

# Single photon emission computed tomography scanning in the diagnosis of knee pathology

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## ABSTRACT

**Purpose.** To evaluate the role of single photon emission computed tomography (SPECT) bone scan for the diagnosis of knee lesions in routine clinical practice.

**Methods.** 40 consecutive case records were examined in patients who underwent a SPECT scan prior to knee arthroscopy in routine clinical practice. The accuracy of clinical examination, SPECT scan results, and arthroscopic findings (as the gold standard) in diagnosing knee lesions were compared.

**Results.** The sensitivity of SPECT scans in detecting medial meniscal, lateral meniscal, anterior cruciate ligament lesions, osteochondral defects, and chondromalacia patellae was 77%, 14%, 33%, 50%, and 74%, respectively. The specificities for the same structural lesions were high at 89%, 94%, 97%, 94%, and 69%, respectively.

**Conclusion.** 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.

**Key words:** anterior cruciate ligament; arthroscopy; knee injuries; magnetic resonance imaging; sensitivity and specificity; tomography, emission-computed, single-photon

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## INTRODUCTION

A significant proportion of patients attending orthopaedic out-patient clinics present with knee disorders. Antecedent history and clinical examination direct further management of these patients. It is recognised that clinical examination is unreliable compared with arthroscopic findings.<sup>1-5</sup> Although arthroscopy offers the advantage of

treating patients at the time of diagnosis, it is more expensive and, as an invasive procedure, it carries the risks associated with anaesthesia and additional costs. Therefore, selection of patients for arthroscopy is required.

Published evidence suggests that magnetic resonance imaging (MRI)<sup>1,6-14</sup> and single photon emission computed tomography (SPECT) scans<sup>15-20</sup> are useful tools to delineate the lesions prearthroscopically. MRI has established itself as the investigation of choice as it gives good anatomical detail. However, MRI is expensive, time-consuming and, in our institute, requires longer waiting times. This led us to look for alternative modes of investigation. SPECT scanning has proved a useful alternative to MRI and also has an important role where MRI is contraindicated and when examination of other structures such as hips is required.<sup>15</sup> The purpose of this study was to evaluate the role of SPECT imaging in a routine clinical setting.

## MATERIALS AND METHODS

We reviewed patients who had arthroscopy over a period of 2 years and then identified 40 patients who underwent a SPECT scan investigation prior to arthroscopy of the knee. SPECT was performed by injecting 800 MBq Technetium-99 labelled methyl diphosphonate (<sup>99</sup>Tc-MDP). A 2-phase study of the knees followed by SPECT was performed on each patient. None of these patients had an MRI scan. Details of these patients are given in Table 1.

All SPECT scans were interpreted by an experienced specialist in nuclear medicine, and arthroscopy

**Table 1**  
Details of patients studied

Details	
Female:male	22:18
Mean age (range) [years]	40 (14-65)
Mean (range) period from time of injury to SPECT [months]	6 (1-19)
Mean (range) period from time of injury to arthroscopy [months]	15 (1-15)

**Table 2**  
Summary of arthroscopic findings

Involved structures	No. of patients with identified lesions
Medial meniscal tear	13
Lateral meniscal tear	7
Anterior cruciate ligament rupture	3
Osteochondral lesion	8
Chondromalacia patella	27

was performed by or was supervised by an experienced orthopaedic surgeon—either a consultant (n=27) or a registrar (n=13). The results of the clinical examination and SPECT scan were then compared to the findings of arthroscopy which were taken as a gold standard for our study and values of sensitivity, specificity, positive predictive value, and negative predictive value were derived.

## RESULTS

The arthroscopic findings revealed normal exami-

**Table 3**  
Summary of outcome

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Medial meniscal lesion				
SPECT scan	77%	89%	0.8	0.9
Clinical examination	46%	67%	0.4	0.7
Lateral meniscal lesion				
SPECT scan	14%	94%	0.3	0.8
Clinical examination	0%	91%	0	0.8
Anterior cruciate ligament injury				
SPECT scan	33%	97%	0.5	0.9
Clinical examination	67%	92%	0.4	0.9
Osteochondral lesion				
SPECT scan	50%	94%	0.7	0.9
Clinical examination	11%	97%	0.5	0.8
Chondromalacia patella				
SPECT scan	74%	69%	0.8	0.6
Clinical examination	15%	77%	0.6	0.3

nations (n=6), isolated lesions (n=13), and combined lesions (n=21). None of these patients had lesions in the posterior cruciate, medial collateral, or lateral collateral ligaments. The arthroscopic findings are summarised in Table 2.

