



# CT Marches to the Front Lines of Trauma Imaging

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Battlefield wounds are complex cases that often test the limits of man and machine. These limits continue to expand as advancements in medicine and technology enable today's soldiers to survive injuries that were often fatal in prior wars.

American soldiers are brought back to Walter Reed Army Medical Center (WRAMC) in Washington, DC, for advanced diagnosis and surgery. We see a range of injuries, from complex fractures to blast and penetrating trauma. Many have been stabilized with fixation devices or casts as a result of their initial evaluation on the battlefield, in the cache, or at Landstuhl Regional Medical Center in Germany, and a large number have had initial surgery to control acute bleeding, including arterial injuries.

Accurately detailing the complexity of injuries on a patient surrounded by or containing metal is a challenge we face weekly. Under the careful leadership of COL Michael P. Brazaitis, MD, Chairman of the Department of Radiology, CT scanning now plays a crucial and growing role in the diagnosis and treatment of injured soldiers.

Today, at WRAMC, we rely on GE Healthcare's LightSpeed® VCT XT,\* 64-slice CT scanner for advanced diagnosis of battlefield wounds. The subtleties we look for include vascular flaps, stenoses, transections and occlusions, bony fractures, and soft tissue injuries. Many of our patients have had arterial repairs, often including graft reconstructions. So we also evaluate the grafts to see if they are patent and whether they need to be revised. Armed with this information, our surgeons have a greater opportunity for surgical success. Yet, not all patients require additional surgery, and the advanced imaging allows identification of patients for conservative management with greater confidence that occult vascular injury will not contribute to long-term complications.

"With our 64-slice CT scanner, we can add a tremendous amount of information to the patient assessment with pictures that are truly amazing," Dr. Brazaitis says.

### Take it to the limit

Overall, our team is quite impressed with the capability of the LightSpeed VCT XT\* on a number of fronts. One clear advantage is that we can perform a complete head-to-toe angiogram when needed. With GE's 2000 mm table, I can image from the skull to the toes and generate beautiful diagnostic images all the way through. Examinations with multi-extremity injuries as well as tall or large-sized patients are potentially difficult imaging studies to conduct, but can be completed with persistence and a little creativity.

When performing a CT angiogram (CTA) on our 64-slice scanner, we can image the neck, chest, abdomen, pelvis, both legs, and usually one but sometimes both arms with just a few cc more contrast than required for a CT study of only one leg. To conduct a similar study in the cath lab, where nearly all patients were sent prior to installation of the 64-slice CT scanner, patients could receive 200 to 300 cc of contrast to visualize all of the vascular structures.

These scans are interesting and fun to conduct because of the variety of parameters we can manipulate to optimize the acquisition. Most of the patients are aggressively hydrated with large circulating volumes, and with leg injuries there is often fast or asymmetrical flow. Timing is therefore a challenge, as is the imaging of multiple body parts. GE's 40 mm detector delivers 0.35 mm isotropic resolution in all scan modes and at all scan speeds so that we can scan the total patient faster than before. And speed is important when scanning soldiers with fast flow and who are in pain.

### About the facility

The Walter Reed Health Care System (WRHCS) provides comprehensive healthcare for more than 150,000 soldiers, other service members, family members, and retirees in and around Washington, DC. Its hub is Walter Reed Army Medical Center, the clinical center of gravity of American military medicine.

WRHCS provides a full range of services for patients, from routine primary care to the most sophisticated, high-tech specialty care. It is patient-focused and dedicated to streamlining each patient's passage to the appropriate level of care they need. Each facility within the system is a valuable partner and brings its unique expertise to bear on healthcare delivery.

The system's staff of 6,000 includes more than 600 Army physicians. Half of them are in training in more than 40 graduate medical specialty programs. Walter Reed trains the majority of the Army's physician subspecialists. In addition, it conducts training for many nursing and enlisted medical specialties. Its status as a worldwide referral center for patients with the most complex and challenging illnesses supports the high quality of its educational missions, and sustains the capabilities of its clinical staff.

WRHCS is also the Army's leading center of clinical research and innovation, attracting annual research support for such efforts as prostate disease, coronary artery disease reversal, comprehensive breast care, therapy of traumatic brain injury, amputee care and limb salvage, advanced diabetes management, technical advances in robotic surgery, nursing care delivery, evaluation of balance disorders, telemedicine, treatment of chronic viral hepatitis, and many other programs.

\*A premium LightSpeed VCT configuration.

