Computed Tomographic Findings in Non-traumatic Hemorrhagic Stroke

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Objective: *To analyze CT findings in hemorrhagic stroke patients correlation with clinical outcome and assess the interobserver agreement of hemorrhagic stroke identification on CT imaging.*
Material and Method: *CT imaging features of 131 cases and clinical data were verified and collected at Siriraj Hospital from Jan 2004 to Dec 2005 and retrospectively analyzed for type, location, mass effect, size of hemorrhage, intraventricular extension, initial level of consciousness (GCS), hospital length of stay and patient outcome. The percentages, predictive values, kappa were calculated.*
Results: *From all types of hemorrhagic stroke, intracerebral hemorrhage remains a common and devastating clinical problem. The most common site was the thalamus and basal ganglia. In the present study, the authors found that fifty-three cases (53/131 cases, 40.5%) with thalamic-ganglionic hemorrhage, nineteen cases (19/131 cases, 14.5%) in lobar hemorrhage, five cases (5/131 cases, 3.8%) in cerebellum, five cases (5/131 cases, 3.8%) in brainstem and eight cases (8/131 cases, 6.1%) occurred in multiple locations. There were twenty-five cases (25/131 cases, 19.1%) of subarachnoid hemorrhage, thirteen cases (13/131 cases, 9.9%) of subdural hemorrhage and three cases (3/131 cases, 2.3%) of intraventricular hemorrhage. Two variables on CT imaging, identified as significant as early mortality predictors, were hematoma volume more than 60 cm^3, and presence of intraventricular hemorrhage extension ($p < 0.05$). The mass effect defined as midline and/or enlargement of contralateral ventricle was not significant ($p = 0.067$). The present study found concordance between CT brain interpretation by two neuroradiologists for the type of hemorrhagic stroke was very good, Kappa = 0.861 as well as for location was 0.866.*
Conclusion: *CT imaging is an imaging instrument for early identification of hemorrhagic stroke patients and providing imaging evidence of high mortality risk.*

Keywords: *Computed Tomographic finding, Computed Tomography, Stroke, Hemorrhagic stroke, Non-traumatic hemorrhagic stroke*

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Stroke is the third most common cause of death in developed countries population after coronary heart disease and cancer(1). The epidemiological data of stroke in Thailand are scanty. The prevalence in Bangkok, Thailand is 690 per 100,000 populations(2). A survey in the elderly population from four regions; Central Region, Northern Region, North-Eastern Region and Southern Region found a prevalence rate of 1.12 percent(3). There are two major types of stroke: one is called an "ischemic" stroke which accounts for 80 percent of all strokes; the other is called a "hemorrhagic" stroke which accounts for about 20 percent of strokes(1,5-8). Hemorrhagic stroke includes intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), intraventricular hemorrhage (IVH), subdural hemorrhage (SDH)(13). Recent advances in

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neuroimaging have made it easier to identify underlying disease mechanisms and to classify cerebrovascular diseases appropriately[10]. Computed Tomography (CT) of the head has a role in evaluation of patients with stroke. Nowadays, CT is an imaging modality of choice of stroke fast track because of rapidly scanning time as the result of development of fast scanning machine such as multidetector CT scanner (MDCT). CT of the head can provide brain imaging diagnosis, used in patient management to differentiate between hemorrhage, ischemic stroke and other lesions that present with stroke like symptoms. CT imaging is an imaging modality which demonstrates normal architecture of related anatomical regional study and therefore, hemorrhagic stroke in either intra-axial location (intracerebral) or extra-axial location (epidural, subdural or subarachnoid spaces) or both are well demonstrated. CT imaging has an additional value in assessment of size or volume of intracerebral hemorrhage which directly correlates to degree of midline shifting, clinical outcomes. Those images' information cannot be done by clinical examination alone[9-11]. Diagnosis and management in the first few hours of acute stroke patients are critical. All stroke patients should be admitted to the hospital for evaluation and treatment. This is best accomplished in an intensive care or stroke unit. Management must be individualized and based on careful clinical and radiological assessment.

Material and Method

The patients were identified from The International Classification of Diseases, 10th Revision (ICD-10), codes with the diagnosis of nontraumatic intracranial hemorrhage (code I-60 subarachnoid hemorrhage, I-61 Intracerebral hemorrhage and I-62 other non-traumatic intracranial hemorrhage).

Criteria for inclusions into the study were:

(1) All patients that were available in assessment of both CT imaging of the brain in PACS workstation and medical record data for review.

(2) Patients who had undergone cranial surgery, the preoperative CT imaging was used for review.

(3) Patients who had more than one CT scan, only the first CT scan was used for analysis.

Plain axial study of CT scan of the brain was performed with multidetector CT scanner (Light speed 16; General Electric Medical System, Milwaukee, Wisconsin, USA). Technique: 120 kV, 250 mA, and 5-mm section thickness. Coverage was from the skull base to the vertex by obtaining contiguous axial sections. The CT scan were searched from databases at a PACS workstation in Siriraj Hospital and reviewed by two neuroradiologists. The CT scan of patients who had non-traumatic intracranial hemorrhage (code ICD-10 = I 60, I 61, I62) and underwent CT scan the brain at Siriraj Hospital from January 2004 to December 2005. Retrospective review was performed at a PACS workstation by two neuroradiologists in the interpretation of stroke CT scans and blinded to the clinical history and lateralization of symptoms. CT scan was described for abnormalities as the precise extent of intracranial hemorrhage, the size and location of the hemorrhage, structural abnormalities herniation, hydrocephalus, intraventricular hemorrhage, subarachnoid hemorrhage and subdural hemorrhage. Discrepancies in interpretation between two observers were resolved by consensus. The intracerebral hematoma (ICH) were divided into the following groups according to the location of the largest blood clot:

1. Lobar hematoma (frontal, parietal, temporal, occipital).
2. Thalamic-ganglionic hematoma (caudate, putaminal and thalamic).
3. Hematoma in the posterior fossa, brainstem and cerebellum.

