Accuracy of 3T using SWI technique to detect Meniscal Tears of the knee

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Purpose

SWI is used widely in brain research. Reports focusing on its use in the knee are lacking. We found that SWI effectively demonstrates menisci, cartilage, subchondral bone, ligaments and muscles. The aim of the present study was to evaluate the feasibility and accuracy of SWI in the diagnosis of meniscal tears compared with T1WI and fat-suppressed proton-density weighted image (FS-PDWI) sequences.

Methods and Materials

Patients

From December 2011 to October 2012, we reviewed the arthroscopic examinations of 150 patients because of symptoms attributable to the meniscus or other structures of the knee at our institution. Ninety-four patients (38 men; 13-71 (mean age, 39) years) had undergone MRI and arthroscopy. Inclusion criteria were: no previous knee surgery; no other ligamentous injury of the knee; and patient agreement to undergo arthroscopic examination 24-48 h after MRI imaging of the knee.

MRI

All patients underwent MRI of the knee on a 3.0-T system (Siemens Trio, Erlangen, Germany). Patients were positioned supine, with the knee extended within a dedicated knee surface coil. Imaging involved axial, sagittal, and coronal spin-echo T1WI (TR/TE 953/20; FOV, 14 cm; matrix, 320; resolution, 0.4 × 0.4 × 3 mm; 3-mm slice thickness) PDW fast-spin echo sequences with fat saturation (TR/TE 3,000/11; FOV, 14 cm; matrix, 320; resolution, 0.3 × 0.3 × 3 mm; 3-mm slice thickness) SWI (TR/TE 23/15.2; FOV, 14 cm; matrix, 320; resolution, 0.4 × 0.4 × 3 mm; 3-mm slice thickness).

Image analyses

Each set of images from T1WI, PDWI and SWI sequences were analyzed independently by two reviewers with 9 years and 15 years of experience in the treatment of musculoskeletal radiology. Images were reviewed on a Picture Archiving and Communication System. Both radiologists were blinded to the surgical results.

The diagnostic criteria for meniscal tears were abnormal signals within the meniscus that extended to the meniscal articular surface or abnormal morphology of the meniscus [1, 13]. We did not look specifically into differences between the types of tears. All MRIs were analyzed by the two radiologists. MRIs were interpreted by consensus review. For questionable images, consensus review with a third reader was employed. MRIs were
assessed for the presence or absence of meniscal tears involving the medial and lateral menisci.

Statistical analyses

With arthroscopy as the standard of reference, the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of T1WI, PDWI and SWI using 3-Tesla MRI for the medial and lateral meniscus were calculated considering only torn menisci as positive.

McNamara’s test was used to compare the differences in the diagnosis between SWI and the other two methods. SPSS ver18.0 (SPSS, Chicago, IL, USA) was used for analyses.

Results

Medial meniscus

A total of 31 medial meniscal tears were described at arthroscopy. T1WI demonstrated 31 medial meniscal tears, and involved 29 TPs, 2 FPs, 4 TNs and 2 FNs. Therefore, the accuracy for the detection of medial meniscal tears was 89.2%, the sensitivity was 93.5%, the specificity was 66.7%, the PPV was 93.5%, and the NPV was 66.7% for T1WI.

PDWI demonstrated 31 medial meniscal tears, which involved 29 TPs, 2 FPs, 4 TNs, and 2 FNs. Therefore, the accuracy for the detection of medial meniscal tears was 89.2%, the sensitivity was 93.5%, the specificity was 66.7%, the PPV was 93.5%, and the NPV was 66.7% for PDWI.

SWI demonstrated 32 medial meniscal tears, which involved 30 TPs, 2 FPs, 4 TNs, and 1 FN. Therefore, the accuracy for the detection of medial meniscal tears was 91.9%, the sensitivity was 96.8%, the specificity was 66.7%, the PPV was 93.8%, and the NPV was 80% for SWI.

Lateral meniscus

A total of 64 lateral menisci were diagnosed as being torn. T1WI demonstrated 64 lateral meniscal tears. The results involved 59 TPs, no FPs, 3 TNs, and 5 FNs. Therefore, the accuracy for the detection of lateral meniscal tears was 92.5%, the sensitivity was 92.2%, the specificity was 100%, the PPV was 100%, and the NPV was 37.5% for T1WI.

PDWI demonstrated 61 lateral meniscal tears, which involved 61 TPs, no FPs, 8 TNs, and 1 FN. Therefore, the accuracy for the detection of lateral meniscal tears was 95.5%,
the sensitivity was 95.3%, the specificity was 89%, the PPV was 100%, and the NPV was 50% for PDWI.

SWI demonstrated 63 lateral meniscal tears, which involved 63 TPs, no FPs, 3 TNs, and one FP. Therefore, the accuracy for the detection of medial meniscal tears was 98.5%, the sensitivity was 98.4%, the specificity was 89%, the PPV was 100%, and the NPV was 75% for SWI.

