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Original Article

Characteristics and prognostic factors of intracranial hemorrhage in children

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ABSTRACT

Objective Finding the characteristics and risk factors associated with prognosis in children suffering from intracranial hemorrhage.

Methods This was a retrospective medical record review of children (older than 1 month old) admitted with intracranial hemorrhage to the Department of Child Health the Sanglah Hospital, Denpasar, during the period of January 1998 to December 2000. Prognostic factors were identified by chi-square and multivariate analysis with significance of $p<0.05$

Results There were 56 patients eligible for the study. Among them were 35 (63%) males and 21 (27%) females. Forty-three (77%) were less than one year of age, 40 (71%) without history of trauma and the major clinical manifestation was paleness (89%). The most common location was subdural bleeding, 21 patients (38%). Factors associated with prognosis was the bleeding location ($p<0.05$)

Conclusions Intracranial hemorrhage was more common in males and in infants. The most common clinical manifestation was paleness. Bleeding location was associated with prognosis **[Paediatr Indones 2003;43:14-19].**

Keywords: intracranial bleeding, children, prognosis

Intracranial hemorrhage (ICH) is extravasation of blood occurring in the brain or in the intracranial tissues due to damage or abnormalities of the intracranial vessels.[1] The occurrence of ICH is estimated to be 2/1,000 people.[2] According to a case series reported by Schoenberg *et al*,[3] 31 (45%) out of 69 children below 15 years with cerebrovascular accidents, had ICH. It is estimated that 40% of head injuries cause death in children of 1–4 years and 70% in children of 5–19 years of age.[4] Intracranial hemorrhage can be caused by head trauma, but sometimes it occurs without trauma.[2,5,6] The etiologic factors of non-traumatic ICH are spontaneous breaking of the arteries, such as aneurysm of the arteries and arteriovenous malformations (AVM), and blood abnormalities like hemophilia, idiopathic thrombocytopenia purpura, leukemia, and hypertension.[2,5,7] In children below one year of age, the occurrence of ICH is more likely due to child abuse.[8]

The symptoms and signs of ICH may vary from no any symptoms at all to a critical or even fatal status. The clinical manifestations depend on the size and site of the bleeding, which include headache, vomiting, seizure, cranial nerve disturbance, as well as change in consciousness; hemorrhage can also depress the cerebral cortex, causing paralysis or even death.[4]

In this study we report the characteristics and some factors associated with the prognosis of ICH.

Methods

This study was conducted retrospectively as a medical record review study. All pediatric ICH patients treated at the Department of Child Health, Sanglah Hospital,

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Denpasar, were included in this study. Excluded children were neonates and ICH patients directly treated by the Neurosurgery Subdivision, during January 1998 to December 2000. Children, aged one month-12 years, with the diagnosis of ICH were included; subjects with incomplete data were also excluded from the study. Data of all eligible patients, such as subjective complaints, clinical symptoms at admission and during treatment, results of head CT Scan, medical treatment, conditions at discharge, were all collected using questionnaires, and the data were then tabulated.

Definitions of variables

Intracranial hemorrhages include parenchymal as well as intraventricular, epidural, subdural and subarachnoid hemorrhages. Head CT Scan establishes the definitive diagnosis of ICH type. The age of the patients were divided into two groups (based on the rate of occurrences of ICH in children): infants (one to 12 months of age) and children (one to 12 years).

Clinical symptoms were represented by the complaints experienced by the patients and the recorded physical examination data at admission and during hospitalization.

The patients were considered to have a head trauma if it was revealed in the history taking and or there was physical evidences of head trauma.

The bleeding location as diagnosed by the head CT scan, was divided into six groups: intraventricular bleeding (any bleeding in the ventricle system[3,7]), intracerebral bleeding (any bleeding located in the brain parenchyma: basal ganglia, white maters, gray maters, and cerebellum[3,7]), subarachnoid bleeding (any bleeding located in the subarachnoid space: between the pia mater and the arachnoid), subdural bleeding (any bleeding located in the subdural space: between the dura mater and the arachnoid), epidural bleeding (any bleeding located above the dura mater: between the skull and the dura mater[3,7]), mixed bleeding (any bleeding in more than one location).

The types of treatment are grouped into two: surgical (any surgical intervention) and conservative (no surgical intervention).

The outcome was evaluated at the time the patient left the hospital, which was categorized into two: good, the patient survived without any sequelae and bad, the patient did not survive or survived with some sequelae.

Statistics

Data were analyzed using SPSS Windows 9.0, and presented in tabular as well as narrative forms. Chi-square test was used for analyzing the relation between clinical factors and the prognosis. Multivariate analysis was used to evaluate the relation between the significant clinical factors and the prognosis of ICH, with a level of significance of $p<0.05$.

Results

During the study period, there were 60 children suffering from ICH. Out of 60, 56 met the inclusion criteria, four patients were excluded from the study due to incomplete data (three patients with no head CT scan reading, and one patient with unidentified status).

