Neuroradiology (1982) 23: 153–156

Neuroradiology

The Time Course of Aneurysmal Haemorrhage on Computed Tomograms

J. van Gijn and K.J. van Dongen

Departments of Neurology and Radiology, University Hospital Rotterdam (Dijkzigt), The Netherlands

Summary. We performed serial CT scans in a prospective series of 100 patients with a ruptured aneurysm who were first scanned within 2 days of the haemorrhage. In all patients the early CT scan showed evidence of extravasated blood. In 96 patients the source of bleeding was clearly at the base of the brain, and 32 of these had a haematoma. We estimated from the results of 139 repeat scans that the probability of recognizing an aneurysmal haemorrhage on CT is 85% after 5 days, 50% after 1 week, 30% after 2 weeks (mostly patients with haematomas), and almost nil after 3 weeks.

Key words: Intracranial aneurysm – Subarachnoid haemorrhage – CT scanning

In the first few days after the rupture of an intracranial aneurysm, computed tomography (CT) shows extravasated blood near the circle of Willis in a high proportion of patients: 100% in some studies [1, 2], 60%–70% in others [3–5], and intermediate percentages in most series [6–14]. The site of the haemorrhage greatly facilitates the distinction from other causes of subarachnoid bleeding such as a cerebellar haematoma [2], and often makes it possible to predict the origin of the ruptured aneurysm [1, 2, 6, 9, 15].

The rate at which the evidence of aneurysmal haemorrhage disappears from the CT scan is not completely known. Some studies never found extravasated blood on CT after day 5 [3], or only rarely [11, 12], and it has been claimed that a positive scan after 1 week is proof of rebleeding [8]. Yet others found persistence of the radiological signs of subarachnoid haemorrhage in the second week [16] or even in the third [17]. We studied the density changes on CT in a prospective series of 100 patients with a ruptured aneurysm in whom the first scan was performed within 2 days of bleeding.

Patients and Methods

Since the end of 1977, all patients with subarachnoid haemorrhage in our care have been immediately investigated by CT, and repeat scans have been performed at least every week or at shorter intervals if clinical deterioration occurred. This protocol was designed for a double-blind clinical trial of tranexamic acid as a possible means of preventing rebleeding [18]; the trial is still in progress. The basis of the present report is formed by 100 consecutive patients who underwent CT within 2 days of subarachnoid haemorrhage, and in whom an aneurysm was subsequently verified by angiography (79) or autopsy (21). The site of the ruptured aneurysm was at the anterior (communicating) artery in 39 patients, the internal carotid artery in 40, the middle cerebral artery in 15, and the posterior circulation in 6 patients.

Results

On the initial CT scan, made on day 0 (day of the haemorrhage), day 1, or day 2, 32 patients showed a haematoma. These haematomas were usually intraparenchymal (28), sometimes in the cavum septi pellucidi (3 patients with aneurysms of the anterior communicating artery), or extracerebral (1). In 64 other patients CT showed extravasated blood in the basal cisterns or fissures, and in the four remaining cases there was only non-specific evidence of subarachnoid blood in the form of increased density of the tentorium near the hiatus [19]. Until operation,

0028-3940/82/0023/0153/$01.00

Table 1. Proportion of patients with persisting evidence of extravasated blood on CT scanning at various times after the initial haemorrhage. The figures are separately shown for patients with and without a haematoma on the first scan

	Days after Haemorrhage									
	0–2	3–5	6	7	8	9	10–13	14–17	18–22	23–29
Patients with haematoma on first scan										
Number of patients scanned	32	4	5	2	7	5	6	7	3	4
Number of patients with haematoma	32	4	5	2	7	5	6	4	2	–
Patients with subarachnoid blood on first scan										
Number of patients scanned	68	8	10	12	11	8	11	18	10	8
Number of patients with extravasated blood in basal cisterns or fissures	64	7	7	5	2	1	1	2	1	–
Number of patients with only non-specific evidence of subarachnoid blood (tentorium)	4	1	1	2	5	2	2	4	–	–

