ORIGINAL ARTICLE

PEDIATRIC CHEST RADIOGRAPHY: AUDIT OF COMMON TECHNICAL FAULTS IN SOUTHERN NIGERIA

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ABSTRACT

Background: Technical faults represent one of the most potent limiting factors in optimizing pediatric radiography. These faults not only affect the technical quality of the radiographs produced but have far reaching consequences.

Objectives: We sought to audit the common technical faults in pediatric chest radiography in South-South Nigeria towards identifying and adopting remedial measures that would ensure improved Radiography service delivery in the region.

Methods: A total of 621 pediatric (<12years) chest radiographs were independently subjectively assessed for the presence or absence of faults and scored by two Quality Assurance (QA) radiographers with 12±2 years average working experience. Parameters assessed were rotation, collimation, blurring, exposure factors, artifacts (all types) and identification.

Result: Findings show that out of 621 pediatric radiographs assessed, 551 had one or more faults. Out of 551 radiographs with faults, 450 (81.7%) were poorly collimated, 159 (28.3%) were either over or underexposed and 71 (12.9%) had artifacts.

Conclusion: Patient rotation, blurring, presence of artifacts, wrong identification and choice of exposure factors are the common faults in pediatric chest radiography in the area studied. Training and retraining of radiographers, installation of dedicated pediatric facilities, legislation monitoring and evaluation of practice and regular QA will help in optimizing pediatric radiography in South-South Nigeria.

Keywords: Technical faults, pediatrics, radiographer, collimation, exposure, artifacts, Identification, rotation.

INTRODUCTION

Audit of technical faults is important in radiography as they form part of the assessment criteria for establishing quality of patient care received in Radiography department. Audits are particularly important in pediatric radiography because of the challenges encountered in and with pediatric examination1.

Pediatric patients in this case refer to children below 12years of age. Individual between the 0 - <12 year have limited or no awareness of the changes in their environment. Their level of cognition varies and directly influences their actions and reaction to change around them, determining also the degree of cooperation obtainable from them during radiological investigations1.

Technical faults in pediatric radiography may be due to the complex nature of these children and their inability to adhere to radigraphers' instruction or factors related to the production of diagnostic quality radiographs.

The significance of these faults varies from minimal to severe. The resultant effect may generate bad publicity, losses to the hospital, wrong and delayed diagnosis, and increased radiation risk arising from ensuring repeat of radiographic examinations2,3,4.

The potential of ionizing radiation to cause damage to biological tissues requires that its use be justified and then optmized4,3,5. Justification implies that the benefit from any radiographic procedure must outweigh the risk. One way of reducing the exposure to risk is by optimizing the procedures involved opti-

mization is aimed at producing diagnostic quality images at minimum radiation dose and cost6. This is particularly important in pediatric radiography because children are more susceptible to the effects of ionizing radiation owing to their highly primitive, rapidly dividing and proliferation cell content, careful and correct radiographic examination reduce repeats, waiting time, radiation does, risk and the cost of examination7.8.

Plain chest x-ray is one of the common x-ray examinations for evaluation of the pediatric chest. This may be due to the ease, availability of the equipment and low cost of the examination. However, the examination challenges the technique and ability of the radiographer and places an added burden on the radiographer because children are usually uncooperative and may noe understand radiographer's instruction during examination. This is further compounded by the fact that a child's reaction to illness is dependent on their mental, physical, social, cultural and environmental factors which in turn, is influenced by their level of cognition1.

Radiographers, therefore, need to awaken their creativity and introduce new ways of coping with any difficulty they may encounter during the course of the examination.

Errors such as patient rotation, poor collimation, and presence of artifacts, improper identification, and wrong choice of exposure parameters, movement and respiratory blurring among others have been documented in literature1,9 and 10.

