



A suspected case of shaken baby syndrome—clinical management in Germany: a case-based overview

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Abstract

Purpose Each year, between 100 and 200 cases with shaken baby syndrome (SBS) are hospitalized in Germany. The reported incidence is 14 in 100,000 children. About 10 to 30% of the affected children do not survive. A high number of unreported cases are assumed. The rate of lifelong disability is high. The current situation in respect of abusive head injuries in infants has been investigated.

Material and methods A case-based overview on the management of SBS in a German reference center for pediatric neurosurgery is presented and discussed against the background of forensic data and child protection network institutions and guidelines.

Results The presented case is an example of a typical SBS presentation. All necessary diagnostic and therapeutic steps are explained and evaluated according to the existing guidelines in Germany. The authors state that hospital SOP can help to detect suspected cases of SBS and define the role of the pediatric neurosurgeon. Although the abusive mechanism of a head trauma is clear in most cases, forensic methods lack the precision to identify a perpetrator in all of them. According to an analysis of a multi-center study on criminal proceedings in Germany, 50% of the proceedings were closed without judgment due to lack of suspicion. Out of the remaining half with judgment, in 17%, the court decided on acquittal since the perpetration could not be assigned to a specific individual.

Conclusion Prevention is the most important factor to protect children from death and disability caused by inflicted brain injury. Pediatric healthcare professionals must be aware of typical signs of suspected child abuse, SBS in particular, and institutional SOP can help to improve management and outcome in these children. Forensic methods lack the precision to identify a perpetrator in every case.

Keywords Abusive head injuries in infants · Diagnostics · Child protection program · Clinical management · Prognosis

Introduction

Each year, between 100 and 200 cases with shaken baby syndrome (SBS) are hospitalized in Germany. The reported incidence is 14 in 100,000 children. About 10 to 30% of the affected children do not survive. Two-thirds of them are suffering from lifelong consequences: visual and speech impairment, learning and developmental disorders, seizures, and severe mental and motor disability. The causal shaking mechanism occurs in many cases repeatedly. In 54 to 60%, the father was identified as the perpetrator, in 9% the

mother's life partner, and in 23 to 30% the mother herself. These data were retrieved from the German ESPED-study (2006–2009) (https://www.bzga.de/fileadmin/user_upload/PDF/pressemitteilungen/daten_und_fakten/nzfh_hintergrundinformationen_schuetteltrauma--d546b47b3890d3f06f480dc9f025adb9.pdf (last consulted on 11 October 2022)). The authors assume a high number of unreported cases and believe that numerous children with disabilities are having an unknown shaken baby syndrome history. The relentless crying of a young infant is considered a major trigger for the shaking. The results of the German study are comparable to other international observations.

The fact that caregivers are overwhelmed by the crying and try shake the baby to silence out of desperation is known for a long time. In Germany, the first crying baby ambulance opened in 1991 and many more followed, but still the

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numbers of inflicted head injury remain high (<https://www.familienhandbuch.de/unterstuetzungsangebote/beratung/schreibambulanz.php>). Numerous advice centers for young families and other educational programs exist. It became obvious that these activities are not sufficient to address the problem and a comprehensive and systematic prevention program was developed.

A nationwide initiative involving 82 expert associations from the fields of healthcare, youth welfare services, and education created the S3(+) *guideline Child abuse and neglect guideline: involving Youth Welfare and Education Services (Child Protection Guideline)* under the auspices of the German Medical Society for Child Protection (Deutsche Gesellschaft für Kinderschutz in der Medizin—DGKiM) (https://www.awmf.org/fileadmin/user_upload/Leitlinien/027_D_Ges_fuer_Kinderheilkunde_und_Jugendmedizin/027-069le_S3_Child_Protection_Guideline_2022-01.pdf). The first author was part of the working group as representative of the German Neurosurgical Society (DGNC) responsible for the chapter on inflicted head trauma.

The S3 guideline provides detailed instructions on how to accompany young parents and their children beginning with pregnancy and following the children through childhood and

adolescence. A dense network of institutions and consulting centers is involved and will be further expanded.

