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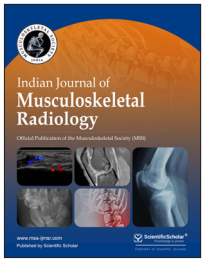

Original Article

Evaluation of Occult Femoral Neck Fractures – Computed Tomography or Magnetic Resonance Imaging?

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ABSTRACT

Aim: There is an increasing incidence of hip fracture with associated morbidity and mortality making accurate and timely diagnosis essential. The aim of this study was to compare computed tomography (CT) and magnetic resonance imaging (MRI) to ascertain the optimum second-line investigation in cases where plain radiograph is not diagnostic.

Material and Methods: Using the radiology information system, a total of 168 patients were identified with the suspected occult neck of femur fractures over 24 months who had undergone CT or MRI as second-line investigation. All relevant imaging was reviewed and diagnosis, any third-line or follow-up imaging was documented.

Results: About 16% of patients undergoing CT as second-line test had proven originally occult femoral neck fractures on plain radiograph compared with 13% of those having MRI. About 13% of patients underwent MRI following CT and in 1/13 case MRI detected an occult fracture that had not been detected on CT. The remaining 11 patients were either negative or MRI proved CT suspicions of fracture when extra diagnostic certainty was requested by the surgeons. CT detected more non femoral pelvic fractures 47% versus 37%.

Conclusion: CT and MRI are comparable at detecting occult femoral neck fractures. Given the increased availability, improved patient tolerance and speed of CT imaging, we advocate its use as the main second-line imaging modality. MRI remains a valuable problem-solving tool in a select few cases following review with a musculoskeletal radiologist.

Keywords: Neck of femur, Fracture, Computed tomography, Magnetic resonance imaging

INTRODUCTION

With an ever-increasing elderly population, hip fracture is a major public health issue with an annual incidence of around 70,000–75,000 hip fractures per annum within the UK.[1,2] It is estimated that as life expectancy rises around the world, the incidence of hip fractures may reach 6.3 million in 2050.[3,4] While most hip fractures are readily diagnosed using radiographs, which have an estimated sensitivity of between 90% and 98%, there is an equivocal or occult hip fracture group in which the clinical findings are suggestive of a fracture which is not confirmed by plain radiographs.[5-7] An accurate diagnosis is mandatory to minimize increased comorbidity and mortality of delayed diagnosis with fast and efficient management of hip fractures also proven to be more cost effective.[8-10]

Magnetic resonance imaging (MRI) has been considered to be the reference standard for second-line imaging[11-13] with limited data on the use of computed tomography (CT) in evaluating occult femoral fractures.[14] National guidelines currently recommend CT if MRI is not available within 24 h, however, given the rapid advances in CT technology, sophisticated three dimensional reconstruction algorithms and availability, it is no longer clear whether modern CT does not have similar reliability and accuracy to MRI.[15]

The purpose of this current study was to retrospectively analyze the clinical accuracy of CT as second-line imaging in the diagnosis of the occult hip fracture.

MATERIALS AND METHODS

Using the radiology information system, 107 CT examinations were performed in two large teaching hospitals for the suspected occult neck of femur fracture over a 24 month period. Radiographic and cross-sectional imaging of each patient was reviewed and the diagnosis, subsequent third-line imaging and other follow-up imaging documented. Standard multi-planar reconstructions in three orthogonal planes with 1–2 mm thickness were obtained with 101 studies performed on a 64 detector helical CT scanner and six studies on an eight detector helical CT scanner.

Surgery and or healing on follow-up imaging were considered as confirmation of fracture. The negative radiological follow-up to study end date or date of death was considered to rule out a fracture.

RESULTS

Fifteen patients (16%) had a fracture of the neck of femur at CT, of which 14 were confirmed at surgery undergoing either hemiarthroplasty, dynamic, or cannulated hip screw fixation. One patient with an impacted subcapital hip fracture was managed conservatively with an uneventful recovery and confirmed healing on subsequent plain radiographs [Appendix 1].

