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Ihab Zidan & Amal Ghanem

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SHORT COMMUNICATION

Intracerebral hemorrhage in children

Ihab Zidan [a,*], **Amal Ghanem** [b,1]

[a] *Faculty of Medicine, Champilion St., Elazariita, Alexandria University, Alexandria, Egypt*
[b] *Medical Research Institute, Aboukir St., Elebrahemeyah, Alexandria University, Alexandria, Egypt*

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KEYWORDS

Intracerebral hemorrhage;
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Abstract *Introduction:* Intracerebral hemorrhage (ICH) in children is relatively less common as compared to adults. It could be traumatic or spontaneous.
Objective: There are limited studies about ICH in children. In this study, we analyze the etiology, clinical features, management options and outcome assessment in this population.
Methods: All patients with intracerebral hemorrhage under 18 years of age admitted to the neurosurgery department; Alexandria University Main Hospital and Medical Research Institute over a period of one year (June 2008–May 2009) were subjected to clinical examination, laboratory and radiological investigations and the cause of hemorrhage was determined.
Results: Thirty patients with ICH were included in this study. Age of patients ranged from one month to 17.5 years with a higher predilection in males. Presenting features were symptoms of raised intracranial pressure (60%), deterioration in sensorium (46%), limb weakness (36%) and seizures (30.0%). Trauma was the most common cause of ICH and was found in 13 patients (43%), followed by bleeding diathesis in nine patients (30%), arteriovenous malformation (AVM) in five patients (17%), intracranial tumor in two patients and an aneurysm in one patient. Treatment modalities consisted of: hematoma evacuation, excision of AVM, AVM emobilization, aneurysm clipping, tumor excision, and conservative management. Eleven patients were treated conservatively and 19 patients were treated surgically. The outcome showed: good recovery in 14(47%), fair recovery in seven (23%), poor recovery in seven (23%), and death in two patients (7%).

Abbreviations: ICH, Intracerebral hemorrhage; AVM, arteriovenous malformation

* Corresponding author. Tel.: +002 01223558137.
E-mail addresses: zidanihab@yahoo.fr (I. Zidan), a_elwany@hotmail.com (A. Ghanem).
[1] Tel.: +002 01284092777.

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Conclusions: Trauma is the leading cause of ICH in children. Bleeding diathesis and AVM come next. The initial neurological status of patients, the size, location and underlying pathophysiology of the hematoma are the most important determinants of patient outcome. Intracerebral hemorrhage due to bleeding diathesis was generally associated with a better outcome.

1. Introduction

The incidence and prevalence of intracranial hemorrhage is not known. The reported incidence of asymptomatic and symptomatic intracranial hemorrhage varies from study to study probably due to differences in populations studied and differences in the sensitivity and timing of diagnostic imaging used.[1–4]

Intracerebral hemorrhage may be either traumatic or non-traumatic (spontaneous intracerebral hemorrhage). In the pediatric age group, intracerebral hemorrhage is not common.[5]

From the most frequent causes for spontaneous intracerebral hemorrhage (SICH) in children are vascular malformations.[6–11] Other causes of SICH include: hematological diseases such as coagulopathies or thrombocytopenia, cerebral tumors and rare entities like moyamoya disease, septicemia or drug abuse.[12–16] Arteriovenous malformations (AVMs) account for 14%[17] to 46%[18] of hemorrhagic stroke in children and nearly 50%[13] of intraparenchymal hemorrhage.

Hematologic abnormalities are reported to be the major risk factor in 10% to 30% of hemorrhagic strokes in most series. Hematologic causes of intraparenchymal hemorrhage include idiopathic thrombocytopenic purpura (ITP), acute lymphoblastic anemia (ALL), sickle cell anemia (SCA), hemophilia, and coagulopathies.[19–24]

Brain tumors are also found to be one of the causes of ICH in children with a much lower incidence than previously mentioned causes.[25,26]

Focal abnormality of brain functions from ICH are site specific and include: motor deficit, sensory deficit, speech problems, cranial nerves palsies, cerebellar manifestations, visual abnormalities and pupillary changes.[27,28] Irritability and fits may occur in about 6–9% of intracerebral hemorrhages.[29] The hemorrhage may expand within minutes or few hours and act as a solid mass, increasing the intracranial pressure.[27]

