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Pediatric imaging: A challenging task in radiography.

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Abstract

Radiographic imaging is an extremely valuable diagnostic tool in pediatrics, for evaluating different abnormalities, but it comes with several challenges. Pediatric radiography is a valuable tool because it requires dedicated imaging exposure protocols to acquire images of different organs. The proper knowledge and high expertise are needed to evaluate the proper detailed images, and most importantly, it needs special consideration for radiation protection while using ionizing radiation.

Pediatric radiography is challenging and needs special training for technologists to understand the psychology of the child, technologists should gain the trust and cooperation of the child duration the entire examination, which begins at the first meeting between the patient and the technologist that is everlasting and forges the bond of a successful relationship. Images acquired during pediatric radiography must have good contrast, and resolution with no-repeat examinations to prevent the harmful effects of radiation. The radiation principle should be followed *i.e.*, justification, optimization, and dose limits while using ionizing radiation in the medical field.

Keywords: Pediatric imaging, Radiation protection, Immobilization devices, Technical parameters.

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Introduction

Pediatric radiography is a subspecialty branch of radiology that deals with the imaging of health and medical care of infants, children, and adolescents from birth up to the age of 14. Radiographic investigations are becoming an integral part of the healthcare system for the evaluation and diagnosis of different abnormalities. This includes the use of a variety of imaging modalities, e.g., X-ray, computed tomography scan, magnetic resonance imaging, and ultra sonography, but some of the imaging modalities may involve ionizing radiations that are harmful to the human body. The evolution of new technology and rapid advances in imaging technology dramatically increase the use of imaging modality [1,2].

Challenges in pediatric imaging

Good environment: The important step in pediatric radiography is to acquire good quality images and gain the trust and cooperation of the child. The Children require a good stimulating atmosphere that easily catches their attention. The environment and atmosphere should be friendly and free from noise where patients feel relaxed. For instance, the walls of the room should be bright colored, the walls should be designed with paintings and images, and the toys, play characters, and cartoons should be placed in the room [3].

Many professionals suggest implementing appropriate distraction techniques that can reduce the child's fear and anxiety. Projectors can be used as a distraction tool within the x-ray room. Proper care needs to be taken while using any electrical equipment and should be ensured that they are positioned in a safe and appropriate place without electrical leads trailing across the room.

The important part is to gain the trust of a child, which begins at the first meeting with the child or patient; makes a bond of a successful relationship, and increases the success rate of examination. Not all technologists enjoy working in such conditions where patients are not cooperative; movement is one of the biggest problems. The technologist must be conscientious and dedicated individuals who enjoy working with pediatric patients and have sufficient patience. Technologists must be kind and sympathetic and understand the intellectual and emotional maturity of both normal and retarded children of various ages. Only then can they function such that when they have completed the examination, the child is happy and the parents are pleased.

Successful radiographic studies are dependent on two things

- The attitude and approach of radio technologists to a child.
- The radiographer must have good knowledge of radiologic equipment and its use.

While coming for an examination most children are accompanied by parents. It is important to follow the protocol:

- Proper introduction of yourself as the technologist.
- Proper instructions should be followed given by the pediatrician or physician.
- Explain the proper procedure and what your needs will be during an examination.

The behavior of children in the new environment is not joyful, the patient is unfamiliar with the environment and it is normal that the child starts crying, fear, and may show resistance. The radiology technologist must-have skills to communicate to the parent and the child to normalize the environment, the technologist should communicate and convey a clear message in a language they can understand, and exactly what he or she is going to do during the examination. Radiology technologists must make or try to build a friendly atmosphere of trust in the waiting room before entering the radiographic examination room. This can be possible while discussing with the parent or caretaker and with the use of immobilization devices as a last resort if the child's cooperation is unattainable. The parent is in the room as an observer, lending support and comfort by his or her presence. The parent serves as a participator, assisting with immobilization.

The parent or caretaker in the examination room comforts the patient with his or her presence. The parent serves as a participator, assisting with immobilization.

Specialized equipment

Equipment and facilities suitable for use in pediatrics require some specialized features. Sometimes, the equipment may differ or vary from premature to adult-sized teenagers. The equipment is easy to use and handle, allowing fast acquisition of diagnostic information (images). Wherever necessary, image viewing and workflow stations allow fast transfer of images to the Picture Archiving and Communication System (PACS), for easy reporting and audits by radiologists [4]. Not all technologists enjoy working with children many become flustered by the lack of cooperation of infants and by the time required for the pediatric examination.

