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Another fractured neck of femur: do we need a lateral X-ray?

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Objective: This study aimed to define the role of the lateral X-ray in the assessment and treatment planning of proximal femoral fractures. Occult fractures were not included.
Methods: Radiographs from 359 consecutive patients with proximal femoral fractures admitted to our emergency department over a 12 month period were divided into anteroposterior (AP) views and lateral views. Three blinded reviewers independently assessed the radiographs, first AP views alone then AP plus lateral views, noting the fracture classification for each radiograph. These assessments were then compared with the intra-operative diagnosis, which was used as the gold standard. A 2×2 contingency square table was created and Pearson's χ^2 test was used for statistical analysis.
Results: The rate of correct classification by the reviewers was improved by the assessment of the lateral X-ray in addition to the AP view for intracapsular fractures ($p<0.013$) but not for extracapsular fractures ($p=0.27$). However, the only advantage obtained by assessing the lateral view in intracapsular fractures was the detection of displacement where the fracture appeared undisplaced on the initial AP view.
Conclusion: This study provides statistical evidence that one view is adequate and safe for the majority of hip fractures. The lateral radiograph should not be performed routinely in order to make considerable savings in money and time and to avoid unnecessary patient discomfort.

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Proximal femoral fractures form a major part of the trauma workload of a trauma and orthopaedic department [1]. Different hospitals have varying protocols for the initial radiographs taken in the emergency department. In most institutes, it is standard practice for every patient with a suspected proximal femur fracture to have hip radiographs providing both anteroposterior (AP) and lateral views [2]. The lateral view requires movement of the contralateral leg into a flexed and abducted position, which indirectly may cause movement at the fracture site.

The correct positional diagnosis of proximal femoral fractures is vital to the selection of the implant with the best biomechanical and clinical profile for that fracture pattern.

With the advent of ''fast-tracking'' systems [3, 4], many patients may not be seen by an orthopaedic doctor until after transfer to a ward. This can make further imaging of the hip logistically difficult, and consequently any subsequent management decisions are often based on the views that are already available. Therefore, an important balance must be maintained between obtaining adequate radiographs to ensure that the correct diagnosis is made, and hence that the appropriate procedure is planned and carried out, and avoiding subjecting patients to unnecessary radiation and discomfort.

The overall aim of this study was to assess whether there is a need for routine lateral hip radiographs of proximal femoral fractures and to examine the extent of their role in diagnosing the fractures type and in their subsequent management.

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Methods and materials

This study was performed in a level 1 trauma centre serving a population of 300 000. A list of all of the patients with proximal femoral fractures that presented to the hospital during the period between August 2006 and July 2007 was obtained using the hospital coding system. All patients with proximal femoral fractures who were treated operatively were included.

Patients were excluded from the study if they had: (a) occult fractures of the proximal femur; (b) no surgery for any reason (as no intraoperative diagnosis was then available); (c) implants in the same femur (periprosthetic fractures); (d) notation that did not accurately define the intraoperative diagnosis; or (e) pathological lesions in the ipsilateral proximal femur.

The plain radiographs of all of the patients included in the study, which were taken in the emergency department, were extracted from the hospital PACS (Picture Archiving and Communication System) by one of the authors. These radiographs were stratified by this author into (a) AP and (b) lateral views. Lateral views were defined as a radiograph taken with a horizontal beam perpendicular to the affected femoral neck with the patient in the supine position with the non-affected hip flexed out of the way.

The operation notes of all patients were examined and the intraoperative diagnosis of the position of the

proximal femoral fracture used as the ''gold standard''. The intraoperative diagnosis was made either during an arthrotomy for prosthetic replacement or, when fixation devices were used, after screening with fluoroscopy. The author who had stratified the radiographs and collected the data from the operation notes took no further part in assessing the radiographs.