Computed tomography (CT), Magnetic resonance imaging (MRI), Conventional angiography and Computed tomography angiography (CTA) or Magnetic resonance angiography (MRA) may be needed to establish the diagnosis of intracranial vascular anomalies.[30] In cases of bleeding in children, the coagulation profile should be checked to exclude coagulation disorders and DIC that may develop as a result of thromboplastin release from the damaged brain tissue.[31]

Management of ICH in children depends on the location of hemorrhage, the volume of the hematoma, the presence of mass effect, the clinical condition of the patient as well as the etiological factors involved in the bleeding.[32–34]

2. Patients and methods

This study represents all patients below 18 years of age diagnosed with intracerebral hemorrhage admitted to the neurosurgery department; Alexandria University Main Hospital and Medical Research Institute over a period of one year (June 2008–May 2009). Patients with other forms of intracranial hemorrhage were excluded.

3. Results

The study group consists of 30 patients, 18 boys and 12 girls. The age ranged from one month to 17.5 years with a mean age of 11.0 years. Mean ages were 11.7 and 10.2 years for boys and girls, respectively.

Symptoms included headache (60%), vomiting (43%), impaired consciousness (46%), focal neurological deficits (36%) and convulsions (30%) as shown in Table 1. Patients with traumatic ICH, aneurysms and AVMs presented acutely as well as three patients with bleeding diathesis and one patient with a cerebral tumor. Five children were younger than 3 years at the time of onset of bleeding. They presented with non specific symptoms like: deterioration of general condition, increased crying, sleepiness, irritability, feeding difficulty, vomiting and fits.

Trauma was the most common cause of ICH, causing hemorrhage in 13 patients (43%), followed by bleeding diathesis in nine cases (30%), AVM in five patients (17%), intracranial tumor in two patients (hemorrhage in pilocytic astrocytoma and posterior fossa tumor) and a middle cerebral artery aneurysm in one patient (Figs. 1–5). Nine cases of bleeding diathesis included; three cases of idiopathic thrombocytopenic purpura, three cases with hemophilia, two cases with acute lymphoblastic leukemia and a case of sickle cell anemia (Table 2). In the three of cases of ITP, the bleeding was probably due to decrease platelet count. Severe factor VIII deficiency (from 5–15%) was the incriminated factor for ICH in hemophilics. In SCA patient, the severe anemia and thrombocytopenia were the main reasons for ICH. In ALL the main cause of ICH was most probably either anemia or thrombocytopenia or both.

Computed tomography (CT) was performed in all our patients, CTA in three patients, angiography in seven patients, magnetic resonance imaging (MRI) in twelve and magnetic resonance angiography (MRA) in nine patients.The location of hemorrhage was supratentorial in 24 patients (80%) and infratentorial in six patients (20%) (two brain stem hematoma and four cerebellar hematomas). In supratentorial hematomas,

Table 1 Clinical features in 30 patients with ICH.

Clinical features	Cases	
	No.	Percent
Increased intracranial pressure	18	60
Deterioration in sensorium	14	46
Vomiting	13	43
Limb weakness	11	36
Seizures	9	30

