Interpretation of trauma radiographs by junior doctors in accident and emergency departments: a cause for concern?

C A J McLauchlan, K Jones, H R Guly

Abstract

***Objectives*—To investigate how well junior doctors in accident and emergency (A&E) were able to diagnose significant *x* ray abnormalities after trauma and to compare their results with those of more senior doctors.**

***Methods*—49 junior doctors (senior house officers) in A&E were tested with an *x* ray quiz in a standard way. Their results were compared with 34 consultants and senior registrars in A&E and radiology, who were tested in the same way. The quiz included 30 *x* rays (including 10 normal films) that had been taken after trauma. The abnormal films all had clinically significant, if sometimes uncommon, diagnoses. The results were compared and analysed statistically.**

***Results*—The mean score for the abnormal *x* rays for all the junior doctors was only 32% correct. The 10 junior doctors with more experience scored significantly better ($P < 0.001$) but their mean score was only 48%. The mean score of the senior doctors was 80%, which was significantly higher than the juniors ($P < 0.0001$).**

***Conclusions*—The majority of junior doctors misdiagnosed significant trauma abnormalities on *x* ray. Senior doctors scored well, but were not infallible. This suggests that junior doctors are not safe to work on their own in A&E departments. There are implications for training, supervision, and staffing in A&E departments, as well as a need for fail-safe mechanisms to ensure adequate patient care and to improve risk management.**

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Royal Devon and Exeter (Wonford) Hospital, Exeter, UK
C A J McLauchlan

Frenchay Hospital, Bristol, UK
K Jones

Derriford Hospital, Plymouth, UK
H R Guly

Correspondence to:
Chris A J McLauchlan, Consultant/Director of Accident and Emergency Department, Royal Devon and Exeter (Wonford) Hospital, Exeter EX2 5DW, UK.

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The majority of patients attending accident and emergency (A&E) departments are seen by senior house officers (SHOs), often in their first postregistration job. The large number and variety of patients seen by these junior and inexperienced doctors means that some diagnostic errors are inevitable and the majority of these are missed *x* ray abnormalities.[1] Tachakra and Beckett discuss reasons for these errors in routine practice.[2] Previous studies have shown that between about 2% and 8% of all *x* rays are misdiagnosed in A&E departments[3,4] but some of these are false positives and many of the missed injuries are insignificant.

If false positives are excluded, significant misdiagnoses occur in about 2% of all *x* rays taken.[3] However, a large percentage of *x* rays are normal and it may be more appropriate to calculate an error rate as the percentage of abnormal *x* rays which are missed, rather than as a percentage of all *x* rays taken. In a small survey using this technique Vincent *et al* found that 35% of significant *x* ray abnormalities were missed by junior A&E.[4]

The purpose of this study was to investigate how well junior doctors in A&E were able to interpret significant *x* ray abnormalities and to compare their results with those of senior doctors in A&E and radiology.

Methods

An *x* ray quiz was prepared featuring 20 abnormal and 10 normal films. Forty nine A&E SHOs working in 10 hospitals in the South West Region were set a standardised test during the first three weeks of February 1991. The majority were inexperienced, but 10 doctors had over five months of A&E experience.

Between 1992 and 1995, 34 senior doctors (senior registrars and consultants) in A&E and radiology in the South West Region were also tested in the same way.

The only information provided with the quiz was that: (1) all films were taken after a history of trauma; (2) some films were normal; and (3) there may be more than one abnormality on some films.

The 20 abnormal *x* rays contained 24 abnormalities, and each abnormal *x* ray had a diagnosis that would affect the patient's management. Doctors were awarded one mark for every abnormality detected, except for a half mark for an ulnar styloid fracture with trans-scaphoid lunate dislocation. The maximum score for the abnormal films was 23.5. The abnormal films showed fractures, dislocations, or other significant injuries which had been missed previously by junior doctors in A&E, but picked up later. The 10 normal films were included for realism so the doctors did not expect an abnormality on each *x* ray. Six of these had minor normal variants such as an accessory ossicle. The maximum score for the normal films was 10; variants did not have to be specified—simply indicating normality was enough to gain a mark. The quiz was conducted in small groups under examination

conditions, showing each *x* ray for half to one minute. At the end of the quiz the correct answers and teaching were given on all the *x* rays to the junior doctors. Each doctor was given a separate score for their interpretations of the normal and abnormal *x* rays.

