

Limited Magnetic Resonance Imaging (MRI) and the Occult Hip Fracture

K B L Lim,*^{BMBS (Nottm), FRCS (Eng), FRCS (Edin)}, A K H Eng,**^{MBBS}, S M Chng,**^{MBBS, FRCR (UK)},
A G S Tan,***^{MBBS, FRCR (UK)}, F L Thoo,****^{FAMS, MBBS, FRCR (UK)}, C O Low,^{†FAMS, MBBS, FRCS (Glas)}

Abstract

Introduction: Diagnosis of hip fracture is normally readily made from clinical evaluation and plain radiographs. Occasionally, clinical suspicion of fracture is not confirmed on plain X-rays. **Materials and Method:** Between January 2001 and March 2002, 422 patients were admitted to our department for post-traumatic hip pain. The diagnosis of hip fracture was unequivocally made in 365 patients (86%). Fifty-seven (14%) patients had a negative or equivocal radiograph. **Results:** Limited magnetic resonance imaging (MRI) of the hip in this group of 57 patients confirmed that 8 (14%) sustained a femoral neck fracture, while 5 (9%) had an intertrochanteric fracture. In 19 patients (33%), some other pathology was found, mainly stable fractures of the femoral trochanters and pubic rami. Overall, 32 scans (56%) were positive and 25 (44%) were negative. Limited MRI detected patients with undisplaced hip fractures and identified them as candidates for surgery. **Conclusion:** The use of MRI in this specific and 'limited' way provides orthopaedic surgeons with a rapid, accurate and cost-effective diagnostic tool in this clinical scenario. Definitive diagnosis allows the correct management plan to be implemented early. We recommend that patients, who have significant hip pain following injury but indeterminate plain radiographs, undergo a limited MRI scan as a matter of routine.

Ann Acad Med Singapore 2002; 31:607-10

Key words: Femoral neck, Hip pain, Proximal femur, Trauma

Introduction

Worldwide, in the past decade, the application of magnetic resonance imaging (MRI) has increased tremendously in the management of musculoskeletal trauma.^{1,2} Not least is its application as a valuable diagnostic tool in occult hip fracture evaluation.^{3,4}

A fracture of the neck or intertrochanteric region of the femur is a common injury in the elderly population, and carries with it significant morbidity and mortality. Diagnosis is usually straightforward, based on clinical assessment and plain radiographs. Occasionally, conventional radiographs are unhelpful, particularly in patients with severe osteoporosis, or who have impacted or undisplaced fractures.

The use of MRI in the evaluation of hip pathology has been reported in the literature. MRI has been shown to be superior to other imaging modalities in occult hip fracture

diagnosis.^{5,6} With better quality of life and increasing life expectancy, the incidence of falls and hip fracture will continue to rise. We decided to evaluate the usefulness of the "limited" MRI scan in patients with a painful hip following injury. A limited MRI scan involves two sequences in the coronal plane, and a further sequence in the sagittal plane if a fracture is detected.

Unlike other studies in the literature, each request for a limited MRI scan of the hip is made only after careful evaluation by senior (consultant-grade) staff, based on clinical assessment and high-quality plain radiographs. In an ideal situation, all radiographs are immediately reported by a qualified radiologist in the first instance, but in clinical practice, this privilege is not routine.

No similar studies have been reported on an Asian population. We are not aware of a larger series in the literature at the present time.

* Registrar

** Medical Officer

† Head and Senior Consultant

Department of Orthopaedic Surgery

*** Radiology Registrar

**** Consultant Radiologist

Department of Radiology

Changi General Hospital

Address for Reprints: Dr Kevin B L Lim, Department of Orthopaedic Surgery, Changi General Hospital, 2 Simei Street 3, Singapore 529889.

E-mail: kevinlim8802@hotmail.com

Materials and Method

Between January 2001 and March 2002, 422 patients were admitted to our department with a definite, or suspected, hip fracture. In 365 patients (86%), the diagnosis was straightforward as plain radiographs readily confirmed the clinical features of fracture (Figs. 1 & 2).

