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# Direct Visualization of Intracranial Aneurysms by Multiplane Dynamic CT

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**Using an intravenous injection of 100–150 ml contrast medium (flow, 1–1.5 ml/sec) adjacent 2-mm-thick cuts are scanned at the level of the circle of Willis. After highlighting and multilevel image summation a complete picture of the vascular anatomy of the base of the brain is obtained. In this way aneurysms as small as 2–3 mm in diameter can be detected. The method has high reliability, as indicated by the results in 31 cases.**

Computed tomography (CT) is the method of choice for the detection of subarachnoid or parenchymatous hemorrhage after rupture of an intracranial vascular malformation. Therefore, many physicians attempt to predict the probable site of a ruptured vascular malformation on the basis of the CT location of blood clots in the subarachnoid spaces [1, 2].

The direct visualization of intracranial aneurysms after contrast medium administration (infusion) is only possible in a limited number of cases [1–6]. It is obvious that detectability depends on the size and location of the aneurysm as well as on the cut thickness and spatial resolution of the scanner. In the case of ruptured aneurysms with massive subarachnoid or parenchymatous hemorrhage the possibility for detection of the aneurysm is questionable. Bryan et al. [3] reported definite evidence of aneurysm in seven (15%) of 46 cases with subarachnoid hemorrhage. In a series of 34 subarachnoid hemorrhages reported by Findlay [4], the aneurysm was shown in 16 cases (47%). Only three of nine aneurysms of the anterior communicating artery were directly visualized in the report of Yock and Larson [1]. Zuccarello et al. [2] reported a direct visualization in 13 (26%) of 50 cases; and Inoue et al. [5] in eight (30%) of 27 cases. Weisberg [6] reported 27 directly visualized intracranial aneurysms, but without statistical data. In our investigations of 104 intracranial aneurysms, definite evidence of an aneurysm could be observed in 10 (26%) of 39 cases that were examined after contrast medium administration (infusion).

With dynamic CT methods, single or multiplane, some authors have reported an excellent imaging of the vascular anatomy of the brain (computed angiography) [7–12]. We describe a method for the detection of small intracranial aneurysms using multiplane dynamic CT.

## Materials and Methods

A dynamic study is always preceded by a plain scan because the plain scan might give important information about the location and the intensity of a subarachnoid and/or parenchymatous hemorrhage. The location of blood clots allows an estimation of the

probable site of hemorrhage origin (e.g., circle of Willis, middle cerebral artery, or vertebrobasilar system). On the other hand, one must know the maximal attenuation of the hemorrhage in the plain scan, so that the injection technique can be appropriately modified. The higher the attenuation of the hemorrhage the higher the iodine concentration in blood which must be achieved, and thus the higher the injection flow and the larger the injected contrast medium dose.

We inject 100–150 ml contrast medium into an antecubital vein with a flow of 1–1.5 ml/sec, using either a Telebrix 300 (Byk Gulden, Konstanz, W. Germany) or a Rayvist (Schering, Berlin, W. Germany) both of which have an iodine concentration level of 300 mg/ml. Our Somatom 2N scanner (Siemens, Erlangen, W. Germany) has a scanning time of 6 sec and an interscan delay of 4 sec. We begin the dynamic scan series after about 30 ml of contrast medium has been injected. Therefore, about 7–12 2-mm-thick cuts with table incrementation of 2 mm can be scanned during the injection time. In this way an area 15–25 mm thick can be examined, which is large enough to include the circle of Willis and the middle cerebral arteries up to the bifurcation.

The obtained high-iodine concentration in blood enables the imaging of all vascular structures in the examined area. According to the blood vessel diameter, we can observe densities up to 150–200 Hounsfield units (H). Yamamoto et al. [11] could detect all blood vessels with an angiographic diameter more than 1 mm. In our experience the most difficult point is the presence of blood clots near blood vessels; the imaging of vascular structures is only possible if the attenuation of the blood rises above the attenuation of the hemorrhage. This goal can be achieved by modifying the injection technique, as mentioned above.