Twelve patients (13%) underwent MRI following CT. Five of these had suspicious but inconclusive findings on CT, all with confirmed non-displaced fractures on MRI [Figure 1]. One patient with a CT reported as showing a fracture underwent MRI due to clinical doubt showing significant soft tissue injury and avascular necrosis of the femoral head but not a fracture [Figure 2]. Five patients had no evidence of fracture on CT, or subsequent MRI performed for ongoing clinical concern and failure to mobilize. Only one patient had a negative CT with positive subsequent MRI [Figure 3].

Eleven patients had evidence of neck of femur fracture when they underwent MRI directly as a second-line investigation to previously negative plain radiograph.

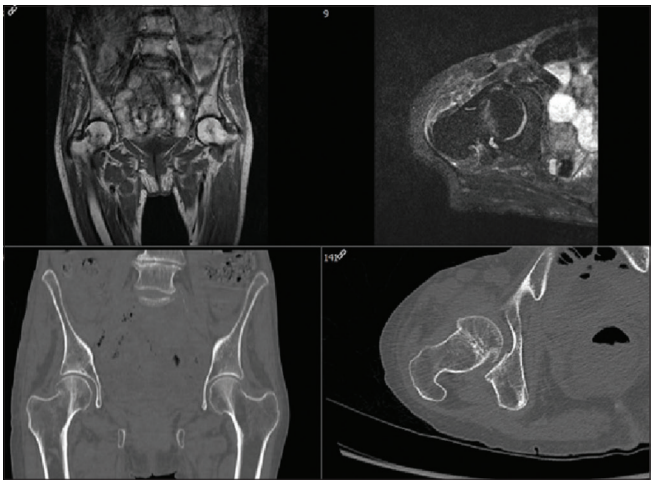

Figure 1: Concern for non-displaced right neck of femur neck fracture on computed tomography (bottom two images) which was confirmed on the subsequent magnetic resonance imaging (top two images) as a dark linear line on T1 weighted imaging (top left) and corresponding high signal line on short-tau inversion recovery imaging (top right).

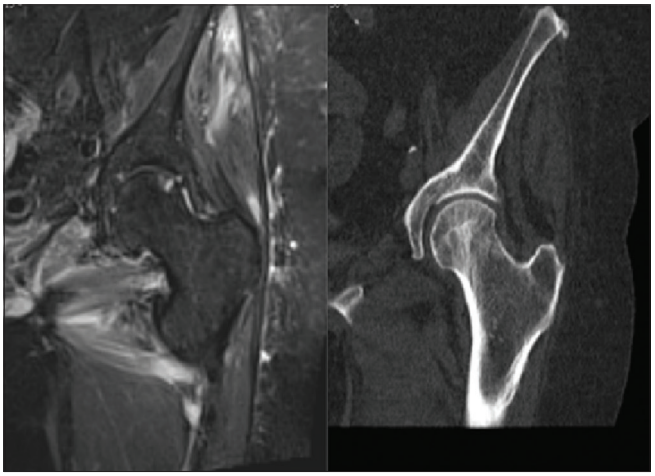

Figure 2: Magnetic resonance imaging (coronal short-tau inversion recovery sequence) was performed due to clinical doubt regarding the computed tomography findings (right) of possible undisplaced fracture at the lateral femoral neck cortex. Magnetic resonance imaging shows a focus of avascular necrosis.

Two patients with previous hip prostheses had MRI as second-line investigation but subsequently underwent CT for further peri-prosthetic evaluation, as this was not possible on MRI due to significant susceptibility artifact [Figure 4] neither of which showed an acute fracture or complication.

