Abusive Head Trauma in Infants and Children in Japan

Masahiro Nonaka, Akio Asai
Department of Neurosurgery, Kansai Medical University, Hirakata, Japan

Subdural hematoma in infants can be caused by abuse, and is thought to be more likely if subdural hematoma is associated with retinal hemorrhage and cerebral edema. In Japan, few doctors disagree that cases of subdural hematoma with retinal hemorrhage and cerebral edema with multiple findings on the body are more likely to have been caused by abuse rather than by household accident. On the other hand, in cases where there are no other significant physical findings, only subdural hematoma and retinal hemorrhage, there is a difference of opinion as to whether the injury was caused by an accident or abuse. The reason for this is that neurosurgeons in Japan promoted the concept that infants can develop subdural hematomas and retinal hemorrhages due to minor trauma at home before the concept of abusive head trauma became known. In addition, the age distribution of subdural hematomas in Japan differs from that in other countries, with peaks at around 8 months, and the reason for this remains unclear. Therefore, the etiology of infant subdural hematoma in Japan needs to be investigated in greater detail.

Key Words: Abusive head trauma · Subdural hematom · Japanese.

INTRODUCTION

In recent years, the number of cases of suspected child abuse reported to child guidance centers in Japan has been on the rise and is becoming increasingly serious. According to the Japanese Ministry of Health, Labor and Welfare, abuse is defined as physical abuse, sexual abuse, neglect, and psychological abuse. Among physical abuse, head trauma caused by physical violence is of great concern to society, because it can lead to severe permanent disabilities and even death. When examining a case of head trauma suspected of abuse, it is not difficult to suspect abuse when there are unnatural bruises on the body surface or multiple fractures on X-rays. However, in many other cases, it is not clear whether the trauma was caused by abuse or an accident. The history of subdural hematoma in infants, which is often difficult to diagnose, and the current concepts in Japan and Western countries regarding the relationship between abuse and subdural hematoma are discussed, as well as the differences between Japan and Western countries.

SUBDURAL HEMATOMA AND ABUSE IN INFANTS AND CHILDREN: A HISTORY IN WESTERN COUNTRIES

In 1946, Caffey reported a case of subdural hematoma and fracture of the long bones. Although the mechanism of injury...
was not clear at the time, it is now recognized as the first case report of subdural hematoma due to abuse. Later, in 1962, Kempe et al. summarized the characteristics of abusive trauma and published it as battered child syndrome. Later, Guthkelch reported two cases of subdural hematoma without conspicuous trauma to the body surface and considered that the injury was caused by shaking due to rapid acceleration and deceleration. In 1974, Caffey proposed the concept of “the whiplash shaken infant syndrome” as a condition in which head shaking causes intracranial and intraocular hemorrhage, resulting in irreversible brain damage and mental retardation. Since then, this condition with intracranial hemorrhage and subdural hematoma has been called “shaken baby syndrome” mainly in the USA, and more broadly, “abusive head trauma (AHT)” in recent years, and it has come to be regarded as a positive finding that raises suspicion of abuse.

The mechanism of retinal hemorrhage associated with subdural hematoma has been postulated to be due to traction between the retina and vitreous body caused by shaking.

**SUBDURAL HEMATOMA AND ABUSE IN INFANTS AND CHILDREN: A HISTORY IN JAPAN**

In Japan, however, a similar condition was reported to be caused by minor head trauma at home, and this condition became widely known as Nakamura's type I pediatric head trauma. Nakamura classified pediatric head trauma into three types according to the intensity of energy at the time of injury (Table 1). Nakamura's type I is caused by minor trauma, such as an infant who was standing on a tatami mat and fell backwards, bruising the back of the head. It is characterized by the presence of subdural hematoma and retinal hemorrhage, and convulsions. He described that if the subdural hematoma and convulsions are not treated properly, the patient’s condition may become severe or even cause death. In 1984, Aoki and Masuzawa reported in English an acute subdural hematoma in an infant that was thought to have been caused by a minor head injury. The report also referred to fundus findings, and stated that all cases had retinal hemorrhage. Ikeda et al. published a similar report. However, these reports did not examine the cause of injury in detail, presumably reflecting the situation in Japan at that time, where abuse was not actively suspected. Therefore, it is now suspected that the papers were not about minor household head trauma, but about abused cases. Subsequently, interest in AHT increased in Japan, and a systematic review published in the USA and Europe pointed out that cases with head trauma and retinal hemorrhage were more likely to have been abused. In Japan today, it is mandatory to notify the Child Guidance Center of suspected cases of child abuse. In particular, the Japanese Ministry of Health, Labor and Welfare’s Child Abuse Response Guide, which was revised in 2014, states that cases of infants with subdural hematomas are highly likely to have been abused. In addition, as a result of reviewing various literature and data, a report was published that calculated the probability of death from a fall of less than 1.5 m to be less than 1 in a million, and the possibility of a fatal subdural hematoma from minor trauma was considered to be extremely rare. This negates the possibility that Nakamura's type I pediatric head trauma could be severe. However, a major change in the trend was announced recently. A systematic review showed that the presence of retinal hemorrhage, subdural hematoma, and cerebral edema, all part of the “triad” characteristic of so-called AHT, did not necessarily indicate abuse. By bringing this idea to the courts in Japan, 18 of 34 criminal cases of suspected AHT have resulted in acquittals since 2017.

