Accuracy of SPECT bone scintigraphy in diagnosis of meniscal tears

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ABSTRACT

Introduction: *Scintigraphy has been considered as a useful tool in the assessment of meniscal tears. Our objective was to assess the accuracy of single photon emission tomography (SPECT), using MRI as the gold standard, in the diagnosis of meniscal tears.*

Materials and Methods: *Between January 2003 and February 2005, 48 patients were studied with SPECT and MRI.*

Results: *The respective sensitivity rate, specificity rate, and positive and negative predictive accuracies of SPECT were 78 %, 88 %, 80 %, and 86 %.*

Conclusion: *SPECT is a valuable imaging technique and could be considered as competitive for MRI in diagnosis of meniscal tears. SPECT is specially a useful alternative when MRI is unavailable or unsuitable and it is beneficial when more possible accuracy is desired (when MRI results are either inconclusive or contradict with other clinical data).*

Key Words: *MRI, Bone SPECT, Meniscal tear.*

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Introduction

In the evaluation of the menisci, most of the time a good physical examination will determine the diagnosis, but sometimes the cause of pain will remain unclear. In these situations, a MRI of the knee can be obtained and is often very useful in confirming the diagnosis. It is generally accepted that MRI scans of the knees are the best diagnostic imaging tool available for the interior of the knee joint, but they do have some limitations. They are excellent at imaging the meniscal cartilage and if a tear is present or absent. However, MRI will misdiagnose 3-5% of meniscal injuries (1). MRI scans are also expensive, so they are ordered only when they make a contribution to the treatment of the knee problem.

On the other hand, although it is not widely carried out in clinical practice, nuclear medicine procedures have also been used in diagnosing meniscal tears and some authors have demonstrated the usefulness of SPECT in the assessment of knee injuries (2-6).

It is believed that the best tool for confirming a diagnosis of a tear is actually looking at the menisci through the arthroscope. However, the rate of unnecessary arthroscopies can be lowered by means of a preliminary imaging selection of patients who will benefit from the arthroscopy. This article presents a prospective study comparing SPECT of the knees with MRI in the diagnosis of meniscal tears.

Methods and Patients

From July 2003 to February 2005, 48 MRI and SPECT examinations were performed in 48 consecutive patients (43 men and 5 women). The time interval between the SPECT and MRI examinations was 2 days to 6 weeks.

MRI: All studies were performed using a scanner (IGE Medical Systems, Signa Herza, Milwaukee, WI) with a 1.5 Tesla magnet. The knee was placed in an extended position with approximately 15° of external rotation. The imaging protocol included sagittal multiecho (repetition time msec/echo time msec, 2,500–3,600/20–120), coronal T1-weighted (600/12), coronal multiecho (2,500–3,000/17–119), and transverse gradient-echo or turbo T2-weighted sequences with a slice thickness of 4.5 mm, no interslice gap, and a matrix of 256 × 256 . MRI results were reported by a radiologist experienced in MRI of the knees.

SPECT: SPECT studies were performed on a dual head ADAC camera, equipped with a pair of low energy, high resolution collimators. Three hours after IV injection of 750 MBq (20 mCi) ^{99m}Tc-methylene diphosphonate (^{99m}Tc–MDP), anterior, posterior, medial and lateral views of both knees and also SPECT mode acquisition of the knee images were obtained. Images were acquired in a 128 × 128 matrix at 64 steps, 40 s each step. Data were processed by back projection and filtered by Hanning 0.8 filter. Images were reconstructed and displayed in all three orthogonal planes.

Statistical Evaluation: Results were analyzed on a per-meniscus basis. Using MRI as a gold standard, the results of bone SPECT were analyzed for sensitivity, specificity, negative predictive value and positive predictive value. All patients gave informed consent to participate in this study, which was approved by the committee on ethics at the faculty of medicine, university of Tehran.

Results

A total of 96 menisci, including 48 left and 48 right menisci, in 48 patients were assessed. Of these, 11% were female and 89% were male,

with a mean age of 22 ± 1.5 years (range, 15–59 years).

Using MRI as the gold standard, tears were present in 35 (36 %) menisci (Figure 1&2). SPECT detected 34 meniscal tears, of which 7 was falsely positive. Therefore, the false-positive rate was 8 % (7 of 96 menisci). One knee showed generalized increased uptake on bone SPECT images, in which the scan could not determine the exact anatomical location of the pathologic process and the bone scan finding was categorized as false-negative for meniscal tear. Overall, there were only 8 false-negative SPECT scans, resulting in a false-negative rate of 9 % (8 of 96 menisci) (Table1).

In the final interpretation, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the SPECT in the identification of meniscal tears, were 78, 88, 80, and 86 %, respectively.

Table 1. SPECT results regarding the gold standard (MRI).

	Number
True positive	29
False positive	7
True negative	52
False negative	8

Figure 1. Magnified coronal T2-weighted MRI image show a medial meniscal tear.

