

# Adherence to referral pathway of hip fractures: A clinical audit

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## ABSTRACT

**Introduction:** Hip fracture is a significant cause of morbidity and mortality, mostly in elderly patients; especially if treatment is delayed. Hip fractures are commonly occult on plain radiographs in osteoporotic or obese patients. Therefore, the National Institute for Health and Care Excellence (NICE) guidance has sought to identify the most cost-effective imaging strategies to ensure this does not happen. Accordingly, an imaging reference pathway has been developed by King's College Hospital, UK. This study aims to evaluate the level of adherence to the pathway and identify poorly performed steps.

**Methods:** Retrospective data from 112 patients investigated for hip fractures over five months at the Radiology Department, of King's College Hospital (KCH) were analysed. The assessment focused on various steps in the referral pathway, including the time taken for each imaging modality, reporting findings, time to diagnosis, and surgical intervention.

**Results:** Results showed that 21.4% of patients had hip fractures identified via plain radiography. In cases where radiographs were negative further imaging with MRI was suggested in 75%. However, only 19.6% of patients underwent CT or MRI to exclude occult hip fractures. Only 6% of patients with negative X-ray findings had an MRI. MRI was underutilized despite its recommendation. Notably, all identified hip fractures were initially detected via plain radiography, while occult fractures found in CT or MRI were confined to the pelvic or sacral region.

Although there were delays in reporting times for radiographs clinical decisions were often made without waiting for reports. Surgical intervention occurred within 48 hours for 67.8% of patients, with delays attributed to valid reasons.

**Conclusions:** Adherence to referral pathway of hip fractures was satisfactory in King's College Hospital while the main deficiency identified was preferring CT over MRI as the second-line imaging method in identifying occult hip fractures. Unexpectedly, all hip fractures were identified by plane radiography while occult fractures identified in CT or MRI were pelvic or sacral fractures.

**Keywords:** *Adherence to referral pathway, Delayed surgical intervention, Kings College Hospital, UK, Hip fractures, NICE guidelines on hip fractures, Radiology audit, Occult fractures, Utilization of MRI,*

## Introduction

Hip fracture, predominantly affecting the elderly, poses significant health risks, including morbidity and mortality, especially with treatment delays. Occult fractures, initially overlooked, can result in adverse outcomes such as avascular necrosis of head of femur and thromboembolic events and emphasize the importance of timely diagnosis (1-3).

Often stemming from falls in individuals with osteoporosis or osteopenia, hip fractures account for a substantial portion of admissions to orthopaedic trauma wards, with mortality rates as high as 10% within a month and one-third within a year, largely due to associated comorbidities (4). Given its complexity, effective management demands a multidisciplinary approach encompassing medical, surgical, and rehabilitation interventions, ensuring continuity of care from hospitalization to community reintegration.

Consequently, the National Institute of Health and Care Excellence (NICE) guidelines outline comprehensive protocols for managing hip fractures, emphasizing early intervention and seamless transitions between care settings. However, diagnosing hip fractures can be challenging, particularly on plain radiographs, especially in osteoporotic or obese patients. To address this, NICE guidance advocates for cost-effective imaging strategies to enhance diagnostic accuracy and improve patient outcomes.

### NICE guidance 2011 (updated 2017, 2023)

This guideline covers managing hip fractures in adults. Recommendations emphasize the importance of early surgery and coordinating care through a multidisciplinary Hip Fracture Programme to help people recover faster and regain their mobility (5).

Out of a long list of guidelines, specific guidance given by NICE on imaging and timing of surgery is as follows.

#### 1.1 Imaging options in occult hip fracture

Offer magnetic resonance imaging (MRI) if hip fracture is suspected despite negative X-rays of the hip of an adequate standard. If MRI is not available within 24 hours or is contraindicated, consider computed tomography (CT).

#### 1.2 Timing of surgery

Perform surgery on the day of or the day after, admission.

The Department of Radiology in the King's College Hospital, UK follows the King's protocol of 'hip fracture referral pathway' which is derived based on NICE guidance.