Further calculations were carried out to assess sensitivity, specificity, positive predictive value, and negative predictive value for all of the above areas (Table 3).

## DISCUSSION

The unreliability of clinical examination<sup>1-5</sup> and the invasiveness of arthroscopy mean that there is a strong need for non-invasive diagnostic tests for the investigation of knee disorders. Clinical diagnosis of medial meniscal lesions has proved to be particularly unreliable<sup>2,4,5</sup> so as partial tears of anterior cruciate ligaments (ACL).<sup>3,4</sup> MRI has established its role for non-invasive investigation.<sup>1,6-14</sup> However, MRI is time-consuming and has a high false-positive rate.<sup>21-23</sup> Bone SPECT scan has been shown to be a useful tool<sup>15-20</sup> in limited series. In one study by Ryan et al.,<sup>20</sup> SPECT scan was comparable to MRI in diagnosing meniscal tears, ACL rupture, and chondromalacia patellae (CMP).

In this study for medial meniscal lesions, SPECT scan has shown a sensitivity of 77% and a specificity of 89%. These results are consistent with those published in the literature—a sensitivity of 77% to 89% and a specificity of 74% to 80%. However, previous studies did not assess the medial and lateral menisci separately.

The sensitivity and specificity of SPECT scan for lateral meniscal lesions in this study were 14% and 94%, respectively. These results were disappointing and the reasons remain unclear. Possible explanations include patients with long-standing or relatively minor lesions.

Published evidence suggests that SPECT scan can

be nearly as sensitive (88%)<sup>8</sup> as MRI (95%).<sup>6</sup> However, in this study, the sensitivity of SPECT scan for ACL injuries was only 33%. The low sensitivity value in our study may be explained by unreliability as a result of a small sample number of ACL lesions.

Other lesions that were found frequently in our study were CMP and osteochondral lesions (OCL). For CMP, published sensitivities with MRI vary between 26% and 84% and are dependent on the size of the lesion. In this study, the sensitivity and specificity of SPECT scan for CMP was 74% and 69%, respectively, and there is evidence that specificity can be as high as 90%.<sup>20</sup> The sensitivity and specificity of SPECT scan for OCL was 50% and 94%, respectively, compared with published MRI data<sup>14</sup> of 87% in sensitivity and 94% in specificity.

## CONCLUSION

In a situation where the waiting period for MRI scan is very long, bone SPECT scan can be helpful—especially for the diagnosis of medial meniscal lesions—in selecting patients for arthroscopy. The high specificity of the SPECT scan for meniscal lesion suggests that this is a valuable technique to evaluate major knee pathology. In a given clinical situation, MRI and bone SPECT scans may be complimentary to each other. Further 'blinded' studies, of considerably larger sample size, would be useful to assess the role of bone SPECT scan in the diagnosis of knee pathology in routine clinical practice. With specific regard to lateral meniscal lesions, the criteria for diagnosis may need to be further considered.

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## REFERENCES

1. Spiers AS, Meagher T, Ostlere SJ, Wilson DJ, Dodd CA. Can MRI of the knee affect arthroscopic practice? A prospective study of 58 patients. *J Bone Joint Surg Br* 1993;75:49-52.
2. Munk B, Madsen F, Lundorf E, Staunstrup H, Schmidt SA, Bolvig L, et al. Clinical magnetic resonance imaging and arthroscopic findings in knees: a comparative prospective study of meniscus, anterior cruciate ligament and cartilage lesions. *Arthroscopy* 1998;14:171-5.
3. Lintner DM, Kamaric E, Moseley JB, Noble PC. Partial tears of the anterior cruciate ligament. Are they clinically detectable? *Am J Sports Med* 1995;23:111-8.