All CT examination was reviewed for the following findings:

The hyperdense lesion represented a hematoma but the hypodense represented infarction (Fig. 1). Hemorrhage were categorized as ICH, SAH, SDH and IVH (Fig. 2, 3).Classification of lesion location as either lobar (frontal, parietal, temporal or occipital), Thalamic-ganglionic hematoma (caudate, putaminal and thalamic), brainstem and cerebellum (Fig. 4-6). The size of the lesion using multiple sections, A useful method of measurement of hematoma volume on CT scans is to use the formula ABC/2, where A is the largest diameter, B is the diameter 90° to A and C is the approximate number of slices that show hemorrhage multiplied by the thickness of each slice, the authors divided the size of hemorrhages to small (less than 30 cm^3), moderate (between 30-60 cm^3), and large (more than 60 cm^3) size. The prognosis of patients with hematoma depends heavily on the size of the lesion (Fig. 7). Blocking of CSF pathways causing hydrocephalus, obstruction of the foramen of Monro, the sylvian aqueduct or the outflow foramina of the fourth ventricle is common in patients with hematoma. (Fig. 8).

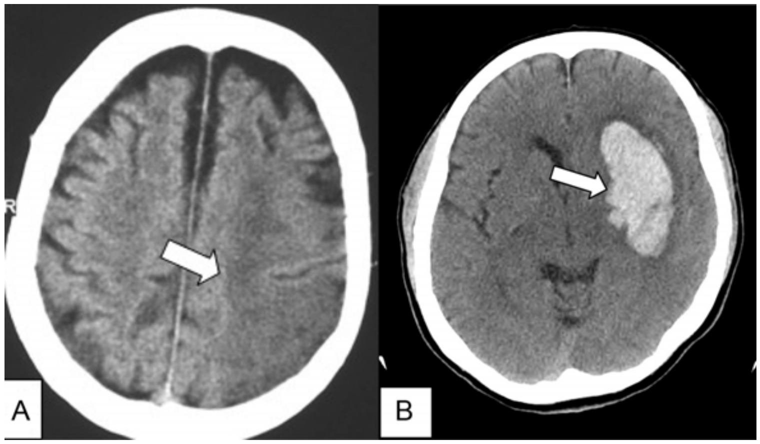

Fig. 1 A) CT brain scan of patient shows parietal infarction (arrow), B) Left basal ganglia hemorrhage (arrow)

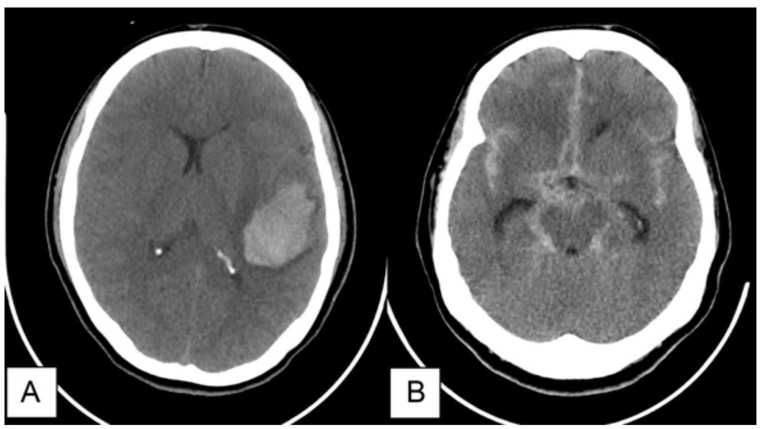

Fig. 2 A) CT scan revealed left temporal lobe intracerebral hemorrhage, B) An extensive of subarachnoid hemorrhage. This is seen as hyperdensity involving the basal cisterns with extension into the ventricular system

Fig. 3 CT brain scan of patient shows: A) Intraventricular hemorrhage bleed in to 3rd ventricle, B) Demonstrates isodensity of subacute right subdural hematoma and chronic hypodense of left subdural hematoma

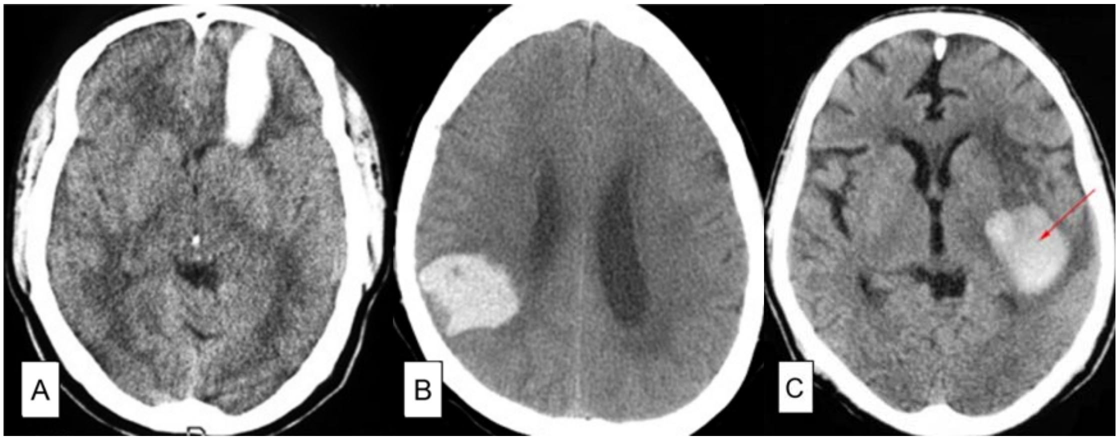

Fig. 4 CT image of Lobar hemorrhage: A) Frontal lobe intracerebral hemorrhage, B) Parietal lobe intracerebral hemorrhage, C) Temporo-occipital lobe intracerebral hemorrhage