Radiographic imaging for suspected femoral neck fractures is crucial. Normal radiographs may miss occult fractures, which constitute about 1% of cases. Adequacy of initial views should be assessed before further imaging. Repeat radiographs are warranted if initial ones are inadequate or if there is a delay in imaging. CT can diagnose hip fractures but may be less reliable for femoral neck fractures with minimal displacement. MRI offers good sensitivity and specificity for femoral neck fractures, detecting soft tissue injuries effectively. Early MRI is cost-effective with 100% accuracy, superior to scintigraphy with 93% sensitivity and 95% specificity (4).

The literature survey observes various databases for high-quality studies on hip fracture management, excluding those lacking proper outcome measures or focusing on irrelevant topics. While Cochrane reviews cover operative management and perioperative care, they lack focus on imaging. Rehman *et al.*, (2016) studied CT versus MRI for occult hip fractures (8), concluding that both methods accurately diagnose such fractures, challenging the belief that MRI is superior. Gill *et al.*, (2013) found that MRI and CT had similar detection rates for occult fractures, suggesting a role for CT in this context (9). Deleanu *et al.* (2015) emphasized the importance of suspecting occult fractures in patients with atypical hip pain, highlighting MRI as the gold standard despite its limitations (10). Abeygunasekera *et al.*, (2020) projected a significant increase in hip fracture rates in Sri Lanka by 2051, underscoring the growing global burden of this condition (11). These studies collectively stress the need for improved imaging protocols to enhance diagnostic accuracy and expedite patient management, especially in regions experiencing rising hip fracture incidence.

This study aimed to evaluate all steps of the hip fracture reference pathway to gauge adherence and identify poorly performed steps hindering protocol adherence.

### King's protocol derived based on NICE guidance (6)

*Patient seen in Emergency Department (ED) - ?fractured neck of femur*



*History / Examination/Plain X-rays* → *If fracture neck of the femur, refer to orthopaedic*



*If no fracture seen and patient unable to mobilize normally with adequate analgesia, consider the following:*

- Fracture pubic rami
- Fracture lumbosacral spine
- Fracture distal to neck of femur
- Medical causes of immobility



*If the above are excluded:*

*-X-rays should be reviewed and reported by Radiology*



*If no fracture was reported:*

*Admit to Clinical Decision Unit (CDU) / Medical ward*

*Senior ED / Ortho-geriatric / Orthopaedic review of patient.*



*If significant clinical suspicion of hip fracture, discuss the case with the radiology Specialty Registrar (SpR) or consultant for consideration of limited 2 sequence MRI of pelvis for exclusion of occult fracture (coronal T1 and STIR whole pelvis).*

*MRI will only be performed during office hours (9 -5 Mon-Fri) and at weekends only in cases where management over the weekend will be affected by the outcome.*

*CT may be performed instead, in the absence of MR availability. Please note that on rare occasions, fractures may be missed in osteoporotic patients even on CT.*

*Pathway is not to be used acutely in the ED to exclude fracture NOF by junior staff.*

## Methods

This study was conducted as a single-centre clinical audit done as a retrospective study at Kings College Hospital, Denmark Hill, London, UK spanning 5 months from 1/9/2022 to 31/1/2023. Study population was patients receiving hip/pelvic radiographs for hip pain at the ED (n=167). Study sample (n=112) included both male and female patients who were suspected upon presentation to ED to have a hip fracture and underwent hip/pelvic radiography, excluding patients under 18 years of age and patients who underwent CT before hip radiographs due to presentation with major trauma. Data were extracted from Radiology Information System (RIS) and Electronic Patient Record System (EPR) at Picture Archiving and Communication System (PACS) workstation.

Patients were identified by the hospital ID, age and gender and data were collected on a *MS Excel* sheet. All the steps in the hip fracture referral pathway were planned to be assessed. Collected patient data included X-ray views, presentation and imaging times, indications for CT/MRI, reporting times, findings in CT and MRI, interventions and follow-ups. Data was analysed using proportions, averages, and graphical representations. Data was sourced ethically and approved by the Department of Radiology's clinical audit lead, ensuring patient anonymity.

