Aneurysmal Rupture during Angiography

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***THE AIM* OF the present study was to analyze the clinical data on rebleeding in cerebral aneurysms during angiography and to evaluate the importance of the time interval between the latest rupture and angiography. Fourteen personal cases and 202 patients reported in the literature are reviewed. Rebleeding during angiography occurred most often (78%) on Day O; 89% bled when angiography was performed within 6 hours of the latest rupture. The prognosis in such ruptures was poor, with a mortality of 79%. Intentional delay in angiography of at least 6 hours from the latest rupture is recommended if the associated hematoma is not large.** (Neurosurgery 33:798–803, 1993)

Key words: Aneurysm, Angiography, Operative timing, Rebleeding

The incidence of rebleeding in cerebral aneurysms in the acute stage (i.e., Day O) is not known. That rebleeding occurs more frequently during the acute phase (Day O) than in the subsequent stages is being currently debated (4, 30, 35, 37, 41). Rebleeding during angiography has been described, but the mechanisms involved remain unclear. To understand this phenomenon, we analyzed 14 personal cases (from a series of 430 consecutive ruptured aneurysms) and reviewed the data on 202 cases reported in the literature (1–6, 8–22, 24–28, 30–34, 36–40, 42–47, 49–81).

PATIENTS AND METHODS

During the past 7 years, 430 ruptured intracranial aneurysms were treated at our hospital. Computed tomography (CT) and angiography were performed routinely (except for 12 patients who were critically ill), and 14 of the 418 patients had an episode of rebleeding during angiography. Rebleeding was confirmed by extravasation of the contrast and was strongly suggested by a remarkable increase in the size of the clot on a postangiography CT scan. There were 12 women and 2 men aged between 44 and 90 years (mean, 63 yr). Angiography was performed under local anesthesia by infiltrating procainamide at the puncture site. Modified neuroleptanalgesia, with pentazocine and diazepam, was also used in several cases. Intravenous administrations of trimetaphan camsylate were used to control the systolic blood pressure when indicated. During the first 4 years of the study, angiography was performed at the earliest time after a CT scan. For the last 3 years, we have intentionally delayed angiography until at least 6 hours after the latest episode of bleeding.

The following data on our 14 patients were reviewed retrospectively: 1) age and sex; 2) size of the aneurysm; 3) location; 4) multiplicity; 5) angiographic technique; 6) contrast material; 7) clinical grades both before and after angiography; 8) time interval between the latest rupture and angiography; 9) treatment; and 10) outcome.

RESULTS

Fourteen of the 418 consecutive patients with ruptured aneurysms bled during angiography—an incidence of 3.3% (*Table 1*). There were 13 saccular aneurysms and 1 dissecting aneurysm varying from 5 mm to 13 mm in long diameter (mean, 7.3 mm). The long diameter was measured in 11 patients: only 3 patients were excluded; 1 had a dissecting aneurysm; in 1, the dome of the aneurysm was lost during rebleeding; and 1 had a "rupturing" aneurysm where measurement was not possible.

Seven of the aneurysms were on the right side, two were on the left, and five on the midline. The ruptured aneurysm was located on the middle cerebral artery (MCA) in five instances, on the anterior communicating artery and the internal carotid artery (ICA) in three instances each, on the vertebrobasilar system in two patients, and the anterior cerebral artery in one patient. Two patients had multiple aneurysms (two and three aneurysms, respectively).

A direct cervical carotid puncture was performed in 1 patient, retrograde brachial angiography was done in 2 patients, and the Seldinger technique was used in the remaining 11 patients (transfemoral, 10; transbrachial, 1). The contrast material used was amidotrizoic acid (Schering AG., Berlin, Germany) in 6

TABLE 1. Clinical Data on Rebleeding during Angiography[a]

	Rebleeding Episodes during Angiography	No. of Patients Admitted
ACA	1 (7%)	28 (7%)
AComA	3 (21%)	141 (34%)
MCA	5 (36%)	97 (23%)
ICA	3 (21%)	109 (26%)
VB	2 (14%)	43 (10%)
Total	14	418