The data were analysed using the non-parametric Wilcoxon rank sum method.

Results

ERRORS IN INTERPRETING THE 20 ABNORMAL *x* RAYS

The numbers of junior or senior doctors correctly diagnosing each abnormal *x* ray are shown in table 1.

Mean scores of the SHOs

The mean score for all the SHOs (n = 49) was 7.53 out of 23.5 (32%) with a range of 4–17 (17% to 72%). The mean score for the 39 inexperienced SHOs was 6.58 (28%) compared to a mean score of 11.25 (48%) for the 10 experienced SHOs. The difference between the two subgroups was statistically highly significant ($P < 0.001$).

Mean scores of the senior doctors

The mean score for the senior doctors (n = 34) was 18.8 out of 23.5 (80%) with range of 13.5–22 (57% to 94%).

The difference between the scores of the junior doctors (SHOs) and of the senior doctors scores was highly significant ($P < 0.0001$).

ERRORS IN INTERPRETING THE 10 NORMAL *x* RAYS

The numbers of junior or senior doctors correctly diagnosing each normal or normal variant *x* ray is shown in table 2.

Table 1 Errors in interpreting the abnormal x rays. Number (and percentage) of junior and senior doctors correct for each abnormal x ray (results are listed in increasing order of correctness for the junior doctors)

x Ray abnormality	*No of junior doctors correct (n=49) n (%)*	*No of senior doctors correct (n=34) n (%)*
Surgical emphysema of neck (fractured larynx)	3 (6)	28 (82)
Trans-scaphoid lunate dislocation (whole injury)*	4(8)	24 (71)
Fluid level in sphenoidal sinus (basal skull fracture)	5 (10)	29 (85)
Dislocated base of 5th metacarpal (AP and oblique views)	6 (12)	22 (65)
Perilunar dislocation (1st example)	6 (12)	34 (100)
Odontoid fracture	7 (14)	27 (79)
Radial head dislocation	7.5 (15)	19 (56)
Depressed skull fracture	8 (16)	32 (94)
Sugical emphysema right orbit	12.5 (26)	30 (88)
Gas under diaphragm	14 (29)	24 (71)
Subluxation of cervical spine	14 (29)	25 (74)
Facial fractures and fluid levels (AP views)	14.5 (30)	26 (76)
Frontal skull fracture with aerocele	15 (31)	25 (74)
Tibial plateau fracture	16 (33)	29 (85)
Effusion of elbow	16.5 (34)	34 (100)
Perilunar dislocation (2nd example)	17 (35)	32 (94)
Greenstick fracture distal tibia	18 (37)	29 (85)
Hanging drop sign, left orbital fracture	20 (41)	32 (94)
Comminuted calcaneal fracture	22.5 (46)	34 (100)
Parietal skull fracture	23 (47)	29 (95)
Air in knee joint with soft tissue wound	23 (47)	33 (97)
Lunate dislocation	24 (49)	34 (100)
Anterior dislocated shoulder on chest x ray	30 (61)	23 (68)
Scaphoid fracture*	10 (20)	25 (74)
Dislocated lunate*	24 (49)	34 (100)
Ulnar styloid fracture*	33 (64)	21 (62)

* Components of trans-scaphoid lunate dislocation.
AP, anteroposterior.