Several approaches have been employed to combat these errors including immobilization or restraints, short exposure time, optimal filtration, collimation and use of fast film-screen combination 13, 12, 16 though not respiration is either absent or unsatisfactory12. Proper immobilization of the child without restraint may be dependent on the trust the child places on such a radiographer. Pediatric radiography doses have been reported17, but studies of this nature have not been carried out in Nigeria.

These necessitate the need to document the common technical errors in pediatric chest radiography in South-South Nigeria in order to explore ways of salvaging them.

Methods

An assessment of pediatric (0-12years) chest radiographs was carried out by two quality assurance radiographers of 12 ± 2year's average working experience. About 691 radiographs were drawn from the archives of Radiology departments of teaching hospitals in South-South geopolitical zone of Nigeria. No ethical clearance was required. A total of 621 pediatric chest radiographs that met the assessment criteria were independently subjectively assessed and scored for the presence or absence of common technical faults. The conditions of viewing were optimized for the assessors with the use of the same viewing bow with luminance values (1500cdm2). Room ambient lighting was in the line with international recommendations.

Parameters assessed were patient rotation, beam collimation, motion and respiratory blur, choice of exposure factors, film identification and artifacts. Collimation was assessed based on the European Guidelines on Quality Criteria for Diagnostic Radiographic Images in Pediatrics chest radiography14. A meter rule was used to measure the distance between the lateral chest wall soft tissue and area of the film exposed. Also, measurements were made from the costophrenic angles and the distal portion of the film exposed and from the first rib to the proximal portion of the exposed radiograph. Radiographs with area of exposure e"2 cm from area of interest were regarded as poorly collimated. Rotation was assessed by the distance of both clavicles from the midline. Radiographs with both clavicles not equidistant from the midline were regarded as rotated. Exposure factors were assessed by the assessed by the presence of unsharpness on

the radiograph. Radiographs without any or all of patient name, number and anatomical marker were regarded as not properly identified. Any opacity, mark or appearance on the radiograph not representative of the patient's area of interest was classified as an artifact.

Parameters were either give a score of 0 for presence of fault or 1 for absence of such fault. Rule of majority (radiographs with the same opinion by the two radiographers) was used to confirm the presence of the technical faults on the radiographs. Film for which the assessors did not agree on the presence or absence of any fault were not included. A total of 621 films assessed met the criterion leaving 70 for which assessors disagreed.

Result

Table 1: Technical Faults and Scores
Technical FaultsScore obtained/ Number of films obtaining score01Motion/ Respiratory blur159392Patient rotation142409Over/under exposure123428Identification (name, number and marker)141410Collimation450101Artifact71 480

Figure 1: Distribution of percentage occurrence of faults

Results show that out 621 pediatric radiographs assessed, 551 had faults out of this, 450 (81.7%) were poorly collimated, 159 (28.9%) were blurred, 142 (25.8%) were rotated, 141 (25.6%) were not properly identified, 123 (22.3%) were either over or underexposed and 71 (12.9%) had artifacts.

Discussion

Good radio diagnosis begins with production of good quality radiographs having sufficient contrast, resolution, low level of unsharpness and devoid of artifacts.

The complexity and varying level of pediatric cognition especially in poor health conditions limits the ability of radiographers to achieve this. Although radiographic technique may not vary directly from that used for adults, modification of radiographic technique by the radiographer is often necessary to overcome the demands of varying child size, conditions and types of pediatric patients. It is often difficult for radiographers with limited experience to modify technique to suit every child at a level appropriate to the child and this is compounded by the fact that in stressful situations children will often regress to a younger developmental ag1. These tend to add to the pressure to obtain good quality films, often leading to increased incidence of faults. These faults have consequences ranging from repeat increased examination cost and time, increased radiation dose to patients and radiation workers, delayed and wrong diagnosis, bad publicity among others2,3,4.

Pediatric chest radiography therefore presents challenges to radiographers trying to make a compromise between image quality and radiation dose, and between examination time and role ambiguity.

However, no matter the condition of the child, justification and optimization of practice are paramount in their radiographic examinations to reduce the potential effect of radiation and to reduce these faults.