The prepared radiographs were examined by three blinded reviewers (authors CS, DM, GT) who are all Fellow of the Royal College of Surgeons (Tr & Orth) trained orthopaedic surgeons. They were asked to state the site of the proximal femoral fracture. Each reviewer independently assessed the radiographs and classified the fractures into one of the following five categories (Figure 1):

1. Undisplaced intracapsular fractures (Garden I and II) [5]
2. Displaced intracapsular fractures (Garden III and IV) [5]
3. Basal cervical fractures
4. Intertrochanteric fractures
5. Fractures with subtrochanteric extension.

Each of these five types of proximal femoral fracture has a different operative treatment plan; therefore, their differentiation is vital.

The assessors were shown first the AP view and then the lateral view. For each AP radiograph, the blinded author was asked to record a diagnosis before going on to review the lateral radiograph. Having seen the lateral radiograph, the blinded author was allowed to modify the diagnosis if necessary and the new diagnosis was recorded in addition to the previous diagnosis. All of the radiographs were presented to the reviewers digitally on a PACS viewing monitor so that magnification, contrast and brightness could be adjusted to aid diagnosis.

The correlation between the reviewers' radiographic positional diagnoses and the definitive intraoperative findings was calculated. Further analysis was performed to determine whether assessment of the lateral views had increased this correlation.

A 2 × 2 contingency square table was created to assess the usefulness of the lateral radiograph in the positional diagnosis of these fractures. Statistical analysis was performed using Pearson's χ^2 test. The alpha level was set at 0.05. For the statistically significant results, the sensitivity and specificity are presented with 95% confidence intervals (CI).

Results

In total, 359 patients were admitted with a diagnosis of a proximal femoral fracture between 1 August 2006 and 31 July 2007. Of these patients, 38 were excluded from the study: 15 were deemed medically unfit for surgery, 16 had no accurate diagnostic operation note, 2 had periprosthetic fractures, 3 had fractures that were not in the proximal femur and 2 were duplicate patients. This left 321 patients who were operated upon for proximal femoral fractures during the course of the year.

Of these patients, 163 (50.8%) had fractures on their right side and the total number of females was 229 (71.3%). The mean age at operation was 81.1(SD ± 9.6) years, and ages ranged from 42 to 101 years.

On examining the operation notes, there were 233 intracapsular, 14 basal cervical and 66 intertrochanteric fractures, and a further 8 fractures with subtrochanteric extension. The fixation techniques used to treat these fractures are shown in Figure 2.

For intracapsular fractures, the addition of a lateral radiograph to the AP view significantly increased the rate of correct diagnosis (Pearson's uncorrected value 6.15, $p<0.013$, degrees of freedom (df)=1). The sensitivity of an AP view alone was 52.6% (39.5–64.7% 95% CI) with a specificity of 88.5% (85.8–91.0% 95% CI). Sensitivity improved to 90.9% (74.5–97.4% 95% CI) and specificity to 90.6% (88.6–91.4% 95% CI) after adding a lateral view. Nevertheless, the only additional advantage provided by the inclusion of the lateral view is in detecting displacement when the intracapsular fracture appeared to be undisplaced on the initial AP view.

For extracapsular fractures, the correct diagnosis rates were not significantly improved by the assessment of the lateral film (Pearson's uncorrected value 1.21, $p=0.27$, df=1).

Discussion

The patient sample used in this study reflects the demographics of the population prone to these fractures [6, 7]. Furthermore, the proportions of fractures treated

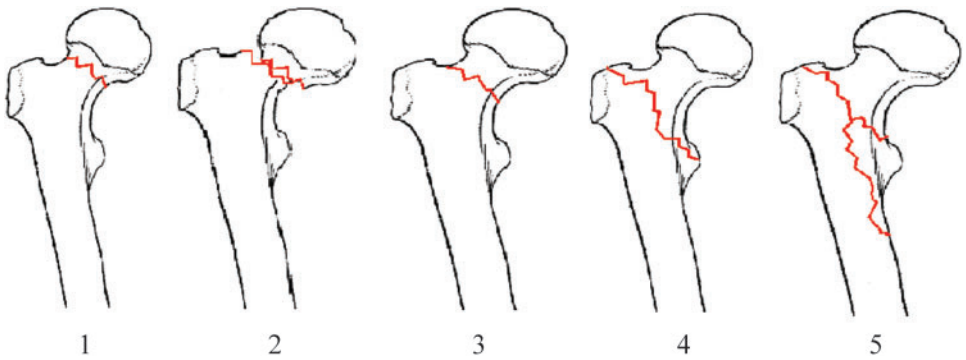


Figure 1. The classification used to divide types of proximal femur fractures. (1) Undisplaced intracapsular fracture. (2) Displaced intracapsular fracture. (3) Basal cervical fracture. (4) Intertrochanteric fracture. (5) Fracture with subtrochanteric extension.

