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Contrast Extravasation into an Acute Spontaneous Intracerebral Hematoma: Multidetector CT Angiographic Findings and Clinical Implications[1]

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Purpose: The purpose of this study was to evaluate multidetector row CT (MDCT) angiographic findings and their clinical significance for contrast extravasation into a spontaneous intracerebral hematoma (ICH).

Materials and Methods: MDCT angiographic studies and clinical records of 115 patients with spontaneous ICH were retrospectively reviewed. Cases were divided into two groups according to the presence or absence of contrast extravasation. The cases in the two groups were compared to determine the differences in radiological and clinical findings. The contrast extravasation group was divided into two subgroups according to radiological findings as follows: single or multiple dot-like contrast extravasation (Type A) and beaded-tubular (with or without dot-like extravasation) contrast extravasation (Type B).

Results: Contrast extravasation was seen in 38 patients (33%). It was associated with a larger hematoma volume, more frequent intraventricular hemorrhage (IVH) and subarachnoid hemorrhage (SAH), a shorter time interval from onset to the time of the CT scan, lower Glasgow coma scale (GCS), and a higher mortality rate. Type A and B contrast extravasation were observed in 16 (42%) and 22 (58%) patients, respectively. The rate of IVH and the clinical outcome of patients with Type B showed a significant correlation.

Conclusion: Two types of contrast extravasation into an ICH show a significant difference in the rate of IVH and in clinical outcome. Detecting the presence of contrast extravasation and classifying them according to the morphologic patterns are important in predicting a prognosis.

Index words : Brain, CT
Brain, hemorrhage
Computed tomography (CT), angiography
Contrast media

Spontaneous intracerebral hemorrhage (ICH) is one of the most devastating forms of stroke (1). Spontaneous ICH is a type of stroke that arises in the brain parenchyma in the absence of trauma or surgery. Common causes include hypertension, amyloid angiopathy, coagulopathy, vascular anomalies, tumors, and treatment with various drugs. However, hypertension is the single most important risk factor for spontaneous ICH. Spontaneous ICH accounts for 10 - 15% of all strokes and is associated with a higher mortality rate than either ischemic stroke or subarachnoid hemorrhage (SAH) (2).

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The mortality rate in spontaneous ICH is increased in patients with a large hematoma, low GCS score, and intraventricular hemorrhage (IVH) (3 - 8). Although spontaneous ICH is usually a monophasic event, sometimes bleeding can persist up to several hours postictus. Continued bleeding associated with ICH may lead to enlargement of an existing hematoma. A hematoma that is enlarging is associated with poor outcome (9 - 11). The incidence of hematoma enlargement is about 14 - 20% by computed tomography (CT) (12, 13). A previous study showed that active extravasation of contrast into spontaneous ICH is a marker for continued bleeding that is associated with hematoma enlargement, and it is the most significant radiological variable associated with fatality in a multivariate model (3). This study reported that the mortality rate in the group with contrast extravasation is significantly higher than the control group without contrast extravasation. However, to date, no study has documented radiological findings of contrast extravasation into a spontaneous ICH by multidetector row CT (MDCT) angiography and their relationship with on the clinical outcome of patients. The purpose of this study was to evaluate the MDCT angiographic findings of contrast extravasation into a spontaneous ICH, and to correlate those radiological findings with clinical outcome.

Materials and Methods

Between November 2003 and December 2005, 115 consecutive patients who presented with acute spontaneous ICH were included in this study. Patients with hemorrhage due to aneurysmal rupture, arteriovenous malformation, moyamoya disease, or infective endocarditis, as well as those receiving anticoagulants or antiplatelet agents, were excluded. The age range of these patients was 36 - 88 years, and the mean age of the study patients was 59.9 years. The study group was composed of 67 males and 48 females.

All CT examinations were performed with a 16-MDCT scanner (LightSpeed Pro 16, GE Healthcare, Milwaukee, WI U.S.A.). In all patients, a non-enhanced scan was obtained according to the following protocol: 5-mm slice thickness, maximum of 200 mAs at 120-kV tube voltage. For MDCT angiography, the following scanning protocol was used: 1.25-mm slice thickness, 0.6 sec of rotation speed, 4 mm per rotation of table feed, pitch of 0.938:1, 210 mAs of tube current, and 120 kVp. A power injector was used to administer 120 mL of 300 mg/mL iohexol (Omnipaque 300, Cork, Ireland), a nonionic contrast medium, into the right antecubital vein at a flow rate of 4 mL/sec. There was no difference in the injection rate between patients. The individual circulation time was determined in the lumen of the common carotid artery using a test bolus of 4 mL of IV-administered contrast medium at a flow rate 4 mL/sec. A scan commenced 3 seconds after the common carotid artery reached 100 Hounsfield unit (HU). After MDCT angiography, a post-enhanced scan was performed with the same protocol as the pre-contrast scan. The acquired images were transferred from the CT scanner to a workstation for image reconstruction. Maximum intensity projections (MIP) in axial, coronal, and sagittal planes and volume-rendered images from the source datasets were generated by using the software (Advantage Windows; GE Medical Systems) installed on the workstation.