**Table 1. Nakamura's classification of pediatric head trauma**

| Type I   | Caused by common and small accidents in daily life |
|---------|-----------------------------------------------|
| Type II | Caused by accidents that are not so severe but cannot be called minor external force |
| Type III| Caused by severe impact accident               |
SUBDURAL HEMATOMA AND ABUSE: DIFFERENCES BETWEEN WESTERN AND JAPANESE REPORTS

In 2003, Gardner compared reports from a single center in Japan by Aoki and Masuzawa and Ikeda et al. and a single center in North America by Kivlin and found a difference in the age distribution of patients. Gardner noted that the age distribution of the cases with subdural hematoma and fundus hemorrhage reported in North America was too different from that reported in Japan, suggesting that the North American and Japanese cases may have been caused by different trauma backgrounds and injury mechanisms. Ganesh points out that there are statistical errors in Gardner’s report, but questioned why the reports from Japan differ from those from elsewhere in the world. The age distributions of subdural hematoma cases described in the article by Kivlin, Aoki and Masuzawa, and Nishimoto and Kurihara are presented in Fig. 1.

A subsequent report from Japan also showed that subdural hematoma due to household trauma peaked at around 8–10 months, while a report from Sweden showed a large peak around 2 months and did not show a peak around 8 months.

Another paper was published from Japan that analyzed the data of the Diagnostic Procedure Combination payment system for AHT by defining subdural hematoma with retinal hemorrhage as possible AHT. They reported that there were 41.7 cases of possible AHT per 100,000 population, with peaks at 2 months and 8 months, respectively. On the other hand, the peak at 8 months is similar to the peak of benign external hydrocephalus, which raises the question of whether it is not abuse. The difference in subdural hematoma between benign external hydrocephalus and abuse is shown in Fig. 2. In order to answer this question, many clinical cases need to be examined in detail. In addition, since most of the reports are from Europe and the USA, the results of epidemiological studies not only from Japan, but from other Asian countries such as Korea and China, are required.

It is particularly necessary to examine how many cases of subdural hematoma and retinal hemorrhage in each country were admitted to be abuse by the caregivers.

CONCLUSION

In Japan, there is little disagreement about diagnosing injuries due to abuse when there are intracranial and retinal findings, as well as findings in other parts of the body. However, for those cases where only subdural hematoma and retinal hemorrhage are observed, there is disagreement as to whether it is due to abuse or accident, and this has affected the judicial system. It is also unclear why the age in months of cases with subdural hematoma and retinal hemorrhage is different in Japan.
pan from in other countries. Therefore, in Japan, some experts believe that subdural hematoma and retinal hemorrhage are more likely to be caused by household trauma. More cases need to be studied in detail to clarify this point.

**AUTHORS’ DECLARATION**

**Conflicts of interest**

No potential conflict of interest relevant to this article was reported.

**Informed consent**

This type of study does not require informed consent.

**Author contributions**

Conceptualization: MN; Data curation: MN; Formal analysis: MN; Methodology: MN; Project administration: MN; Visualization: MN; Writing - original draft: MN; Writing - review & editing: AA

**Data sharing**

None

**Preprint**

None

**ORCID**

Masahiro Nonaka https://orcid.org/0000-0002-8127-2635
Akio Asai https://orcid.org/0000-0001-7348-4403

● Acknowledgements

This study was approved by the Ethics Committee of Kansai Medical University (No. 2019232). Written patient consent was waived because data were deidentified.

