

# Duplex Ultrasonography and Its Impact on Providing Endograft Surveillance

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## Abstract

Increasingly, aortic aneurysms are being repaired using endoluminal grafting techniques. Complications of such surgery include persistent endoleaks, continued growth of the aneurysm and migration or thrombosis of the device. Consequently, patients undergoing endovascular repair must be under rigorous surveillance postoperatively. Spiral computed tomography scanning is the test of choice to assess the integrity of the repair, but frequent scanning subjects the patient to repeated doses of radiation and nephrotoxic contrast agents. Duplex ultrasound has long been used to diagnose the presence of aortic aneurysm and may be an appropriate tool for monitoring endovascular grafts. However, the wide variability in sensitivity, specificity, positive and negative predictive values, and accuracy rates described in the literature reflect the fact that many problems still exist with this technique. Until these difficulties can be resolved, duplex ultrasonography is best used in conjunction with spiral computed tomography.

**Key Words:** Duplex ultrasonography, aortic aneurysm, endograft repair.

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SINCE ITS INTRODUCTION IN 1991 by Parodi et al. (1), endovascular repair of abdominal aortic aneurysms has been widely used. Yet collective experience has shown that although the procedure provides the benefits of less-invasive surgery and shorter length of stay, these advantages may be offset by late complications, such as persistent endoleak, continued growth of the aneurysm and even rupture (2, 3). Consequently, patients undergoing such treatment must remain under periodic surveillance to ensure continued integrity of repair. Spiral computed tomography (CT) is the test of choice, with scanning recommended in the early postoperative period, at 1 month and then at 6 month intervals, if no endoleaks are visualized (4). This rigorous testing schedule, however, subjects the patient to the risks of repeated doses of radiation and nephrotoxic contrast agents. Duplex ultrasonography (DU) is less

expensive, easily obtainable and devoid of risks due to radiation or iodinated contrast agents. In addition, it is widely used as a tool to diagnose and follow abdominal aortic aneurysms. Thus, it may be an appropriate device for endograft surveillance.

Ten studies have been identified comparing CT and DU for postoperative evaluation of endovascular abdominal aortic aneurysm repair (5–14). The total number of patients studied was 804. In seven of these studies, the CT scan and DU were obtained within 7 days of each other. In two others, the time interval between the tests was not stated. The study reported by McLafferty et al. (13) is flawed because the CT scan and DU were not performed during the same time interval. Two hundred one endoleaks were identified in the 804 patients (25%). These reports indicate that DU accurately identifies the presence of endoleaks following endovascular repair of aneurysms, with an overall sensitivity of 93% (range 77–100%), specificity of 94% (range 74–100%), positive predictive value of 78% (range 66–100%), negative predictive value of 98% (range 90–100%), and accuracy of 93% (range 82–100%).