Two neuroradiologists who were blinded to the clinical data evaluated the CT and CT angiographic images. The hematoma volume was estimated on the pre-contrast CT images obtained before CT angiography with the ABC/2 method, where A, B, and C represent the re-

Table 1. Comparison of the Clinical and Radiological Data in Patients with and Without Contrast Extravasation

Patient Data	With Contrast Extravasation (n = 38)	Without Contrast Extravasation (n = 77)	p-value
Age	57.71±12.88	60.68±12.26	0.264
GCS	8.82±3.95	11.49±3.82	< 0.001
Time interval	3.13±4.26	15.59±26.02	< 0.001
ICH volume	59.57±44.6	27.98±32.32	< 0.001
IVH	28/38 (73.7%)	33/77 (42.9%)	0.004
SAH	10/38 (26.3%)	6/77 (7.8%)	0.016
End result			
Improvement	20/38 (52.6%)	65/77 (84.4%)	< 0.001
No change	3/38 (7.9%)	2/77 (2.6%)	0.410
Aggravation	4/38 (10.5%)	4/77 (5.2%)	0.504
Death	11/38 (28.9%)	6/77 (7.8%)	0.006

CTA = CT angiography

spective radii of the hematoma in three dimensions. The hematoma volume was calculated as the average of both values estimated from two image readers. The presence or absence of contrast extravasation was determined by visual detection of the presence of hyperdense contrast media inside the hematoma without evidence of feeding or draining vessels on post-contrast CT images obtained after CT angiography. The number and morphology of contrast extravasation, hematoma location, the presence or absence of IVH, and the presence or absence of SAH were recorded.

Clinical results were obtained by patient medical chart review by an investigator blinded to the radiological data. The following data were recorded: the time interval between symptom onset and CT angiography, systolic and diastolic blood pressures at the time of CT angiography, GCS, initial level of consciousness, and clinical outcome. The presence or absence of a surgical procedure was also recorded. The initial level of consciousness was scored on a six-point scale, with scores defined as follows: coma (grade 1), semicoma (grade 2), stupor (grade 3), drowsiness (grade 4), near alert (grade 5), and alert (grade 6). Clinical outcome was compared with the initial clinical status of the patient and classified as follows: improvement, no interval change, aggravation, and death.

Patient cases were divided into two groups (with or without contrast extravasation), and the contrast extravasation group was subdivided into two groups according to the radiological findings as follows: single or multiple dot-like contrast extravasation (Type A) and beaded-tubular (with or without dot-like extravasation) contrast extravasation (Type B) (Fig. 1).

Statistical analysis was performed with a commercially available statistical software program (SPSS 11, Chicago, IL U.S.A.). To determine a statistically significant difference in the time interval between symptom onset and CT angiography, GCS, initial level of consciousness, systolic and diastolic blood pressures, and hematoma volume between the two groups with and without contrast extravasation and between the two subgroups with contrast extravasation, the Mann-Whitney U test was employed. A difference of clinical outcome was determined with the χ test or Fisher's exact test. The level of statistical significance was set at $p \leq 0.05$.

Results

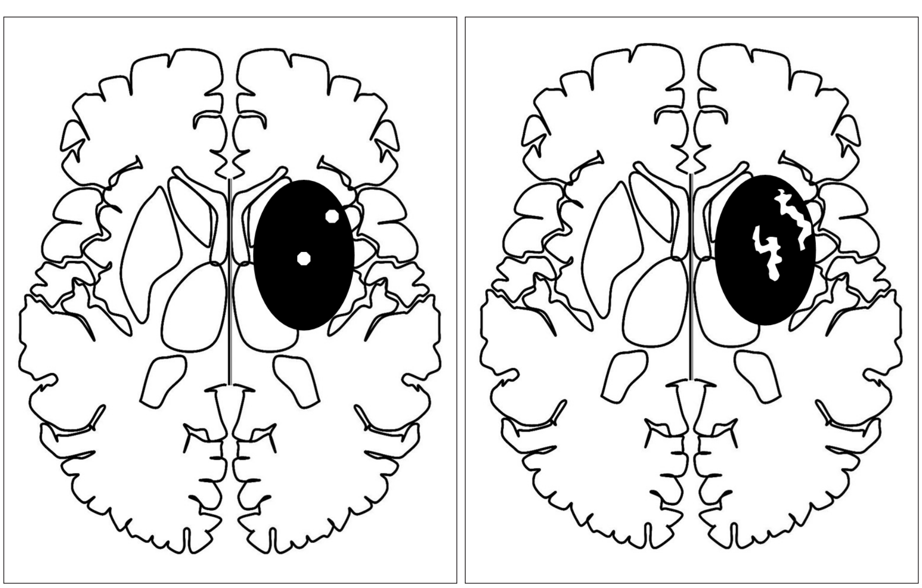
Contrast extravasation into a spontaneous ICH was observed in 38 of 115 patients (33%).

