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Imaging of occult hip fractures: CT or MRI?

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ABSTRACT

Objectives: Patients presenting with hip pain but normal plain radiographs may ultimately be shown on further investigation to have suffered an occult hip fracture (OHF). This diagnosis can be made with CT or MRI. Traditionally MRI has been considered a superior modality. We performed a retrospective review of all patients presenting to our service with a suspected OHF over a four-year period, investigated with either CT or MRI.
Design: Retrospective review.
Setting: Urban trauma centre.
Patients: Patients with suspected hip fractures and negative radiographs.
Intervention: CT or MRI.
Main outcome measures: Detection rate; delay in request for further imaging; delay to theatre; re-presentations with missed fractures.
Results: A total of 179 patients were investigated, with a mean age of 82 ± 13 years. The ultimate diagnosis was of an OHF in 71 cases and pelvic or acetabular fracture in 34. The average time from presentation plain radiograph to further imaging was 2.0 ± 2.7 days, but was significantly shorter for CT. No patient re-presented with unidentified fractures or other localised hip pathology within a 12-month period.
Conclusions: Modern imaging technology does not appear to miss clinically significant fractures. As CT is usually more accessible than MRI, the results of our study should encourage surgeons to consider CT as a first line investigation for occult hip fractures. We advocate a high index of suspicion and early imaging referral for elderly patients presenting with non-specific hip pain following a fall.
Level 3 Evidence.

Introduction

Approximately one-third of the population over the age of 65 suffer a fall each year, rising to over 50% by the age of 80 [1]. In the UK, 75,000 patients sustain hip fractures each year at an annual cost of approximately £2 billion [2]. Demographic projections indicate that this incidence will rise to 91,500 by 2015 and 101,000 in 2020 [2]. The mortality rate at one month is around 10% [2,3] and this is increased in those patients in whom surgery is delayed; observational studies have shown that the mortality rate doubles when surgery is delayed beyond 2 days [4–6]. The incidence of other complications including respiratory and urinary tract infection and thromboembolic events is also increased in patients where hip fractures are not promptly managed [7]. Delayed treatment may also result in the displacement of previously undisplaced intracapsular fractures, necessitating a more complex operation.

Although the diagnosis is usually evident, the initial radiographs may not reveal the fracture in 2–10% of hip fracture cases [8–10] and this may result in misdiagnosis or a delay to surgery as further investigation is awaited (Fig. 1). Much of the available literature advocates magnetic resonance imaging (MRI) as the first line imaging modality for the investigation of occult hip fractures (OHF) [11,12]. Amongst the perceived benefits of MRI are greater image quality, lack of radiation exposure and greater soft tissue detail.

We review the use of MRI and CT for the detection of occult hip fractures and discuss the role of these imaging modalities in clinical practice.

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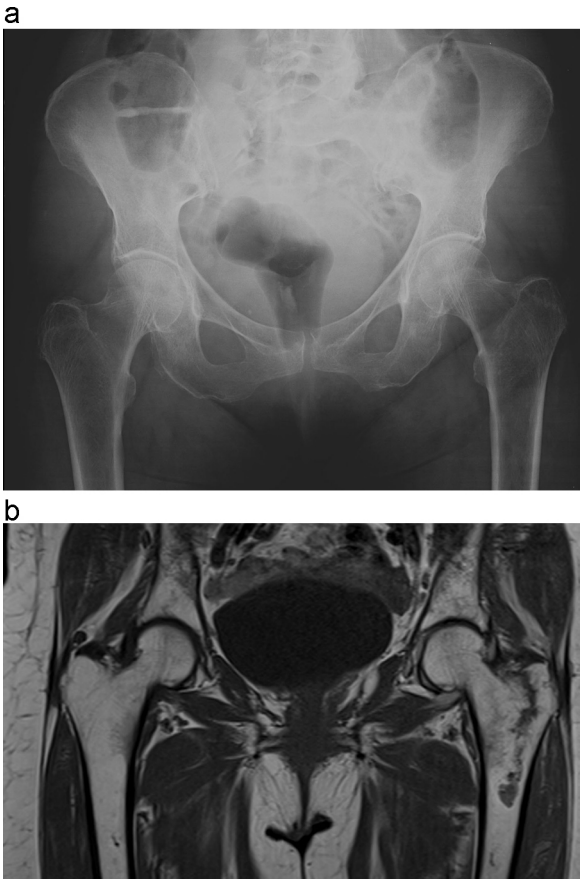

Fig. 1. (a) GT fracture invisible to X-ray. (b) MRI demonstrating GT fracture.

Methods and materials

A retrospective review of all patients presenting to the Royal Infirmary of Edinburgh with a suspected post-traumatic occult hip fracture over a four-year period (January 2008–2012) was conducted. All patients had negative initial radiographs and underwent further imaging with either CT or MRI. The choice of which scan to use was made on an individual basis, based on patient compliance, availability and physician preference.