Quality assurance

Quality assurance plays an important factor in the case of pediatric radiography. Acquisition of optimum quality images is important during radiography that requires the high expertise or skills of technologists and the function of imaging equipment to its maximal capacity. Diagnosis of many pediatric ailments depends on elegant demonstration of tissue characteristics (anatomical detail) and slight changes. Routine quality assurance programs and checks are key to ensuring optimum performance; often requiring constant calibration of this equipment.3Double-check protocols are necessary to ensure there is no missed diagnosis.

Radiation protection

The optimization of protection in pediatric patients during examination requires the use of specific protocols tailored to the patient's age, size, weight, and region of interest being examined.

Even without national dose reference levels for Pediatric examinations, there is much that can be done within clinical departments to ensure that unnecessary exposure to ionizing radiation is minimized. The IR (ME) regulations emphasize the necessity for ‘justification and optimization’ of radiographic exposures as an essential step in the radiation protection process and stress that any examination that does not have a direct influence on patient management should not be undertaken. Unfortunately, unnecessary examinations are still requested by clinicians who are unfamiliar with modern imaging techniques and concerns have been raised over the level of training in radiological techniques that currently exist within undergraduate medical courses 13.

Radiation protection in diagnostic radiography is essential if the patient is exposed to ionizing radiation it should be maintained at a level of minimal acceptable risk. The concept of risk is an important one and we must reduce risks to patients and staff through the radiation protection principle *i.e.*, justification, optimization, and limitation of radiation exposures [4] (Table 1).

Justification	No practice involving exposure to radiation until there are more benefits than risks involved with the examination
Optimization	As Low As Reasonably Achievable (ALARA), states that whenever it is possible use low exposure settings (kVp, mAs) to minimize the radiation dose and risks associated with it.
Dose Limitation	The ionizing radiation exposure should not exceed the limit above which the radiation risk would be deemed unacceptable Adapted from National Radiation Protection Board (1994)14

Table 1. Definition of terms.

Patient positioning

In most, pediatric examinations incorrect and improper positioning is the most common cause of inadequate or poor radiographic image quality and should not be used as an excuse for poor image quality [5]. The acceptability of an image as diagnostic depends upon the clinical question posed and it may be that, in certain circumstances, a lower level of image quality may be acceptable for certain clinical indications. However, inferior image quality cannot be justified unless it has been

intentionally designed and is associated with a reduced radiation dose to the patient.

Field size (FOV) and beam limitation

Inappropriate field size is a common fault and its correction is an effective method of reducing the unnecessary radiation dose to the patient. Correct use of beam limiting devices is required for the radiographer to apply precise knowledge of external anatomical landmarks to the pediatric patient being examined. It is important to collimate accurately to the area of interest and reduce the radiation dose. Accepting the importance of accurate collimation to the area of interest as a method of reducing dose is further emphasized in the European guidelines on quality criteria for diagnostic radiographic Images in paediatrics [5-8]. These guidelines state that the maximum field size tolerance should be less than 2 cm greater than the area of interest and this is further reduced to a tolerance of 1 cm in neonates. Consequently, appropriate quality assurance testing of mobile and stationary radiographic equipment to ensure that the light beam diaphragm correlates with the radiation beam is vital if consistent and accurate collimation is to be achieved.

Protective shielding

For all types of pediatric examinations, it is important to use proper shielding. Lead rubber shields can be used to protect part of the body in immediate proximity. Experimental data have shown that, when using exposures in the range of 60–80 kV, a reduction in gonadal dose of up to 40% can be achieved when 0.25 mm lead rubber equivalent is applied at the field edge [9].

Immobilization device

An immobilization device is a device that is used to ensure that the patient should remain still during the examination, without any movement that can cause blur to the image. Patient motion is of two types voluntary and involuntary. Immobilization techniques are used to minimize voluntary motion, while intrinsic motions are best controlled by extremely short exposures. The shaping of this device must be able to maintain the patient's position. Immobilization devices include:

- Tam-em board
- Pigg-O-Stat
- Sandbags
- Velcro strips
- Tapes
- Towels

Proper immobilization techniques improve image quality, decrease the length of the examination, and decrease the need for repeat examinations. Proper immobilization may require the use of adhesive tape, foam rubber blocks, wedges, sheets towels, diapers, stretch gauze bandages, orthopedic stockinet, and wood blocks.

