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Has a 'shaken baby' always been shaken?

PERSPECTIVES

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There is cause for concern over uncertainty associated with the diagnosis of shaken baby syndrome. We must have scientifically valid evidence in such cases.

Illustration: Espen Friberg

The physical abuse of infants is known to occur, sometimes with brain injury as a consequence. However, I am uncertain as to whether the medical evidence currently considered by experts to constitute proof of shaking is of sufficient scientific quality to be used as judicial proof that shaking has in fact occurred, and consequently that there is 'guilt beyond reasonable doubt'.

The cases concerned are those in which there is suspected physical abuse of infants in the form of shaken baby syndrome, and where it is the guardians who are suspected of this criminal act. The nomenclature in the field is constantly evolving; terms such as 'abusive head trauma' are also used when referring to the condition.

As a retiree, I have been involved in such court cases as an expert witness, both in criminal and child welfare cases. There were no clear external signs of injury in any of the cases, but experts had concluded that the infant's condition was the result of shaking – even though a leading expert has argued that shaking alone is insufficient; a blow to the head is required to produce such injuries (1).

After having examined the relevant literature more closely, I ask: Is there sufficient weight of evidence in the combination of clinical findings that make up the so-called 'triad', and that is considered by experts to be evidence that shaking has occurred?

The triad

The triad consists of three clinical findings: subdural haematoma, extensive retinal haemorrhage and encephalopathy. In my experience, and as shown in the literature (2, 3), encephalopathy is no longer necessary for a 'shaken baby' diagnosis. The combination of subdural haematoma and retinal haemorrhage seems to be sufficient. These findings are now used almost as hard evidence that shaking must have occurred, even when there were no witnesses to the event itself.

If the triad is to be considered to constitute judicial proof, then the publications claiming to show a definite causal link between these findings and shaking must be of such good scientific quality that there can be no doubt about the strength of the evidence. To date, I have been unable to identify any articles of such quality.

Virtually none of the articles that I have read on shaken baby syndrome are based on witness observations or a credible confession close in time to the alleged criminal act. Instead, the articles often refer to multidisciplinary consensus decisions, such as 'evaluated by the hospital's child abuse evaluation team' (4). In addition to basing their decision on the triad, the articles refer to a lack of credibility on the part of the individual who was alone with the infant when he/she became ill. According to one algorithm, failure of the individual to provide a plausible history of trauma that could account for the findings is sufficient to strengthen suspicion (5). According to another algorithm, it renders a diagnosis of shaken baby syndrome 'highly probable' (6). These algorithms are based on previous literature in which the basis for the diagnostic criteria does not appear to have been scientifically validated. It is likely that diagnosis on the basis of these algorithms will also feature in future articles, which will then be added to the existing literature as further evidence of shaking – constituting circular reasoning.

The problem with the triad is that these clinical findings can also occur in other conditions. A state-funded Swedish study points out that almost all of the evidence is based on circular reasoning. Following a comprehensive literature review, the study concludes that there is low quality evidence that the triad can be associated with traumatic shaking, and very low quality evidence for the diagnostic accuracy of the triad in identifying traumatic shaking (7).

The Swedish study, which draws such striking conclusions about the poor scientific quality of the triad and its components, consisted of specialists in paediatric medicine, forensic medicine, neuroradiology, medical methodology and medical ethics. Three of the medical faculties in Sweden were represented. Their conclusions have, with few exceptions, led to Swedish forensic medical practitioners no longer emphasising the triad in cases of suspected shaking (Ingemar Thiblin, chair of the Swedish Society of Forensic Medicine, personal communication).

Proponents of the triad's validity as evidence refer to two French studies from 2010 (3, 8). Neither of these includes findings from cases in which shaking of the infant was observed; instead the occurrence of shaking was confessed – but only weeks or months later – in a police or judicial interview. Confessions obtained under such circumstances are subject to considerable uncertainty (9).

Benign external hydrocephalus

The individual components of the triad can also be seen in other conditions. Benign external hydrocephalus is one such condition, and is the result of an imbalance between the production and elimination of cerebrospinal fluid. In cases of benign external hydrocephalus, cerebrospinal fluid accumulates between the brain and the inside of the cranium, the intracranial pressure increases, the subarachnoid space expands and the circumference of the head increases. The bridging veins, which pass through this space from the cortex to the inside of the cranium, are stretched and may begin to haemorrhage slightly, causing subdural accumulations of blood. These are not usually acute, but tend to resemble chronic accumulations of blood of different ages. New blood products, as seen in acute haematoma, usually make up a very small proportion of the total fluid volume in subdural blood accumulations caused by benign external hydrocephalus.