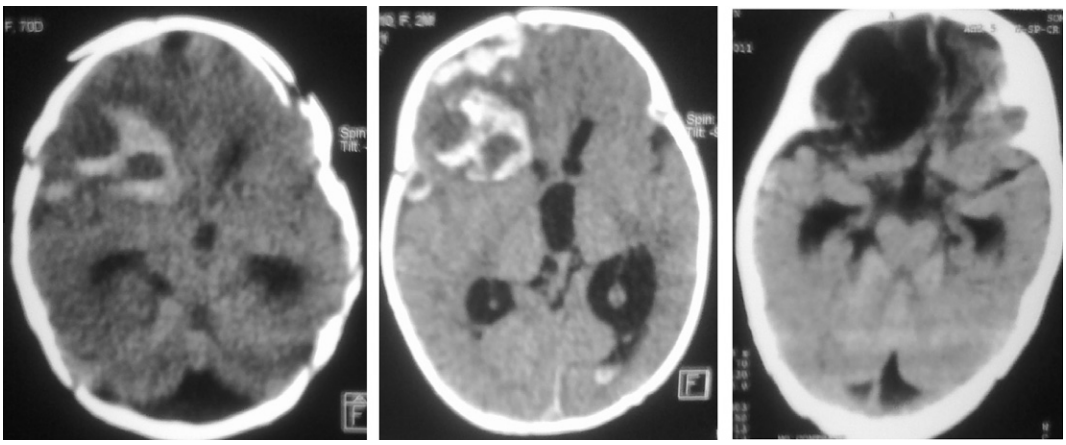

Figure 1 CT scan (axial view) showing post-traumatic right frontal ICH in a 2 months female child. Follow-up CT scan (axial view) three months after a conservative management showing resolution of ICH.

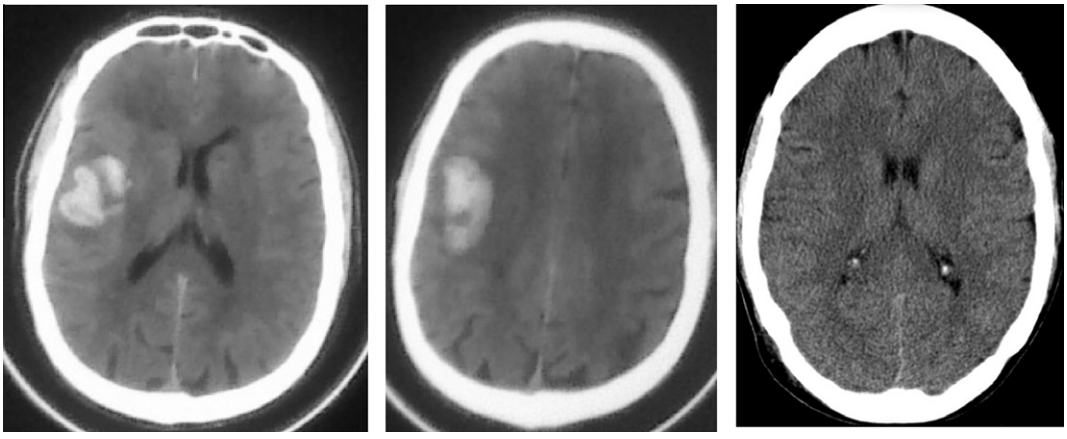

Figure 2 CT scan (axial view) showing right parietal ICH in a hemophilic patient aged 10 years. CT scan (axial view) showing resolution of ICH after two months of conservative treatment.

the most common location was lobar in 19 patients, putamenal in two patients, thalamic in two patients and one case with a caudate hematoma (Table 3). Intraventricular hemorrhage was associated in six of our patients.

The treatment was based on the child's presentation, the precipitating cause and the radiological findings. Eleven patients were treated conservatively; five patients with traumatic ICH and six patients with bleeding diathesis. The conservative treatment consisted of; care of the general condition (airway, breathing and circulation), control of the intracranial pressure, antiepileptic measures as well as correction of the underlying coagulation problem. Nineteen patients were treated surgically and consisted of: hematoma evacuation via craniotomy in eight patient and suboccipital cranieCtomy in three patients, excision of AVM nidus and clipping of feeders in three patients, emobilization of AVM in two patients, aneurysmal clipping in one patient and tumor excision in two patients. Seven patients required an external ventricular drain and three patients required a permanent ventriculo-peritoneal shunt. The average length of hospital stay was 19 days.

The outcome of our patients was classified as good, fair, poor and death. In our series, the outcome of our patients was as follow: good recovery in 14(47%), fair recovery in 7(23%), poor recovery in 7(23%), and death in two patients (7%) (Table 4).

4. Discussion

This study focuses on ICH in children. We included all children presenting with ICH regardless the etiology (traumatic or non-traumatic). This did not match with what is found in the literature as the majority of studies focused either on traumatic ICH alone as in the Kang et al.[35] series or Spontaneous ICH alone as in Beslow et al.[36], Meyer-heim and Boltshauser[13], Lin et al.[3], Al-Jarallah et al.[12] and Kumar et al.[31] series (Table 5).

The mean age of our patients was 11.0 years. A male predilction was found with a male to female sex ratio to equal 1.5:1. This was consistent with the Kumar et al.[31] series which studied SICH in children as well as the Kang et al.[35] series that studied traumatic ICH and showed more prevelance in boys than girls.