Interdisciplinary child protection groups located in nearly all pediatric departments in Germany play an important role in this network. To date, 171 *Kinderschutzgruppen* exist in Germany (<https://www.dgkim.de/kinderschutzgruppen>) (Fig. 1).

During the COVID-19 pandemic, we observed a higher number of patients with SBS in our institution, but so far no conclusive epidemiological data exist in Germany to prove an increase in incidence.

Standard operating procedure (SOP) for suspected shaken baby syndrome in a German reference center for pediatric neurosurgery

In our institution, a SOP for suspected shaken baby syndrome has been implemented in accordance with the existing evidence on inflicted brain trauma. Whenever an infant is admitted with signs of head trauma, e.g., with uni- or bilateral subdural effusions or bleedings, and a doubtful or empty

Fig. 1 Child protection groups in Germany



Infant with uni- or bilateral subdural collections without obvious cause on admission

↓

Check for external signs of injury*

↓

Fudoscopy for retinal hemorrhage (RH)*

↓

cCT or cMRI

↓

Check for possible differential diagnosis (all can be associated with RH) [5]

accidental craniocerebral trauma
 perinatal trauma
 vascular pathology
 arachnoid cyst
 meningoencephalitis or postinfectious hygroma
 coagulopathies
 glutaraciduria type I
 galactosemia
 osteogenesis imperfecta type I/type IV

↓

Differential diagnosis excluded + RH with high dot-blot count⁶

→ Child/caregivers contact only under surveillance

↓

Whole-body examination (including baby gram X-ray)

↓

Forensic medicine assessment

↓

Involvement of child protection group and family pediatrician

↓

Caregivers are confronted with diagnosis (repeated interviews)

