

Diagnostic guidelines in abusive head trauma: key recommendations of a French public hearing

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Abusive head trauma by shaking is a particular type of abusive head injury in infants that entails a huge human cost both in terms of mortality and disability and also a huge financial cost [1]. This syndrome constitutes a major public health problem that concerns the sanitary, medical, social, legal, judicial and educational fields.

French guidelines have been established to help professionals cope with this syndrome

A conference of experts was organised by the French Society of Physical and Rehabilitation Medicine under the patronage of the Ministry of Health. The French High Authority of Health provided methodological support and validated the conclusions. Guidelines for professionals were formulated based on these conclusions.

The diagnosis of a shaken baby case was the primary question addressed because it is the most challenging question for professionals and also the first step of the clinical process

The question was not the identification of the perpetrator or the context in which the abusive shaking occurred.

The diagnosis of abusive head trauma, which depends only on the physicians, is indeed a crucial step. If the diagnosis is

not made, the child will not be looked after adequately. In addition, this child and other children may not be protected as shaking could be repeated. Lastly, considering the French law, the child's rights as a victim of abuse would not be safeguarded.

The results of the expert conference (http://www.has-sante.fr/portail/jcms/c_1095929/recommandation-syndrome-du-bebe-secoue) were published in English and French in two versions, a short one with the main conclusions (“guidelines on establishing a robust diagnosis and the procedures to be adopted by health care and social service staff”) and a long “scoping report” with argumentation and bibliography [2, 3].

Accurate diagnosis of abusive head trauma is important because its incidence is actually underestimated

The published figures (incidence between 15 and 30 per 100,000 infants younger than 1 year of age) certainly underestimate the true incidence for several reasons [4]. First, only the most severe cases are likely to be reported. Children with insufficiently severe symptoms are less likely to be hospitalized and diagnosed as abusive head trauma cases. Even if the child is hospitalized, abusive head trauma is not always diagnosed. In the case of unexpected deaths, abusive head trauma is unlikely to be diagnosed if an autopsy is not performed.

Three early papers reported crucial information about this underestimation.

In 1991, Chadwick et al. [5] reviewed 317 consecutive admissions to a children's trauma centre during a 4-year period for which a history of a fall was alleged by the adults as being the cause of the head injury. Three groups were identified according to the alleged height of the fall, which was less than 1 m for Group 1, from 1 to 3 m for Group 2 and from 3 to 12 m for Group 3. The rate of mortality was considered. It was 7% for Group 1 (7 out of 100 children), compared with a rate of mortality of 0% for Group 2 (0 out of 65 children) and of 0.8%

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for Group 3 (1 out of 118 children). So the lower the fall, the higher the rate of mortality. The only possible explanation for these very illogical results is that the children in Group 1 were, in fact, abused and that a fall is a frequent excuse given by adults to explain the child's condition.

Also, each of the seven children dead from alleged falls from a height less than 1 m was very young. The age of three of them was specified: 6 weeks, 11 months and 13 months. Two other children, reported as having fallen from a distance equal to their own height, were under the age of 4 (as a 4-year-old child is 1 m tall), and the two last ones had fallen from a bed or a table (which suggests a young age). In an editorial, Chadwick insisted on the fact that reliably witnessed cases in mechanistic studies are those occurring in a hospital or an authorized care setting under certain conditions. He considered that cases for which the witnesses are carers or other children should not be included in databases concerning alleged mechanisms [6].

In 1991, in a prospective study of 398 falls by children admitted to Oakland Children's Hospital during a two-year period, Williams [7] compared two populations of children younger than 3 years of age for whom the alleged fall was reported either by family members or carers (Group 1, 53 cases) or by a neutral witness or several witnesses (Group 2, 106 cases). The rate of mortality was 3.8% in Group 1 and less than 1% in Group 2 (a child who fell from 21 m). The rate of severe head trauma was 34% in Group 1 and 0% in Group 2. So, very surprisingly, the severity of the injury seemed to depend on who is the witness.

At last, in 1999, Jenny [8] considered 54 (31.2%) of 173 abused children with head injuries who had been seen by physicians after abusive head trauma and the diagnosis was not recognized. The mean time to correct diagnosis among these children was 7 days (range: 0–189 days). Trauma was more likely to be unrecognized in very young white children from intact families and in children without respiratory compromise or seizures. In seven of the children with unrecognized abusive head trauma, misinterpretation of radiologic studies contributed to the delay in diagnosis. Among the missed abusive head trauma cases, 15 (27.8%) of the 54 children were known to have been reinjured because of the delay in diagnosis. Twenty-two (40.7%) experienced medical complications related to the missed diagnosis. Four of five deaths in the group with unrecognized abusive head trauma might have been prevented by earlier recognition of abuse.