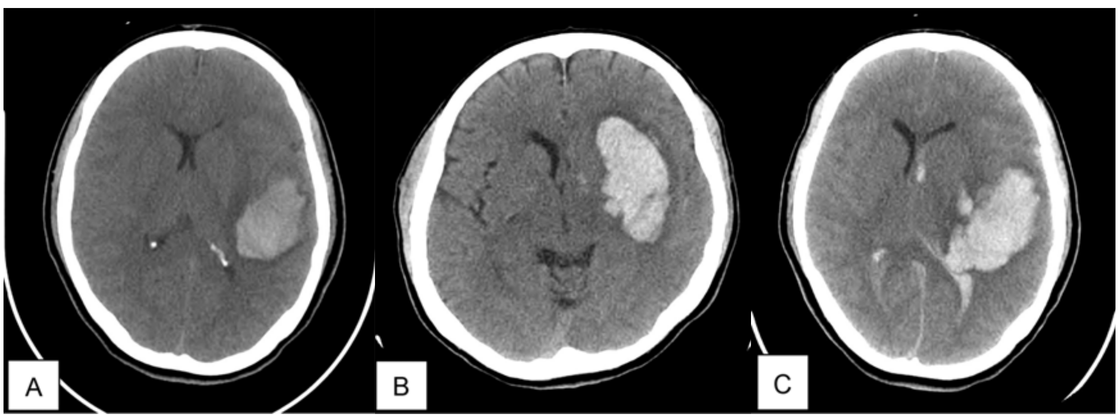

Fig. 5 Hypertensive hemorrhage in the basal ganglia. Hypertensive hemorrhage has a predilection for deep structures including the thalamus and basal ganglia, particularly the putamen and external capsule. Thus, it often appears as a high-density hemorrhage in the region of the basal ganglia: A) Lobar hemorrhage, B) Putamen hemorrhage, C) External capsule hemorrhage

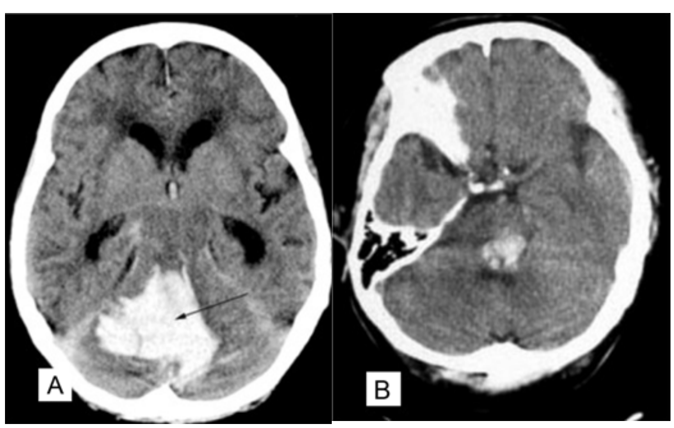

Fig. 6 CT scan shown: A) Cerebellar hemorrhage, B) Brain stem hemorrhage

Fig. 7 The volume of the hemorrhage was calculated by using the "bedside formula" of Kothari et al: hemorrhage volume (in ml) = (A x B x C)/2, where: A = greatest hemorrhage diameter (in mm at CT), B = diameter 90° to A (in mm at CT), and C = approximate number of CT sections with hemorrhage x section thickness

Fig. 8 CT brain presented blocking of CSF pathways causing hydrocephalus

Statistical analysis

1. Baseline characteristics of the present study patients were summarized in terms of frequencies and percentages for categorical variables and continuous data was presented as mean $\pm$ standard deviation (SD).

2. Agreement between interpretation of the two neuroradiologists were calculated with the Kappa test (K) of concordance. Concordance between observers was considered as:

Poor agreement = Less than 0.20
Fair agreement = 0.20 to 0.40
Moderate agreement = 0.40 to 0.60
Good agreement = 0.60 to 0.80
Very good agreement = 0.80 to 1.00

3. Association between clinical data, CT finding data and mortality rate was calculated with Pearson's chi square. A value of $p \leq 0.05$ was considered statistically significant.

Results

One hundred and thirty-one patients (72 male and 59 female) ranging in age from 15 to 93 years (mean $\pm$ Standard Deviation, 57 $\pm$ 17 years) fulfilled the inclusion criteria. All 131 patients with non-traumatic hemorrhagic stroke were classified into four types (Table 1). There were comprised of 84 intracerebral hemorrhages, 30 subarachnoid hemorrhages, 13 subdural hemorrhages and 4 intraventricular hemorrhages. The demographic distribution of each subgroup as summarized in Table 2 and Chart 1.

Intracerebral hemorrhage (Table 3)

Risk factors for intracerebral hemorrhage were as follows: fifty (59.5%) cases with hypertension, two (2.4%) cases with aneurysm, two (2.4%) cases with arteriovenous malformation (AVM), four (4.8%) cases with anticoagulation therapy and thrombolytic therapy, five (6%) cases alcohol abuse and twenty-one (25%) were unknown underlying disease.

A clinical presentation of the patients, each might have one or more signs or symptoms. fifty-nine (38.3%) presented weakness and numbness, thirty-three (21.4%) with severe headache, eighteen (11.7%) with vomiting, sixteen (10.4%) with confusion, seven (4.5%) with seizure, and twenty-one (13.6) were unconscious.

Regarding the duration time of onset, most cases presented in less than 24 hours period. Sixty-seven (79.8%) cases less than 24 hours, fifteen (17.9%) cases between 1-7 days and two cases(2.4%) more than 7 days.

The Glasgow coma score (GCS) on admission, twenty-eight (33.3%) cases were scored between 3 to 8, nineteen (22.6%) cases between 9 to 12 and thirty-seven (44%) cases between 13 to 15.

Treatment, forty (47.6%) patients were treated conservatively and forty-four (52.4%) were treated surgically. Outcome, thirty (35.7%) of patients died and fifty-four (64.3%) survived.

Table 1. Frequency of final stroke diagnosis (ICD-10)

Type of hemorrhagic stroke	No. of patients (%)
Intrecerebral hemorrhage	84 (64)
Subarachnoid hemorrhage	30 (23)
Subdural hemorrhage	13 (10)
Intraventricular hemorrhage	4 (3)
Total	131 (100)

Table 2. The distribution of hemorrhagic stroke type by sex and age (n = 131)

	Type of hemorrhagic stroke			
	ICH (n = 84)	SAH (n = 30)	SDH (n = 13)	IVH (n = 4)
Age				
Mean ± SD	57 ± 17	54 ± 20	64 ± 10	52 ± 24
Range	15-89	17-93	49-79	15-89
Sex				
Male	53 (63%)	11 (37%)	7 (54%)	1 (25%)
Female	31 (37%)	19 (63%)	6 (46%)	3 (75%)

