Evolving Follow-Up Protocols After EVAR: Toward Precision Surveillance

The paradigm is shifting from uniform imaging schedules to risk-based, patient-specific follow-up.

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The advent of endovascular aneurysm repair (EVAR) has significantly reduced the perioperative morbidity and mortality associated with abdominal aortic aneurysm repair. Nonetheless, the long-term success of these interventions hinges on vigilant postoperative surveillance to detect common complications, particularly endoleaks and aneurysm sac enlargement. Traditionally, follow-up protocols have been standardized, often involving frequent imaging irrespective of individual patient risk profiles. However, emerging evidence now advocates for a more tailored approach—aligning surveillance intensity with patient-specific risk factors and procedural complexities. This shift is driven by variability in anatomic complexity, the evolution of endografts, and improved characterization of complications such as endoleak types.

This article examines the paradigm shift from uniform imaging schedules to risk-adapted, patient-specific follow-up protocols in the contemporary landscape of EVAR surveillance, with particular emphasis on a nuanced approach to monitoring, especially regarding type II endoleaks.

THE SHIFT TOWARD RISK-STRATIFIED SURVEILLANCE

Historically, postoperative surveillance following EVAR adhered to rigid schedules, typically involving CTA at 1, 6, and 12 months and then annually thereafter. These recommendations were empirically derived from early multicenter trials and codified in the instructions for use (IFU) of endografts. Although comprehensive, this approach imposed significant burdens, including cumulative radiation exposure, the risk of contrast-induced nephropathy, and substantial health care costs.

In 2018, the Society for Vascular Surgery published updated practice guidelines recommending annual CTA or duplex ultrasound (DUS) imaging if baseline imaging at 1-month post-EVAR did not show evidence of endoleak or sac enlargement. Imaging at 6 months was recommended only in the presence of a type II endoleak on the baseline 1-month post-EVAR imaging.[1] Subsequently, the European Society for Vascular Surgery (ESVS) published hazard-based, stratified surveillance clinical practice guidelines in 2019.[2] Patients undergoing EVAR were stratified into risk groups to guide follow-up based on results from initial imaging and post-EVAR CTA at 30 days. For low-risk patients (no endoleak, anatomy within IFU, and ≥ 10 mm of proximal and distal seal), the guidelines recommended imaging at 5 years postprocedure. Intermediate-risk patients (adequate seal zones but with a type II endoleak) would be evaluated with regular annual imaging with DUS to assess sac expansion or regression and guide decisions with regard to reintervention. High-risk patients (type I or III endoleak or < 10 mm of seal) were recommended for early reintervention evaluation, with follow-up imaging, especially CTA, to monitor seal integrity and sac changes.

The 2024 ESVS guideline update folded the intermediate-risk group into the high-risk group, reclassified the 2019 high-risk group as the EVAR failure group, and placed greater emphasis on anatomic thresholds (eg, neck diameter, angulation, iliac diameter) and reevaluation of risk at each follow-up to more precisely define risk categories.[3]

EVAR outcomes have improved significantly in the 21st century, attributed to enhanced endograft durability, refined patient selection, surgical technique, and operator experience. From 2011 to 2021, the in-hospital complication rate for elective EVAR decreased by 0.7%

per year ($P < .001$), reaching 4% in 2021 according to the Vascular Quality Initiative database.[4] Data from Kaiser Permanente's Endovascular Stent Graft Registry demonstrated a reduction in 1-year secondary intervention rates from 5.9% in 2010 to 2% in 2019 ($P < .001$). Ninety-day readmission rates also decreased from 19.3% to 9.2% over the same period ($P = .03$).[5]

With these improved outcomes, recent studies suggest that uniform surveillance protocols may be excessive for low-risk patients,[6] representing a costly and resource-consuming endeavor,[7] and may even be deleterious to certain patients.[8] Multiple studies confirm that intensive routine surveillance regimens do not improve survival, raising questions about the utility of this approach.[8-11] A stratified follow-up regimen based on preoperative anatomic characteristics and postoperative imaging results remains essential for achieving a balanced surveillance strategy.