Theoretically, DU may be accurate in

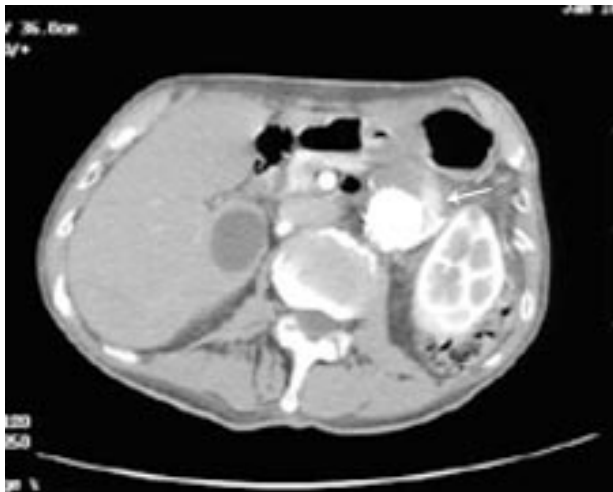
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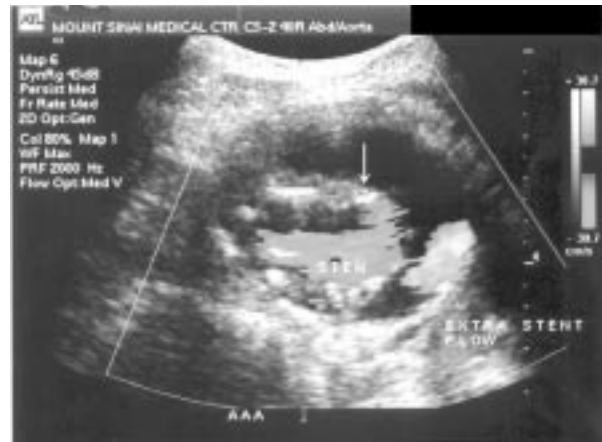
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identifying not only the presence of an endoleak, but its source as well. D'Audiffret was able to localize a potential source of filling by either the inferior mesenteric artery or a lumbar branch in all of the type 2 endoleaks identified (11). Such accuracy requires thorough examination by an experienced technician. Studies should be performed on a high-resolution duplex ultrasound machine. Examination of retroperitoneal structures requires the use of low-frequency curved array, phased array or mechanical sector, and pulsed Doppler scan transducers. Patients, who must have been fasting for a period of eight hours, are studied in the supine position. The entire aortic sac is examined, including the graft and its proximal and distal attachment sites, using the B-mode. Maximum diameter of the sac is obtained. Following this, color Doppler scan is obtained in both the transverse and longitudinal axes, avoiding both excessive overgain and undergain. Pulsatile color scan flow seen within the aortic sac but outside the graft may be indicative of endoleak. If an endoleak is suspected, attention should then be paid to the proximal and distal attachment sites, the inferior mesenteric artery, and the lumbar arteries. Spectral Doppler waveform analysis will help differentiate true endoleak from artifact and determine the direction of flow (Figs. 1–4).

There are limitations in the use of DU to evaluate endovascular grafts postoperatively. For example, integrity of the stent itself cannot be assessed by DU. Plain abdominal X-rays remain the test of choice to diagnose stent fracture. And, as



doleak (arrow).  
**Fig. 2.** Duplex ultrasonography of the same patient demon-



strating the endoleak, labeled as “extra stent flow” on this image. A transverse image of the aneurysm has been obtained, similar to what is seen on computed tomography. The stent is visualized largely surrounded by thrombus (arrow). However, flow is seen outside the stent, indicating the presence of an endoleak.

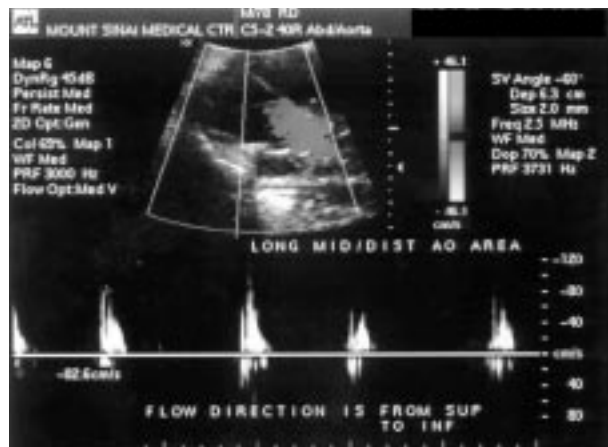


**Fig. 3.** A longitudinal image of the aneurysm demonstrates leakage from the proximal attachment site of the graft. The direction of extra-stent flow (arrow) is from superior to inferior.

with any other abdominal or retroperitoneal examination, excessive bowel gas will interfere with the ability to obtain a high-quality ultrasound.

**Summary**

Spiral computed tomography is currently the best choice to evaluate the results of endovascular repair of abdominal aortic aneurysm. However, the necessary rigorous postoperative surveillance subjects the patient to repeated doses of radiation and nephrotoxic contrast agents. Duplex ultrasonography, a less ex-



**Fig. 4.** Spectral Doppler waveform analysis confirms the presence of the endoleak. In addition, flow direction is determined by the deflection of the waveform above baseline.

pensive tool with no risk of nephrotoxicity or exposure to radiation, may yet prove to be a useful tool to follow patients assuming that the many problems can be resolved.

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**Fig. 1.** Spiral computed tomography demonstrating an en-