Contrast extravasation was seen as a localized hyper-

Table 2. Morphology and the Location of the Contrast Extravasation

Location	Morphology of Contrast Extravasation			Total
	Dot-like	Beaded tubular	Mixed	
Periphery	12	14	2	28 (73.7%)
Center	4	3	-	7 (18.4%)
Mixed	-	2	1	3 (7.9%)
Total	16 (42.1%)	19 (50%)	3 (7.9%)	38

Dot-like = Type A
Beaded tubular and mixed = Type B

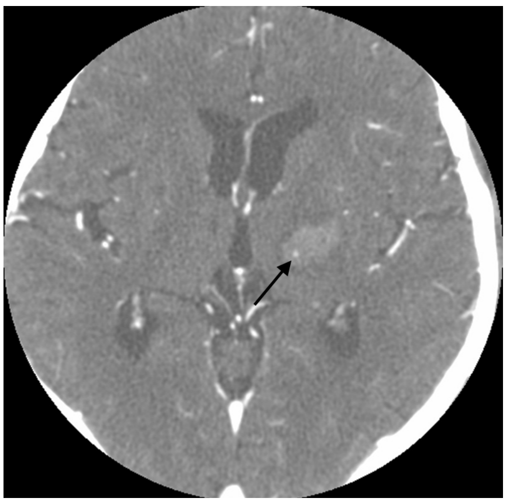


A B

Fig. 1. The classification of contrast extravasation patterns on brain CT and CT angiography imaging are illustrated on the schematic drawing.
A. Type A: single or multiple and central or peripheral dot-like areas of high attenuation within the hematoma.
B. Type B: single or multiple and central or peripheral beaded-tubular areas of high attenuation within the hematoma.

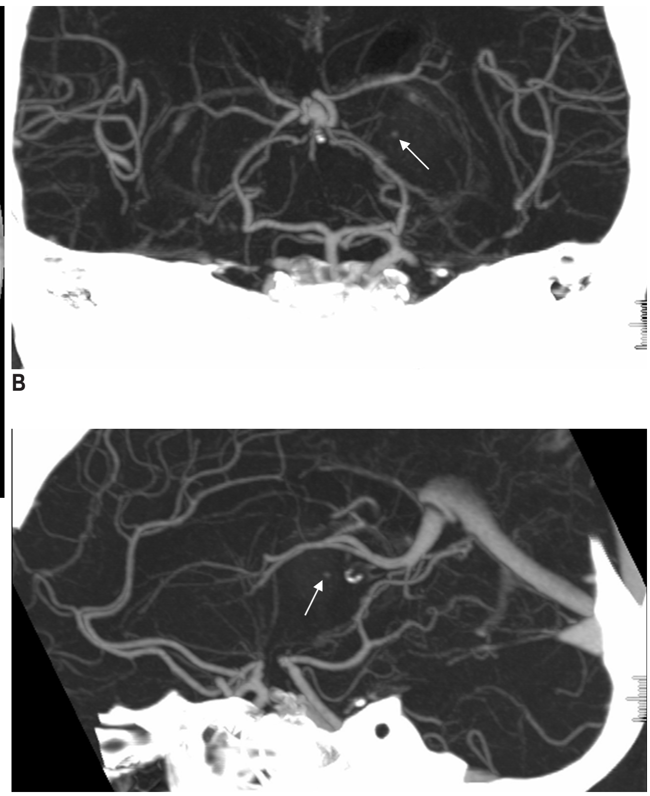
dense zone that was well demarcated from a surrounding blood clot. The density of the hematoma was between 60 and 70 HU in comparison with 90 - 100 HU of contrast extravasation that was easily detected on a post-contrast CT scan. In most cases, extravasation of contrast media was located in the periphery of the hematoma (73.7%).

Table 1 shows the comparative clinical and radiological findings of the patients with contrast extravasation (n = 38) and without contrast extravasation (n = 77). In patients with contrast extravasation, there was a trend toward a larger hematoma volume, a shorter time interval from symptom onset to CT angiography, a lower GCS, a higher frequency of IVH, a lower score of initial con-



A

Fig. 2. Brain CT angiography with Type A contrast extravasation in a 51-year-old man with an acute spontaneous intracerebral hematoma (ICH).
A. A source image of CT angiography shows a small hemorrhage involving the left basal ganglia, internal capsule, and thalamus with dot-like contrast extravasation into the peripheral portion of the hematoma (arrow).
Coronal (**B**) and sagittal (**C**) maximum intensity projection (MIP) images show dot-like contrast extravasation into the hematoma (arrow).