A mean follow-up of 223 days for those with a negative radiological study for the neck of the femur was achieved. There were 35 patients (36%) with no fracture signs at CT, with 11 patients (29%) demonstrating severe degenerative change within the hip joint on CT. One patient with a normal CT examination was further evaluated with plain radiograph

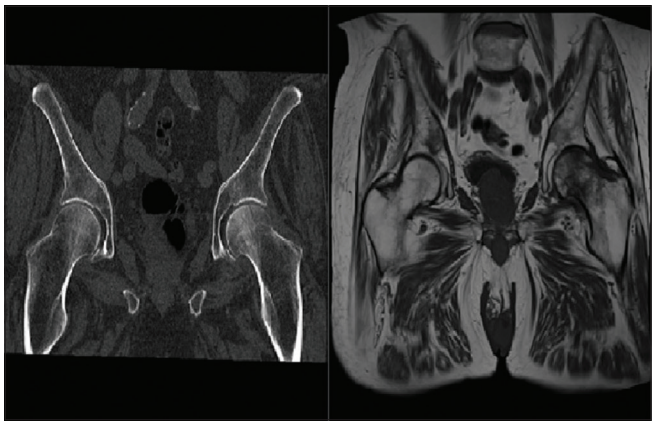

Figure 3: Computed tomography was reported as no fracture. Subsequent magnetic resonance imaging (T1 weighted coronal sequence) in the same patient shows a left subcapital fracture.

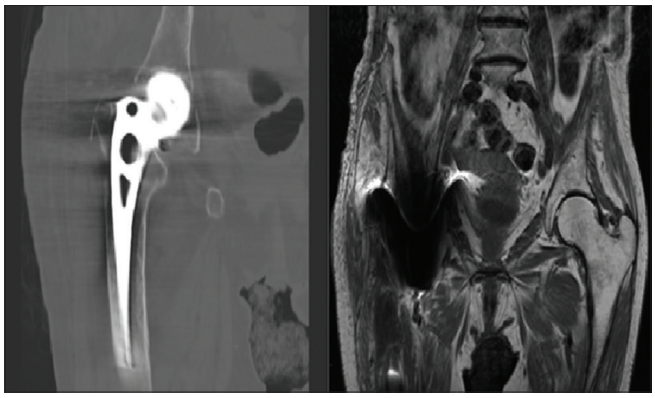

Figure 4: One patient underwent computed tomography for further peri-prosthetic evaluation not possible on magnetic resonance imaging due to significant susceptibility artifact. No acute complication demonstrated.

after a failed trial of mobilization and ongoing clinical concern but no evidence of fracture was demonstrated.

Forty-five patients (47%) demonstrated other fractures on CT, such as pubic ramus, sacrum, acetabular, or isolated greater trochanter fractures. Two patients with isolated greater trochanter fractures on CT re-presented to the accident and emergency department following a further fall between 12 and 27 days post cross-sectional imaging with subsequent intertrochanteric fracture extension and surgical treatment.

In the MRI group, twenty-two patients (37%) that were negative for neck of femur fracture had other fractures that could account for ongoing pain and delay of independent mobilization. In addition, one patient had reported evidence of osteoarthritis, one demonstrated osteomyelitis that was previously unsuspected and there were two patients with significant lumbar intervertebral disc protrusions corresponding to the side of the patient's pain.

DISCUSSION

The current study supports recent reports that suggested that CT has high clinical utility in detecting an occult hip fracture.[16,17]

Sensitivity and specificity were comparable between the two imaging modalities, with only a single false negative on CT. While MRI had increased sensitivity for the detection of incidental findings that may account for symptoms such as disc herniation or avascular necrosis, CT was superior in the evaluation of patients with hip prostheses.