## Results

The sample comprised of 112 patients aged between 18- 100 years and the majority (69.6%) was elderly i.e., above 60 years.

### Radiographic views

The commonly performed (83.9%) radiographic view combination was 'pelvis AP with hip lateral.' While in most of the literature, hip AP and hip lateral are recommended for the diagnosis of neck of femur fractures (7). This combination is also accepted since AP pelvis allows comparison of either side and exclusion of other causes of hip pains such as pelvic or lumbosacral fractures.

## X-Ray findings

A normal finding denotes the absence of any hip fractures or an associated bone injury (pelvic fracture, lumbosacral spine fractures) that explains hip pain in 79/112 (71%). Two X-rays were reported inconclusive/indecisive due to radiographic errors while 31/112 (27%) were abnormal i.e. positive for fractures (Figure 1).

Out of the 31 radiographs which were abnormal, 24 had hip fractures (neck of femur=22, proximal femur=2).

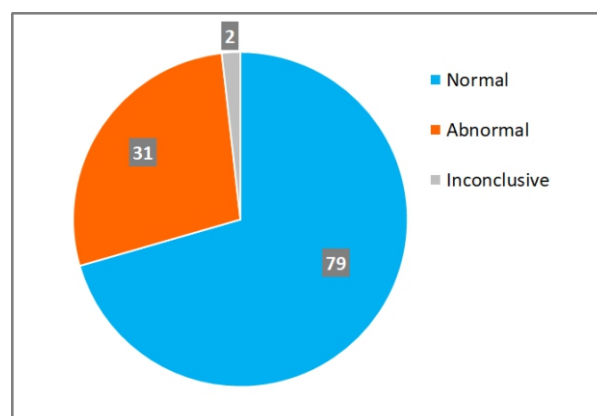
In most of the radiographs reported as normal or inconclusive, 61/81 (75%) a recommendation was included as follows according to the KCH protocol/NICE guidance

*'If there is a high clinical suspicion of hip fracture, limited MRI is advised as per KCH pathway.'*

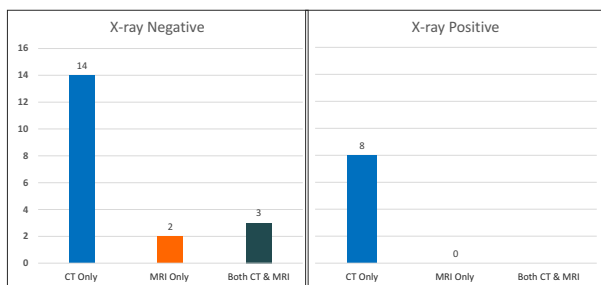
Out of the 61 radiographs reported normal with a recommendation for a MRI, 48 did not have any further imaging (79%).

## Further imaging

Within the whole sample only 27/112 (24%) had further imaging with CT, MRI or both. Although MRI is recommended as the best second line imaging modality, 25/27 had undergone a CT scan, of which 3 had CT followed by MRI whereas only 2/27 had MRI only (Figure 2).



**Figure 1:** Findings of hip/ pelvic radiographs

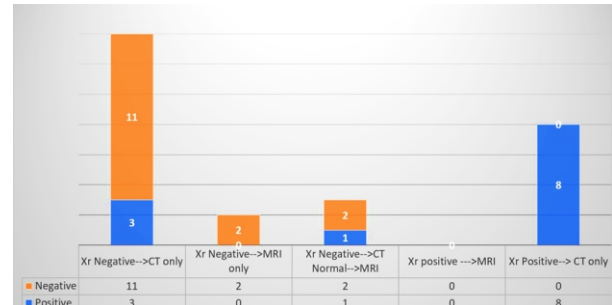


**Figure 2:** Further imaging relative to X-ray finding

Among 81 patients with negative X-ray findings, only 19 (23.4%) underwent further imaging which was either CT or MRI or both. Another three had CT to exclude fractures before the radiographs were reported as positive. (All three were minor pelvic fractures.) Except for those three, rate of performing CT in view of identifying occult fractures was 23.4% (19/81). Only 5 MRI were done (6.1%); three of them were done after negative CT (Figure 3).

