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Sudden unexpected death of two infants in baby carriers

Plötzlicher Kindstod von zwei Säuglingen in Babytragehilfen

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Abbreviations
BRUE Brief resolved unexplained event
HIE Hypoxic-ischemic encephalopathy
OECD Organisation for Economic Co-operation and Development
SIDS Sudden infant death syndrome
SUDI Sudden unexpected death in infancy

Interessenskonflikt: Die Autoren erklären, dass kein Interessenkonflikt besteht.

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Introduction

Sudden unexpected death in infancy (SUDI), previously termed sudden infant death syndrome (SIDS), is the second leading cause of death in infants beyond the neonatal period in Germany, and a major cause of infant mortality in economically well developed countries (OECD Health Statistics, 2019). The risk of SUDI peaks at the age of 2 to 4 months and then decreases continuously till the end of the first year. A complex multifactorial cause, rather than a single characteristic factor, may cause SUDI within a critical period of infant development (Guntheroth WG et al., Pediatrics 2002; 110: e64-e64). Risk factors include prematurity, male gender, bottle-feeding, prone sleeping position, overheating, as well as exposure to smoke amongst others (Carpenter RG et al., Lancet 2004; 363: 185-191). Thus, health professionals consistently advise and educate parents about avoidable risk factors of SUDI at routine well-baby examinations. Since the advent of SUDI prevention strategies in the 1980s, the incidence has decreased 10fold, from 1,55/1.000 live births in 1991 to 0,15/1000 in 2015. This number seems to have reached a steady state (Statistisches Bundesamt Germany, 2015).

In recent years, baby carriers with full or half buckles for easier handling have become popular in Western countries. These tools mimic traditional baby slings allowing to carry the infant conveniently during daily routines for facilitating close body contact. However, they also raise health concerns when such devices are not applied correctly. SUDI associated with the use of full or half buckle baby carriers, as well as baby slings, have been reported in the United Kingdom, France, Spain, Australia, and the US (Batra EK et al., J Pediatr 2015; 167: 183-187; Bergounioux J et al., Eur J Pediatr 2015; 174: 1665-1670; Maqueda Castellote E et al., An Pediatr (Barc) 2012; 77: 416-417).

To our knowledge, SUDI associated with baby carriers has not yet been reported in Germany despite the popularity of these devices. Here, we present two recent cases of

SUDI associated with parental care of the infants in full buckle baby carriers.

Case reports

Case No1. A healthy, term, then one-month-old girl (see Table 1) was carried in a full buckle baby carrier by her father. The device was suitable for the two-year-old sibling. An adjustment to adapt the baby carrier to the weight of the infant was not performed. Due to winter season, the strap-on device was partially covered with the father's coat. The infant was initially agitated while the father went for a walk, and was later presumably asleep. When returning home after 30 minutes, spontaneous breathing was noted to have ceased, and there was bloody mouth and nasal exudate. Cardiopulmonary resuscitation was initiated by the parents. The medical emergency team was successful in establishing spontaneous circulation after 50 minutes, and after endotracheal intubation and single doses of epinephrine. After transfer to our neonatal intensive care unit, laboratory examinations indicated multi-organ failure. Neurological examination revealed absent brain stem reflexes. Amplitude-integrated EEG evolved from burst-suppression to flat trace. MRI scan showed bihemispheric cytotoxic edema of the brain consistent with hypoxic-ischemic encephalopathy (HIE). Further clinical and apparative examinations showed no signs of child abuse, such as retinal bleeding, hematomas, or bone fractures. Tracheal/oropharyngeal swab was positive for E. coli and entero/rhinovirus. Blood culture was positive for Staph. epidermidis and Staph. hominis (interpreted as contamination). Chest x-ray showed no signs of viral bronchitis or pneumonia.

A multidisciplinary panel recommended to withdraw life support, considering the loss of brain function. The infant died 7 days after admission in mutual consent with the parents. Post mortem examination lead to the overall conclusion on SUDI.

Case No2. A healthy, term male infant at 2 ½ months of age (see Table 1) received osteopathic treatment due to torticollis. Minutes after the treatment while being carried in a full buckle baby carrier by the mother, the infant was reported to be very agitated. During a short walk, the mother tried to comfort the boy, holding him thoroughly. The infant then presumably fell asleep. After 5 minutes, the infant presented bloody nasal exudate and had stopped breathing. Cardiopulmonary resuscitation was initiated. After arrival of the medical emergency team, the infant received an endotracheal tube, epinephrine, and was defibrillated with a single shock of 10 Joule, because ECG monitoring initially indicated ventricular fibrillation. Return of spontaneous circulation was established after 45 minutes. After admission to the pediatric intensive care unit, laboratory examinations indicated multi-organ failure. There was no sign of child abuse. ECG showed low voltage without further pathologies (QTc 404 ms). Clinical and apparative examinations revealed signs of HIE, including diffusion-weighted MRI scan. Due to the absence of spontaneous breathing and the persistence of abnormal neurological examinations, the patient died 8 days after admission in mutual consent with the parents to withdraw life support.