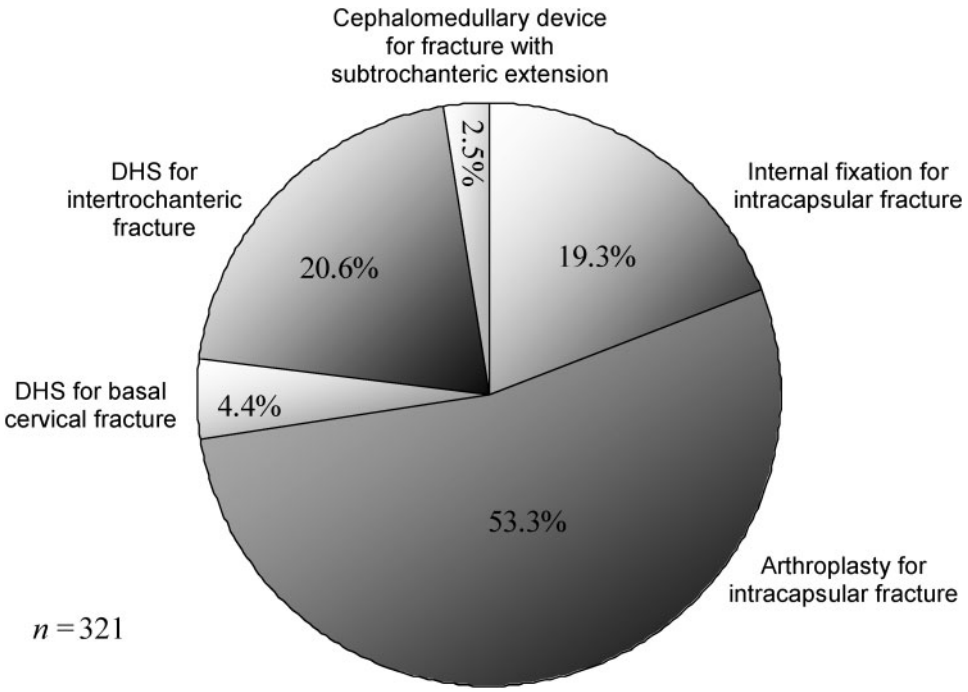


Figure 2. Surgical fixation techniques used to treat the proximal femur fractures. DHS, dynamic hip screw.

by each of the surgical procedures used in Figure 2 are consistent with those reported in previous studies [6, 8]. It is important to diagnose the fracture site correctly pre-operatively because the discovery of a misdiagnosis in the operating theatre can increase the anaesthetic time: the patient may need to be repositioned, a change of operating table may be required or it may be necessary to locate and open further operating instrumentation. If misdiagnosis is not realised until after making the incision, the subsequent difficulties can be greatly exacerbated. These could include extending the skin incision to accommodate a different procedure, increased blood loss and increased risk of infection. All of these factors increase operative complications in a population of elderly patients who already have high mortality and morbidity rates [6, 8–10].

Our study shows that lateral radiographs do not aid in the diagnosis of the type of extracapsular fractures, but were of benefit for the correct diagnosis of intracapsular fractures because they are sometimes able to detect displacement when the intracapsular fracture appeared undisplaced on the initial AP view. No reviewer down-graded the diagnosis from a displaced intracapsular fracture on the AP view to an undisplaced intracapsular fracture after reviewing the lateral view; therefore, the benefit of a lateral radiograph is limited to those fractures that appear undisplaced on the AP view. A previous small study had concluded that lateral radiographs are not needed routinely, but did not specify situations in which they are required [11]. This has now been clarified. Another more recent small study also showed that lateral radiographs must not be taken as a blind ritual in every case [12]. The authors of this work suggested that lateral radiographs should be reserved for cases where a fracture is not clearly evident on AP radiographs and where there is doubt regarding the displacement factor or fracture extension that could hinder pre-operative planning [12].

