Volume 5 Issue 4 August 2026

Journal of VASCULAR SOCIETIES GREAT BRITAIN & IRELAND

ISSN 2754-0030

The journal is owned by the Vascular Society for Great Britain and Ireland (VSGBI)

AFFILIATED SOCIETIES INCLUDE:
British Association of Chartered Physiotherapists in limb Absence Rehabilitation (BACPAR)
British Society of Endovascular Therapy (BSET) British Society of Interventional Radiology (BSIR) Rouleaux Club
Society of Vascular Nurses (SVN) College and Society for Clinical Vascular Science (CSCVS)
UK National Interventional Radiology Trainee Research (UNITE) Collaborative
Vascular Anaesthesia Society of Great Britain & Ireland (VASGBI) Vascular and Endovascular Research Network (VERN)

www.jvsgbi.com

VASCULAR SOCIETY

The Vascular Society for Great Britain and Ireland

About the VSGBI

The Vascular Society of Great Britain and Ireland (VSGBI) is the pre-eminent organisation in the country promoting vascular health by supporting and furthering excellence in education, training and scientific research.

The Society represents and provides professional support for over 600 members, including vascular surgeons, vascular radiologists and others involved in independent vascular practice in Great Britain and Ireland.

The Society focuses on non-cardiac vascular disease, including diseases of the aorta, peripheral arteries, veins and lymphatics. Vascular specialists are trained in the diagnosis and management of conditions affecting all parts of the vascular system.

The VSGBI is a charitable organisation funded by members subscriptions, an annual scientific meeting, grants and donations. It has a professional structure including a permanent Secretariat, Executive Officers and Council elected by Members.

Benefits of Membership

Membership of the Society is widely recognised in the vascular community as a mark of professional achievement.

The advantages of membership of the Vascular Society include:

- The VSGBI **represents vascular specialists working in the UK and Ireland, as well as welcoming overseas members** and helps drive policy through its relations with Royal Colleges, other related professional societies (e.g. BSIR) and the Department of Health. Members have access to the Executive and Council who prepare and enable these policies.
- The VSGBI **promotes vascular education and training**, runs training courses (ASPIRE and ASPIRE Digital). **Specialist Affiliate members gain free membership of European Vascular Surgeons in Training** and has lobbied for positions such as the post CCT Fellowships, and the Endovascular Fellowships.
- The VSGBI **organises specialist courses and meetings** delivered locally, together with an annual meeting with scientific and political updates.
- The VSGBI **publishes virtual educational resources** which are available to members.
- The VSGBI **publishes a quarterly journal,** the *Journal of the Vascular Societies Great Britain and Ireland*, which is available to members.
- The VSGBI **publishes policy documents** and quality improvement resources which are available on it's website.
- VS members can enjoy **ESVS membership at a discounted rate**, and benefit from ESVS membership benefits.
- The VSGBI together with HQIP and the clinical effectiveness unit (CEU) at the RCS England **maintains the National Vascular Registry**. NVR is the principal outcomes registry for the UK and for the AAA Screening Programmes (England, Wales, Scotland and Northern Ireland).
- The Society's **Professional Standards Committee, (PSC) offers support to individuals and hospitals**. For further information visit **www.vascularsociety.org.uk** Council and Committees page. Details of the support and advice scheme are given in the Professional Standards Committee section.
- The Society is an associate partner of the BJS. This entitles VS members to a **reduced BJS subscription**.
- The Society is **actively supporting vascular research** through the James Lind Alliance Priority Setting Partnership, Specialist Interest Groups (SIGs), funding of three RCS England Surgical Speciality Leads (SSLs), funding of Clinical Fellows (England and Scotland) and the Vascular Research UK website (https://www.vascular-research.co.uk/).

SIGN UP FOR VSGBI MEMBERSHIP

If you are not already a member to find out more email admin@vascularsociety.org.uk or visit https://vascularsociety.org.uk/about/member-benefits/

MEMBERSHIP CATEGORIES INCLUDE:

FULL MEMBERSHIP – £300 PER YEAR
Consultant or Specialist Vascular Surgeon.

ASSOCIATE MEMBERSHIP – £140 PER YEAR
Consultant Specialist in another speciality, SAS or locally employed (unless preparing for CESR), Scientist, Medical Associate Professional (PA or SCP) or Podiatrist.

SPECIALIST AFFILIATE – £115 PER YEAR
Speciality trainee (holding national training number) or locally employed doctor training with aim of CESR.

NON-SPECIALIST AFFILIATE – NO FEE
Medical student, Foundation doctor or Core surgical trainee considering a career as a vascular surgeon.

SENIOR – £45

OVERSEAS – £115

SCAN TO JOIN

The Vascular Society of Great Britain & Ireland c/o Executive Business Support Ltd
Stowe House, St Chad's Road, Lichfield, Staffordshire WS13 6TJ
Telephone: 02072057150 e-mail: admin@vascularsociety.org.uk

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

The *JVSGBI* is an international peer-reviewed journal which publishes relevant, high quality original research, reviews, case reports and news to support the vascular community.

ADDRESS FOR CORRESPONDENCE:
Journal of Vascular Societies GB&I
c/o Executive Business Support
Stowe House
St. Chad's Road
Lichfield
Staffordshire
WS13 6TJ

ARTICLE SUBMISSIONS AND GENERAL ENQUIRIES PLEASE EMAIL:
Editorialoffice@jvsgbi.com

ADVERTISING AND SALES ENQUIRIES PLEASE EMAIL:
info@jvsgbi.com

The *JVSGBI* is published online quarterly in Feb, May, August and November on the *JVSGBI* website. Articles, when finalised for publishing, will be published online, and then at the discretion of the Editor in Chief, included in the online issue and/or printed issue.

ISSN 2754-0022 (print)
ISSN 2754 0030 (online)

Produced by: Executive Business Support and Production 10 Limited

Printed on 100% recycled paper

JOURNAL OWNED AND PUBLISHED BY

VASCULAR SOCIETY

AFFILIATED SOCIETIES INCLUDE:
British Association of Chartered Physiotherapists in limb Absence Rehabilitation (BACPAR)
British Society of Endovascular Therapy (BSET)
British Society of Interventional Radiology (BSIR)
Rouleaux Club
Society of Vascular Nurses (SVN)
College and Society for Clinical Vascular Science (CSCVS)
UK National Interventional Radiology Trainee Research (UNITE) Collaborative
Vascular Anaesthesia Society of Great Britain & Ireland (VASGBI)
Vascular and Endovascular Research Network (VERN)

FOLLOW US ON @VSjournalGBI

VASCULAR SOCIETY

BACPAR

CSVS
THE COLLEGE AND SOCIETY FOR CLINICAL VASCULAR SCIENCE
Great Britain and Ireland

Society of Vascular Nurses
SVN
www.svn.org.uk

V A S

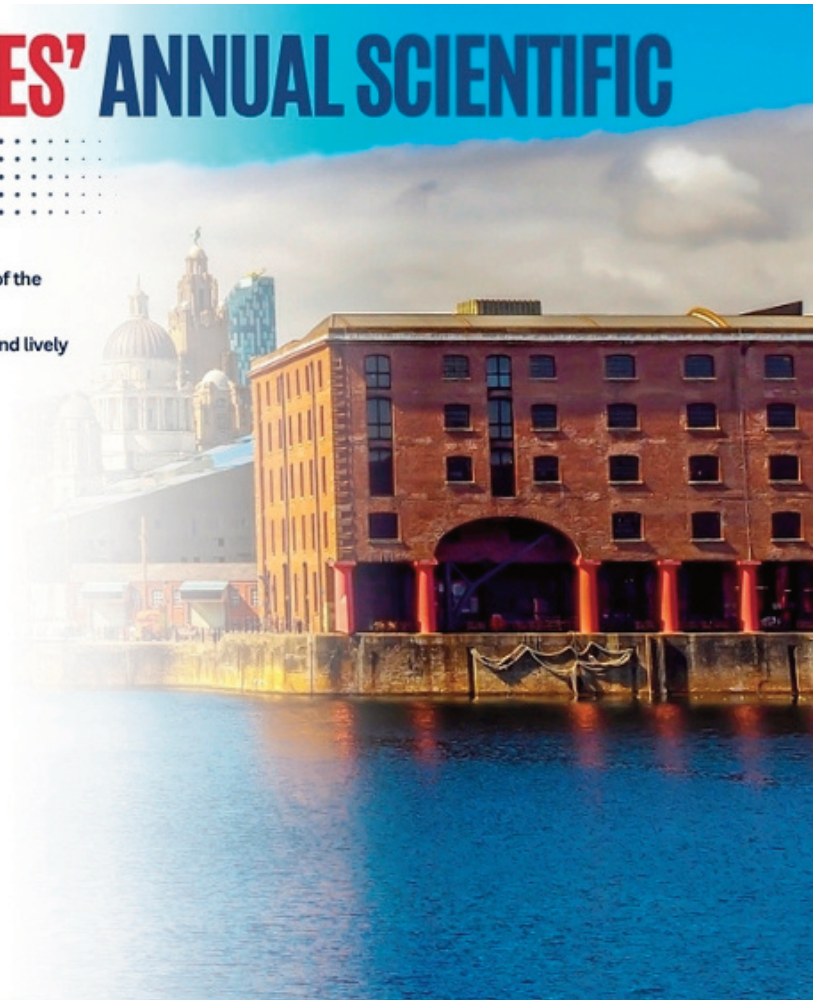
60 YEARS ANNIVERSARY

The Vascular Societies' Annual Scientific Meeting 2026

Celebrating 60 years of the Vascular Society

25th-27th November 2026 I Liverpool Experience Campus

THE VASCULAR SOCIETIES' ANNUAL SCIENTIFIC MEETING 2026



This year's meeting is particularly special as we celebrate the 60th Anniversary of the Vascular Society.

Across three days, the ASM will feature expert speakers, cutting-edge research and lively debate.

Practical learning such as:

- IR Skills for Vascular Surgeons: Hands on workshop
- Introduction to Vascular Surgery Course
- Ultrasound for Vascular Surgery Practice in the UK Course

Registration Now Open!

25th - 27th November 2026

Liverpool Experience Campus

Draft programme now available

Early bird registration rates, available until midnight on 27th September 2026.

Further information can be found -
https://vascularsociety.org.uk/

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):159
http://doi.org/10.54522/jvsgbi.2026.243

www.jvsgbi.com

Editor's foreword

Welcome to the August 2026 edition of the *JVSGBI*, which is a free, open-access, quarterly, online journal that represents the whole vascular community. The *JVSGBI* has published over 160 articles in total, which include 32 editorials, 67 original research articles, 18 protocols and 29 case reports. The *JVSGBI* website had over 20,000 hits in the first four months of 2026, with wide spread interest across the globe

This edition begins with an editorial outlining the VSGBI plans to address global vascular surgery to improve outcomes and achieve equitable surgical care for all, particularly in underserved populations such as low and middle income countries.

This issue also contains two original research articles, a systematic review and three case reports. The first original article from Owaga and colleagues analyse the reliability of 3 different tools used to score calcification on peripheral CT angiograms. The second original article from Howitt and colleagues presents results from an online survey designed to capture practice variation during the consent process of patients undergoing superficial venous intervention. The systematic review and meta-analysis by Imperatore and colleagues evaluates the prognostic utility of natriuretic peptides for predicting adverse postoperative outcomes in patients undergoing vascular surgery.

The first case report from Tufts and colleagues describes an anatomical iliac artery variation, the second case report from Marquez and colleagues from Colombia describes an unusual presentation of a splenic artery aneurysm, and the third case report and literature review by Daysley and colleagues describes the management of a radial artery pseudoaneurysm.

In September 2026 the *JVSGBI* Editorial Board aims to resubmit a MEDLINE application. This is the earliest that MEDLINE will accept a reapplication. The Board are working hard to ensure the resubmission addresses the detailed feedback from our previous unsuccessful submission.

I hope readers find the articles in this issue of interest.

Ian Chetter
Editor in Chief JVSGBI
Vascular Society GBI President

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):160-163
http://doi.org/10.54522/jvsgbi.2026.240

www.jvsgbi.com

EDITORIAL

Developing a vision and strategy for global vascular surgery within the Vascular Society of Great Britain & Ireland

Moody N,[1] Kirengo T,[2] Al-Saadi N,[3] Sandford B,[4,5] Davenport R,[6] Garnham A,[7] Sritharan K[8]

1. Department of Applied Health Sciences, College of Medicine and Health, University of Birmingham, Birmingham, UK
2. Specialty Registrar in Vascular Surgery, Department of Vascular Surgery, University Hospital of Wales, Cardiff, UK
3. Specialty Registrar in Vascular Surgery, Department of Vascular Surgery, University Hospitals Birmingham NHS Foundation Trust, Birmingham, UK
4. Consultant Vascular Surgeon, Guy's and St Thomas' NHS Trust, London, UK
5. Faculty of Life Sciences and Medicine, King's College London, London, UK
6. Consultant Vascular & Trauma Surgeon, Centre for Trauma Sciences, Blizard Institute, Queen Mary University of London, London, UK
7. Consultant Vascular Surgeon, Royal Wolverhampton Hospitals NHS Trust, Wolverhampton, UK
8. Consultant Vascular Surgeon, York & Scarborough Teaching Hospitals NHS Foundation Trust & Chair, Education & Training Committee, VSGBI

Corresponding author:
Nick Moody
Murray Learning Centre, Department of Applied Health Sciences, College of Medicine and Health, University of Birmingham, Birmingham, B15 2FG, UK
Email: nickmoody18@gmail.com

Received: 18th August 2026
Accepted: 21st August 2026
Online: 24th August 2026

Introduction

Global surgery is a field encompassing research, education and advocacy, which aims to improve health outcomes and achieve equitable surgical and anaesthetic care for all.[1] Within the field of global surgery there is a special emphasis on underserved populations such as those in low- and middle-income countries (LMICs) and those facing a humanitarian crisis.[2] The 2015 Lancet Commission on Global Surgery brought the scale of surgical inequity into focus, demonstrating that the poorest third of the world receive only 3–6% of operations whilst the richest third receive 75%.[2] It estimated that 16.9 million deaths annually are from conditions requiring surgical care, more than HIV/AIDS, malaria and tuberculosis combined, and that 77 million disability-adjusted life years lost could be averted by providing basic surgical care.[3]

In the context of global surgery, vascular diseases represent a significant and growing burden. For instance, 81% of people with diabetes mellitus (DM) currently live in LMICs, and 77% of those with DM in LMICs have significant unmet needs including a lack of access to diagnostics and medical therapies, resulting in poor DM control and increased DM-related complications.[4] Meanwhile, the prevalence of peripheral artery disease (PAD) increased by 102% between 1990 and 2021.[5] Recent evidence predicts a further substantial increase in the global prevalence of vascular diseases in the coming decade. The number of people living with DM globally is projected to rise by 45% between 2024 and 2050, with 95% of this increase occurring in LMICs.[6] Over the same period, the number of people with PAD worldwide is expected to rise by 220%, with more than 50% of PAD cases in 2050 expected to occur in LMICs.[7]

In addition, the global burden of traumatic and conflict-related injury is rising,[8] with a growing proportion of vascular injuries seen.[9,10] Reporting of conflict-related trauma varies considerably, so the exact burden remains uncertain, with little evidence from large-scale conflicts such as in Sudan and Syria.[11–13] However, available data from Ukraine reports that extremity vascular injuries have accounted for 12–14% of combat-related wounds in the war so far, higher than in some previous conflicts.[14,15]

Taken together, these trends indicate a rise in the prevalence of conditions which require vascular expertise. Despite this, there are few dedicated global vascular surgery initiatives, and vascular surgery remains an under-represented specialty in global surgery discourse. A bibliometric analysis published in 2019 showed that, of 1623 articles published on global surgery between 1987 and 2017, only 11 could be attributed to vascular surgery.[16]

To this end, and in line with the Vascular Society of Great Britain and Ireland (VSGBI)'s core objectives, we are establishing the VSGBI Global Health Subcommittee, with the overarching aim of supporting the development of local teams to deliver high-quality vascular surgery services for patients in need globally. To achieve this, the Global Health Subcommittee will build a community of practice amongst UK surgeons with an interest in global surgery, as well as developing strategic, equitable and collaborative partnerships with international surgical societies and developing educational and research initiatives which are responsive to

Key words: global, vascular, conflict, low income, development

locally-led needs. Through this work, the Subcommittee aims to strengthen opportunities for advocacy and raise the profile of vascular surgery in high level global health policy discussions.

Building a community of practice

Building a community of practice will reduce silos and maximise the impact of work related to the provision of vascular services in a global setting, facilitating sharing of resources and collaboration amongst members. It will establish and map the ongoing work of vascular clinicians engaged in global surgery, identifying opportunities for collaboration and cooperation, and it will aid in understanding the work in which individuals may be interested in becoming involved.

Education and training

Postgraduate education and training in vascular surgery is limited in LMICs, where it is often fragmented.[17] General surgeons manage most vascular emergencies in these settings, including the complex vascular injuries seen in trauma and conflict, and often receive little or no structured exposure to vascular techniques.[18] This has resulted in a high demand for courses which aim to teach the basics of vascular surgery in LMICs, and trauma and humanitarian settings.[19] This Subcommittee will endeavour to contribute to vascular surgery education and training. It will do so in a needs-led rather than supply-led way by engaging local partners to identify priorities, before working with VSGBI members and key stakeholders to deliver educational resources and training which are context-specific and relevant. This may include support for regional vascular skills courses, curriculum development for vascular content within surgical training, remote and blended learning, reciprocal fellowships and observership opportunities. Critically, the primary goal is not for surgeons from Great Britain and Ireland to operate abroad, but to support the development of a self-sustaining vascular surgical workforce educated and retained within its own health system.

Research

A significant obstacle to providing adequate vascular care in many LMICs and conflict and disaster settings is the lack of reliable data on the burden of vascular diseases and injuries and their outcomes. This is particularly the case when examining LMICs individually rather than as a homogenous group. For instance, what may be true of upper-middle income countries in Asia may not be true of low-income countries in East Africa. There is growing recognition of the need for surgical research as part of an agenda to increase data-driven practice. Collaborative and co-designed models, such as those undertaken by the National Institute for Health and Care Research Global Surgery Unit at the University of Birmingham, and King's Global Health Partnerships, have demonstrated that high-quality prospective clinical trials and implementation studies are achievable in resource-limited settings. In addition, there is growing research collaboration between surgical societies and organisations involved in conflict zones. This Subcommittee will seek to extend vascular research in this context by supporting prospective epidemiological and registry-based studies in LMICs and conflict and disaster settings, in the first instance. In time it will aim to progress to implementation-based research. It will promote locally-led research agendas and aim to embed equitable authorship and data ownership from the outset. Research capacity building – ie, training in research methodology and mentorship of LMIC investigators – will be treated as an output and not a byproduct. This will serve to nurture research collaboratives and facilitate an evidence base to support local researchers and clinicians to advocate for vascular surgery, ensuring its inclusion as part of universal health coverage.

Advocacy

While establishing an evidence base is key, as the Lancet commission has demonstrated, evidence alone does not change policy.[20] Up to this point, vascular surgery has not been actively advocated for in the global surgery and non-communicable disease discourse, despite sitting at the intersection of the two. National Surgical, Obstetric and Anaesthesia plans rarely mention vascular services.[21] Global diabetes strategies advocate for prevention and glycaemic control but rarely mention the surgical care of established complications.[22] This Subcommittee will advocate for the inclusion of vascular care within national surgical planning, with limb salvage a possible measurable health system outcome. Amputation carries substantial lifelong costs to individuals, families and society, so the case is economic as well as clinical.[23]

Building sustainable partnerships

VSGBI already collaborates with international vascular societies in a variety of ways. This Subcommittee will extend this approach, engaging directly with partner organisations to understand the most pressing, feasible and appropriate avenues of collaboration. It will build partnerships with surgical societies in countries where vascular societies do not yet exist, working with interested parties such as the national surgical societies as well as societies in aligned fields – for example, World Orthopaedic Concern. This Subcommittee will take a holistic and health systems approach to improving the provision of vascular surgery. Training a vascular surgeon serves little purpose if the health system means that patients are not able to reach hospital in a timely fashion or risk impoverishment due to the out-of-pocket costs of surgery. Vascular surgery provision depends as much on the presence of a vascular surgeon as it does on financing mechanisms, supply chains for equipment and consumables, referral networks and service delivery infrastructure, including theatre and nursing teams. These determinants lie largely outside the remit of vascular surgery itself, which is precisely why partnerships with non-vascular organisations working on these issues will be as integral to the Subcommittee's strategy as those with vascular surgical societies.

Why now?

The establishment of this Subcommittee comes at a time of increasing interest in global engagement from VSGBI members, many of whom are already working on humanitarian and global health-related projects and initiatives, without a single vascular forum to share ideas, collaborate or pool resources for greater impact. Other surgical specialty organisations in the UK have already shown what is possible. The British Association of Paediatric Surgeons has a well-established International Affairs Committee. This promotes and facilitates international exchange of professional and educational values in paediatric surgery, as well as neonatal skills courses.[24] The British Association of Urological Surgeons (BAUS) has established Urolink, which represents BAUS in LMICs and contributes to health improvement projects, training, education and the provision of equipment and advice.[25]

The establishment of this Subcommittee also comes at a crossroads internationally. Armed conflict rates are rising, resulting in both an increase in the humanitarian cost of war and an increasing focus on military spending by national governments, often at the expense of international aid budgets, particularly in the UK, Europe and the USA.[26,27] This has resulted in a reduction in opportunities to pursue international collaborative research and educational initiatives. Meanwhile, political decision-makers in the USA are seeking to actively undermine and erode international collaborations.[28] It is therefore commendable that the VSGBI has chosen this moment to engage in activities which strengthen global health collaborations.

Conclusion

This Subcommittee will bring together those who are interested in vascular surgery provision in a global context for educational, research and advocacy purposes. It will collaborate internationally in a way which is long-term rather than episodic, bidirectional rather than extractive and, wherever possible, locally led in priority and direction setting. We therefore invite readers with existing global health projects, partnerships or educational commitments to become part of our community of practice, so that we can map projects and connect individuals. We call on trainees and consultants who wish to contribute in this field to express an interest, and for colleagues based at, or with links to, organisations in other countries and regions to tell us what would be most useful to them. For this initiative to flourish, we need your support and engagement. Further details on how you can get involved will be available on the VSGBI website soon.

Conflict of Interest: None.

Funding: None.