* photographic documentation

Fig. 2 SOP for suspected shaken baby syndrome

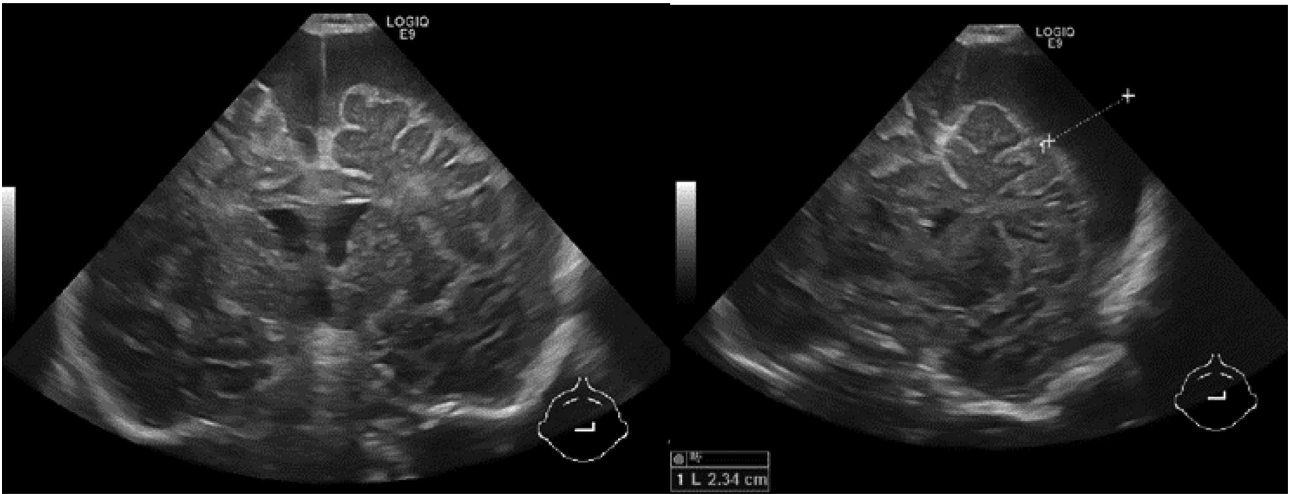
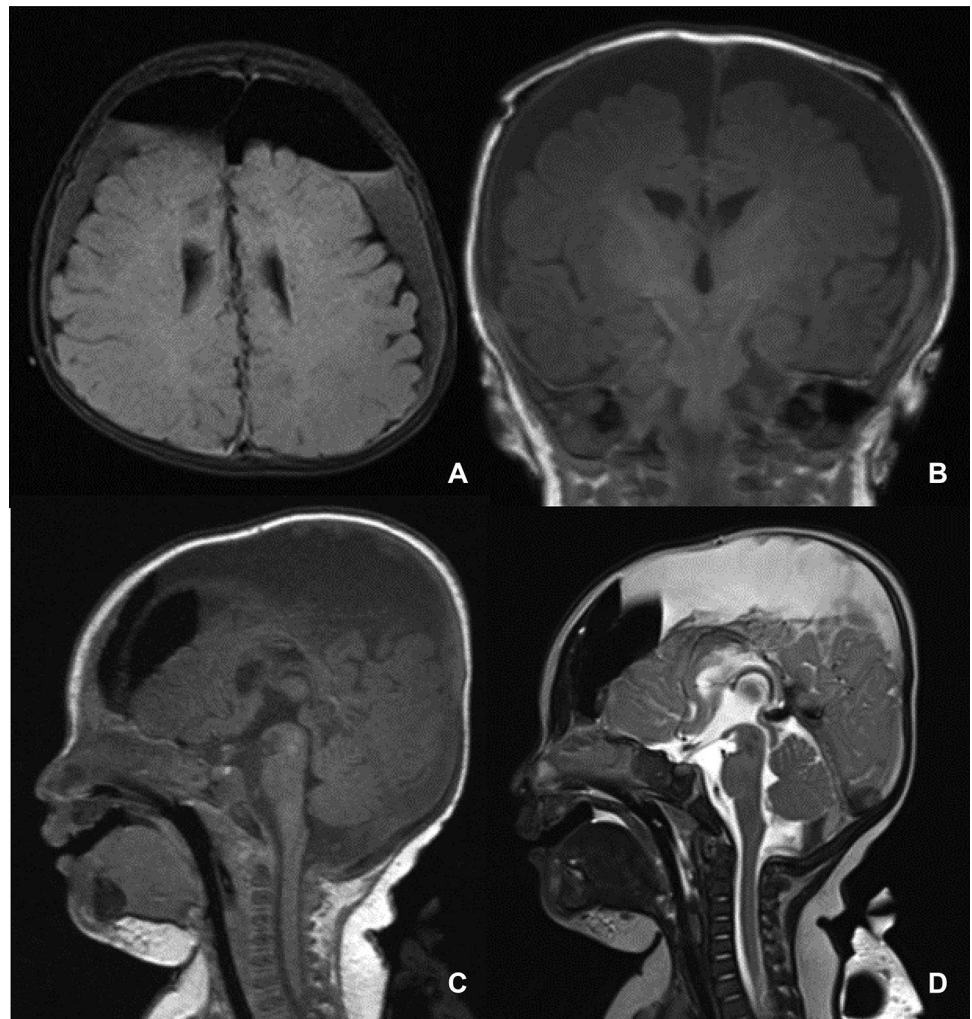


Fig. 3 Initial brain ultrasound demonstrating bilateral hemorrhagic hygroma

Fig. 4 Initial MRI after insertion of bilateral subdural drainages without further signs of intracranial injuries (FLAIR (A), T1 (B, C), and T2 (D))



history reported by the caregivers, the involved medical staff must be alarmed and follow the SOP (Fig. 2).

Case report

During the last winter, a three-month-old infant has been admitted to our emergency department after repeated seizures since early morning, in the last hours with a 10-min frequency. On admission tonic–clonic seizures of the left extremities, a gaze deviation to the right and a tense fontanelle were present. Body inspection excluded external signs of injury. The parents denied a relevant event that could have led to their child's condition. Immediate transfontanelar ultrasound revealed bilateral massive subdural hemorrhagic hygroma (Fig. 3) and the child was transferred to the operation room for insertion of bilateral external subdural drains.

The child was born in gestational week 39 by Cesarean section. It was the first child of a father who has an older child from a previous relationship and a mother with a history of drug abuse and childhood epilepsy. The postnatal anamnesis of the child was unremarkable.