In our series, headache, vomiting and impaired conscious level were the main presenting symptoms in older children while those younger than three years old presented mainly with irritability, fits, feeding difficulty, lethargy and sleepiness. Lit-

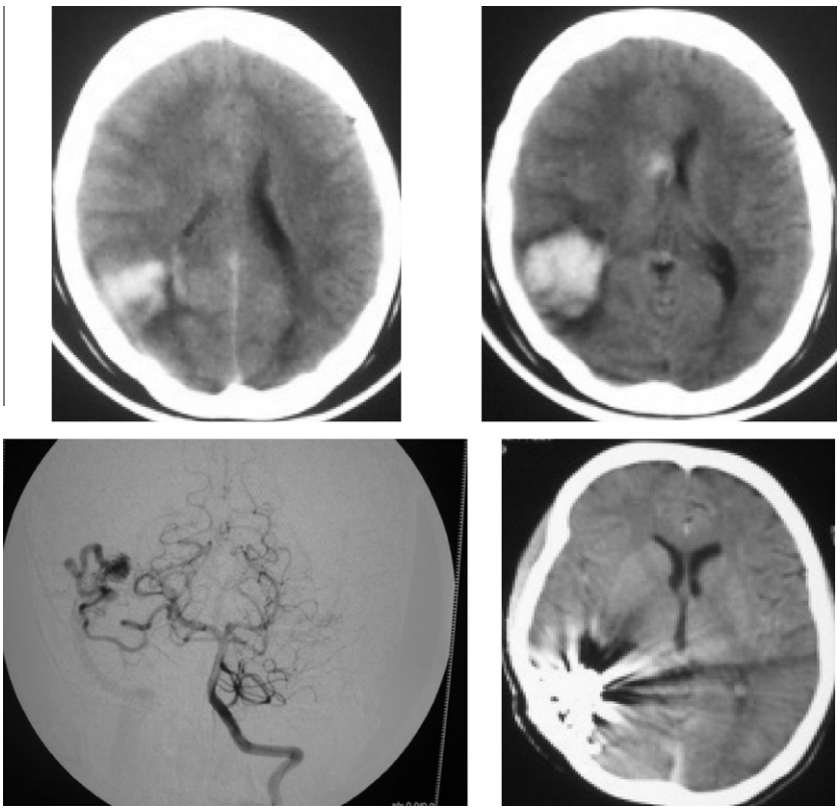

Figure 3 CT scan (axial view) showing spontaneous right pareito-occipital ICH in male child aged 15 years. CT scan (axial view) showing the mass effect of ICH in form of effacement of the right lateral ventricle. Conventional angiography showing right occipital AVM. CT scan (axial view) after endovascular embolisation of the AVM.