Out of 56 children with ICH, 16 (29%) had head trauma, 7 due to traffic accident (3 at 10 years, 1 at 9 years, 2 at 8 years, and 1 at 7 years of age) and 9 household accident (6 fell from a bed, 3 slipped and fell on the floor), while the other 40 (71%) had no history of head trauma. Fatal outcome happened in 26 children (46%), and 3 children (5%) had neurological deficits at discharge (1 hemiplegia, 1 ptosis and visual impairment of the left eye and 1 developed hydrocephalus requiring VP shunting).

TABLE 1. CHARACTERISTICS OF ICH

Characteristics of patients	1998 n	1999 n	2000 n	Total n(%)
Age				
≤1 year	9	16	18	43 (77)
>1 year	3	4	6	13 (23)
Sex				
Male	8	13	14	35 (62)
Female	4	7	10	21 (38)
History of trauma				
Trauma (+)	2	6	8	16 (29)
Trauma (-)	10	14	16	40 (71)
Prognosis				
Good	5	9	16	30 (54)
Bad	7	11	8	26 (46)

In this study, our ICH patients usually had more than one clinical symptoms; the most common complaint was being pale (88%), followed respectively by decreased level of conciousness (86%), pupil anisocory (71%), seizures (64%), bulging of the fontanels (63%), vomiting (55%), decreased appetite (52%), fever (38%), and headache (14%).

Based on the head CT scan examination, the most common location of the bleeding is subdural bleeding (21 subjects, 38%), followed by intracerebral bleeding (20 subjects), epidural bleeding (7 subjects), subarachnoidal bleeding (4 subjects), intraventricular and mixed location bleeding (2 subjects each). In this study, two patients experienced bleeding in more than one location, they had subdural and intracerebral bleeding.

In this study, most patients were given conservative therapy (35 children, 61%), and the other (21 children, 39%) were treated surgically.

Table 2. Prognosis of ICH in children based on age, sex, history of trauma, and bleeding location

	Prognosis			
	Good	Bad	Total	
Age (Year)				
≥1 year	19	24	43	
>1 year	11	2	13	
Total	30	26	56	p = 0.010
Sex				
Male	17	18	35	
Female	13	8	21	
Total	30	26	56	p = 0.333
Trauma history				
Trauma (+)	12	4	16	
Trauma (-)	18	22	40	
Total	30	26	56	p = 0.333
Bleeding location				
Intraventricular	1	1	2	
Intracerebral	13	7	20	
Subarachnoid	2	2	4	
Subdural	7	14	21	
Epidural	7	0	7	
Mixed	0	2	2	
Total	30	26	56	p = 0.333

Bad prognosis occurred more common in children less than one year (24 out of 43) compared to children more than 1 year, which occurs only in two out of 11 patients. These two groups were statistically different ($p=0.01$)

There was no statistical difference in the prognosis due to the patients' gender ($p>0.33$). Although the history of head trauma did not show any significant difference in the ICH outcome, it seemed that children with a reason of bleeding i.e., reported head trauma seemed to have a better prognosis (12 out of 16) than children without history of head trauma (18 out of 40).

Patients with bleeding occurring in more than one location had the worst prognosis, while those experiencing subdural bleeding had a bad prognosis (14 out of 21). There was a statistically significant difference between locations of bleeding and prognosis ($p<000.5$).

Table 3. Relationship between clinical factors and prognosis of intracranial bleeding in children

Clinical factors	*t*	p
Age	1.301	0.199
Bleeding location	-2.906	0.005
Traumatic history	0.56	0.956

The multivariate analysis indicates that factor most commonly associated with bad outcome of intracranial bleeding in children was the location of bleeding.

Discussion

Intracranial hemorrhage in children still has a high death rate and in surviving patients, developmental problems, as well as subsequent behavioral and academic problems often appear. To minimize morbidity and mortality, early detection and initially accurate diagnosis and treatment are needed, particularly for children showing no clear clinical symptom.[3] In the three years period of this study, there was a yearly increase in number of ICH patients. This was perhaps caused by several factors such as an improved recording and reporting system, improvement on diagnostic and medical tools, and even improvement in the referral system to our hospital.

The rate of ICH occurrence depends on age, sex, and race.[2] In the neonatal period, ICH is mostly found in premature babies,[12] while in children the rate of ICH is lower than that in adults (26% vs. 46%).[6] In this study, ICH occurs more often in infants. Other

studies also found similar result, such as the one conducted by Master *et al* [13] discovering that children below two years had a higher risk of ICH especially when accompanied by head trauma. Greenes *et al*, [13] in their study, concluded that ICH were more frequent in children below one year-old (especially below three months old). It is due to the fact that the skull of a young child is still soft and breaking of the sinus dura can be caused by bone movement if the sutures are not yet fused.[14] In addition, abnormality in the factors of coagulopathy such as deficiency in vitamin K frequently occurs in children of this age group.[15]

In this study, there were more male patients than female (63% vs. 37%). Similar results are also found in the study conducted by Diaz *et al*,[16] (75% of 33 were males), Billmire *et al*,[17] (54.8% of 84), Duhaime *et al*[14] (65% of 100) and Greenes *et al*[13] (57% of 608).

