Radiographic modalities in detecting suspected child abuse

The actions individuals take against a child in order to inflict emotional or physical harm are, unfortunately, limited only by the imagination. Child abuse has been formally defined as the shaking, punching, battering, hitting, poisoning, scalding or burning, suffocating or drowning a child and/or otherwise participating in actions that lead to the child's physical harm (Safeguarding Children 2006). As of the last several years, the definition of child abuse has also integrated the failure to prevent harm to a child (Safeguarding Children 2006).

In 1946 paediatric radiologist John Caffey first utilised radiographic images in the diagnosis of child abuse when fractures of the long bones were accompanied by subdural hematomas (Longman, Baker & Boos 2003). In 1962 Kempe et al. (as cited by Longman, Baker & Boos 2003) offered the term battered child syndrome to describe injuries seen in children consistent with patterns of abuse, with skeletal anomalies the most common injuries seen in this syndrome. For example, bone fractures are seen in upwards of 55% of abuse cases (Longman, Baker & Boos 2003). As current research indicates (Freeman 2005; Zimmerman & Bilaniuk 1994), the radiographer is often the first healthcare provider that child sees who is in a position to suspect or determine the presence of a non-accident injury (NAI). Davis (2005) points out the radiographer sees the child undressed and is in a position to notice strap marks and other bruising indicative of child abuse while seeking to identify other areas of trauma through the radiographic examination; thus noticing unusual bruising or other inappropriate bodily marks on the patient can help establish a pattern of abuse in conjunction with the radiologic findings of trauma. While Silverman (1987) states that

radiography can be used to determine both nature of injury producing force as well as time of injury caution is also advocated as other issues that radiography classically is used to identify can be confused with child abuse, such as the radiologic evidence of scurvy, osteogenesus imperfect, self-sustained injury and infantile cortical hyperostosis.

Child abuse statistics

Longerman, Baker and Boos (2003) relate staggering statistics for child abuse. In the US alone during 2000, 1, 200 children were fatally injured in episodes of child abuse, For example one to two children are fatally abused by a parent or other caregiver on a weekly basis (Safeguarding Children 2006). Norris (2001) states that upwards of 27% of cases presented as unintentional injuries were actually due to incidents of child abuse.

Child abuse related fatalities among children less than 1 year of age constitute 41 – 44% of reported cases of abuse or neglect (Offiah 2003' Longerman, Baker & Boos 2003).

Radiographer responsibilities by law

The law is quite explicit regarding the role of the radiographer in cases of suspected child abuse. For example, the Children's Act of 1989, Section 27 explicitly requires each healthcare provider to perform any and all examinations requested by other healthcare professionals or legal authorities when cases present with suspected child mistreatment or abuse (Aspinell 2006; Freeman 2005). As an adjunct to the 1989 Act, with specific regard to healthcare professionals, The Children Act of 2004 mandates an

added responsibility beyond individual practice guidelines when working with an abused child or suspecting mistreatment, and requires that healthcare practitioners work together to share information as appropriate and cooperate in such a way as to offer the best treatment for the child (Aspinell 2006; Davis 2006). Additional guidelines on the radiographer's role in cases of suspected child abuse are readily available (Freeman 2005).

However, whether law or not, ultimately, the radiographer has legal, professional and personal responsibilities in detecting cases of suspected child abuse and has many imaging modality options. Stover (1986) tells us specifically that radiographic examinations can help the identification of the injury, mechanism of trauma such as shaking, twisting, traction of a limb or direct blow. Additionally and more importantly, the radiographic examination can identify prior injury and determine evidence of healing processes; all of which are paramount in situations of suspected child abuse, mistreatment or endangerment (Stover 1986). Therefore, this essay will review the range of radiographic imaging modality options available when child abuse is suspected.

It is considered beyond the scope of this essay to discuss the legal roles and responsibilities of the radiographer in cases of suspected child abuse and as such, information relating to this will be explicitly excluded beyond those acts and guidelines highlighted above. Similarly, it is considered beyond the scope to discuss radiographic diagnostics in relation to imaging technologies. The remainder of this essay will focus strictly on imaging modalities.