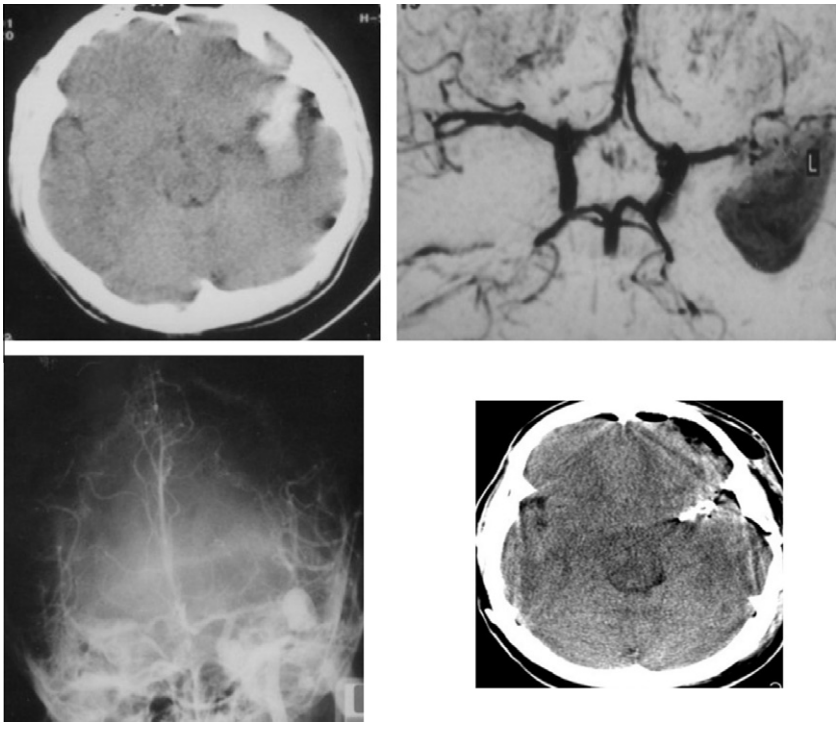

Figure 4 CT scan (axial view) showing spontaneous left sylvian ICH in male child aged 17 years. CT angiography showing the left sylvian ICH without evidence of an aneurysm. Conventional angiography showing left middle cerebral artery aneurysm. Post-operative CT scan (axial view) showing clipping of the left middle cerebral artery aneurysm.

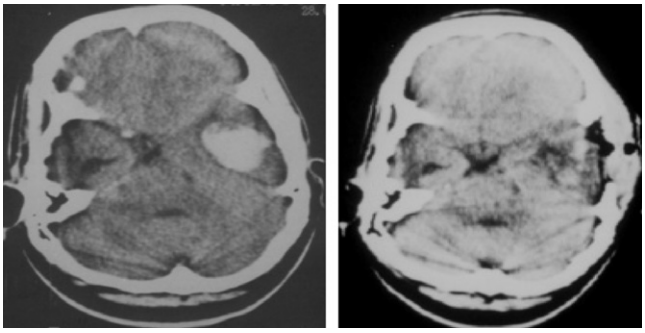

Figure 5 CT scan (axial view) showing left temporal ICH in a 10 years male child suffering from ALL. Post-operative CT scan (axial view) showing complete evacuation of ICH.

Table 2 Etiology of ICH in our 30 cases.

Etiology of ICH	Cases	
	No.	Percent
Trauma	13	43
Bleeding diathesis:	9	30
ITP	3	
Hemophilia	3	
ALL	2	
SCA	1	
AVM	5	16
Tumor	2	6
Aneurysm	1	3

Table 3 Location of ICH.

Location of ICH	Cases	
	No.	Percent
Supratentorial	24	80
Lobar	19	
Putamenal	2	
Thalamic	2	
Caudate	1	
Infratentorial	6	20
Cerebellar	4	
Brain stem	2	

erature[3,4,12] is quite homogeneous concerning the presenting symptoms in ICH in children.

Trauma was the most frequent cause of ICH in our study group. This finding did not match the results of Meyer-Heim and Boltshauser[13], Kumar et al.[31] and Lin et al.[3] series, in which AVMs represented the major cause of ICH (Table 5). This difference can be explained by selection criteria of our patients that included both traumatic and spontaneous cases of ICH, however in their series[3,13,31] spontaneous ICH was only included.

The second most common cause of ICH in our series was bleeding disorders reported in 30% of the cases. Similarly, Al-Jarallah et al.[12] reported bleeding disorders in 32% of his patients. However, this was much higher compared to Meyer-Heim and Boltshauser[13] and Kumar et al.[31]series (Table 5). The high incidence of ICH due to bleeding disorders in our series can be explained by high number of children suffering from hematological disorders treated in the Medical Research Institute of Alexandria, a referral center for such cases.

In our series AVMs were the third leading cause of ICH in children seen in 17% of the patients. Hemorrhage is the most frequent clinical presentation of an AVM in adults and children but is more often seen in pediatric patients than in adults.[37] In Beslow et al.[36] series, AVMS represented the major cause of ICH (Table 5) however this study did not include cases of trauma and tumors.

It is well known that brain tumors can cause SICH.[26] Intracerebral hemorrhage associated with brain tumors is not common and children are rarely involved with this type of hemorrhage.[38] In our study ICH caused by tumors was rare and found only in two patients. This was consistent with the series of Meyer-Heim and Boltshauser[13] and Kumar et al.[31] who showed a similar incidence of ICH due to brain tumors (Table 5).

In the present study, an aneurysm was found in only one case and presented with a temporal ICH. This is a much lower incidence compared to Meyer-Heim and Boltshauser series[13] who found aneurysms in 15% of their cases. This may be due to inclusion of only spontaneous cases of ICH in Meyer-Heim and Boltshauser series[13] in contrast to our study that included all cases of ICH in children.