With the LightSpeed® VCT XT,\* we can image through almost all reasonably sized metallic objects, such as bilateral external fixation devices and intramedullary rods, and still generate amazing images. When we have to, we can increase to 140 kVp and compensate with a denser contrast material or faster injection rate. Even at this rate, the 8 MHU tube does not overheat. When coupled with the scanner's 100 kW generator, the scanner enables faster gantry rotations and greater anatomical coverage.

The LightSpeed VCT XT\* helps us balance radiation dose with diagnosis. The system's Smart mA feature adjusts the mA to changes in body size and helps us utilize dose-saving features, particularly to reduce dose when imaging extremities such as the legs. With the ability to reach 800 mA, we can slice through thick body parts or large-sized patients with the same contrast injection. This system provides excellent image quality along with dose-saving features.

Even with the presence of shrapnel, the system captures excellent images of the neck and allows for the detection of pseudoaneurysms, which is a challenging diagnosis. Yet, we can scan through drains or suction devices to identify numerous injuries such as flaps, intimal damage, transections from bones, and missile trajectories.

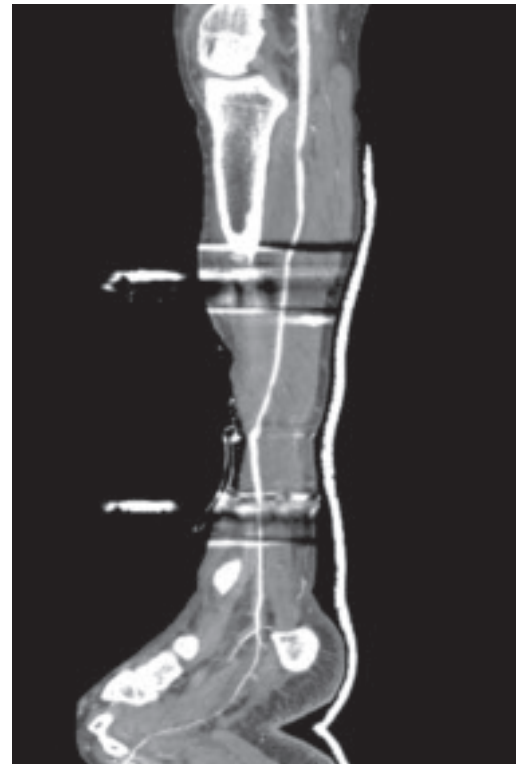
Ninety percent of the time or more, we get the information that our surgeons need to manage their patients, and with a CTA on the LightSpeed VCT XT,\* we can obtain the right diagnosis.

### Every picture tells a story

The wounded soldiers at WRAMC typically have numerous residual fragments from various dense objects embedded in their wounds. On older scanners, the dense objects might have resulted in an uninterpretable or falsely negative imaging study. Prior to leaving WRAMC, COL David L. Gillespie, MD, FACS, who was Chief and Program Director, Vascular Surgery Service, preferred CTA for diagnostic work-up over angiography. He explains, "We can image through many different types of metal and view other substances like rocks and dirt with minimal artifacts.

We can retrace images, view 3D reconstructions, and generate transverse views, such as MIPs and MPRs, to view anatomic detail in a more relaxed mode versus performing the evaluation on-the-fly in the cath lab."

Patients benefit as well with a noninvasive CTA. Compared to angiography, they experience less pain, receive less contrast, and endure a shorter procedure – often 15 minutes on the CT scanner rather than one hour in the cath lab. Plus, there are no catheter related complications.



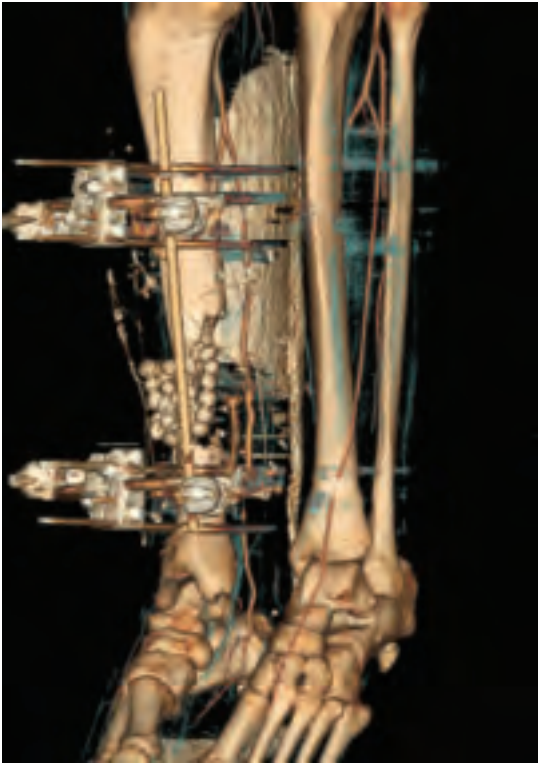
**Figure 1.** Curved multiplanar reformat of the posterior tibial artery shows a patent vessel after reconstruction of the artery with an interposition graft. Despite large and dense metallic external fixation pins, the artery is clearly demonstrated all the way down to the toes.