The next step is the highlighting of each of the dynamic scans. This procedure enables the distinction between blood vessels and blood clots, if the limit for highlighting is kept above the attenuation of hemorrhage. All or a part of these marked scans can be added together, so that the image is a composite picture with a depth effect. When photographed with a wide window, this picture shows only bony components and the marked structures (i.e., blood vessels), while all the other soft-tissue structures disappear (fig. 1). Arteries and veins are equally opacified and cannot be differentiated from each other, but the anatomic correlation allows the recognition of the circle of Willis, anterior and middle cerebral arteries, basilar artery, posterior cerebral arteries, and sometimes the posterior communicating arteries as well as the temporal and tentorial veins and the sinuses [12]. The whole vascular anatomy of the base of the brain can be evaluated in a single image. Therefore, an aneurysm can be detected as a saccular structure adjacent to an artery. The detectability of the method is very high; the smallest aneurysms that we observed were 2–3 mm in size.

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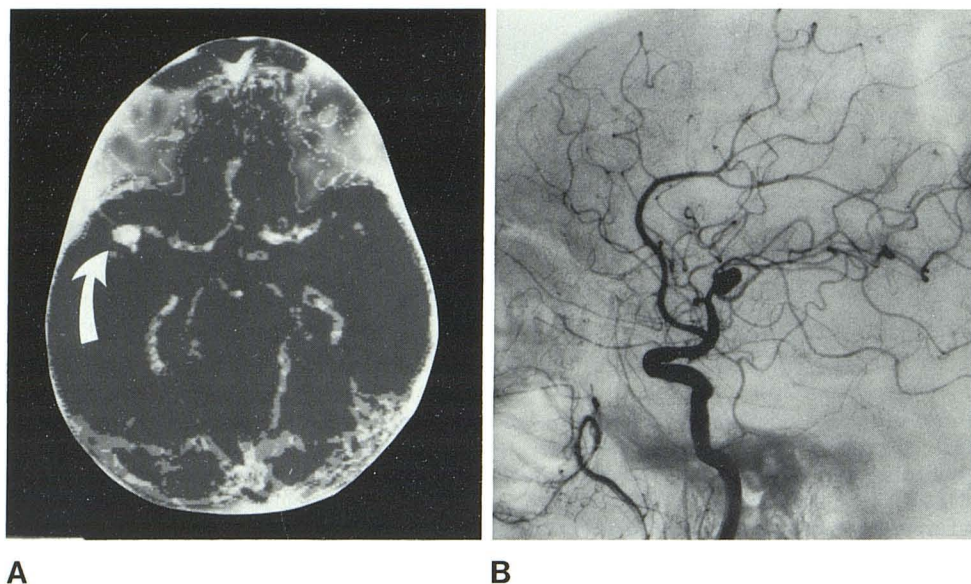


Fig. 1.—A, Aneurysm on bifurcation of left middle cerebral artery (arrow). B, Left-sided carotid angiogram. Saccular aneurysm on bifurcation of middle cerebral artery. Upward displacement of middle cerebral artery due to parenchymatous hemorrhage.