Our study sought to assess the common technical faults on plain pediatric chest radiographs in South-South Nigeria using a representative sample of pediatric chest radiographs.

The results show poor collimation, motion blur, patient rotation, improper or lack of film identification, wrong choice of exposure factors and artifacts to be common technical faults in pediatric chest radiography in South-South Nigeria (Table 1).

Poor collimation (field size e"2cm than the area of interest) accounted for 81.7% of the total faults (Figure 1). This may be expected as radiographers would prefer using a large radiation field to avoid cutting off anatomical details which may necessitate repeat, increasing radiation does to patients,

cost of examination and examination time. This fell short of CEC guidelines which recommended the maximum field size tolerance to be less than 2cm greater than the area of interest and to be further reduced to a tolerance of 1cm in neonates14. Although collimation is an appropriate way of reducing radiation does to the patient, its application requires the radiographers to apply precise knowledge of external anatomical landmarks to the pediatric patient being examined, good patient immobilization and nature of the underlying disease. Corks et al10, Hardy and Boynes1 have identified poor collimation as a recurring phenomenon in pediatric radiography.

Patient rotation and motion blur accounted for 25% and 28.9% of faults respectively (Figure 1). Both faults in some cases occurred in isolation or concurrently. They were probably due to wrong positioning, movement of patient and non-control of respiration. These affect not only the technical quality of the radiograph but also cause misrepresentation as well as distortion in the final image which may make interpretation difficult.

The CEC15, Cooks et al, observed that incorrect radiographic positioning and unsuccessful immobilization of pediatric patients were the most frequent causes of inadequate and poor quality pediatric images. Correct positioning of patient of patient in supine position prior to exposure and use of restraints in difficult circumstances has proven to be beneficial in reducing these faults13.

The selection of exposure factors has also been a challenge. This is attributable to the varying sizes of pediatric patients and different clinical conditions. It is not made any easier by the constraint of imaging with facilities that do not have automatic exposure control (AEC). The image quality and radiation dose to patients are determined by the exposure factors used and image receptor detective quantum efficiency. About 22.3% of the radiographs were either over or under exposed (Figure1). This might have been due to wrong choice of exposure factors.

About 25.6% of the radiographs had no proper identification (name, number and anatomical marker). The urgency with which pediatric examination are performed may be implicated in this. Wrongly placed anatomical markers and obscuration of anatomical details by markers and opaque legends may cause wrong diagnosis or necessitate repeat which increases dose to patients, examination and patient waiting time, cost of examination and also stresses the patient and radiographer.

Artifacts are not uncommon findings in pediatric radiography and result from poor patient and room preparation. Although it is the responsibility of the radiographer to ensure all radio-opaque materials are removed from the region of interest, some of them may elude the radiographer and appear on the processed radiograph. Others may come from the darkroom. Presence of artifacts is the least common fault (12.9%) in pediatric radiography as observed in our study (figure 1).

The results outlined above are evidence of need for QA action and regulation of practice in the system. Several studies Egbe et al19, Ekpo et al20 made recommendations for introduction of viable QA in the past in the face of similar technical findings even in adult radiographs and poor equipment maintenance policies. These recommendations are upheld in the current study.

Also, attitudinal change particularly towards pediatric patients and their examinations, installation of dedicated pediatric facilities, legislation, monitoring, and evaluation of practice by the regulatory authorities will help in the optimization of pediatric radiography and reduce these faults to a minimum in South -South Nigeria.

Conclusion

The most common technical faults in pediatric radiography in the area studied are poor collimated, motion blur, and patient rotation, wrong choice of exposure factors, poor identification and presence of artifacts. These faults result from complexity of childhood especially in ill situations and factors related to image production which is in turn controlled by the

radiographer. QA programs in the system, individual radiation workers adherence to guidelines and use of dedicated pediatric radiography units as well as modalities that will increase the child's level cooperation may be beneficial in eliminating these faults.

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