References

1. Dare AJ, Grimes CE, Gillies R, *et al*. Global surgery: defining an emerging global health field. *Lancet* 2014;**384**(9961):2245–7. https://doi.org/10.1016/S0140-6736(14)60237-3
2. Meara JG, Leather AJM, Hagander L, *et al*. Global surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet* 2015;**386**(9993):569–624. https://doi.org/10.1016/S0140-6736(15)60160-X
3. Murray CJ, Vos T, Lozano R, *et al*. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012;**380**(9859):2197–223. https://doi.org/10.1016/S0140-6736(12)61689-4
4. Manne-Goehler J, Geldsetzer P, Agoudavi K, *et al*. Health system performance for people with diabetes in 28 low- and middle-income countries: a cross-sectional study of nationally representative surveys. *PLoS Med* 2019;**16**(3): e1002751. https://doi.org/10.1371/journal.pmed.1002751
5. Kou T, Qian X, Liu Y, *et al*. Global, regional, and national burden of peripheral artery disease: a systematic analysis of prevalence, incidence, deaths, and DALYs with projections for the next 15 years. *Nutr Metab Cardiovasc Dis* 2025;**35**(12):104226. https://doi.org/10.1016/j.numecd.2025.104226
6. International Diabetes Federation (ID). *IDF Diabetes Atlas* (11th edn). Brussels; 2025. Available at: https://idf.org/news-and-resources/resources/idf-diabetes-atlas-11th-edition-2025/
7. Deng L, Du C, Liu L, *et al*. Forecasting the global burden of peripheral artery disease from 2021 to 2050: a population-based study. *Research (Wash DC)* 2025;**8**:0702. https://doi.org/10.34133/research.0702
8. Armed Conflict Location & Event Data Project (ACLED). Conflict Index. Madison, Wisconsin, USA; 2025. Available at: https://www.linkedin.com/posts/acleddata_acled-conflict-index-2025-watchlist-activity-7289930292214030338-NH76
9. Vuoncino M, Soo Hoo AJ, Patel JA, White PW, Rasmussen TE, White JM. Epidemiology of upper extremity vascular injury in contemporary combat. *Ann Vasc Surg* 2020;**62**:98–103. https://doi.org/10.1016/j.avsg.2019.04.014
10. Bilman V, Tiruneh A, Silverberg D, Skvortsov R, Katorza E, Halak M. Editor's Choice – Preliminary Assessment of Contemporary Wartime Vascular Injuries. *Eur J Vasc Endovasc Surg* 2025;**70**(4):503–14. https://doi.org/10.1016/j.ejvs.2025.05.031
11. Chevalley K, Zimmerman J, Mittendorf A, *et al.* Civilian pattern of injuries in armed conflicts – a systematic review. *Scand J Trauma Resusc Emerg Med* 2024;**32**(1):125. https://doi.org/10.1186/s13049-024-01299-7
12. Elamin A, Abdullah S, ElAbbadi A, *et al*. Sudan: from a forgotten war to an abandoned healthcare system. *BMJ Global Health* 2024;**9**(10):e016406. https://doi.org/10.1136/bmjgh-2024-016406
13. Khan A, Ammar U, Abbara A, Hariri M, Darwish A, Alawa J. Peripheral extremity surgery performed during the Syrian conflict – a scoping review. *PLOS Global Public Health* 2025;**5**(2):e0004116. https://doi.org/10.1371/journal.pgph.0004116
14. Sivash, II, Koval BM. Negative pressure wound therapy for combat-related extremity vascular injuries: clinical experience from the war in Ukraine. *Scand J Trauma Resusc Emerg Med* 2025;**33**(1):188. https://doi.org/10.1186/s13049-025-01502-3
15. White JM, Stannard A, Burkhardt GE, Eastridge BJ, Blackbourne LH, Rasmussen TE. The epidemiology of vascular injury in the wars in Iraq and Afghanistan. *Ann Surg* 2011;**253**(6):1184–9. https://doi.org/10.1097/SLA.0b013e31820752e3
16. Sgrò A, Al-Busaidi IS, Wells CI, *et al*. Global surgery: a 30-year bibliometric analysis (1987–2017). *World J Surg* 2019;**43**(11):2689–98. https://doi.org/10.1007/s00268-019-05112-w
17. Bencheikh N, Zarrintan S, Quatramoni JG, Al-Nouri O, Malas M, Gaffey AC. Vascular surgery in low-income and middle-income countries: a state-of-the-art review. *Ann Vasc Surg* 2023;**95**:297–306. https://doi.org/10.1016/j.avsg.2023.05.024
18. Sritharan K MM, Zuhaili B, Baig S, Sultan J. Personal experiences of UK and US Consultant Vascular Surgeons in Gaza. *J Surg* 2025;**10**:11412. https://doi.org/10.29011/2575-9760.11412
19. Kirengo T, Ibrahim H, Musajee M, *et al.* Strengthening vascular surgery training in Sub-Saharan Africa: 1-Year Kenyan experience. *J Surg Res* 2026; **322**:27–34. https://doi.org/10.1016/j.jss.2026.03.047
20. Nepogodiev D, Picciochi M, Ademuyiwa A, *et al*. Surgical health policy 2025–35: strengthening essential services for tomorrow's needs. *Lancet* 2025;**406**(10505):860–80. https://doi.org/10.1016/S0140-6736(25)00985-7
21. Citron I, Chokotho L, Lavy C. Prioritisation of surgery in the National Health Strategic Plans of Africa: a systematic review. *Lancet* 2015;**385**:S53. https://doi.org/10.1016/S0140-6736(15)60848-0

22. Hunt D, Hemmingsen B, Matzke A, *et al*. The WHO Global Diabetes Compact: a new initiative to support people living with diabetes. *Lancet Diabetes Endocrinol* 2021;**9**(6):325–7. https://doi.org/10.1016/S2213-8587(21)00111-X
23. Cavanagh P, Attinger C, Abbas Z, Bal A, Rojas N, Xu ZR. Cost of treating diabetic foot ulcers in five different countries. *Diabetes Metab Res Rev* 2012;**28**(Suppl 1):107–11. https://doi.org/10.1002/dmrr.2245
24. Lakhoo K, Youngson GG. Global paediatric surgery: meeting an unmet need – the response of the British Association of Paediatric Surgeons. *Pediatr Surg Int* 2018;**34**(12):1369–73. https://doi.org/10.1007/s00383-018-4365-7
25. Venn S, Mabedi C, Ngowi BN, Mbwambo OJ, Mteta KA, Payne SR. Disseminating surgical experience for sustainable benefits: the Urolink experience. *BJU Int* 2022;**129**(6):661–7. https://doi.org/10.1111/bju.15733
26. Loft P, Brien P. UK to reduce aid to 0.3% of gross national income from 2027. London: House of Commons Library; 2025. Available at: https://commonslibrary.parliament.uk/uk-to-reduce-aid-to-0-3-of-gross-national-income-from-2027/?utm
27. Davies S, Pettersson T, Sollenberg M, Öberg M. Organized violence 1989–2024, and the challenges of identifying civilian victims. *J Peace Res* 2025; **62**(4):1223–40. https://doi.org/10.1177/00223433251345636
28. Clark J. Trump administration has its sights set on destroying international research collaborations. *BMJ* 2026;**393**:e316815. https://doi.org/10.1136/bmj-2026-316815

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):164-169
http://doi.org/10.54522/jvsgbi.2026.237

www.jvsgbi.com

ORIGINAL RESEARCH

Evaluation of contemporary calcium scoring methods in peripheral artery disease

Ogawa K,[1] Tan MT,[2] Asif A,[2] Lakshminarayan R[2]

1. Hull York Medical School, University of York, Heslington, UK
2. Department of Radiology, Hull University Teaching Hospitals NHS Trust, Hull, UK

Corresponding author:
Dr Raghuram Lakshminarayan
Department of Radiology,
Hull University Teaching
Hospitals NHS Trust,
Hull, HU3 2JZ, UK
Email: raghu.l@nhs.net

Received: 29th April 2026
Accepted: 11th June 2026
Online: 25th June 2026

Plain English Summary

Why we undertook the work: Calcium in the blood vessels is common in peripheral arterial disease. We wanted to compare some of the methods of assessing calcium in blood vessels and see if there are any differences in how each method scores the same amount of calcium.

What we did: We compared 100 patients' arterial calcium on their CT scans and graded them individually between three interpreters trained in reporting vascular imaging. A CT scan is a set of images that provides a cross-sectional image of a patient, allowing doctors to view individual structures within a patient's body. We then compared our results to see if there are any discrepancies.

What we found: We found that each method of assessing calcium for the same blood vessel can have a very different assessment of its severity. We also found that the methods of assessing calcium are not the same between different interpreters.

What this means: Current methods of calcium scoring may not be standardised between each other, resulting in different severity gradings between different interpreters. Current systems could be improved with more objective measurements. More research is required into creating generalisable calcium scoring systems.

Abstract

Background: Peripheral arterial calcification is an indicator of poor outcomes following endovascular revascularisation in peripheral arterial disease (PAD). Calcium scoring methods are often used in clinical trials and clinical practice to quantify calcium deposition in PAD. It is suggested that the amount of vessel calcification (VC) can have an impact on outcomes following endovascular intervention. However, there are few studies assessing the reproducibility of contemporary calcium scoring tools.

Methods: We analysed 100 pre-interventional computed tomography angiography images of randomly selected patients who had undergone peripheral angioplasty between June 2022 and December 2022, evaluating the Peripheral Artery Calcium Scoring System (PACSS), the Peripheral Academic Research Consortium (PARC) calcium scoring grade and the Fanelli grade. Three independent raters trained in VC scoring and vascular reporting graded all 100 patients using measurements obtained from multi-planar reconstructions, and the inter-rater and methodological agreement intraclass correlation coefficients (two-way random effects, absolute agreement, single rater) were calculated to determine the reliability of the VC scoring systems.

Results: There was a significant difference in the proportions of PARC ($p<0.001$) and PACSS grades ($p<0.001$) allocated by the three scorers. The inter-rater reliability of the grading systems ranged from 0.585 to 0.672, with reliability decreasing for moderate-to-severe and severe lesions. The methodological agreement of the scoring systems was 0.860, but decreased in grading of moderate-to-severe and severe lesions.

Conclusion: There is poor agreement between the three main calcium scoring systems. Calcium scoring systems for grading calcifications may suffer from poor reproducibility between vascular reporters. Those developing calcium scoring systems should reconsider variables susceptible to inter-rater variance, which might impact its use.

Key words: calcium, peripheral artery disease, diagnostic, CT

Introduction

Vessel calcification (VC) of the peripheral arteries poses a significant challenge to endovascular treatment of peripheral arterial disease (PAD)[1] due to its association with poorer outcomes.[2] The importance of VC is highlighted in it being a research priority for the assessment of PAD and chronic limb threatening ischaemia.[3,4] To date, there has yet to be a conclusive validation of the current contemporary calcium scoring systems. Three of the main scoring systems used are the Peripheral Artery Calcium Scoring System (PACSS), the Peripheral Academic Research Consortium (PARC) score and the Fanelli score, which can be used in angiography or on computed tomography (CT) angiography. These scores are frequently employed in studies assessing the efficacy of various interventions for PAD, and have been shown to be associated with poorer outcomes post-intervention.[2] Although the scores were not developed with interchangeability purposes, studies assessing the impact of VC use one or a variant of these scoring systems.[2] This implies that VC severity assessed by one scoring system would have a similar clinical impact to that of another scoring system, despite a lack of evidence showing equivalence or interchangeability. In recent years, studies have emerged questioning the reliability and accuracy of these scoring systems,[5] which will have important repercussions considering their use in clinical trials.

The aim of this study is to evaluate the reliability of contemporary calcium VC scoring systems in assessing calcium lesion severity between different reporters, and to assess if severity gradings of different VC scoring systems are interchangeable.

Methods

Retrospective VC scoring was carried out on 100 patients who had undergone peripheral endovascular intervention in a tertiary centre from June 2022 to December 2022 and had a preoperative CT peripheral angiography. The CT angiography was carried out with a Cannon Aquillion One (320 detectors) at 100 kV and 200 mA with a slice thickness of 1 mm. 80 mL of iodinated contrast was injected at a rate of 4 mL/s. The 100 patients were randomly selected via simple computer-assigned randomisation from a pool of eligible records. The inclusion criteria included patients receiving an index procedure for endovascular treatment of PAD, who had had a preoperative CT angiogram and had an identifiable infrainguinal index lesion on preoperative CT that was subsequently treated. Exclusion criteria were patients <18 years of age and those who had prior surgical or endovascular treatment of the target lesion.

Data on the sex, age and peripheral calcium scores (PARC, PACSS and Fanelli) were collected. Procedure reports were used to identify the target (treated) lesion of which its severity of VC would be graded. The scores were evaluated on IMPAX CT multi-planar reconstruction at maximal intensity projection to view the whole extent of VC of the target lesion, with the inbuilt geometric measuring tool for measurement purposes. Three independent raters were selected who were trained in vascular reporting, the use of multi-planar reconstruction technique on IMPAX and the use of the VC scoring systems. The information shared with them included the patient's details, the CT images they were supposed to review and the location of the segment of treated calcium that they would score. The identity of each rater has been anonymised in the reporting of their results.

Definitions

As the scoring grades of the PARC score, PACSS and the Fanelli score are different, we homogenised the grading such that each scoring system's definition will be assigned an analogous numerical grade. Comparisons between calcium scoring systems have been carried out for previous studies analysing their inter-rater reliability but, whilst Allan *et al*[5] used a simplified binary assessment for VC (non-severe vs severe) for the purpose of analysing the impact of differing methods of assessing calcium lengths and extant, we have taken this further and extrapolated the grading to all levels of calcium severity. For instance, the PACSS and Fanelli grading scheme graded calcium on a scale of 0–4. We equated these numerical grades to a qualitative descriptor such as that described in the PARC score, which meant that a grade of 0 would be equated to no VC; a grade of 1 would be equated to focal VC; a grade of 2 would be equated to mild VC; a grade of 3 would be equated to moderate VC; and a grade of 4 would be equated to severe VC. Vice-versa, the descriptive grades were made analogous to the numerical grades for statistical analysis. A description of these grades and definitions is shown in Table 1.

Although the PACSS is normally assessed via high intensity fluoroscopy and digital subtraction angiography, PACSS scoring on CT imaging has been used in a number of studies[6–8] despite a lack of evidence to show that there would be a significant difference in the appearance of calcium on CT imaging. Assessment based on CT imaging most closely resembles real-world practice of vascular care, with non-invasive investigation now becoming a norm for investigation of PAD prior to intervention.[4]

As the PARC score and PACSS used the measurement of lesion length, we defined lesion length as the length of VC that is continuous with the segment of the treated calcium lesion.

We used the intraclass correlation coefficient (ICC) to determine the reliability of the scoring systems. The ICC was used to determine the methodological agreement, which is how consistently the PACSS, PARC score and Fanelli scores agreed with each other within a single rater, as well as the inter-rater reliability, which is how consistently the same PACSS, PARC grade and Fanelli grades were applied to the same VC between the three different raters. We calculated the inter-rater reliability and methodological agreement for the overall grades. We also assessed the inter-rater reliability and methodological agreement of the moderate-to-severe grades and the severe grade by assessing them in a binary format as grades 0–2 versus grades 3–4, and grades 0–3 versus grade 4, respectively. This is because, methodologically, the PACSS, the PARC and the Fanelli scoring

Table 1 Summary of definitions of the PARC vessel grades, PACSS and Fanelli grades.

Vessel calcification grades	None (Grade 0)	Focal (Grade 1)	Mild (Grade 2)	Moderate (Grade 3)	Severe (Grade 4)
PARC scoring system	No vessel calcification	<180° (1 side of vessel) circumferential calcium Less than half of the total lesion length	<180° circumferential calcium Greater than half of the total lesion length	≥180° (both sides of vessel at same location) circumferential calcium Less than half of the total lesion length	≥180° circumferential calcium Greater than half of the total lesion length
PACSS	No vessel calcification	Unilateral calcification* <5 cm	Unilateral calcification ≥5 cm	Bilateral calcification† <5 cm	Bilateral calcification ≥5 cm
Fanelli grades	No vessel calcification	0–90° circumferential calcium	90–180° circumferential calcium	180–270° circumferential calcium	270–360° circumferential calcium

*With subgrades a, b and c to denote intimal, medial and mixed-type calcification, respectively.
†With subgrades a, b and c to denote intimal, medial and mixed-type calcification, respectively.

systems share similar assessments for moderate and severe VC grades, requiring either the presence of bilateral calcification or >180° of circumferential calcification (Table 1). Hence, an analysis of the moderate to severe VC grades will be able to identify if these definitions are reproducible between reporters. The PACSS and the PARC grades differ in their definition of severe VC in that the PACSS uses a measurement of ≥180° circumferential calcification greater than half of the total lesion length whereas the PARC grade uses an objective length of bilateral calcification ≥5 cm. The Fanelli grading system does not incorporate a length measurement at all (Table 1). The analysis of severe VC grades would be able to assess if the differences in these definitions impact the reproducibility of the scoring systems.

We also opted not to use the subtypes defined in PACSS, further denoting intimal, medial and mixed-type calcification as these subtypes are not used in the PARC or the Fanelli scoring system, limiting analysis of its inter-rater reliability.

Statistical analysis

Continuous values are presented as mean ± standard deviation. Ordinal values are assessed as proportions and compared with a χ^2 test. Proportion comparisons are reported with χ^2 and p values. Averages were compared using the Kruskal–Wallis test and reported with p values. The ICC was calculated to determine the methodological agreement and inter-rater reliability. The ICC model used is a two-way random effects, absolute agreement, single-rater model. ICC values are reported with 95% confidence intervals (CI) and with its reliability strength as defined by Koo *et al*,[9] where <0.5 indicates poor reliability; 0.5–0.75 indicates moderate reliability; 0.75–0.9 indicates good reliability; and >0.9 indicates excellent reliability. Reliability strength was reported using the range of the 95% CI. We reported the inter-rater reliability and methodological agreement ICCs with a 95% CI range. Significance was evaluated at $p<0.05$. Statistical analysis was conducted with the use of PSPP v2.0.0.

Results

Demographics

After excluding ineligible patients, we identified a total of 147 patients and randomly selected 100 patients (68 men and 32 women) for analysis. Their average age was 70.8±12.5 years.

Outcomes

The mean PARC grade was 2.67±1.27, the mean PACSS grade was 2.53±1.33 and the mean Fanelli grade was 2.51±1.25. There was a significant difference in the average grades of the three VC scoring systems ($p=0.017$). There was a significant difference in the proportions of the PARC and PACSS grades ($\chi^2=43.2$, $p<0.00$ and $\chi^2=27.5$, $p<0.001$, respectively). There was no significance in the proportion of Fanelli grades ($\chi^2=8.9$, $p=0.347$). Within each rater we found that there was a significant difference in the proportion of grades between the PARC, PACSS and Fanelli scoring systems ($\chi^2=23.1$, $p=0.003$; $\chi^2=28.0$, $p<0.001$; and $\chi^2=43.2$, $p<0.001$ for raters 1, 2 and 3, respectively). A summary of the grades is shown in Figures 1–3.

The overall methodological agreement was good to excellent with an ICC of 0.860 (95% CI 0.773 to 0.904). However, the methodological agreement for moderate-to-severe grading was moderate-to-excellent (0.872, 95% CI 0.773 to 0.967) and the methodological agreement for severe grading was poor-to-moderate (0.502, 95% CI 0.351 to 0.622) (Table 2).

The overall inter-rater reliability of the PARC calcium grading system was poor-to-moderate, with an ICC of 0.585 (95% CI 0.479 to 0.682). The inter-rater reliability of the PARC system for moderate-to-severe grades was also poor-to-moderate with an ICC of 0.525 (95% CI 0.411 to 0.631), and the reliability of its severe grades was poor with an ICC of 0.345 (95% CI 0.218 to 0.472).

The overall inter-rater reliability of PACSS was poor-to-moderate with an ICC of 0.603 (95% CI 0.492 to 0.700). The inter-rater reliability of PACSS for moderate-to-severe grades was also poor-to-moderate with an ICC of 0.484 (95% CI 0.366 to 0.600), and the

Figure 1 Summary of vessel calcification grades using the Peripheral Academic Research Consortium (PARC) scoring system, based on each rater's assessment. Data labels in boxes represent the number of each grade assigned.

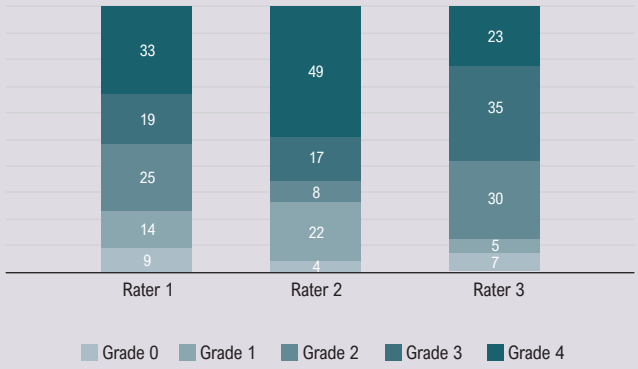


Figure 2 Summary of vessel calcification grades using the Peripheral Artery Calcium Scoring System (PACSS), based on each rater's assessment. Data labels in boxes represent the number of each grade assigned.

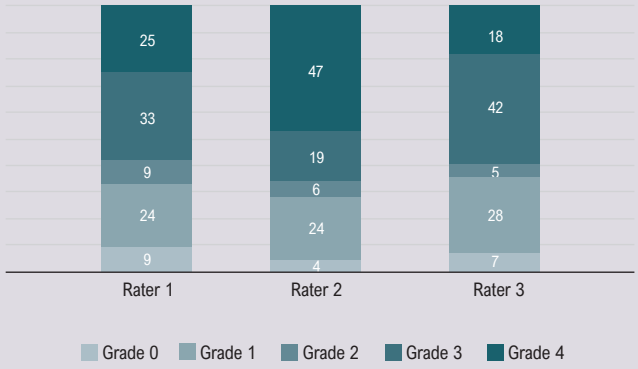
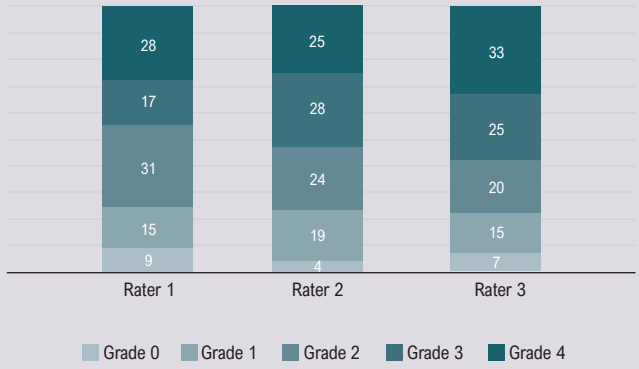


Figure 3 Summary of vessel calcification grades using Fanelli grades, based on each rater's assessment. Data labels in boxes represent the number of each grade assigned.



reliability of its severe grades was poor-to-moderate with an ICC of 0.374 (95% CI 0.235 to 0.622).

The overall inter-rater reliability of the Fanelli grading system was moderate-to-good with an ICC of 0.672 (95% CI 0.579 to 0.753). The inter-rater reliability of the Fanelli grading system for moderate-to-severe grades was poor-to-moderate with an ICC of 0.577 (95% CI 0.470 to 0.676), and the reliability of its severe grades was poor-to-moderate with an ICC of 0.547 (95% CI 0.436 to 0.650).

Discussion

Severe VC when assessed via PACSS is known to be a risk factor of angioplasty-associated complications,[10,11] in-stent restenosis[12] and lower PACSS grades are associated with better angioplasty success.[13] However, the literature is more controversial in predicting prognostic success of interventional and surgical procedures, with Stavroulakis *et al* suggesting that a PACSS grade of 4 did not impact the loss of patency of total lesion revascularisation[14] and

Table 2 Summary of intraclass coefficient gradings for inter-rater and intra-rater reliability of the calcium scoring systems.

	Methodological agreement (ICC)	Inter-rater reliability (ICC)		
	Combined scoring systems	PARC	PACSS	Fanelli
Overall	0.860 (0.773 to 0.904) [good–excellent]	0.585 (0.479 to 0.682) [poor–moderate]	0.603 (0.492 to 0.700) [poor–moderate]	0.672 (0.579 to 0.753) [moderate–good]
Moderate–severe grade	0.872 (0.773 to 0.967) [moderate–excellent]	0.525 (0.411 to 0.631) [poor–moderate]	0.484 (0.366 to 0.600) [poor–moderate]	0.577 (0.470 to 0.676) [poor–moderate]
Severe grade	0.502 (0.351 to 0.622) [poor–moderate]	0.345 (0.218 to 0.472) [poor]	0.374 (0.235 to 0.507) [poor–moderate]	0.547 (0.436 to 0.650) [poor–moderate]

95% confidence interval of the intraclass coefficient grading is shown in round brackets. Category of reliability based on 95% confidence interval shown in square brackets. The ICC model used was a two-way random-effects, absolute agreement, single-rater model.

Yanaguichi *et al* suggesting that higher PACSS grades do not predict wound recurrence rates post-endovascular therapy,[15] whereas Dukic *et al*[16] suggest that lower PACSS is associated with greater clinical success and Mori *et al*[17] suggest that higher PACSS is associated with poorer clinical outcomes. A systematic review and meta-analysis of the impact of VC demonstrated that major adverse limb events, amputation, major adverse cardiovascular events and mortality were associated with more severe VC, but included a heterogenous assessment of calcium scoring methods, further highlighting the need for reproducible and generalisable VC scoring tools that can be used in preoperative imaging.[2]

Apart from the original study by Fanelli *et al* linking calcification circumference ≥270°,[18] no literature has been published on the clinical significance of the Fanelli and PARC scores. Attempts have been made to validate these grades with intravascular ultrasound (IVUS) but the literature is divided: Yin *et al* suggest that the PACSS and PARC scoring systems can be validated in grading superficial calcium,[19] but Allan *et al* point out that PACSS, PARC grade and Fanelli grades themselves fail to agree between each other, particularly in the assessment of severe VC.[5] Our findings do not contrast greatly with the recent findings of Nugteren *et al*, where the inter-observer agreement of the PACSS score was moderate-to-substantial and the intra-observer agreement of the PACSS score was generally good. We do, however, differ in our findings when evaluating for moderate-to-severe VC, as expressed in their binary PACSS score, where they found better inter-observer agreement and similar intra-observer agreement compared with their assessment of the original PACSS.[20] Our results contrast sharply with the finding that inter-rater agreement decreases with discrimination of moderate/severe grade calcium when assessed by the PACSS, but instead reinforce the finding made by Allan *et al* that the inter-rater agreement of the contemporary calcium scoring systems are poor in the assessment of severe and moderate-to-severe VC. This might be due to the existence of the prearranged criteria that do not exist in the original PACSS criteria, such as the addition of multiple calcified plaques where the target lesion is >5 cm or where the length of the target lesion is equal to the length of contiguous stenosis >50% in the vessel. It is also acknowledged that these scoring arrangements were created to increase the inter-observer agreement.

We propose a few reasons why the inter-rater agreement of severe VC may be poor. First, the PACSS and PARC grade use both vessel length and circumferential coverage in their grading system, whilst the Fanelli grade exclusively uses circumferential coverage. Second, between PACSS and PARC grades, the vessel length is not evaluated in the same manner: PACSS uses a nominal lesion length (≥5 cm) whilst PARC uses a proportional measurement (>50% of total lesion length). Third, PACSS calculates circumferential coverage differently from PARC as well: PACSS uses bilateral calcification whereas PARC uses a defined calcium arc circumference (≥180°), and the Fanelli grade stipulates a different calcium arc circumference from PARC grade (≥270°) whilst the PACSS grade does not define a specific circumference but uses unilateral or bilateral calcification. Fourth, there is a significant difference even between raters as to what they view as the most clinically significant VC, especially as to whether VC distal and/or proximal to the target vessel should also be considered due to its possible implications in lesion crossing, prognosis, etc. We believe this to be the main reason why three different raters differed in the identification of the target lesion and why they differed in agreement in the identification of patients with no significant vessel calcification. We find that this inter-rater disagreement is the most important factor, particularly when assessing lesion length. Although the PACSS uses an objective cut-off of 5 cm, it is these differences in the assessment of the target lesion and therefore lesion length that resulted in poor inter-rater agreement. Furthermore, the greater reliability of the Fanelli grades might also be attributed to a lack of areas where these discrepancies can occur, and where there are fewer relative measurements – whether length of calcium or the unilateral/bilateral appearance of calcium.

