Giant Intracranial Aneurysms: Rapid Sequential Computed Tomography

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Giant intracranial aneurysms often present as mass lesions rather than with subarachnoid hemorrhage. Routine computed tomographic (CT) scans with contrast material will generally detect them, but erroneous diagnosis of basal meningioma is possible. Rapid sequential scanning (dynamic CT) after bolus injection of 40 ml of Renografin-76 can conclusively demonstrate an intracranial aneurysm, differentiating it from other lesions by transit-time analysis of the passage of contrast medium. In five patients, the dynamics of contrast bolus transit in aneurysms were consistently different from the dynamics in pituitary tumors, craniopharyngiomas, and meningiomas, thereby allowing a specific diagnosis. Dynamic CT was also useful after treatment of the aneurysms by carotid artery ligation and may be used as an alternative to angiographic evaluation in determining luminal patency or thrombosis.

Giant intracranial aneurysms are defined as those aneurysms larger than 1.5 cm in diameter. Neurologic presentation often is consistent with multiple sclerosis, dementia, degenerative disease, or an intracranial mass with focal neurologic symptoms. Before computed tomography (CT), angiography was required to demonstrate the lumen of the aneurysm, with the true size estimated only by vascular displacement [1]. With CT it is now possible to demonstrate the entire aneurysm. However, routine CT studies of giant aneurysms have demonstrated that nonthrombotic aneurysms may be confused with either an intra- or extracranial mass [1]

Dynamic CT using a bolus intravenous injection of contrast medium followed by rapid sequence CT scanning has been used for transit studies of brain blood flow in patients with cerebral vascular disease [2]. The behavior and appearance of various lesions, including arteriovenous malformations, aneurysms, and benign and malignant tumors, using dynamic CT have been described [3, 4]. We report our experience with dynamic CT in giant intracranial aneurysms before and after carotid ligation.

Subjects and Methods

Five patients known to have giant aneurysms by prior studies were evaluated by dynamic CT. Two were nonthrombosed, two partially thrombosed, and one completely thrombosed. Three studies were performed after treatment by carotid ligation. One patient with a meningioma was included for comparison. Dynamic CT results in meningioma, pituitary adenoma, and craniopharyngioma (reported elsewhere) are commented on [5, 6].

All scans were performed on a GE CT/T 8800 using graphic data analysis capabilities available in experimental software and imaging programs supplied by General Electric Corp. (GEDIS 6.16-6.21). Initial noncontrast CT through the aneurysmal mass was performed to determine the levels of interest for subsequent dynamic CT. Dynamic CT scans 10 mm thick were obtained at two levels using a 4.8 sec scan time with an interscan time of 1.5 sec. Eight scans per level were obtained.

Renografin-76 (40 ml) warmed to 37°C was power injected into the largest available
antecubital vein via a short 18 gauge catheter. Initially, a bolus of 40 ml delivered over a 3–4 sec interval was used; however, because of an extravasation of contrast medium into the soft tissues of the upper arm in some patients, the injection time was increased to 5–6 sec. This did not significantly change the contrast density–time curves. The total contrast load was 80 ml (29 g I). Renal function in all patients was within normal limits at the time of the study, and no changes were noted subsequently.

Graphic analyses of the change in the CT attenuation with time were performed for specific regions of interest (transit time analysis). In all cases the aneurysm lumen, thrombus, and normal arterial structures were compared. Graphic analyses were accomplished by both point-to-point plotting and gamma variant fitting of the data. All illustrations are point-to-point plots, since the recirculation peak of contrast transit is best demonstrated in this way. In all cases aneurysm lumen transit analyses were compared to density–time transit analyses of the largest normal arterial structure demonstrated. After the contrast medium injections for dynamic CT, routine axial scans were obtained.

Results

Regions identified as the lumen of the aneurysm showed an average change in CT number of 200 H (60–376 H) (figs. 1 and 2). One patient with a small, almost thrombosed, aneurysm lumen demonstrated a change in CT number of only 60 H. Large vessels such as the main trunk of the middle cerebral artery displayed an average maximum change in CT number of 115 H (60–125 H), having rapid washin and washout phases. The washin peak occurred between 6 and 11 sec, and washout cleared by 23 sec (figs. 1 and 2). The drop in CT number was to near baseline levels. The aneurysm lumens demonstrated washin and washout phases with similar timing as large vessels (figs. 1 and 3), except in one completely thrombosed aneurysm. A small recirculation peak was present in all aneurysms with a patent lumen and in all density plots of intracranial vessels (figs. 1, 3, and 4), but was absent in a hypervascular tentorial meningioma (fig. 5) and in other suprasellar lesions as reported elsewhere [5, 6].

Four patients had aneurysms with significant intraluminal thrombus. In none was there a change in CT number within the clot (fig. 2C).

Four patients had enhancing aneurysm walls. One of the four showed significant change in CT number within the wall during dynamic CT (30 H), but this did not approach the magnitude of the change within the lumen. One supraclinoid carotid aneurysm had two separate areas of wall enhancement: one outside an outer ring of hypodensity and one between this ring and an inner ring of hyperdensity. Dynamic CT was performed on this patient after placement of a Sevierstone clamp on the common carotid artery, and the findings suggested a completely thrombosed aneurysm (fig. 4). Repeat angiography was not performed.