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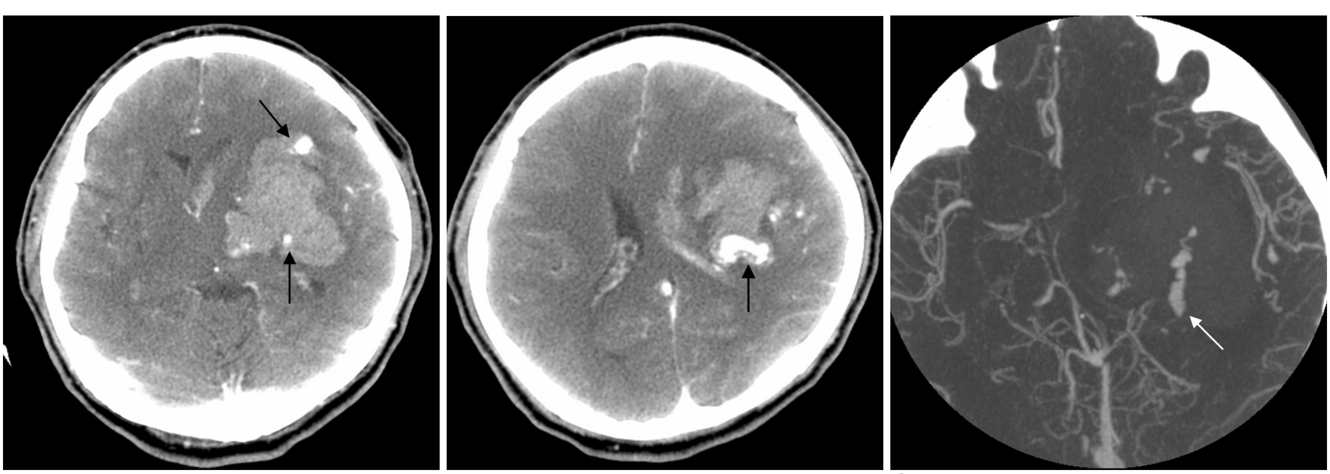

A B C

Fig. 3. Brain CT and CT angiography with Type B contrast extravasation in a 46-year-old man with an acute spontaneous ICH.
A and B. An enhanced brain CT shows hemorrhage involving the left basal ganglia and thalamus with extension into the lateral ventricle and dot-like and beaded-tubular contrast extravasation into the peripheral portion of the hematoma (arrows).
Axial (**C**) and sagittal (**D**) MIP images show a mixed pattern of contrast extravasation in the hematoma (arrows).

sciousness, a lower improvement rate, and a higher mortality rate than in patients without extravasation. The overall mortality rate was 17.8% (17 of 115). The mortality rate for patients with contrast extravasation (11/38;28.9%), was significantly higher than in patients without extravasation (6/77;7.8%) ($p=0.006$). Neither the systolic blood pressure nor the diastolic blood pressure was associated with the presence of contrast extravasation. No significant differences were observed for other factors between two groups. The two groups were not significantly different in the location of hematoma except for the posterior fossa where the number of patients without extravasation was significantly larger than those with extravasation ($p\leq0.001$). The mortality rate of patients who underwent decompressive surgery was not significantly different from those patients that did not undertake surgery in both groups with or without contrast extravasation.

The morphology and location of contrast extravasation into an ICH is shown in Table 2. On brain CT and CT angiography, there was no evidence of tangled abnormal vascular structures, aneurysm, or draining veins coming out of the hematoma. However, some cases showed lenticulostriate arteries going into the area of the contrast extravasation (Fig. 4).

Type A and B were observed in 16 (42%) and 22 (58%)

Table 3. Clinical and CT Angiographic Findings in Patients with Contrast Extravasation

No.	Sex/Age	TI (hrs)	MS	GCS	Type	ICH location	ICH Volume (cm^3)	IVH	SAH
1	M/36	1.5	near alert	13	A	Rt. BG	8.98	-	-
2	M/46	1	near alert	15	A	BG	17.6	-	-
3	M/49	3	coma	4	A	Rt. BG & IC	83.0	+	-
4	F/50	1.5	semicoma	4	A	Rt. TH	36.4	+	-
5	F/51	1	drowsy	12	A	BG	11.3	-	-
6	M/51	2	alert	12	A	Lt. BG & IC	3.94	-	-
7	M/53	0.67	drowsy	12	A	Rt. BG & CR	59.5	+	-
8	F/57	2	drowsy	13	A	Lt. TH	9.90	+	-
9	M/58	5	drowsy	13	A	Rt. F-P lobe, Rt. BG	84.0	+	-
10	F/61	4	stupor	11	A	Lt. F-P lobe	36.0	-	-
11	M/66	0.5	stupor	10	A	Lt. TH	9.84	-	-
12	F/66	4	semicoma	6	A	Lt. BG & CR	113	+	-
13	M/67	3	drowsy	13	A	Rt. P lobe	81.8	-	+
14	M/79	1	stupor	9	A	Rt. F-T & BG	161	+	-
15	F/82	2	drowsy	14	A	Lt. BG	28.7	-	-
16	M/88	24	semicoma	4	A	Lt. BG	149	+	-
17	F/37	4	stupor	7	B	Lt. T lobe	35.0	+	+
18	M/42	1.67	drowsy	13	B	Rt. TH & IC	19.4	+	-
19	M/45	1	drowsy	13	B	Rt. Insula, EC, & BG	52.6	-	-
20	M/46	1	semicoma	5	B	Lt. BG & TH	93.0	+	-
21	M/47	3.5	drowsy	13	B	Rt. P lobe	31.0	+	-
22	M/47	6	coma	3	B	Rt. T lobe	85.7	+	+
23	F/48	1	stupor	7	B	Lt. TH	19.8	+	-
24	M/50	2	semicoma	4	B	Lt. BG & IC	105	+	+
25	M/50	1	semicoma	4	B	Lt. BG & TH	93.0	+	-
26	M/50	0.5	semicoma	4	B	Rt. BG & TH	128	+	+
27	F/51	5	stupor	5	B	Lt. BG & F-T lobe	59.6	+	+
28	F/53	0.5	stupor	5	B	Lt. BG & Rt. TH	83.5	+	-
29	M/55	9	stupor	6	B	Rt. F lobe	128	+	+
30	M/56	1	alert	12	B	Rt. BG	8.91	-	-
31	M/58	9	drowsy	13	B	Rt. BG	65.3	+	-
32	M/63	10	stupor	7	B	Both F-T lobe	107	+	+
33	M/66	0.5	drowsy	13	B	Rt. F-P lobe	23.1	+	-
34	F/67	2	semicoma	5	B	Rt. BG	2	+	-
35	F/70	0.67	semicoma	4	B	Lt. TH & BG	68.3	+	-
36	M/72	2	drowsy	12	B	Lt. P-O lobe	99.0	+	+
37	F/79	1	stupor	10	B	Lt. TH	22.5	+	-
38	F/81	0.5	semicoma	5	B	Lt. BG	106	+	+

