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DISCUSSION

Britt Tonnessen, MD (*New Orleans, La*). Thank you for an excellent presentation on a topic of great interest to us all. In prior publications, the group from Norfolk has championed the use of Duplex ultrasound for the identification of endoleaks. Still, sensitivity of endoleak detection, measured up against CT, ranges from 12% to 97% in the literature. The most obvious rationale for this discrepancy is the variability among vascular laboratories and lack of a standardized protocol, as the authors emphasize.

In this robust retrospective study, the authors identified more endoleaks on US than on CT-particularly type II endoleaks. The crux of this manuscript is in the authors' contention that US is, in their hands, more frequently able to identify those patients who require a secondary procedure for their endoleak. They found a sensitivity of 90% for US versus 58% for CT. Just so that we do not lose total confidence in CT, a negative CT did successfully rule out endoleak requiring intervention 98% of the time.

One shortcoming of these data is that the examinations were not performed concurrently. Potentially, endoleaks may have resolved or appeared during the mean of 18 days between paired the studies, introducing the possibility of a type I statistical error.

Skepticism aside, many of us have already adopted Duplex ultrasound as part of our post-EVAR surveillance. Lack of a standardized regimen incorporating US has likely led to disparate practices. At this meeting last year, data was presented that showed that the absence of endoleak on the 1 and 12 month CT predicts low aneurysm related morbidity with one endovascular device. A more "relaxed" regimen of CT follow-up, incorporating Duplex, may be appropriate in this setting. Such algorithms need to be prospectively validated and standardized.

I have the following questions for the authors:

1. What is the current surveillance algorithm in Norfolk? Given the variability in ultrasound quality, do the authors believe that this algorithm should and can be widely adopted?
2. Migration is one post-EVAR complication that is time-dependent, often occurring late in the follow-up. Migration is best detected prior to the development of a type I endoleak. Particularly with devices reported to have high migration rates, how do you intend to follow these patients for migration?
3. If we assume that many of these endoleaks caught on US but not on CT were "low-flow" and not false positives, how did the authors decide when a type II endoleak was "clinically significant"? In other words, what was your threshold for intervention?

Gregory C. Schmieder, MD. Thank you for your questions. The first question is about our surveillance protocol. We recently adopted a protocol of duplex ultrasound at six months, twelve months, eighteen and twenty-four months; no routine CT scans. If there are any questions about an endoleak or we are concerned secondary to sac enlargement or some other finding, then a CT scan will be obtained. We use CT scans in a more isolated and directed approach. In regards to migration, this is one of the weak

elements of a color duplex ultrasound exam. As you mentioned, however, the development of a Type 1 endoleak is the most concerning outcome from migration. As we have demonstrated, you can clearly detect Type 1 endoleaks very well with duplex color ultrasound. Also, we are currently looking at measurements of the distance from the renal artery to the stent grafts with duplex to see if we can truly get a good measurement using duplex ultrasound and that is a current ongoing study. The third question is how we determine when patients get reinterventions for Type 2 endoleaks which as you mentioned were detected more with ultrasound compared to CT scan. Most of that decision is based on clinical variables, such as sac size enlargement. Is there an absolute definitive number that we use at our institution? No. Some of it is surgeon-specific. Also, another indication for intervention is a persistent endoleak without sac regression in a large aneurysm, which has been shown in studies to have more adverse outcomes.