After the emergency surgery, MRI of the brain was performed excluding further intracranial signs of injury (Fig. 4). Fundoscopy revealed bilateral massive bilateral retinal bleedings with a high dot-blood count. The following day a baby gram demonstrated a metaphyseal fracture of the left femur (Fig. 5). The child was kept on the pediatric intensive care unit (PICU) due to prolonged seizures under phenobarbital treatment, which was discontinued after slow dosing of levetiracetam. After 5 days, the left subdural hematoma resolved and the left drain could be removed. Another 4 days later, a second MRI showed multiple intracerebral hemorrhages mainly in the left hemisphere and a thrombosis of the sagittal sinus (Fig. 6). Doppler studies demonstrated resolution of the thrombus and anticoagulation was discontinued. The right drain was explanted. A ventricular dilatation was found at that time. The child stabilized and the seizures stopped. In the following, daily ultrasound controls of the CSF spaces were performed showing a stable ventricular width and no increase of the head circumference was observed.

Both parents were not allowed to be with the child unattended. They were confronted with the clinical findings and the diagnosis of a traumatic injury. In repeated daily interviews by different doctors and nurses, the parents were asked to remember any possible causes for the obvious injuries without giving conclusive explanations.

Directly after the completion of diagnostics, the local child protection group and the institute of forensic medicine were involved. The child protection group informed the family pediatrician and the responsible youth welfare office. The

pediatrician reported no abnormalities. Both parents were visited by the youth welfare office for the inspection of the household and interviews, which could not clarify the situation. The forensic medicine report stated child abuse and as an immediate consequence the criminal police was involved.

After further investigation by the criminal police department, the father was taken into custody and later confessed repeated shaking of his baby and was convicted. Mother and child moved into a mother–child institute and a pediatric neurological rehabilitation program was started in a specialized clinic. In the following weeks, the child developed a progressive resorptive hydrocephalus and was readmitted for insertion of a ventriculoperitoneal shunt.

Ten months after the injury the child is suffering from significant global and motor retardation and is under ongoing physio- and logopedic therapy.