Strengths and limitations

One strength of this study is that it is the largest study to assess the inter-rater reliability of calcium scoring systems. It also uses non-invasive imaging for calcium scoring, which best reflects the use of these scoring systems in day-to-day clinical practice as well as research settings. The ICC is a better generalisable statistic to determine reliability of these scoring systems than Cohen's kappa used in the study by Allan *et al*,[5] as Cohen's kappa is more suitable for nominal or binary assessments whereas the ICC is more suitable for analysing continuous values.[21] In our case, VC grades are continuous as there is an established relationship that the higher the grade, the worse the severity of VC. The use of multiple raters also adds greater value to assessing the reliability of the calcium scoring systems.

One limitation of this study is that it does not point out which scoring system is 'reliable' as we did not provide a 'gold-standard' measurement with which to compare these scoring systems. However, in a study validating PARC and PACSS grading on catheter angiograms with IVUS, Yin *et al* found that IVUS was more sensitive to the extent of circumferential calcium as well as the length of calcium.[19] In the absence of an agreed measurement standard using non-invasive imaging, this raises further questions concerning in what areas these scoring systems may be flawed and what characteristics of a lesion's morphology should be considered to have a significant relation to clinical outcomes.

Conclusion

Inter-rater agreement and reliability of contemporary calcium scoring systems are poor in the assessment of severe VC. There is a lack of reproducibility of calcium scoring systems and universal measurements of VC between them. More literature is required to establish the link between predictable quantification of VC severity and clinical outcomes to best optimise outcomes in patients with PAD.

KEY MESSAGES

- The severity of calcium has implications for the treatment of peripheral arterial disease.
- Calcium scoring systems demonstrate variable agreement in assessment of calcium severity.
- Criteria used in calcium scoring systems suffer from poor inter-rater reliability in the grading of severe vessel calcification.
- Poor reproducibility of grading of moderate-to-severe and severe calcium between calcium scoring systems highlight the importance of generalisable definitions for grading calcium.

Conflict of Interest: RL has received honoraria from Bentley, Terumo Aortic, WL Gore, Penumbra, Shockwave, Jotec, Lombard and Cook Ltd. KO, MTT and AA have no competing interests.

Funding: None.

Acknowledgements: This study was presented at the British Society of Interventional Radiology Annual Scientific Meeting 2024 in Brighton.

Ethical statement: This study had ethics approval as part of an audit process with formal institutional approval by the local audit team and, due to the retrospective nature of this study, requirement for informed consent was waived.

Author contributions: Conception and design: KO, RL. Analysis and interpretation: KO, MTT, AA, RL. Data collection: KO, MTT, AA. Manuscript writing: KO. Critical revision: KO, MTT, AA, RL. Statistical analysis: KO.

Reviewer acknowledgement: *JVSGBI* thanks to Professor Athanasios Saratzis, University of Leicester / University Hospitals of Leicester NHS Trust, and Dr Frances Sheehan, Imperial College Healthcare NHS Trust, for their contribution to the peer review of this work.

References

1. Rocha-Singh KJ, Zeller T, Jaff MR. Peripheral arterial calcification: Prevalence, mechanism, detection, and clinical implications. *Catheter Cardiovasc Interv* 2014;**83**(6):E212–20. https://doi.org/10.1002/ccd.25387
2. Wiggers RBM, Harmsen IM, Kok M, *et al*. A systematic review of the association between arterial calcification on preoperative imaging and clinical outcomes in peripheral arterial disease. *J Vasc Surg* 2025;**82**(5):1884–900.e10. https://doi.org/10.1016/j.jvs.2025.06.029
3. Conte MS, Bradbury AW, Kolh P, *et al*. Global Vascular Guidelines on the Management of Chronic Limb-Threatening Ischemia. *Eur J Vasc Endovasc Surg* 2019;**58**(1):S1–S109.e33. https://doi.org/10.1016/j.ejvs.2019.05.006
4. Nordanstig J, Behrendt CA, Baumgartner I, *et al.* European Society for Vascular Surgery (ESVS) 2024 Clinical Practice Guidelines on the Management of Asymptomatic Lower Limb Peripheral Arterial Disease and Intermittent Claudication. *Eur J Vasc Endovasc Surg* 2024;**67**(1):9–96. https://doi.org/10.1016/j.ejvs.2023.08.067
5. Allan RB, Wise NC, Wong YT, Delaney CL. Accuracy and reliability of peripheral artery calcium scoring systems using an intravascular ultrasound reference standard. *Ann Vasc Surg* 2023;**91**:233–41. https://doi.org/10.1016/j.avsg.2022.11.014
6. Elbadawy A, Ali H, Saleh M. Midterm outcomes of common femoral endarterectomy combined with inflow and outflow endovascular treatment for chronic limb threatening ischaemia. *Eur J Vasc Endovasc Surg* 2020;**59**(6):947–55. https://doi.org/10.1016/j.ejvs.2020.02.028
7. Mezzetto L, Mastrorilli D, Scorsone L, *et al*. Early and midterm outcomes of hybrid first line treatment in patients with chronic limb threatening ischemia. *Vascular* 2022;**30**(5):891–901. https://doi.org/10.1177/17085381211040986
8. Saratzis A, Salem M, Sabbagh C, *et al.* Treatment of aortoiliac occlusive disease with the covered endovascular reconstruction of the aortic bifurcation (CERAB) technique: results of a UK multicenter study. *J Endovasc Ther* 2021;**28**(5):737–45. https://doi.org/10.1177/15266028211025028
9. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J Chiropr Med* 2016;**15**(2):155–63. https://doi.org/10.1016/j.jcm.2016.02.012
10. Tan M, Urasawa K, Koshida R, *et al*. Evaluation for the efficacy and safety of the crosser catheter as a CTO crossing device and a flossing device. *Cardiovasc Interv Ther* 2018;**33**(1):77–83. https://doi.org/10.1007/s12928-016-0444-7
11. Bernardini G, Bisdas T, Argyriou A, *et al*. Risk factor analysis for crossing failure in primary antegrade wire-catheter approach for femoropopliteal chronic total occlusions. *J Endovasc Ther* 2023;**30**(3):433–40. https://doi.org/10.1177/15266028221083456
12. Ichihashi S, Shibata T, Fujimura N, *et al.* Vessel calcification as a risk factor for in-stent restenosis in complex femoropopliteal lesions after Zilver PTX paclitaxel-coated stent placement. *J Endovasc Ther* 2019;**26**(5):613–20. https://doi.org/10.1177/1526602819860124
13. Horie K, Tanaka A, Taguri M, Inoue N. Impact of scoring balloons on percutaneous transluminal angioplasty outcomes in femoropopliteal lesions. *J Endovasc Ther* 2020;**27**(3):481–91. https://doi.org/10.1177/1526602820914618
14. Stavroulakis K, Bisdas T, Torsello G, Tsilimparis N, Damerau S, Argyriou A. Intravascular Lithotripsy and Drug-Coated Balloon Angioplasty for Severely Calcified Femoropopliteal Arterial Disease. *Journal of Endovascular Therapy* 2023;**30**(1):106-13. https://doi.org/10.1177/15266028221075563
15. Yanagiuchi T, Kato T, Hirano K, *et al*. Infrapopliteal 3-vessel occlusive disease is the only predictor of wound recurrence after complete wound healing via endovascular therapy in patients with chronic limb-threatening ischemia. *J Endovasc Ther* 2025;**32**(4):999–1008. https://doi.org/10.1177/15266028231197983
16. Dukic D, Martin K, Lichtenberg M, *et al.* Novel therapeutic concepts for complex femoropopliteal lesions using the Jetstream atherectomy system. *J Endovasc Ther* 2024;**31**(6):1218–26. https://doi.org/10.1177/15266028231161246
17. Mori S, Takahara M, Nakama T, *et al.* Impact of calcification on clinical outcomes after drug-coated balloon angioplasty for superficial femoral artery disease: Assessment using the peripheral artery calcification scoring system. *Catheter Cardiovasc Interv* 2023;**101**(5):892–9. https://doi.org/10.1002/ccd.30622
18. Fanelli F, Cannavale A, Gazzetti M, *et al.* Calcium burden assessment and impact on drug-eluting balloons in peripheral arterial disease. *Cardiovasc Intervent Radiol* 2014;**37**(4):898–907. https://doi.org/10.1007/s00270-014-0904-3
19. Yin D, Maehara A, Shimshak TM, *et al*. Intravascular ultrasound validation of contemporary angiographic scores evaluating the severity of calcification in peripheral arteries. *J Endovasc Ther* 2017;**24**(4):478–87. https://doi.org/10.1177/1526602817708796
20. Nugteren MJ, Ünlü Ç, Samim M, Scheffer HJ, de Borst GJ, Hazenberg CEVB. Inter- and intra-observer agreement of the peripheral arterial calcium scoring system in patients undergoing (infra)popliteal endovascular interventions. *Cardiovasc Intervent Radiol* 2024;**47**(11):1441–9. https://doi.org/10.1007/s00270-024-03839-1
21. Watson PF, Petrie A. Method agreement analysis: A review of correct methodology. *Theriogenology* 2010;**73**(9):1167–79. https://doi.org/10.1016/j.theriogenology.2010.01.003

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):170-176
http://doi.org/10.54522/jvsgbi.2026.242

www.jvsgbi.com

ORIGINAL RESEARCH

Current practice in consenting patients for superficial venous intervention

Howitt A,[1] Mohamed A,[1] Hitchman L,[1] Sciberras P,[1] Long J,[1] Pymer S,[1] Smith G,[1] Chetter I,[1] Garnham A,[2] Carradice D[1]

1. Academic Vascular Unit, Hull University Teaching Hospitals NHS Trust, Hull, UK
2. Department of Surgery, The Royal Wolverhampton NHS Trust, Wolverhampton, UK

Corresponding author:
Miss Annabel Howitt
Academic Vascular Unit,
Hull University Teaching
Hospitals NHS Trust,
Hull, HU3 2JZ, UK
Email: Annabel.howitt1@nhs.net

Received: 12th November 2025
Accepted: 25th August 2026
Online: 28th August 2026

Plain English Summary

Why we undertook the work: Varicose veins are very common and affect nearly 40% of the UK population, both men and women equally. They can become symptomatic resulting in aching, itching or swelling of the affected leg. Complications of varicose veins include bleeding, phlebitis (painful inflammation of a vein) and leg ulcers. There is strong evidence to show that people who suffer from symptoms from varicose veins, or get a complication related to varicose veins, have a poorer quality of life. Options to treat varicose veins are offered on the NHS, which include a type of keyhole surgery that burns the vein from the inside causing the problem vein to close. Other treatments include an injection of a foam or another technique where the surgeon makes small cuts to pull out the troublesome veins. They are usually done as a day case procedure under local anaesthetic, meaning recovery time is quick and often people are back to work or daily activities within a few days. As with any surgical procedure, there can sometimes be complications. Before deciding to have an operation to treat varicose veins, the surgeon or clinician should discuss the procedure, benefits and what complications could happen. This is called the consent process. Without a proper consent process the patient would not have all the correct information to make the right decision for themselves, it can increase anxiety and confusion for the patient, and it can also risk a lawsuit for the surgeon. Sometimes people might get a complication from the procedure and, if they were not informed enough beforehand, they may end up regretting the surgery because they did not have all the right information to enable them to weigh up the options. Traditionally, the consent process set up is a discussion between surgeon and patient on the day of the procedure, a form is signed by the patient and then the surgery can go ahead. However, currently there is not much research investigating what surgeons do or say in the consent process. The purpose of this project is to find out what surgeons say to their patients before offering surgery for varicose veins and how they give information to their patients. It also aims to capture what a surgeon's own understanding is of how common or uncommon each complication may be in practice.

What we did: We sent out an online survey to vascular surgeons across the UK. This included surgeons in training, of various levels, and consultants who performed varicose vein procedures. The survey collected information on what complications are discussed and how often, as well as those not discussed. It also gathered information on how surgeons classify different complications according to how common or uncommon they think the complication is. It also collected data on how a surgeon gives the patient information on the procedure.

What we found: One hundred and thirty surgeons completed the survey. Most of the respondents were consultants (113/130; 87%) and the rest were surgeons in training. The spread of responses covered the entire UK including Scotland, Wales, Northern Ireland and all regions within England. There were 34 complications in total that surgeons said they would discuss with patients. However, only three of these 34 complications were routinely mentioned by the majority of surgeons (which we defined as 70%). These were venous thromboembolism, recurrence (the veins coming back later) or sensory disturbance (numbness or tingling of the skin in the area treated). The overall result has shown a large variation in how surgeons' consent, what they tell patients and the ways that they tell patients.

What this means: There are large differences in how risks are discussed with patients. This means patients may currently receive inconsistent information about the risks of varicose vein procedures, which can affect understanding and their decision-making. It highlights for clinicians that there needs to be clearer guidance and better research to support consistent evidence-based consent discussions. For the NHS, it supports developing a national framework for consent which could help reduce patient complaints, improve patient experience and lower the number of legal claims related to poor consent for varicose vein surgery.

Abstract

Background: The consent process is a core element and legal prerequisite to surgical practice globally. Failure of the consent process is a frequently and increasingly cited cause of dissatisfaction and successful litigation claims within NHS surgical practice, and superficial

venous treatments are disproportionately represented within vascular surgery. The aim of this study is to capture clinician practice in consenting for superficial venous intervention.

Methods: An online survey was devised and piloted in a tertiary vascular unit prior to national distribution to clinicians through professional platforms and networks including members of the Vascular Society of Great Britain and Ireland. The threshold for consensus of inclusion of complications was defined at 70% in accordance with published Delphi studies.

Results: There were 130 respondents (87% of whom were consultants) across all regions of the UK. Thirty-four distinct complications were listed as routinely quoted during consent. Only 29% of respondents use pre-printed/pre-prepared consent forms, but 64% agree that they would be of benefit. The median number of complications quoted by respondents was 7 (range 3–34). Only three reached consensus, with 97% routinely quoting venous thromboembolism, 78% recurrence and 78% sensory disturbance. 84% of respondents gave an indication of the frequency of complications, but there was significant variation in quoted frequencies. Summary descriptions of frequency are unlikely to be a reasonable replacement for percentages as there was considerable disagreement over categorisation. For example, a complication rate of 9% was categorised as 'rare' by 29%, 'common' by 56% and 'very common' by 15% of respondents.

Conclusion: There is significant variation in the mode, method and delivery of the consent process nationally. Work is urgently needed to improve the overall quality of this process and ensure a standardised national approach.

Key words: consent, current practice, superficial venous intervention, shared decision-making

Introduction

The consent process for any surgical intervention is a fundamental part of medical and surgical practice worldwide. Increasing quality and availability of information, support tools and greater patient expectations for engagement in treatment decisions and autonomy over their care has shifted the paternalistic role of the clinician to a supportive and collaborative one, with a shared decision-making approach between patient and clinician at its heart.[1,2] This has been echoed through the creation of NHS England's shared decision-making models and initiatives such as 'NHS Choices'.[2]

Aside from supporting shared decision-making, valid consent is a legal prerequisite to any surgical procedure performed. This is implemented in UK law through legislation, and high-profile cases such as Montgomery versus Lanarkshire (2015) have set out further legal precedents which may be ethically reasonable but practically challenging to employ.[3] Guidance for the main ethical and professional principles of the consent process in the UK is set out by the General Medical Council (GMC) and further recommendations issued by professional bodies such as the Royal College of Surgeons (RCS).[4,5] These frameworks are purposefully broad and therefore do not provide detailed procedure-specific guidance including contemporary risks for routine discussion, strategies for communicating complication rates or presentation of information to patients, leaving scope for variation in specific consent practice.

According to Hospital Episode Statistics (HES) data, 30,000 superficial venous procedures are delivered annually by the NHS in England with a similar number estimated to be delivered in the private sector. These treatments are known to be safe and effective, with a low risk of complications, a rapid recovery and very high rates of patient satisfaction.[6–8] Despite this, varicose vein procedures historically account for the largest individual contribution towards successful legal claims (48%) within vascular surgical practice in the NHS.[9,10] Flaws in the consent process are significantly and increasingly contributing factors towards successful litigation claims across all surgical specialties, with an increase from 128 to 248 claims per year in 2011–2012 and 2021–2022.[11]

The purpose of this observational survey is to establish current consent practice and variation in consenting for superficial venous intervention across UK vascular units, whilst establishing agreed complications clinicians prioritise in routine discussion. Exploring variation in practice will identify areas for improvement, inform the development of more streamlined standardised consent processes and support consistency in the provision of patient information relating to superficial venous procedures across the UK.

Methods

Questionnaire development

A 10-part online pilot survey was devised by members of the venous special interest group. The content was reviewed and refined by two consultant vascular surgeons with established expertise in venous research, a vascular surgery registrar and an academic research manager with qualitative methodology expertise. The survey included a combination of free-text, binary and multiple-choice items to ensure the breadth and nuance of

perspectives were captured. The survey was piloted to assess content and face validity within a single tertiary vascular unit amongst 10 consultants and eight registrar level doctors in two rounds. Minor alterations to question phrasing were made by three reviewers who devised the survey based on the pilot group feedback to improve readability and clarity of wording. Amendments were re-tested to the same pilot group with no further changes, producing the final questionnaire (see Appendix 1 online at www.jvsgbi.com). Items purposefully used the umbrella term endovenous ablation to encompass all minimally invasive techniques including endothermal ablation (radiofrequency ablation and LASER), foam sclerotherapy, mechanochemical ablation, cyanoacrylate closure and phlebectomy. Open surgical techniques including high tie and ligation and stripping were not included as risk profiles significantly differ. In the context of this paper, superficial venous interventions are used interchangeably with endovenous ablation due to the exclusion of open techniques in the survey. The target population were UK-based vascular surgeons who carry out superficial venous interventions both in the NHS and private sector. This encompassed all training levels from ST3+ to consultant (or equivalent). We defined 'clinicians' as 'doctors' to reduce heterogeneity in respondent backgrounds, training and professional responsibility. Whilst acknowledging this excludes colleagues with nursing backgrounds and other allied healthcare professionals who hold critical roles in the multidisciplinary care of patients, in most surgical settings the surgeon holds primary legal and professional responsibility for the consent process and whose perspectives are directly relevant to the study.

Questionnaire dissemination

The final survey was distributed to trainee and consultant vascular surgeons nationally using the Qualtrics XM platform. Dissemination was through the Vascular Society Annual Vascular Meeting, Vascular and Endovascular Research Network (VERN), Vascular Society (VSGBI) and Vascular Research UK with links promoted on social media platforms. Responses remained anonymous, allowing clinicians to report routine practice confidentially and reduce social desirability bias. Due to dissemination via open online platforms, the total number who viewed the survey was unknown so the true response rate could not be calculated.

Using a free-text box, respondents listed the complications routinely discussed with their patients undergoing superficial venous intervention. To minimise recall bias, once completed respondents were unable to revisit this section to reduce the possibility of later survey content influencing responses and preventing retrospective changes to answers once respondents were exposed to a complication list. During consent clinicians often quote information around the incident rates of complications, which may be presented numerically as a percentage or qualitatively using descriptive terms to demonstrate the likelihood of occurrence. To explore this practice, the questionnaire asked respondents to allocate descriptors ('rare', 'common' or 'very common') to individual complications identified by the study authors based on their perceived incidence.

The survey also aimed to understand how clinicians relate these descriptive terms to quantitative risk, asking respondents to assign percentage incidence rates to each descriptor above. The final part of the survey gathered broader information on individuals' contemporary practice including the use of incorporated adjuncts (such as pictures, written advice, videos) and views on the value of pre-populated consent forms.

Data were entered into a bespoke spreadsheet and analysed using Microsoft® Excel® (Microsoft, Redmond, WA, USA). Responses not containing any completed survey questions were excluded from analysis. Partially completed survey responses were included for fully answered questions to maximise data capture. Clinicians' free-text responses were used to map the assigned percentage incidence rates associated with the descriptors 'rare', 'common' or 'very common' onto a graph to visualise the distribution of responses.

The agreement thresholds were defined prior to data collection as 70% for inclusion and <30% for exclusion. A complication was considered to achieve agreement for inclusion if it was independently reported by at least 70% of respondents. This is in keeping with commonly set consensus thresholds used in Delphi and RAND studies.[12]

Results

The survey had 130 respondents with a completion rate of 96% (130/136). Amongst respondents, 13% (17/130) were trainees and 87% (113/130) were consultants. The data included 52% (68/130) of clinicians who performed more than 80 varicose vein interventions annually and 48% (62/130) of clinicians performing fewer than 80 cases annually. The spread of responses covered the entire UK including Scotland, Wales, Northern Ireland and all regions within England.

Thirty-four distinct complications were listed by respondents as routinely quoted during consent (Table 1). The median number of complications quoted by respondents was 7 (range 3–34). There were no differences between trainees or consultants in the number of complications quoted.

On review of these complications, only three reached the agreement threshold for routine inclusion. The complication that reached the highest agreement threshold at 97% (126/130) was venous thromboembolism. 78% (101/130) of respondents quoted recurrence and 78% (102/130) sensory disturbance. 68% (23/34) of complications listed by clinicians met consensus for exclusion (these are listed in Table 1). Of these, 56% (19/34) were listed by less than 10% of respondents.

When communicating complications to patients, 16% (21/129) of respondents do not give any indication of the frequency of complications and, of the 83% (107/129) who do, there is significant variation in how this information is presented. 48% (62/129) quote the risk of complications as a percentage, 18%

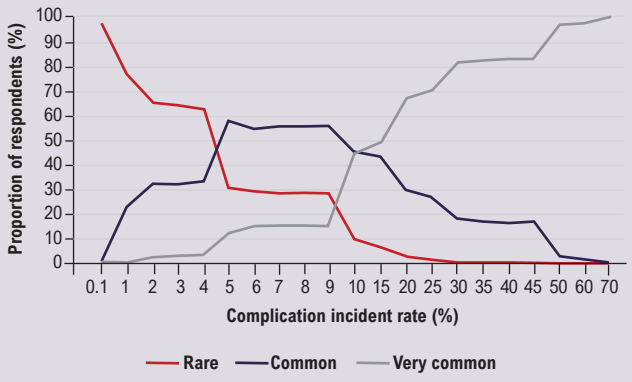
Table 1 The complications respondents routinely quote during the consent process
Green: those with consensus to include; Amber: no consensus to include or not; Red: those with consensus to not include

Complication	Number of respondents (N)	Percentage of respondents (%)
Venous thromboembolism	126	96.9
Nerve injury/damage/complications/sensory disturbance/tingling/numbness	102	78.5
Recurrence/further treatment	101	77.7
Infection	67	51.5
Bleeding	65	50.0
Pain/discomfort/neuralgia/ache/tenderness	62	47.7
Pigmentation/staining/discolouration	50	38.5
Superficial venous thrombosis/phlebitis / congealed blood	46	35.4
Bruising	45	34.6
Skin burns/thermal injury	41	31.5
Failure	39	30.0
Scar	28	21.5
Residual/persistent veins	21	16.2
Lumpiness/matting/palpable cord/rubbery veins	14	10.8
Swelling	10	7.7
Headaches/visual disturbance/chest tightness	9	6.9
Residual/persistent symptoms/non-resolving	9	6.9
Stroke/TIA	9	6.9
Thread veins/flares	7	5.4
Ulceration/skin necrosis	6	4.6
Allergy/reaction/granuloma	5	3.8
Damage to surrounding structures	5	3.8
Heart attack/cardiorespiratory problems	5	3.8
Poor cosmesis	5	3.8
Mortality/death	4	3.1
Anaesthetic risk	3	2.3
Blisters	2	1.5
Motor nerve injury specifically/foot drop	2	1.5
Tattoo	2	1.5
Amputation/limb loss	1	0.8
Catheter fracture	1	0.8
Intolerability	1	0.8
Need for ongoing compression	1	0.8

(23/129) would use the incidence per 100 or per 1000 cases and <1% (5/129) use pictorial representations. 20% (27/129) of respondents use a combination of these. Other approaches included broad descriptor summaries (adopted by four respondents) and patient information leaflets (quoted by three respondents).

There was wide variation in the incidence rates which clinicians assigned to each descriptor (Figure 1). For example, for a complication incidence rate of 5%, 10% of respondents would describe that as 'very common', nearly 50% would describe it as 'common' and 40% would describe it as 'rare'. The only consensus seen was that >70% of respondents would describe a complication with an incidence of less than 1.5% as 'rare' and a complication with an incidence rate above 25% as 'very common'. There was no agreed incidence rate range for the descriptor of 'common'. A sensitivity analysis was performed to look separately at the seniority

Figure 1 Categorisation of the incident rate of complications by clinicians. Respondents were asked to assign quantitative percentages to each descriptor category 'rare', 'common' and 'very common'.



of the respondent and the case load of the respondent, and no difference was found between these.