In all cases with X-rays positive for fractures (31), CT was the only follow-up imaging method and this counted up to 8. (However, three of them were reported as positive only after performing CT as

described above.) In all CT reports, X-ray findings were confirmed and a more detailed description was given. Where indicated, the nature of the fracture whether pathological or not is confirmed.



**Figure 3:** Findings in CT & MRI

### Follow up Imaging after negative X-ray findings

There were 4 cases with positive findings (fractures) in follow up CT or MRI but not identified or occult in the plane radiographs. All these cases were either pelvic or sacral fractures while plain radiographs identified all hip fractures in this study.

### Case 1

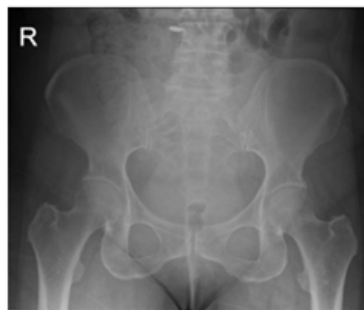


Image 1.1



Image 1.2

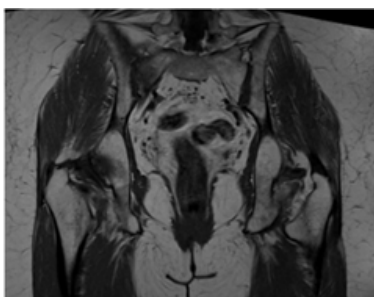


Image 1.3

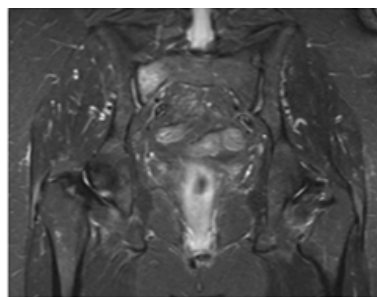


Image 1.4

Image 1.1: X-ray AP pelvis, reported normal.

Image 1.2: CT pelvis bone window, undisplaced fracture in right sacral ala, not identified at the time of CT reporting.

MRI T1W (Image 1.3) and STIR (Image 1.4) show T1 low and STIR high signal intensity in the right sacral ala indicating bone oedema.

**Case 2**

Image 2.1



Image 2.2

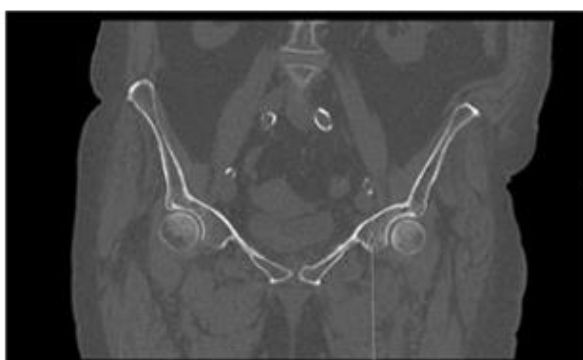


Image 2.3

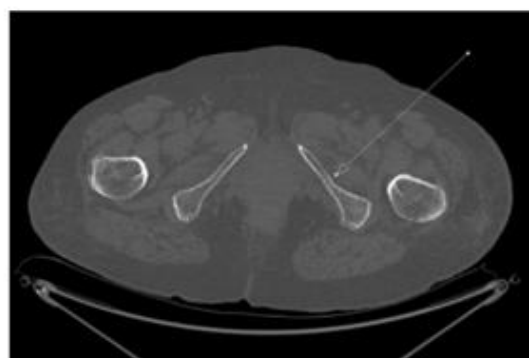


Image 2.4

Image 2.1: X-ray AP pelvis; reported normal.