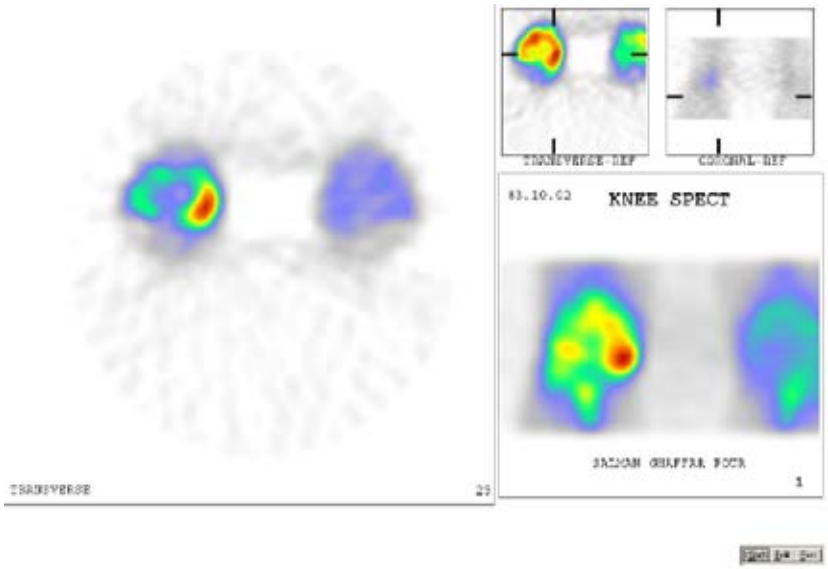

Figure 2. SPECT images of the same patient show a crescent of increased activity in the medial tibial plateau which is characteristic feature of meniscal tear.

Discussion

MRI has become the radiologic procedure of choice for the diagnosis of soft tissue derangements of the knees. However, some authors have reported that SPECT is valuable in the preoperative assessment of knee pathologies (7-9). In fact, recently SPECT has also begun to be used for detection of meniscal tears and has been documented to have a higher sensitivity than MRI. Generally, very few studies have directly compared SPECT and MRI in the specific indication of the detection of meniscal tears. Most of these reports determined that the spatial resolution of MRI remains superior, but SPECT has repeatedly been proven to detect and characterize tears with greater accuracy than MRI.

In 1998, Ryan PJ et al. studied 100 patients with undiagnosed knee pain by clinical examination, MRI, SPECT bone scintigraphy and arthroscopy (10). Using arthroscopy as a gold standard, both MRI and SPECT showed high diagnostic ability to detect meniscal tears, with respective sensitivity rate, specificity rate, and positive and negative predictive accuracies of 80%, 71%, 84% and 71% for MRI and 84%, 80%, 88% and 76% for SPECT. Some meniscal tears were detected by MRI alone (n=5), or SPECT alone (n=8). The authors found that the comparable diagnostic ability of SPECT bone scintigraphy implies that it can be used successfully when MRI is unavailable or unsuitable. This study prompted an editorial by Ryan in Nuclear Medicine Communications that advocated the application of SPECT, when MRI is unavailable or unsuitable (11).

Most recently Vellala RP et al assessed the role of single photon emission computed tomography bone scan for the diagnosis of knee lesions in routine clinical practice in 40 patients(12). The sensitivity of SPECT scans in detecting medial meniscal and lateral meniscal was 77% and 14%, respectively. The specificities for the same structural lesions were high at 89% and 94%, respectively. These investigators concluded that SPECT bone scan appears to be useful in the diagnosis of knee pathology in routine practice and in selecting patients for

arthroscopy, especially most useful for the diagnosis of medial meniscal tears.

In our study SPECT revealed the majority of lesions seen on arthroscopy and MRI. The major limitation of this study was considering MRI as the gold standard. MRI itself has some drawbacks, which make it unsatisfactory to be a gold standard and if arthroscopy is considered as the reference test, MRI will have some false positive and false negative results. On the other hand, both MRI & SPECT have various relative advantages and disadvantages. In general, SPECT is less costly than MRI because it involves lower capital equipment costs. SPECT is also widely available. The major limitation with the use of SPECT is the radiation exposure.

Magnetic resonance imaging has some advantages over SPECT of the knees too. Most significantly, no ionizing radiation is used but it is more expensive than SPECT and in general, MRI has more contraindications and scheduling difficulties. Some authors concluded that MRI, except in certain circumstances, is an expensive and unnecessary diagnostic test in patients with suspected meniscal and ACL pathology (may be due to many false positive MRI reports) (1). These facts in addition the above-mentioned research results indicate that SPECT and MRI are both valuable advanced imaging techniques but the absence of radiation exposure may make MRI preferable for the workup of patients suspected of having meniscal tears. However SPECT has clear advantages when more possible accuracy is desired such as when MRI results are either inconclusive or contradict with other clinical data (i.e. SPECT should be performed if MRI is negative but there are clinical evidences of meniscal tear). Also SPECT is available alternative when MRI is unavailable or unsuitable. This approach must be addressed in larger series of patients and a larger prospective study is currently being performed at our institution to confirm these data and approach.

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