Although orthopaedic rote dictates that every fracture should be visualised in two views, this study has shown with statistical validity that one view is adequate and safe for the majority of hip fractures. The lateral radiograph is required only for intracapsular fractures that appear undisplaced on the AP view and should not be performed routinely. Some authors believe that all intracapsular fractures should be treated with internal fixation, whether displaced or not [13]. If this operative rationale is held, the need for a pre-operative lateral radiograph is further reduced.

Although our study demonstrates that lateral radiographs of extracapsular fractures are not required, some might argue that the degree of displacement in these fractures may only be apparent on the lateral view, and if gross displacement is noted, then the level of surgeon involvement and/or supervision needs to be increased. This has importance only when consultant-based service provision is not available. Our study did not consider the degree of displacement when diagnosing extracapsular fractures, but it did differentiate between basal cervical fractures, intertrochanteric fractures and fractures with subtrochanteric extension, each of which has a different treatment plan. Displacement of extracapsular fractures is mostly shown on the AP view, but if there is any suspicion of severe displacement and no senior surgeon is available, then we recommend performing a lateral radiograph pre-operatively to confirm the degree of displacement. In all cases of extracapsular fractures, a lateral view is taken intraoperatively using image intensification prior to commencing the surgery. Others might argue that a subtrochanteric extension of a trochanteric fracture may be apparent only on the lateral view and that this fracture pattern has relevance for the treatment plan. In our study, however, all subtrochanteric extensions were apparent on the AP view and the lateral radiograph did not alter diagnosis or treatment

plan. Rarely, it can be difficult to confirm whether the fracture is intracapsular or extracapsular from an AP view alone, especially for more junior staff. Failure to make this distinction correctly can be disastrous, and so on these rare occasions we recommend that a lateral radiograph is done pre-operatively to help assess the site of the proximal femoral fracture. This difficulty did not occur during our study.

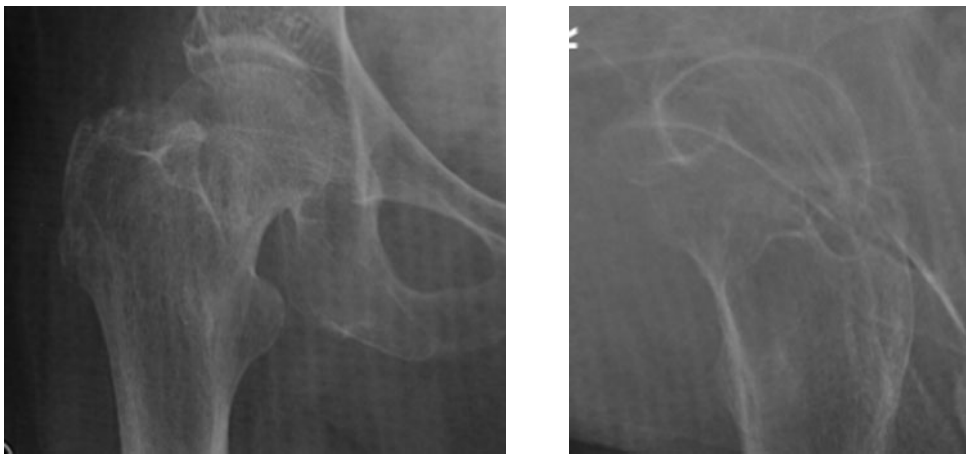
If the recommendations of this study are to be applied in practice, the following points need to be considered:

- Radiographers undertaking images for suspected proximal femoral fractures must be trained to diagnose these fractures.
- If the fracture is intracapsular and appears undisplaced on the initial AP view, then a lateral view should be obtained (Figure 3).
- If the fracture is clearly displaced and intracapsular on the initial AP view, there is no need for additional views.
- If the fracture is clearly extracapsular on the initial AP view, there is no need for additional views.
- If there is no clear fracture on the initial AP view, a lateral view should be obtained.

