Evaluation of Abdominal Aortic Aneurysms Using Magnetic Resonance Angiography

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Introduction

The work up and subsequent treatment of abdominal aortic aneurysms (AAAs) routinely includes contrast-enhanced imaging, usually performed during CT scans. However, when the patient has a known allergy to intravenous contrast, or suffers from renal insufficiency, the evaluation of the aorta can be completed by contrast-enhanced magnetic resonance angiography (MRA).

Method

At our institution, the MR evaluation of the abdominal aorta is performed to yield the following sequences:

- Localizers
- Axial/Coronal Single Shot T2/True-FISP images
- Timing bolus
- Coronal 3D MRA with three phases
- Delayed Axial 2D fat saturated T1 weighted sequences

The evaluation requires less than 30 minutes of machine time. During the examination, approximately 30 ml of gadolinium chelate is administered. The patient must hold his or her breath for at least 15-20 seconds. If the patient is unable to hold breath, evaluation is possible using the obtained 2D images that are less susceptible to motion. However, 2D images cannot be used for very accurate analyses.

While evaluating abdominal aortic aneurysm (AAA), it is important to ascertain several factors that will enable the physician to choose between endovascular treatment and open repair of the aneurysm.

The variables involved in planning for an endovascular repair of an AAA include the diameter and the length of the unaffected aorta below the level of the renal arteries (aortic neck), the angulation of the aneurysm, the maximum diameter of the sac, presence of extension into the iliac vessels, length of the affected region, angulation of the iliac vessels, and the diameter of the external iliac arteries. Since the MRA is obtained in the coronal plane, accurate cross sectional diameter and length measurement require a curved planar reformat of the source images.

The Aquarius Workstation from TeraRecon, Inc., is one of the best tools available today to perform such analyses. The images are transferred to the Aquarius

Workstation and subsequently loaded into the 3D viewer, where they can easily be manipulated to display the best possible view.

Results

Two curved planar reformatted (CPR) images are obtained using the CPR tool bar, each coursing from the level of the renal arteries along the course of the aneurysm and the right and left iliac systems as demonstrated below (Figure 1).

The length of the aortic neck can now be obtained. The cross reference line located in the lower left screen is manipulated so that the origin of the aneurysm can be seen on the top left screen (this screen is the 2D image perpedicular to the course of the vessel and can be used to calculate diameters). A diameter greater than 28 mm at the level of the aortic neck is often the upper limit for endovascular treatment of an aortic aneurysm. A short length of the neck may indicate the need for an endovascular device with supra-renal fixation.

The diameters of the common iliac arteries are obtained by moving the cross reference line caudally and measuring off of the 2D generated image perpendicular to the course of the vessel. A diameter of the common iliac arteries exceeding 18 mm will dictate the necessity to extend the device into the external iliac arteries and exclude the internal iliac system on each side. Most centers prefer to avoid occlusion of both internal iliac systems as this may lead to inadvertent complications including buttock claudication and bowel ischemia.