In consistence with the findings of Al-Jarallah et al.[12] and Meyer-Heim and Boltshauser[13], the main location of hemorrhage was supratentorial (Table 5). The most common site for supratentorial ICH in the present study was lobar found in 64% of our cases, which was consistent with Lin et al.[3] who found lobar ICH in 50% of their cases.

Table 4 Outcome of patients.

Outcome	Trauma	Bleeding diathesis	AVM	Tumor	Aneurysm	Total (no.)		Total (%)
						Conservative	Surgical	
Good	6	6	2	–	–	14		47
						6	8	
Fair	3	1	1	1	1	7		23
						3	4	
Poor	4	1	1	1		7		23
						1	6	
Death	–	1	1	–	–	2		7
						1	1	

Table 5 Summary of data from series of ICH in children reported in the literature.

Series	Type of ICH	No of patients	Age range (mean in ys)	Sex M:F	Clinical presentation (%)				Leading causes of ICH (%)							Location of ICH (%)		Management (%)		Mortality (%)
		Duration			H	IC	FD	F	Tr	BD	AVM	Tu	An	Ca	Uk	ST	IT	C	S	
Present	Sp & Tr	30 (2008–2009)	1 m-17.5 years (11)	1.5:1	60	46	36	30	43	30	17	7	3	–	–	80	20	37	63	7
Beslow et al.[36]	Sp	22 (2006–2008)	4.2 ys-16.6 years (10.3)	1:1	77	50	50	41	–	–	55	–	4.5	32	9	91	9	50	50	4.5
Kumar et al.[31]	Sp	32 (1998–2007)	2 ms-17 years (14.5)	1.5:1	70	50	36	28	–	3	69	6	–	6	6	87.5	12.5	16	84	6
Kang et al.[35]	Tr	21 (1980–1986)	4 ms-17 years	6:1	–	67	33	8	100	–	–	–	–	–	–	95	5	71	29	9.5
Meyer-Heim and Boltshauser[13]	Sp	34 (1999–2000)	2 ms-16.9 years (7)	1.3:1	61	42	13	26	–	12	47	3	15	6	12	88	12	32	68	25
Al-Jarallah et al.[12]	Sp	68	3 ms-18 years (7.1)	1.7:1	46	8	21	37	–	32	34	14	6	3	10	Not mentioned		Not mentioned		8.8

ICH, intracerebral hemorrhage; AVM, arteriovenous malformation; C, conservative; S, surgical. Sp, spontaneous; Tr, traumatic; H, headache; IC, impaired consciousness; FD, focal deficit; F, fits; ST, supratentorial; IT, infratentorial; BD, Bleeding diathesis; Tu, tumor, Ca, cavernoma; An, aneurysm; Uk, unknown.

Treatment methodology in the present study was based on the child's clinical presentation, the cause of ICH as well as the radiological criteria of the hematoma. In our study, 11 patients were managed conservatively and 19 cases were managed surgically. These findings were consistent with Meyer-Heim and Boltshauser[13] results, where 32% of patients were treated conservatively and 68% were surgically treated (Table 5). Kang et al.[35] in their series reported a higher incidence of conservative treatment followed in 71% of their patients. Beslow et al.[36] reported in their series of spontaneous ICH that conservative treatment was followed in 50% of the cases.

The outcome after intracranial bleeding depends on many different factors such as size and localization of hemorrhage as well as the clinical status at time of presentation. In the present study the outcome of our patients (Table 4) showed: good recovery in 47%, fair recovery in 23%, poor recovery in 23%, and death in 7%. Al-Jarallah et al.[12] in their series found a mortality of 8.8%, where as Lin et al.[3] found a mortality of6% (Table 5).

5. Conclusion

Trauma is an important cause of ICH in children, alongside bleeding diathesis and AVMs which are the next leading causes. The initial neurological status of the patients beside the size, location and underlying pathophysiology of the hematoma are the most important determinants of the patient's outcome. Intracerebral hemorrhage due to bleeding diathesis was generally associated with a better outcome due to the appropriate diagnosis and treatment of the underlying disease, in addition to early surgical intervention when indicated.

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