New CT Protocol Yields Improved Venous Images

PLATO may have touted necessity as the mother of invention, but it was necessity combined with a desire to fully utilize available technology that led to a new method for imaging veins in the chest.

A team of University of Cincinnati researchers led by Cristopher Meyer, M.D., and Achala Vagal, M.D., and 3D Lab Supervisor Rhonda Strunk, R.T., R(CT), have found that changing the contrast bolusing and acquisition timing in multidetector CT (MDCT) of the chest satisfies the demand of thoracic and vascular surgeons for reliable venous images and may also increase reliability in the diagnosis of venous diseases.

Cristopher Meyer, M.D.
University of Cincinnati

Achala Vagal, M.D.
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MDCT, a top performer in creating 3D arterial images, falters with the central veins. "The main problem is that the inflow of unopacified blood—as seen in previous protocols—resulted in significant artifacts," said Dr. Meyer, an associate professor of radiology. "These artifacts have been reported in the literature to be mistaken for thrombi, causing significant false-positive diagnoses. The problem is not contrast breaking up, but poor mixing and laminar flow in the great veins during the first pass."

Added Dr. Vagal, assistant professor of radiology and a radiologist at University Hospital: "It really is 'back to the future.' We had to re-learn to wait for the contrast. These faster multidetector scanners are great for studying the arteries, because the scanner speed lets us chase contrast flow through the arteries.

"When you're studying the veins, patience is the key," Dr. Vagal continued. "Early contrast enhancement is no good because the veins are incompletely opacified."

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That difficulty resonated with many physicians who heard Dr. Vagal present the protocol guidelines at the North American Society for Cardiovascular Imaging meeting last October, in the cleverly named "Don't Struggle in Vein: Performing High-Quality Thoracic MDCT Venography."

Dominik Fleischmann, M.D., an assistant professor in the Department of Radiology at Stanford University in California, expressed the frustration many in the radiology audience have felt. "The difficulty is that when you want to do a CT venogram and you use a direct venography approach and inject contrast medium, if it's undiluted, it results in a lot of artifacts," said Dr. Fleischmann. "If you use an indirect approach, injecting contrast and waiting until the blood recirculates and comes back from the veins, the timing is difficult to predict."

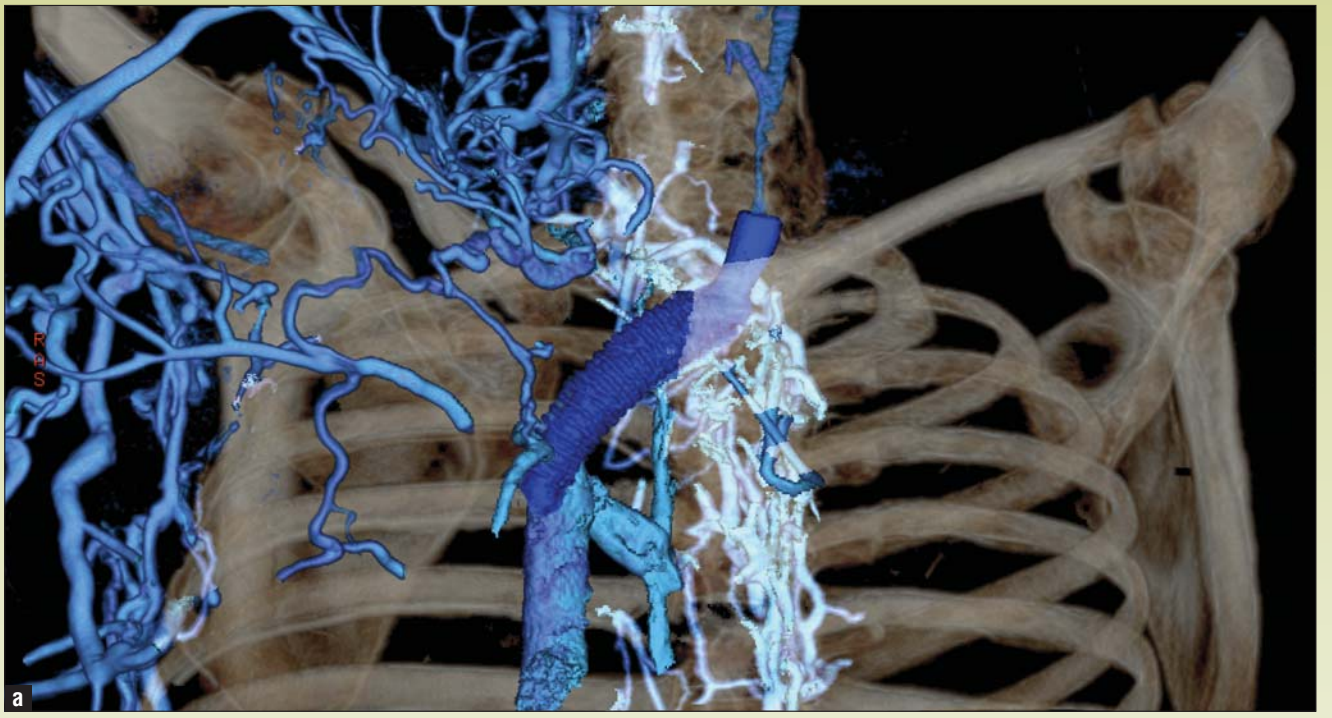
New Protocol Requires Two Contrast Injections