Thirty-six of the 129 respondents (28%) use pre-prepared consent forms, but 64% (83/129) agree that they would be of benefit. Benefits described included standardisation of information given to all patients, thus helping communicate the risks of superficial venous intervention and serve as a prompt to minimise exclusion of information. It was emphasised that standardised forms could save consultation time and therefore improve depth of discussion. Those who disagreed stated that individual nuanced discussions with patients were of higher benefit and highlighted that standardised consent forms exclude personalised risk assessment or patient-specific factors. It was argued that the discussion is more important than the documentation and a pre-printed consent form may not reflect the depth of the actual consultation. Others felt that clinic letters were more crucial in the consent process. Some were concerned that pre-populated consent forms would inevitably encompass all possible complications as opposed to the most relevant patient- or procedure-specific ones. A key theme throughout was that a pre-prepared consent form has numerous benefits but, alone, it will not solely improve the consent process.

Discussion

The key purpose of this study is to provide contemporary observational data on the perceptions and practice of consenting for venous procedures from a clinician's perspective. This national survey observes significant variability in how UK vascular surgeons approach the consent process and demonstrates that there is little agreement on which complications should be routinely discussed, frequency of occurrence or continuity in communication of risk to patients. Heterogeneity was seen in the clinicians' interpretation of frequency descriptors, which could impact patient understanding and threaten the robustness of the consent process. Twenty-one of the 129 respondents (16%) did not explicitly indicate risk frequency at all and, in those who did, a range of methods was used. Some clinicians categorised risk using descriptors such as 'rare', 'common' or 'very common'. Whilst these are widely adopted in clinical practice, the results challenge the reliability and consistency as tools for risk communication. On this basis, qualitative descriptive terms should not be used in isolation but, rather, should be supported by quantitative data and patient-tested education materials to provide context and aid interpretation. Inconsistencies in terminology may create additional barriers for patients with lower health literacy who may have challenges interpreting risk in numerical or qualitative formats. A study of patient encounters reported that one-fifth of health professionals had at least one daily encounter with patients who struggled with comprehension and application of health information. For patients to actively engage in meaningful consent, the appropriate method of communicating must align with the health literacy level.[13–15]

Numerical presentation such as percentages or frequencies per 100 cases was another commonly reported method of conveying risk. Although these approaches remove ambiguity associated with qualitative descriptions, their accuracy depends on underlying clinical evidence, with reliance upon quality of the data and the familiarity of the clinician to the data. Both of these can be variable, and neither were examined in this study. In addition, clinicians expressed a desire to personalise risk; however, there are limited data to support this process at present. Best evidence is dynamic and changes with emergence of new data; for example, a recent publication has called into question what the current best evidence suggests regarding the incidence of venous thromboembolism following treatment.[16] Incidence rates may be higher than conventionally considered previously by a factor of 10. Not only should the clinical community be kept informed of developing changes in data patterns, but information packages supporting decision-making and consent resources need to be responsive as well. The increased use of personalised care will accompany improving data and may further complicate or simplify the consent process. Unfortunately, superficial venous interventions are excluded from existing vascular registries, despite being the most frequently performed procedures within vascular surgery. This limits the synthesis and dissemination of high-quality contemporary data on complications and represents a key evidence gap. Addressing this would support more accurate risk communication and a more consistent approach to consent across the specialty.

Meaningful and valid consent of course extends beyond the communication of risk, although this is usually a critical element in retrospective dispute. In addition to frameworks set out by the RCS and GMC, guidance on medical consent is provided in the Department of Health reference guide to consent for treatment.[17] These establish the underlying principles; however, practical guidance on procedure-specific risks or communication strategies conveying risks are not offered. The findings of this study highlight the consequences of this gap and, whilst not an assessment of consent quality or clinical outcomes, it was observed that patients

receive a varied scope of information depending on the clinician conducting the consent, which could contribute to uncertainty around meeting expectations established by the Montgomery ruling.[18] Shared decision-making relies on accurate and consistent communication of risk. If clinicians disagree on which complications to discuss or the likelihood of occurrence, patients may find challenges in making informed choices about the care they receive and could contribute to dissatisfaction.

A lack of unanimity on any one complication to discuss with patients suggests that clinicians' prioritisation of procedural risks vary. Venous thromboembolism was among the few complications to reach the agreement threshold, likely reflecting the potential for morbidity and mortality from an intervention intending to improve quality of life. Clinicians placed greater emphasis on complications with severe clinical consequences rather than more common but less serious outcomes such as bruising or pain. There was an under-emphasis of perceived 'minor' complications, but these could have significant importance for patients if impacting recovery time, return to work or care duties and overall experience. Most quoted complications reached less than 10% agreement for inclusion in the consent process. If so few of the expert clinicians agree to routine discussion with patients, this poses the question of whether they should be quoted routinely and reserved for individualised discussions based on risk factors, preferences, information needs and circumstances. Determining this balance, as highlighted in the Montgomery case, remains a challenge in clinical practice and requires the patient perspective, which was not assessed during this study and must be addressed in future research priorities.

Previous studies have sought to address the issue of informed consent for superficial venous procedures. The DISCOVAR study group reached consensus through a Delphi process on 12 major and 12 minor complications that should be included for consent discussions, but the study methods did not explore how these are implemented in practice.[19] They also quoted the Royal Dutch Medical Association (KNMG) guidance that complications occurring in >1% of patients must be discussed. This threshold varies from UK case law, where potentially any complication, however rare, may be required to protect against litigation. Another study sought to outline essential information that should be shared with patients including benefits and alternative treatments.[20] None of these studies examine how consent is delivered in routine clinical practice or how clinicians interpret and communicate information to patients.

Contemporary NHS Resolution data show approximately 130 vascular surgery claims annually in England, with around £205 million paid on successful claims between 2014/15 and 2023/24.[21] As discussed previously, historical evidence suggests varicose vein surgery accounted for almost half of successful vascular claims, but modern NHS Resolution data do not provide a procedure-specific breakdown so there remains uncertainty regarding the current contribution.[9] This sustained rise in litigation claims relating to consent highlights the importance of effective communication and robust consent practices in the modern healthcare climate. A misalignment of patients' expectations compared with actual outcomes and misunderstanding of procedural risk may contribute to dissatisfaction and, in turn, complaints or medicolegal challenges. The increase in claims across all specialties (with the primary cause of Failure to Warn - Informed Consent) has amounted to a cost of around £80,000,000 between 2021 and 2022, the highest in a one-year period to date.[11] In a resource-constrained NHS, reducing litigation costs due to deficiencies in the consent process is a compelling priority. However, while greater standardisation of components of the consent process may improve the consistency and quality of information provided to patients, such an approach should complement (rather than replace) individualised patient-centred discussions that reflect their values and preferences.

KEY MESSAGES

- There are inconsistencies and wide variation in the mode, method and delivery of consent for superficial venous procedures.
- There are disparities between individual clinicians on how they perceive and convey risk to patients.
- The number of legal claims and costs relating to failures in the consent process are rising.
- The next steps in research should capture patient perspectives.

Study limitations

The limitations of this study include a selection bias, as data were collected using a voluntary response strategy so clinicians with a particular interest in venous disease may have been more likely to participate. As with many contemporary surveys, due to open dissemination of the survey through professional platforms online a response rate could not be calculated. There are potential reporting biases, as some clinicians may have over-reported the complications quoted in their routine practice or conversely under-reported them. Independent anonymous online completion aimed to reduce social desirability bias; however, the survey relied on self-reported practice rather than objective auditing of actual practice. The agreed threshold for consensus was set at 70% a priori (in line with thresholds commonly used in Delphi methodology), and whilst this varies within the literature, only four outcomes in this study reached >50% agreement so the principal findings are unlikely to be affected. The patient perspective was not assessed in this study so findings do not reflect patient needs or expectations. It is established that vascular patients prefer a shared decision-making process with their surgeon, therefore future research priorities should explore patient expectations of the consent process through qualitative interviews and focus groups alongside involvement of key medicolegal stakeholders.[22]

Conflict of Interest: IC is the Editor of *JVSGBI*.

Funding: None.

Author contributions: Conception and design: DC, AH, GS, AG, IC. Analysis and interpretation: AH, AM, DC. Data collection: AH. Writing the article: AH, AM. Critical revision of the article: DC, LH, JL, SP, PS, AM. Final approval of the article: DC. Statistical analysis: AH, AM, DC. Overall responsibility: AH.

Reviewer acknowledgement: *JVSGBI* thanks to Louise Allen, Lead Vascular Nurse Specialist, Imperial College Healthcare NHS Trust and Harishankar Ramachandran Nair, Consultant Vascular Surgeon, St Thomas' Hospital, London for their contribution to the peer review of this work.

References

1. Care Quality Commission. Better care in my hands: A review of how people are involved in their care. 2016. Available from: https://www.cqc.org.uk/publications/themed-work/better-care-my-hands-review-how-people-are-involved-their-care
2. NHS England. Shared Decision-Making: Summary Guide. 2019. Available from: https://www.england.nhs.uk/publication/shared-decision-making-summary-guide/
3. Chan SW, Tulloch E, Cooper ES, Smith A, Wojcik W, Norman JE. Montgomery and informed consent: where are we now? *BMJ* 2017;**357**:j2224. https://doi.org/10.1136/bmj.j2224
4. Royal College of Surgeons. Consent: Supported Decision-Making. Available from: https://www.rcseng.ac.uk/standards-and-research/standards-and-guidance/good-practice-guides/consent/
5. General Medical Council. Guidance on professional standards and ethics for doctors. Decision making and consent. Available from: https://www.gmc-uk.org/professional-standards/the-professional-standards/decision-making-and-consent
6. Michaels JA, Nawaz S, Tong T, Brindley P, Walters SJ, Maheswaran R. Varicose veins treatment in England: population-based study of time trends and disparities related to demographic, ethnic, socioeconomic, and geographical factors. *BJS Open* 2022;**6**(4):zrac077. https://doi.org/10.1093/bjsopen/zrac077
7. Hitchman LH, Mohamed A, Smith GE, *et al*. Provision of NICE-recommended varicose vein treatment in the NHS. *Br J Surg* 2023;**110**(2):225–32. https://doi.org/10.1093/BJS/ZNAC392
8. Carradice D, Mekako AI, Mazari FAK, Samuel N, Hatfield J, Chetter IC. Randomized clinical trial of endovenous laser ablation compared with conventional surgery for great saphenous varicose veins. *Br J Surg* 2011;**98**(4):501–10. https://doi.org/10.1002/BJS.7394
9. Markides GA, Subar D, Al-Khaffaf H. Litigation claims in vascular surgery in the United Kingdom's NHS. *Eur J Vasc Endovasc Surg* 2008;**36**(4):452–7. https://doi.org/10.1016/J.EJVS.2008.06.018
10. Campbell WB, France F, Goodwin HM. Medicolegal claims in vascular surgery. *Ann R Coll Surg Engl* 2002;**84**(3):181. PubMed PMID: 12092871.
11. Ainsworth N, Hussain MI, Houten R, *et al*. Informed consent failures: National Health Service Resolution data. *Br J Surg* 2023;**110**(8):993–5. https://doi.org/10.1093/bjs/znad131
12. von der Gracht HA. Consensus measurement in Delphi studies. Review and implications for future quality assurance. *Technol Forecast Soc Change* 2012;**79**(8):1525–36. https://doi.org/10.1016/j.techfore.2012.04.013
13. Wittink H, Oosterhaven J. Patient education and health literacy. *Musculoskelet Sci Pract* 2018;**38**:120–7. https://doi.org/10.1016/J.MSKSP.2018.06.004
14. Murugesu L, Heijmans M, Rademakers J, Fransen MP. Challenges and solutions in communication with patients with low health literacy: Perspectives of healthcare providers. *PLoS One* 2022;**17**(5). https://doi.org/10.1371/JOURNAL.PONE.0267782
15. Nutbeam D. The evolving concept of health literacy. *Soc Sci Med* 2008;**67**(12):2072–8. https://doi.org/10.1016/J.SOCSCIMED.2008.09.050
16. Turner BRH, Machin M, Jasionowska S, *et al*. Systematic review and meta-analysis of the additional benefit of pharmacological thromboprophylaxis for endovenous varicose vein interventions. *Ann Surg* 2023;**278**(2):166–71. https://doi.org/10.1097/SLA.0000000000005709
17. General Medical Council (GMC). Good medical practice - professional standards. Available from: https://www.gmc-uk.org/professional-standards/professional-standards-for-doctors/good-medical-practice
18. UK Supreme Court. Montgomery (Appellant) v Lanarkshire Health Board (Respondent). 2015. Available from: https://www.bailii.org/uk/cases/UKSC/2015/11.html
19. de Mik SML, Stubenrouch FE, Legemate DA, Balm R, Ubbink DT. Treatment of varicose veins, international consensus on which major complications to discuss with the patient: a Delphi study. *Phlebology* 2019;**34**(3):201–07. https://doi.org/10.1177/0268355518785482
20. Kiernan A, Moneley D, Doyle F, Harkin DW. A modified Delphi process to form an expert consensus in Ireland on the essential information to be included in shared decision making for varicose vein surgery. *Phlebology* 2023;**38**(4):259–69. https://doi.org/101177/02683555231158284
21. Abadi PH, Barmayehvar B, Thompson A, Sritharan K. Litigation trends in vascular surgery in the UK: a retrospective analysis of NHS Resolution data and impact of the COVID-19 pandemic. *Ann Vasc Surg* 2025;**121**:595–602. https://doi.org/10.1016/j.avsg.2025.08.039
22. Santema K, Stoffer EA, Kunneman M, Koelemay MJW, Ubbink DT. What are the decision-making preferences of patients in vascular surgery? A mixed-methods study. *BMJ Open* 2017;**7**:e013272. https://doi.org/10.1136/bmjopen-2016-e013272

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):177-187
http://doi.org/10.54522/jvsgbi.2026.238

www.jvsgbi.com

SYSTEMATIC REVIEW

The effect of preoperative natriuretic peptide testing on outcome in vascular surgery: a systematic review and meta-analysis

Imperatore G,[1] Bradley N,[2] Hanna L,[2] Gudgeon J,[3] Chong P[4]

1. Health Science Interdisciplinary Centre, Sant'Anna School of Advanced Studies, Pisa, Italy
2. Vascular Surgery Registrar, NHS KSS Deanery, UK
3. Consultant Anaesthetist, Frimley Health NHS Foundation Trust, UK
4. Consultant Vascular Surgeon, Frimley Health NHS Foundation Trust, UK

Corresponding author:
Giuseppe Imperatore
Health Science Interdisciplinary Centre, Sant'Anna School of Advanced Studies, Piazza Martiri della Libertà, 33, Pisa, 56127, Italy
Email: Giuseppe.imperatore@santannapisa.it

Received: 20th May 2026
Accepted: 24th July 2026
Online: 14th August 2026

Plain English Summary

Why we undertook the work: Patients undergoing vascular surgery are at risk of heart-related complications after their operation. B-type natriuretic peptide (BNP) is a substance released by the heart when it is under stress. We wanted to understand if measuring BNP levels before surgery can help predict which patients are more likely to experience heart problems or death after their vascular procedure, and if it adds value to the standard tests currently used by surgeons.

What we did: We performed a systematic review, which is a comprehensive and structured search of medical databases to gather all existing research on this topic. We also conducted a meta-analysis, a statistical method used to combine the results of these individual studies to get a clearer, single overall answer. Through this process we evaluated patients undergoing both elective (planned) and emergency (urgent) vascular surgery. We collected and compared data from these studies to determine how well BNP levels predict postoperative heart events such as heart attack, death or prolonged hospital stay.

What we found: Our review included 11 studies involving 3,062 patients. We found that elevated preoperative BNP levels are significantly associated with a higher risk of major heart-related complications and death following vascular surgery. Natriuretic peptide testing appears to provide additional prognostic information that traditional risk assessment tools might miss.

What this means: Measuring these heart markers before surgery is a simple, quick and helpful way to find patients who are at a higher risk of having heart problems around the time of their operation. However, there is currently no single, universally agreed-upon cut-off value to define 'high risk', as different hospitals and studies use widely varying threshold numbers. By using this test, doctors can keep a closer eye on high-risk patients and better prepare for their surgery. This ultimately helps to make the operation safer, prevent heart issues and improve patient recovery.

Abstract

Objective: The aim of this systematic review and meta-analysis was to evaluate the prognostic utility of natriuretic peptide testing for predicting adverse postoperative outcomes in patients undergoing vascular surgery, and to assess their incremental value within established perioperative risk stratification frameworks. Specific endpoints included mortality, myocardial infarction, stroke and prolonged hospitalisation. A secondary objective was to determine whether natriuretic peptide testing offers incremental prognostic value over conventional risk assessment tools.

Methods: A systematic review and meta-analysis was conducted in accordance with PRISMA guidelines. A comprehensive search of PubMed, Embase, Scopus and the Cochrane Library was performed to identify studies published between 2004 and 2025 evaluating the association between preoperative B-type natriuretic peptide (BNP) levels and postoperative outcomes in adult vascular surgery patients. Eligible studies included randomised controlled trials, cohort studies and case–control studies. Two reviewers independently conducted data extraction and quality assessment. A random-effects meta-analysis was performed and subgroup analyses were conducted based on patient characteristics and procedure type.

Results: Eleven studies including 3,062 patients were included in the systematic review. All included studies were observational (prospective or retrospective cohorts). Most studies reported a significant association between elevated preoperative BNP levels and increased risk of perioperative cardiac complications including myocardial infarction, myocardial injury and

cardiac death. Several studies also suggested an association with short-term mortality, although mortality-specific data were limited. Five studies reporting multivariable-adjusted odds ratios were pooled. Elevated preoperative BNP levels were associated with a significantly increased risk of perioperative cardiac events (pooled OR 4.08; 95% CI 3.20 to 5.20; p<0.001). No significant statistical heterogeneity was observed (I^2=0%). The magnitude and consistency of association support integration of natriuretic peptide testing within multimodal perioperative risk pathways in vascular surgery.

Conclusions: Elevated preoperative BNP levels are consistently associated with an increased risk of perioperative cardiac complications across observational studies in vascular surgery patients. Meta-analytical pooling confirms a strong and robust association, indicating approximately a fourfold higher risk among patients with elevated natriuretic peptide levels. The magnitude and consistency of the association support integration of natriuretic peptide testing within multimodal perioperative risk pathways in vascular surgery. Natriuretic peptide testing provides incremental prognostic information beyond traditional risk factors and may support individualised perioperative risk stratification. However, prospective validation and randomised trials are required before routine clinical implementation can be recommended.

Key words: B-type natriuretic peptide, preoperative testing, vascular surgery

Introduction

Vascular surgery includes a wide range of procedures addressing disorders of the vascular system, such as atherosclerosis, aneurysms and peripheral arterial disease. These conditions often require interventions including revascularisation procedures and aneurysm repair. Patients undergoing vascular surgery frequently present with multiple comorbidities, particularly cardiovascular disease, which increases perioperative complexity and significantly influences postoperative outcomes.[1,2]

The majority of vascular surgical procedures are considered high risk, typically due to either the magnitude of the physiological insult caused by intervention (such as aortic aneurysm repair), or due to the typical burden of comorbidity in patients undergoing intervention (such as revascularisation for peripheral arterial disease). Effective preoperative assessment in this setting allows for potential optimisation, or selection of patients towards less invasive options for intervention. The optimal strategy for preoperative assessment in this context remains challenging and has been the subject of extensive research. Conventional measures including bedside assessment and the use of scoring systems such as the American Society of Anaesthesiologists (ASA) classification, the Clinical Frailty Score (CFS) and the Revised Cardiac Risk Index (RCRI) have been widely reported; however, they include an element of subjectivity. Functional physiological testing such as Cardiopulmonary Exercise Testing (CPEX) is widely performed, and may offer a reasonable prediction of the physiological response to major surgical insult. Perioperative major cardiovascular event rates in high-risk vascular procedures may exceed 10–15%, underscoring the need for improved preoperative risk discrimination. In order to augment these strategies as part of a multimodal assessment, there is a growing interest in the use of biomarkers as quantifiable measures of perioperative risk.

Among these, B-type natriuretic peptide (BNP) has received considerable attention. BNP is a hormone produced by cardiac myocytes in response to myocardial stretch and increased ventricular pressure, conditions typically associated with heart failure and other forms of cardiovascular dysfunction.[3,4] Elevated BNP levels are widely recognised as markers of heart failure severity and are routinely used for diagnosis and prognostication in heart failure patients.[4] Typically, values <100 ng/L are considered normal, those >400 ng/L are considered high risk for cardiac failure, and those between 100 and 400 ng/L require clinical assessment and warrant further investigation.

However, it is critical to recognise that natriuretic peptide levels are not entirely specific to heart failure. Circulating levels are frequently elevated by non-cardiac factors common in vascular patients such as advancing age, renal impairment, sepsis, tachycardia and chronic lung diseases, whereas they can be falsely decreased by obesity or suppressed by cardiac medications like diuretics and beta-blockers. Consequently, an elevated preoperative value may reflect these combined clinical confounders rather than isolated cardiac failure, underscoring why absolute thresholds must be interpreted with caution.

Emerging evidence suggests that BNP may also serve as a valuable biomarker for assessing cardiovascular risk in patients undergoing vascular surgery.[5,6] In this context, elevated preoperative BNP levels have been associated with adverse outcomes including increased mortality, prolonged hospital stays and higher complication rates.[7,8] Assessing BNP levels before surgery could therefore aid in identifying patients at higher cardiovascular risk who may benefit from intensified perioperative monitoring and management.[4] Surgical stress, fluid shifts, sympathetic activation and perioperative haemodynamic instability may unmask subclinical myocardial dysfunction, which natriuretic

peptides are uniquely positioned to detect.

When discussing natriuretic peptides, it is clinically essential to differentiate between BNP and NT-proBNP. Both biomarkers originate from the cleavage of the common precursor proBNP, which is released by cardiac myocytes in response to myocardial wall stretch. However, they exhibit fundamentally different physiological profiles, clearance pathways and circulating half-lives. BNP is a biologically active hormone with a short half-life of approximately 20 minutes, cleared rapidly from the plasma via receptor-mediated degradation and neutral endopeptidases. Conversely, NT-proBNP is a biologically inactive N-terminal fragment with a significantly longer half-life (around 120 minutes), exhibiting higher stability in vitro and relying primarily on renal clearance. Consequently, NT-proBNP has seen increased adoption in modern clinical settings, and more recent literature frequently uses it as the primary measure of cardiac stress. Furthermore, because of these metabolic differences, absolute clinical cut-off thresholds vary dramatically between the two assays (with NT-proBNP levels typically being significantly higher than BNP levels for equivalent degrees of cardiac dysfunction). Given their shared pathophysiological pathway as indicators of subclinical myocardial stretch, pooling data from both assays under the unified category of 'natriuretic peptides' is clinically justified to maximise the volume of evidence, provided that assay-specific cut-offs are critically interpreted.

Despite this potential, the role of BNP testing in preoperative risk stratification for vascular surgery remains unclear. The use of both physiological testing and biomarkers is supported by recent guidelines for patients undergoing major surgery;[9] however, this is not represented in all guidance.[10] Although some evidence from various surgical specialties supports its prognostic value, there is no consensus regarding its utility specifically in vascular surgery, due to heterogeneity in study designs, patient populations and outcome measures across studies.[8,11,12] This has led to conflicting findings regarding whether BNP testing should be routinely incorporated into the preoperative evaluation of vascular surgery patients and whether it offers incremental value over traditional risk assessment methods.[7] Given these uncertainties, a systematic evaluation of the existing evidence is warranted to clarify the role of BNP testing in improving clinical outcomes in patients undergoing vascular surgery. Traditional indices such as the RCRI demonstrate limited discrimination in contemporary vascular surgery cohorts, particularly in patients undergoing major aortic procedures.

This systematic review and meta-analysis aims to evaluate the available evidence on the prognostic utility of preoperative BNP testing in patients undergoing vascular surgery. Specifically, this study seeks to:

- Assess the association between elevated preoperative natriuretic peptide levels and perioperative and postoperative cardiac complications including myocardial infarction, myocardial injury and cardiac death.
- Examine the relationship between preoperative BNP levels and short-term mortality, where reported.
- Evaluate the incremental value of natriuretic peptide testing when integrated into established perioperative risk stratification and management frameworks.
- Describe the range and methodological basis of BNP/NT-proBNP threshold values used to predict adverse outcomes in vascular surgery populations.

Through a comprehensive synthesis of available evidence, this review aims to clarify the clinical relevance of preoperative natriuretic peptide testing and to inform future research on its potential role in perioperative risk assessment and management in vascular surgery.

Methods

Review design

This systematic review was conducted in accordance with the PRISMA 2020 guidelines[13] and was registered on the PROSPERO database (ID 1102118). A comprehensive search of the literature was conducted to evaluate the utility of preoperative BNP testing in predicting outcomes in vascular surgery patients. The review includes studies that assess the association between BNP levels and postoperative complications such as mortality, stroke, myocardial infarction and prolonged hospitalisation. Studies reporting preoperative BNP testing in relation to vascular surgery outcomes were considered for inclusion.

Inclusion and exclusion criteria

To ensure that only relevant studies were included in the review, the following inclusion and exclusion criteria were applied:

Inclusion criteria:

- Studies that assess the impact of preoperative natriuretic peptide testing (either BNP or NT-proBNP) in patients undergoing vascular surgery (e.g., aortic aneurysm repair, carotid endarterectomy, lower extremity bypass).
- Studies involving adult patients (≥18 years) undergoing elective or emergency vascular surgical procedures.
- Studies that report preoperative BNP or NT-proBNP levels measured pre-operatively and outcomes such as mortality, cardiovascular events (eg, stroke, myocardial infarction) or length of hospital stay.
- Randomised controlled trials (RCTs), cohort studies and case–control studies.