[a] **ACA, anterior cerebral artery; AComA, anterior communicating artery; ICA, internal carotid artery; MCA, middle cerebral artery; VB, vertebrobasilar system.**

patients and iohexol (Daiichi Pharmaceutical Co., Ltd., Tokyo, Japan) in 8 patients. All injections were made by a mechanical injector. For the common carotid, 8 to 12 ml of the contrast medium was injected at the rate of 8 to 10 ml/s, and 6 to 8 ml of the contrast was used for the vertebral injection at 4 to 6 ml/s. Local anesthetic alone was used in seven patients, and neuroleptanalgesia and general anesthesia were used in one patient each, respectively. Blood pressure control was accomplished by administering nifedipine (10 mg orally) in one patient, and trimetaphan camsylate was administered intravenously in 10 patients.

According to the Hunt and Kosnik (29) grading system, one patient was a Grade II, five were Grade III, three were Grade IV, and five were Grade V. After angiography, the grading of the same group was 10 Grade V patients and 3 Grade IV.

Barring a single patient who presented in the subacute stage, the interval between the episode of bleeding and admission was 23 to 120 minutes (mean, 88 min). The interval between the latest rupture and bleeding during angiography varied from 90 to 240 minutes (mean, 130 min). Eleven patients bled during angiography when it was done on an "as early as possible" basis. Two patients—one a delayed referral and another in whom the angiography was intentionally delayed—also bled during angiography. During the last 3 years, "intentionally" delayed angiography did not result in any such bleeding episodes.

In our series, 10 patients were treated conservatively, 3 underwent clipping, and balloon occlusion was performed in 1 patient. The final outcome was 13 deaths and severe disability in 1 case.

DISCUSSION

Looking back into the management of patients with ruptured intracranial aneurysms, the following points may be relevantly mentioned: 1) the angiographic technique and the contrast agent; 2) the management strategy of ruptured intracranial aneurysms; and 3) the recognition of such aneurysms by the general physicians and the referral pattern. Improvements in angiographic technique have popularized the transfemoral Seldinger procedure over the direct cervical puncture. Similarly, the once toxic and irritating contrast media have given way to the newer nonionic media that are less toxic. On the surgical front, with advances in microsurgical technique, the management strategy for ruptured aneurysms is changing from delayed to early surgery. This brings up the question of early diagnosis and angiography, because patients are referred early and in good grades.

Data from the literature

Since the first report by Abbott et al. (1) on rebleeding during angiography, several such cases have appeared in the literature. Of the 202 reported cases of rerupture during angiography (including our 14 cases), 6 patients did not have saccular aneurysms and hence were excluded from the review. These exceptions were one fusiform aneurysm (28), two traumatic aneurysms (12, 54), one aneurysm on a moyamoya vessel (60), one mycotic (66), and one dissecting aneurysm (our series). Data available on 196 cases with saccular aneurysms were summarized as follows.

Age was available for 140 patients only. The largest group was composed of patients who were in their 5th (38 patients) and 6th decades (37 patients). Twenty-one patients were in their 7th decade, and 20 in their 4th; there were 11 patients in the 8th and 10 patients in the 3rd decade of life. Two patients were in the 9th, and one patient was in the 10th decade. Sex was distinguished in 164 patients—108 women and 56 men. The laterality of the aneurysm was described in 153 patients. Sixty-two aneurysms were on the right, 44 were on the left, and 47 were on the midline. The location of the aneurysm was described in 179 patients (*Table* 2).

