Comparison of a PACS Workstation with Laser Hard Copies for Detecting Scaphoid Fractures in the Emergency Department

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Picture archiving and communication systems (PACS) for imaging studies is rapidly being adopted in hospitals throughout the UK. However, very little comparison has been made between PACS and laser hard copies for assessing the diagnostic accuracy of detecting fractures by emergency physicians. A prospective paired comparison study was undertaken looking at correct reporting of scaphoid X-rays on PACS and conventional film by emergency department medical staff. A total of 34 imaging studies were reported by 38 physicians using both PACS workstations and laser-printed films. The percentage of emergency physicians correctly reporting imaging studies was similar when comparing PACS images to laser film copies (80.7% versus 81.0%). The sensitivity and specificity of PACS for diagnosing scaphoid fractures was 79.5% and 81.6%, versus 78.1% and 83.8% for conventional films. There is no significant difference in accuracy of diagnosis between PACS and laser film copies when scaphoid X-rays are reported by emergency physicians.

KEY WORDS: PACS, PACS system performance, performance measurement

INTRODUCTION

Over the last decade there has been increased financial investment and allocation of resources to the installation of picture archiving and communication systems (PACS) for displaying imaging studies. In the UK, over 120 National Health Service Trusts have implemented PACS systems and over 640 million images have been stored onto such systems.¹

In most emergency departments a large number of X-rays are requested by emergency physicians to assist in the diagnosis of a wide variety of illnesses and injuries. The imaging request relies on the fact that there should be a robust system for diagnostic imaging producing high quality images amenable to accurate interpretation. However,

despite the rapid installation of PACS systems throughout many hospitals, very little comparison has been made of interpretation accuracy between images stored on PACS and laser-printed film images.

There have been a number of studies comparing conventional films with digitised soft copies²⁻⁵ but so far no study has compared digital soft copies with hard copies. Although it is unlikely that users with access to PACS will use hard copies of digital images in everyday practice, it is important to note that when the PACS system is not functioning in a hospital, users are likely to revert to using laser-printed imaging films.

One of the unintended consequences of our desire to seek a 'filmless' radiology service has been the critical nature of computer back-up systems, maintenance and support systems. If the computer system fails, PACS becomes useless and patient care can potentially suffer.⁶⁻⁸

In the event of a failure of the PACS system clinicians would revert to interpreting laser copies and this study was directed at determining if this in fact was inferior to PACS and indeed pose any clinical risk. We specifically looked at scaphoid fractures and studied whether or not there was any difference in accuracy of reporting such films by emergency physicians using hard copies and PACS images. We chose scaphoid images to see

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whether subtle fractures would be missed on printed films in the absence of image manipulation tools available on PACS workstations.

METHODS

During the period of December 2005 until March 2006, 34 out of 235 scaphoid imaging studies requested by the ED staff were randomly selected by a senior radiographer 16 with reported fractures and 18 normal. Hard copies of the 34 studies were also printed directly from the computed radiography reader. This simulated the potential scenario of a PACS failure, or a computer systems failure, requiring hard copies for clinical use. All radiographs were of the standard four-view scaphoid series including a PA view, a lateral view, an oblique view and a 30°-angled scaphoid view. All images had been reported by a consultant radiologist who identified whether or not the images showed a scaphoid fracture. All the images were anonymised and randomised into different orders, so that there were two arms in the trial: hard copies versus PACS images.

Total of 38 emergency department medical staff both junior and middle grade were chosen to take part in the study, all with least 3 months experience in emergency medicine and training to use PACS, including the use of image manipulation tools.

All staff were asked to independently review the laser-printed hard copies on a standard wall-mounted X-ray viewing box. One week later, they were asked to independently review the same images on a PACS workstation. For each imaging study, they had to state whether or not there was a fracture present. There was no opportunity to discuss the images with other physicians. By separating the two sessions by 1 week and using a large number of films, the effect of learning and recall bias was minimised.