What could be learned from these three papers is that the mechanism of falls is frequently alleged by adults to justify the lesions observed in an infant, that the safest context for a child is not always to be looked after by a person alone, whether family member or carer, and lastly, that the rate of correct initial diagnosis dramatically depends on the sociofamilial background.

Diagnosis of abusive head trauma is of major importance considering the frequent recurrences of shaking

Another point is that shaking may be repeated and recurrent. In an observational retrospective study of 112 children diagnosed with abusive head trauma, Adamsbaum et al. [9] identified the recurrence of shaking episodes in 55% of cases, from 2 to 30 times, with an average of 10 times per child. Consequently, diagnosing abusive head trauma as soon as possible is a crucial issue.

Prevention is not confined to the first shaking. It's also the prevention of new shakings by diagnosing the first one and the first signs of violence as soon as possible

It's obvious that new parents or, in fact, all those who look after toddlers must receive information on the possibility of being exasperated by a child's crying and the risk of shaking him/her to stop the cries. But that is not enough. If violence, particularly shaking, is not identified, it means exposing the child to new violence with deleterious consequences. Missed diagnoses increase the risk of recurrence of abuse [8, 10].

Points that have been looked into by the conference of experts

The discussion was organised in three parts.

The first part was devoted to clinical and paramedical aspects: elements suggestive of abusive head trauma or that may lead to misdiagnosis; risk factors related to the child, the shaker and the parents; the type of lesions that could occur, the paraclinical assessment necessary and sufficient to detect them, and the medical differential diagnosis. Diagnostic criteria were established.

The second part was devoted to the causal mechanisms of the lesions: questions about other mechanisms that could induce the same lesions as those observed in abusive head trauma, especially subdural hematoma and retinal hemorrhages, were addressed; the possibility of timing the lesions, and the meaning of expansion of pericerebral spaces.

The third and last part focused on protecting the child and the medicolegal aspects.

Answers were issued from the literature and the experts' experience.

The nature of the evidence supporting conclusions regarding abusive head trauma

The methods that allow promotion of evidence-based medical conclusions could not be applied in abusive head trauma. It is obviously impossible to shake different groups of babies to know which lesions are created depending on the frequency or the intensity of the shaking! So, we had to find another way to

reach valid conclusions. We also wanted these conclusions to be the most objective. They had to be independent of the different risk factors, which are variables showing a statistically significant association with abusive head trauma but which may not necessarily be the cause of it. We decided to focus on the lesions observed. The method chosen was to compare the most frequent lesions seen in abusive head trauma with those caused by other mechanisms. Either the lesions are similar, and in this case the mechanism invoked is plausible, or the lesions are different and the mechanism invoked is rejected.

The lesions chosen were extra-axial hemorrhages (subdural or subarachnoid) and/or retinal hemorrhages (RH). Subdural hematomas, which may be accompanied by subarachnoid hemorrhages, are described by the conference of experts as generally multifocal. As indicated elsewhere in this special issue, the sites of subdural hematomas can be divided into four locations: the right and left subdural spaces, the interhemispheric fissure and the tentorium cerebelli. Unifocal subdural hematoma involves only one of these locations while multifocal subdural hematoma involves more than one location. In addition, some these locations are suggestive of the shaken baby syndrome (falx cerebri and posterior fossa) in the absence of high deceleration accidental trauma.

Retinal hemorrhages were classified in three types depending above all on their aspect and their retinal localisation (in depth and on surface area).

The following mechanisms were studied:

First, mechanisms frequently invoked by the adults when the child is brought to the hospital, which are falls from a low height or an attempt to resuscitate the infant after loss of consciousness. The possibility that the lesions may be induced by another child or during playing or childbirth was also discussed.

Second, a mechanism invoked by some professionals as not having on its own the potential of causing the lesions of the abusive head trauma, namely shaking without impact.

And, finally, a mechanism that could have been invoked as having the potential to cause subdural hematomas without shaking, namely hypoxia and anoxia.

What were the main results concerning the mechanisms involved in abusive head trauma? [2, 3]

First: The mechanisms frequently invoked by the adults when the child is brought to hospital.

What about low height falls?

A low height fall (<1.5 m) does not cause injury in most cases. Fewer than 1 out of 1 million infants younger than 5 years dies each year.

A subdural hematoma is very rare/always localized/sometimes in front of a skull fracture.

Retinal hemorrhages are very rare, generally unilateral, situated in the posterior pole and never multilayered.

No case has been found in the literature of a child younger than 1 year of age with both a subdural hematoma and retinal hemorrhage after a short fall.

Resuscitation manoeuvres

A subdural hematoma never occurs due to cardiorespiratory resuscitation. The intracranial lesions observed after resuscitation are due to the circumstances that led to the need for resuscitation manoeuvres.