Compression bands and head clamps

Compression or retention bands are used and are valuable aids for immobilization. However, Compression bands are more effective and easier to use with infants and children when used in combination with sandbags. An immobilization board is the best device suited for use on the horizontal radiographic table. When upright or erect radiography is necessary, the pigg-o-stat device should be used.

Technical specifics

There are already existing policy guidelines regarding acceptable quality diagnostic radiographs in pediatric imaging which are set to ensure the production of an adequate and uniformly acceptable image that provides an accurate interpretation of the images while following the radiation protection principle using a reasonably low radiation dose per radiograph. To fulfill the objective, there are certain general rules and recommendations which are as follows: [10,11].

- The use of modern digital imaging or radiography is recommended use so that exposure factors can be optimized and repeats are avoided
- The use of high-contrast films is capable of yielding high-resolution images
- Use of proper exposure parameters with automatic exposure controller
- Use of correct positioning, centering, collimation, and immobilization methods
- There should be proper departmental protocol regarding imaging of pediatric patients, only necessary and important radiographic examinations should be performed and routine radiography should be avoided, whenever possible, minimal projections with minimum exposure settings must be used to visualize the area of interest.

Radiographic exposure parameters

Focal spot size if a choice of focal spot size is available, then the decision should be made upon the ability of the focal spot to provide the most appropriate exposure time and radiographic voltage selection at a stated focus-to-film distance (FFD) – this will not always be the smaller focal spot.

Tube filtration

Most x-ray tubes have installed as a minimum a 2.5 mm aluminum equivalent filtration. The effect of filtration is to absorb low-energy photons emitted from the anode, thereby reducing patient dose and increasing the quality of the beam. The use of a high kV technique is often desirable, but not all generators are capable of the short exposure times necessary. Where the range of selectable mA values is limited and where the minimum exposure time is 0.01 seconds or greater, it may be necessary to increase filtration to enable the selection of an appropriate higher kV without producing excessive film blackening. It is recommended that the minimum additional filtration for Pediatric examinations is 1 mm aluminum plus 0.1 mm copper [5], although this is dependent upon the

filtration already incorporated within the tube and should be decided locally. This additional filtration need not be permanently placed within the x-ray tube but the facility made available to add filtration to the tube when required.

Voltage

Despite recommended high kV techniques, low kV pediatric examinations continue to be undertaken. High voltages facilitate the use of short exposure times and the extremely short exposure times needed for pediatric radiographic examinations can only be achieved if a high frequency (or 12-pulse) generator is used. The use of added filtration can allow the utilization of high kV techniques with longer exposure times when operating older equipment.

Anti-scatter grids

The use of anti-scatter grids in the radiographic examination of infants and young children is generally accepted as unnecessary. Pediatric examinations undertaken with the use of anti-scatter grids result in increased radiation dose to the patient and therefore their continued use should be questioned if diagnostic radiographs of satisfactory quality can be produced without them. Fluoroscopic equipment should also have the facility to quickly remove and insert grids and once again, the necessity of the use of a grid in the examination of young children should be questioned [12].

Screen film systems

Although advancing technology is quickly bringing in the digital age, many imaging departments still operate a film/screen imaging system, and therefore it is important to consider their value as a method of reducing patient dose. High-speed systems result in a lower patient dose and allow shorter exposure times to be used therefore minimizing movement unsharpness.

Digital systems

Digital imaging technology permits a wide range of exposure parameters to be used without significantly affecting the perceived image quality. It is therefore essential that appropriate exposure parameters are established and adhered to ensure minimum patient dose. Ideally, the exposure setting (kV/mAs) combination used should be sufficient to ensure that the noise in the image is just low enough for the image quality to be diagnostically acceptable.

Automatic brightness control

Fluoroscopy can result in large patient doses if unnecessary grids are not removed or the radiologist or radiographer does not correctly use or apply their knowledge of the equipment. A simple method of reducing patient dose if imaging a large area containing a contrast agent is to switch off the automatic brightness control to prevent the machine from trying to penetrate the contrast. This simple step can avoid excessive doses for the patient [13-16].