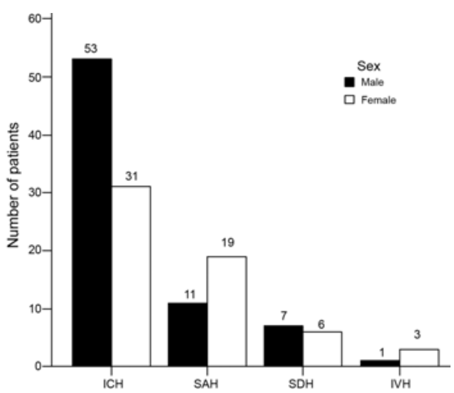

Chart 1. The distribution of hemorrhagic stroke type by sex

Subarachnoid hemorrhage (Table 3)

A risk factors for subarachnoid hemorrhage were as follows: seven (23.3%) cases with hypertension, fifteen (50%) cases with aneurysm, two (6.7%) cases with arterio-venous malformation (AVM), one (3.3%) case with alcohol abuse and five (16.7%) were unknown underlying disease. A clinical presentation of the patients with subarachnoid hemorrhage, eight (11%) presented weakness and numbness, twenty-five (34.2%) with severe headache, nine (12.3%) with vomiting, four (5.5%) with confusion, twelve (16.45%) with stiff neck, five (6.8%) with seizure and ten (13.7%) were unconscious. Regarding the duration time of onset, there were eighteen (60%) cases less than 24 hours, ten (33.3%) cases between 1-7 days and two cases (6.7%) more than 7 days. Glasgow coma score (GCS), eight (26.7%) cases were scored between 3 to 8, four (13.3%) cases between 9 to 12 and eighteen (60%) cases between 13 to 15. Treatment, ten (33.3%) patients were treated conservatively and twenty (66.7%) were treated surgically. Outcome in subarachnoid hemorrhage, seven (23.3%) of the patients died and twenty-three (76.7%) survived.

Subdural hemorrhage (Table 3)

Risk factors for subdural hemorrhage were as follows: seven (53.9%) cases with hypertension, four (30.8%) cases with anticoagulation therapy and thrombolytic therapy and two (15.4%) had unknown underlying disease.

A clinical presentation of the patients, four (18.2%) presented with weakness and numbness, eight (36.4%) with severe headache, four (18.2%) with vomiting, two (9.1%) with confusion, one (4.5%) with stiff neck, one (4.5%) with seizure and two (9.1%) were unconscious.

Duration time of onset, six (46.2%) cases less than 24 hours, five (38.5%) cases between 1-7 days and two cases (15.%) more than 7 days.

Glasgow coma score (GCS), two (15.4%) cases were scored between 3 to 8, four (30.8%) cases between 9 to 12 and seven (53.8%) cases between 13 to 15.

Treatment, two (15.4%) patients were treated conservatively and eleven (84.6%) were treated surgically. Outcome, two (15.4%) of the patients died and eleven (84.6%) survived.

Intraventricular hemorrhage (Table 3)

Risk factors for intraventricular hemorrhage were as follows: three (75%) cases with hypertension and one (25%) with unknown underlying disease.

Clinical presentation of the patients, one (14.2%) presented with weakness and numbness, three (42.9%) with severe headache, three (42.9%) with vomiting.

Duration time of onset in intraventricular hemorrhage, three (75%) cases less than 24 hours and only one (25%) cases between 1-7 days.

Table 3. The clinical data in patients with intracerebral hemorrhage, subarachnoid hemorrhage, subdural hemorrhage and intraventricular hemorrhage

Clinical data	Intracerebral hemorrhage (n = 84)	Subarachnoid hemorrhage (n = 30)	Subdural hemorrhage (n = 13)	Intraventricular hemorrhage (n = 4)
Risk factors				
Hypertension	50 (59.5%)	7 (23.3%)	7 (53.9%)	3 (75%)
Aneurysm	2 (2.4%)	15 (50%)	-	-
Arterio-venous malformation	2 (2.4%)	2 (6.7%)	-	-
Anticoagulation therapy or Thrombolytic therapy	4 (4.8%)	-	4 (30.8%)	-
Alcohol	5 (6%)	1 (3.3%)	-	-
Unknown	21 (25%)	5 (16.7%)	2 (15.4%)	1 (25%)
Clinical presentations				
Weakness/numbness	59 (38.3%)	8 (11%)	4 (18.2%)	1 (14.2%)
Severe headache	33 (21.4%)	25 (34.2%)	8 (36.4%)	3 (42.9%)
Vomiting	18 (11.7%)	9 (12.3%)	4 (18.2%)	3 (42.9%)
Confusion	16 (10.4%)	4 (5.5%)	2 (9.1%)	-
Stiff neck	-	12 (16.4%)	1 (4.5%)	-
Seizure	7 (4.5%)	5 (6.8%)	1 (4.5%)	-
Unconscious	21 (13.6%)	10 (13.7 %)	2 (9.1%)	-
Duration of onset				
< 1 day	67 (79.8%)	18 (60%)	6 (46.2%)	3 (75%)
1-7 days	15 (17.9%)	10 (33.3%)	5 (38.5%)	1 (25%)
> 7 days	2 (2.4%)	2 (6.7%)	2 (15.4%)	-
Glasgow coma score				
3 - 8	28 (33.3%)	8 (26.7%)	2 (15.4%)	1 (25%)
9 - 12	19 (22.6%)	4 (13.3%)	4 (30.8%)	1 (25%)
13 - 15	37 (44%)	18 (60%)	7 (53.8%)	2 (50%)
Treatment				
Operative	44 (52.4%)	20 (66.7%)	11 (84.6%)	2 (50%)
Conservative	40 (47.6%)	10 (33.3%)	2 (15.4%)	2 (50%)
Outcome				
Survival	54 (64.3%)	23 (76.7%)	11 (84.6%)	4 (100%)
Death	30 (35.7%)	7 (23.3%)	2 (15.4%)	-

Glasgow coma score (GCS), one (25%) cases were scored between 3 to 8, one (25%) case between 9 to 12 and two (50%) cases between 13 to 15.

Treatment, in intraventricular hemorrhage, two (50%) patients were treated conservatively and two (50%) were treated surgically and all survived.