While MRI is regarded as the best available secondary imaging modality to detect a missed hip fracture[18-20] lack of resources and out of hours access make this unfeasible, particularly with an increasing elderly population. Multidetector (MD) MDCT is available 24 h in many hospitals and can offer rapid imaging acquisition, which is particularly advantageous in a potentially cognitively impaired imaging cohort that is usually in considerable pain. There are no contraindications to CT such as pacemakers, metallic implants, and although MRI requires only a few sequences many patients may struggle to cope or comply due to claustrophobia or pain. Other diagnostic imaging modalities such as bone scintigraphy have failed to demonstrate comparable sensitivity or specificity when imaging within 24 h, and coupled with its lack of availability outside the working week has fallen from favor in the guidelines.[21,22] Ultrasound with its wide availability and non-ionizing radiation has recently been evaluated in a study of 30 patients with excellent sensitivity, but requires highly experienced operators and training raising concern for reproducibility and the provision of a continuous and emergency service.[23]

With an ever-burgeoning NHS financial constraints must also be considered with NHS economic data presenting the cost for a CT scan (one area, no contrast) at £90, and the cost of MRI (one area, no contrast) at £162.[24] This constitutes a possible, significant cost saving on imaging alone in this study, not including the potential increased hospital stay while awaiting non-out of hours available imaging.

While MRI still has a use in demonstrating subtle bone edema and extra-osseous pathology, this study demonstrates that it can be reserved as a problem-solving tool for the minority of cases in which there is ongoing diagnostic uncertainty. Since the data from this study were collected this is now the approach adopted by our institution where MRI is the third line and only performed after discussion and review with a consultant musculoskeletal radiologist as outlined in our management algorithm [Appendix 2].

This study would support the theory that advances in CT technology may well now be overcoming the previously reported diagnostic limitation in the published literature.[25,26] MDCT has no major disadvantages, and while

there is an increase in patient radiation dose, with modern scanner algorithms and the elderly patient cohort, the risks are negligible.