Image 2.2: CT bone window coronal view; left sacral ala undisplaced fracture

Image 2.3: CT bone window coronal view; fracture in left superior pubic ramus extending towards acetabulum.

Image 2.4: CT bone window axial view; fracture in left inferior pubic ramus

**Case 3**

X-ray did not help to identify any fractures. CT scan revealed comminuted fractures in inferior and superior pubic rami.

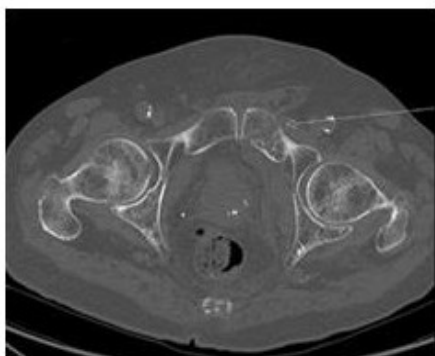


Image 3.1

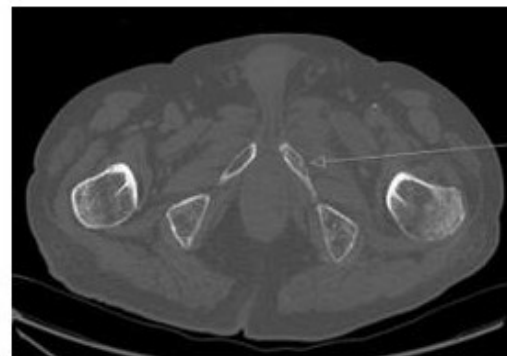


Image 3.2

Image 3.1: CT pelvis bone window axial view; Fracture in superior pubic ramus

Image 3.2: CT pelvis bone window axial view; Fracture in inferior pubic ramus

#### Case 4



Image 4.1



Image 4.2

Image 4.1: X-ray AP pelvis; reported normal.

Image 4.2: CT pelvis 3D bone reconstruction; un-displaced fracture in the right iliac bone extending to the acetabulum and the superior pubic ramus.

#### Indications for CT scans

25 CT scans were conducted in 112 patients (22.3%) for various indications. 20 CT scans were for excluding fractures, 10 preceding x-ray reports. 4 later revealed abnormalities and the rest were normal. Another 10 were to rule out occult fractures post-normal radiograph reports. 5 were solely for surgical or management planning, including identifying synchronous fractures not found on radiographs.

#### Indications for MRI and the outcome

Only 5 MRI were performed in 112 patients; 3 followed CT.

MRI findings were:

Case 1 - X-ray inconclusive, MRI normal.

Case 2 - History of recurrent falls, MRI before X-ray, both normal. X-ray reported in 2 hours.

Case 3 - Normal X-ray, CT for L1 fracture, MRI 5 days later for hip pain, diagnosed sacral fracture which was retrospectively identified on CT.

Case 4 - Normal X-ray, discharged then readmitted, CT and MRI normal, identified hip joint strain in MRI.

Case 5 - Normal X-ray, CT and MRI done simultaneously, both normal.

#### Time taken for imaging, reporting, diagnosis and intervention.

The time taken for interventions in hip fractures is critical in management as indicated by NICE guidance. Therefore, the time taken to undergo each Imaging method and the time taken for reporting were assessed in this study.