Table 2 Errors in interpreting the normal x rays (results are listed in increasing order of correctness for the junior doctors)

Normal or normal variant x ray	*No of junior doctors correct (n=49) n (%)*	*No of senior doctors correct (n=34) n (%)*
Foot with normal epiphysis, base of 5th metatarsal*	10 (20)	31 (91)
Foot (accessory navicular)	11 (22)	34 (100)
Tibia/fibula (growth retardation lines)	12 (24)	29 (85)
Wrist (fused carpals)	16 (33)	31 (91)
Lateral skull	24 (49)	25 (74)
Lateral cervical spine	26 (53)	32 (94)
Ankle (accessory ossicle)	27 (55)	30 (88)
Chest x ray	27 (55)	32 (94)
Bipartite patella	27.5 (56)	31 (91)
Axial view of shoulder	36 (73)	33 (97)

* 32 junior doctors (65%) thought it was a fracture.

Mean scores of the SHOs

The mean score of the SHOs was 4.3 correct out of 10 (43%) (range 10% to 60%). The 39 inexperienced SHOs scored a mean of 3.9 (39%) compared with a mean of 5.8 (58%) scored by the 10 more experienced SHOs. The difference between the two subgroups was again statistically significant, although at a lower level than for the abnormal *x* rays ($P = 0.01$).

Mean scores of the senior doctors

The mean score of the seniors was 9.2 out of 10 (92%) (range 70% to 100%), significantly better than the juniors.

Discussion

A patient who comes to an A&E department with a depressed skull fracture or a dislocated lunate when a new junior SHO has just started may have a less than even chance of it being correctly diagnosed on *x* ray. As the mean score for all abnormal *x* rays was only 32% it would need an optimist to bet on a correct diagnosis being made. This is worrying.

Senior doctors had a mean score of 80%. These doctors were included to show that the quality of the information and *x* rays was such that the films were diagnosable to the more experienced eye. Some errors in the senior group also show that no system can be infallible.

Diagnosis depends not just on an *x* ray, but on clinical features as well. In this study doctors were handicapped by not being given the mechanism of injury or any clinical details other than that the patient had suffered trauma. They also did not have any normal *x* rays to use as comparisons. If a patient has a very painful or swollen limb and the *x* ray is thought to be normal, the doctor should ask advice. (This is one of the important rules of A&E radiology.[5]) The senior doctors were similarly handicapped, but scored highly.

The SHOs with over five months of A&E experience scored 48%. Doctors seem to learn during their time in A&E, but the percentage of significant injuries misdiagnosed by these more experienced SHOs is still unacceptable. Normal *x* rays also proved to be a problem, with only 43% being correctly diagnosed as normal

by the junior doctors, compared to 92% by the seniors.

Many of the injuries shown in this quiz were uncommon or classically difficult for juniors to diagnose. However, all the abnormal *x* rays had implications for the patient's management. Sixty five (92%) of the junior doctors missed the lunate and the perilunate dislocations (compared to less than 10% in the seniors). This is a commonly missed injury in clinical practice, with previous series finding only 57%[6] and 79%[7] correctly diagnosed in the first 24 hours. This delayed diagnosis may mean a worse prognosis.[6]

Fractured calcanea are a more common injury and while they are usually easily seen on calcaneal views, the site of tenderness is often not correctly localised and doctors ask for ankle *x* rays. Although visible on the lateral ankle view, the fracture is usually much less obvious, and 54% of SHOs missed a severe fracture of the calcaneum with gross disruption of the subtalar joint (seniors were 100% correct).

Eighty four per cent of juniors failed to diagnose the depressed skull fracture (compared to only 6% of seniors). In previous series, between 10% and 60% of linear skull fractures were missed,[8 9] but it is even more important not to miss a compound depressed skull fracture because of potential complications from both sepsis and intracranial injury.

Serious sepsis could also complicate an undiagnosed frontal aerocele and a compound knee joint injury, incorrectly diagnosed by 69% and 53% of juniors respectively (compared to 26% and 3% of seniors).

Carpometacarpal dislocation, missed by 88% of juniors (and 35% of seniors), if diagnosed late would lead to difficulty in reduction and probable long term disability. If clinically or radiologically suspected, a true lateral *x* ray must also be ordered to elucidate the diagnosis.

The normal *x* rays introduced for realism also caused problems, with such features as epiphyses and accessory ossicles being frequently misdiagnosed by juniors as fractures. The apophysis at the base of the fifth metatarsal was mistaken for a fracture by 65% of the junior doctors, which underlines the lack of awareness of normal *x* ray features.