The time interval between the latest rupture and angiography was available for study in 179 patients (*Table* 3). Among the 139 patients with rebleeding on Day 0, a detailed time interval between the latest rupture and the rebleeding was available in 108 patients. Sixty-seven patients (62%) developed another rupture within 3 hours, another 29 in 6 hours (27%), 6 in 9 hours (6%), 3 in 12 hours (3%), 2 in 18 hours (2%), and 1 in 24 hours (1%). Thus, 96 patients (89%) developed rebleeding within 6 hours from the ictus. These data are shown in *Figure 1.*

TABLE 2. The Location of the Reruptured Aneurysms during Angiography (179 cases)[a]

Location	n	%
ICA	61 cases	(34)
MCA	59	(33)
AComA	43	(24)
ACA	6	(3)
VB	10	(6)

[a] **ACA, anterior cerebral artery; AComA, anterior communicating artery; ICA, internal carotid artery; MCA, middle cerebral artery; VB, vertebrobasilar system.**

TABLE 3. Time Interval between the Latest Rupture and Angiography (179 cases)

Time Interval	n	%
Day 0	139	(78)
1 week	24	(13)
2 weeks	8	(5)
1 month	7	(4)
2 months	1	(1)

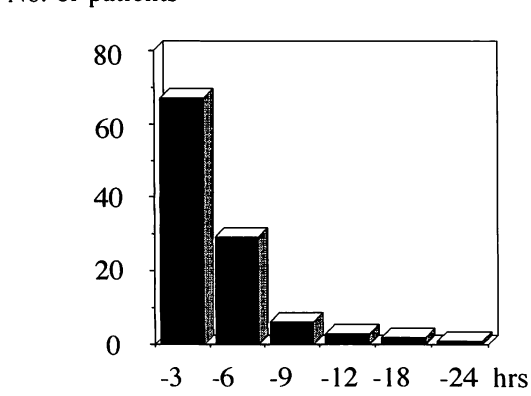

FIGURE 1. Graph shows the time interval from the latest rupture to the angiography on Day 0.

Angiographic technique was described in 90 patients. A direct puncture of the carotid artery was performed in 52 patients. The Seldinger technique was employed in 33 patients (through 1 transbrachial [in our series] and 32 transfemoral routes). Rupture occurred in one patient when a direct puncture of the carotid artery was combined with contralateral carotid compression (77). In four patients, rebleeding occurred during carotid compression in the neck (49, 81). The specific anesthetic technique was described in 81 patients (although local anesthesia was probably used in all patients). Local anesthesia was employed in 35 patients, neuroleptanalgesia in 28 patients, and general anesthesia in 18 patients.

The clinical grades before and after angiography were described in 154 and 129 patients, respectively. The clinical grades before angiography were 0 in 1 patient (17), II in 14 patients, III in 35 patients, IV in 50 patients, and V in 54 patients. Grades after the angiography were I in 1 patient, II in 2 patients, III in 3 patients, IV in 21 patients, and V in 102 patients.

Forty-five patients were treated by clipping. The other modes of treatment such as balloon occlusion and carotid ligation (excluding ventricular drainage) were performed in 10 patients. Ninety-eight patients were treated conservatively (including ventricular drainage). Forty-one patients had ventricular rupture, and 90 did not. Nine patients with ventricular rupture were alive, and 32 had died. Sixteen patients without ventricular rupture were alive, and 74 had died.

The details of the final outcome were available on 192 patients. Nineteen patients made a good recovery, 11 had a moderate disability, 5 had a severe disability, and 152 patients had died. In addition, five patients were simply described as being alive. Thus, 40 patients were alive and 152 had died. The rate of good recovery was 10%, and the survival rate was 21%. The mortality rate was 79%.

Timing of rebleeding during angiography

Rebleeding in ruptured aneurysms has been reported to occur more often within the first 24 hours than later (4, 30, 35, 37, 41). Within the first 24 hours, there are reports indicating that the rebleeding occurs more often within 6 hours of the ictus (4, 30). Our data and other reports (4, 30–32, 44, 58, 68) have shown that rebleeding during angiography often occurs within 6 hours from the time of the latest ictus (*Fig. 1*). Whether this rebleeding within 6 hours occurs as a natural course or is induced by angiography remains unclear. A comparison between the natural incidence of rebleeding and the incidence of rebleeding during angiography will have to be studied to evaluate the role and the risk of early angiography in ruptured intracranial aneurysms. Ito et al. (31) and Inagawa et al. (30) report that the incidence of rebleeding during angiography was significantly higher than the incidence of rebleeding during the initial 5 to 6 hours in the natural course of events.