Interobserver agreement

The CT findings, interpretation by two neuroradiologists, were calculated with Kappa test (K) of concordance. Concordance for the type of hemorrhagic stroke interpretation between observers was very good (K = 0.861). Result of interpretation by neuroradiologist 1 showed intracerebral hemorrhage 36 cases, intracerebral hemorrhage with intraventricular extension 47 cases, intraventricular hemorrhage 3 cases, subarachnoid hemorrhage 15 cases, subarachnoid hemorrhage with intraventricular hemorrhage 11 cases, intracerebral hemorrhage with intraventricular hemorrhage and subarachnoid hemorrhage 6 cases and subdural hemorrhage 13 cases. The neuroradiologist 2 shown intracerebral hemorrhage 37 cases, intracerebral hemorrhage with intraventricular extension 43 cases, intraventricular hemorrhage 3 cases, subarachnoid hemorrhage 16 cases, subarachnoid hemorrhage with intraventricular hemorrhage 11 cases, intracerebral hemorrhage with intraventricular hemorrhage and subarachnoid hemorrhage 8 cases and subdural hemorrhage 13 cases, as shown in Table 4.

Agreement for location of hematoma in intracerebral hemorrhage interpretation between observers was very good (K = 0.866). Result of interpretation by

Table 4. Agreement between interpretations of two neuroradiologists for hemorrhagic stroke type

	Neuroradiologist 2							
Neuroradiologist 1	ICH	ICH/ IVH	IVH	SAH	SAH/ IVH	ICH/IVH/SAH	SDH	Total
ICH	36	-	-	-	-	-	-	36
ICH/IVH	1	41	1	-	-	4	-	47
IVH	-	1	2	-	-	-	-	3
SAH	-	-	-	14	1	-	-	15
SAH/IVH	-	-	-	2	8	1	-	11
ICH/IVH/SAH	-	1	-	-	2	3	-	6
SDH	-	-	-	-	-	-	13	13
Total	37	43	3	16	11	8	13	131

neuroradiologist1 showed 20 lesions in lobar, 49 lesions in thalamic-ganglionic, 5 lesions in cerebellum, 5 lesions in brainstem and 11 lesions in multiple locations. By neuroradiologist 2 showed 19 lesions in lobar, 41 lesions in thalamic-ganglionic, 5 lesions in cerebellum, 5 lesions in brainstem and 20 lesions in multiple locations, as shown in Table 5.

The most common site of intracerebral hemorrhage was the thalamus and basal ganglia. Of fifty-three cases (40.5%) with thalamic-ganglionic hemorrhage, nineteen cases (14.5%) in lobar hemorrhage, five cases (3.8%) in cerebellum, five cases (3.8%) in brainstem and eight cases (6.1%) in multiple location. Three cases (2.3%) in intraventricular hemorrhage, twenty-five cases (19.1%) in subarachnoid hemorrhage and thirteen cases (9.9%) in subdural hemorrhage, as shown in Table 6, Chart 2-4. Side of hematoma, fifty-one (56.7%) were right side, thirty-six (40%) left side. Intraventricular extension of the hematoma was presented in 68 cases. The volume of hematoma divided into three categories(17, 53), sixty hematoma (66.7%) less than 30 cm^3, seventeen hematoma (18.9%) between 30-60 cm^3 and thirteen hematoma (14.4%) were 61 cm^3 or greater. There were twenty cases (15.3%) midline shift only, twenty-three cases (17.6%) ventricle dilated and thirty-six cases (27.5%) were combined, as shown in Table 6.

In the statistical analyses, in the present study used clinical data on the patient including hospital length of stay, initial level of consciousness (Glasgow Coma Scale score) and CT findings data including hematoma size, intraventricular extension and mass effect. Mean hospital length of stay (Chart 3) in survival patients were 20.63 + 15.88 range 1-218 days and hospital length of stay in dead patients were 9.26 + 30.18 range 1-73 days. Dead patients stayed in hospital shorter than survived patients (p = 0.026).

Table 5. Agreement between interpretations of two neuroradiologist for location of hematoma

	Neuroradiologist 1	Neuroradiologist 2
Lobar	20	19
Thalamic-ganglionic	49	41
Cerebellum	5	5
Brainstem	5	5
Multiple locations	11	20
Total	90	90

Table 6. CT findings after consensus

Location	n	%
Location		
Lobar	19	14.5
Thalamic-ganglionic	53	40.5
Cerebellum	5	3.8
Brainstem	5	3.8
Multiple location	8	6.1
Pure intraventricular (IVH)	3	2.3
Subarachnoid hemorrhage (SAH)	25	19.1
Subdural hemorrhage (SDH)	13	9.9
Side of hematoma		
Right	51	56.7
Left	36	40.0
Mid	3	3.3
Intraventricular extension		
Present	68	51.9
Absent	63	48.1
Size of hematoma		
Small (< 30 cm^3)	60	66.7
Moderate (30-60 cm^3)	17	18.9
Large (> 60 cm^3)	13	14.4
Mass effect		
No mass effect	52	39.7
Midline shift	20	15.3
Ventricle dilated	23	17.6
Midline shift and ventricle dilated	36	27.5

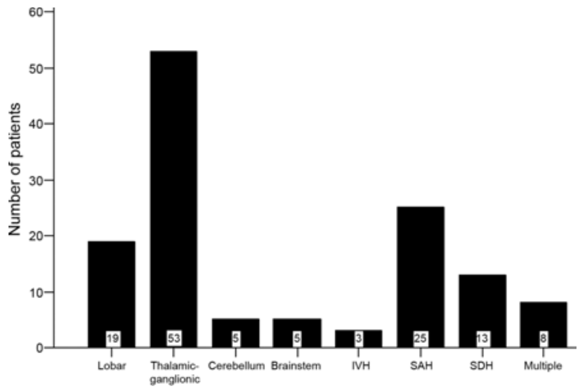

Chart 2. The distribution of bleeding localization in hemorrhagic stroke

Correlation of GCS score and outcome (Chart 4) shown score 3 to 8 had associated with death and score 13 to 15 associated with survival (p = 0.000). Hematoma size (chart 5) divided into three categories, in survived patients forty-six (77%) were small, nine (15%) medium and five (8%) large size. In dead patients, fourteen (46%) were small, medium and large was resembled eight (27%). Large size of hematoma association with death (p = 0.013).