TI = Time interval from onset of symptoms to CT angiography, MS = Initial mental status, GCS = Glasgow coma scale, BG = basal ganglia, TH = thalamus, IC = internal capsule, EC = external capsule, CR = corona radiate, F = frontal, T = temporal, P = parietal, O = occipital, + = presence, - = absence patients, respectively. Table 3 summarizes the clinical and radiological data of patients with contrast extravasation. The age range of patients with Type A (n = 16) was 36 - 88 years, and the mean age was 60 years. This group was composed of 10 males and 6 females. Type B (n = 22) was composed of 14 males and 8 females, and their ages ranged from 37 to 81 years with mean age of 56.1 years.

Table 4 shows the comparative clinical and radiological findings of patients with Type A and Type B contrast extravasation. In Type A, the improvement rate is significantly higher than in Type B (p = 0.007). In Type B, the frequency of IVH is significantly higher than in Type A (p = 0.03). No significant differences were observed for other factors between the two groups.

Table 4. Comparison of the Clinical and Radiological Data in Patients with Type A and Type B Contrast Extravasation

Patient Data	Type A (n = 16)	Type B (n = 22)	p-value
Age	58.67±14.82	57.09±11.76	0.732
GCS	10.07±4.20	8±3.63	0.174
Time to CTA	3.61±5.85	2.82±2.91	0.882
ICH volume	55.40±51.11	62.29±40.86	0.179
IVH	8/16 (50.0%)	20/22 (90.9%)	0.030
SAH	2/16 (12.3%)	8/22 (36.4%)	0.143
End result			
Improvement	13/16 (81.3%)	7/22 (31.8%)	0.007
No change	1/16 (6.3%)	2/22 (9.1%)	1.000
Aggravation	0/16 (0%)	4/22 (18.2%)	0.105
Death	2/16 (12.5%)	9/22 (40.9%)	0.078

CTA = CT angiography

Discussion

This study shows that the radiological findings of contrast extravasation into a spontaneous ICH by MDCT angiography were characteristic for differentiation from those of an aneurysm or vascular malformation. On a post-contrast CT scan and CT angiography, the extravasation of contrast was seen as an extremely hyperdense area that was clearly separated from a surrounding blood clot and there was no evidence of either tangled abnormal vascular structures, aneurysm, or draining veins coming out of the hematoma. Some cases showed enhancing lenticulostriate arteries going into the area of contrast extravasation (Fig. 4). On follow-up CT scans, the hyperdense areas disappeared and post-surgical pathologic reports clearly indicated that there was no evidence of aneurismal sac or vascular malformation. A MIP image of CT angiography was useful for demonstrating the three dimensional morphology of contrast extravasation into a spontaneous ICH.

Contrast extravasation has been described as a hyperdense area that disappears on a follow-up CT scan (14). Mericle et al. (15) have suggested that extravasation of contrast medium could be defined as a hyperdense area with a maximal HU measurement over 90 and/or disappearance of the hyperdensity on a repeated CT obtained within 24 hours. Nakano et al. (16) have described the rapidly clearing hyperdense areas as evidence of ex-