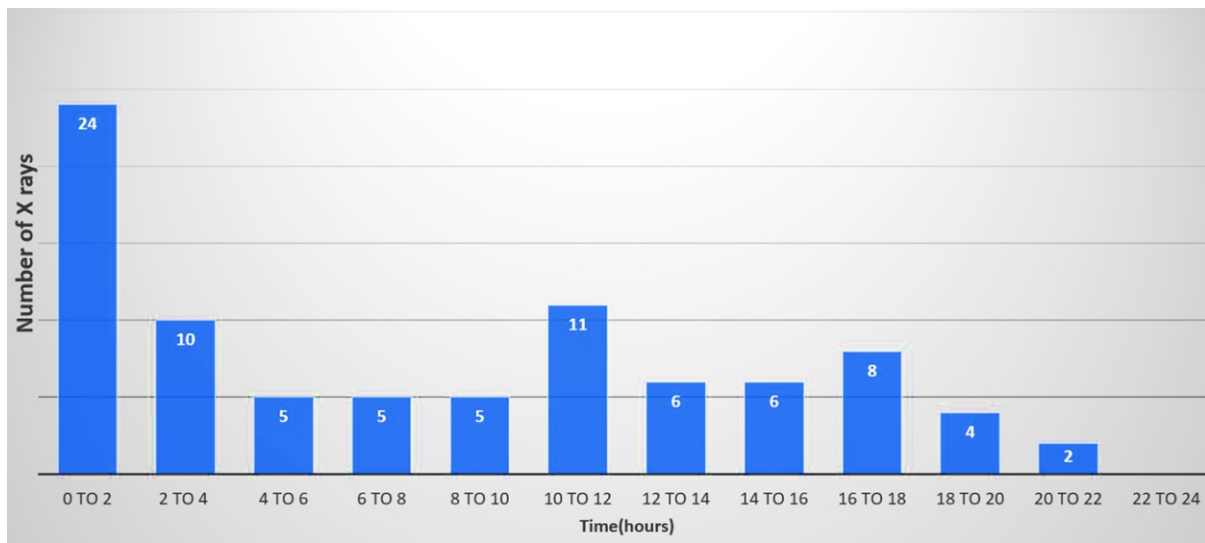
In addition, the time taken to arrive at a diagnosis and the time taken for intervention was also assessed (Table 1).

**Table 1:** Time of presentation and reporting for X-rays

|                                        | <b>Time in days (d)/ hours(hr) / Minutes(min)</b> | <b>Comments</b>                                          |
|----------------------------------------|---------------------------------------------------|----------------------------------------------------------|
| <b>Time from presentation to X-ray</b> |                                                   |                                                          |
| Shortest                               | 11 min                                            |                                                          |
| Longest                                | 15 hr 58min                                       | Unwitnessed fall, pelvic tenderness detected later in ED |
| Average                                | 3 hr 46 min                                       |                                                          |
| <b>Time taken for X-ray reporting</b>  |                                                   |                                                          |
| Shortest                               | 7 min                                             |                                                          |
| Longest                                | 6d 8hr 53 min                                     | 1 < 2 days - 12<br>> 2 days - 14                         |
| Average                                | 22 hrs 6 min                                      |                                                          |
| 1 <sup>st</sup> 24 hr                  |                                                   | 86 - 77%                                                 |
| After 24 hrs                           |                                                   | 26 - 23%                                                 |

**Table 2:**

|                                    | <b>Time in days (d)/ hours (hr) / Minutes(min)</b>          | <b>Comments</b>                                                               |
|------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------|
| <b>Time from X-ray to CT</b>       |                                                             |                                                                               |
| Shortest                           | 58 min                                                      |                                                                               |
| Longest                            | 6 d/ 20 hr/ 43 min                                          | A CT done after readmission in 14 days is excluded.                           |
| Average                            | 21 hr/ 36 min                                               |                                                                               |
| <b>Time taken for CT reporting</b> |                                                             |                                                                               |
| Shortest                           | 22 min                                                      |                                                                               |
| Longest                            | 15 hrs 55 min<br>15 hr 4 min<br>12 hr 33 min<br>1 hr 50 min | All others within 2 hours<br><br>3 extreme cases excluded                     |
| Average                            | 2 hr 30 min                                                 | 76% reported within<br>1 hr 15 min (64% within 1 hr)                          |
|                                    | 51 min                                                      | 3 extreme cases excluded                                                      |
| <b>Time from X-ray to MRI</b>      |                                                             |                                                                               |
| Shortest                           | 1 hr 52 min<br>2 hr 29 min<br>4 hr 24 min                   |                                                                               |
| Longest                            | 17 hr 2 min<br>17 hr                                        | 2 were done at 45 pm and reported next day 9-10 am. Reporting time was 17 hr. |
| Average                            | 8 hr 30 min<br>2 hr 54 min                                  | Above 2 cases excluded                                                        |