Discussion

Dynamic CT with its ability to demonstrate rapid change in CT attenuation values typical of arterial transit may be
Fig. 2 — Partially thrombosed right carotid bifurcation aneurysm. A. Contrast-enhanced scan. Partially thrombosed aneurysm with eccentric enhancement of the lumen, peripheral rim enhancement of aneurysm wall, and central isodense region of thrombus. B. Dynamic CT scan with time-density analysis of lumen of aneurysm (1) compared to left middle cerebral artery (2). Both curves show rapid washin and washout phase with markedly elevated peak values consistent with vascular structure. Small recirculation peaks are seen between 24 and 32 sec. C. Dynamic CT scan comparing isodense region of intraluminal thrombus (1) to right middle cerebral artery (2). Intraluminal thrombus has no peak. Middle cerebral artery has time-density curve pattern typical of vascular structure with rapid washin and washout phase and smaller recirculation peak.

useful in those cases where the diagnostic possibilities are aneurysm, meningioma, craniopharyngioma, or hematoma. Arterial transit is typified by a rapid washin and washout of contrast medium characterized by a steep upslope and downslope on transit-time analysis of the CT attenuation values. A smaller peak of recirculation of contrast media occurs between 32 and 48 sec.

Difficulty may arise in evaluating thin-walled aneurysms on routine infusion-contrast-enhanced CT scanning, be-
A B

Fig. 4.—Completely thrombosed left supraclinoid carotid aneurysm. A, Contrast-enhanced CT scan 3 weeks after common carotid clamping. Hyperdense aneurysm with peripheral enhancement and area of hypodensity posterolaterally. B, Dynamic CT. Hyperdense aneurysm (1) has flat time-density curve when compared to basilar artery (2), indicative of thrombosis.

rysm from meningioma and resolve the questions that arise between patent lumen, aneurysm wall, or intraluminal clot [1-3]. It also will allow treated and untreated partially thrombosed aneurysms to be followed by repeated studies (fig. 3).

Since an aneurysm lumen is an extension of the parent intracranial arterial vessel, transit-time analysis of both lumen and vessel are similar, except that the aneurysm lumen will display a greater amplitude (peak value) when it occupies a larger volume of the CT slice than the comparison vessel (figs. 1 and 3). When the size of the aneurysm approaches that of a comparable vessel, no difference should be expected in the time-density curves or peak values.
Common carotid ligation is a prevalent conservative treatment for giant aneurysms, particularly if they arise from the cavernous or supraciliary segments of the internal carotid artery. Acute intraluminal thrombosis may follow and the conventional CT study will demonstrate a hyperdense centre, with enhancement being difficult to determine. If the lumen is eccentric and small and if aneurysmal wall calcification is present, difficulty will arise in determining luminal patency or thrombosis. On dynamic CT, the hyperdense intraluminal clot shows a markedly diminished peak value and a flat transit-time curve indicative of the absence of flow of contrast medium within the thrombotic aneurysm (fig. 4B).

In our opinion, angiography after carotid ligation may be less successful than dynamic CT to conclusively eliminate luminal patency, since the parent vessel is occluded and the aneurysm fills by collateral flow through the circle of Willis [7]. Although corroborative angiography has not been performed in our series, it is our experience that dynamic CT time-density curves easily determine luminal patency or thrombosis (figs. 3 and 4).

The recirculation peak of contrast transit in all intracranial vessels and aneurysms with a patent lumen aids in the differentiation from a hypervascular tumor (fig. 5). The absence of a recirculation peak in hypervascular tumors [5] is believed to be due to masking of its presence by superimposition of the tumor enhancement plateau during the time period of our imaging. Whatever the mechanism, its absence aids in differentiating a hypervascular lesion from an intracranial aneurysm.

Of concern is the possibility of not scanning through a patent lumen. If a single series of scans through one level were performed, this could be a factor; however, it is possible to perform at least three series of dynamic CT scans on a single patient with normal renal function and by so doing ensure that all parts of the aneurysm are imaged. Dynamic CT measures a change in CT number so that vascular regions continue to be defined as such with minimal damping effect, despite the presence of prior contrast material.

In summary, we found dynamic CT capable of differentiating a giant aneurysm from other parasellar masses. Intracranial giant aneurysms demonstrate a pattern of contrast medium transit typical of vascular structures, but with greater amplitude except when thrombosed. These higher peak values of large lumen aneurysms are explained by partial volume effects. The status of an aneurysm lumen may be followed by repeat dynamic CT after either carotid ligation or antihypertensive therapy. A decrease in peak value and flattening of the density-time curves indicates thrombosis, thereby probably obviating angiography.

REFERENCES


Fig. 5.—Tentorial meningioma. Hypervascular tentorial meningioma shows rapid washin and washout phases in early part of the time-density curve (2). Recirculation peak absent on this curve and present on curve plotted from pericallosal artery (1). Absence of recirculation peak inconsistent with aneurysm.