Today at WRAMC, we perform the majority of diagnostic vascular work-ups on the 64-slice CT scanner. Dr. Gillespie believes that CTA is a remarkable single assessment tool. "We have more angles and views with CTA; therefore, I find it incredibly useful for image evaluation and interventional planning," he says. In the end, better images result in a more complete and accurate patient assessment.

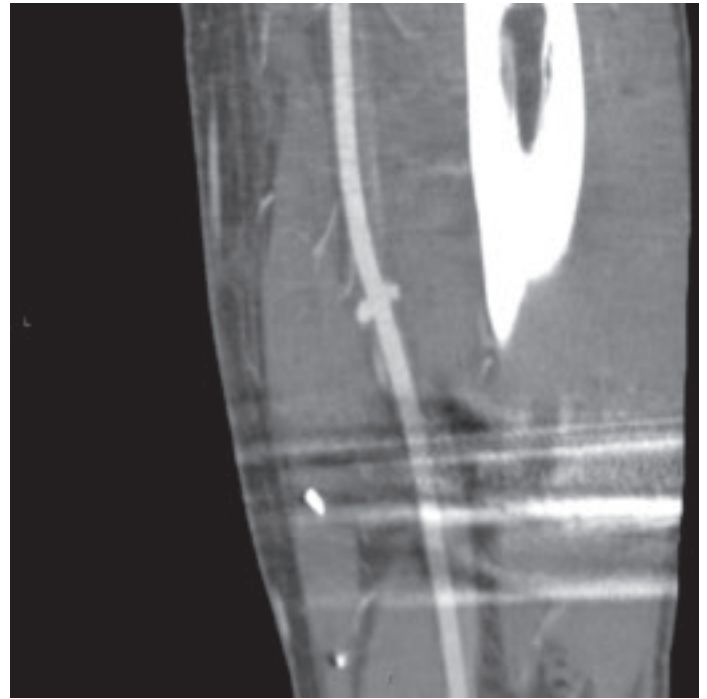
### Breaking new ground

Advanced visualization and 3D reconstruction is performed on GE's Advantage Workstation.® An outstanding workstation that I've used for working with these patients, it makes the hard things easy and the seemingly impossible possible. Although the workstation reconstructs images automatically, we can turn off certain features like the automatic tracking to work around shrapnel, pins, and clips.

\*A premium LightSpeed VCT configuration.



**Figure 2.** Volume rendered image of the lower extremities demonstrates the complex nature of the injuries with external fixation devices, drains, antibiotic beads, casting material, and complex fractures and soft tissue injuries. Despite extensive metal and other interventions, with 140 kVp scanning the arteries are clearly depicted and the relationships of the vessels to the other structures can be clearly understood and transmitted to the surgeons for management.



**Figure 3.** Curved multiplanar image through the superficial femoral artery shows two separate small pseudoaneurysms, one from each side of the artery that was penetrated by shrapnel. This was not suspected by clinical examination. Note that despite the presence of metallic fixation devices externally and shrapnel internally, there is no difficulty seeing and interpreting the vascular anatomy. The artery was subsequently surgically repaired.

In particular, curved MIPs are most useful for viewing difficult injuries, such as an artery that is pulled into a wound or one that endures missile trauma. It is not unusual for a single study to contain 5,000 individual slices after numerous reconstructions. For these studies, the Advantage Workstation® is invaluable; I can do things I can't do on different workstations. Seeing things in 3D really does make a difference. Even though all the information is theoretically on the 2D images, it is more obvious and easier to understand on the curved MIPs or slab MIPs. With the vascular mapping provided by this advanced scanner, our surgeons can plan multiple flaps to a wound that fails to heal or follow the vascular supply in a leg that has most of the small vessels destroyed.

At WRAMC, we are using the LightSpeed® VCT XT\* to visualize areas with extensive damage and break new ground with CT imaging. The trauma cases here are extraordinary – I've never seen them anywhere else. Yet, through all of these imaging challenges we don't lose sight of the end result. Our goal is to manage the patient acutely and use the imaging data for reconstructive surgery while sparing them from unnecessary interventions or additional surgeries. ■

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