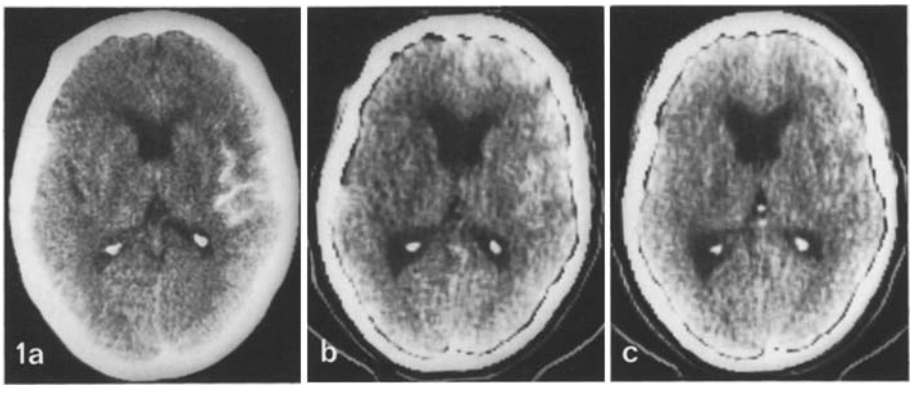

Fig. 1a–c. 59-year-old man with ruptured aneurysm of the right middle cerebral artery. **a** (day 0): blood in the right Sylvian fissure; **b** (day 17): persisting evidence of subarachnoid blood; **c** (day 20): still traces of subarachnoid blood

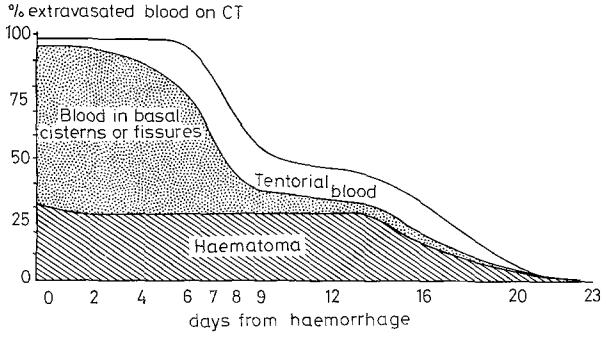

Fig. 2. Time course of density changes on CT after subarachnoid haemorrhage (by extrapolation of the findings in Table 1)

rebleeding, or death, 139 repeat scans were performed in these 100 patients. Surgery was undertaken in 46 patients; the time of operation varied from day 3 to day 32, the median being 11 days.

Table 1 shows, at various points in time, the proportion of patients with persisting evidence of a haematoma or of subarachnoid blood on CT. Most haematomas resolved between day 14 and day 22. The increased attenuation values in the basal cisterns and fissures disappeared more rapidly, usually day 5–9. There were exceptions, however, and one patient showed cisternal blood as long as 20 days (Fig. 1), without clinical signs of rebleeding and with clear and slightly xanthochromic cerebrospinal fluid on day 14. In approximately one-third of the patients with subarachnoid blood, increased density of the tentorial surface remained visible on CT for a few days more than at the base of the brain.

Figure 2 shows the curves that best fit the results of Table 1, expressed as percentages of the remaining patients. The early decline of the proportion of haematomas, from 32% to 28%, reflects the death of six patients with a haematoma on day 0 or day 1. Thereafter, the mortality was approximately similar in patients with or without an intracranial haematoma on the first scan. Figure 2 shows that the probability of detecting a haematoma or a cisternal haemorrhage in patients who have not died, rebled or been operated upon, is 96% after 2 days, 85% after 5 days, 50% after 1 week, 30% after 2 weeks, and almost nil after 3 weeks.