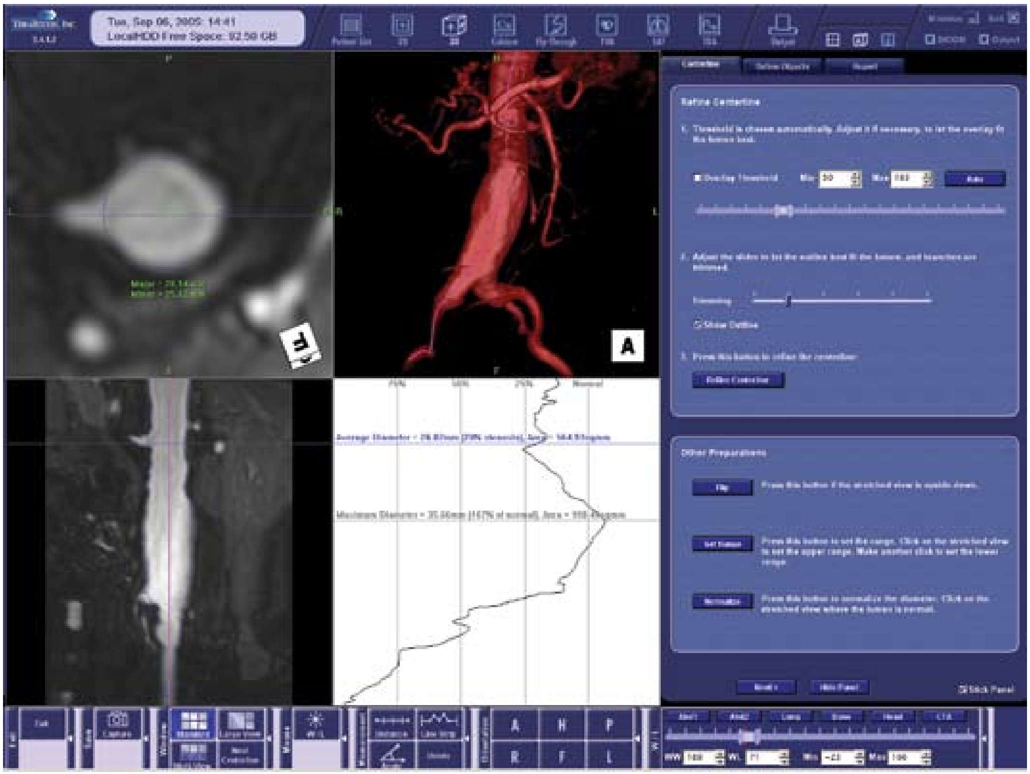


Figure 1

Figure 2

Figure 3

A tortuous neck or iliac artery can be evaluated on the 3D images (shaded surface or MIP) images. (Figure 2 ,3)

If an endovascular repair is to chosen, proper measurements must be obtained to ensure the correct proximal and distal seal.

The Aquarius Workstation can facilitate this process by providing reformated images from which accurate measurements can be obtained. In addition to the above mentioned measurements, the distance between the lowest renal artery and the iliac artery bifurcation on each side must be measured as demonstrated below (Figure 4)

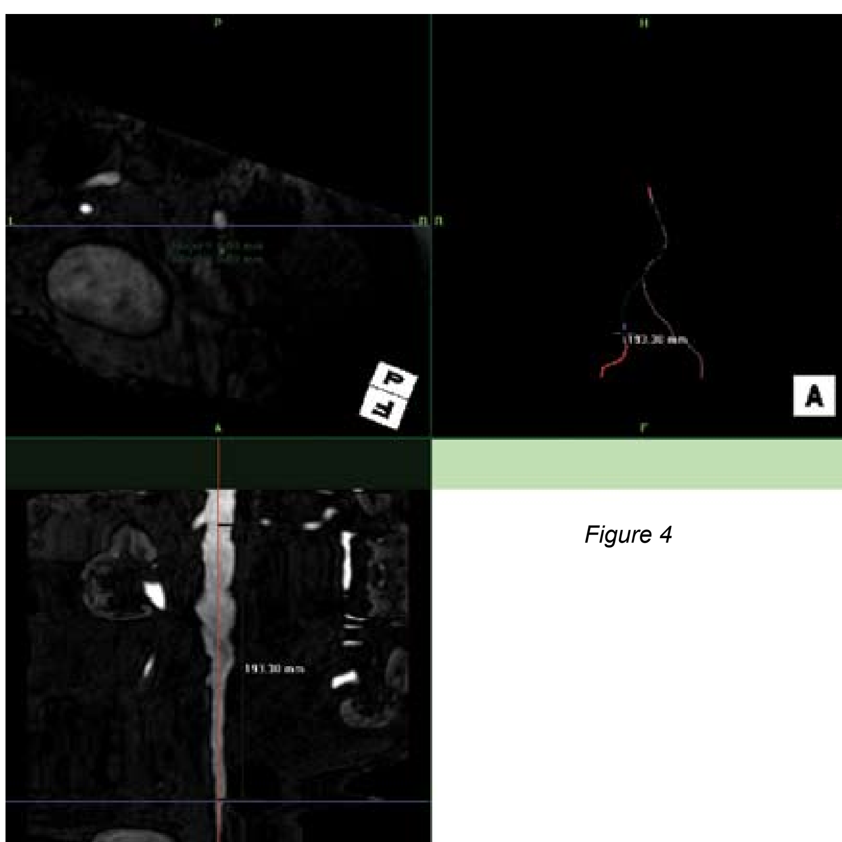


Figure 4

The Aquarius Workstation provides various templates to facilitate the endograft ordering process by easily producing an order form from the obtained measurements. A sample form is shown below. This automated tool enables the generation of accurate measurements for stent graft creation from various manufacturers by simply following the easy steps in the upper right hand box. (Figure 5)

Endoleak evaluation

An endoleak is a common complication of endovascular repair occuring in approximately 20% of the cases. While this complication is routinely diagnosed on a CT examination, MRA can further elucidate this finding due to its greater contrast resolution and the ability to perform time-resolved angiographic imaging.