The results of the scans were recorded along with the clinical course of the patient. The medical records of the patients were reviewed and data was abstracted on medical co-morbidities and fall risk factors.

Our service provides all trauma and orthopaedic services for a stable catchment population of approximately 840,000 [13]. Patients were followed-up for further presentations within 12 months of imaging by reviewing the digitised medical records and cross referencing these with general medical notes where necessary.

The Stastical Package for the Social Science SPSS v20 (SPSS Inc., Chicago, IL, USA) was used to analyse data. Chi-square test or Fisher's exact test was used to analyse the categorical variables. The student *T*-test was used for continuous variables. Multivariate logistic regression models were estimated for OHF positive patients together with fall-related and bone-disease factors (As relative hazards and 95% confidence intervals [CI], the probability value was used as the criterion for significance at $p \leq 0.05$.).

Results

Over the four-year study period, between 800 and 1000 patients per year were admitted to our service with a confirmed diagnosis of hip fracture. There were 179 patients admitted with post-traumatic hip pain and inability to mobilise, but with no fracture on plain radiographs, and these patients underwent either CT or MRI. Occult hip fractures were detected in 71 (39.6%) of these patients, 37 using CT scan and 34 with MRI. 116 patients were female and 63 male, with a mean age of 82 ± 13 years (IQR 75–88). 85% of patients presented within 24 h of injury or incident. The demographic and premorbid characteristics of those patients shown to have occult fractures were comparable to those without occult fractures (Table 1).

As a single modality, 100 MRI scans and 77 CT scans were performed. Two patients underwent both MRI and CT and were excluded from further analysis. These patients were initially investigated with MRI based on their presentation, but MRI was indeterminate due to extensive bone oedema caused by advanced degenerative change. Subsequent CT excluded fracture in one patient and identified a subcapital hip fracture in the other.

The average time from presentation plain radiograph to further imaging was 2.0 ± 2.7 days. There was a greater overall delay from initial radiographs to obtain an MRI when compared with CT (3.78 days ± 3.014 vs. 1.78 ± 1.68, $p < 0.05$). This was particularly the case for out of hours and weekend imaging. Notably, a statistically significant difference was noted in the time taken from request for further imaging to the scan being performed, with MRI taking longer than CT (1.01 ± 1.124 days vs. 0.27 ± 0.719, $p < 0.05$). Interestingly, clinician delay to request for further imaging also demonstrated a tendency for MRI to take longer (2.77 ± 2.87 vs. 1.51 ± 1.536, $p < 0.05$). In practical terms the delays resulted in 25 patients receiving an operation beyond 24 h of admission with a hip fracture.

Of the 71 occult fractures, 24 were subcapital, 7 were cervical, 4 were basicervical (AO type A1.1), 21 were intertrochanteric (AO type A1.2 or A1.3 or A2) and 15 were greater trochanter fractures. Fractures of the acetabulum, pubic rami or sacrum were diagnosed in 34 patients, of whom 7 were diagnosed on CT and 27 on MRI. Of those patients undergoing MRI, 28 received additional diagnoses relating to soft tissue abnormalities (Table 2). No such soft tissue diagnoses were made amongst those patients who underwent CT, who were therefore presumed to have sustained non-specific

Table 1
Baseline presenting characteristics.

	OHF negative (109)	OHF positive (70)	Total
Sex (M/F)	36/72	27/44	
Age (mean ± SD) (IQR)	79.05 ± 13.82 (75.00–88.00)	83.00 ± 13.46 (73.50–75)	
Presentation <24 h	93 (85.3%)	61 (87.1%)	
Living at home	92 (84.4%)	57 (81.4%)	
Angina	37 (33.9%)	26 (37.1%)	63
Previous MI	31 (28.4%)	12 (17.1%)	43
Diabetes	23 (21.1%)	13 (18.6%)	36
Osteoporosis	17 (15.6%)	8 (11.4%)	25
Previous fragility fracture	4 (3.7%)	1 (1.4%)	5
Dementia	24 (22.0%)	18 (25.7%)	42
Stroke	8 (7.3%)	4 (5.7%)	12
Peripheral vascular disease	2 (1.8%)	6(8.5%)	8
Rheumatoid arthritis	5 (4.6%)	3 (4.3%)	8
Osteoarthritis	15 (13.8%)	13 (18.5%)	28
	4 (3.7%)	5 (7.1%)	9
Medication			
Bisphosphonates	7 (6.4%)	9 (12.8%)	16
Calcium	12 (11.0%)	10 (14.2%)	22
Walking aids			
Immobile	0	1 (1.4%)	
Independent	44 (40.3%)	27 (38.6%)	
Stick (1 or more)	34 (31.2%)	24 (34.3%)	
Frame	29 (26.6%)	19 (27.1%)	
Scooter	0	2	