Location of the reruptured aneurysms

The aneurysms that rebled were more common in the anterior circulation, which coincides with the greater frequency of aneurysms in this territory. The incidence of angiographic rebleeding was the highest for MCA aneurysms in our series, but the reviewed literature indicated a higher incidence of angiographic rupture for ICA and MCA aneurysms. It may be recalled that the MCA, anatomically, is a continuation of the ICA, and relevant changes in the intravascular pressure may be transmitted from the ICA to the MCA.

Change of the intraluminal blood pressure during angiography

Changes in blood pressure during contrast injections have been reported. Although Bakay and Sweet (7) and Greitz (23) showed no significant increase in the intraluminal pressure within the ICA during contrast injections, Lin et al. (48) showed a transient increase in the intraluminal pressure within the ICA after brachial injections. An abrupt increase in the intraluminal pressure in the ICA, if any, could lead to the rupturing of the aneurysm. This pressure change may be transmitted to the MCA territory also.

Incidence of rebleeding during angiography

A rate of 3.3% of rebleeding in our series is almost the same as 3.1% (26 of 837 patients) reported by Sampei et al. (68), who had performed angiography on an "as early as possible" basis. We think that angiography on this basis has a potential risk of about 3% of rerupture during the procedure. Angiographic rebleeding predictably worsened the patients' clinical grading, and the outcome was obviously poor with a 79% mortality rate. Among the survivors, about 10% made a good recovery, indicating what chances of recovery these patients have (16, 44, 68, 71).

CONCLUSIONS

We believe that diagnostic angiography may be reasonably and safely delayed for about 6 hours to avoid the high-risk period. During this waiting period, the patients are adequately sedated and their blood pressure is kept under control. This, however, may not apply to patients with large hematomas demanding emergency surgery.

