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AJNR Am J Neuroradiol 1996, 17 (3) 455-457
http://www.ajnr.org/content/17/3/455

This information is current as of June 15, 2024.
CT Angiography in the Examination of Patients with Aneurysm Clips

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Summary: The use of CT angiography is described in three patients for the evaluation of intracranial clips after surgery for an aneurysm. A postprocessing technique is described in which shaded-surface-display models were superimposed on maximum intensity projection CT angiograms. CT angiograms showed residual aneurysmal filling adjacent to a clip, patency of a vessel thought to be compromised by recent clip placement, and errant position of a clip, which required repeat surgery.

Index terms: Aneurysm, intracranial; Computed tomography, postoperative; Computed tomography, three-dimensional

Once an intracranial aneurysm is identified and treated surgically, concerns may arise as to the proper placement of the clip. Postoperative evaluation has traditionally been done with catheter angiography (1). Computed tomography (CT) angiography is a recently described technique that has been used for the evaluation of intracranial aneurysms (2–4). We have had the opportunity to examine three patients with this technique after clip placement for aneurysms of the circle of Willis. In these cases, CT angiography provided information that could otherwise have been obtained only by catheter angiography. We describe a technique in which shaded-surface-display (SSD) and maximum intensity projection (MIP) images were superimposed with the use of a computer workstation.

Subjects and Methods

CT angiography was performed with a GE Hi-speed helical scanner (General Electric Medical Systems, Milwaukee, Wis). Parameters were 120 kV, 280 mA, 1 mm/s table speed, 1-mm collimation, 1:1 pitch, and a 12.8-cm field of view. Sixty axial source images were obtained from the foramen magnum through the circle of Willis after administration of intravenous contrast material. Contrast material (Omnipaque 300, Sanofi-Winthrop, Barcelona, Puerto Rico) was delivered via an antecubital vein at 2 mL/s for a total of 100 mL. Acquisition of source images was started 30 seconds after the start of contrast injection. Images were transferred to a GE Advantage Windows Workstation (General Electric Medical Systems, Milwaukee, Wis). Each data set was then reconstructed by using both SSD and MIP algorithms. For purposes of clarity, the SSD model was tinted blue (Fig 1A) and the MIP model was tinted red (Fig 1B). The windows on the MIP model were then adjusted to exclude bone and vascular detail while retaining detail of the clip itself (approximate window width and level values were 1500 and 3000, respectively) (Fig 1C). The MIP model was then electronically superimposed on the SSD model and matched voxel for voxel (Fig 1D).

Three patients were studied with CT angiography after surgery to repair aneurysms. One patient (case 1) with recent subarachnoid hemorrhage had surgery for an aneurysm of the anterior communicating artery. During the operation, two distinct aneurysms were found: a narrow-necked, thin-walled aneurysm arising from the anterior communicating artery was clipped with difficulty, and a thick-walled, broad-based aneurysm arising off the right A1 segment was coated with cotton fibers to encourage fibrosis but was not clipped. CT angiography was done in an attempt to verify proper clip placement, and the angiogram showed the unclipped aneurysm in proximity to the clip (Fig 1D).

In another patient (case 2), elective surgery was done to clip an aneurysm of the left supraclinoid internal carotid artery via a pterional approach. Postoperatively, the patient was disoriented and an expressive aphasia developed. Clinically, it was unclear whether this represented postoperative edema or developing infarction. Examination by transcranial Doppler sonography was difficult owing to postoperative air under the bone flap. CT angiography was done to evaluate the patency of the middle cerebral artery, which was thought to be compromised by clip placement. The cortical nature of the patient’s signs and symptoms made it unlikely that they were caused by...
small perforator occlusion. The CT angiogram showed filling of the middle cerebral artery and the clip in its expected position (Fig 2). Subsequent unenhanced CT scans showed no progression to infarction, and the patient’s deficit reversed.

In a third patient (case 3), elective surgery was done to clip an aneurysm of the left internal carotid artery via a left pterional approach. Findings on a routine postoperative CT scan indicated that the aneurysm clip had possibly migrated medially. CT angiography confirmed this finding (Fig 3A) as well as showed the position of the clip after repeat surgery (Fig 3B).

Discussion

After surgical treatment of an intracranial aneurysm, concerns may arise as to placement of the clip. Potential problems include partial clipping of the neck, allowing continued filling of the aneurysm, inadvertent occlusion of vessels after improper placement, and migration of the clip after placement. Policy regarding repeat catheter angiography to confirm adequate clip placement varies from institution to institution, and not all centers perform routine postoperative angiography in all patients (1). It is recommended that for patients with aneurysm clips, MR imaging be avoided if at all possible; one recent article (5) reported the death of a patient during MR imaging to verify clip placement, despite careful attempts to document the type of clip that had been placed.

Recently, CT angiography has been used in imaging of the intracranial circulation (2–4). We have had the opportunity to use CT angiography to evaluate clip placement after surgery to repair aneurysms. Remarkably, CT angiograms are not severely degraded by the presence of nearby aneurysm clips. We attribute this to the very thin collimation used (1 mm), which seems to limit the severe beam-hardening artifacts seen in routine head studies (6). In one patient, a star-shaped artifact of varying severity was seen in the x- and y-axes in the immediate vicinity of the clip (Fig 1D). This artifact was a component of the SSD image. Much detail of the clip itself can be seen, particularly on
MIP images at the proper window settings. The SSD format gives excellent detail of the skull base and vasculature (4), but little detail of the clip. The MIP format can give excellent detail of the clip at the proper window settings. By superimposing the two models, information about the relationship of clip and vasculature can be obtained.

Some beam-hardening artifacts will always be present in proximity to the clip, which will limit CT angiographic evaluation of placement of the aneurysm clip. For example, in Fig 3B, the clip is shown to be in grossly the correct position relative to the aneurysm; however, residual filling of the aneurysm neck cannot entirely be excluded. Therefore, CT angiography in its present form cannot replace catheter angiography for the evaluation of aneurysm clip placement. CT angiographic findings were not confirmed by conventional angiography in these cases. The surgical findings and clinical outcome correlated well, however.

In the cases presented here, CT angiograms showed an aneurysm immediately adjacent to a clip, patency of a vessel possibly compromised by clip placement, and migration of a clip, which required repeat surgery. Subsequent work in this area might focus on further reduction of artifacts and on correlative studies with digital subtraction angiography.

References


Fig 2. Superimposed shaded-surface-display (blue) and maximum intensity projection (red) CT angiograms (case 2). The study was performed to evaluate possible compromise of the internal carotid artery or middle cerebral artery by recent clipping of an aneurysm of the left supracalcioid internal carotid artery. The model is viewed from above and in front. The aneurysmal clip (arrow) is identified relative to the supracalcioid internal carotid artery. The middle cerebral artery on the left (arrowhead) fills normally and is not compromised by the clip.

Fig 3A. Misplacement of an aneurysmal clip. The patient had surgery to treat an asymptomatic aneurysm of the supracalcioid internal carotid artery.

A, Superimposed shaded-surface-display (SSD) (blue) and maximum intensity projection (MIP) (red) CT angiograms obtained after surgery show continued filling of the aneurysm (arrow), with the aneurysm clip having migrated medially to the planum sphenoidale (arrowhead). On the basis of this study, the patient had repeat surgery.

B, Superimposed SSD and MIP CT angiograms after the second surgery show proper positioning of the clip (arrow). Note, however, that there is a significant artifact in the immediate vicinity of the clip, which could obscure residual filling.