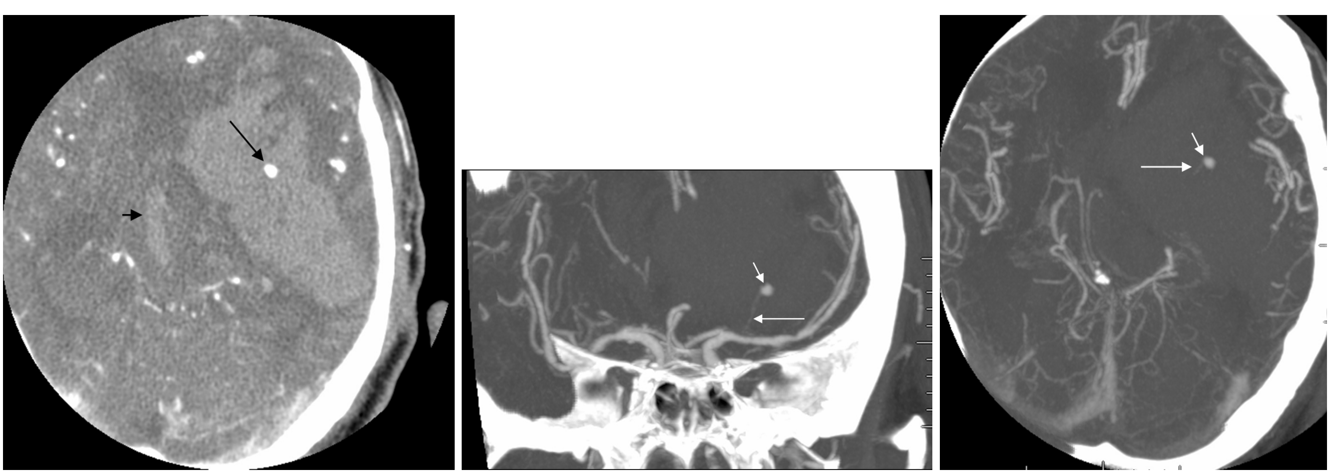

Fig. 4. Brain CT angiography with Type A contrast extravasation in a 88-year-old man with a huge acute spontaneous ICH.
A. A source image of CT angiography shows a huge hematoma involving the left basal ganglia and frontotemporoparietal lobes with an intraventricular extension (short arrow) and dot-like contrast extravasation (long arrow) into the central portion of the hematoma.
Coronal (**B**) and axial (**C**) MIP images show dot-like contrast extravasation (short arrow) arising from the enhancing lenticulostriate artery (long arrow) into the hematoma.

travasation of the contrast medium. In the present study, contrast extravasation was measured between 90 and 100 HU in comparison with the surrounding blood clot where contrast extravasation measured 60 to 70 HU. Among all patients with contrast extravasation, only 28 patients (73.7%) underwent decompressive surgery and the pathologic reports described no evidence of any aneurysm or vascular malformation within the evacuated hematoma. In 10 patients (26.3%) with contrast extravasation who had not undergone decompressive surgery, hyperdense areas in the hematoma on initial CT scans disappeared on the follow-up CT scans.

In our study, the radiological findings of contrast extravasation varied from a single dot-like appearance to a multiple bizarre beaded or tubular appearance on post-contrast CT and CT angiography. We classified those cases of contrast extravasation into two types according to the morphology on CT angiography. Type A (Fig. 2, 4) consisted of patients with contrast extravasation showing a single or multiple dot-like appearance and Type B (Fig. 3) consisted of those showing single or multiple beaded-tubular appearance with or without a combined dot-like pattern. When CT angiography showed mixed findings of dot-like and beaded-tubular appearance, it was classified as Type B. We divided the group with contrast extravasation into only two subgroups, because subdivision into more than three subgroups would reduce the group size and thereby decrease the statistical power.

Murai et al. (17) classified the mode of contrast extravasation into four types by MR imaging as follows: punctate (Type A), linear (Type B), both punctate and linear (Type C), and absent (Type D). In this study, it was reported that enlargement of the hematoma was significantly more common in patients with Type A and Type C. As defined in their study, Type B contrast extravasation indicated thin capsular enhancement surrounding the hematoma rather than actual contrast extravasation within the hematoma. We have not found any case with surrounding capsular enhancement by CT and CT angiography in our study. We believe that both Type A (dot-like) and Type B (beaded-tubular) contrast extravasation in our study corresponded to punctate extravasation (Type A) in the study by Murai and colleagues (17). These investigators did not further subdivide the punctate contrast extravasation into subgroups as we did in the present study. Yamaguchi et al. (18) have classified MR imaging findings of contrast extravasation into Type A (no contrast enhancement), Type B (punctate enhancement within the hematoma or within 5 mm of its margin), and Type C (zonal or macular contrast enhancement). In their study, Type C enhancement indicated continued hemorrhage, which corresponds to our Type B. In the two studies described above, it was demonstrated that the pattern of contrast extravasation was significantly associated with enlargement of the hematoma. However, the relationship between the pattern of extravasation and clinical outcome has not been analyzed. In the present study, we found that there is a significant difference in clinical outcome between the two types of contrast extravasation.

