Editorial

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Artificial intelligence (AI) tools in today's angiology and vascular surgery

Volume 18 Issue 3 - 2025

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Received: September 01, 2025 | **Published:** September 02, 2025

Artificial intelligence (AI) tools are catalyzing a remarkable transformation in Angiology and Vascular Surgery, introducing new paradigms for diagnosis, operative planning, patient monitoring, and personalized decision-making. As AI technologies mature, their integration into vascular practice is poised to redefine workflows and patient outcomes, but not without pertinent challenges that demand ongoing attention.[1]

Foundations of AI in vascular medicine

At its core, AI comprises technologies such as machine learning, neural networks, natural language processing, and computer vision. These enable computers to recognize complex patterns in vast medical datasets, predict outcomes, and provide decision support.[1] In vascular surgery, such analytical power is especially valuable, given the intricate interplay between patient comorbidities, anatomical variation and procedural risk.

Diagnostic advancements

AI-driven algorithms have been vigorously evaluated for their accuracy in vascular diagnostics. Deep learning models and convolutional neural networks (CNNs) significantly enhance the analysis of imaging modalities—CT, MRI, duplex ultrasound—automating tasks like segmentation of vessels, plaque characterization, and identification of aneurysm morphology with high sensitivity and specificity.[1,2] For example, studies have shown AI methods to surpass traditional scoring in carotid plaque vulnerability and peripheral arterial disease (PAD) evaluation, driving earlier intervention and clinical efficiency.[2,3] AI can also interpret noninvasive data, such as the ankle-brachial index or Doppler waveforms, streamlining PAD detection and risk stratification.[2]

Preoperative planning and outcome prediction

Personalized medicine in vascular surgery has seen major gains from AI, as machine-learning models are trained on historical procedural data, imaging characteristics, and patient populations to predict surgical outcomes, stent/graft patency, and the likelihood of postoperative complications.[2,3] Platforms leveraging ensemble learning and support vector machines (SVM) now assist in preoperative decision-making. For conditions like abdominal aortic aneurysm (AAA), AI can analyze complex growth trends and stratify rupture risk—guiding surveillance intervals or intervention thresholds.[2,4]

Clinical decision support and workflow

AI-powered clinical decision support systems (CDSS) now provide real-time, evidence-based input to vascular surgeons and angiologists.[2,5] These systems aggregate patient records, imaging findings, and physiologic data, helping prioritize critical cases, identify ideal endovascular approaches, and personalize anticoagulation or anti-platelet regimens for complex patients—such as those with diabetes or multi-morbidity.[6,2] The synthesis of genomics and EMR data further amplifies the precision of these recommendations.

Wearables, surveillance, and follow-up

Advancements in wearable sensor technologies, coupled with AI, have led to automated outpatient surveillance in high-risk vascular patients. AI systems monitor for adverse trends in hemodynamic parameters, predict readmissions, and automatically flag patients needing urgent evaluation—streamlining outpatient care.[2,7] This continuous, intelligent surveillance mitigates the limitations of episodic in-person visits.

Surgical education and simulation

With the complexity of vascular interventions growing, AI and extended reality simulations have emerged as powerful educational tools. Intelligent simulators give tailored feedback, case-specific rehearsal, and objective skills assessment, expediting surgeon learning while boosting procedural safety.[8,7] These resources are critical to ensuring that training keeps pace with the evolving technological demands of the specialty.

Ethical considerations and barriers

Despite the promise, significant obstacles must be navigated. Issues of data privacy, model transparency, algorithmic bias, and the lack of standardized evaluation metrics persist.[4,3] Most current AI models still require robust, prospective validation in diverse vascular patient populations to ensure generalizability and safety. Ethical deployment, regulatory oversight, and collaborative efforts between surgeons, engineers, and data scientists are vital for safe clinical integration.[4,6]

Future directions

Continued research investment, expansion of high-quality, multicenter datasets, and interdisciplinary collaboration will be critical to maximize AI's promise in angiology and vascular surgery. The future envisions seamless integration of AI across diagnostics, operative strategy, longitudinal care, and professional training, improving both patient outcomes and healthcare efficiency.[2,7,3]

Acknowledgement

None

Conflicts of interest

Author declare no conflicts of interest.

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Citation: Camacho N, Teixeira R. Artificial intelligence (AI) tools in today's angiology and vascular surgery. *J Cardiol Curr Res.* 2025;18(3):65–66. DOI: 10.15406/jccr.2025.18.00626