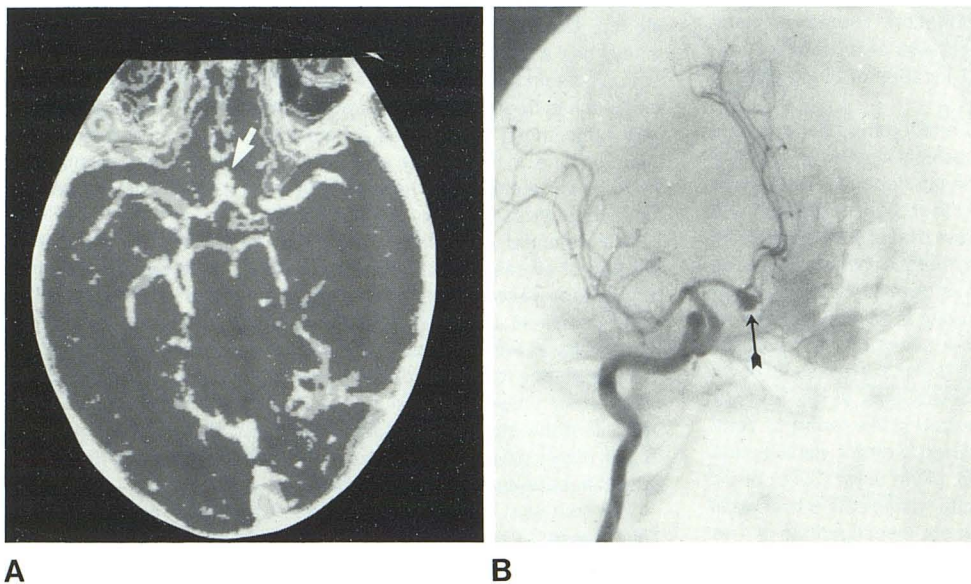


Fig. 2.—A, Aneurysm on anterior part of circle of Willis. B, Right-sided carotid angiogram. Aneurysm of anterior communicating artery (arrow).

## Results

We have examined 31 cases suspected of intracranial aneurysm. In 16 cases one or more aneurysms were visualized in various locations (table 1, figs. 2-4). Of the 15 negative cases, five showed a massive subarachnoid hemorrhage, but neither the multiplane dynamic CT nor the twice-performed four vessel angiography could reveal a vascular malformation. In the other 10 negative cases, only the clinical symptomatology indicated subarachnoid hemorrhage, while the lumbar puncture and the plain scan were negative. In these cases we considered angiographic confirmation superfluous.

Only one false-positive case with signs of an aneurysm on the distal part of the basilar artery was observed. This false interpreta-

TABLE 1: Presence or Absence of Intracranial Aneurysms Directly Visualized by Multiplane Dynamic CT in Patients with Suspected Subarachnoid Hemorrhage

Location	No. Patients with Aneurysm
Anterior communicating artery	5
Internal carotid artery	2
Posterior communicating artery	3
Middle cerebral artery	4
Vertebrobasilar artery	2
No aneurysm	15
Total	31



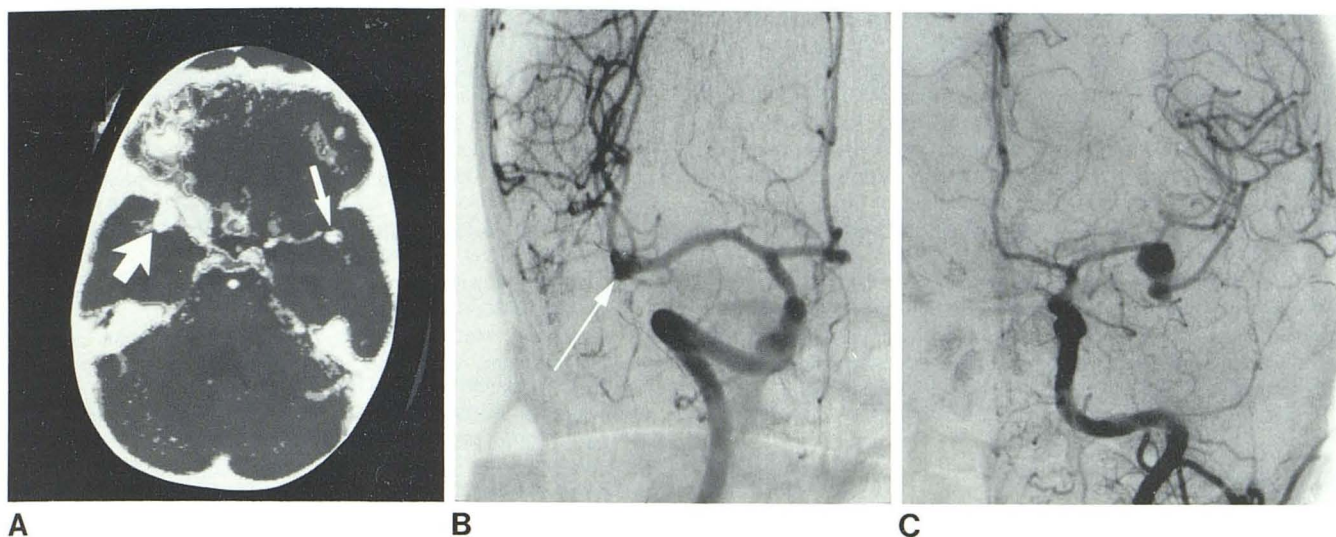
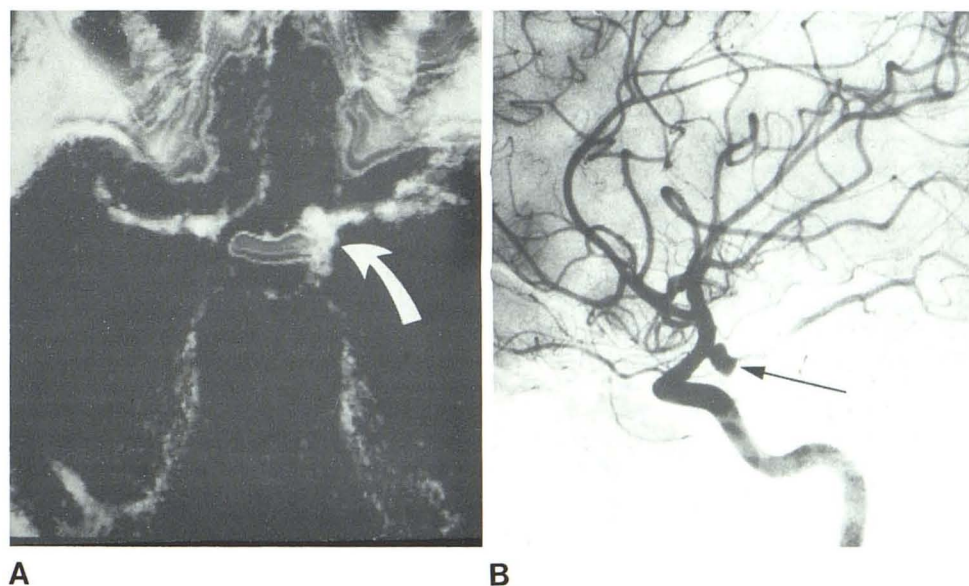