In the remaining 57 patients (14%), clinical suggestion of hip fracture was not confirmed on initial plain X-rays. Patients with poor quality plain films of the hip were sent for a repeat X-ray. Each patient in this group was assessed clinically; hip X-rays were read by the department’s consultants collectively. With the exception of Sundays and public holidays, this is a daily routine in our department. If the X-ray was negative or equivocal for fracture, the patient was included in the study and went on to have a limited MRI of the hip. There were no exclusions because of in-situ metallic implants or prostheses.

All scans were performed on a Magnetom Vision (Siemens Medical Systems, Germany) 1.5 Tesla scanner. For these limited MR scans for suspected hip fractures,

coronal spin echo T1 weighted (90° flip angle, TR = 435, TE = 14, 256 x 256 matrix, 4 mm slice thickness) and coronal T2 weighted turbo inversion recovery magnitude (180° flip angle, TR = 4000, TE = 30, TI = 150, 256 x 256 matrix, 4 mm slice thickness) were done.

Results

Fifty-seven patients with clinical features of hip fracture, but without plain X-ray confirmation (Fig. 3), underwent a limited MRI of the hip. Of the 57 patients included in the study, 43 (75%) were males and 14 (25%) were females. The age range of the 57 patients was 12 to 96 years (mean, 71.8 years; SD, 20.1 years). There were 42 Chinese, 10 Malay, 4 Indian and 1 Caucasian patients. There were 5 patients below the age of 40. A 22-year-old male was the youngest patient in this series who was diagnosed with an undisplaced femoral neck fracture at limited MRI.

Thirty-two of the 57 scans (56%) were positive; the rest were entirely normal (25/57 scans or 44%). In the former

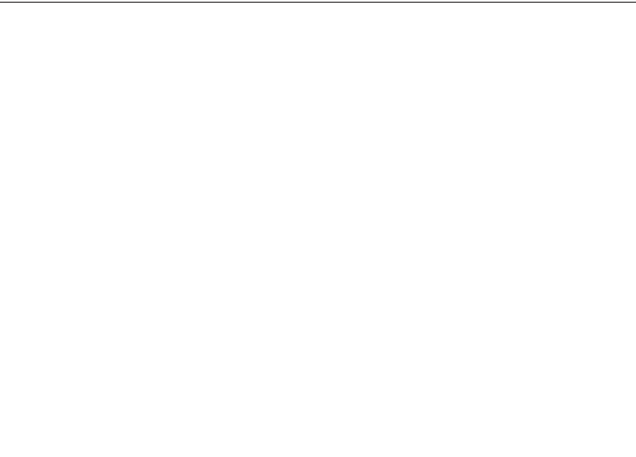


Fig. 1. Left hip radiograph illustrating a displaced intertrochanteric fracture.



Fig. 2. Right hip radiograph showing an undisplaced femoral neck fracture.

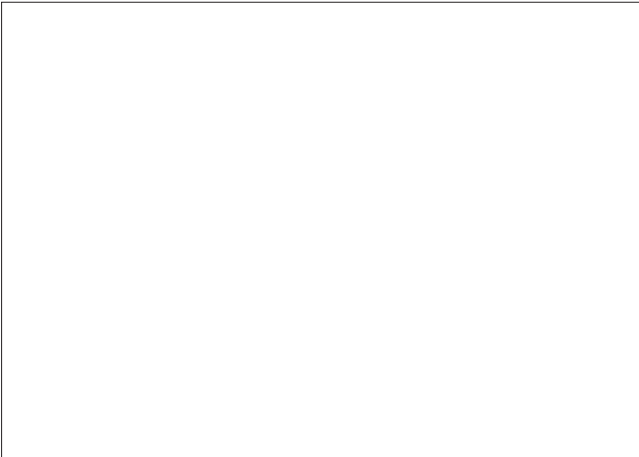


Fig. 3. Equivocal left hip X-ray; no obvious fracture but some sclerosis in the region of the femoral neck.