Exclusion criteria:

- Studies that do not measure BNP preoperatively or do not report relevant postoperative outcomes.
- Studies focusing on non-vascular surgery patients or paediatric populations.
- Studies that do not provide sufficient data for statistical analysis (eg, missing data on BNP levels or outcomes).

Search strategy

A comprehensive literature search was performed across multiple electronic databases, including PubMed, Cochrane Library, Scopus and Embase. The search strategy was designed to identify studies published up until 2025. Keywords and medical subject headings (MeSH) terms related to "BNP", "pre-operative testing", "vascular surgery", "outcome" and "mortality" were used in the search. Examples of the search terms included:

- "B-type natriuretic peptide" OR "BNP" OR "N-terminal pro-b-type natriuretic peptide" OR "NT-proBNP" OR "natriuretic peptides"
- "vascular surgery" OR "vascular intervention" OR "vascular procedures"
- "pre-operative assessment" OR "preoperative"
- "outcome" OR "complication" OR "mortality" OR "stroke" OR "myocardial infarction"

The search was limited to studies published in English.

Data extraction

Data extraction was performed independently by two reviewers. Discrepancies were resolved through discussion or consultation. The following information was extracted from each included study:

- Study characteristics: first author, year of publication, study design, study setting and sample size.
- Participant characteristics: patient demographics (age, sex), baseline cardiovascular risk factors and major comorbidities.
- Procedural characteristics: type and complexity of vascular surgery performed.
- Biomarker assessment: BNP measured, assay method, timing of preoperative measurement and study-specific threshold values.
- Outcomes: perioperative and postoperative cardiac complications (including myocardial infarction, myocardial injury and cardiac death), and short-term mortality when reported.
- Effect estimates: adjusted and unadjusted effect measures (odds ratios, hazard ratios or relative risks) with corresponding confidence intervals, and variables included in multivariable models.
- Risk of bias and study quality: methodological quality assessed using the Newcastle–Ottawa Scale (NOS).

Quality assessment

The quality of the included studies was assessed using the Cochrane Collaboration Risk of Bias tool[14] for RCTs and the NOS[15] for cohort and case–control studies. These tools evaluate the risk of bias across various domains, including selection bias, performance bias, detection bias and reporting bias. Each study was classified as having low, unclear or high risk of bias. The overall quality of evidence was summarised using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system.[16]

Data synthesis

The extracted data were synthesised using both qualitative and quantitative methods. For studies that provided comparable data, a systematic review was conducted to assess the pooled effect of preoperative BNP testing on postoperative outcomes. Statistical analysis was performed using Review Manager (RevMan) software (Version 5.4, Cochrane Collaboration). For continuous outcomes (eg, length of stay), the mean difference (MD) with 95% confidence intervals (CI) was calculated. For dichotomous outcomes (eg, mortality, stroke), the odds ratio (OR) with 95% CI was used. Statistical significance was defined as a two-sided p value of <0.05. Subgroup analyses were planned to explore whether the association between BNP levels and outcomes differed based on patient characteristics (eg, age, comorbidities) or surgery type.

Meta-analysis

Given that the included clinical literature evaluates both BNP and NT-proBNP, we chose to pool these biomarkers under the unified term 'natriuretic peptides'. This decision was pragmatic and pre-specified to maximise the number of eligible studies and statistical power for the quantitative synthesis. While BNP and NT-proBNP are physiologically distinct molecules with different circulating half-lives and absolute assay thresholds, both reflect myocardial stretch and subclinical ventricular dysfunction.

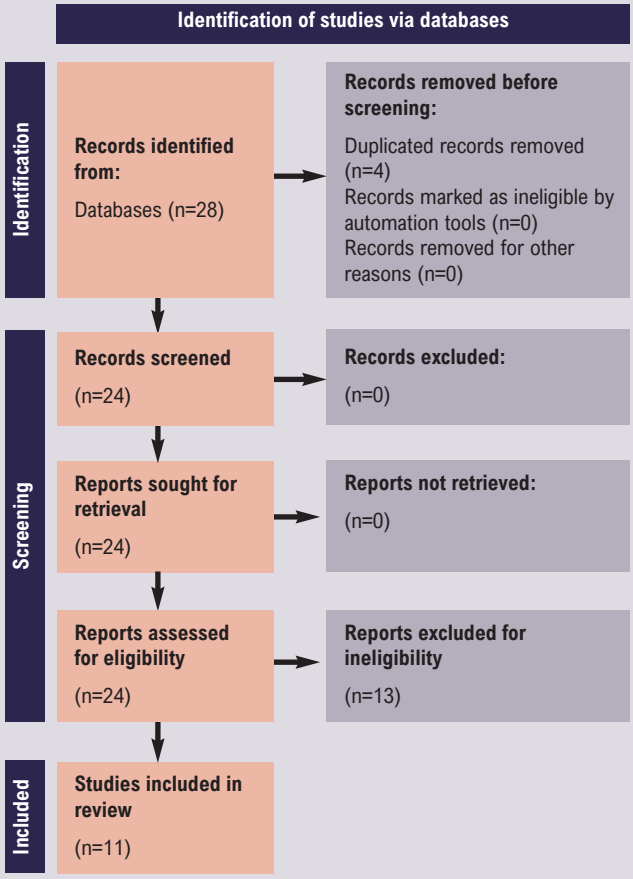
A random-effects meta-analysis was performed to pool adjusted ORs for perioperative or postoperative cardiac events associated with elevated preoperative BNP levels. The primary pooled endpoint was perioperative or 30-day major cardiac events. Effect estimates and corresponding 95% CIs were transformed to the logarithmic scale and combined using the generic inverse variance method. Between-study variance was estimated using the DerSimonian–Laird method.

Effect estimates were log-transformed and pooled using the generic inverse variance method within a random-effects framework (DerSimonian–Laird), with Hartung–Knapp adjustment applied due to the limited number of studies. Statistical heterogeneity was assessed using Cochran's Q test and quantified with the I^2 statistic (an I^2 value of $<25\%$ was considered low heterogeneity). Sensitivity analyses were performed using leave-one-out procedures to evaluate the robustness of pooled estimates. Given the small number of pooled studies, assessment of publication bias was considered exploratory and interpreted with caution. Meta-regression was not feasible due to the limited number of studies.

Visual inspection of the funnel plot did not demonstrate marked asymmetry. Egger's regression test did not identify statistically significant small-study effects (intercept=1.17, p=0.12). However, interpretation is limited by the small number of included studies (n=4), and these analyses should be considered exploratory.

All statistical analyses were conducted using Python (Version 3.14.2) with standard scientific computing libraries and Review Manager (RevMan) software (Version 5.4, Cochrane Collaboration).

Figure 1 PRISMA 2020 flow diagram.



Results

Study selection

A total of 28 studies were identified through the literature search. After removing duplicates, 24 studies were screened for eligibility. Following the application of inclusion and exclusion criteria, 11 studies were ultimately included in the systematic review. A flow diagram summarising the study selection process is presented in the PRISMA flowchart in Figure 1. Reasons for the exclusion of studies at each stage of the selection process are outlined in the diagram.

Study characteristics

The characteristics of the included studies are summarised in Table 1. The studies were published between 2004 and 2018 and involved a total of 3062 patients with a mean age of 66–75 years. All studies were observational: retrospective (n=4, 36%) and prospective (n=7, 64%) in design. The results of the included studies are summarised in Table 2. The studies were conducted across multiple countries including South Korea, the Netherlands, Canada, Italy, the UK, Taiwan and Germany. The surgical procedures included abdominal aortic aneurysm repair, carotid endarterectomy, lower limb revascularisation or bypass surgery, and major amputations. Preoperative BNP was measured in all studies, although the threshold values varied substantially ranging from 40 ng/L to 533 ng/L and were frequently derived using receiver operating characteristic (ROC) analyses. Several studies reported median BNP values instead of fixed cut-off points.

Study quality, assessed using the NOS, was generally moderate to high. However, limitations included small sample sizes in some cohorts, heterogeneity in BNP measurement protocols and incomplete adjustment for confounding variables.

Outcome measures

The most commonly reported outcomes across the included studies were: (1) perioperative and short-term mortality; (2) perioperative and postoperative cardiac events including myocardial infarction, myocardial injury and acute coronary syndromes; and (3) composite cardiovascular endpoints. Ten studies focused primarily on short-term perioperative outcomes whereas only one study evaluated long-term survival. None of the included studies systematically evaluated non-cardiac complications or length of hospital stay as primary endpoints.

Effect of preoperative BNP testing on mortality and on cardiovascular events

Three studies found that elevated preoperative BNP levels were associated with higher mortality rates following vascular surgery. Three studies showed that patients with BNP levels exceeding 100 ng/L had a significantly higher risk of 30-day and 90-day mortality. On the other hand, two studies did not find a significant association between BNP levels and mortality, potentially due to a smaller sample size or different patient population.[17,18] Four studies demonstrated a positive correlation between elevated BNP levels and an increased incidence of cardiovascular events, such as myocardial infarction and stroke, following vascular surgery. For instance, one study[19] showed that patients with BNP levels >50 ng/L were 2.5 times more likely to experience a stroke or myocardial infarction within 30 days postoperatively compared to those with lower BNP levels.[20–23] However, there was significant variability in BNP threshold levels used across studies, contributing to some heterogeneity in the results.[4,18,24]

(1) Association with cardiovascular events

The majority of included studies demonstrated a significant association between elevated preoperative BNP levels and adverse cardiac outcomes following vascular surgery. Several large cohorts reported BNP as an independent predictor of perioperative cardiac events:

- Yang *et al*[39] identified BNP >302 ng/L as independently associated with perioperative cardiac events (OR 4.5, p<0.001).
- Choi *et al*[4] reported similar findings with a cut-off of 301 ng/L (OR 3.89, p<0.001).
- Feringa *et al*[45] found a strong association using a higher threshold of 533 ng/L (OR 17.2, p=0.002).

Table 1 Summary of study characteristics.

Author	Year	Study design	n	Country	Cohort	BNP threshold	Outcome
Yang *et al.*[39]	2012	Retrospective	365	South Korea	AAA OSR (120), bypass (158), carotid (87)	302 ng/L (ROC)	BNP >302 independently associated with perioperative cardiac events, OR 4.5 (2.3 to 8.7), p<0.001
Schouten *et al.*[5]	2009	Prospective	400	Netherlands	AAA (159), LL revasc (130), carotid (111)	350 ng/L (ROC)	BNP >350 independently associated with long-term survival (median 29-month follow-up), OR 1.9 (1.1 to 3.2), p=0.02
Huang *et al.*[38]	2022	Retrospective	1176	Canada	LL bypass (1176)	300 ng/L	BNP >300 associated with increased odds of 30-day mortality, MI, myocardial injury (p<0.001)
Vetrugno *et al.*[12]	2012	Prospective	45	Italy	AAA (45)	75 ng/L (ROC)	BNP <75 had NPV of 84% at predicting perioperative cardiac event
Berry *et al.*[2]	2005	Prospective	41	UK	AAA OSR (11), bypass (17), amputation (13)	–	Higher median BNP in patients who experienced perioperative MI (240 vs 39)
Cuthbertson *et al.*[20]	2007	Prospective	70	UK	Bypass (70)	40 ng/L	BNP >40 had sensitivity 75% and specificity 70% for detecting perioperative death or myocardial injury
Yeh *et al.*[28]	2005	Retrospective	5	Taiwan	AAA (5)	–	Median BNP higher in patients with cardiac events (1217 vs 95, p<0.001)
Gibson *et al.*[29]	2007	Prospective	41	UK	AAA (11), bypass (17), amputation (13)	–	Median BNP higher in patients with cardiac events (210 vs 34.5, p<0.001)
Choi *et al.*[4]	2010	Retrospective	531	South Korea	AAA (160), bypass (256), carotid (97), other (18)	301 ng/L	BNP >301 independently associated with perioperative cardiac events, OR 3.89 (3.15 to 4.74), p<0.001
Feringa *et al.*[45]	2006	Prospective	170	Netherlands	AAA (67), LL bypass (103)	533 ng/L (ROC)	BNP >533 independently associated with perioperative cardiac events, OR 17.2 (2.8 to 106.4), p=0.002
Mahla *et al.*[30]	2007	Prospective	218	Germany	AAA (52), LL bypass (129), carotid (37)	–	Median BNP higher in patients with cardiac events (551 vs 179, p<0.001)

AAA, abdominal aortic aneurysm; BNP, B-type natriuretic peptide; Gilman Index: Prognostic index (specific to one study); LL, lower limb; MI, myocardial infarction; n, number of patients; NPV, negative predictive value; OSR, open surgical repair.

Two smaller prospective studies consistently showed significantly higher median BNP values among patients experiencing perioperative myocardial infarction or cardiac events compared with event-free patients. In addition, Cuthbertson *et al* reported that BNP >40 ng/L had a sensitivity of 75% and specificity of 70% for predicting perioperative death or myocardial injury,[20] while Vetrugno *et al* demonstrated a high negative predictive value for BNP <75 ng/L.[12] Overall, 10 of the 11 studies supported a strong relationship between elevated preoperative BNP and perioperative cardiac morbidity.

(2) Association with mortality and long-term outcomes
Evidence for mortality prediction was more limited but remained consistent. Huang *et al*, in the largest cohort (n=1176), reported that BNP >300 ng/L was associated with increased odds of 30-day mortality, myocardial infarction and myocardial injury (p<0.001).[38] Schouten *et al* showed that elevated BNP (>350 ng/L) was independently associated with reduced long-term survival over a median follow-up of 29 months (OR 1.9, p=0.02).[5] Other studies primarily focused on cardiac events and did not report mortality separately. No study failed to demonstrate at least a trend toward worse survival in patients with elevated BNP. Thus, available evidence indicates that preoperative BNP is associated with both short-term mortality and reduced long-term survival, although mortality-specific data remain limited.

(3) Heterogeneity of BNP thresholds
A substantial clinical heterogeneity in BNP cut-off values was observed across studies, ranging from 40 ng/L to >500 ng/L. Thresholds were derived using different statistical approaches and varied according to population characteristics and outcome definitions. This variability represents a major source of clinical and methodological heterogeneity and limits the identification of a universal prognostic threshold.

Table 2 Summary of the results of the studies.

Author	BNP assessment	Outcome	Follow-up
Yang *et al.*[39]	Preoperative measurement	Cardiac outcomes; POCE prediction	30 days
Schouten *et al.*[5]	Preoperative and postoperative measurement	Perioperative cardiac events; long-term all-cardiac mortality	6 months
Huang *et al.*[38]	Preoperative measurement	Composite of death, MI and troponine rise; clinical outcomes	30 days
Vetrugno *et al.*[12]	Preoperative measurement	Cardiac complications; postoperative BNP	3 days
Berry *et al.*[2]	Preoperative and postoperative measurement	MI and cumulative mortality	48 hours
Cuthbertson *et al.*[20]	Preoperative measurement	Death and myocardial injury	72 hours
Yeh *et al.*[28]	Preoperative measurement	Postoperative complications	-
Gibson *et al.*[29]	Preoperative and postoperative measurement	Non-fatal MI; cardiac death	6 months
Choi *et al.*[4]	Preoperative measurement	PMCE	14 days
Feringa *et al.*[45]	Preoperative measurement	Cardiac events	30 days
Mahla *et al.*[30]	Preoperative and postoperative measurement	Cardiac and non-cardiac postoperative events; overall mortality	826 days

BNP, B-type natriuretic peptide; MI, myocardial infarction; PMCE, perioperative major cardiovascular events; POCE, postoperative cardiac events.

Effect on length of hospital stay

Evidence regarding length of hospital stay was limited and inconsistently reported across included studies; therefore, no firm conclusions could be drawn on the association between preoperative BNP levels and hospital length of stay.[2,25–27]

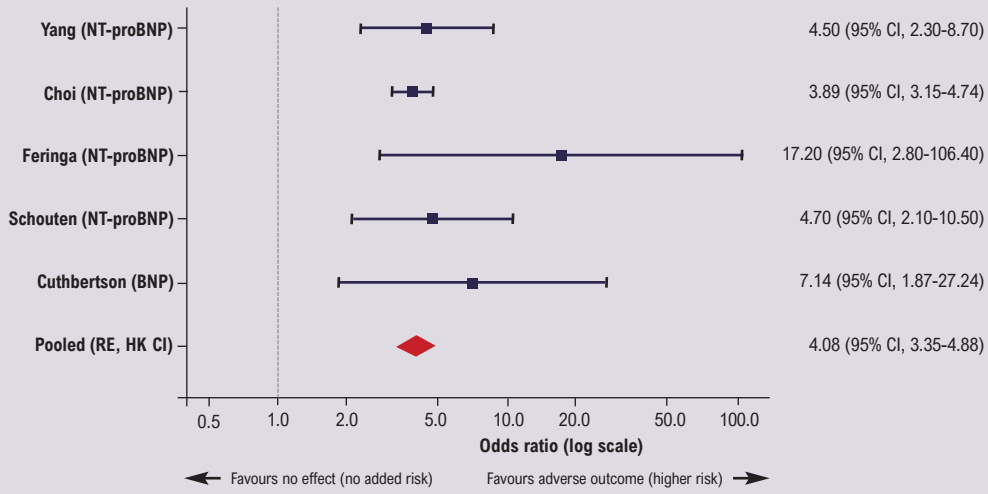
Meta-analysis of perioperative cardiac events

Of the 11 studies included in the systematic review, five were pooled in the quantitative meta-analysis. The remaining six studies were excluded from the quantitative synthesis due to the lack of directly extractable comparable statistical data. Specifically, these studies did not report multivariable-adjusted ORs or HRs with corresponding 95% CI for perioperative cardiac events. Instead, they presented outcomes as unadjusted univariable comparisons, raw median natriuretic peptide values between event and non-event groups[2, 28–30] or diagnostic accuracy metrics without regression-derived effect estimates.[12,20] Pooling these disparate statistical formats would introduce severe methodological bias; therefore, they were appropriately restricted to the qualitative narrative synthesis.

Five studies reporting multivariable ORs for perioperative or postoperative cardiac events were included in the quantitative synthesis. Using a random-effects model, elevated preoperative BNP levels were associated with a significantly increased risk of cardiac complications (pooled OR 4.08; 95% CI 3.39 to 4.92).

Hartung–Knapp adjustment confirmed the robustness of the association (OR 4.08; 95% CI 3.20 to 5.20; p<0.001). This effect size reflects a clinically meaningful amplification of perioperative cardiac risk across vascular surgery cohorts. No significant heterogeneity was observed among studies (I^2=0%, Q=3.36, p=0.50). The absence of statistical heterogeneity suggests a stable prognostic signal despite variability in thresholds and populations.

Figure 2 Forest plot demonstrating the predictive value of elevated preoperative BNP levels for postoperative cardiac events in vascular surgery patients.



The results of the meta-analysis are shown in the forest plot in Figure 2.

Leave-one-out sensitivity analyses did not materially alter the pooled effect estimate, indicating that the results were not driven by any single study.

Subgroup analyses

Formal subgroup analyses were limited across the included studies, and none of the 11 studies performed fully prespecified and consistently stratified subgroup analyses. Consequently, robust assessment of effect modification by patient or procedural characteristics was not possible. Four studies adjusted for major clinical covariates including age, renal dysfunction, diabetes mellitus and heart failure and consistently found that elevated BNP levels remained independently associated with perioperative cardiac events after multivariable adjustment. This suggests incremental prognostic value beyond traditional risk factors.

However, evidence regarding differential prognostic performance across specific patient subgroups and procedural categories was largely indirect and inconsistently reported. Although some cohorts including older patients or individuals undergoing major aortic or complex revascularisation procedures reported higher effect estimates, these findings were not derived from formal stratified analyses and should be interpreted cautiously.

Overall, heterogeneity in reporting, limited stratification and inconsistent subgroup definitions preclude definitive conclusions regarding subgroup-specific risk profiles. Further prospective studies incorporating standardised and prespecified subgroup analyses are required to clarify whether the prognostic utility of natriuretic peptide varies across vascular surgical populations.

Risk of bias results

The overall risk of bias in the included studies varied. While seven studies used appropriate statistical methods, four studies were limited by small sample sizes, lack of blinding and incomplete reporting of outcomes. The methodological quality of studies assessing mortality outcomes was generally high, but studies examining complications and length of hospital stay had a moderate to high risk of bias due to unadjusted confounding factors and incomplete outcome reporting.

Discussion

This systematic review and meta-analysis shows that elevated preoperative BNP levels are strongly and consistently associated with an increased risk of perioperative cardiac complications in patients undergoing vascular surgery. The quantitative synthesis of five studies reporting multivariable effect estimates showed that patients with elevated natriuretic peptide levels had approximately a fourfold higher risk of perioperative cardiac events, confirming the substantial prognostic value of these biomarkers. Importantly, this association remained robust after Hartung–Knapp adjustment and was characterised by minimal statistical heterogeneity, indicating a high degree of consistency across studies despite differences in patient populations and surgical procedures. These findings support the biological plausibility of natriuretic peptides as markers of subclinical myocardial dysfunction and perioperative cardiovascular vulnerability.[19]

The findings of this review align with previous studies investigating the role of natriuretic peptide in predicting cardiovascular events in both cardiac and non-cardiac surgical populations. Numerous studies have demonstrated the prognostic value of preoperative BNP levels in forecasting postoperative complications and major adverse cardiovascular events, including among patients undergoing vascular procedures.[31,32] Despite these consistent associations, the current literature remains heterogeneous and fragmented. Variability in study design, patient selection, perioperative risk profiles and outcome definitions limits the comparability and generalisability of findings across studies.[19,33,34] Importantly, no prior comprehensive systematic review or meta-analysis has focused specifically on vascular surgery, a field characterised by distinct haemodynamic stresses and a high burden of comorbidities that may influence both BNP levels and postoperative risk. This gap underscores the need for focused research efforts to refine the role of BNP in this setting and to develop standardised, evidence-based guidelines for its use as a perioperative risk stratification tool in vascular surgery.[34,35]

Further complicating clinical translation are the notable methodological differences across studies, particularly in BNP thresholds and timing of measurement.[35,36] Reported BNP cut-off values vary widely, ranging from 50 to 300 ng/L, and the timing of preoperative BNP measurement is inconsistent.[35,36] The heterogenous use of cut-offs of BNP is an important limitation of the current evidence base and therefore limits the conclusions drawn in this review. Indeed, the cut-off values implemented in the studies included are not in keeping with the ESC 2022 guidelines.[9] In particular, most reported cut-off values were empirically derived and were not aligned with contemporary guideline recommendations, representing a major barrier to routine implementation. Despite low statistical heterogeneity in this pooled analysis (I^2=0%), important clinical and methodological heterogeneity remained. The magnitude of association observed in this meta-analysis appears greater than that reported for several individual predictors incorporated within traditional perioperative risk scores.

There is a clear gap in the evidence base which warrants further investigation in contemporary cohorts with validated cut-offs of BNP to more effectively assess the potential association between elevated BNP and perioperative outcome. Investigation of specific patient populations, such as those undergoing major vascular intervention rather than pooled cohorts, would be preferable. Such studies should also aim to determine how these biomarkers can be incorporated into perioperative management pathways specifically tailored to vascular surgery patients.[37,38] Natriuretic peptide likely improves risk discrimination rather than replacing existing clinical scores. Standardisation in measurement timing, outcome reporting

and adjustment for key confounders will be essential to facilitate the integration of natriuretic peptide testing into routine clinical practice and to support its use in clinical decision-making, risk stratification and postoperative surveillance in this high-risk population. Although thresholds varied widely, values in the range of 300–350 ng/L consistently identified higher-risk individuals in larger cohorts. BNP should therefore not be considered a standalone determinant of perioperative risk. Its greatest clinical value appears to lie in integration within established multimodal risk assessment frameworks, where it may refine clinical judgement, support individualised perioperative management and facilitate more targeted monitoring strategies. However, these aggregate values may be more applicable to elective abdominal aortic aneurysm populations – such as those identified through screening programmes – than to patients with chronic limb-threatening ischaemia, who frequently present with an elevated baseline due to a higher systemic comorbidity burden. Consequently, disease-specific and procedure-specific threshold values are urgently needed, and further targeted prospective work is required to establish tailored cut-offs across distinct vascular subgroups. Furthermore, it is noteworthy that our comprehensive search identified no published studies evaluating natriuretic peptide in vascular surgery between 2018 and 2025, highlighting a clear contemporary evidence gap that future investigations must address.

Additionally, the inclusion of intermediate-risk carotid surgery alongside high-stress aortic and lower limb reconstructions in some cohorts (eg, Yang *et al*,[39] Choi *et al*[4] and Mahla *et al*[30]) represents a potential clinical confounding factor. This variation in the magnitude of surgical insult can dilute the observed prognostic signal of preoperative natriuretic peptides on postoperative outcomes.

Strengths and limitations

Methodological and clinical strengths

This systematic review and meta-analysis is strengthened by the inclusion of multiple moderate- to large-sized observational cohorts and the consistent reliance on multivariable-adjusted effect estimates. Rather than pooling raw unadjusted data, our meta-analysis pooled adjusted ORs, which accounts for key clinical confounders and isolates the independent prognostic contribution of preoperative natriuretic peptide. Furthermore, the use of robust statistical methods, specifically the random-effects framework combined with the Hartung–Knapp adjustment, enhances the reliability, clinical interpretability and conservative nature of our pooled findings.