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REFERENCES

1. Abbott KH, Gay JR, Goodall RJ: Clinical complications of cerebral angiography. **J Neurosurg** 9:258–274, 1952.
2. Allan DM, Witcombe JB: Intracranial extravasation of contrast medium during carotid angiography. **Br J Radiol** 50:404–411, 1977.
3. Allcock JM: Radiology of the skull and brain, in Newton TH, Potts GD, (eds): *Angiography*. C.V. Mosby Co., St. Louis, 1974, vol 2, Book 4, pp 2442–2443.
4. Ando T, Sakai N, Yamada H, Iwai T, Nishimura Y, Hirata T, Funakoshi T, Takada M: Analysis of reruptured cerebral aneurysms and the prophylactic effects of barbiturate therapy on the early stage. **Neurol Res** 11:245–248, 1989.
5. Aoyagi N, Hayakawa I: Rerupture of intracranial aneurysms during angiography. **Acta Neurochir (Wien)** 98:141–147, 1989.
6. Appel L: Visualisation angiographique du passage du produit de contraste dans un hématome sur anévrysme intracranien. **Ann Radiol (Paris)** 6:146–150, 1963.
7. Bakay L, Sweet WH: Cervical and intracranial intra-arterial pressures with and without vascular occlusion. **Surg Gynec Obstet** 95:67–75, 1952.
8. Beamer YB, Corsino JF, Lynde RG: Rupture of an aneurysm of the internal carotid artery during arteriography with filling of the subarachnoid space and demonstration of a temporal lobe mass. Case report. **J Neurosurg** 31:224–226, 1969.
9. Bortoluzzi M, Di Lauro L, Poli R, Marini G: Extravasation of contrast medium from cerebral aneurysmal rupture during angiography. Remarks on four cases. **J Neurosurg Sci** 23:133–140, 1979.
10. Cerniauskas PV, Zimman HM, Gentile LR, Gastaldi GR: Ruptura de un aneurisma intracraneano durante la angiografía cerebral. **Pren Méd Argent** 57:1155–1157, 1970.
11. de Tribolet N, Oberson R, Zander E: Perangiographic rupture of a right posterior communicating artery aneurysm. **Neurochirurgia** 19:26–29, 1976.
12. Deecke L, Goldscheider HG, Rittmeyer K: Aneurysmal rupture during angiography. **Arch Psychiat Nervenkr** 226:37–42, 1978.
13. Drury PJ, Powell T: Renewed bleeding of a posterior inferior cerebellar artery aneurysm during vertebral angiography. **Postgrad Med J** 56:720–723, 1980.
14. Dublin AB, French BN: Cerebral aneurysmal rupture during angiography with confirmation by computed tomography: A review of intra-angiographic aneurysmal rupture. **Surg Neurol** 13:19–26, 1980.
15. Esposito S, Delitala A: Rupture of aneurysms during angiography. **Neurochirurgia** 27:150–153, 1984.
16. Faulhauer K, Mühler E: Kontrastmittelextravasat aus einem Karotisaneurysma in das Ventrikelsystem. **Nervenarzt** 48:621–625, 1977.
17. Feild JR, Robertson JT, Desaussure RL: Complications of cerebral angiography in 2000 consecutive cases. **J Neurosurg** 19:775–781, 1962.
18. Ferrari G, Vio M: Radiological demonstration of rupture of a carotid aneurysm during cerebral angiography. Case report. **J Neurosurg** 31:462–464, 1969.
19. Freemon FR: Dye entering subarachnoid space through a bleeding intracranial aneurysm. **JAMA** 211:295–296, 1970.
20. Gallagher JP, Yamamoto YL: Rupture of an intracranial aneurysm following arteriography: Case report. **Bull Georgetown Univ Med Center** 9:97–99, 1956.
21. Gerlock AJ: Rupture of posterior inferior cerebellar artery aneurysm into the subarachnoid space during angiography. Case report. **J Neurosurg** 42:469–472, 1975.
22. Goldstein SL: Ventricular opacification secondary to rupture of intracranial aneurysm during angiography. Case report. **J Neurosurg** 27:265–267, 1967.
23. Greitz T: A radiological study of the brain circulation by rapid serial angiography of the carotid artery. **Acta Radiol (suppl)** 140:21–33, 1956.
24. Handa J, Aoyama I, Handa H: Extravasation from an intracranial aneurysm during angiography. Case report. **Arch Jap Chir** 43: 302–306, 1974.
25. Haraguchi S, Tsubouchi T, Ebina K, Suzuki K, Takita K, Kohgo T: Clinical significance of extravasation from intracranial aneurysm during angiography (in Japanese). **Neurol Surg (Tokyo)** 9:285–293, 1981.
26. Hayakawa I, Watanabe T, Tsuchida T, Sasaki A: Perangiographic rupture of intracranial aneurysms. **Neuroradiology** 16:293–295, 1978.
27. Henry MMP, Guerin J, Vallat JM, Pouyanne H: Extravasation per-angiographique du produit de contraste au cours des ruptures d'aneurysmes (àpropos de 2 cas). **Neurochirurgia** 14:121–126, 1971.
28. Hoff JT, Potts DG: Angiographic demonstration of hemorrhage into the fourth ventricle. Case report. **J Neurosurg** 30:732–735, 1969.
29. Hunt WE, Kosnik EJ: Timing and preoperative care in intracranial aneurysm surgery. **Clin Neurosurg** 11:79–89, 1974.
30. Inagawa T, Kamiya K, Ogasawara H, Yano T: Rebleeding of ruptured intracranial aneurysms in the acute stage. **Surg Neurol** 28: 93–99, 1987.
31. Ito S, Kwak R, Emori T, Nakamura T, Kadoya S, Fuji T, Suzuki T: Risk factors of cerebral aneurysm re-rupture during angiography (in Japanese). **Neurol Surg (Tokyo)** 13:399–407, 1985.
32. Iwa H, Kyoi K, Tsunoda S, Yokoyama K, Imanishi M, Utsumi S: Clinical characteristics of contrast medium extravasation from intracranial aneurysm during cerebral angiography: Study on personal experience and review from literature (in Japanese). **Neurol Surg (Tokyo)** 14:263–270, 1986.
33. Jackson JR, Tindall GT, Nashold BS: Rupture of an intracranial aneurysm during carotid arteriography. A case report. **J Neurosurg** 17:333–336, 1960.
34. Jamieson KG: Rupture of an intracranial aneurysm during cerebral angiography. **J Neurosurg** 11:625–628, 1954.
35. Jane JA, Kassell NF, Torner JC, Winn HR: The natural history of aneurysms and arteriovenous malformations. **J Neurosurg** 62: 321–323, 1985.

