Roemer et al (22) utilized STIR and PD sequences for evaluation of osteoarthritis of the knee joint on a 1.0T unit, whereas we utilized the same sequences for evaluation of ligamentous and meniscal injuries on a 1.5T MR imaging system. Roemer et al (22) concluded that no loss of information was present when these sequences were utilized and similar findings were observed in our study as well.

Few potential limitations need to be considered. A major potential limitation of our study was that we utilized full protocol knee MRI as the standard reference and did not have any surgical findings or pathological correlation of our results. Another potential limitation was that we did not evaluate the interobserver and intraobserver reliability of the limited protocol MRI. Thirdly, evaluation of bone contusion and cartilage defects was not performed.

These limitations aside, we believe that the results of this study can have a potential role in the evaluation of internal derangement of the knee when there is a strong clinical suspicion of cruciate ligament or meniscal injury. This will help reach the adequate diagnosis early and save the patient from undergoing time-consuming expensive investigations. However, it is recommended that further multicentric studies on large sample size should be carried out and correlated with arthroscopy to validate the results of this study. Moreover, it is also recommended that patients having inconclusive findings on the limited protocol should undergo routine MRI study for further evaluation. Furthermore, patients having a suspicion of any malignancy or infection should undergo evaluation with full MRI study directly, preferably with contrast, to make adequate diagnosis possible.

Utilization of sagittal proton density and coronal short tau inversion recovery sequences can lead to an adequate diagnosis of cruciate ligament tears and meniscal injuries with high accuracy. This protocol can be adopted in all cases of knee injuries in developing countries so that underlying abnormality can be accurately detected at low cost.

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