Intraventricular hemorrhage extension (Chart 6) in survival patients present forty (43.5%) cases, fifty-two (56.5%) cases absent and in dead patients twenty-eight (71.8%) cases present Intraventricular hemorrhage extension, eleven (28.2%) absent. Survived patients associated with absent Intraventricular hemorrhage extension and death associated with presence of Intraventricular hemorrhage (p = 0.003). Thirteen (14.1%) cases with midline shift in survived patients, seven (17.9%) cases died, fourteen (15.2%) cases with ventricle dilated survived and nine (23.1%) cases died. Twenty-one (22.8%) cases were combined with midline shift and ventricle dilated in survived patients and fifteen (38.5%) died. No association between mass effect and survival or dead patients as shown in Chart 7.

Discussion

Stroke is an important public heath problem in older age and can cause permanent neurological damage or even death if not promptly diagnosed and treated. According to World Health Organization data[14] estimates that in 2001 there were over 20.5 million strokes worldwide and up to 5.5million were fetal. The prervalence rate in Bangkok is 690 per 100,000 population and 1.12% for all over the country of Thailand[2,3]. By these figures, stroke is an important disease for the Public heath system in Thailand. Neuro-imaging plays a crucial role in the evaluation of

Table 7. Correlation between CT findings, clinical and outcome

	Outcome		p-value
	Survived	Death	
Hospital stay			0.026*
Mean ± SD	20.63 ± 15.88	9.26 ± 30.18	
Range	1-218	1-73	
GCS			
3-8	13 (14.1%)	26 (66.7%)	0.000*
9-12	19 (20.7%)	9 (23.1%)	0.757
13-15	60 (65.2%)	4 (10.3%)	0.000*
Hematoma size			
Small (< 30 cm^3)	46 (76.7%)	14 (46.7%)	0.139
Medium (30-60 cm^3)	9 (15%)	8 (26.7%)	0.095
Large (> 60 cc cm^3)	5 (8.3%)	8 (26.7%)	0.013*
Intraventricular extension			
Present	40 (43.5%)	28 (71.8%)	0.003*
Absent	52 (56.5%)	11 (28.2%)	
Mass effect			
Midline shift	13 (14.1%)	7 (17.9%)	0.578
Ventricle dilated	14 (15.2%)	9 (23.1%)	0.280
Midline shift and ventricle dilated	21 (22.8%)	15 (38.5%)	0.067

* Statistical significant p < 0.05

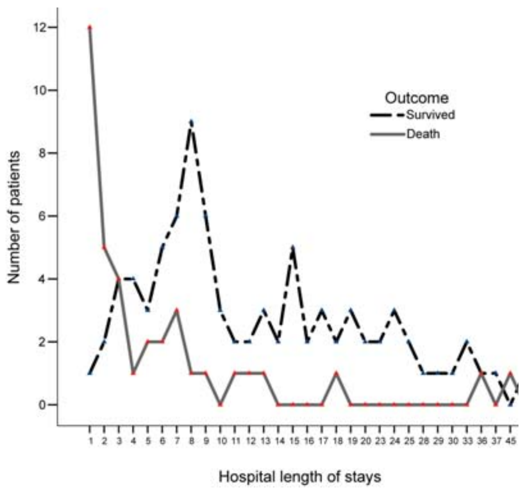

Chart 3. The distribution of hospital length of stay by outcome

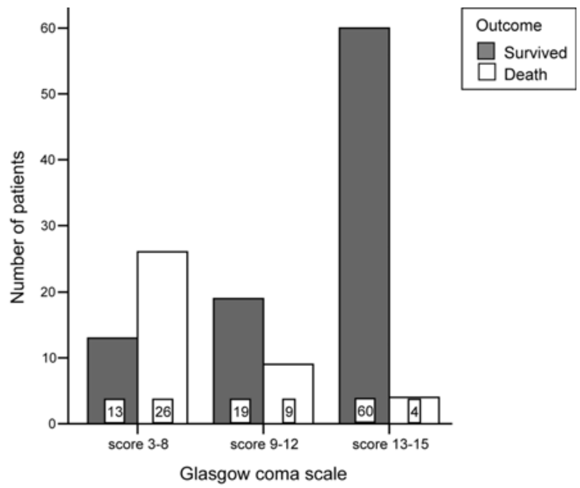

Chart 4. The distribution of Glasgow Coma Scale score by outcome

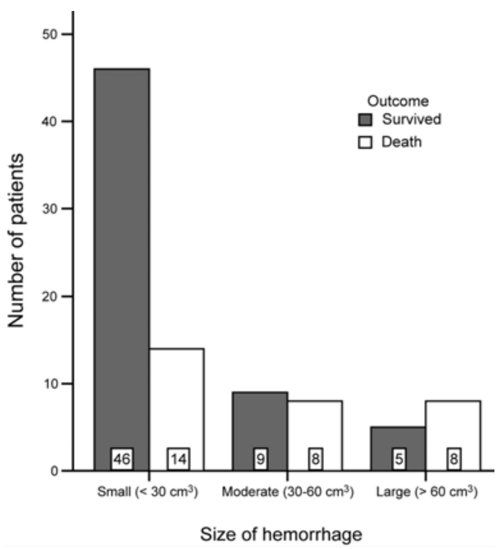

Chart 5. The distribution of hemorrhage size by outcome

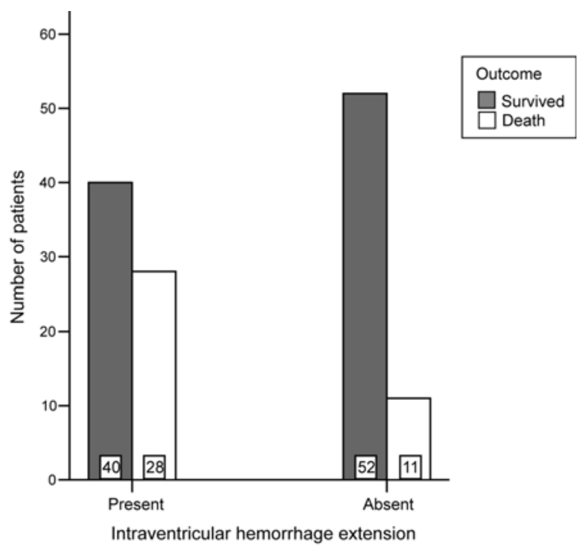

Chart 6. The distribution of intraventricular hemorrhage extension by outcome

patients presenting with acute stroke symptoms. While patient symptoms and clinical examinations may suggest the diagnosis, the brain imaging study can confirm the diagnosis and differentiate hemorrhage from ischemia with high accuracy. Imaging of the brain using computed tomography is a helpful imaging modality to determine the type and severity of stroke particularly in hemorrhagic stroke[9-11].

