The Radiological Investigation of the Skeleton in Suspected Non-Accidental Injury in Children – A Practical Guide for the Skeletal Survey

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Abstract
Imaging plays an important role in the assessment of children with possible non-accidental injury. Studies have shown that there is significant variability in imaging performed to identify fractures in children with possible non-accidental injury. In 2013 the European Society of Paediatric Radiology (ESPR) voted in favour of adopting the RCR/SCoR/RCPCH guideline concerning the radiological investigation for non-accidental injury in children. We present a poster illustrating the required radiographic investigations of the skeleton in suspected non-accidental injury in children, that can serve as a practical tool to facilitate adherence to the guideline. We also provide a summary of the key points of the guideline, and discuss challenges and possible solutions for these challenges for implementation of the guideline in the Belgian context.

Introduction

Paediatric non-accidental injury (NAI) is a considerable health problem, and imaging plays a fundamental role in it assessment. Over the last decades, several national surveys performed in the UK, the USA and The Netherlands, have shown significant variability in imaging performed to identify fractures in suspected NAI in children (1-3). In 2008 the Royal College of Radiologists (RCR) and the Society and College of Radiographers (SCoR) endorsed by the Royal College of Paediatric and Child Health (RCPCH) published a joint British guideline concerning the radiological investigation for NAI in children. In 2011 a study was performed aimed to determine the practice among members of the European Society of Paediatric Radiology (ESPR) and their affiliated institutions with regards to imaging of paediatric NAI (4). Practice at that time was compared with the joint guideline by the RCR/SCoR/RCPCH. The study concluded that the survey data demonstrated significant variation in the protocols of the contributing institutions. The authors identified a need for a European consensus protocol and recommended implementation of the RCR/SCoR/RCPCH guidance. During the ESPR meeting in 2013 there was an overwhelming vote in favour of adopting the RCR/SCoR/RCPCH guideline as the standard across Europe. Since then the guideline has been updated in 2017 and in 2018 (5).

Guideline summary

The RCR/SCoR/RCPCH guideline identifies imaging that should be undertaken when NAI in a child is suspected. The guidance is designed to assist clinicians, paediatricians, radiographers, radiologists, and nuclear medicine technologists who request, perform or report imaging by setting out clear recommendations on each stage. In the development of the guidance, the authors incorporated evidence-based research for the type of imaging conducted to detect occult injuries, while minimizing radiation exposure and patient distress. When it comes to imaging of the skeleton in search of fractures the guideline states that children under two years of age should undergo a full skeletal survey, with a standard series of views, which can be found in Appendix A of the guideline (5). The choice of imaging in older children should be considered on a case-by-case basis. The guideline further states that the skeletal survey should be performed by two radiographers with documented education and training in imaging of suspected NAI and forensic radiography techniques. Two radiologists with at least six months of specialist paediatric radiology training, including experience of suspected NAI in children, should provide a consensus report within 24 hours. This allows new radiographs to be taken in a timely manner if indicated. When serious injury is identified in a child due to

FIGURE 1: Poster illustrating the required radiographic investigations of the skeleton in suspected non-accidental injury in children.

Skeletal survey for suspected non-accidental injury in children

Practical guidance for following the RCR guideline [reference see below]

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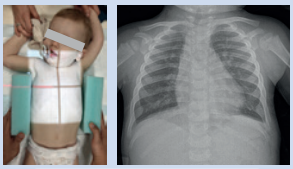
This is an example of the skeletal survey in a larger child. For a small child, the following images can be combined:

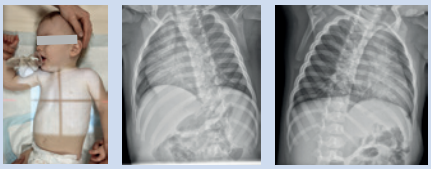
- Lateral cervical, thoracic and lumbar spine (into 'Lateral whole spine'),
- AP humerus and forearm (into 'AP whole arm, centre at elbow'),
- AP femur, tibia and fibula, knee and ankle (into 'AP whole lower limb, hip to ankle').

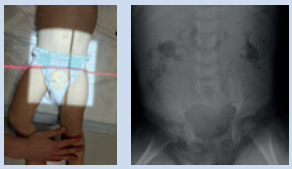

Anterior-posterior (AP) skull

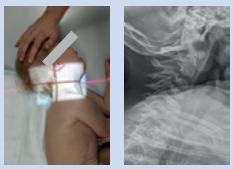

Lateral skull


AP chest (including shoulders)

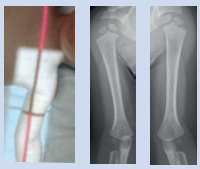

Lateral chest & thoracic spine

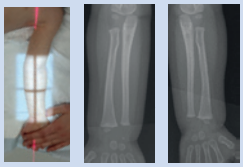

Right & left oblique chest (show both sides, ribs 1-12)