36. Jenkinson EL, Suger O, Love H: Rupture of an aneurysm of the internal carotid artery during cerebral angiography. Case report. **AJR** 71:958–960, 1971.
37. Juvela S: Rebleeding from ruptured intracranial aneurysms. **Surg Neurol** 32:323–326, 1989.
38. Karadayi A, Lindqvist M, Tovi D: Rupture of an intracranial aneurysm with ventricular opacification during angiography: Case report. **Neurochirurgia** 16:59–62, 1973.
39. Kamiyama K, Onuma T, Sakamoto T, Suzuki J: Intraventricular extravasation of contrast media through ruptured intracranial aneurysm - report of two cases (in Japanese). **Neurol Surg (Tokyo)** 6:1005–1013, 1978.
40. Kashiki Y, Ando T, Ohashi H, Yamada H, Sakata K: Ventricular opacification due to rupture of an intracranial aneurysm during cerebral angiography. Case report (in Japanese). **Brain Nerve (Tokyo)** 27:519–525, 1975.
41. Kassel NF, Torner JC: Aneurysmal rebleeding: A preliminary report from the cooperative aneurysm study. **Neurosurgery** 13:479–481, 1983.
42. Kobayashi K, Nakajima K, Suzuki A, Oota H, Sayama I, Ito Z: Ruptured cerebral aneurysm with extravasation of contrast material. Proceedings of The 10th Tohoku Noushinnkeigeka Shudankai (in Japanese), p 64, 1978 (abstr).
43. Koenig GH, Marshall WH, Poole GJ, Kramer RA: Rupture of intracranial aneurysms during cerebral angiography: Report of ten cases and review of the literature. **Neurosurgery** 5:314–324, 1979.
44. Koga H, Kaneko M, Hosaka Y: Extravasation from aneurysms during angiography. **Surg Neurol** 12:453–456, 1979.
45. Koike T, Ishii R, Kameyama S, Ihara I, Takeuchi S, Kobayashi K: Clinical analysis of cerebral vasospasm following subarachnoid hemorrhage. Part I: Sequential changes of incidence and degree and its clinical significance (in Japanese). **Neurol Med Chir (Tokyo)** 19:793–800, 1979.
46. Lehrer HZ, Gross LA, Poon TP: Ruptured intracranial aneurysm. Contrast agent extravasation during brachial arteriography. **Arch Neurol** 27:351–353, 1972.
47. Liliequist B, Lindqvist M, Probst F: Rupture of intracranial aneurysm during carotid angiography. **Neuroradiology** 11:185–190, 1976.
48. Lin JPT, Kricheff II, Chase NE: Blood pressure changes during retrograde brachial angiography. **Radiology** 83:640–646, 1964.
49. Liu CT: Rupture of cerebral aneurysm during angiography. **California Med** 103:54–55, 1965.
50. Marc JA, Schechter MM, Azar-Kia B: Intraventricular bleeding from cerebral aneurysmal rupture. **Neuroradiology** 5:184–186, 1973.
51. Mironov A, Marquardt B, Thron A: Rupture of intracranial aneurysms during angiography and CT: Coincidental or causal event? A case report. **Neurochirurgia** 27:146–149, 1984.
52. Murphy DJ, Goldberg RJ: Extravasation from an intracranial aneurysm during carotid angiography. Case report. **J Neurosurg** 27:459–461, 1977.
53. Murray JB, Wortzman G: Contrast medium extravasation from aneurysmal rupture during cerebral angiography. **Clin Radiol** 28: 277–285, 1977.
54. Nakamura T, Matsuoka Y, Nishimura S: Traumatic cerebral aneurysm showing remarkable extravasation into the lateral ventricle—Report of a case in an infant (in Japanese). **Neurol Surg (Tokyo)** 5:371–378, 1977.
55. Nakao S, Kondo A, Ishikawa J, Yamasaki T, Hiwatashi S, Aoyama I, Makita Y: Ventricular opacification during carotid arteriography due to a rupture of anterior communicating aneurysm (in Japanese). **Rinsho Hoshasen** 25:485–488, 1980.