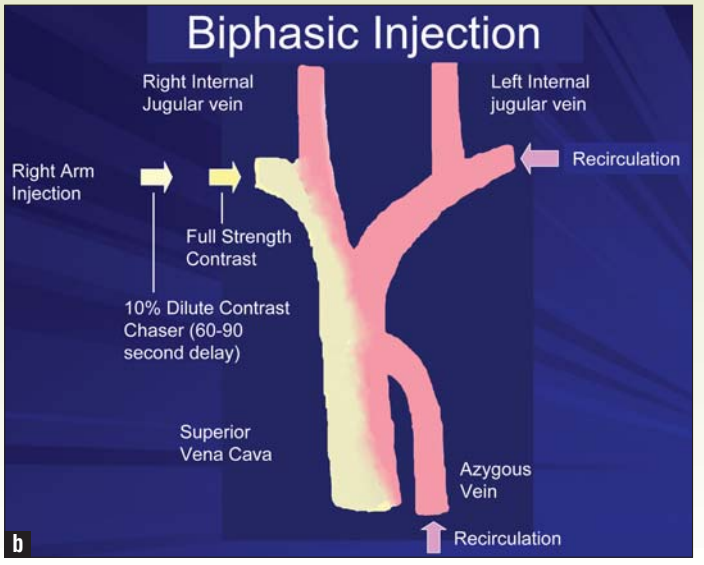
Those challenges are exactly where the University of Cincinnati team concentrated its effort, devising largely through trial and error a method that compensated for the extra time it takes contrast to reach the veins. The resulting protocol calls for the CT technologist to prepare two syringes of contrast agent.

The first syringe is full-strength contrast agent, 140 cc at 4 cc per second, said Dr. Meyer, followed by a 10 percent contrast solution comprising 90 cc saline and 10 cc contrast at 3 cc per second.

"The team images at 60 to 90 seconds," he said. "The initial bolus recirculates to overcome the inflow artifacts from the jugular veins, azygous vein and contralateral veins. The dilute contrast chaser densely opacifies the central veins and challenges them without streak artifact."

Dr. Meyer said he believes the success of the method is in its simplicity





(a) Image of a "jailed" left subclavian vein. 3D reformat with skeletal landmarks demonstrates extensive chest wall collaterals, high-grade stenosis of the left internal jugular vein and absence of flow in the left subclavian vein due to jailing by the brachiocephalic venous stent.

(b) Diagram representing the biphasic injection process employed by Cristopher Meyer, M.D., and Achala Vagal, M.D.

Photos courtesy of the University of Cincinnati.

and ease of reproduction, as well as the accuracy of images produced. "The 3D modeling really caters to vascular surgeons' needs," he said. "They have embraced this method because we can help them visualize the anatomy in the same way they'll see it at a dissection or in surgery. This technique helps us move from planar images to images our colleagues can wrap their minds around."

The team has applied its approach to patients experiencing problems with venous dialysis access, as well as those with venous stenosis and fibrosing mediastinitis. "We're getting good results in all of our patients, not just one or two," said Dr. Vagal.

Dr. Fleischmann said he looks forward to a more formal investigation reporting a higher number of patient outcomes compared to controls. "In my opinion, this is a simple, very reasonable protocol, and from clinical experience I would expect that this protocol works very well on a substantial number of patients undergoing CT venography of the thorax," said Dr. Fleischmann. "Before recommending it as a standard technique, however, there needs to be some more data."

Enthusiasm for the seeming ease and success of the approach led the team to spread the news before formal reporting could be done, said Dr. Vagal. "We just started getting these beautiful studies with awesome reconstructions and we thought, 'Maybe we should present this, because it's not out there,'" she said.