Radiographs were made using a Philips Optimus Diagnost T8, with Fujifilm FCR IP type CC cassettes exposed at 52-55kVp, 2mAs. The images were digitised using a Philips PCR Corado unit. The PACS workstation used was a Philips CL monitor, on which the original unaltered non-magnified images could be viewed in its entirety. Window width and level could be adjusted using a control mouse. In addition, magnification of any

part of the images could also be accomplished and all images could have the grey scale inverted. Staff were free to use any of the image enhancing techniques available on PACS while trying to interpret the studies.

RESULTS

In total 34 imaging studies were available for viewing both as hard copies and on the PACS workstation. Of these 34 studies, 16 were reported by radiologists as demonstrating scaphoid fractures. The remaining 18 studies were reported as being entirely normal.

Of the 38 emergency physicians who took part in the study 26 were senior house officers (SHO) and 12 senior registrar/registrar level trainees with EM experience ranging from 3 to 48 months.

Figure 1 shows which radiographs had fractures and which were normal. In addition, the number of doctors correctly reporting each radiograph is shown for both the PACS images and the hard copy films.

The percentage of emergency physicians correctly reporting imaging studies was similar when comparing PACS images to hard copies (80.7% versus 81.0%). There was no difference between senior house officer and registrar grade physicians.

The sensitivity and specificity of PACS for diagnosing scaphoid fractures was 79.5% and 81.6% respectively (positive predictive value 79.3%, negative predictive value 81.9%). For the hard copy images, the sensitivity and specificity were 78.1% and 83.8% respectively (positive predictive value 82.7%, negative predictive value 79.4%).

DISCUSSION

In comparing PACS images and laser hard copies, we found no significant difference in the likelihood of a scaphoid fracture being correctly identified or missed for either modality.

The use of PACS imaging in emergency medicine is generally accepted as being useful, but very few comparative studies have been undertaken to directly compare PACS images to the hard copy images in the emergency department.⁶

Image Number	Radiologist Report of a Fracture the Radiographs	Number of Doctors Reporting X-ray Correctly (n=38)	
		PACS	Hard Copy
1	No	34	37
2	No	38	36
3	No	30	33
4	No	33	28
5	No	19	20
6	No	33	30
7	No	24	26
8	No	27	24
9	No	25	23
10	No	38	36
11	No	36	35
12	No	34	37
13	No	35	29
14	No	28	26
15	No	31	30
16	No	26	26
17	No	38	38
18	No	31	29
19	Yes	34	38
20	Yes	19	24
21	Yes	21	24
22	Yes	28	29
23	Yes	38	38
24	Yes	31	35
25	Yes	33	33
26	Yes	27	29
27	Yes	27	29
28	Yes	33	30
29	Yes	38	38
30	Yes	37	36
31	Yes	29	34
32	Yes	27	27
33	Yes	38	35
34	Yes	22	24

Fig 1. Imaging studies that had fractures, and number of physicians correctly reporting the imaging study, whether on PACS or hard copy conventional film.

Although small, our study was designed to see if there was an appreciable difference in reporting on digital workstations and hard copy films in day-to-day clinical practice in the emergency department setting. We deliberately chose scaphoid fractures as these injuries are frequently missed.

Our results show that viewing laser-printed hard copies did not diminish the diagnostic accuracy. We were surprised to find, however, that the additional facilities available on PACS for image

manipulation (such as windowing, levelling and magnification) did not add to the diagnostic accuracy of scaphoid fractures. It is already known that these functions can be useful when studying chest radiographs for conditions such as small pneumothoraces, interstitial lung disease and pulmonary nodules.^{4,9}

It is important to stress that due to the available image manipulation functions, PACS remains far superior to the hard copy images when considering other imaging studies, such as chest radiographs,⁵ and is also shown to be very useful in fields such as paediatric emergency medicine¹⁰ and critical care medicine.^{11,12} PACS has also been shown to reduce the chances of a misdiagnosis in the emergency department.¹³

In conclusion we can state that in our group of patients there is no significant difference in the clinical interpretation of scaphoid fractures when viewed on either PACS workstations or laser-printed hard copy films. Therefore, when PACS malfunctions or there is a computer systems failure, the use of optimised laser hard copy images by doctors in the emergency department is unlikely to impact on the detection of fractures.

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