The aim of the present study was to evaluate the CT findings in non-traumatic hemorrhagic stroke patients and association of clinical data, CT finding data and clinical outcome. The present study in 131 cases of hemorrhagic stroke, the incidence of intracerebral hemorrhage, subarachnoid hemorrhage, intraventricular hemorrhage and subdural hemorrhage were 84,30,13 and 4 cases, respectively. The present study shows that the mean age of patients who have non-traumatic hemorrhagic stroke is 5th-6th decade of life. Incidence of hypertension risk factor was found 59.5% in intracerebral hemorrhage, 23.3% in subarachnoid

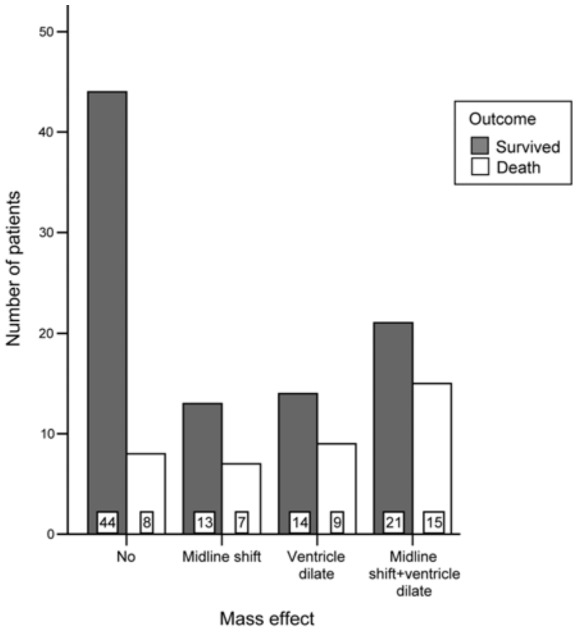

Chart. 7 The distribution of mass effect by outcome

hemorrhage, 53.9% in subdural hemorrhage and 75% in intraventricular hemorrhage, while 50% in subarachnoid hemorrhage caused by ruptured aneurysm. Hypertension is present in approximately 70% of stroke cases. The risk of stroke rises in proportion to blood pressure, for males as well as for females[15,16]. However, the present study shows that hypertension is an associated risk factor in 67 patients out of 183 patients (36%).

In the present study weakness and numbness was the major presenting symptom of the patients in ICH group (38.8%). Headache at onset was the most important clinical feature in subarachnoid hemorrhage followed by stiff neck: 50% commonly caused by ruptured aneurysm. Ruptured aneurysm is suggestive when CT scan shows subarachnoid hemorrhage with hematoma located near the major branches of arteries of the circle of Willis. Subdural hemorrhage present headache (36.4%) followed by weakness and vomiting in the same percent (18.2%), headache and vomiting most presented in intraventricular hemorrhage. There is no limitation in evaluation of attenuation of acute hematoma in the presented patients because of the estimated time from stroke onset to first medical contact less than 24 hours in all types of hemorrhage. This is also an important factor for CT scan in evaluation of hemorrhagic stroke due to 93% sensitivity if the scan time is within 48 hrs compared to 17%-58% if CT scan performed beyond 48 hrs[22].

The level of consciousness on admission was evaluated through the Glasglow Coma Scale (GCS). Level of consciousness is an important determinant of outcome in patients with hemorrhage as observed in the present study found a high percent in GCS score 13 to 15, 44% in intracerebral hemorrhage, 60% in subarachnoid hemorrhage, 54% in subdural hemorrhage and 50% in intraventricular hemorrhage. Patients were already in coma when admitted (GCS score less than or equal to 8) shown in 33% in intracerebral hemorrhage, 27% in subarachnoid hemorrhage, 15% in subdural hemorrhage and 25% in intraventricular hemorrhage. Low scores of GCS on admission were associated with a greater global and stroke-related mortality ($p = 0.000$). There is a choice of treatment, one is operative treated and the other is conservative treated. In the present study operative treated more than conservative treated (52% in intracerebral hemorrhage, 67% in subarachnoid hemorrhage, 85% in subdural hemorrhage and 50% in intraventricular hemorrhage.

During the present hospitalization 39 patients died (29.8%). The highest incidence of death was found in intracerebral hemorrhage (35.7%) but the incident in other type was 23.3% in subarachnoid hemorrhage, 15.4% in subdural hemorrhage. None of intraventricular hemorrhage had died.

The mean duration of hospital stay in the present study was 17.7 days (range 1-218 days) resembled in Poungvarin et al, the mean total hospital stay of stroke at the stroke unit in Siriraj Hospital was 15.64 days, ranging from 1-120 days[21].

