

## Use of the TeraRecon Aquarius System to Teach Anatomy to Medical Students

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### Introduction

The Wake Forest University School of Medicine in Winston-Salem, NC, has long been known for its innovative approaches to medical student education. Seventeen years ago, we developed a highly emulated problem-based learning curriculum, with students gaining exposure to patient care and high-tech imaging during their first month of medical school. Twelve years ago we became the first medical school to provide laptop computers to all our students, placing their entire curriculum online. In 2006 we became the first medical school to provide real-time interactive 3D imaging to all students using the TeraRecon Aquarius system.

The traditional methods for teaching gross anatomy are still followed at Wake Forest as they are at other medical schools. Traditional lectures plus a dissection laboratory with 18 embalmed cadavers remains the core of the educational experience. What is unique about the Wake Forest Anatomy Course is the fact that these cadavers, before being dissected, undergo whole-body scanning with CT and MRI, and the digital data are transferred to an Aquarius Server to which all students have access before, during, and after physical dissection.

Each June before the new students arrive for classes, their cadavers are transported to our research imaging center sealed in body bags for CT and MR scanning. The cadavers are imaged from the top of their heads to mid-thigh using protocols listed in the table below:

Cadaver CT Protocol
GE 16-Slice CT Scanner
120 kV, 500 mA
300-500 5-mm-thick axial slices
FOV 45 cm
Standard Algorithm
Cadaver MRI Protocol
GE Signa 1.5T with EXCITE
Separate 3D volume acquisitions: Head/Neck, Chest, Abdomen/Pelvis
SPGR TR 6.78 TE 2.16
FOV 42 cm, slice thickness = 1.4 mm
#slices/ volume = 176
256x256 matrix

Typical images from these data sets displayed on the AquariusNET thin-client are shown in Figures 1 and 2 below:

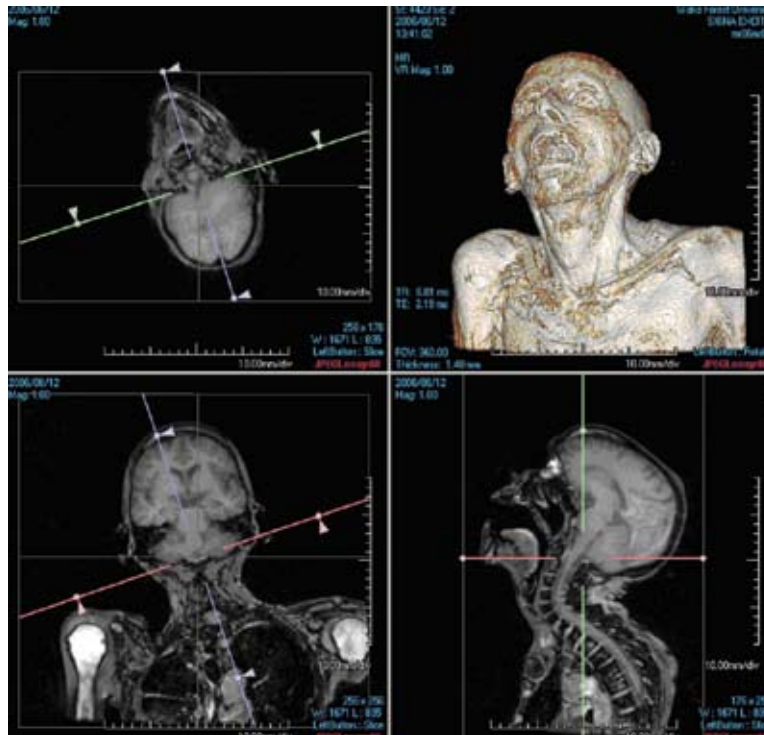
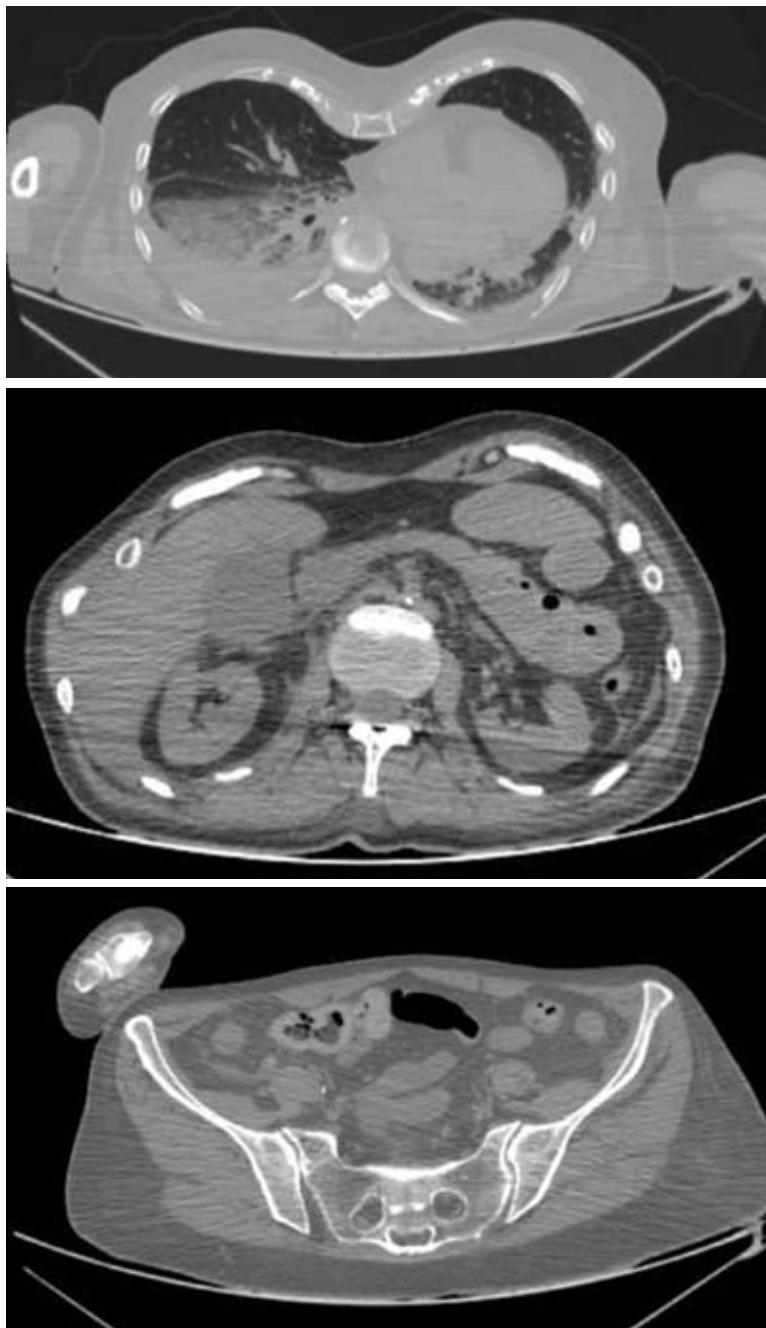


Figure 1. Multiplanar MR images of a cadaver head and neck. A gradient echo sequence was selected because it can be acquired relatively quickly in 3D mode with good anatomic delineation. The multiplanar-3D capabilities of the Aquarius system are especially useful because many cadavers (like this one) lie in somewhat contorted, non-orthogonal positions.



Figure 2. Multiplanar CT images of a cadaver, equivalent to the MRI series of Figure 1.

Surprisingly, the images of cadavers look strikingly similar to those in living subjects. It is often even possible for the students to determine the cause of death, such as brain tumor or pneumonia, from reviewing their cadaver images.