Retinal hemorrhages are also extremely rare and, when they do occur, are situated in the posterior pole, described as punctiform or flame-shaped.

Shaking by a child

There was no case reported in the literature. The only data were biomechanical. Children younger than 9 years of age are unable to shake masses corresponding to a 6-month-old baby. Children younger than 13 years of age are unable to shake masses corresponding to a 1-year-old child. And whenever masses could be shaken, the acceleration due to shaking is significantly inferior to the one generated by an adult [11].

Activities considered to be “play” by the carers

Sometimes the alleged mechanism reported is rocking an infant in a baby bouncer. But, in this case, the acceleration generated by the rocking cannot cause lesions as it is not intense enough. Also, there were no cases of traumatic brain injury with retinal hemorrhages or subdural hematomas resulting from such a mechanism.

There are no literature data on other activities considered to be “play.”

Childbirth

On the other hand, subdural hematomas and retinal hemorrhages are very frequent after birth but they disappear within a few weeks, always within a month and the child remains asymptomatic.

Asymptomatic subdural hematomas may be seen soon after birth. The frequency, from 9% to 46%, depends on the imaging technique (US vs. MRI), the time of the examination and the type of the delivery (greater after vacuum-assisted or forceps delivery). Subdural hematomas are often multifocal, supratentorial in the posterior half of the skull or infratentorial. The lesions are homogeneous and of the same density. The subdural hematomas resolved spontaneously by the end of a month.

Retinal hemorrhages are observed in a third of asymptomatic neonates, also more frequently after instrumented delivery. They disappear by the end of a month and usually within a few days.

Second: What could be said about shaking alone without impact, a mechanism invoked by some professionals as not having the potential to cause the lesions of the abusive head trauma:

It was found that there are enough arguments to affirm that subdural hematomas can occur with shaking without any impact. Moreover, the occurrence of subdural hematomas is more strongly associated with the act of shaking than with the existence of an impact.

Retinal hemorrhages also appear to be more strongly associated with the act of shaking than with the existence of an impact. All types of retinal hemorrhage can occur. “Profuse, multiple hemorrhages of all types (intra-, pre- or subretinal), coating the whole retina or flecked out to its periphery, combined with unilateral or bilateral premacular hemorrhagic plaques are almost pathognomonic for shaken baby syndrome (as this type of retinal haemorrhages is extremely rare in other circumstances).”

The last mechanisms that have been studied: hypoxia and anoxia. These have been invoked by some professionals as having the potential to cause lesions of abusive head trauma without shaking [12].

It was found that a subdural hematoma is not observed in children with serious hypoxia, even with prolonged cardiac arrest. Also, despite the fact that deaths of children younger than 1 year old are frequently related to severe hypoxia, subdural hematoma is rarely found at autopsy and if so the cause is known. In fetuses and neonates who die during the first month of life, most often during the first week, histologically detectable intradural hemorrhage and very thin posterior, both supra- and infratentorial, subdural effusion may be observed in case of hypoxia. But hypoxia does not induce macroscopic subdural hemorrhage in children older than 1 month of age.

It was concluded that a subdural hematoma never results from hypoxia or anoxia in children older than 1 month. Retinal hemorrhages are never observed after hypoxia

Summary

After a low height fall (<1.5 m), a subdural hematoma is very rare and is usually localized adjacent to a skull fracture; Retinal hemorrhage is very rare. To the best of our knowledge, no case has been found in the literature of a child younger than 1 year with both a subdural hematoma and a retinal hemorrhage after a short fall.

Subdural hematoma never results from play, reanimation or hypoxia or anoxia in children older than 1 month. Retinal hemorrhages are extremely rare after reanimation and are not observed after hypoxia

On the opposite, subdural hematomas and retinal hemorrhages are very frequent after birth but they disappear within a few weeks, always within a month, and the child remains asymptomatic.

Subdural hematomas and retinal hemorrhages may be due to shaking without an impact, and moreover, both of them are more strongly associated with the act of shaking than with the existence of an impact.

Besides the question of the mechanisms to which lesions could be a result, another question that has been looked into was the meaning of large pericerebral spaces [2, 3]

The observation of both a widening of the pericerebral spaces and a subdural hematoma has evoked two possible explanations: The first one was that this observed widening of the pericerebral spaces is part of an expansion of the subarachnoid space – a clinical entity that was alleged to predispose rupture of the bridging veins and so to subdural hemorrhage. But no data were found in the literature to support this hypothesis. Also, biomechanical analysis showed that expansion of the subarachnoid space has, on the contrary, a shock-absorbing effect by reducing the displacement of the brain relative to the skull [13]. The second hypothesis was that the observed widening of the pericerebral spaces is the consequence of a previous, undiagnosed head injury. Two prospective studies suggest that widening of the pericerebral spaces observed at the initial phase of head injury corresponds to damage resulting from a previous, undiagnosed head injury [14, 15].