The use of CT has greatly facilitated the diagnosis of hemorrhagic stroke and the differentiation of intracerebral hemorrhage, subarachnoid hemorrhage, subdural hemorrhage and intraventricular hemorrhage. Thus, CT is for the most part was responsible for the high levels of interrater agreement in these stroke subtypes (in the present study, $k = 0.861$ for type of hemorrhage and $k = 0.866$ for location of hemorrhage). In Wermer et al[20], studied the interobserver variation between three radiologists in classifying, fifty large hematoma on CT as deep or lobar. The kappa values were almost perfect, ranging from 0.88 to 0.96. The CT finding of non-traumatic intracranial hemorrhage appears to be distinctive. This has allowed definitive diagnosis and precise anatomical delineation of the lesions. Thus, CT is for the most part responsible for the high levels of inter-rater agreement in these stroke subtypes. In the present study the authors found concordance between CT brain interpretation by two neuroradiologist for the type of hemorrhagic stroke was very good, k = 0.861 and for location was k = 0.866. In Klaus et al[19] reported that Interobserver agreement is high (k = 0.96 for ICH and k = 0.82 for SAH) for major stroke types as well as for categories of hemorrhagic stroke on the basis of review of medical records and results of imaging data. The finding of hematoma formation at different sites is similar to Weisbergs' series. They found ganglionic-thalamic hemorrhage most frequently involved (77% of cases) followed by lobar hematoma (15%). Cerebellar, brainstem and pure intraventricular hemorrhage are less common. Multiple intracerebral hemorrhaging occurred in 5 cases in the present series. In the present study found the basal ganglia and thalamus are the most frequent sites of intracranial bleeding. 53 of 84 intracerebral hemorrhages (40%) affected this region. The most frequent cause of bleeding is vascular rupture, most often associated with hypertension. The relative proportions of hematoma in lobar (14.5%), brainstem (3.8%), cerebellum (3.8%) and pure intraventricular hemorrhage (2.3%) are similar to those previously reported. The intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH) often have poor outcomes. Indeed, the most common hemorrhagic strokes were ICH. ICH has the highest mortality and morbidity rates of any stroke subtype. The comparison of patients who died with those who survived revealed five variables which were significant. In the statistical analyses, the authors used clinical data on the patients, including hospital length of stay, initial level of consciousness (GCS score) and CT findings data, including hematoma size, intraventricular extension and mass effect. From the analyses, it was obvious that the variables hospital length of stay, lower level of consciousness, large hematoma size and presence of intraventricular hemorrhage extension were significant importance, while the presence of mass effect (midline shift and ventricle dilated (hydrocephalus) on CT scan had no prognostic influence on outcome (survival or death).

Conclusion

Computed tomography (CT) scan is the most widely used imaging procedure to evaluate stroke patients. CT is by no means the only neuroradiologic examination that has to be performed in patients with stroke, but it is safe, non-invasive creates a series of cross-sectional images of the brain and can show evidence of bleeding into the brain almost immediately after stroke symptoms appear. CT provides a substantial amount of information, including the size and location of the hemorrhage and the presence of intraventricular, subarachnoid, or subdural blood.

The present study demonstrates that from all type of hemorrhagic stroke, intracerebral hemorrhage there remains a common and devastating clinical problem. A most risk factor were hypertension, but AVM, blood dyscrasia and unknown etiologies were the cause of non-hypertensive intracerebral hemorrhage, while ruptured aneurysm resulted in bleeding subarachnoid hemorrhage. CT findings by themselves can help predict which patients are at high risk of short-term mortality and may require intensive treatment. Three variables on CT imaging were identified as early mortality predictors in patients where hematoma volume was more than 60 cm3 ($p = 0.013$), the presence of intraventricular hemorrhage extension ($p = 0.003$) and mass effect were defined as the presence of ventricular shift across the midline and/or enlargement of contralateral ventricle. In the present study, there was no mass effect association with clinical outcome ($p = 0.067$). Although the majority of hemorrhagic strokes are visible on the computed tomography scan, it necessitates finding a competent reader to appreciate the finding. The present study is not epidemiological in nature and results cannot be used for incidence calculations. Some limitations in the present study included retrospectives method and uncompleted medical records. This observational survey from computed tomography diagnosed and localized hemorrhaging in hemorrhagic stroke patients. A prospective study with a larger sample size is suggested.

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ลักษณะการตรวจพบจากภาพเอกซเรย์คอมพิวเตอร์ในผู้ป่วยโรคหลอดเลือดสมองที่ทำให้เกิดเลือดออกในสมองที่ไม่ได้มีสาเหตุจากอุบัติเหตุ

พิพัฒน์ เชี่ยววิทย์, ณสุดา ด่านชัยวิจิตร, ยงชัย นิละนนท์, นิพนธ์ พวงวรินทร์

วัตถุประสงค์: *เพื่อศึกษาลักษณะที่ตรวจพบจากภาพเอกซเรย์คอมพิวเตอร์, ความสัมพันธ์ของลักษณะที่พบกับผลลัพธ์ทางคลินิกและศึกษาความสอดคล้องในการแปลผลภาพเอกซเรย์คอมพิวเตอร์*

วัสดุและวิธีการ: *โดยศึกษาในผู้ป่วยโรคหลอดเลือดสมองที่ทำให้เกิดเลือดออกในสมองและได้รับการตรวจด้วยเครื่องเอกซเรย์คอมพิวเตอร์ของโรงพยาบาลศิริราช ตั้งแต่เดือนมกราคม พ.ศ. 2547 ถึงเดือนธันวาคม พ.ศ. 2548 จำนวน 131 ราย*

ผลการศึกษา: *พบว่าโรคหลอดเลือดสมองที่เกิดเลือดออกในสมองส่วนใหญ่จะเป็นชนิด Intracerebral hemorrhage (ICH) ซึ่งตำแหน่งที่พบมากที่สุดคือ thalamus และ basal ganglia พบ 53 ราย (40%) รองลงมาคือ lobar 19 ราย (14.5%), cerebellum 5 ราย (3.8%), brainstem 5 ราย (3.8%) และพบหลายตำแหน่ง 8 ราย (6.1%). ปัจจัย 2 ชนิดที่ได้จากภาพ CT คือ ก้อนเลือดขนาดใหญ่มากกว่า 60 ลูกบาศก์เซนติเมตร และการแตกของเลือดเข้าโพรงสมองมีความสัมพันธ์กับการเสียชีวิตของผู้ป่วยอย่างมีนัยสำคัญทางสถิติ ($p < 0.05$) ส่วนปัจจัย mass effect ไม่มีความสัมพันธ์กัน ($p = 0.067$) ความสอดคล้องในการแปลผลภาพเอกซเรย์คอมพิวเตอร์ นั้นมีค่าดีมาก $K = 0.861$ สำหรับการแปลผล ชนิดของเลือดออกในสมอง และ $K = 0.866$ สำหรับการแปลผลตำแหน่งของก้อนเลือด*

สรุป: *การตรวจด้วยเอกซเรย์คอมพิวเตอร์มีประโยชน์ในผู้ป่วยโรคหลอดเลือดสมองที่ทำให้เกิดเลือดออกในสมองและมีลักษณะสำคัญบางประการที่สามารถชี้นำให้เห็นว่าผู้ป่วยอาจมีภาวะอันตรายถึงแก่ชีวิตได้ซึ่งช่วยในการพยากรณ์โรคได้*