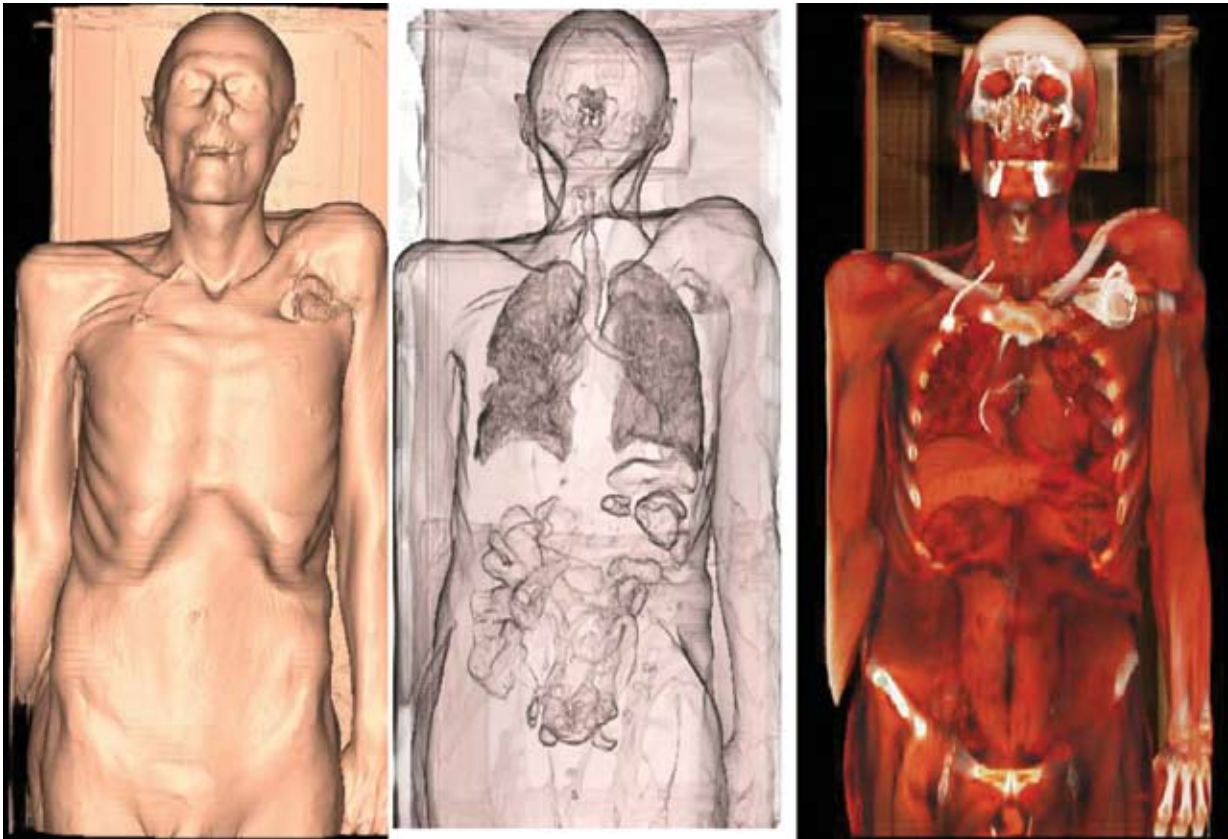


*Figure 3. Cadaver CT images (chest, abdomen, pelvis) are difficult to distinguish from those in living subjects.*

Each dissection station in the Anatomy Laboratory is supplied with internet/intranet access and has suspended above it a 21-inch flat-screen color monitor. Using the Aquarius system, students call up interactively the actual images of their cadavers and manipulate them real-time in concert with the physical dissection they are performing. Images below are illustrative of this process:

## Conclusion

In conclusion, the Aquarius system has revolutionized the teaching of anatomy at the Wake Forest University School of Medicine. The use of real-time multiplanar 2D and 3D imaging has excited students about the role radiology and advanced imaging techniques play in modern medicine. Hopefully, we are not only educating them, but recruiting the best and brightest to follow into imaging-based specialties.



*Figure 4. "Virtual dissection" of a cadaver from CT data set using the Aquarius system, showing surface-rendered image (left), air containing spaces (middle), and muscles/viscera (right).*