Discussion

It is striking that we found radiological evidence of extravasated blood in all 100 patients who underwent CT within 2 days of aneurysm rupture. In aneu-

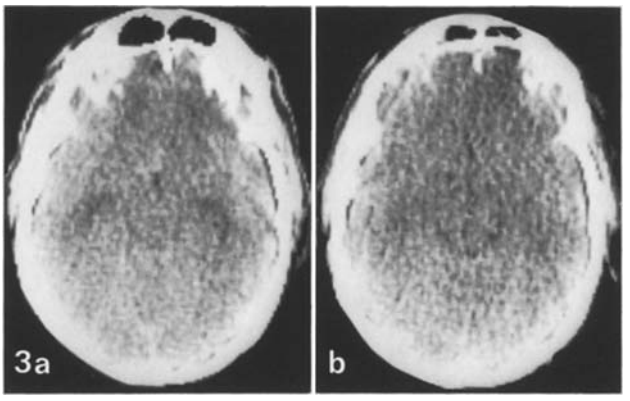

Fig. 3a and b. 49-year-old man with ruptured aneurysm of the anterior communicating artery. **a** (day 1): slight hyperdensity in frontal interhemispheric fissure, anterior to the 3rd ventricle; there is also evidence of blood near the tentorial margin, especially on the left. **b** (day 8): all signs of subarachnoid blood have disappeared, and the attenuation values in the frontal interhemispheric fissure are below that of brain tissue

rysmal haemorrhage the localising value of a haematoma or, to a somewhat lesser extent, cisternal blood is well known. Even the relatively non-specific finding of increased density of the tentorium on CT can be helpful if doubt remains whether a lumbar puncture was traumatic or not. The modest difference between our results and studies that detected CT abnormalities in 84%–95% of patients in the first 2 days after subarachnoid haemorrhage from a ruptured aneurysm [7, 9, 11, 13] might be explained by two factors. First, we accepted even slight density changes in the basal cisterns or fissures as evidence of blood (Fig. 3), whereas at least some other investigators made this diagnosis only when the attentuation values were distinctly above that of brain tissue [12]. Secondly, patients with slight haemorrhages ('warning leaks' [20]) might have been included in other series but, by different referral patterns, not in ours. At any rate, a ruptured aneurysm is rather unlikely if CT scanning shows normal density of all cisterns and fissures within 2 days of the onset of symptoms.

Even after 5 days the characteristic abnormalities are still present in about 85%. After that time, the blood rapidly clears from the basal cisterns and fissures. Intracerebral haematomas did not resolve until after 2 weeks, which is in accordance with a previous study [21]. As a haematoma was present in 28% of the patients who survived the first day, and as subarachnoid blood persists in a few other patients during the second week, approximately one-third of all patients can be expected to show local evidence of aneurysmal haemorrhage after 2 weeks. Presence of cisternal blood for more than a week was found in five patients (seven scans), of whom four were treated with antifibrinolytic drugs. In exceptional cases such as shown in Figure 1, subarachnoid blood can persist as long as 3 weeks on CT. An explanation in this patient might be cerebral ischaemia, which was suggested by adjacent areas of hypodensity on higher CT slices. Blood in a cerebral fissure could be 'trapped' between infarcted and swollen brain tissue, and become isolated from the circulation of the cerebrospinal fluid. If this occurs, the removal of iron pigments and hence the visibility on CT would follow the same time course as for intraparenchymal haematomas.

We conclude from our study that a single CT scan in the second or even third week after the initial bleed is not sufficient for distinguishing between a first and a recurrent haemorrhage.