CONCLUSION

A negative CT is near perfect in ruling out an occult neck of femur fracture and given the widespread availability and lower cost CT can be used first in the investigation of the occult neck of femur fracture, with MRI used in cases of uncertainty or ongoing clinical concern.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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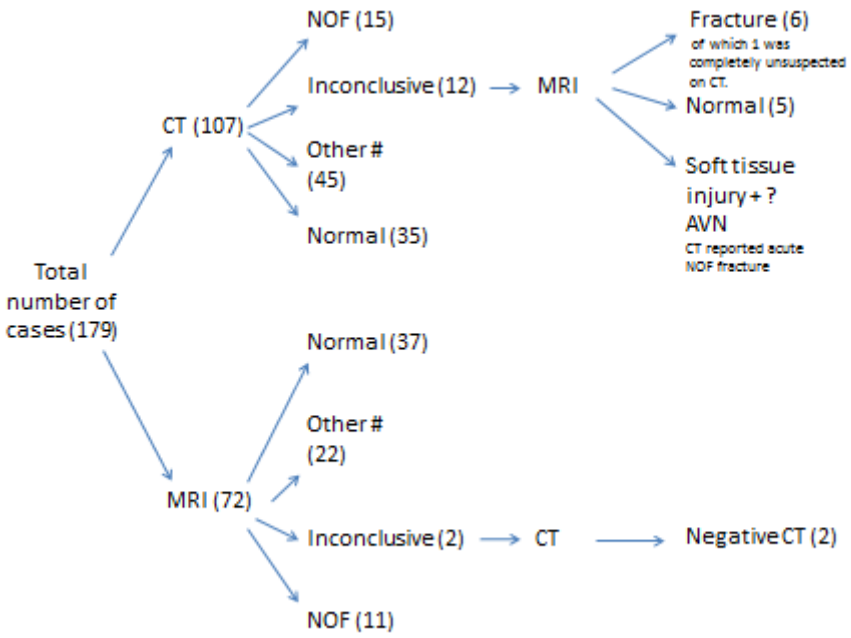
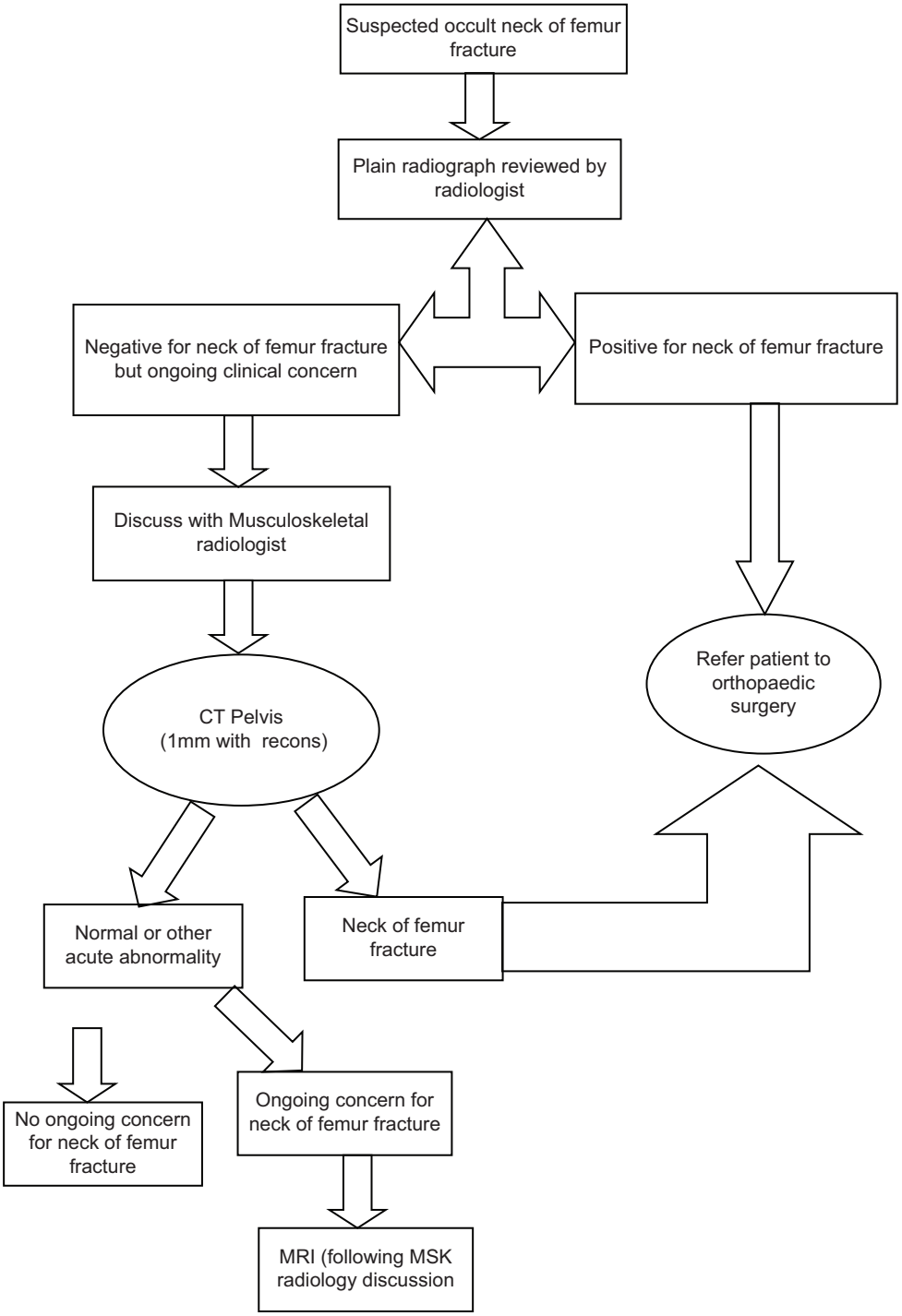
APPENDIX 1



Appendix 1: Break-down of study results

APPENDIX 2



Appendix 2: Local management algorithm