COMPLEXITY DICTATES SURVEILLANCE INTENSITY

The anatomic and procedural complexities of EVAR significantly influence the risk of postoperative complications, thereby dictating the intensity and frequency of surveillance. Factors such as a short or angulated neck, presence of calcification or thrombus, and involvement of branch vessels increase the likelihood of endoleaks and endograft-related complications. Consequently, patients with complex anatomies or those undergoing procedures involving fenestrated/branched endografts warrant more rigorous follow-up.[12] Novel devices also necessitate intensive surveillance, as their mid- and long-term outcomes remain uncertain.[6]

Conversely, patients with straightforward anatomies and favorable intraoperative results may benefit from a de-escalated surveillance regimen. A study validating the 2019 ESVS surveillance protocols identified 71% of patients as low risk, defined as having no endoleaks, adequate proximal and distal seal, and device implantation within IFU. Over 5 years of follow-up, late type II endoleaks occurred in 10% of this group, but only 2% persisted, and none required secondary intervention.[13] Other studies have reported that fewer than 10% of patients benefit from routine annual imaging post-EVAR,[14] reinforcing the idea that a risk-stratified approach could reduce both surveillance frequency and associated health care costs. In a study of Medicare beneficiaries, nonadherence to routine annual surveillance imaging did not result in worse outcomes.[9]

SURVEILLANCE OF EVAR WITH TYPE II ENDOLEAK

Type II endoleaks, resulting from retrograde flow into the aneurysm sac via branch vessels like the inferior mesenteric artery (IMA) or lumbar arteries, are the most common post-EVAR complication, accounting for 16% to 39% of all cases.[15,16] Although often benign, persistent type II endoleaks may lead to sac expansion and, rarely, rupture. Their behavior is heterogeneous, necessitating a specific, tailored management approach.

A meta-analysis of 45 studies involving more than 36,000 participants identified several risk factors for type II endoleak, including a patent IMA, multiple patent lumbar arteries, larger aneurysm diameter, and older age.[17] Numerous studies indicate that isolated type II endoleaks without aneurysm sac enlargement do not affect survival.[16,18] Persistent type II endoleaks have been associated with increased rates of reinterventions and occasional late aneurysm rupture, but not with decreased survival.[18,19] Although secondary interventions for type II endoleak remain common, no conclusive evidence has linked it to higher mortality.[20]

Therefore, type II endoleaks do not inherently signify poor prognosis unless associated with sac enlargement or evolution into other endoleak types. Management should emphasize close monitoring of sac behavior, with intervention reserved for those exhibiting sac enlargement of ≥ 10 mm. In the absence of sac growth, annual surveillance imaging is generally sufficient, while more intensive surveillance and consideration for reintervention are warranted when significant sac enlargement is observed.

FUTURE DIRECTIONS: TOWARD PRECISION SURVEILLANCE

The evolution of EVAR follow-up protocols reflects a broader trend toward precision, patient-centered care. By integrating patient-specific risk factors, procedural details, and advanced imaging techniques, clinicians can devise individualized surveillance strategies that optimize outcomes while minimizing unnecessary testing and interventions.

Emerging technologies, including machine learning algorithms, hold promise for enhancing risk stratification and complication prediction. Moreover, ongoing research into the pathophysiology of endoleaks and the development of novel endograft materials will likely further refine follow-up strategies in the coming years.

CONCLUSION

Lifelong surveillance remains essential for patients with aortic disease. However, the optimal frequency of surveillance continues to evolve, and it is increasingly clear that a one-size-fits-all approach is suboptimal. A personalized, risk-profile–based approach is necessary. By incorporating anatomic complexity, procedural factors, and patient-specific risks, we can tailor surveillance protocols to achieve a balance between efficacy and efficiency.

Continued research and technologic advancement will undoubtedly further refine these strategies, enhancing patient care in the dynamic field of EVAR. Accumulating data support the idea that low-risk patients—defined as those with EVAR performed within IFU, with healthy sealing zones (ie, aortic neck < 28 mm in diameter, ≥ 10 mm in length, without thrombus, calcification, or tortuosity, and nonectatic or nonaneurysmal iliac arteries), and no endoleak on 30-day CTA—do not require annual surveillance imaging and may be monitored less frequently.

Additionally, type II endoleaks without sac enlargement generally follow a benign course and should be monitored with routine annual imaging. In contrast, sac enlargement should not be dismissed as benign, the underlying cause must be investigated, and close surveillance or reintervention should be considered based on the etiology. ■

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