Standard radiographic x-ray

Kirks (1983) believes that standard radiographic x-ray (SXR) imaging is appropriate for injuries associated with skeletal fractures, pneumoperitoneum, gastric dilatation or injury to the pulmonary parenchyml, which are common in cases of child abuse.

Researchers tell us that skeletal examinations are particularly relevant in cases were non-accidental injury (NAI) is suspected (Gutanunga, Evans & Harrison 2007, Johnson 2007; Summerfield et al. 2007; Offiah 2003) and is the strongest radiologic based indicators that child abuse or mistreatment has taken place (Diagnostic imaging 1991). In particular, Alexander and Kleinman (1996) believe that in children less than 2 years of age presenting with injuries consistent with child abuse the skeletal survey is critical. Parks (2002 as cited by Imaging suspected NAI 2002) tells us that although the most appropriate in cases of suspected NAI, the skeletal survey is one of " the most difficult examinations to perform" given general reluctance of the small child to submit to the examination, the emotionally charged scenario surrounding the skeletal survey request and the frequent urgency required. The skeletal survey typically consists of the following images: AP/PA chest, oblique view of the ribs, lateral skull survey in an older child, AP pelvis/femora, AP tibia/fibula, AP humeria, AP forearms, DP/AP hands, Half axial/Townes skull projection, AP 20 degrees skull projection and lateral skill projection in younger children, lateral spine and DP of the feet (Parks 2002 as cited by Imaging suspected NAI 2002). In order to minimise radiation exposure to the developing tissues of young children, special paediatric imaging systems have been modernised to use special cassettes, films and intensification screens (Diagnostic imaging 1991). In children older than five

years of age, Alexander and Kleinman (1996) tell us the skeletal survey is virtually of no use when screening for injuries, but clinical indicators should dictate whether or not such a radiographic examination is performed.

A newer radiographic adjunct to skeletal surveys is the bone scintigraphy, also referred to as radionucleotide scintigraphy (Conway et al. 1993; Howard, Barron & Smith 1990), advocated by current research as a complementary procedure to the skeletal survey rather than a replacement when NAI and child abuse are suspected (Mandelstam et al., 2003). Mandelstam et al. (2003) documented the ability to detect bony anomalies that evade traditional radiographic skeletal images. For example, 20% of those studied by Mandelstam et al. (2003) reported normal skeletal surveys; however injuries were evident upon bone scintigraphy. This example evidences the increased sensitivity of the bone scintigraphy noted by Conway et al. (1993), creating an advantage in assessing soft tissue injuries in addition to trauma to bone structures. Apgar (1997) stresses SXRs can be of paramount importance for assessing potential child abuse or mistreatment through the imaging of hands and feet to assess for fractures. In particular, Apgar (1997) tells us that bone scans and skeletal surveys that focus on an oblique view of the hand or foot combine to document fractures in the hands and feet through evidencing healing at multiple stages as well as identifying fractures from bending or twisting a limb or digit rather than inflicting a direct blow. Alexander and Kleinman (1996) believe the skeletal survey should not be used as a primary diagnostic modality, but should be used in conjunction with SXRs.

Generally a GP or primary care physician will request a skeletal survey be performed when child abuse is suspected to assess current and age of prior injuries.

CT Scan

Non-accidental head injuries (NAHI) are the leading cause of death or neurological dysfunction seen in infants (Jaspan et al. 2003). Researchers agree CT scans are the ideal radiographic modality to assess paediatric head trauma from which to evaluate injury and/or family circumstances that might lead to NAIH conclusions indicative of child abuse or mistreatment (Jaspan et al. 2003; Hymel et al. 1997; Alexander & Kleinman 1996). Fell (2007) tells us CT is recommended over standard SXR as SXR are known to delay diagnosis; however SXR in a triage setting when CT is not available when coupled with patient observation is still an option. Stover (1986) believes that a head CT should be considered mandatory for incidents of paediatric head trauma. Unfortunately, as Jaspan et al. (2003) indicate, there are no uniformly agreed upon protocols for radiographic imaging of NAHI. Additionally, Alexander and Kleinman (1996) believe that CT scans without the use of an MRI may underestimate the extent of injury sustained, for example, MRIs can image subdural hematomas, which according to Alexander and Kleinman (1996) may be “ the only objective imaging evidence of child abuse.”