Limitations

Despite these strengths, several critical limitations must be addressed:

- Conflation and pooling of BNP and NT-proBNP: a key methodological limitation is the clinical pooling of BNP and NT-proBNP. The use of entirely different analytical platforms explains the massive range of study-specific threshold values. While pooling these assays was a pragmatic decision designed to maximise statistical power and compile a sufficient sample size, it prevents the determination of a universal clinical cut-off. Clinicians must interpret absolute values with extreme caution.
- The paradox of zero statistical heterogeneity: our quantitative synthesis yielded a pooled I^2 value of 0%. While this mathematically suggests a highly consistent prognostic direction, an I^2 of 0% across populations with highly variable biomarker thresholds and surgical procedures is highly unusual. This finding must be interpreted as a likely artifact of our small sample size, which severely limits the statistical power of standard tests to detect true underlying clinical and methodological heterogeneity.
- Search strategy and language bias: our search was limited to peer-reviewed studies published in the English language, which introduces a potential language and geographic bias. Second, we did not systematically search grey literature databases or clinical trial registries, nor did we perform manual hand-searching of the reference lists of included studies and previous reviews. Consequently, while the pooled effect estimate remains statistically robust, it must be interpreted within the boundaries of these literature search limitations.
- Heterogeneity in surgical stress magnitude: the clinical impact of elevated preoperative natriuretic peptides is highly dependent on the magnitude of the surgical insult. Notably, several key included cohorts such as those of Yang *et al*,[39] Choi *et al*[4] and Mahla *et al*[30] included patients undergoing carotid endarterectomy alongside major aortic and lower limb revascularisations. Carotid surgery involves significantly less systemic haemodynamic stress, minimal fluid shifts and a lower systemic inflammatory response compared with open abdominal aortic aneurysm repair or distal bypasses. Mixing procedures of such vastly different physiological stress levels may have diluted or skewed the postoperative outcome measures, representing a key source of clinical confounding.
- Observational design and confounding: all the included studies were observational, leaving the results inherently susceptible to selection, residual and confounding biases. Crucial unmeasured perioperative variables – such as acute haemodynamic instability, dynamic medication adjustments (eg, beta-blockers, ACE inhibitors), patient frailty and customised anaesthetic optimisation strategies – could not be standardised and may have independently influenced both biomarker levels and clinical outcomes.

Clinical implications and future directions

Preoperative BNP testing may represent a valuable adjunct for perioperative risk stratification in patients undergoing vascular surgery. Identification of patients with elevated natriuretic peptide levels may support targeted preoperative optimisation, intensified perioperative monitoring, early cardiology consultation and

KEY MESSAGES

- Elevated preoperative natriuretic peptide levels (typically defined across literature as BNP >300 ng/L or NT-proBNP >300–350 ng/L, though highly assay- and disease-specific) are a strong predictor of perioperative cardiac events in vascular surgery patients. Natriuretic peptide testing offers incremental prognostic value over conventional risk assessment scores.
- Preoperative natriuretic peptide testing may serve as a supportive tool to refine individualised risk assessment within established multidisciplinary clinical frameworks.

individualised postoperative surveillance.

In selected high-risk patients, biomarker-informed risk stratification may also contribute to procedural planning and timing of surgery. However, natriuretic peptide testing should be integrated within comprehensive multimodal clinical frameworks rather than used in isolation, to maximize predictive accuracy and clinical utility.[40,41]

Future research should prioritise large prospective multicentre studies using standardised assay platforms, validated cut-off values aligned with contemporary guidelines and harmonised outcome definitions. Particular emphasis should be placed on well-characterised procedure-specific cohorts, including major aortic and complex revascularisation populations.[42,43]

Randomised controlled trials evaluating BNP-guided perioperative management strategies are urgently needed to determine whether biomarker-informed pathways improve clinical outcomes compared with standard care. Long-term follow-up studies should assess associations with late cardiovascular events, mortality and functional decline. In parallel, formal health economic evaluations are required to clarify the cost-effectiveness of routine natriuretic peptide testing.[44] Future work may integrate natriuretic peptide measurements within machine learning-based perioperative risk models to enhance individualised risk prediction.

Finally, mechanistic studies may help elucidate the pathophysiological pathways linking elevated BNP to perioperative vulnerability, facilitating refinement of biomarker thresholds and development of targeted preventive interventions.

Conclusion

This systematic review and meta-analysis demonstrates that elevated preoperative BNP levels are strong and consistent predictors of perioperative cardiac complications following vascular surgery. Quantitative synthesis indicates that patients with elevated natriuretic peptide concentrations have approximately a fourfold increased risk of adverse cardiac events.

BNP provides meaningful incremental prognostic information beyond traditional clinical risk factors and may support individualised perioperative management in selected high-risk patients. However, substantial methodological heterogeneity and the absence of interventional evidence currently limit routine clinical implementation.

Further high-quality prospective studies and randomised trials are required before widespread adoption can be recommended. Careful evidence-based integration of natriuretic peptide testing into multimodal risk stratification frameworks has the potential to improve outcomes and optimise resource utilisation in vascular surgical practice.[45]

Conflict of Interest: The authors declare that there is no conflict of interest.

Funding: None.

Reviewer acknowledgement: *JVSGBI* thanks Dr Jia Liu Stevens, Consultant Anaesthetist, University Hospital Sussex NHS Trust and Dr Sasi Pathmanathan, Vascular Perioperative Physician, Hull Royal Infirmary, Hull, for their contribution to the peer review of this work.

References

1. Biccard BM, Lurati Buse GA, Burkhart C, *et al*. The influence of clinical risk factors on pre-operative B-type natriuretic peptide risk stratification of vascular surgical patients. *Anaesthesia* 2012;**67**(1):55–9. https://doi.org/10.1111/j.1365-2044.2011.06958.x
2. Berry C. Predictive value of plasma brain natriuretic peptide for cardiac outcome after vascular surgery. *Heart* 2005;**92**(3):401–2. https://doi.org/10.1136/hrt.2005.060988
3. Clerico A, Carlo Zucchelli G, Pilo A, Passino C, Emdin M. Clinical relevance of biological variation: the lesson of brain natriuretic peptide (BNP) and NT-proBNP assay. *Clin Chem Lab Med (CCLM)* 2006;**44**(4). https://doi.org/10.1515/cclm.2006.063
4. Choi JH, Cho DK, Song YB, *et al.* Preoperative NT-proBNP and CRP predict perioperative major cardiovascular events in non-cardiac surgery. *Heart* 2010; **96**(1):56–62. https://doi.org/10.1136/hrt.2009.181388
5. Schouten O, Hoeks SE, Goei D, Bax JJ, Verhagen HJM, Poldermans D. Plasma N-terminal pro-B-type natriuretic peptide as a predictor of perioperative and long-term outcome after vascular surgery. *J Vasc Surg* 2009; **49**(2):435–42. https://doi.org/10.1016/j.jvs.2008.08.063
6. Yun KH, Jeong MH, Oh SK, *et al.* Preoperative plasma N-terminal pro-brain natriuretic peptide concentration and perioperative cardiovascular risk in elderly patients. *Circ J* 2008;**72**(2):195–9. https://doi.org/10.1253/circj.72.195
7. Fox AA, Body SC. Assessment of preoperative B-type natriuretic peptide in adult surgeries: is it useful? *Anesth Analg* 2011;**112**(5):1005–07. https://doi.org/10.1213/ANE.0b013e318210c739
8. Khurshaidi MN, Waqar A, Asghar MS, *et al*. Prognostic value of preoperative pro-B-type natriuretic peptide: early predictor of cardiovascular complications and mortality after major abdominal surgery. *Cureus* 2020;**12**(11):e11338. https://doi.org/10.7759/cureus.11338
9. Halvorsen S, Mehilli J, Cassese S, *et al.* 2022 ESC Guidelines on cardiovascular assessment and management of patients undergoing non-cardiac surgery. *Eur Heart J* 2022;**43**(39):3826–924. https://doi.org/10.1093/eurheartj/ehac270
10. National Institute for Health and Care Excellence. Abdominal aortic aneurysm: diagnosis and management. NICE guideline NG156. Available at: https://www.nice.org.uk/guidance/NG156 [Accessed 20 March 2020]
11. Leibowitz D, Planer D, Rott D, Elitzur Y, Chajek-Shaul T, Weiss AT. Brain natriuretic peptide levels predict perioperative events in cardiac patients undergoing noncardiac surgery: a prospective study. *Cardiology* 2008;**110**(4):266–70. https://doi.org/10.1159/000112411
12. Vetrugno L, Costa MG, Pompei L, *et al*. Prognostic power of pre- and post-operative B-type natriuretic peptide levels in patients undergoing abdominal aortic surgery. *J Cardiothorac Vasc Anesth* 2012;**26**(4):637–42. https://doi.org/10.1053/j.jvca.2012.01.018
13. Page MJ, McKenzie JE, Bossuyt PM, *et al*. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;**372**:n71.

https://doi.org/10.1136/bmj.n71
14. Higgins JPT, Altman DG, Gotzsche PC, *et al.* The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ* 2011;**343**:d5928. https://doi.org/10.1136/bmj.d5928
15. Deeks J, Dinnes J, D'Amico R, *et al*. Evaluating non-randomised intervention studies. *Health Technol Assess* 2003;**7**(27)1–173. https://doi.org/10.3310/hta7270
16. Guyatt GH, Oxman AD, Sultan S, *et al*. GRADE guidelines: 9. Rating up the quality of evidence. *J Clin Epidemiol* 2011;**64**(12):1311–16. https://doi.org/10.1016/j.jclinepi.2011.06.004
17. Kristensen SD, Maeng M. Perioperative myocardial infarction: in the twilight zone between surgery and cardiology. *Eur Heart J* 2017;**38**(31):2418–20. https://doi.org/10.1093/eurheartj/ehx392
18. Karthikeyan G, Moncur RA, Levine O, *et al*. Is a pre-operative brain natriuretic peptide or N-terminal pro–B-type natriuretic peptide measurement an independent predictor of adverse cardiovascular outcomes within 30 days of noncardiac surgery? *J Am Coll Cardiol* 2009;**54**(17):1599–606. https://doi.org/10.1016/j.jacc.2009.06.028
19. Rodseth RN, Biccard BM, Le Manach Y, *et al*. The prognostic value of pre-operative and post-operative B-type natriuretic peptides in patients undergoing noncardiac surgery. *J Am Coll Cardiol* 2014;**63**(2):170–80. https://doi.org/10.1016/j.jacc.2013.08.1630
20. Cuthbertson BH, Amiri AR, Croal BL, *et al*. Utility of B-type natriuretic peptide in predicting perioperative cardiac events in patients undergoing major non-cardiac surgery. *Br J Anaesth* 2007;**99**(2):170–6. https://doi.org/10.1093/bja/aem158
21. Cuthbertson BH, Croal BL, Rae D, *et al*. N-terminal pro-B-type natriuretic peptide levels and early outcome after cardiac surgery: a prospective cohort study. *Br J Anaesth* 2009;**103**(5):647–53. https://doi.org/10.1093/bja/aep234
22. Nakamura M, Tanaka F, Sato K, Segawa T, Nagano M. B-type natriuretic peptide testing for structural heart disease screening: a general population-based study. *J Cardiac Failure* 2005;**11**(9):705–12. https://doi.org/10.1016/j.cardfail.2005.06.436
23. Endicott KM, Amdur RL, Greenberg MD, Trachiotis GD. B-type natriuretic peptide predicts morbidity and long-term mortality in coronary artery bypass grafting and valve aurgery. *Innovations (Phila)* 2016;**11**(6):439–43. https://doi.org/10.1097/imi.0000000000000312
24. Tissières P, Da Cruz E, Habre W, *et al.* Value of brain natriuretic peptide in the perioperative follow-up of children with valvular disease. *Intensive Care Med* 2008;**34**(6):1109–13. https://doi.org/10.1007/s00134-008-1025-8
25. Bryce GJ, Payne CJ, Gibson SC, *et al.* B-type natriuretic peptide predicts postoperative cardiac events and mortality after elective open abdominal aortic aneurysm repair. *J Vasc Surg* 2013;**57**(2):345–53. https://doi.org/10.1016/j.jvs.2012.07.053
26. Park JH, Shin GJ, Ryu JI, Pyun WB. Postoperative B-type natriuretic peptide levels associated with prolonged hospitalization in hypertensive patients after non-cardiac surgery. *Korean Circ J* 2012;**42**(8):521. https://doi.org/10.4070/kcj.2012.42.8.521
27. Zhang Z, Zheng Z, Nie H, Dong H, Lei C. Association between the preoperative N-terminal pro-B-type natriuretic peptide and acute kidney injury in gastrointestinal surgery patients managed with enhanced recovery strategy: a retrospective cohort study. *Perioper Med (Lond)* 2025;**14**(1):45. https://doi.org/10.1186/s13741-025-00528-6
28. Yeh HM, Lau HP, Lin JM, Sun WZ, Wang MJ, Lai LP. Preoperative plasma N-terminal pro-brain natriuretic peptide as a marker of cardiac risk in patients undergoing elective non-cardiac surgery. *Br J Surg* 2005;**92**(8):1041–5. https://doi.org/10.1002/bjs.4947
29. Gibson SC, Payne CJ, Byrne DS, Berry C, Dargie HJ, Kingsmore DB. B-type natriuretic peptide predicts cardiac morbidity and mortality after major surgery. *Br J Surg* 2007;**94**(7):903–09. https://doi.org/10.1002/bjs.5690
30. Mahla E, Baumann A, Rehak P, *et al*. N-terminal pro-brain natriuretic peptide identifies patients at high risk for adverse cardiac outcome after vascular surgery. *Anesthesiology* 2007;**106**(6):1088–95. https://doi.org/10.1097/01.anes.0000267591.34626.b0
31. Ryding ADS, Kumar S, Worthington AM, Burgess D. Prognostic value of brain natriuretic peptide in noncardiac surgery: a meta-analysis. *Anesthesiology* 2009;**111**(2):311–19. https://doi.org/10.1097/ALN.0b013e3181aaeb11
32. Comanici M, Nadarajah D, Katumalla E, Cyclewala S, Raja SG. Use of preoperative natriuretic peptide in predicting mortality after coronary artery bypass grafting: a systematic review and meta-analysis. *J Cardiothorac Vasc Anesth* 2023;**37**(9):1785–92. https://doi.org/10.1053/j.jvca.2023.04.020
33. Thet MS, Hlwar KE, Thet KS, Han KPP, Oo AY. Preoperative B-type natriuretic peptides to predict postoperative atrial fibrillation in cardiac surgery: a systematic review and meta-analysis. *Heart Lung Circ* 2024;**33**(1):23–32. https://doi.org/10.1016/j.hlc.2023.10.015
34. Rumman R, Venus K. Preoperative B-type natriuretic peptide testing in patients undergoing noncardiac surgery. *CMAJ* 2022;**194**(39):E1350. https://doi.org/10.1503/cmaj.220782
35. Jehn S, Mahabadi AA, Pfohl C, *et al.* BNP and NT-proBNP thresholds for the assessment of prognosis in patients without heart failure. *JACC: Advances* 2023;**2**(10):100688. https://doi.org/10.1016/j.jacadv.2023.100688
36. Abdelrehim AR, Alnasser FA, Alnozaha FA, *et al.* Perioperative levels of troponin and BNP and the outcome after coronary artery bypass grafting. *Heart Surg Forum* 2023;**26**(3):E240–E248. https://doi.org/10.1532/hsf.5471
37. Wayne Causey M, Singh N. Clinical implications of B-type natriuretic peptide and N-terminal pro—B-type natriuretic peptide in the care of the vascular surgery patient. *Semin Vasc Surg* 2014;**27**(3-4):143–7. https://doi.org/10.1053/j.semvascsurg.2015.01.004
38. Huang B, Yang GK, Strandberg S, Misskey J, Hsiang Y. Exploring the utility of brain natriuretic peptide measurement in vascular surgery. *Ann Vasc Surg* 2022;**78**:233–8. https://doi.org/10.1016/j.avsg.2021.05.066
39. Yang JH, Choi JH, Ki YW, *et al*. Plasma N-terminal pro-B-type natriuretic peptide Is predictive of perioperative cardiac events in patients undergoing vascular surgery. *Korean J Intern Med* 2012;**27**(3):301–10. https://doi.org/10.3904/kjim.2012.27.3.301
40. Marinescu M, Oprea VD, Nechita A, Tutunaru D, Nechita LC, Romila A. The use of brain natriuretic peptide in the evaluation of heart failure in geriatric patients. *Diagnostics* 2023;**13**(9):1512. https://doi.org/10.3390/diagnostics13091512
41. Welsh P, Campbell RT, Mooney L, *et al.* Reference ranges for NT-proBNP (N-terminal pro-B-type natriuretic peptide) and risk factors for higher NT-proBNP concentrations in a large general population cohort. *Circ Heart Fail* 2022;**15**(10):e009427. https://doi.org/10.1161/CIRCHEARTFAILURE.121.009427
42. Schmidt G, Frieling N, Schneck E, *et al*. Comparison of preoperative NT-proBNP and simple cardiac risk scores for predicting postoperative morbidity after non-cardiac surgery with intermediate or high surgical risk. *Perioper Med* 2024;**13**(1):44. https://doi.org/10.1186/s13741-024-00400-z
43. Hiraoka E, Tanabe K, Izuta S, *et al.* JCS 2022 Guideline on Perioperative Cardiovascular Assessment and Management for Non-Cardiac Surgery. *Circ J* 2023;**87**(9):1253–337. https://doi.org/10.1253/circj.CJ-22-0609
44. Keyzer JM, Hoffmann JJ, Ringoir L, Nabbe KC, Widdershoven JW, Pop VJ. Age- and gender-specific brain natriuretic peptide (BNP) reference ranges in primary care. *Clin Chem Lab Med* 2014;**52**(9):1341–6. https://doi.org/10.1515/cclm-2013-0791
45. Feringa HHH, Bax JJ, Elhendy A, *et al*. Association of plasma N-terminal pro-B-type natriuretic peptide with postoperative cardiac events in patients undergoing surgery for abdominal aortic aneurysm or leg bypass. *Am J Cardiol* 2006;**98**(1):111–15. https://doi.org/10.1016/j.amjcard.2006.01.058

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):188-191
http://doi.org/10.54522/jvsgbi.2026.236

www.jvsgbi.com

CASE REPORT

Aberrant retro-psoas course of the left common iliac artery on CT: a case report

Tufts M,[1] Pietroski A,[2] Al-Katib S[2]

1. Medical Student, Oakland University William Beaumont School of Medicine Rochester, Michigan, USA
2. Diagnostic Radiology, Corewell Health William Beaumont University Hospital, Royal Oak, Michigan, USA

Corresponding author:
Matthew Tufts
Medical Student, Oakland University William Beaumont School of Medicine
586 Pioneer Dr, Rochester, Michigan 48309, USA
Email: mtufts@oakland.edu

Received: 13th April 2026
Accepted: 29th May 2026
Online: 24th June 2026

Abstract

Retro-psoas course of the common iliac artery is an extremely rare anatomical variant with important procedural implications. In this case report we describe a 60-year-old man who presented with acute abdominal pain and was found to have a left common iliac artery traveling posterior to the psoas major muscle. Imaging also revealed a high aortic bifurcation at L3 and associated ipsilateral anomalies including a tortuous external iliac artery, absent or poorly visualised internal iliac artery, and the ureter travelling with the iliac vein rather than the anomalous artery. Recognition of rare vascular anomalies like this retro-psoas course is critical for radiologists and surgeons to ensure safe surgical and endovascular planning. Additional vascular mapping is recommended prior to any pelvic procedures in such cases.

Introduction

The common iliac arteries follow a predictable and well-described anatomic course. The abdominal aorta bifurcates into left and right common iliac arteries at approximately the L4–L5 vertebral level. Each common iliac artery travels inferiorly along the anteromedial surface of the psoas major muscle before dividing into the external and internal iliac arteries at the level of the sacroiliac joint.[1] This anatomic relationship with the psoas muscle, ureter and adjacent neurovascular structures is typically consistent.

Deviations from this course are exceptionally rare but may have important clinical and procedural implications. Unrecognised anomalies may increase the risk of complications during abdominal or pelvic surgery, as well as during endovascular interventions.[2,3] It is important to recognise these variants on imaging to avoid unexpected problems during procedures.

A retro-psoas course of the common iliac artery is among the rarest of vascular anomalies. In this variant the artery passes posterior to the psoas major muscle rather than along its anteromedial surface. A systematic review identified only nine previously reported cases.[4–12] We present this case to add to the limited literature on this variant and to highlight the imaging features that allow prospective identification, which has direct implications for surgical and endovascular planning.

Key words: retro-psoas, common iliac artery, vascular anomaly

Case report

A 60-year-old male with past medical history of chronic pancreatitis presented to the emergency department with a six-hour history of epigastric abdominal pain radiating to the back, associated with chest pain, nausea, and multiple episodes of non-bloody, non-bilious emesis. He endorsed regular alcohol use. The patient underwent a CT of the abdomen and pelvis which demonstrated sequela of chronic pancreatitis with mild peripancreatic fat stranding, suggestive of superimposed acute interstitial pancreatitis. A 2 cm pancreatic pseudocyst was identified.

In this patient the aortic bifurcation occurred at the level of L3, superior to the expected L4–L5 level (Figure 1). The left common iliac artery followed an anomalous retro-psoas course, passing against the anterior lumbar spine and sacrum over approximately 8 cm, markedly more posterior than the right iliac system (Figures 2–4), which bifurcated normally at its expected level.

The left common iliac bifurcation was not clearly identified. Small posteriorly projecting

Figure 1 Coronal contrast-enhanced CT demonstrating high aortic bifurcation at the level of L3.

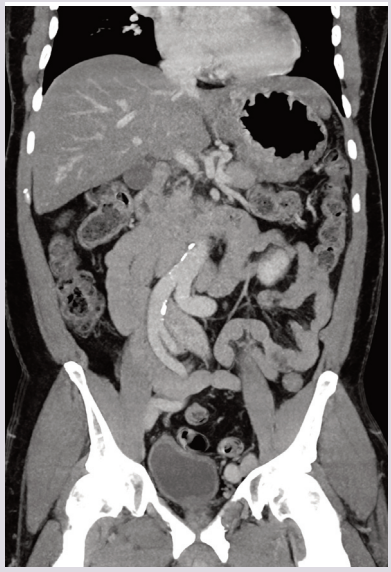


Figure 2 Axial contrast-enhanced CT demonstrating an anomalous retro-psoas course of the left common iliac artery.

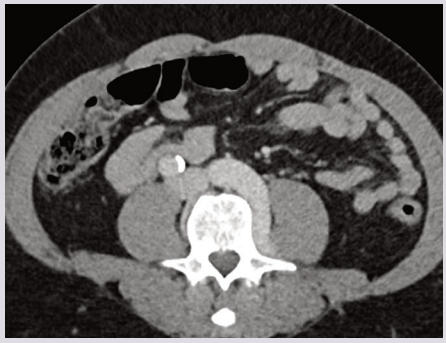


Figure 3 Axial contrast-enhanced CT demonstrating an anomalous retro-psoas course of the left common iliac artery. The left ureter (yellow arrow) does not follow the anomalous arterial course, instead maintaining its expected anatomical trajectory anterior to the psoas muscle.

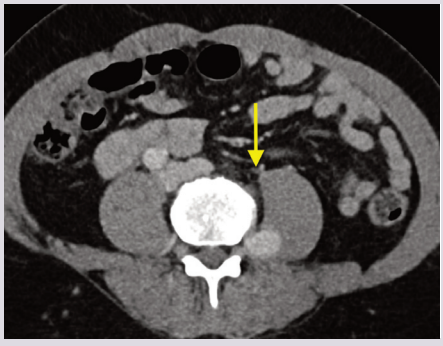
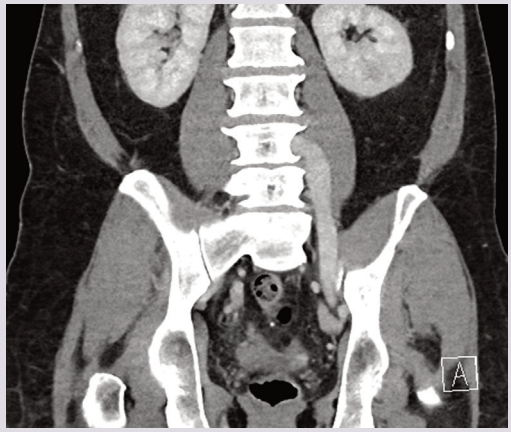


Figure 4 Coronal contrast-enhanced CT demonstrating an anomalous retro-psoas course of the left common iliac artery.

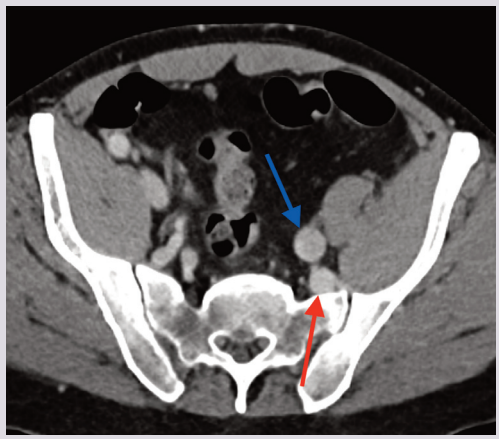


branches were present, presumed to represent anomalous internal iliac branches (Figure 5). The left external iliac artery was tortuous, coursing posterior to the left common iliac vein before resuming a more anterior normal configuration distally (Figure 5).