Subdural haematomas may thus occur as a spontaneous complication of benign external hydrocephalus (10, 11). This can be a diagnostic pitfall with respect to the diagnosis of shaken baby syndrome (10). Consequently, subdural haematoma cannot be pathognomonic for shaken baby syndrome.

Epilepsy with unconsciousness and seizures may be a startling initial symptom of benign external hydrocephalus (12, 13). A reasonable response by parents who witness the sudden onset of unconsciousness and respiratory arrest will be to try to shake life into the child – an act that may be misinterpreted and further strengthen suspicion.

Together with colleagues, I have recently published a study showing that approximately 25 children with benign external hydrocephalus are born in Norway every year (14). The head circumference of these children is normal at birth, but increases too rapidly in the first months post-partum. There is also a marked preponderance of boys (86 %) among these children. A similar age and gender distribution is found in most major articles on shaken baby syndrome, such as those by Adamsbaum, Hobbs and Vinchon, who together found that 70 % of cases were in boys (3, 8, 15), with an average age of four months. Could the epidemiological similarity between benign external hydrocephalus and shaken baby syndrome with respect to age and gender be the result of benign external hydrocephalus with subdural haematoma as a complication being misdiagnosed as shaken baby syndrome?

Traumatic shaking and benign external hydrocephalus can, according to the literature, both give rise to subdural haematomas. One might expect there to be differences in radiological images associated with the two conditions. Traumatic shaking is usually assumed to have occurred immediately prior to

the child becoming acutely ill, and it is the person who was alone with the child at the time who comes under suspicion. If the haematoma is caused by an *acute* action, then one should expect to see an *acute*-looking haematoma with white, coagulated blood (on CT), and not a chronic haematoma or simply bloody fluid, as often seen in such cases. Likewise, in an acute haematoma one should expect to find compression of the ventricles and subdural space as well as a midline shift to the opposite side of the brain if the bleeding is unilateral.

By contrast, if the subdural blood accumulation is a complication of benign external hydrocephalus and due to gradual leakage of blood in an already expanded subarachnoid space, the subdural haematoma should have an appearance consistent with precisely that: a chronic subdural haematoma, perhaps with some smaller clots with an acute-like appearance.

So, is there a clear radiological difference between the CT and MRI images that are presented as cases of benign external hydrocephalus and shaken baby syndrome respectively? There is in part, but in my opinion only to a small degree. I found 40 articles published in the last ten years with illustrations said to show examples of shaken baby syndrome. The articles contained a total of 68 MRI or CT images which, according to the authors, showed examples of shaken baby syndrome without signs of external violence. The large majority of these (78 %) had radiological characteristics that are more consistent with benign external hydrocephalus (16) than with a head injury inflicted by acute violence. Only 22 % were most consistent with a traumatic acute subdural haematoma. The radiological similarity between alleged shaken baby syndrome and benign external hydrocephalus is also evident in illustrations said to represent benign external hydrocephalus (11, 16) and shaken baby syndrome (8, 17). To me these pictures are alarmingly similar.

Why these infants also show extensive retinal haemorrhages has not been established for certain, but high intracranial pressure can cause such bleeding – so-called Terson's syndrome (18). Elevated intracranial pressure is transmitted to the retina via the fluid-filled optic nerve sheath (4), which in infants is very short, causing haemorrhages. Not even extensive retinal haemorrhages can be considered an unambiguous sign of shaken baby syndrome (4, 10, 19, 20).

Research project launched

I am concerned about the uncertainty associated with the diagnosis of shaken baby syndrome in criminal and child welfare cases. Based on my interpretation of the clinical findings and images in those cases with which I have been involved, including some with rapidly increasing head circumference *prior to* the alleged shaking, external hydrocephalus often seems to be a more likely diagnosis than that the child has been subjected to traumatic shaking.

We have initiated a research project with the aim of reviewing the medical basis for the verdicts handed down by Norwegian courts in such criminal cases. The project has received all necessary approvals from the following bodies: The National Committee for Medical and Health Research Ethics (NEM), the

Norwegian Data Protection Authority and the Director of Public Prosecutions. The research group includes law professors Aslak Syse and Ulf Stridbeck at the University of Oslo, as well as a neuroradiologist and a paediatric neurosurgeon from outside Norway.

This matter relates to the guarantee of due process in cases that may result in long prison sentences or in children being permanently removed from their parents. I call for scientifically sound evidence that the criteria that are applied at present really can be used as judicial proof of 'guilt beyond all reasonable doubt' in cases of shaken baby syndrome. The judges in such cases are entirely dependent on medical expertise. If the advice given by experts in court is based on weak scientific foundations, serious consequences may ensue.

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