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The impact of focused training on abnormality detection and provision of accurate preliminary clinical evaluation in newly qualified radiographers

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ABSTRACT

Introduction: Preliminary clinical evaluation (PCE) can be a useful initial assessment of traumatic abnormalities by frontline radiographers; new graduates are expected to have the skills and knowledge required to provide this initial interpretation. This study evaluates the abnormality detection performance and accuracy of PCE commenting in newly qualified radiographers.

Method: Four newly qualified radiographers completed a fracture/dislocation detection task consisting of 58 cases, including providing a PCE for each suspicious area. Following this, an 8-week training program was completed to improve competence in recognizing abnormalities and providing an accurate PCE. Equally weighted jackknife alternative free-response receiver operating characteristic (wJAFROC) analysis was performed; a difference between pre- and post-training would be considered significant at a test alpha of less than 0.05.

Results: Fracture/dislocation detection was significantly better in the post-training evaluation for fixed observers and random cases ($F(1,57) = 4.48$, $p = 0.0387$). The reader averaged wJAFROC FOM and 95% CIs for pre- and post-training were 0.619 (0.516, 0.737) and 0.703 (0.622, 0.852). A paired t-test demonstrated a significant difference in PCE scores in favour of the post-training evaluation $p = 0.0006$. This small cohort demonstrated difficulty in recognising undisplaced fractures and buckle fractures.

Conclusion: An 8-week training program had a positive impact on participants' ability to localise and accurately describe fractures. Implementation of abnormality detection training should be considered during preceptorship periods. Due to the small sample size, it is inappropriate to suggest these findings are representative of all graduate radiographers.

Introduction

The Preliminary Clinical Evaluation (PCE) is a commenting scheme designed to improve the specificity of the widely adopted red-dot abnormality detection system; the Society and College of Radiographers[1] are advocates of this system and the Standards for Proficiency outline that radiographers should be able to distinguish abnormal appearances and trauma processes.[2] Furthermore, there is an expectation that all radiographers have sufficient knowledge of radiographic anatomy and common abnormalities,[3] which would facilitate effective participation in a PCE system. PCE provides radiographers with an opportunity to have a positive impact on timely patient management. Effective communication of abnormal findings is considered to reduce the time-to-diagnosis, which may also have an impact on the length of hospital stay.[4] Despite recognised benefits, there have been few publications of large-scale empirical studies confirming the success of PCE. The uptake of PCE has been slow with the suggestion that this may in part be due to the increase of reporting radiographer activity.[5] If PCE is to be a worthy successor to the red-dot abnormality detection system, radiographers must provide a service that is accurate, and an effective driver of improved patient outcomes.

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A meta-analysis by Brealey et al.[6] suggests radiographers have good accuracy when using a red-dot abnormality detection system, albeit against varying reference standards with associated differential verification biases. Very little exists by way of objective observer studies that assess performance but a few recent studies aptly illustrate the image interpretation abilities of radiographers.

Piper and Paterson[7] undertook an alternative free-response receiver operating characteristic (AFROC) study to assess the effect of training on the ability of 38 participants (radiographers and nurses) to accurately locate an abnormality and to simply state the nature of the abnormality. Improvements were observed after training with radiographers demonstrating post-training increases in figure of merit (0.63–0.73), sensitivity (60%–69%), and specificity (73%–83%), respectively.

The free-response study by McEntee and Dunnion[8] indicated that radiographers can accurately detect abnormal wrist images with sensitivity comparable to that of radiologists (radiographers 87.7%, radiologists 88.9%), but specificity was poorer (radiographers 64.4%, radiologists 80.5%). McEntee and Dunnion[8] concluded that, although not statistically significant, the number of years of experience could positively affect interpretation skill; they did not however assess the effects of training on performance. Earlier work by Hardy & Culpan[9] has proven that sensitivity and specificity levels do improve following training; 72%–88% and 50%–53%%, respectively. It is generally accepted that an increasing number of years of radiographic experience will have a positive impact on the correct interpretation of trauma images. In less experienced staff it is likely that providing training would expedite accurate contributions in a PCE system.