Becker et al. (3) have reported that most contrast extravasations were located in the center of the hematoma and the peripheral location of extravasation was almost never seen. However, our study showed that in 73.7% of cases, the contrast medium extravasated into the periphery of the hematoma. The location of contrast extravasation did not correlate with the location of the hematoma in the brain in our study. Becker et al. (3) suggested that the reason for contrast extravasation tended to occur centrally within the hematoma is that the contrast medium is extravasating from a vascular source and not from necrotic and edematous tissue surrounding the primary hemorrhage. In the study of seven cases with contrast extravasation into an acute ICH, Mizukami et al. (10) reported that ruptured arteries were found in the periphery or on the wall of hematoma in 4 of 7 cases by surgery or histological examination. The main bleeding source was the lenticulostriate artery in all cases and this artery was not always located in the center of the hematoma. In their operative and autopsy findings, bleeding was postulated to develop in the direction of least resistance, by disruptive mechanical force. This would appear to be along a plane external to the putamen and between it and the claustrum. We believe that the location of a bleeding source would be affected by the anatomy of ruptured artery and the location of hematoma along the tissue plane of least resistance. In most cases, the source of bleeding may be located within the hematoma, but not necessarily in the center.

Becker et al. (3) reported that the frequency of contrast extravasation in patients with spontaneous ICH was 46%. In the study of primary ICH with contrast extravasation during intra-arterial angiography by Yamaguchi et al. (18), the rate of contrast extravasation was 42%. Murai et al. (17) reported that 36% of patients with acute hypertensive ICH had contrast extravasation into a hematoma by a MRI scan. In our study, the incidence of contrast extravasation (33%) is similar to those observed by the other studies described above.

Because hematoma enlargement occurs primarily in the early hours after onset of symptoms, one would expect that the risk of extravasation would be higher in patients with a shorter time interval from onset of symptom to CT angiography (12, 13). In our study, the time interval from symptom onset to CT angiography in patients with contrast extravasation was significantly shorter than in patients without extravasation ($p < 0.001$). However, the difference in the time interval between two subgroups with contrast extravasation was not significant ($p = 0.882$).

There have been numerous efforts to identify clinical and radiological characteristics predictive of clinical outcome of a patient. Among several factors that influence the outcome, hematoma size and GCS have been considered as the most reliable independent factors to predict outcome in spontaneous ICH. Broderick et al. (19) reported that volume of hematoma is the strongest predictor of outcome for all locations of spontaneous ICH. Spontaneous ICH is usually a monophasic event, but sometimes bleeding can persist up to several hours after onset. Spontaneous ICH combined with persistent bleeding may lead to enlargement of an existing hematoma. This enlarging hematoma is associated with a poor outcome (9 - 11). The incidence of hematoma enlargement is about 14 to 20% on a CT scan (12, 13). Becker et al. (3) reported that the GCS and hematoma volume were significantly associated with contrast extravasation. Presumably, contrast extravasation indicates an ongoing hemorrhage and would therefore predispose to hematoma enlargement. Hallevy et al. (20) reported that a strong association was found between ICH mass effect and size, intraventricular extension, a decreased level of consciousness and a poor outcome. These findings are concordant with our results that show a strong association between contrast extravasation and a larger hematoma volume, the presence of IVH and SAH, a lower level of consciousness, a lower GCS, and a poor outcome. In our study, the actual incidence of hematoma enlargement was not evaluated because most cases with contrast extravasation underwent decompressive surgery before the follow-up CT scans. However, we believe that contrast extravasation is a marker for continued bleeding that is associated with an enlarging hematoma and poor outcome. In the group with contrast extravasation, there was no significant difference in hematoma volume between the two types of contrast extravasation, although clinical outcome was more favorable for the Type A group.

Contrast extravasation is associated with hypertension and it implies that elevation in blood pressure might contribute to the risk of continued hemorrhage. Elevated blood pressure at admission has been associated with increased mortality, increased hematoma size, and hematoma enlargement (8, 21). However, in our study, we failed to find a significant difference in blood pressure between the group with contrast extravasation and the group without extravasation.

Broderick et al. (22) reported that operative removal of hemorrhage was associated with decreased 30-day mortality, after adjusting for the volume of ICH and IVH, initial GCS, age, and the location of hemorrhage. However, overall morbidity and mortality were not significantly different in patients who underwent surgery when compared with patients that did not undergo surgery. In a randomized study of 52 patients, Juvela et al. (23) also reported that there was no significant difference in morbidity and mortality for patients who underwent surgery and those who did not. Although the present study was not designed to evaluate the effectiveness of operative decompression on a hematoma, and is not a randomized treatment trial of ICH, our results also show that there was no significant difference in mortality between the two groups with regard to surgery.