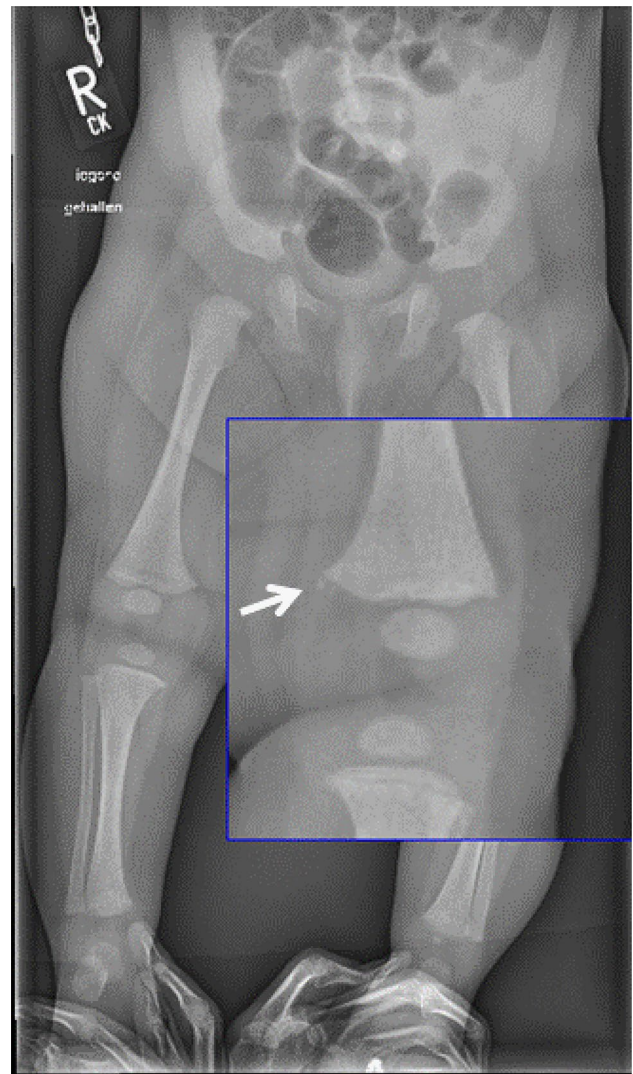
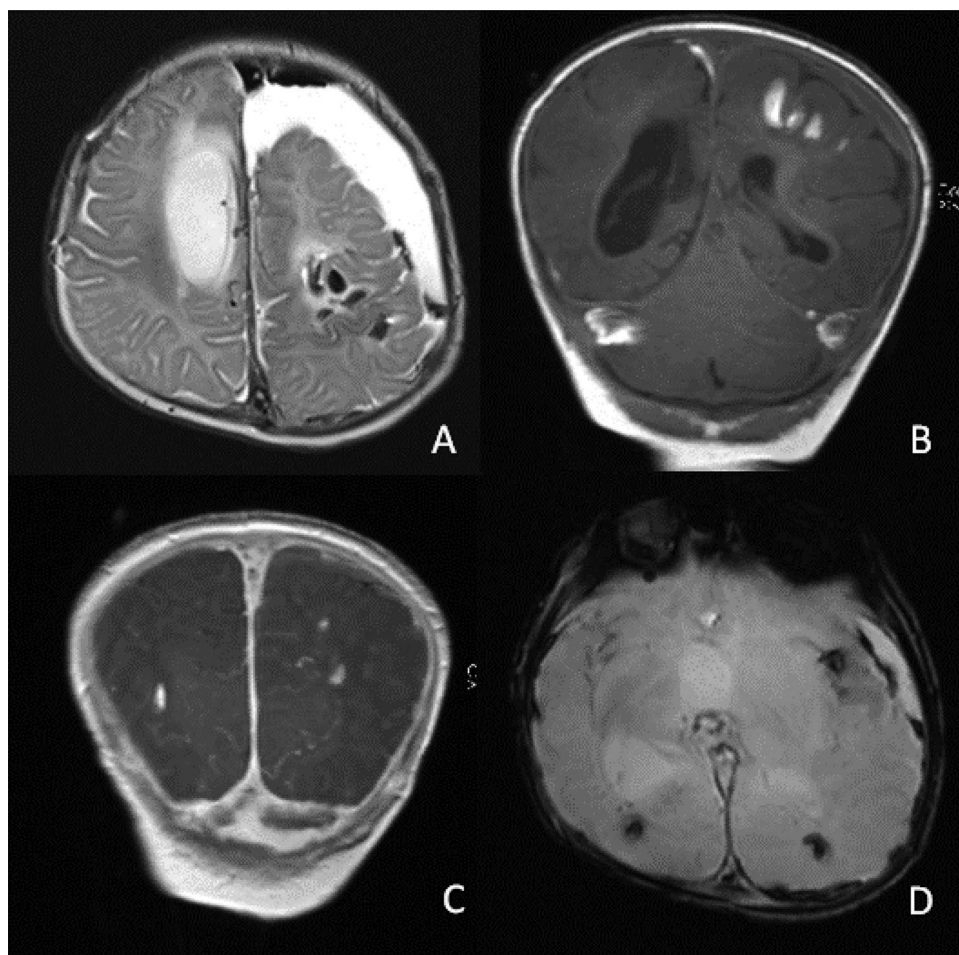


Fig. 5 Baby gram revealing metaphyseal fracture of the left femur

Fig. 6 MRI with multiple diffuse intracerebral hemorrhages and thrombosis of the sagittal sinus (T2 (A), T1 (B, C), and T2* (D))



Discussion

The circumstances of the presented case are typical for suspected shaken baby syndrome (SBS) and the reported clinical management serves as an example of the implementation of the German Child Protection Guideline (https://www.awmf.org/fileadmin/user_upload/Leitlinien/027_D_Ges_fuer_Kinderheilkunde_und_Jugendmedizin/027-069le_S3_Child_Protection_Guideline_2022-01.pdf). It is crucial to identify a potential SBS as early as possible in order to prevent further abuse and additional associated injuries and death. All health care professionals working with children should be able to recognize the signs of potential child abuse and SBS in particular. A regular training program on the application of the SBS SOP is helpful in this respect. Hymel et al. could demonstrate the usefulness of a clinical prediction rule for pediatric abusive head trauma [1]. Subdural hygromas, with or without hemorrhagic components, are frequently seen in pediatric neurosurgical practice, and a careful evaluation of all differential diagnoses is important.