The left common iliac artery demonstrated short segment fusiform dilation measuring up to 1.6 cm in maximum diameter. For comparison, the right common iliac artery measured 1.2 cm, within normal limits. The external iliac arteries were within normal limits of maximum diameter.

No asymmetric atherosclerosis, stenosis, occlusion, dissection or extrinsic compression was identified. The left ureter followed a normal course alongside the psoas muscle and iliac veins, passing under the vas deferens and inserting normally without hydronephrosis (Figure 3). The right iliac system was normal.

Figure 5 Axial contrast-enhanced CT demonstrating flipped positioning of the anomalous left common iliac artery (red arrow) and common iliac vein (blue arrow), with the artery coursing posterior to the vein rather than in its expected anteromedial relationship.



Discussion

Anomalies of the iliac vasculature are exceedingly rare. A retro-psoas course of the common iliac artery was first described in 1991, with only eight additional cases reported since. All documented instances describe a unilateral anomaly with normal contralateral iliac anatomy, and both left-sided and right-sided variants have been reported.[4–12]

In early embryonic development, paired dorsal aortas run alongside the neural tube before fusing in the midline to form the descending aorta. Their lowermost portions remain unfused, and it is from these caudal segments that the iliac arteries arise. The level at which fusion terminates determines the position of the aortic bifurcation.[13,14] An early bifurcation at L3 is therefore a developmental variant. Notably, four prior cases share an aortic bifurcation at the L3–L4 level, suggesting this may be a recurring associated finding rather than coincidence and raising the possibility of a shared embryologic mechanism.[4,6,7,11]

Between the fourth and sixth weeks of gestation, the common iliac, internal iliac and external iliac arteries are forming simultaneously from the same embryologic source. During this period the dorsal aortas are fusing, the umbilical circulation is being established and the primitive iliac branches are acquiring their definitive positions within the developing pelvis.[15] A single developmental disturbance during this window most likely explains the full spectrum of left-sided anomalies seen in this case.[16]

The precise mechanism by which the common iliac artery comes to lie posterior to the psoas muscle is not fully understood, but several explanations have been proposed. The common iliac artery and the psoas muscle form at the same time and in close proximity to one another. As they grow, the artery normally settles into a position in front of and to the side of the psoas.[17] One explanation is that the artery establishes its course too early, before the psoas has finished moving into its final position. The psoas descends and rotates forward as it matures, and if the artery is already fixed in place when this happens, the muscle could effectively sweep in front of the artery, leaving it stranded behind. Another possibility is that the artery itself simply grows in the wrong direction from the start, tracking posteriorly rather than anterolaterally, possibly due to abnormal signaling in the surrounding tissue.

This case also illustrates an important principle regarding ureteral landmarks in the setting of anomalous pelvic vasculature. The ureter classically crosses anterior to the common iliac artery at the pelvic brim, a relationship routinely relied upon in urological, gynaecological and colorectal surgery.[18] In this case, the left ureter follows the course of the iliac vein rather than the artery. Ureteral position cannot be inferred from arterial landmarks alone when iliac anatomy is anomalous, and dedicated assessment of the ureteral course on preoperative cross-sectional imaging is warranted in all such cases.[19]

In this case, the retro-psoas left common iliac artery is accompanied by several ipsilateral anomalies. No clearly defined left internal iliac artery is identified. The left external iliac artery is tortuous with an inverted positional relationship to the common iliac vein, and multiple small posteriorly projecting arterial branches are present whose course remains uncertain. Three possibilities are proposed for the pelvic visceral blood supply: direct branches from the common iliac trunk; a hypoplastic internal iliac artery with anomalous branching; or an accessory internal iliac configuration. This distinction has direct clinical consequences as prostatic and uterine artery embolisation, internal iliac occlusion during endovascular aortic repair and pelvic surgical ligation all require reliable internal iliac mapping before proceeding.[3] Conventional angiography or dedicated thin-slice CTA with multiplanar pelvic reformations would be beneficial prior to any pelvic intervention.[19]

KEY MESSAGES

- A retro-psoas common iliac artery is an extremely rare variant with fewer than 10 reported instances.
- Anatomical landmarks, such as the ureter crossing anterior to the iliac artery, may be unreliable in patients with this anomaly.
- Additional vascular mapping is recommended prior to any pelvic procedures in patients with this variant.

Conclusions

The retro-psoas course of the common iliac artery is among the rarest of vascular anomalies, with fewer than 10 cases documented in the literature. This case is notable not only for the retro-psoas common iliac course but for the accompanying constellation of ipsilateral anomalies, including an absent internal iliac artery, a tortuous and positionally inverted external iliac artery, and a ureteral course that follows the vein rather than the artery. Although the findings were incidental and the patient asymptomatic at the time of discovery, the anatomic complexity has meaningful implications for any future surgical or endovascular intervention. Preoperative vascular mapping with dedicated CTA or conventional angiography may be beneficial.

Conflict of Interest: None.

Funding: None.

Patient consent to publication: We confirm that informed consent has been obtained from the patient before data collection and writing of the article.

References

1. Standring S. *Gray's anatomy: the anatomical basis of clinical practice*. 42nd ed. Philadelphia: Elsevier; 2020.
2. Koide M, Fukui K, Sogabe K, *et al*. Endovascular treatment for iatrogenic rupture of an iliac artery with severe tortuosity. *Case Rep Radiol* 2020;**15**(8): 1348–53. https://doi.org/10.1016/j.radcr.2020.06.011
3. Gallitto E, Gargiulo M, Faggioli G, *et al*. Impact of iliac artery anatomy on the outcome of fenestrated and branched endovascular aortic repair. *J Vasc Surg* 2017;**66**(6):1659–67. https://doi.org/10.1016/j.jvs.2017.04.063
4. Kim BJ, Kim Y. Anomalous retro-psoas iliac artery: a case report. *J Korean Soc*

Radiol 2020;**81**(6):1511–16. https://doi.org/10.3348/jksr.2020.0002
5. Ozawa M, Kondo H, Sugawara T, *et al*. Anomalous retro-psoas iliac artery in a patient with right renal cancer: a case report. *Radiol Case Rep* 2020;**15**(9): 1477–9. https://doi.org/10.1016/j.radcr.2020.06.022
6. Oztunali C, Acu B. Fourth lumbar artery continuation of the common iliac artery with a retro-psoas course demonstrated by CT. *Surg Radiol Anat* 2023; **45**(12):1545–50. https://doi.org/10.1007/s00276-023-03252-2
7. Schulz B, Euler A. Two rare vascular findings in one patient: retro-psoas iliac artery and common pulmonary venous confluence. *RoFo* 2024;**196**(11): 1174–5. https://doi.org/10.1055/a-2311-0043
8. Sonneveld DJ, van Dop HR, van der Tol A. Anomalous retro-psoas iliac artery in a patient with an abdominal aortic aneurysm. *Eur J Vasc Endovasc Surg* 1998;**16**(1):85–6. https://doi.org/10.1016/s1078-5884(98)80099-3
9. Vohra R, Leiberman DP. An anomalous right iliac artery presenting as iliac stenosis. *Eur J Vasc Surg* 1991;**5**(2):209–11. https://doi.org/10.1016/s0950-821x(05)80690-5
10. Jain A, Patil VP, Horton P, *et al.* Common iliac artery lying posterior to psoas major identified during kidney transplantation. *Transplantation* 2008;**86**(4): 623–4. https://doi.org/10.1097/tp.0b013e3181826bf3
11. Cauchi D, Xuereb JA, Grech R. A rare finding of left sided anomalous retro-psoas iliac artery. *EC Clin Med Case Rep* 2024;**7**(12):1–4.
12. Yang CJ, Tzeng WS, Shu G, Cheng HM. Anomalous retro-psoas iliac artery: a case report. *J Radiol Sci* 2015;**40**:13–16. https://doi.org/10.6698/JRS.201503_4001.03
13. Rosen RD, Bordoni B. Embryology, aortic arch. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK553173/
14. di Gioia C, Ascione A, Carletti R, Giordano C. Thoracic aorta: anatomy and pathology. *Diagnostics (Basel)* 2023;**13**(13):2166. https://doi.org/10.3390/diagnostics13132166
15. Hammond E, Nassereddin A. Anatomy, abdomen and pelvis: external iliac arteries. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023. Available from: https://www.statpearls.com/point-of-care/21478
16. Link DP, Garza AS, Monsky WL. Congenital single, pelvic iliac artery: a case report. *J Vasc Interv Radiol* 2009;**20**(9):1231–4. https://doi.org/10.1016/j.jvir.2009.05.042
17. Siccardi MA, Tariq MA, Valle C. Anatomy, bony pelvis and lower limb: psoas major. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK535418/
18. Lescay HA, Jiang J, Leslie SW, Tuma F. Anatomy, abdomen and pelvis, ureter. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK532980/
19. Lee GK, Fox PM, Riboh J, *et al.* Computed tomography angiography in microsurgery: indications, clinical utility, and pitfalls. *Eplasty* 2013;**13**:e42. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC3742152/

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):192-194
http://doi.org/10.54522/jvsgbi.2026.239

www.jvsgbi.com

CASE REPORT

Splenic artery pseudoaneurysm presenting with upper gastrointestinal bleeding successfully treated by endovascular embolisation: a case report

Márquez JA,[1] Llanos Luengas LV,[2] Mendoza LF[2]

1. Vascular and Endovascular Surgeon, Sociedad de Cirugía de Bogotá Hospital de San José, Bogotá, Colombia
2. Vascular Surgery Fellowship Program, Sociedad de Cirugía de Bogotá Hospital de San José, Bogotá, Colombia

Corresponding author:
Laura Valentina Llanos Luengas
Sociedad de Cirugía de Bogotá Hospital de San José, Bogotá, Colombia
Email: lvllanos@fucsalud.edu.co

Received: 9th July 2026
Accepted: 31st July 2026
Online: 11th August 2026

Abstract

Background: A splenic artery pseudoaneurysm is an uncommon vascular lesion accounting for less than 3% of splenic artery aneurysmal lesions, associated with a high risk of rupture (37–47%) and mortality rates up to 90%. Its clinical presentation is often non-specific and may include upper gastrointestinal bleeding, making early diagnosis crucial.

Case presentation: An 80-year-old man was admitted with acute melaena and severe anaemia. Emergency upper gastrointestinal endoscopy revealed an apparent 'ulcerated subepithelial gastric lesion' associated with active bleeding that could not be controlled with epinephrine injection. Computed tomography angiography showed a 42 mm vascular lesion arising from the splenic artery, irregular contour, absence of mural calcification, an eccentric configuration in close contact with the posterior gastric wall, without a clearly identifiable fistulous or epithelialised tract between the two structures, raising a high suspicion for a splenic artery pseudoaneurysm. Urgent angiography confirmed the diagnosis. Endovascular treatment was successfully performed with proximal and distal coil embolisation, achieving complete exclusion of the lesion. Follow-up endoscopy confirmed successful haemostasis and the patient was discharged four days later.

Conclusion: Splenic artery pseudoaneurysm can present with unexplained upper gastrointestinal bleeding. Early endovascular embolisation appears to be safe and effective.

Key words: splenic artery aneurysm, gastrointestinal bleeding, endovascular embolisation

Introduction

Splenic artery pseudoaneurysms are rare vascular lesions, accounting for less than 3% of splenic artery aneurysmal lesions, and are most commonly associated with pancreatitis, trauma and peptic ulcer disease.[1] Clinical presentation is frequently non-specific, with abdominal pain and gastrointestinal bleeding being the most common manifestations. Early diagnosis using appropriate imaging modalities followed by prompt treatment is recommended to prevent rupture, which has been reported in 37–47% of cases and has an associated high mortality. Endovascular management, including embolisation or stent graft placement, has emerged as the preferred and effective minimally invasive therapeutic treatment strategy; however, potential complications including splenic infarction should be considered.[2] We report an unusual case of an 80-year-old man with a splenic artery pseudoaneurysm presenting with upper gastrointestinal bleeding who was successfully treated with an endovascular approach.

Case presentation

An 80-year-old man presented to the emergency room with upper gastrointestinal bleeding manifesting with sudden melaena. He denied abdominal pain or constitutional symptoms and had a history of hypertension, dyslipidaemia, right eye glaucoma and critical aortic valve stenosis with a prior transcatheter aortic valve replacement (TAVI) one year earlier. He denied tobacco or alcohol use. On admission he was haemodynamically stable but anaemic (haemoglobin 8.1 g/dL, haematocrit 25.4%). Emergency upper gastrointestinal endoscopy performed by the gastroenterology team revealed a bloody gastric residue and an apparent 5 cm

Figure 1 CT angiogram tridimensional reconstruction showing a pseudoaneurysm arising from the splenic artery.

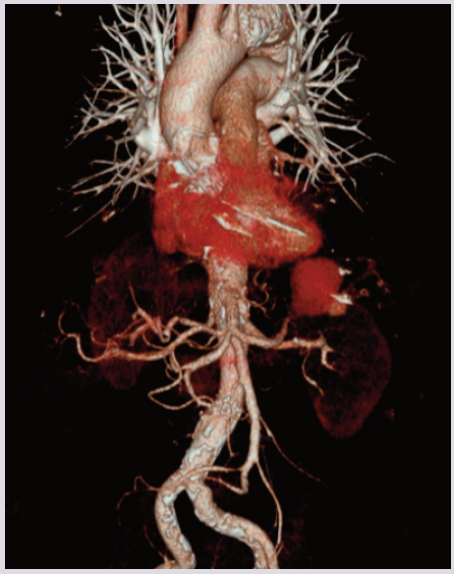


Figure 2 Selective catheterisation of the splenic artery confirmed the presence of a splenic artery pseudoaneurysm.

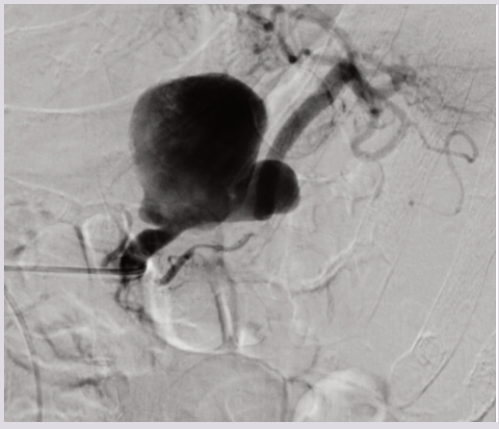


Figure 3 Final aortogram. Proximal and distal embolisation of the splenic artery with microcoils and successful exclusion of the pseudoaneurysm.

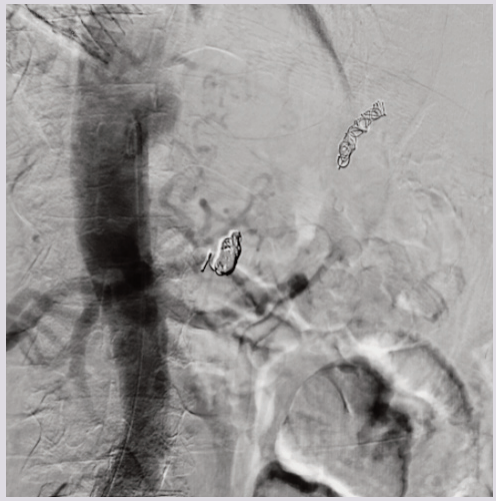
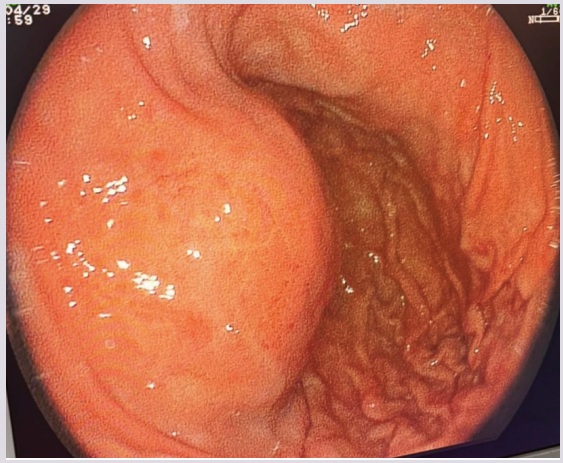


Figure 4 Follow-up upper gastrointestinal endoscopy with successful control of gastrointestinal bleeding.



subepithelial lesion, with superficial gastric mucosal ulceration along the greater curve with active bleeding, without a fistulous connection clearly identified. Endoscopic haemostasis was attempted with epinephrine injection but failed to achieve bleeding control. CT angiography (CTA) showed a well-defined vascular lesion arising from the splenic artery, measuring 38 × 39 × 42 mm (craniocaudal × anteroposterior × transverse dimensions) characterised by an irregular contour, absence of mural calcification, an eccentric configuration and intense arterial contrast enhancement (Figure 1). The lesion was in close contact with the posterior gastric wall, without a clearly identifiable fistulous or epithelialised tract between the two structures, raising a high suspicion for a splenic artery pseudoaneurysm. The patient required transfusion of two units of packed red blood cells. However, without an adequate clinical response and persistent upper gastrointestinal bleeding, urgent transfemoral visceral angiography and selective catheterisation of the splenic artery confirmed the presence of a splenic artery pseudoaneurysm (Figure 2). Endovascular treatment was successfully performed using sandwich embolisation with proximal (four microcoils) and distal (three microcoils) coil deployment, achieving complete exclusion of the pseudoaneurysm without procedural complications (Figure 3). The patient was admitted to the intensive care unit for close monitoring. Control upper gastrointestinal endoscopy showed adequate gastrointestinal bleeding control (Figure 4) and the patient was discharged home four days after the procedure.

Discussion

Splenic artery aneurysms are the most common visceral arterial aneurysms after aortic and common iliac artery aneurysms. True splenic artery aneurysms have a prevalence of less than 1%,[3] and splenic artery pseudoaneurysms are even rarer. Frequent aetiologies of splenic artery pseudoaneurysms include pancreatitis and direct trauma to the splenic artery. In the present case we speculate that the pseudoaneurysm may have resulted from inadvertent guidewire- or catheter-related injury to the splenic artery during the patient's previous TAVI. Splenic artery pseudoaneurysms have a variable clinical presentation, ranging from mild abdominal pain to life-threatening rupture or gastrointestinal fistulation. The associated risk of rupture may be as high as 47%,[4] so early clinical suspicion, accurate diagnosis and prompt treatment if appropriate is essential. CTA is the most accessible non-invasive and preferred imaging modality for diagnosis. However, in the setting of active haemorrhage, catheter angiography remains the diagnostic and therapeutic gold standard. Different endovascular interventions can be considered including coil embolisation (coil trapping, isolation or sandwich technique) to prevent continued sac pressurisation from the collateral circulation, or covered stent placement.[3] Splenic infarction remains one of its most common complications. Despite the rich collateral blood supply to the spleen, partial splenic infarction has been reported in up to 40% of patients following embolisation.[5] Level 2/3 post-procedural monitoring is therefore recommended.

Conclusions

Splenic artery pseudoaneurysm is a rare but potentially fatal condition due to its significant risk of rupture. Clinical manifestations are often non-specific and a high index of suspicion is crucial, especially in patients with gastrointestinal bleeding. CTA and intra-arterial angiography play a key role in the diagnosis and treatment.

KEY MESSAGES

- Consider splenic artery pseudoaneurysm in unexplained upper gastrointestinal bleeding.
- CTA followed by catheter angiography enables prompt diagnosis and definitive endovascular treatment.
- Sandwich coil embolisation appears to be a safe and effective treatment.

This case highlights the effectiveness of endovascular embolisation allowing definitive haemorrhage control with excellent outcomes. Early recognition and timely intervention remain critical to reducing morbidity and mortality.

Conflict of Interest: None.

Funding: None.

Patient consent to publication: Informed consent was obtained for this case report.

References

1. Khurram R, Al-Obudi Y, Glover TE, Shah R, Khalifa M, Davies N. Splenic artery pseudoaneurysm: Challenges of non-invasive and endovascular diagnosis and management. *Radiol Case Reports* 2021;**16**(6):1395–9. https://doi.org/10.1016/j.radcr.2021.03.013
2. El Oukli Y, Kerroum Y, Alaoui Maliki M. Pseudo aneurysm of the splenic artery fistulized in the stomach revealed by upper digestive hemorrhage. *Sch J Med Case Rep* 2020;**8**(7):741–3. https://doi.org/10.36347/sjmcr.2020.v08i07.023
3. Abdul R, Teelucksingh S, Omar M, *et al.* Splenic artery pseudoaneurysm presenting with massive rectal bleeding. *Radiol Case Reports* 2019;**14**(7): 791–4. https://doi.org/10.1016/j.radcr.2019.03.038
4. Chenyao L, Qingliang Z, Hailong Z. Gastrointestinal bleeding caused by splenic artery pseudoaneurysm in chronic pancreatitis: a case report and literature review. *J Surg Case Rep* 2024;**9**:rjae574. https://doi.org/10.1093/jscr/rjae574
5. Rinaldi LF, Brioschi C, Marone EM. Endovascular and open surgical treatment of ruptured splenic artery aneurysms: a case report and a systematic literature review. *J Clin Med* 2023;**12**(18):6085–5. https://doi.org/10.3390/jcm12186085

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):195-198
http://doi.org/10.54522/jvsgbi.2026.241

www.jvsgbi.com

CASE REPORT

Endovascular coil embolisation of radial artery pseudoaneurysm: a case report and literature review

Daysley H,[1] Hamadneh M,[2] Chikhhal R[2]

1. Centre of Clinical Sciences, Hull York Medical School and Academic Vascular Surgical Unit, Hull, UK
2. Academic Vascular Surgical Unit, Hull, UK

Corresponding author:
Dr Hannah Daysley
Vascular Department,
Hull Royal Infirmary,
Anlaby Road, Hull HU3 2JZ, UK
Email: hannah.daysley1@nhs.net

Received: 27th July 2026
Accepted: 24th August 2026
Online: 26th August 2026

Abstract

Background: Radial artery pseudoaneurysm (RAP) is a rare but recognised complication of transradial percutaneous coronary intervention (PCI) with an incidence of 0.009–0.2%. Management depends on pseudoaneurysm size, morphology and patient factors. While conservative measures are often effective for small lesions, larger or symptomatic pseudoaneurysms may require surgical or endovascular intervention.

Case report: A 77-year-old woman developed a right radial artery pseudoaneurysm following transradial PCI. Initial duplex ultrasound demonstrated a 16 × 10 × 13 mm pseudoaneurysm, which was managed conservatively. Two weeks later she presented with worsening wrist pain, swelling and extensive bruising. Repeat ultrasound demonstrated enlargement to 45 × 21 × 29 mm with a 16 mm neck, making thrombin injection unsuitable. Owing to recent myocardial infarction and high anaesthetic risk, open surgical repair was considered inappropriate. A digital subtraction angiogram confirmed adequate ulnar collateral circulation. Following multidisciplinary discussion, endovascular coil embolisation of the radial artery was performed successfully using detachable Ruby coils. Post-procedural angiography and duplex ultrasound confirmed complete occlusion of the radial artery and pseudoaneurysm without evidence of hand ischaemia. The patient recovered without complications and was discharged four days later.

Conclusion: This case demonstrates that endovascular coil embolisation is a safe and effective treatment for enlarging radial artery pseudoaneurysms in carefully selected patients unsuitable for open surgery. Pre-procedural assessment of collateral hand perfusion and multidisciplinary decision-making are essential to achieve favourable outcomes.

Key words: pseudoaneurysm, embolisation, radial artery

Introduction

Radial artery pseudoaneurysms (RAP) are primarily caused by iatrogenic trauma. The transradial approach has become the preferred access route for cardiac catheterisation due to lower rates of bleeding and vascular morbidity compared with femoral access.[1] RAP following percutaneous coronary intervention (PCI) are rare with incidences ranging from 0.009% to 0.2% of radial catheterisations, including PCI cases.[1–4] Pseudoaneurysms occur due to a breach of the arterial wall with persistent communication between the lumen and surrounding soft tissue, often exacerbated by risk factors such as anticoagulation, multiple puncture attempts, incomplete haemostasis, advanced age and larger sheath sizes.

Management is guided by pseudoaneurysm size, symptoms and patient risk profile. Conservative measures such as stopping anticoagulation, ultrasound-guided compression and thrombin injection have been successfully employed, while surgical repair or endovascular techniques are often reserved for larger or refractory lesions.[3] In this case report we describe the management of a RAP following PCI.

Case report

Preoperative assessment

A 77-year-old woman presented with progressive

Figure 1 Bruising and swelling of right arm following percutaneous coronary intervention and development of radial artery pseudoaneurysm.

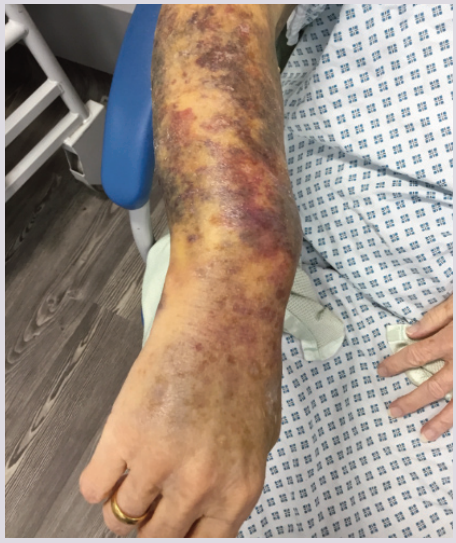


Figure 2 Ultrasound scan of right radial artery.