WHAT CAN BE DONE TO IMPROVE THE SITUATION?

Most patients attending A&E departments are seen by SHOs who are often in their first postregistration post, but it must be recognised that undergraduate training and the preregistration year does not train doctors to work independently in A&E departments.[10 11] Other studies have shown deficiencies in junior A&E doctors' knowledge or skills of basic life support,[12] *x* ray anatomy,[13] and applied hand anatomy.[14] A&E consultants have a responsibility to ensure that patients attending their department are correctly diagnosed and managed. Not only do professional ethics insist that patients are given the best possible care, but increasingly systems to ensure this best care will be demanded by purchasers and by the hospital's insurers and risk managers.[15] This must involve adequate teaching and support for the junior medical staff, as emphasised by the Royal Colleges. The effect will be that hospitals that do not adequately resource their A&E departments will have to pay larger insurance subscriptions to the Central Negligence Scheme for Trusts (CNST).[16] A&E consultants who feel their departments are underfunded can, with appropriate evidence, discuss these issues with their chief executive or even with the purchasers.

At present, teaching and support commonly consists of an introductory course for junior doctors, regular tutorials, and the provision of a library of textbooks, including new A&E texts of radiographic anatomy[17 18] and other resources including a library of normal and abnormal *x* rays. An atlas of normal variants should also be freely available.[19]

Doctors also need support from other specialties and from more senior doctors within A&E. Increasingly, departments are providing senior and middle grade cover within the department for, if possible, 16 or more hours per day. The national shortage of junior doctors is leading to some departments appointing more permanent middle grade staff.[20] The often inadequate middle grade and senior staffing levels, and their importance, has been commented on by the National Audit Office both in 1992 and 1996.[21 22]

The missed diagnosis of *x* rays can be kept to a minimum by a "hot" reporting system,[3] but where this is not available, radiographers can improve diagnostic accuracy by a "red spot" system to mark abnormal *x* rays.[23] As a back up, all A&E *x* rays should be reported by a radiologist within 24 hours. (The Royal College of Radiologists recommend that in general all *x* rays should be reported within three working days, but this upper limit would not be ideal for some of the missed injuries in A&E, especially over weekends and public holidays.) Such fail-safe systems must be subjected to regular audit or review along with the missed injuries for feedback to the doctors. Senior A&E doctors and radiologists are only human and if there is any reason to doubt their *x* ray report, the patient or their *x* rays (or both) must be reviewed as a further safety measure.[5]

While this back up for SHOs is essential, it must be recognised that one of the hallmarks of inexperience is that doctors may not know when to ask for advice. In other specialties (for example, radiology, pathology, anaesthetics) junior medical staff have to receive training, and may be examined on their abilities before being allowed to treat patients or make diagnostic decisions. They then work under close supervision before being allowed to work independently. Although not all pitfalls can or should be covered, a scheme to detect abnormalities and provide safe management can be taught.[5] In A&E, doctors should receive specific training in the interpretation of *x* rays and should be tested on their ability before being allowed to work independently. Such a system may involved SHOs spending their first month in post receiving formal teaching and

working under close one to one supervision before being allowed to practice under the looser supervision which occurs at present. Such formal training would benefit not only A&E departments but also the other specialties, including general practice, in which our SHOs subsequently work. This will necessitate a reorganisation of the staffing and funding of accident and emergency departments which, although costly, will be necessary to ensure adequate patient care.

CONCLUSIONS

This study shows that SHOs are not safe to treat and discharge patients on their own. It is vital that A&E departments have adequate education, staffing levels, audit, and fail-safe mechanisms to avoid misdiagnoses and minimise complaints.

The staffing of A&E departments needs to be altered so that most patients are seen by experienced and trained doctors, mainly to ensure adequate care, but also to make for better risk management. A&E is a good training ground for doctors wanting to work in general practice and other specialties as well as A&E, but these inexperienced doctors must be closely supervised.

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