IVH can be divided into primary and secondary IVH according to the bleeding source. If bleeding originates from a source within the ventricle, it is a primary IVH, and it has a favorable outcome. However, if it results from extension of a parenchymal hemorrhage, it is a secondary IVH (7, 24). Weerd et al. (25) first described the difference in prognosis between a primary IVH and secondary IVH. Several studies have also described that an IVH from extension of a parenchymal ICH is associated with poor outcome (26, 27). In these studies, IVH tends to occur in patients with larger parenchymal hemorrhages, which is itself of adverse prognostic significance. Tuhrim et al. (4) suggested that the volume of intraventricular blood is an independent predictor of outcome and a more important contributor to mortality after ICH than the mere presence of an IVH. We did not evaluate the volume of IVH, but the rate of IVH is significantly higher in patients with contrast extravasation, as compared to patients without extravasation. The mortality rate in patients with contrast extravasation was significantly higher than in patients without extravasation. Furthermore, patients with Type B contrast extravasation had a higher rate of IVH than those with Type A extravasation. We believe that a beaded-tubular appearance of contrast extravasation in patients with Type B may be associated with more aggressive ongoing bleeding than in patients with Type A that is a dot-like extravasation. If continued bleeding in the parenchymal hemorrhage is aggressive, then the chance of extension of hemorrhage into the ventricle would be elevated. Previous results concerning the relationship between secondary IVH and poor outcome are consistent with our results.

For several years, a conventional single-detector CT (SDCT) scan has helped to make a diagnosis of ICH and has provided detailed anatomical information about the location and size of the hematoma. Unlike a conventional brain CT scan, SDCT angiography has a limited role in evaluating cranial vessels because of its lower spatial resolution, longer acquisition time, and motion artifact. However, MDCT has opened new frontiers for CT angiography. It is now possible to cover larger areas with higher spatial and temporal resolution. This is a decisive improvement for CT angiography of the brain, which makes it more competitive with magnetic resonance angiography and conventional angiography (28, 29). For spontaneous ICH with combined contrast extravasation, MDCT angiography would be better for not only detecting contrast extravasation itself, but also evaluating its three-dimensional radiological findings to predict patient outcome than with a conventional SDCT scan.

There are some limitations in our study. First, our study was retrospective and the number of patients with acute spontaneous ICH was relatively small. Second, institutional criteria for surgical decompression of hematoma are dependent on the advice of a neurosurgeon. This may cause a poor statistical relationship in clinical outcome between patients who underwent surgical intervention and those who did not. Third, the statistical power for the analysis of two types of contrast extravasation is limited because the sample size is small. Finally, we did not compare all possible risk factors between patients with contrast extravasation and those without extravasation, because some factors were not available on the clinical records and this study was not designed to identify all independent predictive risk factors for contrast extravasation.

In conclusion, we have demonstrated the characteristic findings of contrast extravasation into a spontaneous ICH and have classified them into two subgroups according to the morphology. On statistical analysis, we found a significant difference in the mortality rate between patients with contrast extravasation and those without extravasation. In patients with contrast extravasation, there is a trend toward shorter time interval from symptom onset to CT angiography, a lower level of consciousness and GCS, a larger hematoma volume, a higher rate of IVH and SAH, and poor clinical outcome. Type A contrast extravasation is also significantly different from Type B contrast extravasation in the rate of IVH and the clinical outcome. We believe that early detection of contrast extravasation in patients with acute spontaneous ICH on MDCT angiography is important in predicting the outcome of the patient.

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급성 자발성 뇌내혈종 내로의 조영제 유출에 대한 다중검출 전산화단층촬영 혈관조영술의 영상의학적 소견 및 임상적 의의[1]

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목적: 다중검출 전산화단층촬영(MDCT) 혈관조영술에서 발견된 급성 자발성 뇌내혈종 내로의 조영제 유출에 관한 영상소견과 임상적 의의를 알아보고자 하였다.

대상과 방법: 급성 자발성 뇌내혈종으로 MDCT 혈관조영술을 시행한 115명을 대상으로 조영제 유출 여부에 따라 두 집단으로 나누어 조영제 유출과 관련된 위험인자와 임상소견 및 예후에서 두 집단 간에 유의한 차이가 있는지 알아보았다. 조영제 유출이 있었던 집단을 그 모양에 따라 다시 두 집단으로 나누어 임상소견 및 예후에 유의한 차이가 있는지 분석하였다. 점 모양의 조영제 유출이 있으면 유형 A로, 관 모양 및 혼합형의 유출이 있으면 유형 B로 분류하였다.

결과: MDCT 혈관조영술에서 혈종 내로의 조영제 유출은 33%에서 관찰되었다. 조영제 유출이 있는 집단에서 혈종의 크기가 더 컸고, 뇌실 및 지주막하출혈의 빈도가 높았으며, 증상발현 후 검사 시행까지의 시간 간격은 더 짧았고, 글라스고우혼수척도가 더 낮았고, 사망률은 더 높았다. 조영제 유출이 있었던 집단에서는 유형 A가 42%, 유형 B가 58%에서 관찰되었다. 유형 B에서는 뇌실 내 출혈의 빈도가 높았고 예후는 유형 A에서 유의하게 좋았다.

결론: 유형 A와 B 사이에는 뇌실 내 출혈의 빈도 및 예후에서 유의한 차이가 있다. MDCT 혈관조영술을 이용하여 초기에 조영제 유출을 발견하고 특징적인 영상소견에 따라 유형을 분류해 봄으로써 환자의 예후를 예측하는 데에 도움을 얻을 수 있다.