According to both radiologists, there were no significant differences between T1WI and SWI (P>0.05) with regard to the diagnosis of meniscal tears, and there were no significant differences between PDWI and SWI (P>0.05) for the diagnosis of meniscal tears.

Both menisci

A total of 95 medial and lateral meniscal tears were seen at surgery. T1WI demonstrated 90 medial meniscal tears, which involved 88 TPs, two FPs, 7 TNs, and 7 FNs. Therefore, the accuracy for the detection of meniscal tears was 91.3%, the sensitivity was 92.6%, the specificity was 77.8%, the PPV was 97.8%, and the NPV was 50% for T1WI.

PDWI demonstrated 92 medial meniscal tears, which involved 90 TPs, 2 FPs, 7 TNs, and 5 FNs. Therefore, the accuracy for the detection of meniscal tears was 93.3%, the sensitivity was 94.7%, the specificity was 77.8%, the PPV was 97.8%, and the NPV was 58.3% for PDWI.

SWI demonstrated 95 meniscal tear, which involved 93 TPs, 2 FPs, 7 TNs, and 2 FNs. Therefore, the accuracy for the detection of medial meniscal tears was 96.2%, the sensitivity was 97.9%, the specificity was 77.8%, the PPV was 97.9%, and the NPV was 77.8% for SWI.

There were no significant differences between the radiologists when evaluating T1WI, PDWI and SWI of meniscal tears.

Conclusion

In this study, patients who had undergone routine sequences and SWI of knee and arthroscopy, This study found that the sensitivity and accuracy of MRI for detecting meniscal tears were high. However, there were no significant differences in meniscal tears between sensitivity, specificity, and accuracy of readings for SWI, T1WI and PDWI images. Therefore, the use of SWI to establish or confirm a diagnosis of meniscal tear can use in clinical practice.
SWI had the higher sensitivity and accuracy than those of T1WI and PDWI. There was no significant differences were observed between SWI, T1WI and PDWI in the diagnosis of meniscus tear for both readers.

In the diagnosis of meniscal tear, the finding of surfacing intrameniscal T1WI- or PDWI at conventional MR imaging establish or confirm a diagnosis has become a routine part of clinical practice. It is a non-invasive technique with high accuracy for meniscal tears. A short TE is necessary for imaging linear tears in the menisci. Currently, SWI has become a useful tool for evaluation of neurologic disorders and is becoming more widely used in peripheral vessel, spine imaging and abdomen. In this study, SWI sequence was successfully attempted for knee in meniscal tear patients. Susceptibility weighted image (SWI) can identify susceptibility differences between tissues resulting from sources such as venous blood, calcification, hemorrhage, iron, etc. Williams et al. report that UTE-T2* values tended to be lower in histologically and clinically normal meniscus tissue and higher in torn or degenerate tissue. SWI uses a specific algorithm based on GRE T2* weighted magnitude and phase data to create images sensitive to variations in tissue magnetic susceptibility. The normal menisci is composed of fibrocartilaginous tissue, in contrast, a torn meniscus is composed of mucinous ground substance, regenerative chondrocytes, variable synovial in growth, and neovascularity. The histopathic status of meniscus tear tissue can reflected by the magnitude, phase and spatial distribution of T2* values. In this study, SWI had the highest sensitivity, accuracy and NPV in the diagnosis of meniscal tears (Fig 1, 2). Therefore, our results may demonstrate that SWI using phase and magnitude information is comparable with T1WI and PDWI. The qualitative analysis of T1WI, PDWI and SWI were no significant differences (P>0.05) from both radiologists. Almost all the pictures were corresponding to the diagnosis requirement.

The NPV of T1WI and PDWI were low in this study. We consider that there was hard for us to distinguish the grade 2 and grade 3 sometimes. We often encounter a questionable articular surface or free-edge irregularity and increased intrameniscal signal that approaches the articular surface but does not definitely touch the surface. However, it is unclear whether these findings correspond to meniscal tears on T1WI and PDWI. SWI provides higher contrast between the torn menisci and normal menisci than on T1WI and PDWI (Fig 3, 4).

There are several limitations to this study. First, the small number of patients limited enough to show differences between the two sequences under consideration. A large number of patients might thus be necessary to confirm SWI as a substitute for T1WI and PDWI imaging. The second limitation is that Context bias was also possible because the two readers were aware that all patients had undergone arthroscopy, which may have increased the likelihood of the readers interpreting an abnormality as a tear. The potential for context bias was reduced by the fact that patients with positive findings for any one of several structures underwent surgery.
In conclusion, SWI can be used in the diagnosis of meniscal tears. The sensitivity, accuracy, NPV is higher than those of T1WI and PDWI.

References


**Personal Information**