4. Solomon DH, Simel DL, Bates DW, Katz JN, Schaffer JL. The rational clinical examination. Does this patient have a torn meniscus or ligament of the knee? Value of the physical examination. *JAMA* 2001;286:1610–20.
5. Curtin W, O'Farrell D, McGoldrick F, Dolan M, Mullan G, Walsh M. The correlation between clinical diagnosis of knee pathology and findings at arthroscopy. *Ir J Med Sci* 1992;161:135–6.
6. Rappeport ED, Wieslander SB, Stephensen S, Lausten GS, Thomsen HS. MRI preferable to diagnostic arthroscopy in knee joint injuries. A double-blind comparison of 47 patients. *Acta Orthop Scand* 1997;68:277–81.
7. Chen MC, Shih TT, Jiang CC, Su CT, Huang KM. MRI of meniscus and cruciate ligament tears correlated with arthroscopy. *J Formos Med Assoc* 1995;94:605–11.
8. Chung HW, Kim YH, Hong SH, Kim SS, Chung JK, Seong SC, et al. Indirect signs of anterior cruciate ligament injury on SPET: comparison with MRI and arthroscopy. *Nucl Med Commun* 2000;21:651–8.
9. Vallotton JA, Meuli RA, Leyvraz PF, Landry M. Comparison between magnetic resonance imaging and arthroscopy in the diagnosis of patellar cartilage lesions: a prospective study. *Knee Surg Sports Traumatol Arthrosc* 1995; 3:157–62.
10. Warwick DJ, Cavanagh P, Bell M, Marsh CH. Influence of magnetic resonance imaging on a knee arthroscopy waiting list. *Injury* 1993;24:380–2.
11. Kriegsman J. Negative MRI findings in knee injury: clinical implications. *Contemp Orthop* 1991;22:549–55.
12. Elvenes J, Jerome CP, Reikeras O, Johansen O. Magnetic resonance imaging as a screening procedure to avoid arthroscopy for meniscal tears. *Arch Orthop Trauma Surg* 2000;120:14–6.
13. De Smet AA, Tuite MJ, Norris MA, Swan JS. MR diagnosis of meniscal tears: analysis of causes of errors. *AJR Am J Roentgenol* 1994;163:1419–23.
14. Potter HG, Linklater JM, Allen AA, Hannafin JA, Haas SB. Magnetic resonance imaging of articular cartilage in the knee. An evaluation with use of fast-spin-echo imaging. *J Bone Joint Surg Am* 1998;80:1276–84.
15. Ryan PJ. Bone SPECT of the knees. *Nucl Med Commun* 2000;21:877–85.
16. Ryan PJ, Taylor M, Grevitt M, Allen P, Shields J, Clerke SE, et al. Bone single-photon emission tomography in recent meniscal tears: an assessment of diagnostic criteria. *Eur J Nucl Med* 1993;20:703–7.
17. So Y, Chung JK, Seong SC, Sohn YJ, Kang HS, Lee DS, et al. Usefulness of <sup>99</sup>Tcm-MDP knee SPET for pre-arthroscopic evaluation of patients with internal derangements of the knee. *Nucl Med Commun* 2000;21:103–9.
18. Grevitt MP, Taylor M, Churchill M, Allen P, Ryan PJ, Fogleman I. SPECT imaging in the diagnosis of meniscal tears. *J R Soc Med* 1993;86:639–41.
19. Cook GJ, Ryan PJ, Clarke SE, Fogelman I. SPECT bone scintigraphy of anterior cruciate ligament injury. *J Nucl Med* 1996;37:1353–6.
20. Ryan PJ, Reddy K, Fleetcroft J. A prospective comparison of clinical examination, MRI, bone SPECT, and arthroscopy to detect meniscal tears. *Clin Nucl Med* 1998;23:803–6.
21. Fischer SP, Fox JM, Del Pizzo W, Friedman MJ, Snyder SJ, Ferkel RD. Accuracy of diagnoses from magnetic resonance imaging of the knee. A multi-center analysis of one thousand and fourteen patients. *J Bone Joint Surg Am* 1991;73:2–10.
22. Raunest J, Oberle K, Loehnert J, Hoetzinger H. The clinical value of magnetic resonance imaging in the evaluation of meniscal disorders. *J Bone Joint Surg Am* 1991;73:11–6.
23. Mink JH, Levy T, Crues JV 3rd. Tears of the anterior cruciate ligament and menisci of the knee: MR imaging evaluation. *Radiology* 1988;167:769–74.