Fig. 3.—A, Large aneurysm on sphenoid segment of left middle cerebral artery (*thick arrow*), small one on bifurcation of right cerebral artery (*thin arrow*). B, Right-sided carotid angiogram. Small aneurysm (3 mm diameter)

on bifurcation of right middle cerebral artery (*arrow*). C, Same case, left-sided carotid angiogram. Large aneurysm on bifurcation of left middle cerebral artery.

Fig. 4.—CT (A) and right-sided carotid angiogram (B) show aneurysm (*arrow*) at origin of right posterior communicating artery.



tion was caused by a very high attenuation value of the hemorrhage in the interpeduncular cistern (about 90 H). No false-negative cases were observed when the aneurysm was included in the examined area. This fact emphasizes the value of the plain scan for the prediction of the location of the bleeding malformation.

## Discussion

Multiplane dynamic CT offers a better approach to the intracranial morphology, and especially to the vascular anatomy. Functional studies and evaluation of enhancement patterns over time are possible only by single-plane dynamic CT [10].

Our results indicate the role of multiplane dynamic CT for the detection of small intracranial aneurysms. Except for one false-positive study, all the aneurysms were imaged and the location and size were in agreement with angiography. The angiographic diameters of the imaged aneurysms were 2–3 to 15 mm, which emphasizes the diagnostic accuracy of the method. Large or giant intracranial aneurysms can be easily imaged by conventional CT. In these cases single-plane dynamic CT enables an improvement of the specific diagnosis, which may be otherwise difficult.

Of great importance seems to be the reliability of the method in the five negative cases with massive subarachnoid hemorrhage. The combination of negative multiplane dynamic CT and negative four vessel angiography could eliminate the necessity for further

angiographic investigations. These cases of subarachnoid hemorrhage of unexplained origin represent 10%–20% of the whole [13].

In clinical practice we perform multiplane dynamic CT as the first examination for subarachnoid hemorrhage in any suspicious case. The obtained additional information about the presence, location, and size of one or more aneurysms, together with the basic information from the plain scan (e.g., distribution of the hemorrhage, infarcted areas), allows better timing of further diagnostic and therapeutic procedures.

CT detection of intracranial aneurysms can be decisively advanced by multiplane dynamic techniques. Further familiarity with this method in the future could result in more frequent detection of unruptured intracranial aneurysms, so that treatment could be done with lower risk [14].

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