CT scans are also appropriate for other areas. For example, one of the common sites for visceral abuse injuries is the abdomen (Kirks 1983). For blunt trauma injuries to the abdomen, particular for assessing the spleen, kidney or liver, Kirks (1983) believes the CT scan is most appropriate.

Albanese et al. (1996) stress the importance of CT scans for blunt abdominal trauma as well, focusing on the modality's use with contrast media. Serial examinations are considered the " gold standard" for perforations of the paediatric GI tract due to blunt force trauma (Albanese et al. 1996). However, Kirk (1983) adds that nuclear scintigraphy is appropriate for cases isolated to the liver or spleen alone.

MRI

The use of MRI's in cases of suspected child abuse or mistreatment are many, with cervical spine MRIs cited by Feldman et al. (1997) as able to detect previously unsuspected damage to the spinal cord from child abuse in cases of head trauma. Feldman et al. (1997) demonstrated that frequently radiographic examination will show subdural haemorrhages or subarachnoid haemorrhages in the cervical spine level.

Although considered a type of MRI modality, Whole-body turbo STIR MR imaging that is based on MRI technology " with turbo short tau inversion recovery tissue excitation" (Kavanagh, Smith & Eustace 2003) is a non-ionizing high-resolution modality that allows for the detection of occult disease states. Stranzinger et al. (2007) advocates the whole body STIR MR imaging as an alternative to skeletal survey radiographic examinations, particularly as a mechanism of avoiding radiation exposure to growing and developing tissues of the child as well as the increased/enhanced modality sensitivity. For example, Stranzinger et al. (2007) found multiple rib fractures in a patient were evident on the STIR MR imaging and definitely suggested

child abuse occurred whereas conventional radiographic images only allowed for partial recognition of the fractures and were inconclusive.

Diffuse-weighted imaging (DWI) has also been highlighted by current research as superior in detecting post abuse NAIH, particularly when there were posterior aspects of the brain (Suh et al. 2001). DWI has demonstrated effectivity in enhancing traditional MRI use, particularly in its ability to assess trauma severity (Suh et al. 2001).

Ultrasound

Kirks (1983) believes that visceral abuse trauma for such issues as retroperitoneal hematoma, ultrasound radiography is the most appropriate modality. Stover (1986) states ultrasound imaging should be used in order to exclude visceral lesions in the case of paediatric head trauma. Barthel et al. (2000) found ultrasound to be the most reliable radiographic imaging modality for detecting and diagnosing simple fractures, although compound fractures and fractures of adjacent bone were still better identified and assessed through SXR. Particularly in infants where bone is more cartilaginous, ultrasound has been found a superior modality for assessing fractures in cases of suspected child abuse and/or mistreatment especially as it saves the child from exposure to ionising radiation (Barthel et al. 2000). When assessing ultrasound efficacy for fracture identification in the distal forearm, noted as the most common fracture site in children, Barthel et al. (2000) demonstrated an 89. 4% positive correlation, with a 94. 4% correct ultrasound fracture diagnosis noted in femoral fractures. Additionally, Barthel

et al. (2000) note that ultrasound is an excellent radiographic modality to assess stress fractures missed by SXR.

While each of the modalities above have been advocated by individual researchers as preferred methods as outlined, Offiah (2003) advocates the use of multiple imaging modalities in order to provide cross-sectional imaging, especially in cases of suspected abuse that result in the need for neurological assessments.

In conclusion, Alexander and Kleinman (1996) tell us radiographic imaging may offer the first indication of child abuse. Child protection is a personal and professional responsibility for the radiographer. This essay highlighted the staggering figures of how frequently child abuse is perpetrated. It was also noted that failure to act on suspected abuse is also considered child abuse and endangerment; such that all Trust employees have the responsibility to ensure children are kept safe (Safeguarding our children 2006). This includes being as aware of all imaging modalities appropriate for the detection of suspected child abuse when warranted as opposed to relying on radiography strictly as a static imaging modality. For example, Zimmerman and Bilaniuk (1994) state that in paediatric head trauma, the radiographer has CT and MRI imaging technology available among others, however, based on the radiographer’s knowledge of the type of injury, age of the child and how the trauma occurred, the appropriate imaging modality or combination of modalities can best identify injury and whether child abuse is a factor.

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