Fig. 4. T1-weighted limited MRI scan of the same patient (as Fig. 3) showing a hypointense line in the left femoral neck region, representing an undisplaced fracture.

TABLE I: RESULTS OF MRI SCAN

Limited MRI diagnosis	No.	%
Femoral neck fracture	8	14
Intertrochanteric fracture	5	9
Other pathology	19	33
Normal scan	25	44
Total	57	100

MRI: magnetic resonance imaging

group, 8 (14%) were diagnosed with neck of femur fracture (Fig. 4), and 5 were diagnosed with intertrochanteric fracture (9%). In the remaining 19 patients, some other fracture was diagnosed in the majority. In 1 patient, MRI revealed “abnormal marrow in the left acetabulum and pelvis” which was suspicious of metastasis. This patient was further evaluated and investigations were negative for metastatic disease.

Discussion

We live in a climate of medical practice where patient expectations are high and medico-legal cases are on the increase. While it was acceptable a decade ago to keep a patient on traction in hospital for a week or longer for a *possible* hip fracture, this is no longer the case. Early, accurate diagnosis allows doctors to formulate and initiate the correct plan of management. The advantages of early diagnosis include prompt surgery, early postoperative mobilisation, and fewer complications related to prolonged bed rest and immobilisation. A missed hip fracture that subsequently displaces is a disaster and clearly has medico-legal implications.

Discussion of Results

Our study shows that 57 of 422 patients (13.5%) with post-traumatic hip pain had clinical features of hip fracture but had no obvious fracture on plain X-ray. At limited MRI scan of the hip, 32 cases (56%) were positive. In this group, 13 hip (8 femoral neck and 5 intertrochanteric) fractures were diagnosed. Where appropriate, the patients and their families were counselled and offered surgery. The remainder (25) was managed conservatively. A single case was investigated further to exclude bony metastases.

Limited MRI was conclusive in all 57 cases. Thirteen hip fractures (23%) that would have benefited from early surgery would have been missed on clinical findings and plain radiography alone. Likewise, 18 patients with a stable fracture (that did not require surgery) and 25 with normal hips would have been confined to bed and traction unnecessarily. One patient with possible metastasis around the left acetabulum would not have been further investigated. The majority would have been discharged only after a long

TABLE II: SPECIFIC DIAGNOSES DETECTED APART FROM FEMORAL NECK AND INTERTROCHANTERIC FRACTURES

Specific diagnosis	No.	%
Greater trochanter fracture	7	36.8
Pubic ramus or rami fracture	6	31.6
Subtrochanteric fracture	3	15.8
Acetabular fracture	2	10.5
Others	1	5.3
Total	19	100

inpatient stay, possibly in excess of a fortnight. In a significant number of patients, pressure sores, pneumonia, and even thromboembolic complications would have developed as a direct result of prolonged immobilisation.

At the time of data analysis, we noted that among the 57 patients who underwent limited MRI, hip X-rays were formally reported (by a radiologist) for 18 (32%). Within this subgroup of 18, limited MRI detected 7 fractures that orthopaedic surgeons missed (39%) and 5 fractures that radiologists failed to diagnose. Interestingly, 4 of these 5 patients had clinically significant fractures that required surgical fixation.

MRI and Other Imaging Modalities

MR imaging has been shown to be sensitive and quite specific in the evaluation of hip fractures. Previous studies have shown an accuracy of up to 100% using a single T1 coronal MR sequence alone.⁷⁻⁹ Based on the American College of Radiology ACR Appropriateness Criteria, MR imaging has a rating of 9/9 in the evaluation of suspected insufficiency fracture of the hip in osteoporotic patients, in whom plain X-rays are normal. Imaging time is short: the entire investigation can normally be completed in 10 to 15 minutes, unlike a complete MR of the hip which would normally take 30 to 45 minutes. A short scan time allows cases to be done on a “semi-urgent” basis as it is easier to slot the cases between scheduled cases. They can usually be done on the day of request or the following day. In our hospital, a limited MR scan of the hip costs S\$400, as much as a computed tomography (CT) of the hip; while a complete MRI study of the same joint would cost S\$900.