In every case without a clear etiological explanation, early fundoscopy is indispensable to rule out retinal hemorrhage. A variety of differential diagnoses can be associated with both subdural effusions and retinal hemorrhage (see Fig. 2), but they are extremely rare and can be excluded with adequate diagnostic assessments [2].

Type and distribution of retinal hemorrhages play an essential role. A high dot-blood count in multiple retinal sections is highly predictive for SBS. In a prospective study comparing fundoscopy findings in children with traumatic and inflicted brain injury, Minns et al. confirmed the high predictive value of retinal hemorrhages in child abuse. In children less than 3 years of age with more than 25 dot-blood counts uni- or bilaterally, the probability for abuse is 93% [3]. In forensic medicine retinal hemorrhages together with subdural effusions after exclusion of differential diagnoses are considered as clear signs of inflicted injury. It is important to note that retinal hemorrhages cannot be used as a crucial indicator after cardiopulmonary resuscitation since congestive bleedings are a possible consequence.

Additional signs of trauma without a documented event, also earlier date injuries, finally prove an abusive background.

The pathophysiological mechanisms of SBS are still not fully understood and injury pattern do not allow a complete reconstruction of the history of abuse. There is little doubt on the underlying acute or chronic ischemic and or hypoxic encephalopathy in SBS. The severity can vary substantially and a possible involvement of the brainstem could be a crucial factor. Nevertheless, a clear correlation between the extent of encephalopathy and the severity of the perpetration is difficult to assess. In general, severe global encephalopathy is associated with a high mortality or disability rate [4].

Neurosurgical treatment is mainly focusing on draining or evacuation of CSF and blood, depending on the presentation and course. ICP monitoring and adapted ICP management according to a standard ICP protocol can become necessary in order to prevent any secondary damage to the brain parenchyma. No supportive data exist on the potential benefit of decompressive craniectomy in this specific patient group and is not performed in our institution.

To date, the available forensic methods are not sufficient to unequivocally assign an abusive act to a specific perpetrator in many cases. A multi-center study on criminal proceedings in Germany mirrors this dilemma. In 50% of cases, the proceedings were closed without judgment due to the lack of suspicion. Out of the remaining half with judgment, in 17%, the court decided on acquittal since the perpetration could not be assigned to a specific individual. In the rest of the cases, a guilty verdict was issued, leading to imprisonment in 84% (63% suspended on probation). All confessed perpetrators stated an impulsive demand to shake [5].

Surprisingly, primary care pediatricians were not among the complainants in this study, which underlines the importance of pediatric hospitals and the need to increase awareness.

Conclusion

Prevention is the most important factor to protect children from death and disability caused by inflicted brain injury. Nevertheless, significant case numbers are still a reality and all pediatric healthcare professionals must be aware of typical signs of suspected child abuse; SBS in particular and institutional SOP can help to improve management and outcome in these children. The role of the pediatric neurosurgeon is the prevention of further secondary damage of the brain parenchyma.

Although the abusive mechanism is clear, forensic methods lack the precision to identify a perpetrator in every case.

Apart from the forensic dilemma, the specific family situation needs to be considered as well in respect of the future protection and well-being of a concerned child. Not all inflicted injuries occur in a violent environment. Most often young families and their first child are affected as a result of excessive demand, low frustration tolerance, and impulse control. The growing complexity of our living conditions could increase the vulnerability of young families in the future and further efforts to improve the supportive child protection network are urgently needed.

Abbreviations SBS: Shaken baby syndrome; SOP: Standard operating procedure; ESPED: Erhebungseinheit für seltene pädiatrische Erkrankungen in Deutschland; DGKiM: Deutsche Gesellschaft für Kinderschutz in der Medizin; MRI: Magnetic resonance imaging; PICU: Pediatric intensive care unit; CSF: Cerebrospinal fluid; ICP: Intracranial pressure

Author contribution Martina Messing-Jünger wrote the main manuscript text and prepared Figs. 1, 2, 3, 4, 5, and 6. Jasmin Alhourani performed the case retrieval. Both authors reviewed the manuscript.

Data availability Not applicable.

Declarations

Ethics approval Not applicable.

Consent for publication All authors gave their consent for publication.

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

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