What neuroimaging should be performed in children in whom inflicted brain injury (iBI) is suspected: a systematic review

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CRD summary
The review concluded that the optimal imaging strategy for children with suspected inflicted brain injury would be an initial computed tomography (CT) scan, followed by early magnetic resonance imaging (MRI) and diffusion weighted imaging in cases of abnormality or where there were ongoing clinical concerns. Given the limitations in the evidence presented, this conclusion appears overstated.

Authors' objectives
To define the optimal neuroimaging strategy for identifying inflicted brain injury in children.

Searching
ASSIA (Applied Social Science Index and Abstracts), ChildData, CINAHL, EMBASE, MEDLINE, Scopus, SIGLE, Trip Plus, Social Care Online, Web of Science and all Evidence Based Medicine Review databases (such as DARE, HTA and the Cochrane Library) were searched for articles published between 1970 and January 2008 in any language. Search terms were reported. Four relevant websites relating to child brain injuries and child abuse and neglect were also searched. Reference lists of obtained articles were handsearched.

Study selection
Primary studies of any design of children aged less than 18 who were undergoing brain computed tomography (CT) and additional investigations (repeat CT, magnetic resonance imaging (MRI) or ultrasound) to identify intracranial abnormalities resulting from inflicted brain injury. Studies had to include fatally or non-fatally abused children with ante-mortem radiology, with abuse ranked as follows: one - confirmed at case conference or court proceedings; two - confirmed by stated criteria including multidisciplinary assessment; three - abuse defined by stated criteria. Inflicted brain injury was defined as intracranial injury (extra-axial bleeding, intraparenchymal haemorrhage, diffuse axonal injury, hypoxic ischaemic injury) resulting from physical abuse. Detailed exclusion criteria were reported in the paper.

Most studies included young children up to four years of age; the mean age ranged between three and 14 months (where reported). The timings of the investigations varied between less than 24 hours to up to six months, but many studies conducted imaging less than five days after the original CT scan.

Studies were selected by two people independently from a panel of 30 medical specialists involved in child protection work. Disagreements were resolved by a third person.

Assessment of study quality
Studies were graded based on study design, but no further quality assessment was performed.

Data extraction
The review aimed to establish the additional value of an MRI scan to an initial CT scan and to estimate the proportion of cases where this would provide additional information. Details of the timings of both investigations and the additional findings on the MRI were extracted. The estimated proportion of each type of inflicted brain injury was calculated (method not reported) with the 95% confidence interval (CI). Study authors were contact for further information.

The authors did not state how many reviewers performed the data extraction.

Methods of synthesis
Results were presented in a narrative synthesis, grouped by the imaging method.
Results of the review
Eighteen studies (n=367 children) were included. Two studies were cross-sectional and the rest were case series or studies.

MRI versus initial CT scan: Seven studies assessed the diagnostic yield of an early MRI brain examination performed after an initial CT scan. In all cases the CT scan was abnormal, but not all children then underwent an MRI. The proportion of children where the MRI revealed new information about subdural haematoma or another intracranial abnormality was 25% (95% CI 18.3 to 33.2; three studies). The most common additional findings were subdural haematoma or subarachnoid haemorrhage in 66 out of 115 children.

Diffusion weighted imaging (DWI): Four studies used DWI and found additional cases of brain injury not apparent with conventional MRI (n=30 children, aged under two years).

Follow-up CT scans: Four studies provided data for 80 out of 131 children who had follow-up CT scans. Early repeat scans within five days showed evolving haemorrhages and infarcts. Later follow-up scans showed chronic changes such as brain atrophy and subdural haematoma.

High-resolution ultrasound: Three studies evaluated high-resolution ultrasound in 21 children. Subdural haematomae and contusional tears were detected in six children. However, in one study, ultrasound failed to detect some findings from CT or MRI.

Authors’ conclusions
From this review, the recommended optimal strategy for an infant with a suspected inflicted brain injury is an early CT scan, followed by MRI with diffusion weighted imaging in cases of abnormality or where there are ongoing concerns.

CRD commentary
This review specified inclusion criteria relating to the participants, investigations and outcomes, criteria for study design were broad. The search strategy was comprehensive, covering many databases and relevant websites, without language restrictions, reducing the risk of missing any studies.

The authors stated that each study was graded for quality, but this information did not appear to have been reported. Most studies did not compare findings on the MRI and CT scans, and in only three studies did the children undergo both procedures. The included studies were also conducted over a 30 year period, so the imaging technology would have developed over this time, thus the results of earlier studies may not be comparable to later ones. The presentation of results in a narrative seemed appropriate.

Given the limitations in the evidence, the authors’ conclusion about the optimal imaging strategy appears overstated.

Implications of the review for practice and research
Practice: The authors stated that brain imaging in suspected cases should be reviewed by radiologists with expertise in paediatric neuroradiology and who are familiar with the patterns of injury seen in inflicted brain injury.

Research: The authors stated that prospective studies investigating the benefits of MRI/DWI in children with a normal early CT scan, and the optimal timing of MRI are needed.

Funding
Not stated.

Bibliographic details
PubMedID
19348842

DOI
10.1016/j.crad.2008.11.011

Original Paper URL
http://www.clinicalradiologyonline.net/article/S0009-9260(09)00024-5/abstract

Indexing Status
Subject indexing assigned by NLM

MeSH
Adolescent; Brain Diseases /diagnosis; Brain Injuries /diagnosis; Child; Child Abuse /diagnosis; Child Welfare; Child, Preschool; Diagnostic Imaging /methods; Diffusion Magnetic Resonance Imaging /methods; Humans; Infant; Infant, Newborn; Magnetic Resonance Imaging /methods; Prognosis; Time Factors; Tomography, X-Ray Computed /methods; Ultrasonography /methods

AccessionNumber
12009104700

Date bibliographic record published
23/09/2009

Date abstract record published
25/08/2010

Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.