**Figure 8:** Time taken for X-ray reporting in the first 24 hours

**Table 3:** Time taken for MRI reporting

|                              | Time in days (d)/<br>hours (hr) /<br>Minutes (min) |                  | Comments                            |
|------------------------------|----------------------------------------------------|------------------|-------------------------------------|
| Time taken for MRI reporting |                                                    |                  |                                     |
|                              | After CT (3)                                       | Only MRI (2)     |                                     |
| Shortest                     | 14 hr 42 min                                       | 1 hr 35 min      |                                     |
| Longest                      | 7 d 8 hr 53 min                                    | 1 d 14 hr 21 min |                                     |
| Average                      | 4 d 13 hr 12 min                                   | 20 hr            | Overall average was 3 d 1 hr 36 min |

**Table 4:** Time taken from presentation to diagnosis

|                 | Time in days (d)/ hours (hr) / Minutes (min)                           |  | Comments              |
|-----------------|------------------------------------------------------------------------|--|-----------------------|
|                 | <b>All cases</b>                                                       |  | <b>Positive cases</b> |
| <b>Shortest</b> | 47 min                                                                 |  | 4 hr 48 min           |
| <b>Longest</b>  | 15 d 8 hr                                                              |  | 6 d 12 hr             |
|                 | The patient discharged after 14 days & readmitted next day due to pain |  |                       |
|                 | 7 d 12 hr                                                              |  |                       |
| <b>Average</b>  | 1 d 7 hr 36 min                                                        |  | 1 d 16 hr             |

**Table 5:** Time taken from presentation to intervention

|                           | <b>Time</b><br><b>Days (d)/ hours (hr)</b><br><b>/ Minutes (min)</b> | <b>Remarks</b>                                                                                                                                                                                                          |
|---------------------------|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Shortest</b>           | 18 hr 44 min                                                         |                                                                                                                                                                                                                         |
| <b>Longest</b>            | 7 d 4 hr 43 min                                                      |                                                                                                                                                                                                                         |
| <b>Average</b>            | 2 d 12 hr 12 min                                                     |                                                                                                                                                                                                                         |
| <b>Within 24 hours</b>    | 4                                                                    |                                                                                                                                                                                                                         |
| <b>Within 48 hours</b>    | 15                                                                   |                                                                                                                                                                                                                         |
| <b>More than 48 hours</b> | 9                                                                    | 6 - delayed due to medical reasons<br>1 - embolised (pathological #) prior to surgery (4 d 23 hr)<br>1 - awaiting for surgeon (2 d 20 hr)<br>1 – X-ray reported normal. CT done late due to persistent pain (6 d 16 hr) |

## Discussion

This NHS clinical audit assessed adherence to King's College Hospital protocol for hip fracture referrals. We aimed to identify delays hindering timely interventions within 24 hours or 48 hours. Additionally, we evaluated rates of further imaging, particularly MRI scans, for occult hip fractures missed on plain radiographs, following NICE guidance (5).

Out of 167 patients in the Emergency Department for hip and pelvic radiographs within 5 months, 112 met our inclusion criteria (69.6% elderly over 60). The most common view (83.9%) was 'pelvis AP with hip lateral' while hip AP and lateral are recommended (7). AP pelvis allows bilateral comparison and excludes other causes of hip pain while hip lateral is complementary to AP for better identification of hip fractures. Of the radiographs 71% were normal and 2 were inconclusive. Later, both inconclusive ones were considered negative while 27% showed hip or pelvic fractures explaining the pain on presentation.