Four types of endoleaks have been described:

Type I	Originating from ends of grafts
Type II	Originating from collateral (most often IMA and lumbar arteries)
Type III	From a discontinuity of the graft device
Type IV	Porosity (rarely seen with new endo grafts)

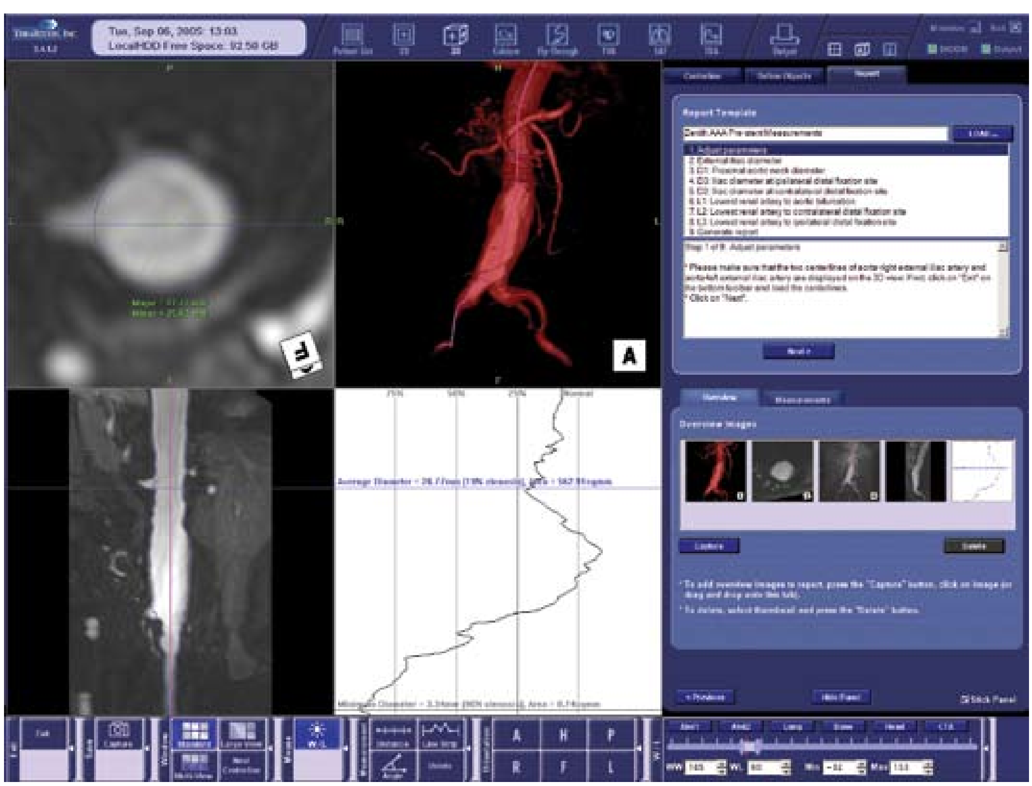


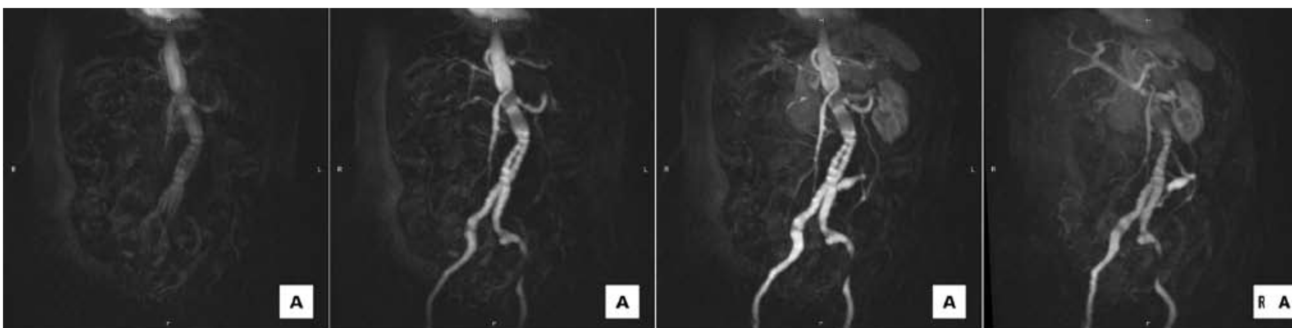
Figure 5

In addition, endotension, which is pressurization of the aneurysm sac from a yet unknown etiology, has been described as a type V endoleak.

The reformating capabilities of the Aqaurius Workstation can significantly improve delineation of the endoleak from a 3D data set.

In addition, the Workstation offers a 4D evaluation platform that can significantly help elucidate feeders and draining vessels of an endoleak. A sequence of static images from a dynamic image data set is shown below. (Figure 6)

Utilizing the rotating cababilities of the Workstation and its ability to advance one frame at a time, we can clearly demonstrate the origin of this endoleak. The same data set from the patient above is rotated below: (Figure 7, 8)



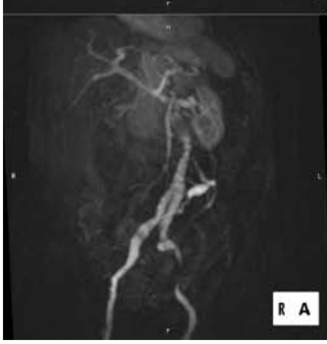


Figure 6

Figure 7 3D volume rendering of MRA showing origin of endoleak

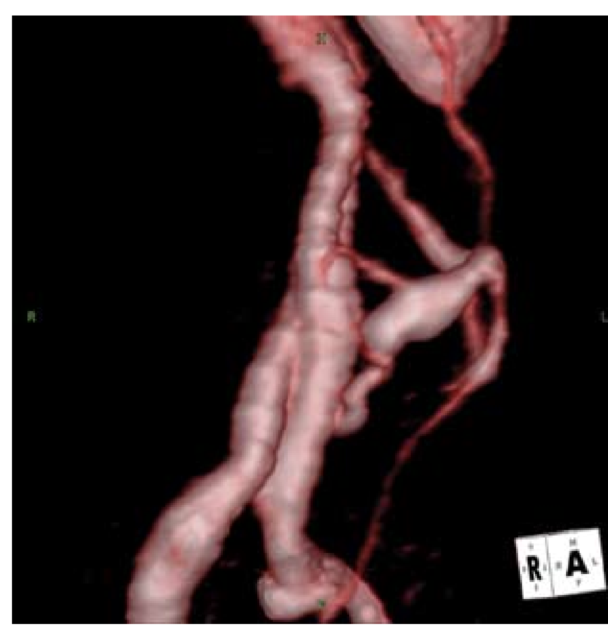


Figure 8 3D volume rendering of MRA showing origin of endoleak

To do this, right click on the data set (which, as of the time of writing should not exceed 29 acquisitions) and select the ‘4D’ option.

The 4D interface is very similar to the 3D interface except that a cine tool bar is now available in the distal lower right screen. If this tool bar is not visible, close a few of the other tool bars to bring it into view. (Figure 9)

Figure 9

In this way one can advance the frames to identify the feeding vessel and the type of endoleak present in the selected patient in indeterminate cases which will help clarify the treatment plan.

Conclusion

While the evaluation of abdominal aortic aneurysms is predominantly performed with CT angiography, MR angiography should be used in unique situations. The obtained images with either modality will need to be reprocessed so that accurate measurements can obtained and the correct treatment option, including choice of stent grafts, can be ascertained.

The Aquarius Workstation by TeraRecon is an indispensable tool that is both sophisticated and easy to utilize for this purpose. In addition, it provides unique features such as 4D image analysis, which aid in the monitoring of the patients subsequent to their therapy.

[1] Use of gadolinium chelates for MRA of the body is an off-label use of this medication.