Intracranial hemorrhage can occur with or without trauma (spontaneous bleeding).[2,10] Arteries can spontaneously break because of hypertension, aneurysms, arterio-venous malformation (AVM), brain tumors, or abnormalities in the coagulation system.[2,9] The diagnosis of ICH, whether caused by trauma or any other causes, always presents a problem to the physician, especially if there are no clear lesion, and can be more complicated when those accompanying the pediatric patients do not know the history.[7] Intracranial hemorrhage in infants, when no significant trauma is present, may be due to the shaken impact syndrome or child abuse.[8,16] In those conditions, the shaking or swaying of the baby's head with intensity of acceleration and deceleration and a sudden stop can cause bleeding.[4] In this study, head trauma was found in 29% cases, while 71% did not have any clear history of head trauma. In the study conducted by Greenes *et al*[13] only 3% did not have a traumatic case history, while 84% had a trauma due to a crash, and 13% due to traffic accidents. The difference between this study from that conducted by Greenes is the subjects being studied. The studied subjects by Greenes were children coming to the emergency unit with head trauma. However, in this study we cannot consider trauma as the positive cause of the bleeding due to limited data and this therefore need to be further studied.

The most frequent location of bleeding found in this study was subdural hemorrhage (38%). In the study conducted by Diaz *et al*,[16] 81% of ICH occurrences were subdural hemorrhages, and in the study conducted by Duhaime *et al*[14], of the 100 children with head trauma, 16% experienced mixed subdural hemorrhages and sub-arachnoid hemorrhages, while 13% experienced subdural hemorrhages, 3% sub-arachnoid, and 3% epidural hemorrhages.

The high frequency of subdural hemorrhages occurring in children under one year-old is caused by the fact that physically the bones of their skulls are more elastic, which by the presence of acceleration and deceleration as in the case of shaken impact syndrome or child abuse will lead to the occurrence of bleeding, especially that occurring in the occipital region and in the posterior interhemispheric fissure because in that region the lambdoidea suture and the sagital suture are overlapping. Bone movement can cause the breaking of the sinus dura, which in turn leads to the occurrence of subdural hemorrhages. [17,19]

The clinical symptoms of ICH are due to the blood loss, the pressure effect of ICH causing increased intracranial pressure, and the presence of blood in the brain tissues causing the appearance of neurological symptoms correlated to the location of the bleeding.[9,20,21] In this study, the blood loss caused paleness. Increased intracranial pressure was manifested by the bulging of the fontanel (the fontanel is still open in children <18 months), vomiting, headache, decreased consciousness, and neurological deficits, usually in the form of seizures, spasticity, and anisocor pupil (**Table 2**). Menkes[3] reported, of the 116 babies with subdural hematoma, 73% had a bulging fontanel, 70% had vomiting, 60% had a seizure, 22% had decreased consciousness, 12% had papil edema, and 54% had retina bleeding. In the study conducted by Grenees *et al* [13], of 30 children with intracranial injury/bleeding, 52% were with one or more decreased level of consciousness.

The treatment for the patients with intracranial bleeding is surgery or conservative treatment.[22] Usually surgery is conducted if the patient worsens or needs an immediate removal of the hematoma in order to decrease the high intracranial pressure or to eliminate local compression on the brain structure.[3]

The prognosis of intracranial bleeding is determined by factors such as age, the severity of neurological abnormality in the initial examination, the presence or absence of complication such as that of

cerebral edema, hydrocephalus as well as herniation phenomena and the speed of treatment.[9] In this study, factors associated with bad prognosis were age below 1 year, the absence of any clear traumatic case history, and bleeding which occurs in the subdural location. The multivariate analysis revealed that factor with the greatest significance was the location of bleeding. The relationship between the bleeding location and the prognosis of intracranial bleeding may be due to bleeding that occurred in vital location, such as bleeding which causes brain stem herniation, or this finding may be due to the small sample size. In this study, the number of patients who died were 23 patients (41%). In the study done by Diaz *et al*,[16] the death rate was 21%, while in the study conducted by Duhaime *et al*[14], of over 1175 babies with head trauma, only 2.3% died during treatment. The difference in these death rates was probably caused by the difference in the extent and location of bleeding, the severity of clinical symptoms, the initial treatment, and the difference in the number of samples in each study.

There were several limitations in this study because this study was done retrospectively. The first constraining factor was the persons who accompanied the pediatric patients did not tell the truth because they were afraid to be blamed for the patient's injuries. Secondly, the readings of head CT scans were not done by a single person. Finally we can only demonstrate the association of some factors with the outcome. Further study is needed to indentify the cause of good or bad outcome of patients with ICH.

In summary, the incidence of ICH was 0.7% and there were increased number of patients every year. The death rate was 41%. Most of the children with ICH were below one-year-old, male, and without a history of trauma. The clinical symptoms were generally more than one and paleness was the most common. The location of the bleeding was correlated with a bad prognosis.

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