Radionuclide bone scan has previously been used as a supplemental imaging technique to diagnose radiographically occult fractures. This technique, particularly if used with single photon emission CT, is extremely sensitive. However, specificity is low. Delay in bone scan activity is also well known in the elderly and osteoporotic patients, as well as patients on steroid therapy.^{10,11}

In this clinical setting, MRI is also superior to CT. MR does not use ionising radiation. Furthermore, it can

demonstrate soft tissue injury like muscular haematoma and joint effusion which are not readily appreciated on CT. Similarly, bone bruise is more obvious on MRI.

Conclusion

In patients who present with hip pain following trauma and where no definite fracture is detected on conventional radiographs, additional imaging with limited MRI of the hip proved useful in detecting occult fractures, with significant clinical impact on patient management. In our series of 57 patients, 23% were found to have a hip fracture that would normally be treated by surgery. The remainder were reassured and treated conservatively; exclusion of significant fractures in these patients also meant early ambulation and a short inpatient stay.

The limited MR scan of the hip can be done in a matter of minutes. The cost is competitive compared with other imaging modalities (including radionuclide bone scan and CT scan). Specificity of the diagnosis achieved with MR can obviate supplemental imaging examinations, with their attendant additional expense and radiation exposure.

Our results concur with those studies in the literature. The routine use of MRI in this specific and 'limited' manner in patients with post-injury hip pain, but with normal or equivocal hip X-rays (as reviewed by a consultant), has provided orthopaedic surgeons with a rapid, accurate and cost-effective test.

In order that the cost of health care does not increase from unnecessary MRI scans, the decision to proceed with this test should be made jointly by the senior orthopaedic

surgeon and radiologist. In the majority of cases, high quality X-rays should still be adequate for diagnosis.

REFERENCES

1. Stiris M G, Lilleas F G. MR findings in cases of suspected impacted fracture of the femoral neck. *Acta Radiol* 1997; 38:863-6.
2. Bogost G A, Lizerbram E K, Crues III J V. MR imaging in evaluation of suspected hip fracture: frequency of unsuspected bone and soft-tissue injury. *Radiology* 1995; 197:263-7.
3. Evans P D, Wilson C, Lyons K. Comparison of MRI with bone scanning for suspected hip fracture in elderly patients. *J Bone Joint Surg* 1994; 76B:158-9.
4. Rizzo P F, Gould E S, Lyden J P, Asnis S E. Diagnosis of occult fractures about the hip. *J Bone Joint Surg* 1993; 75A:395-401.
5. Mlinek E J, Clark K C, Walker C W. Limited magnetic resonance imaging in the diagnosis of occult hip fractures. *Am J Emerg Med* 1998; 16:390-2.
6. Pandey R, McNally E, Ali A, Bulstrode C. The role of MRI in the diagnosis of occult hip fractures. *Skeletal Radiol* 1998; 27:199-204.
7. Deutsch A L, Mink J H, Waxman A D. Occult fractures of the proximal femur: MR imaging. *Radiology* 1989; 170:113-6.
8. Quinn S F, McCarthy J L. Prospective evaluation of patients with suspected hip fracture and indeterminate radiographs: use of T1-weighted MR images. *Radiology* 1983; 187:469-71.
9. Schultz E, Miller T T, Boruchov S D, Schmell E B, Toledano B. Incomplete intertrochanteric fractures: imaging features and clinical management. *Radiology* 1999; 211:237-40.
10. Matin P. The appearance of bone scans following fractures, including immediate and long-term studies. *J Nucl Med* 1979; 20:1227-31.
11. Scott S, Alazraki N, Manaster B. Failure of bone scanning to detect fractures in a woman on chronic steroid therapy. *Skeletal Radiol* 1984; 12:204-7.