**References**

1. Aoki N, Masuzawa H: Infantile acute subdural hematoma. Clinical analysis of 26 cases. J Neurosurg 61: 273-280, 1984
2. Caffey J: Multiple fractures in the long bones of infants suffering from chronic subdural hematoma. Am J Roentgenol Radium Ther 56: 163-173, 1946
3. Caffey J: The whiplash shaken infant syndrome: manual shaking by the extremities with whiplash-induced intracranial and intraocular bleedings, linked with residual permanent brain damage and mental retardation. Pediatrics 54: 396-403, 1974
4. Chadwick DL, Bertocci G, Castillo E, Frasier L, Guenther E, Hansen K, et al.: Annual risk of death resulting from short falls among young children: less than 1 in 1 million. Pediatrics 121: 1213-1224, 2008
5. Choudhary AK, Servaes S, Slovis TL, Palusci VI, Hedlund GL, Narang SK, et al.: Consensus statement on abusive head trauma in infants and young children. Pediatr Radiol 48: 1048-1065, 2018
6. Duhaime AC, Christian CW: Abusive head trauma: evidence, obfuscation, and informed management. J Neurosurg Pediatr 24: 481-488, 2019
7. Frasier LD, Kelly P, Al-Eissa M, Otterman GJ: International issues in abusive head trauma. Pediatr Radiol 44 Suppl 4: S647-S653, 2014
8. Gardner HB: Retinal and subdural haemorrhages: Aoki revisited. Br J Ophthalmol 87: 919-920, 2003
9. Guthkelch AN: Infantile subdural haematoma and its relationship to whiplash injuries. Br Med J 2: 430-431, 1971
10. Högberg U, Andersson I, Squier W, Högberg G, Fellman V, Thiblin I, et al.: Epidemiology of subdural haemorrhage during infancy: a population-based register study. PLoS One 13: e0206340, 2018
11. Högberg U, Squier W, Andersson J, Högberg G, Fellman V, Thiblin I, et al.: Do inter-country differences in the frequency of abusive head trauma reflect different proportions of overdiagnosis of abuse or true differences in abuse? J Epidemiol 30: 276-277, 2020
12. Ikeda A, Sato O, Tsugane R, Shibuya N, Yamamoto I, Shimoda M: Infantile acute subdural hematoma. Childs Nerv Syst 3: 19-22, 1987
13. Kempe CH, Silverman FN, Steele BF, Droegemueller W, Silver HK: The battered-child syndrome. JAMA 181: 17-24, 1962
14. Kivlin JD: A 12-year ophthalmologic experience with the shaken baby syndrome at a regional children’s hospital. Trans Am Ophthalmol Soc 97: 545-581, 1999
15. Levin AV: Retinal hemorrhage in abusive head trauma. Pediatrics 126: 961-970, 2010
16. Lynæe N, Elinder G, Hallberg B, Rosén M, Sundgren P, Eriksson A: Insufficient evidence for 'shaken baby syndrome' - a systematic review. Acta Paediatr 106: 1021-1027, 2017
17. Maguire SA, Watts PO, Shaw AD, Holden S, Taylor RH, Watkins WJ, et al.: Retinal haemorrhages and related findings in abusive and non-abusive head trauma: a systematic review. Eye (Lond) 27: 28-36, 2013
18. Nakamura N, Kobayashi S, Hirakawa K, Yamada H, Jinbo M: Characteristics of head injuries and intracranial hematomas in infants and children. II. Acute and subacute intracranial hematoma. No To Shinkei 17: 785-794, 1965
19. Nishimoto H, Kurihara J: Re-estimation of acute subdural hematoma in children caused by trivial household head trauma. Shoni No Noshinkei 31: 215-223, 2006
20. Rekate HL : Subdural hematomas in infants. J Neurosurg 62 : 316-317, 1985

21. Vinchon M, de Foort-Dhellemmes S, Desurmont M, Delestret I : Confessed abuse versus witnessed accidents in infants: comparison of clinical, radiological, and ophthalmological data in corroborated cases.

22. Yamaoka Y, Fujiwara T, Fujino Y, Matsuda S, Fushimi K : Incidence and age distribution of hospitalized presumptive and possible abusive head trauma of children under 12 months old in Japan. J Epidemiol 30 : 91-97, 2020