Utility of multislice computed tomography and reformatted images: identification of migratory intraventricular clot exacerbating obstructive hydrocephalus

Technical note

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Multidetector CT has become widely available and with it the ability to rapidly create detailed reformatted images. Multiplanar images can be created depicting the anatomy in planes other than the traditional axial plane, using isotropic to near-isotropic data. It is important for both clinicians and radiologists to be aware of this capability in order to take advantage of such images. To illustrate the value of this type of imaging, the authors present a case of a third ventricular clot that migrated into the cerebral aqueduct exacerbating hydrocephalus. (DOI: 10.3171/JNS/2008/109/7/0156)

KEY WORDS • cerebral aqueduct • clot • hydrocephalus • image reformatting • imaging • multislice computed tomography

In the last decade, multidetector CT scanners have become widely prevalent across the US. In addition to the traditional 5-mm axial slices, thinner axial images can be created and used for diagnostic purposes. Moreover, these images can be rapidly postprocessed to create multiplanar images. Sagittal, coronal, or oblique reformatted images can be created, as can images representing combinations of these views.

We present an unusual set of images of a migratory intraventricular clot that caused an exacerbation of hydrocephalus. Intraventricular hemorrhage is a common cause of obstructive hydrocephalus, since a clot may form and physically obstruct the outflow of cerebrospinal fluid. In the past, depending on its size, such a clot might not have been visualized on CT. This case demonstrates the particular value of sagittal reformatted images in showing the clot’s change in position.

Illustrative Case

This 74-year-old man was involved in a snowmobile accident, found helmeted in a ditch hours later, and was initially unresponsive. His medical history included treated prostate cancer and mild asthma, but was otherwise non-contributory. Initial physical examination showed stable vital signs and hemodynamic status, with a Glasgow Coma Scale score of 12 (out of 15). On neurological evaluation he was found to be somnolent, confused, and unable to follow simple commands. He moved all 4 limbs purposefully and opened his eyes spontaneously, but his speech was incoherent. The results of laboratory tests were within normal limits except for a mild leukocytosis. A CT of the patient’s head (Fig. 1) demonstrated hydrocephalus with subarachnoid hemorrhage and intraventricular blood, including a clot in the third ventricle. A CT angiogram of the circle of Willis showed no evidence of an intracranial aneurysm.

The patient had no other injuries except for a fracture of the T-6 vertebral body. He was admitted to the neurosurgical special care unit for close neurological monitoring of his closed head injury. At 8 hours postadmission, his level of consciousness deteriorated and his Glasgow Coma Scale score dropped to 7. An endotracheal tube was placed to maintain airway patency, and repeated head CT was performed. The scan (Fig. 1) revealed interval enlargement of the lateral and third ventricles. The reformatted sagittal images showed that the third ventricular clot had moved into the aqueduct of Sylvius (Fig. 1).

An external ventricular drain was placed on an emergency basis in the intensive care unit for relief of the obstructive hydrocephalus. Significant improvement was observed in the patient’s level of consciousness on the 2nd day of hospitalization, and by the next morning he was obeying...
commands, with diplopia, but no additional focal neurological deficit. After 3 days in the intensive care unit, the patient’s endotracheal tube was removed and he was transferred back to the neurosurgical special care unit. Follow-up CT and MR imaging studies showed clearing of intraventricular blood and decreased ventricular caliber. The external ventricular drain was clamped on Day 16 and successfully removed on Day 18, with no subsequent clinical or radiological evidence of recurrence of hydrocephalus. The patient was placed in a TLSO for the single-column T-6 vertebral body fracture and was able to walk satisfactorily without change on serial radiographs.

The patient underwent extensive inpatient rehabilitation while in our institution and made good progress functionally and cognitively. He was able to ambulate in a TLSO brace with assistance, and was discharged to a traumatic brain injury rehabilitation facility on hospital Day 22. On outpatient follow-up at 2 as well as 4 months, his condition was found to have improved and he had no focal neurological deficit; at 6-months’ follow-up he had made a full recovery. Repeat CT scans at 2 and 4 months showed only mild ventricular dilatation appropriate for the patient’s age.

Discussion

Obstructive hydrocephalus is a well-known complication of intraventricular hemorrhage, and the cerebral aqueduct is the most common site of ventricular cerebrospinal fluid obstruction, due to the small caliber of the aqueduct. In the case reported in this paper, a third ventricular clot was propelled into the proximal portion of the cerebral aqueduct. The clot was not readily apparent on the traditional 5-mm axial CT images, but was quite apparent on the sagittal reformatted images. Slight differences in patient positioning and slice selection contributed to this issue; moreover, perception of the clot’s position relative to the adjacent structures was not as readily intuitive in the axial plane as it was in the sagittal plane.

Current CT scanners use multiple detector rows of 0.5- to 1.25-mm thickness each, depending on the type of CT scanner. For example, with a 16-slice General Electric scanner in axial mode (nonhelical), there are 16 rotating 1.25-mm detector rows, which collect data, which are reconstructed and displayed as 5-mm axial images. These 5-mm images represent composite data from four 1.25-mm detector rows.

Fig. 1. A–C: Initial CT scan. Axial CT images (A and B) reveal hydrocephalus and intraventricular blood in the dependent lateral ventricles (long arrow) and third ventricle (arrowhead). Sagittal reformatted image (C) clearly demonstrates the clot in the third ventricle extending to the aqueduct of Sylvius (arrow). D–F: Eight-hour follow-up scan. Axial CT images (D and E) show worsening hydrocephalus with acute enlargement of the third ventricle (arrow, D) and the clot still visible in the posterior third ventricle (arrow, E). The sagittal reformatted image (F) clearly shows that the clot (arrow) has dropped into the proximal aqueduct of Sylvius. Note the relationship of the clot to the calcified pineal gland (arrowhead) on both sagittal reformatted images.
and can be reprocessed to display thinner 1.25-mm images for more detailed review, as long as the data have not been deleted from the CT scanner hard drive, which depends on both workload and the data storage capacity of each unit.

It is these thinner axial slices that allow reformatted multiplanar (sagittal, coronal, oblique) and 3D images to be created. When the more traditional, thicker 5-mm axial images are used for reformating, they are of limited value as they exhibit a “stair-step” artifact (Fig. 2A), having been constructed from anisotropic, rectangular voxels (volume elements). The quality of the multiplanar reformats derived from thin slices (Fig. 2B) reflects the fact that the voxels are nearly isotropic. Isotropism implies that the side dimensions of each voxel in the data set are equal (that is, cubes instead of shoe boxes). This symmetry allows reformatting in any plane, with spatial resolution identical to the original scanning plane. Isotropism is reasonably achieved with multiple sections of 1 mm thickness or less, while near-isotropic imaging is achieved with slightly thicker slices.1–3

Our reformatted images clearly depict a migratory, obstructing intraventricular clot and the adjacent anatomy. We know of only one other case report describing the use of imaging in a patient with hydrocephalus in conjunction with a migratory intraventricular clot, and in that paper only traditional axial images were presented.4

Conclusions

In this case of a migratory intraventricular clot, sagittal reformatted images clearly displayed the clot’s downward migration into the cerebral aqueduct, causing rapidly worsening hydrocephalus. It is important for radiologists and clinicians to be aware that thin-slice reconstructed and multiplanar reformatted images can be made directly from the CT raw data of a multidetector scanner, without the need to rescanning the patient, reducing both radiation exposure and cost to the patient.

Disclaimer

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References