These guidelines could then be used by experienced radiography staff in conjunction with trauma and orthopaedic surgeons in a consultant-orientated service. They apply to fractures that are apparent on the AP view and require only that the radiographer makes a judgement on the initial AP film. In our study group, 239 lateral hip radiographs would have been avoided if these recommendations had been applied, this equates to 74.5% of all patients radiographed with a proximal femoral fracture. Nevertheless, we must remember that any radiograph that is performed for the diagnosis of a proximal femoral fracture should be of good quality and adequate exposure and must demonstrate the hip joint and proximal femur sufficiently; if this is not the case, additional imaging is essential.

Since the introduction of X-rays into medicine in 1895, the overall effect of X-rays has been to improve healthcare, but a balance must be struck between their contribution to better management, which may be life-saving, and their dangers [14]. In the UK, around £600 million is spent on imaging each year and imaging accounts for over 90% of radiation exposure to the population [14]. Each AP pelvis radiograph subjects the patient to a radiation dose of approximately 30 times that of a standard chest radiograph, and a lateral radiograph of the hip exposes the patient to a radiation dose of approximately 2.5 times that of an AP view [12, 15, 16]. Avoiding the routine use of lateral radiographs for proximal femoral fractures will therefore result in a significant reduction in radiation dose and consequently a reduction in cancer risk for these patients. We normally assume that there is a latent period of about 10 to 30 years between the time of radiation and the induction of cancer. For somebody aged 81 years (the average age of patients with proximal femoral fracture in our study), the cancer risk will be tiny compared with the risks associated with old age, but the benefits might be of significance to younger patients. As a rough estimate, if we use the cancer risk for an adult, 1 in 20 000 per millisievert (mSv), we would avoid inducing 1 cancer for about every 10 000 lateral radiographs that are not performed, assuming the average radiation dose of a lateral hip radiograph is 2 mSv (C Taylor, Radiation Protection Adviser, Department of Medical Physics and Engineering, Leeds Teaching Hospital, personal communication, 2009).

The cost of each additional radiograph is about £15 (in our institution) and thus our recommendations would provide a projected saving of £300 per month at our institution (which serves a population of 300 000) alone. Other authors quote a cost of £30 per lateral radiograph [17]. The time taken by radiographers to perform a lateral hip radiograph as a percentage of the total examination (AP pelvis and lateral hip radiographs) is about 70%. This shows the amount of radiographer time that could potentially be saved. In addition, unnecessary discomfort that may be experienced by patients when having a lateral hip radiography [12, 17] will be avoided. Positioning for the lateral hip view can be extremely uncomfortable and distressing for the patient, especially for elderly patients who constitute the largest group undergoing this examination [11]. The patient lies supine with the contralateral leg raised so that the femur is perpendicular to the trolley,



(a) (b)

Figure 3. (a) Anteroposterior (AP) and (b) lateral view radiographs of a fracture that appears undisplaced on the AP view but is shown to be displaced by the lateral view.

the knee is flexed to 90 degrees and the ankle is supported to maintain this position [18].

This study has its limitations, namely, it has been conducted retrospectively and only included patients with confirmed proximal femoral fracture. It did not look at the total number of radiographs performed for clinically suspected neck of femur fractures. A prospective study including all patients with clinically suspected proximal femoral fractures could now be directed to confirm the findings of this study.

Conclusion

This study has demonstrated that not all neck of femur fractures need more than a single AP view to diagnose the position of the fracture safely. However, every intracapsular fracture that appears undisplaced on the initial AP view does require a lateral radiograph to assess displacement. Use of these guidelines will ensure that only the views needed are available when the patient is first encountered by an orthopaedic surgeon, and that the patient is not submitted to any unnecessary discomfort and radiation. It must be stressed that all patients should have an adequate set of radiographs to ensure the correct diagnosis and treatment plan; if there is any doubt, further imaging should be obtained.

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