Diagnostic criteria of shaking were established by the French conference of experts based exclusively on the lesions observed and on what was said by the adult to explain the child’s state, not on risk factors [2, 3]

At the end of the clinical and radiologic assessments (whatever the initial symptoms), the probability of a diagnosis of abusive head trauma will vary according to the lesions observed and the type of subdural hematoma (multifocal or unifocal) and retinal hemorrhage.

In a child under 1 year of age, after having ruled out differential diagnoses (disorder of hemostasis/perinatal condition/infection/metabolic disease), and if the clinical history is absent, incoherent, changes over time or is incompatible with the observed lesions or the child’s age,

- I. In case of multifocal subdural hematoma and/or subarachnoid hemorrhage
 - The diagnosis of shaking is probable, even in the absence of retinal haemorrhages.
 - The diagnosis of shaking is highly probable or even certain when retinal haemorrhages profuse or flecked across the retina out to its periphery are associated.
- II. In case of unifocal subdural hematoma and/or subarachnoid haemorrhage
 - The diagnosis of shaking was considered as probable, if there is an associated extensive, not limited to the posterior pole, RH.

- There was no consensus as to whether diagnosis of shaking must be considered as probable or possible if there is an associated retinal haemorrhages limited to the posterior pole.
- The diagnosis of shaking was considered as possible if there is no associated retinal haemorrhages.

Other elements can be present and reinforce the diagnosis of shaken baby syndrome: associated hypoxic brain lesions or cervical lesions or the description of violent shaking by an eye witness.

In all cases, the observation of any of the following:

- abuse-specific bone lesions and bruising (particularly on the scalp) on a child too young to move around
- a history of abuse, or of unexpected poorly explained sibling death (s)
- a delay in seeking medical assistance

are strongly suggestive of a diagnosis of abuse and should prompt the implementation of appropriate measures.

Is it possible to go further than established diagnostic criteria according to both the location and the type of subdural hematoma observed?

Two studies gave us more information on the frequency and the type of subdural hematoma observed in child younger than 1 year of age. In the first study, Adamsbaum et al. [9] reported 112 patients diagnosed as abusive head trauma and it must be noted that in 111 cases among 112, subdural hematoma were multifocal. (The last one was located in the interhemispheric fissure.) Thereby the second part of the established diagnostic criteria, relying on a unifocal should actually have a very limited clinical use as opposed to the first part depending on a multifocal location.

In the second study, Matschke [16], first of all, confirmed that the observation of a subdural hematoma in a child of this age is an uncommon event. He found only 50 subdural hematomas (7%) from a total of 715 autopsies of infants of this age during the study period (50 years). These subdural hematomas were attributed to abusive head trauma (15 patients), disorder of hemostasis (13), perinatal condition (13), infection (4), metabolic disease (1) and accidental trauma (1). Also, two patients for whom history was very suggestive of abusive head trauma were classified in the group of the four “unexplained subdural hematomas” because of poor documentation. So abusive head trauma was the most common single cause for subdural hematoma. This is consistent with the strong association of subdural hematoma with the act of shaking. Now what could be said from the type of subdural hematoma observed?

Matschke [16] classified these 50 subdural hematomas in four categories: bilateral or unilateral/localized or diffuse. Twenty-one subdural hematomas were diffuse (42%), of which 13 were attributed to abusive head trauma. So among the 15 subdural hematomas due to abusive head trauma, 13 were diffuse. The diffuse pattern, so-called “en nappe,” i.e. not localized, of the bleeding seems to be a very suggestive characteristic of abusive head trauma.

In conclusion, in infants younger than 1 year of age, the evidence suggests that subdural hematoma is an uncommon event that must incite the professional to first consider abusive head trauma as the cause. Furthermore, it appears that in the vast majority of abusive head trauma cases, the subdural hematomas seem to be diffuse “en nappe” rather than localized, and to be multifocal rather than unifocal.

Finally, another element that has not been taken into account by the French guidelines is the possibility recently described of sometimes identifying bridging vein thrombosis secondary to rupture. This finding not only makes the diagnosis of abusive head trauma certain but also indicates a recent vein injury [17, 18].

The French guidelines have already deeply modified the way of functioning of many professionals, even though they are still not widely enough distributed or known

Their use has increased the number of reports to district prosecutors by emergency physicians. They also enable judicial experts to assert the diagnosis of syndrome of the shaken baby in appropriate cases.

Issued from the French guidelines and also from experience of legal experts, a penal mission of imputability has been proposed (annex 1)

The objective is to help both non-medical professionals (judges and lawyers) and medical experts. Step-by-step guidelines, including a checklist of items to address were established [19].

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Conflicts of interest None

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