Post mortem examination did not show signs of a vascular dissection as putative association between osteopathic treatment and cardio-respiratory arrest or any other traumatic injury, as well as congenital organ malformation or acquired disease. Klebsiella (not further specified) was detected post mortem in the tissue of trachea, lung and spleen (no consequence). SUDI was concluded the likely cause leading to infant's death.

Discussion

We report two cases of SUDI in full buckle baby carriers, to our knowledge the first cases reported in Germany. Patients' histories, clinical and apparative findings combined with post mortem examinations strongly suggest suffocation as mechanism of death.

Reviewing previous reports, the circumstances leading to suffocation in adult-worn (full or half buckle) baby carriers and baby slings are similar. Airway obstruction and suffocation presumably occur when the infant falls into a chin-to-chest position. Furthermore, when the infant is fully contained by the baby carrier or baby sling, it may be forced into a C-shaped, curved positioning of the spine, which may aggravate airway obstruction. In addition, the infant's nose or mouth might be obstructed by the adult's body or the device itself, especially when the size of the carrying device is inadequate. In the first case presented, an adjustment of the baby carrier to the low weight of the infant, and therefore preventing the infant from a lower sitting position, was not performed.

Until neurodevelopment allows complete head control at about 4 months of age, infants appear to be at high risk for SUDI in baby carriers. There are various factors that may increase this risk constellation: Infants in this age group generally do not show a lot of body movement while being carried. Therefore, critical situations might be overlooked by the parents, thinking that the infant is presumably asleep. In winter season, parents may cover the baby carrier with their jacket or a blanket. This may not only lead to overheating but also to poor visibility of the infant and a lack of observation.

Carrying devices currently on the market can be divided into 3 groups. Firstly, the 'traditional' baby sling made of soft fabric is especially used to carry infants within the first weeks of life. Secondly, the full buckle baby carrier is a strap-on device with buckles to adjust its fitting. Its construction allows carrying infants up to 20 kilograms of bodyweight. Thirdly, the product in between those two groups, i.e. the half buckle baby carrier, combines the main characteristics of the preceding: It enables to individually wrap the carrier and adjust its fitting with buckles. Reviewing published SUDI cases, it seems that neither of the devices possess a particular, higher risk of SUDI when compared to each other.

It should be considered that there are various other devices such as sitting devices and car seats that also pose a risk of SUDI. Nevertheless, public health authorities in non-EU countries have already issued safety warnings concerning baby slings and baby carriers (Health Canada, 2010; U.S. Consumer Product Safety Commission, 2010). To our knowledge, this kind of information and public communication is not present in Germany to date. Recently, a bulletin by *Stiftung Warentest*, a leading German consumer test magazine, revealed concerns about various baby carriers. Among 11 tested baby carriers, four were tested and specified as 'defective' in terms of basic manufacturing, handling, ergonomics and noxious substances, but most importantly the general risk of SUDI was not addressed in their report written for the general public (Stiftung Warentest, 2020; 64-70).

Up-to-date counseling by health professionals and media targeting parents could be relevant for avoiding this preventable cause of death. To date, the number of cases with SUDI associated with baby slings or carriers appears to be low, but additional cases may have not been reported in medical journals. It is imaginable that brief resolved unexplained events (BRUE) in baby slings or carriers are not recorded at all.

Conclusion

While baby slings and baby carriers have growing popularity, the devices may exhibit a significant risk for SUDI. Baby slings and baby carriers should be used with particular caution in infants below 4 months of age. According to the age and weight of the infant, parents should focus on correct size and fitting of the strap-on device. Appropriate warnings and instructions need to be provided by manufacturers and health professionals, e.g. at the well-baby examinations scheduled for 3-10 days (U2) and 4-6 weeks (U3).

Table 1: Clinical findings and further investigations in two cases with SUDI associated with baby carriers

	Case No1	Case No2
Weeks of gestation	38 $^{2}/_{7}$	41 $^{6}/_{7}$
Birth weight (g)	3110	3830
Sex	F	M
Antenatal sonography	No pathological findings	No pathological findings
Past medical history	0	Amniotic infection syndrome, 5 days of antibiotic treatment
Family medical history	0	0
Current Age (days / months)	25 / 1	65 / 2 ½
Current Weight (g)	3700	6040
Carrying device	Full buckle baby carrier	Full buckle baby carrier
- Recommended age (months)	0 - 36	0 - 36
- Recommended weight (kg)	3.5 - 20 (min. – max.)	3.5 - 20 (min. – max.)
Carrying position	Device in front of carrier, infant sitting in the device, face towards the carrier	Device in front of carrier, infant sitting in the device, face towards the carrier
Clinical signs	Bloody mouth and nasal discharge	Bloody nasal discharge
pH at admission	< 6,3	6,6
Serum lactate at admission (mg/dl)	167	175
Neurological signs	Absent brain stem reflexes	Absent brain stem reflexes
EEG	Burst-suppression, flat trace	Low voltage, flat trace
MRI	Bihemispheric cytotoxic edema with minor infarction in putamina	General hypoxia with infarction of putamina, hippocampi, fornici cerebri, brain stem. No signs of vascular dissection
Toxicological screen	Negative	Negative
Post mortem examination	Further details were not made available by the state prosecutor	No signs of organ anomaly, external force injury, chronic illness