Despite claims of good accuracy, it is thought that PCE has not been widely implemented due to a perceived lack of confidence and inadequate training[4,10] with previous research suggesting that the requirement to provide a written comment caused a reduction in abnormality detection accuracy.[7,9] However, this is not a universal opinion, where it has been suggested that good image interpretation performance indicates an ability to provide a written comment.[12] If training issues do exist, and are not addressed appropriately, then the effectiveness of the PCE could be restricted.[9]

Much of the previous work discussing the uptake of PCE focuses on the quality of training and the preparedness of radiographers to provide an accurate PCE comment. Graduate radiographers are expected to have sufficient image interpretation ability, despite a lack of formal certification of competency.[11] The aim of this paper is to evaluate the abnormality detection performance and PCE accuracy of a small sample of graduate radiographers using an objective observer study to assess detection accuracy, and a scoring system to assess commenting accuracy. Given that questions remain about training and the ability of radiographers to provide a comment, this study will operate a pre- and post-training design to assess the impact of focussed training on a graduate radiographer's ability to accurately localise and describe a red-dot type abnormality.

Materials & methods

Local Research and Development, and the Health Research Authority[13] decided that the project was suitable as service evaluation. The clinical cases selected were all acquired more than 12-months prior to this study. This reduces the likelihood of new abnormalities being detected on our review of the cases, since the patient is likely to have presented symptomatically in this time period if an occult fracture had been present. This was important to ensure the correct abnormality status in normal and abnormal images. Where follow-up imaging was available, it was reviewed to ensure that no occult abnormalities were present on cases used in the observer study. All observers provided written consent.

Case selection

A three-month audit of abnormality prevalence for all examinations of trauma to single appendicular parts was undertaken in the study centre revealing a 29.4% incidence of abnormality. We used this data to determine the number of normal/abnormal cases (prevalence) for the observer study, and also the distribution of appendicular examinations that should be included. The range of the subtlety of abnormalities within the selected cases was also consistent with the local workload. One of the authors (BS) compiled the caseload based on the findings of the abnormality prevalence audit. Replicating the local clinical workload provides a comparative assessment of participant interpretation, relative to their clinical practice.[14] We performed a sample size calculation to predict the required number of cases, based on six observers completing the study. Obuchowski[15] developed a mathematical model to provide sample size tables for ROC analyses based on the intricate relationships of accuracy, inter-observer variability, patient variability and the correlations in accuracy imposed by the study design. Test alpha was set at 0.05 to control the probability of Type I error, while the power is set at 80%. We estimated that 58 cases would be required for a suitably powered study with a ratio of 4:1 (negative: positive) cases. This ratio was the nearest to the 29.4% prevalence of abnormal cases established from our audit.

The image bank of 58 examinations consisted of 17 abnormal appendicular examinations and 41 normal appendicular examinations. Cases containing normal variants were not excluded and were considered as normal. The mean distribution of each appendicular examination over the previous three months was calculated alongside the percentage occurrence. The percentage occurrence was then applied to the sample size to provide the number of each examinations required. Table 1 summarises the 17 abnormal cases and the gold standard PCE comments, and the 41 normal cases used in this study. The gold standard PCE descriptions are a consensus of two Advanced Practitioner's interpretations; who verified the descriptions of the abnormalities rather than relying on the report. DICOM headers were removed from all cases to ensure anonymity. All annotations identifying fractures or dislocations were also removed. Each abnormal case contained only one abnormality to allow quantification of a single comment. No discrepancies with the original radiological report were identified in the case selection process.

Observer performance study & PCE scoring

Four observers evaluated the 58 cases on two occasions: (i) pre-training and (ii) post-training. All observers were in a preceptorship period; eight weeks of training elapsed between the two evaluations. We based our sample size calculation on 6 observers, but only 4 were able to complete the study. For one of the observers it transpired that they did not fulfil the inclusion criteria (newly-qualified radiographer, first-appointment), and for another there was an unavoidable delay in commencing their employment, therefore they were excluded from the study. An eight-week training schedule, separating the pre- and post-training evaluations, consisted of intensive educational sessions designed to deliver information relative to abnormality detection. The sessions were designed and delivered by one of the authors (BS), an Advanced Practitioner (skeletal reporting). The introductory session covered basic terminology and concepts, which familiarised participants with a systematic approach to fracture detection, forces and fracture patterns, established vocabulary, and a model of forming a comment. All appendicular body parts were covered; each session followed the same format, which included radiographic anatomical knowledge, common fractures, assessment