References

1. Scotti G, Ethier R, Melançon D, Terbrugge K, Tchang S (1980) Computed tomography in the evaluation of intracranial aneurysms and subarachnoid hemorrhage. Radiology 123: 85–90
2. Van Gijn J, van Dongen KJ (1980) Computed tomography in the diagnosis of subarachnoid haemorrhage and ruptured aneurysm. Clin Neurol Neurosurg 82: 11–24
3. Liliequist B, Lindqvist M, Valdimarsson E (1977) Computed tomography and subarachnoid hemorrhage. Neuroradiology 14: 21–26
4. Modesti LM, Binet EF (1978) Value of computed tomography in the diagnosis and management of subarachnoid haemorrhage. Neurosurgery 3: 151–156
5. Davis JM, Davis KR, Crowell RM (1980) Subarachnoid hemorrhage secondary to ruptured intracranial aneurysm: prognostic significance of cranial CT. AJR 134: 711–715
6. Kendall BE, Lee BCP, Claveria E (1976) Computerized tomography and angiography in subarachnoid haemorrhage. Br J Radiol 49: 483–501
7. Moran CJ, Naidich TP, Gado MH, Holloman WG, Shalen PR (1978) Leptomeningeal findings in CT of subarachnoid hemorrhage. J Comput Assist Tomogr 2: 520
8. Weisberg LA (1979) Computed tomography in aneurysmal subarachnoid hemorrhage. Neurology 29: 802–808
9. Brismar J (1979) Computer tomography as the primary radiologic procedure in acute subarachnoid haemorrhage. Acta Radiol 20: 849–864
10. Bryan RN, Shah CP, Hilal S (1979) Evaluation of subarachnoid hemorrhage and cerebral vasopasm by computed tomography. J Comput Tomogr 3: 144–153
11. Bell BA, Kendall BE, Symon L (1980) Computed tomography in aneurysmal subarachnoid haemorrhage. J Neurol Neurosurg Psychiatry 43: 522–524
12. Liliequist B, Lindqvist M (1980) Computer tomography in the evaluation of subarachnoid haemorrhage. Acta Radiol Diagn 21: 327–331
13. Yamamoto M, Jimbo M, Kitamura K, Kobayashi N, Saito Y (1980) Computed tomography in the diagnosis of hemorrhage secondary to intracranial aneurysm. Neurol Surg 8: 623–631

14. Inoue Y, Saiwai S, Miyamoto T, Ban S, Yamamoto T, Takemoto K, Taniguchi S, Sato S, Namba K, Ogata M (1981) Postcontrast computed tomography in subarachnoid hemorrhage from ruptured aneurysms. J Comput Assist Tomogr 5: 341–344
15. Silver AJ, Pederson ME, Ganti SR, Hilal SK, Michelson WJ (1981) CT of subarachnoid hemorrhage due to ruptured aneurysm. AJNR 2: 13–22
16. Isu T, Uemura K, Goto K, Ishi K (1978) Computed tomographic findings in intracranial hemorrhage due to ruptured intracranial aneurysm. Rinsho Hohasen 23: 701–709
17. Weir B, Miller J, Russell D (1977) Intracranial aneurysms: a clinical, angiographic and computerized tomographic study. Can J Neurol Sci 4: 99–105
18. Vermeulen M, Muizelaar JP (1980) Do antifibronolytic agents prevent rebleeding after rupture of a cerebral aneurysm? A review. Clin Neurol Neurosurg 82: 25–30
19. Naidich TP, Leeds NE, Kricheff II, Pudlowski RM, Naidich JB, Zimmerman RD (1977) The tentorium in axial section. I. Normal CT appearance and non-neoplastic pathology. Radiology 123: 631–638
20. Gillingham FJ (1967) The management of ruptured intracranial aneurysms. Scott Med J 12: 377–383
21. Dolinskas CA, Bilaniuk LT, Zimmerman RA, Kuhl DE (1977) Computed tomography of intracerebral hematomas. I. Transmission CT observations on hematoma resolution. AJR 129: 681–688

Received: 1 March 1982

Dr. J. van Gijn
Department of Neurology
University Hospital Rotterdam
(Dijkzigt)
Dr. Molewaterplein 40
NL-3015 GD Rotterdam
The Netherlands