56. Noda S, Tamaki N, Yamaguchi M, Matsumoto S: Giant suprasellar aneurysm with extravasation of contrast medium into the ventricular system. **Surg Neurol** 13:208–210, 1980.
57. Odom GL: Cerebral vasospasm. **Clin Neurosurg** 22:29–58, 1975.
58. Ohata M, Kawanuma S, Inaba Y: Rupture of intracranial aneurysm due to cerebral angiography (in Japanese). **Neurol Surg (Tokyo)** 3:435–441, 1975.
59. Ohi Y, Ueki S, Isoda H: Rupture of a giant aneurysm of the internal carotid artery during cerebral angiography (in Japanese). **Rinsho Hoshasen** 24:953–956, 1979.
60. Okuma A, Oshita H, Funakoshi T, Shikinami A, Yamada H: A case of an aneurysm in the cerebral moyamoya vessel—aneurysmal rupture during cerebral angiography and spontaneous regression of the aneurysm (in Japanese). **Neurol Surg (Tokyo)** 8:181–185, 1980.
61. Osgood C, Martin LG: Intraventricular contrast extravasation during carotid angiography. **Surg Neurol** 2:49–50, 1974.
62. Palmieri A, Liguori R, De Rosa R: A propos d'un cas de rupture d'anéurysme artériel sacculaire intracranien au cours d'une artériographie. **Ann Radiol (Paris)** 14:943–947, 1971.
63. Perret G, Nishioka H: Report on the cooperative study of intracranial aneurysms and subarachnoid hemorrhage. Section IV. Cerebral angiography. An analysis of the diagnostic value and complications of carotid and vertebral angiography in 5484 patients. **J Neurosurg** 25:98–114, 1966.
64. Pirker E : Aneurysmaruptur während einer Karotisangiographie. **Fortschr Röntgenstr** 100:415–416, 1964.
65. Pool JL, Potts DG: *Aneurysms and Arteriovenous Anomalies of the Brain. Diagnosis and Treatment.* New York, Harper & Row, 1965, pp 116–117, 122–123.
66. Roach MR, Drake CG: Ruptured cerebral aneurysma caused by micro-organisms. **N Engl J Med** 273:240–244, 1965.
67. Sakamoto T, Yoshimoto T, Suzuki J: Extravasation from an intracranial aneurysm during carotid angiography (in Japanese). **Brain Nerve (Tokyo)** 24:603–606, 1972.
68. Sampei T, Yasui N, Mizuno M, Nakajima S, Ishikawa T, Hadeishi H, Suzuki A: Contrast medium extravasation during cerebral angiography for ruptured intracranial aneurysm. Clinical analysis of 26 cases (in Japanese, English abstr). **Neurol Med Chir (Tokyo)** 30:1011–1015, 1990.
69. Shirohata N, Ikuno H, Mishima Y, Tei T, Suzuki T, Nakamura T, Hashi K, Nishimura S: Rupture of cerebral aneurysm during angiography (in Japanese). **Jpn J Stroke** 1:146–147, 1979.
70. Someda K, Yasui N, Moriwaki Y, Kawamura Y, Matsumura H: Extravasation of contrast material into subdural space from internal carotid aneurysm during angiography. Case report. **J Neurosurg** 42:473–477, 1975.
71. Takahashi Y, Inoue K, Tsuruta J, Oogawara S, Shimizu K: Emergency operation for ruptured cerebral aneurysm during angiography (in Japanese). **Jpn J Stroke** 1:254, 1979 (abstr).
72. Taveras JM, Wood EH: *Diagnostic Neuroradiology.* Baltimore, Williams & Wilkins, 1976, p 929.
73. Teal JS, Wade PJ, Bergeron RT, Rumbaugh CL, Segall HD: Ventricular opacification during carotid angiography secondary to rupture of intracranial aneurysm. Case report. **Radiology** 106:581–583, 1973.
74. Triska H: Ein Fall von Kontrastmittelextravasat bei einem ruptierten Aneurysma der Art cerebri media. **Zbl Neurochir** 22:291–295, 1962.
75. Todorow S, Oldenkott P: Rupture of an intracranial aneurysm of the carotid artery with ventricular visualization during angiography. **Neurosurg Rev** 4:95–99, 1981.