European guidelines on quality criteria for diagnostic radiographic images in pediatrics

These guidelines state that patient positioning, before radiation exposure, must be exact and proper way whether a patient is co-operated or not. The guidelines advocate the use of immobilization devices in infants, toddlers, and young children. Those devices should be properly applied and must ensure that the patient does not move and remain still during the examination and that the correct projection is achieved [17-19].

Holding children still – A five-point model

Few pieces of research have been published that demonstrate different techniques in holding and comforting children, even though it is generally agreed that all health professionals working with children need education and training in the immobilization and distraction of children [20]. To this end, Stephens et al. [8] designed a five-point model of child comfort and immobilization for nursing procedures that can be adapted to meet the needs of other health disciplines [21].

- Prepare child and guardian for the procedure and explain their role
- Invite guardian to be present
- Use a specific room for painful procedures
- Position child in a comforting manner
- Maintain a calm and positive atmosphere

Prepare child and guardian

Attending a medical examination within a hospital environment is a major event in the lives of most children and therefore radiographers should approach the child in a serious but friendly manner, understanding that the role of the radiographer is not to make the child happy but to offer reassurance, inspire confidence and provide appropriate information [22,23]. Before the radiographic examination commences, both the child and guardian need to know why the examination is necessary, how the procedure will be performed, and essentially what is there. It is often difficult for radiographers with limited experience with children to provide explanations at a level appropriate to the child and this difficulty is compounded by the fact that in stressful situations children will often regress to a younger developmental age.

It is not, therefore, appropriate to use chronological age alone as a guide to the level of explanation instead an assessment of the apparent developmental age displayed by the child needs to be made. Taking time to explain the procedure is essential if maximum co-operation is to be achieved and the use of physical restraints minimized. The explanation should, if possible, be made in a neutral environment such as the waiting area and, as the age at which comprehension begins is uncertain, it should be worded in such a way as to be understandable to both adults and children, including children as young as 12 months of age. An effective explanation, although time-consuming, will result in a more efficient examination as an improved child and guardian cooperation

will reduce actual examination time and, if the explanation can be undertaken outside of the imaging room, will reduce patient waiting times. A possible approach to effective explanation [24].

Invite guardian to be present

The health of a child is dependent not only on the child's physical and mental well-being but is also influenced by cultural, social, and environmental factors. In the past patients, including children, have been treated as clinical cases rather than individuals in their own right, and attention has been given almost exclusively to their medical condition. The emphasis within health care has now changed and children are treated not only as individuals but also as part of a family, community, and culture. This change has not occurred overnight but has resulted from several initiatives to involve guardians and family in the care of hospitalized children and to help the family maintain normal functioning (family-centered care) [7]. The presence of a parent/caretaker within the examination room provides the child with security9. Guardians are also able to comfort the child familiarly and often instinctively implement appropriate distraction techniques that can reduce the child's fear and anxiety, increase the child's cooperation and minimize the need for restraining devices [25].

Positioning child/toddler/infant in a comfortable manner

Radiographers need to be more creative in their imaging strategies when examining children and work with what is presented rather than 'forcing' the child to adopt a position routinely used in the imaging of adults. The need for 'cuddles' and comfort throughout an imaging examination is not restricted to very young children and children as old as 7 or 8 years will prefer to sit across a guardian's lap or next to a guardian to gain comfort from their presence [26].

Distraction tools

The use of distraction techniques within health care is growing in prominence and the experts in the use of distraction and play are play specialists. Play specialists are not generally employed within imaging departments but instead; tend to work mainly in children's wards and outpatient clinics. However, most play specialists would welcome the opportunity to discuss child-friendly environments and distraction techniques with other health care professionals a should be contacted to advise on the needs of children within radiology departments [27].

Reporting suspected child abuse

Most institutions and medical centers have a proper procedure in place to report suspected child abuse or Non-Accidental Trauma (NAT), previously, the term Battered Child Syndrome (BCS) was used. Generally, the radiographer is not responsible to make a judgment as to whether child abuse has occurred or not, but rather to report the facts as they are seen or suspected. If Non-Accidental Trauma (NAT) is suspected, the technologist should discuss this with the assigned higher authority or another supervisor as determined by the protocol of the department [12].