Of the negative radiographs, 75% suggested MRI, aligning with NICE guidance (5). Additionally, 5% had CT or MRI before the X-ray report. In the entire sample, 112 adult patients were investigated

for suspected hip fractures over 5 months, with 24% (27/112) undergoing further imaging. Of these, 19.6% (22/112) were referred for suspected occult hip fractures, and five others for surgical or management planning. Four out of 27 patients had occult fractures missed on plane radiography.

In a study by Gill *et al.*, 92 out of 1353 patients were referred for additional imaging for suspected hip fractures, with a rate of 6.8% (9). In our study, the rate of performing CT or MRI was notably higher at 19.6%. Our study found that 23.4% (19/81) of patients with negative X-rays underwent further imaging to detect occult fractures, while there is no adequate evidence in the literature regarding this matter. The decision to perform CT or MRI depends on clinical suspicion and follow-up protocols.

King's protocol following NICE guidelines prioritizes MRI for detecting occult fractures (6,5), but only 6% (5) of 81 patients with negative X-rays received MRI, 3 post-normal CT. Among 27 who had second-line imaging, 25 had CT, including the 3 who later had MRI. Notably, CT was preferred over MRI (61:31 in Gill *et al.*, vs. 25:2 in our audit). In the audit of Gill *et al.*, CT scans were used in those patients where MRI was contraindicated or where there was going to be

more than a 24-hour wait. The same guideline is given in King's protocol, though the outcome was completely different having very low tendency to go for MRI. CT was chosen contradicting NICE and King's protocol, with a lower tendency for MRI.

Four occult fractures were found in CT/ MRI, missed in plain radiographs, with an overall rate of 3.5% (4/112) and 21% (4/19) among CT/ MRI patients. No occult hip fractures were found in follow-up imaging. Twenty-four (21.4%) femur fractures were diagnosed by plain radiographs, none being occult. Occult fractures detected later were pelvic or sacral. The small CT/ MRI sample size raises outcome validity concerns.

X-ray reporting exceeded 24 hours in 23%. 13 patients had further imaging before X-ray reports; 12/13 were positive. In 3 cases, surgery preceded X-ray reports without further imaging. This suggests clinical decisions were made without radiologist input, but no adverse outcomes were detected.

MRI reporting time was longer than anticipated, with evening scans reported the next day. Other time intervals met expectations. Adherence to NICE guidance or KCH protocol aims for intervention within 48 hours, preferably 24 hours, to reduce morbidity and mortality. In our study, 67.8% had intervention within 48 hours, 4 within 24 hours. Delayed surgery (9 cases) had acceptable reasons, except one due to late diagnosis. One normal X-ray led to a delayed CT in this case, revealing pelvic and sacral fractures necessitating screw fixation after 6 days.

## Conclusions

Adherence to the referral pathway of hip fractures is satisfactory overall in King's College Hospital. Although X-ray reporting delays led to decisions without radiologist input; no adverse outcomes were detected. MRI reporting times exceeded expectations, particularly for scans after 4-5 pm. The rest of the steps in the referral pathway were followed satisfactorily. Surgical intervention within 48 hours was common, with some delays for valid reasons.

High rates of CT/MRI for hip fracture investigations were observed. However, the clinical evaluation

accuracy in identifying the patients for further imaging by assessment of the follow-up and discharge criteria is needed. The main deficiency identified is preferring CT over MRI as the second-line imaging method in identifying occult hip fractures though MRI is considered the gold standard in NICE guidance. Unexpectedly all hip fractures were identified by plane radiography while occult fractures identified in CT or MRI were pelvic or sacral fractures.

## Recommendations

1. Conduct a mini-audit to evaluate discharge criteria and follow-up for patients with negative X-rays but no further imaging, ensuring proper clinical decisions.
2. Advocate for MRI with a low threshold for patients with negative X-rays but high clinical suspicion, following NICE guidance and King's protocol over CT.
3. Prioritize urgent reporting of MRI for occult hip fractures to the MSK/ Radiology team. Train Radiology specialty registrars to review and provide provisional reports, especially after 5 pm if needed.

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