76. Tsuda H, Imai T: Rupture of an aneurysm during cerebral angiography. A survival case report (in Japanese). **Myakangaku** 11: *303–306, 1971.*
77. Vines FS, Davis DO: Rupture of intracranial aneurysm at angiography. Case report and comment on causative factors. **Radiology** 99:353–354, 1971.
78. Waga S, Kondo A, Moritake K, Handa H: Rupture of intracranial aneurysm during angiography. **Neuroradiology** 5:169–173, 1963.
79. Watanebe K, Togyu Y, Nishimura H, Konno T: Three cases of hypertensive intracerebral hematomas and a case of cerebral aneurysm with extravasation (in Japanese). Proceedings of the The 10th Tohoku Noushinnkeigeka Shudankai, p 64, 1978 (abstr).
80. Wilkins RH: Aneurysmal rupture during angiography: Does acute vasospasm occur? **Surg Neurol** 5:299–303, 1976.
81. Wright RL: Pressure considerations in carotid compression during angiography. **J Neurosurg** 19:375–377, 1962.

COMMENTS

Komiyama and colleagues have brought us up-to-date on the often discussed and much feared complication of aneurysmal rupture during angiography. In my aneurysm experience, this complication is extremely rare, but one cannot help but speculate that early and ultraearly aneurysm surgery demands urgent angiography, which may well substantially increase the risk of recurrent hemorrhage from the ruptured sac. Recurrent hemorrhage from an aneurysm is the most feared complication of subarachnoid hemorrhage, and it always results in a worse grade and a worse outcome. This report of a 3.3% incidence of rebleeding and a very similar 3.1% rate of recurrent hemorrhage during angiography reported by Sampei certainly gives one reason to pause before rushing a patient to the angiographic suite in the first 6 hours or, perhaps, even in the first day.

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This article provides some valuable data regarding both the 3% incidence of rerupture of an aneurysm during angiography that is performed within 6 hours of the latest rupture and the poor prognosis in these patients with rerupture. The authors recommended an intentional delay of at least 6 hours from the latest rupture before performing cerebral angiography if there is no large localized hematoma. These are important items of information and should be incorporated into the daily clinical care of patients.

We have experienced two cases of rerupture of intracranial aneurysm during cerebral angiography in our series of over 800 cases. We performed cerebral angiography by the transfemoral approach and internal carotid injection. We postulated that vascular spasm around the catheter may cause a dramatic increase in wedge pressure, resulting in the rerupture of the aneurysm. Since then (1983), we have changed our catheter location to the common carotid artery and have not yet experienced rerupture of an aneurysm during the angiography in our series of 560 cases. I would like to emphasize that our aneurysm work-up with cerebral angiography is usually performed beyond 6 hours after the clinical onset of symptoms.

With the advent of high-resolution digital angiography, nowadays, we perform all our cerebral angiography with a smaller volume of contrast at a slower rate of injection for common carotid studies (volume, 4–5 ml at 3 ml/sec) and vertebral studies (volume, 3–4 ml at 3 ml/sec). It would be interesting to find out the rate of rerupture during angiography with these reduced volumes of contrast and rates of injection.

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