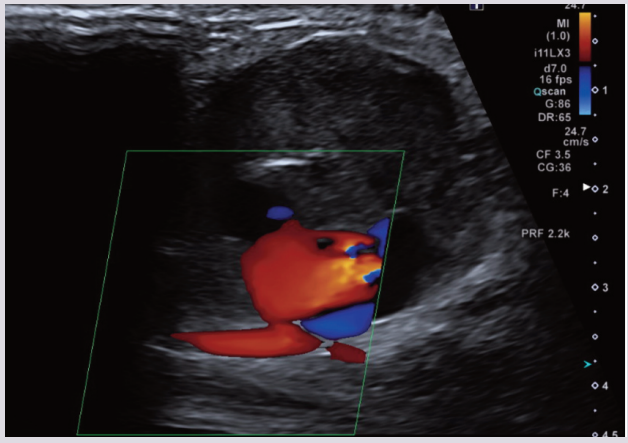


Figure 3 Digital subtraction angiogram demonstrating compensatory ulnar artery blood flow and pseudoaneurysm on the radial artery.

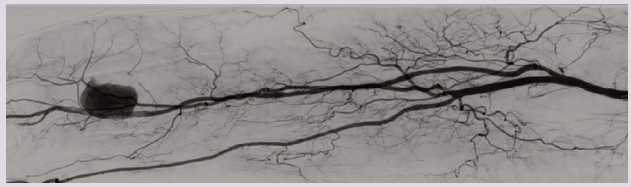
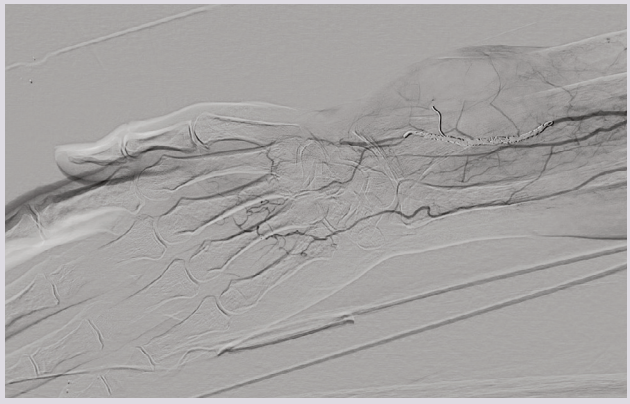


Figure 4 Post-procedure digital subtraction angiogram demonstrating successful embolisation of the radial artery.



right wrist swelling, pain, bruising and collapse. Two weeks earlier she had undergone PCI via a right radial approach following a myocardial infarction, which was complicated by RAP (16 × 10 × 13 mm) managed with ultrasound-guided compression. Comorbidities included atrial fibrillation and hypertension, managed with edoxaban, bisoprolol and ramipril. Examination revealed extensive right forearm and hand bruising, normal motor and sensory function, a palpable ulnar pulse and a warm well perfused hand with normal capillary refill time. There was a tender pulsatile 4 cm diameter mass over the radial artery at the wrist (Figure 1). A Modified Allen's test confirmed a patent palmer arch and a peripheral duplex scan confirmed a RAP measuring 45 × 21 × 29 mm with a neck diameter of 16 mm (Figure 2). A digital subtraction angiogram confirmed the RAP and patency of both radial and ulnar arteries (Figure 3). The patient was discussed at the multidisciplinary meeting. Further ultrasound-guided compression and thrombin injection were precluded by previous failure, pain and RAP neck size. The patient was deemed a high-risk candidate for general anaesthesia due to recent cardiac events and highly unlikely to tolerate a surgical procedure under local anaesthetic. Endovascular options were discussed and embolisation was considered the most appropriate intervention option.

Endovascular management

Forty-eight hours prior to the procedure the patient's edoxaban was stopped and she was placed on prophylactic enoxaparin to minimise the risks associated with atrial fibrillation. Under local anaesthetic via 4F sheath right brachial artery access, right radial artery embolisation with successful exclusion of the RAP was achieved using five ruby coils (2 mm × 4 cm, 2 mm × 2 cm, 3 mm × 5 cm, 4 mm × 6 cm and 3 mm × 20 mm sizes) and one packing coil (15 cm) (Figure 4). Brachial access haemostasis was achieved with compression.

Postoperative management and outcomes

Postoperatively, the patient's pain improved and the hand remained warm pink and well perfused with no neurological deficit. The ulnar pulse was palpable but there was no pulse in the distal radial artery

or RAP. Duplex ultrasound confirmed successful distal radial artery embolisation and successful exclusion of the RAP. After 24 hours the patient was restarted on edoxaban and, following review by both the physiotherapy and occupation therapy teams, was discharged four days after the intervention. At 6-week follow-up the patient had minimal symptoms and the extent of the bruising and size of the RAP were reducing.

Discussion

RAP remains an uncommon complication following transradial coronary intervention with a reported incidence of 0.009–0.2%.[1–4] A recent large systematic review analysing 75 published RAP cases noted that approximately 76% of patients developed symptoms or enlargement requiring active intervention, while only a minority were successfully managed conservatively.[5] RAP recognised risk factors include multiple puncture attempts, larger sheath size, inadequate haemostasis, prolonged catheterisation, anticoagulation and advanced age.[6,7] Our patient exhibited several of these factors.

Management is guided by pseudoaneurysm size, neck morphology, symptoms and patient comorbidity. Small (<2–3 cm) asymptomatic pseudoaneurysms may be observed, as spontaneous thrombosis has been reported.[8] Ultrasound-guided compression remains an accepted first-line treatment; however, it is often painful, requires prolonged compression and is less effective in anticoagulated patients or wide-neck lesions. The recent systematic review reported a success rate of only 58.5% for compression therapy, with many patients requiring subsequent intervention because of persistent flow or interval enlargement.[5] The failure of initial compression in our patient is therefore consistent with published experience.

Ultrasound-guided thrombin injection has become the preferred minimally invasive treatment for many iatrogenic peripheral pseudoaneurysms because of its high efficacy and low morbidity. Large series report technical success rates of 95–99%, with recurrence rates generally below 5%.[9,10] However, treatment is dependent on favourable anatomy, particularly a relatively narrow neck that minimises the risk of thrombin entering the parent artery and causing distal embolisation. Wide-neck pseudoaneurysms, rapidly enlarging lesions and lesions with complex morphology are generally considered unsuitable for thrombin injection.[10] In this case, enlargement from 16 mm to 45 mm with a wide neck following failed compression rendered thrombin injection inappropriate because of the published associated risks.

Open surgical repair has historically been regarded as the definitive treatment for symptomatic, enlarging or complicated RAPs. Reported surgical success rates exceed 95%, and recurrence is uncommon.[5,11] Risks associated with surgery include wound infection, haematoma, sensory nerve injury, and the risks of regional or general anaesthesia. These considerations are particularly important in elderly patients with significant cardiovascular comorbidity. In our patient, recent myocardial infarction, ongoing anticoagulation, and poor tolerance of general anaesthesia or prolonged local anaesthetic substantially increased operative risk, making open repair less attractive.

Endovascular techniques provide an alternative for poor surgical candidates. Covered stent placement has been described with preservation of radial artery patency, but experience remains limited to isolated case reports.[12] Deployment is technically challenging because of the small calibre and tortuosity of the radial artery, and long-term patency remains uncertain, particularly in elderly patients. The wide pseudoaneurysm neck and relatively small parent vessel in this case made durable stent exclusion unlikely and increased the risk of acute thrombosis or endoleak.

Coil embolisation is less frequently reported but represents an effective strategy when sacrifice of the radial artery is acceptable. Published experience is limited to case reports and small series; however, these reports consistently demonstrate technical success rates approaching 100%, durable pseudoaneurysm exclusion and very low complication rates when adequate collateral circulation is present.[5,13,14] In the systematic review by Hajeh *et al*, all reported patients treated with percutaneous embolisation achieved successful exclusion of the pseudoaneurysm without hand ischaemia.[5] Compared with covered stents, coil embolisation is technically simpler, avoids the need for long-term stent surveillance and eliminates the possibility of persistent sac perfusion. The principal prerequisite is confirmation that the ulnar artery and palmar arch can maintain hand perfusion. In our patient, angiography confirmed robust ulnar inflow and a complete palmar arch, permitting safe radial artery sacrifice without digital ischaemia. Adequate perfusion is confirmed angiographically by inserting a suitable sized occlusion balloon into the radial artery, then injecting contrast into the access site, documenting radial and ulnar patency, superficial and deep palmar arch, digital arterial filling and any anatomical variants.

An alternative endovascular strategy would have been selective coil embolisation of the pseudoaneurysm sac or neck while preserving radial artery patency. This approach offers the theoretical advantage of definitive pseudoaneurysm exclusion without sacrificing the radial artery and may therefore be preferable where the anatomy permits stable coil deployment. Recent case reports have demonstrated successful selective coil embolisation of radial artery pseudoaneurysms with preservation of the parent artery.[13,14] The feasibility of this technique depends on the morphology of the pseudoaneurysm, as coils must be positioned securely within the sac or across the neck without protrusion into the parent vessel. In our patient, the relatively large 16 mm neck and rapidly enlarging 45 mm pseudoaneurysm would have increased the risk of coil migration or incomplete exclusion, making selective sac embolisation less predictable. Given the confirmed robust ulnar collateral circulation, intentional radial artery embolisation was therefore considered a more definitive approach.

An additional technical consideration was the use of brachial artery access. This provided a short direct route to the target vessel and allowed the procedure to be performed entirely under local

KEY MESSAGES

- Radial artery pseudoaneurysm should be considered in patients presenting with delayed wrist pain, swelling or a pulsatile mass following transradial coronary intervention.
- Management of a RAP is driven by patient specific factors to ensure successful repair.
- Endovascular coil embolisation is a viable treatment for enlarging, wide-neck radial artery pseudoaneurysms when conservative management has failed and open surgery carries significant risk.
- Assessment of collateral hand circulation and multidisciplinary decision-making are essential before radial artery sacrifice to minimise the risk of hand ischaemia.

anaesthesia. A recent systematic review of brachial artery access for endovascular interventions reported pooled complication rates of 4.8% for haematoma, 1.4% for haemorrhage, 1.1% for pseudoaneurysm, 0.6% for arterial thrombosis, 0.5% for neuropathy and 0.4% for limb ischaemia.[15] In this case, haemostasis was achieved with manual compression alone and no access site complications occurred, supporting brachial access as a safe and practical option for selected upper limb interventions.

This report adds to the limited literature supporting endovascular coil embolisation for complex RAP after transradial PCI. Most published RAP cases continue to be managed surgically or with thrombin injection.[5] Our case demonstrates that coil embolisation can provide definitive treatment after failed compression in a rapidly enlarging wide-neck pseudoaneurysm in a patient unsuitable for surgery, with preservation of hand perfusion and no neurological or access site complications.

A limitation of this case report is the lack of saved radiological imaging to support the findings of an intact palmar arch, despite that being documented and discussed in her case and management. However, these findings were supported by the clinical assessments including modified Allen's test and postoperative pulses and neurovascular findings. A further limitation is the absence of long-term follow-up beyond the early postoperative period. Although immediate technical and clinical success was achieved, longer surveillance would be valuable to confirm complete pseudoaneurysm resolution and preservation of hand function.

Conclusion

Radial artery pseudoaneurysm following transradial PCI remains an uncommon complication but should be considered in any patient presenting with delayed wrist swelling, pain or a pulsatile mass after catheterisation. Prompt duplex ultrasound facilitates diagnosis and guides management. This case illustrates that endovascular coil embolisation can provide definitive treatment when conservative management has failed and surgery carries excessive risk. Careful pre-procedural assessment of collateral hand circulation and multidisciplinary decision making are essential to optimise outcomes.

Conflict of Interest: None.

Funding: None.

Patient consent to publication: Full written informed consent from the patient was obtained for publishing this article and accompanying images.

References

1. Alqahtani NG. Radial artery pseudoaneurysm: a rare complication after coronary angiography. *Clin Case Rep* 2024;**12**:e8725. https://doi.org/10.1002/ccr3.8725
2. Riangwiwat T, Blankenship JC. Vascular complications of transradial access for cardiac catheterization. *US Cardiol Rev* 2021;**15**:e04. https://doi.org/10.15420/usc.2020.23
3. Din JN, Murphy A, Chu K, *et al*. Radial artery pseudoaneurysms after transradial cardiac catheterisation. *Vasa* 2016;**45**:229–32. https://doi.org/10.1024/0301-1526/a000529
4. Kanei Y, Kwan T, Nakra NC, *et al*. Transradial cardiac catheterization: a review of access site complications. *Catheter Cardiovasc Interv* 2011;**78**:840–6. https://doi.org/10.1002/ccd.22978
5. Hajeh Y, Al-Hakim R, Alqahtani NG, *et al*. Radial artery pseudoaneurysm after transradial coronary angiography and intervention: a systematic review of 75 reported cases. *Cureus* 2026;**18**:e123456. https://doi.org/10.1016/j.jscai.2026.104263.
6. Nagai S, Abe S, Sato T, *et al*. Ultrasonographic evaluation of vascular complications after transradial coronary procedures. *Am J Cardiol* 1999; **83**:180–6. https://doi.org/10.1016/s0002-9149(98)00821-2
7. Riangwiwat T, Blankenship JC. Vascular complications of transradial access for cardiac catheterization. *US Cardiology Review* 2021;**15**:e04. https://doi.org/10.15420/usc.2020.23
8. Toursarkissian B, Allen BT, Petrinec D, *et al*. Spontaneous closure of selected iatrogenic pseudoaneurysms and arteriovenous fistulae. *J Vasc Surg* 1997; **25**:803–09. https://doi.org/10.1016/s0741-5214(97)70209-x
9. Kang SS, Labropoulos N, Mansour MA, *et al*. Expanded indications for ultrasound-guided thrombin injection of pseudoaneurysms. *J Vasc Surg* 2000; **31**:289–98. https://doi.org/10.1016/s0741-5214(00)90160-5
10. Saad NEA, Saad WEA, Davies MG, *et al*. Pseudoaneurysms and the role of minimally invasive techniques in their management. *Radiographics* 2005;**25**: S173–S189. https://doi.org/10.1148/rg.25si055503
11. Morgan R, Belli AM. Current treatment methods for postcatheterization pseudoaneurysms. *J Vasc Interv Radiol* 2003;**14**:697–710. https://doi.org/10.1097/01.rvi.0000071089.76348.6a
12. Tsiafoutis I, Zografos T, Koutouzis M, Katsivas A. Percutaneous endovascular repair of a radial artery pseudoaneurysm using a covered stent. *JACC: Cardiovascular Interventions* 2018;**11**(11):e91–2 https://doi.org/10.1016/j.jcin.2018.03.047
13. Alberto C, Luca P, Gabriele FA, *et al*. Percutaneous management of radial artery pseudoaneurysm: two illustrative cases and a literature overview. *Catheterization and Cardiovascular Interventions* 2025;**107**(2):489–501 https://doi.org/10.1002/ccd.70365
14. Washimi S, Yamada T, Takahashi A. Successful coil embolization with distal radial access for a ruptured radial artery pseudoaneurysm in a patient with SARS-CoV-2 infection. *Clin Case Rep* 2022;**10**:e05509 https://doi.org/10.1002/ccr3.5509
15. Khan K, Amir E, Akano O, Borucki J, Al Thaher A, Stather P, Ali T. Challenging the controversy surrounding percutaneous brachial artery access related complications: a systematic review and meta-analysis. *Vasc Endovascular Surg* 2025;**59**(1):47–63. https://doi.org/10.1177/15385744241278048

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):199-200
http://doi.org/10.54522/jvsgbi.2026.244

www.jvsgbi.com

NEWS

Updates from the Vascular Societies

JVSGBI is owned by the Vascular Society for Great Britain and Ireland (VSGBI), for all affiliated societies and the wider vascular community. Here's the latest news from one of the societies.

British Society of Interventional Radiology (BSIR)

www.bsir.org
@BSIR_News

- The BSIR Special Interest meetings have now drawn to a close, receiving good delegate numbers and positive support from industry. Since the last report:
  - The BSIR Paediatrics UK Annual Meeting took place on Monday 18th May in Birmingham. This meeting continues to be well attended and is increasingly and important forum for trainees and allied health professionals with an interest in paediatric IR.
  - The BSIR Interventional Oncology UK meeting took place on 4th-5th June in Newcastle, attracting over 120 delegates across two days.
  - IOUK was preceded on 3rd June by the second Interventional Oncology Network for Research and Innovation Collaboration (IONIC-UK) workshop, sponsored by the National Institute for Health and Social Care Research (NIHR), and convened by Professor Tze Wah.
  - The second BSIR Registrar Study Day took place virtually on 11th June, once again supporting over 50 attendees online, this year focussed on non-vascular IR.
- BSIR has been pleased to represent IR in several Parliamentary events in recent months, including the VVAPPG Parliamentary Drop-in, focussed on Making the Case for Reform in the Vascular Sector, and the Annual ABHI Reception.
- The Society continues to respond to NICE consultation requests through input from members. This year Executive Officers have also been involved in high level DHSC discussions regarding the New Hospitals Programme. We are pleased to be working alongside the Vascular Society in response to MHRA's request for input in to SWEDPAD 2 Findings and Consideration of Current MHRA Advice on Paclitaxel-Coated Devices.
- Registration is now open for BSIR 2026 in Birmingham on 4-6th November.
  - Join us to explore novel interventional treatments from developments in venous and arterial IR, continued advances in thyroid pathology and musculoskeletal embolotherapy, and the evolving landscape of interventional oncology.
  - With a strong focus on how treatments are implemented in real-world practice, the programme has been designed to facilitate discussion - from panels exploring thoracic venous occlusions to live acute limb ischaemia MDT discussions.
  - The programme includes debates on the role of IR within the RCR, the practical requirements of a modern IR service and the Wattie Fletcher Lecture focussing on the importance of IR education. There are also dedicated Trainee and Nurses & Radiographers programmes, designed to inspire the next generation of IRs and the whole IR team.
  - An overview of the programme can be found at: www.bsirmeeting.org.

You can find out more about upcoming BSIR events and activities on the BSIR website www.bsir.org

Society of Vascular Nurses (SVN)

www.svn.org.uk
@vascularnurses

The Society of Vascular Nurses (SVN) has remained active in the field of education over recent months. In collaboration with the lower limb charity Legs Matter, we have delivered a series of popular *'On the Sofa'* webinars, featuring informal question-and-answer discussions on a range of arterial and venous disease topics. Designed as an accessible introduction to vascular care, these webinars have been well received and remain available to view on the Legs Matter Facebook page.

Our successful partnership with the Vascular Society also continued with the Joint Virtual Summer Symposium. The event attracted more than 150 delegates and received excellent feedback from attendees. We are extremely grateful to the many expert clinicians who contributed to a varied and engaging programme, helping to make the symposium such a success.

The SVN roadshow programme has continued to grow, with the next event taking place in York in September. These educational study days provide practical

teaching on a broad range of vascular and venous conditions, delivered by experienced SVN Council members alongside local vascular clinicians. Demand has been consistently high, and we look forward to expanding the programme to more locations across the UK.

Preparations are also well underway for the Joint Societies Conference in Liverpool this November. The programme is now finalised, with speakers confirmed across a range of sessions. We are particularly looking forward to contributing to the Joint Societies symposium on acute limb ischaemia. It is also encouraging to see a year-on-year increase in submissions for the James Purdy Prize abstract competition, reflecting the growing engagement of nurses in vascular research. In addition, the SVN continues to support conference attendance through an expanding bursary programme.

Finally, we have maintained our engagement with the Vascular and Venous All-Party Parliamentary Group (APPG). Representatives from the SVN recently attended an event at the Houses of Parliament, bringing together key stakeholders to engage Members of Parliament in discussions surrounding the report *Making the Case for Reform in the Vascular Sector*. This important work continues to raise awareness of the challenges facing vascular services and the need for sustained investment and improvement.

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

We are a peer-reviewed, open-access journal and we encourage new, relevant and interesting content to support the treatment and care of vascular patients

The *JVSGBI* is published quarterly online at
www.jvsgbi.com
in February, May, August and November

CALL FOR PAPERS

We are inviting contributions of the following article types:

EDITORIALS Original articles that present an important issue and conclusions that reach an advance in understanding

ORIGINAL RESEARCH Written by the researchers who actually undertook the study. This will include the hypothesis and purpose of the study, research method and results.

CLINICAL TRIALS Reports on Clinical Trials including Prospective Clinical Trials

REVIEWS Presents the current state of understanding on a topic.

CLINICAL CASE STUDY Provide an interesting insight and learning into clinical and management issues

DEBATE Present an argument or discussion on a relevant topic, presenting a well-argued viewpoint and represents the "pro" and "con" format

Q&A Submit your questions and a member of the Editorial Board will be asked to provide a solution or explanation into the question raised

SUBMIT YOUR ARTICLE

ON AVERAGE, ARTICLES ARE PUBLISHED ONLINE WITHIN 12 WEEKS AND INCLUDED IN THE NEXT ISSUE

Visit our website for full author instructions

Circulation to more than 1500 healthcare professionals taking care of vascular patients throughout the UK

THE JVSGBI ALSO PUBLISH NEWS FROM AND ACTIVITIES FOR ITS AFFILIATED SOCIETIES

VASCULAR SOCIETY · BSET British Society of Endovascular Therapy · ROULEAUX CLUB UK Vascular Trainees' Association · CSVS The College and Society for Clinical Vascular Science Great Britain and Ireland · VASGBI The Vascular Anaesthesia Society of Great Britain & Ireland · BACPAR · BSIR British Society of Interventional Radiology · Society of Vascular Nurses SVN www.svn.org.uk · UK National Interventional Radiology Trainee Research (UNITE) Collaborative · VERN Vascular and Endovascular Research Network

Submit your manuscripts and any enquires to: editorialoffice@jvsgbi.com

Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2026;5(4):202
http://doi.org/10.54522/jvsgbi.2026.246

www.jvsgbi.com

Reviewer acknowledgement (Volume 5)

As we come to the end of our fifth year of publication and our twentieth issue of *JVSGBI*, we would like to thank our reviewers for taking the necessary time and effort to review the manuscripts published in Volume 5. We appreciate their valuable comments and suggestions, which have helped us to improve the quality of the articles we have published online at www.jvsgbi.com

Judith Long
Academic Vascular Surgical Unit, Hull University Teaching Hospitals NHS Trust

Louise Allen
Lead Vascular Nurse Specialist, Imperial College Healthcare NHS Trust

Nina Al-Saadi
The Dudley Group NHS Foundation Trust

Kasia Bera
OUH NHS Foundation Trust/NDS Oxford University

Panagiota Birmpili
Oxford University Hospitals NHS Foundation Trust

Julie Brittenden
Glasgow

Colin Chan
Countess of Chester NHS Trust, Chester

Emily Chan
Vascular Surgery Specialty Registrar (ST8), Hull University Teaching Hospitals NHS Trust, Hull

Annie Clothier
Vascular Clinical Nurse Specialist, SVN Committee member

Ben Cooper
Vascular Nurse Consultant, NHS Grampian

Gail Curran
Vascular Specialist, Nurse North West Anglia NHST Foundation Trust, Society of Vascular Nurses Council Member (Treasurer)

Jo Cutteridge
NIHR Academic Clinical Fellow in Vascular Surgery, Nuffield Department of Surgery, University of Oxford

Hannah Daysley
Hull University Teaching Hospitals NHS Trust

Martin Gannon
Nottingham Vascular Unit

Andrew Garnham
Black Country Vascular Unit, Royal Wolverhampton NHS Trust

Siobhan Gorst
SVN President, Lead Vascular ACP Doncaster & Bassetlaw Teaching Hospitals

Louise Hitchman
York and Scarborough Teaching Hospitals NHS Trust

Rakesh Kapur
Consultant Vascular Surgeon, Hull University Teaching Hospitals

Ross Lathan
Hull York Medical School

Patrick Lintott
Buckinghamshire Healthcare NHS Trust

Harishankar Ramachandran Nair
Consultant Vascular Surgeon, St Thomas' Hospital, London

Sandip Nandhra
Newcastle University/Newcastle Hospitals

Akhtar Nasim
Consultant Vascular Surgeon & Clinical Director for Vascular Services, Sheffield Vascular Institute

Douglas Orr
Consultant Vascular Suergeon, Queen Elizabeth University Hospital, Glasgow

Sasi Pathmanathan
Vascular Perioperative Physician, Hull Royal Infirmary, Hull

Athanasios Saratzis
University of Leicester / University Hospitals of Leicester NHS Trust

Rob Sayers
Glenfield Hospital Leicester

Frances Sheehan
Imperial College Healthcare NHS Trust

Laura Shields
City of Glasgow College

Kaji Sritharan
Consultant Vascular Surgeon, York

Jia Liu Stevens
Consultant Anaesthetist, University Hospital Sussex NHS Trust

Max Troxler
Leeds Vascular Institute, Leeds Teaching Hospitals

Michael Wall
Black Country Vascular Network

Anyone interested in joining our team of reviewers, please email your name, place of work and your area of expertise to: editorialoffice@jvsgbi.com

A full list of reviewers, including those who helped with the review of articles that didnt make publication, can be found online at: https://jvsgbi.com/authors/jvsgbi-reviewers/