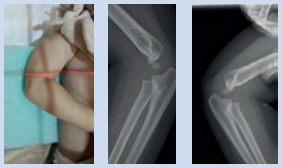

AP abdomen and pelvis

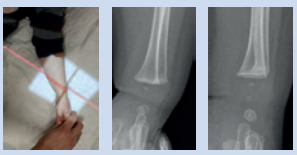

Lateral cervical spine


Lateral lumbosacral spine


AP right & left humerus (shoulder to elbow)

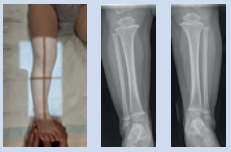

AP right & left forearm (elbow to wrist)

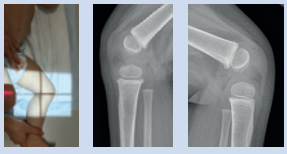

Coned right & left lateral elbow


Coned right & left wrist


AP right & left hand and wrist


AP right & left femur (hip to knee)


AP right & left tibia and fibula (knee to ankle)


Coned right & left knee


Coned right & left ankle


AP right & left foot

Follow-up imaging is required as part of the complete skeletal survey and should be obtained ideally between 11-14 days after the initial skeletal survey, or as soon as possible thereafter.

Follow-up radiographs should be performed of any abnormal or suspicious areas on the initial skeletal survey plus the following views: chest AP and both obliques, AP upper limbs, AP lower limbs (without coned views of joints).

The radiological investigation of suspected physical abuse in children

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suspected NAI, any multiple birth siblings of the index case less than two years old should undergo the same imaging as the index case. Age-appropriate imaging should be considered in all siblings and children older than two years old living in the same household on a case-by-case basis. The guideline also states that skeletal surveys should be undertaken in a child-friendly environment within a radiology department that is equipped for paediatric imaging, in the presence of a registered paediatric nurse or an appropriately educated health or care practitioner, and where sedation of a child and involvement of play therapists can be offered. Even if the initial skeletal survey is normal, all children should have follow-up imaging, since follow-up imaging may identify fractures that only become visible when healing. Follow-up imaging may also provide invaluable information about fractures identified or suspected on the initial imaging and can assist with dating the injuries. Follow-up imaging should be performed ideally within 11 to 14 days, and no later than 28 days after the initial skeletal survey. When it comes to radioisotope bone scanning, the guideline describes that a bone scan can highlight areas of suspicion, but that further imaging is necessary to confirm whether or not there are any fractures. In addition, bone scanning cannot help with dating of injuries and this procedure involves a high radiation dose: the guideline concludes that bone scans are therefore not indicated in the search for skeletal injuries in suspected NAI in children.

To the best of our knowledge, there are no studies concerning the adherence to the RCR/SCoR/RCPCH guideline in Belgium. However, a recently established multidisciplinary collaboration between various hospitals in Antwerp identified substantial variability in imaging protocols for children suspected of non-accidental injury. It is possible that this is also a problem in other parts of Belgium. We strongly advocate for adherence to the RCR/RCPCH guideline, but are aware of several challenges when it comes to strict adherence to this guideline within the Belgian healthcare system and setting. First of all, care for paediatric patients in Belgium is offered by public, private and university hospitals, polyclinics and private physicians, which can make spreading the message about the existence of this guideline a challenge, something we hope this article can help with. We believe that lack of familiarity with the practical execution of the skeletal survey - specifically the exact sequence and positioning techniques - creates another barrier to the correct implementation of the current guideline. In order to overcome this, we provide a practical guide for performing the skeletal survey in suspected NAI in children, with the hope that this will be a helpful tool for paediatricians, radiographers and radiologists (Figure 1).

In Belgium, the specialty training in radiology follows the recommendations of the European Society of Radiology (ESR). The ESR developed the European Training Curriculum for Radiology, designed to provide a template for radiologists in training, which states that knowledge should be developed concerning "the most frequent disorders of the skeletal system in the paediatric population, in particular traumatic (accidental and non-accidental)" (https://www.myesr.org/education/training-curricula/). However, a formal fellowship or training for radiographers or radiologists in (forensic) paediatric radiology does not exist in Belgium, neither does a specific training in imaging of suspected NAI in children. Moreover, the profession of radiographers is a shortage occupation in Belgium (https://www.vdab.be/beroep/f684faca-cdfa-4ad8-bc86-b833cc389dfc/technoloog-medische-beeldvorming), which can be attributed to the low influx from the Bachelor´s degree in Medical Imaging and Radiotherapy, and Nursing.

Given these challenges, it is crucial to consolidate expertise in Belgium regarding the performance and interpretation of skeletal surveys in children with suspected NAI. We strongly encourage structured collaboration between university and non-university hospitals, with agreements on which hospitals are responsible for conducting skeletal surveys. Our tool aims to enhance the accuracy and reliability of NAI evaluations for fractures in children. To ensure consistent interpretation of the results of skeletal surveys, systematic case-by-case consultations between radiologists and radiologists in training should become standard practice, ideally with the active involvement of the referring physician. Establishing such a structured, nationwide approach is essential to improve the evaluation and detection of NAI, ultimately ensuring better protection for vulnerable children.

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