Conclusion

The article concludes that there is a need for proper education and training of the technologist in pediatric radiography to avoid and overcome the challenges. The technologist should have a positive attitude and good communication skills besides clinical skills to increase the chance of successful examination. Periodic training and workshops are also important to update technologists with the latest trends in pediatrics radiography. The overall factors that affect the examination are poor clinical knowledge, bad attitude, impatience, poor knowledge of immobilization devices, and uncooperative patient or attendant (caretaker) besides that there are also some other factors like room design, lighting, distraction tools that can affect the overall quality of the examination.

References

1. Frush DP, Donnely LF, Rosen NS. Computed tomography and radiation risks: What pediatric health care providers should know. Pediatrics 2003; 112:951-7.
2. Goske MJ, Applegate KE, Boylan J, et al. The 'image gently' campaign: Increasing CT radiation dose awareness through a national education and awareness program. Pediatr Radiol 2008; 38: 265 9.
3. Erondu OF. Challenges and peculiarities of paediatric imaging. Open Acces 2013; 8: 29.
4. Thukral BB. Problems and preferences in pediatric imaging. Indian J Radiol Imaging 2015; 25: 359-64.
5. https://op.europa.eu/en/publication-detail/-/publication/47eb62b0-698d-4166-bc34-cc3f8d07d2e3
6. http://www.dh.gov.uk
7. Collins P. Restraining children for painful procedures. Paediatric Nursing 1999; 11 (3): 14–16.
8. Stephens BK, Barkey ME, Hall HR. Techniques to comfort children during stressful procedures. Accid Emerg Nurs 1999; 7(4): 226–36.
9. Ross DM, Ross SA. Childhood pain: The school-aged child's viewpoint. Pain 1984; 20, 179–91.
10. https://onlinelibrary.wiley.com/doi/abs/10.1111/nin.12019
11. Knight SP. A paediatric X-ray exposure chart. J Med Radiat Sci 2014; 61(3): 191-201.
12. Grainger RG, Allison DJ. Diagnostic radiology–A textbook of medical imaging (3rd edn) Churchill Livingstone, London 1997.
13. https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1578_web-57265295.pdf
14. https://www.sprmn.pt/pdf/EuropeanGuidelineseur16260.pdf
15. https://inis.iaea.org/search/search.aspx?orig_q=RN:31046634
16. Hall EJ. Lessons we have learned from our children: Cancer risks from diagnostic radiology. Pediatr Radiol 2002; 32: 700-6.

17. Brenner DJ, Elliston CD, Hall EJ, et al. Estimated risks of radiation-induced fatal cancer from pediatric CT. AJR Am J Roentgenol 2001; 176: 289-96.
18. Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: Aretrospective cohort study. Lancet 2012; 380: 499 505.
19. Mathews JD, Forsythe AV, Brady Z, et al. Cancer risk in 680 000 people exposed to computed tomography scans in childhood or adolescence: Data linkage study of 11 million Australians. BMJ 2013; 346: f2360.
20. Ditchfield M. 3T MRI in paediatrics: Challenges and clinical applications. Eur J Radio 2008; 68: 309-19.
21. Frush DP, Donnely LF, Rosen NS. Computed tomography and radiation risks: What pediatric health care providers should know. Pediatrics 2003; 112: 951–7.
22. https://www.sor.org/getattachment/Learning-advice/Professional-Practice/Diagnostic-imaging-pathways/Diagnostic-Imaging-Pathways/Paediatric-Imaging/Delivering-Quality-Imaging-Services-for-Children.pdf?lang=en-gb
23. Hall EJ. Lessons we have learned from our children: Cancer risks from diagnostic radiology. Pediatr Radiol 2002; 32: 700–6.
24. Brenner DJ, Elliston CD, Hall EJ, et al. Estimated risks of radiation-induced fatal cancer from pediatric CT. AJR Am J Roentgenol 2001; 176: 289-29.
25. Conway JJ. Radionuclide bone scintigraphy in pediatric orthopedics. Pediatr Clin. North Am J 1986; 33(6): 1313-1334.
26. Cohen RS, Trush DP, Donnelly LF. Data acquisition for paediatric CT angiography Problems and solutions. Pediatr Radiol 2000; 30(12): 813-822.
27. Cohen MM, Cameron CB, Duncan PG. Pediatric Anaesthesia morbidity and mortality in the peri operative period. Anesth Analg 1990; 70: 160-7.

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