

Dear editor and reviewers:

Thank you for your constructive feedback. Please find below our reply to your requests which are [blue coloured](#) in the revised version of the manuscript.

Editor's comments:

Comments of the Editor Please format the reference list according to the conference style. Note: abbreviated journal names are in italic, volume numbers are in bold.

[All references were checked according to instructions](#)

Comments of Reviewer #1 The authors present the potential feasibility of additively manufactured porous biodegradable embolization devices for controlled vascular flow redistribution. The topic is timely and potentially suitable for conference presentation. However, the following comments should be addressed prior to publication.

General Comments

1. It would be better to include quantitative results for the key parameters in the abstract. Please also include appropriate keywords.

[Thank you for your suggestion. We included some numbers in Abstract. We have been using the official template for the conference where they do not use keywords.](#)

2. Citations are missing in several parts of the Introduction. Please provide appropriate and up-to-date references to support the relevant statements.

[Thank you for your suggestion. We added some sentences in introduction to demonstrate that PCS issues have been reported since 1984 by Beard et al. to recent publication in 2026 by Krambek et al.](#)

3. It would be better to provide the definitions of all abbreviations in the figure captions when they are first used.

[Thank you for your suggestion. We included abbreviations in all figures.](#)

4. Some of the references are outdated. Please update the reference list by including more recent and relevant literature.

[Thank you for your suggestion. We revised the Introduction and reference list to include several recent publications from 2025-2026 addressing pelvic congestion syndrome, embolization techniques, venous hemodynamics, additive manufacturing, and biodegradable vascular devices. Historical references were retained where they correspond to seminal contributions in the field, while recent references were added to better reflect the current state of the art.](#)

5. There is a distinction between the terms "computational" and "computer." Please use the appropriate terminology consistently throughout the manuscript.

[Thank you for your comment. We have uniform use of CFD on this version of manuscript.](#)

6. The manuscript provides insufficient background on additive manufacturing and its applications in the medical field. Please expand the relevant literature review and clearly explain the role and potential applications of additive manufacturing in medical devices.

[We have included two new reviews on additive manufacturing for medical devices.](#)

7. To simplify the presentation of the experimental results, the authors state that the samples were cut to different lengths. What specific lengths were used, and what was the rationale for selecting these lengths? It would be better to present this information in a table.

[We included an explanation about lengths linked to Table 1 and Table 2.](#)

8. Please clarify whether PLA is biocompatible and whether its biodegradability alone is sufficient to support its intended biomedical application. Appropriate references should be provided.

Thank you for your comment. We clarified that PLA was selected exclusively as a prototyping material for the hydraulic validation presented in this study. We explicitly state that PLA is not intended as the final implant material and that biocompatibility, degradation behavior, sterilization, and regulatory suitability were outside the scope of the present work and will be addressed in future studies.

9. The boundary conditions are not clearly presented. Please provide all boundary conditions used in the computational/CFD analysis.

We have included details on boundary conditions

10. Please provide sufficient details of the meshing procedure, including the mesh type, element size, number of elements/nodes, and relevant mesh-quality parameters.

Thank you for your comment. We expanded the CFD methodology section to specify that SolidWorks Flow Simulation employs a finite-volume formulation based on a Cartesian hexahedral mesh with adaptive local refinement and cut-cell technology. We also added information regarding the mesh density used for the simulations and the rationale for selecting the final mesh.

11. Was a mesh/grid independence test performed? If so, please present the results and explain how the final mesh was selected.

Thank you for this observation. A formal mesh-independence analysis was not performed in the present conference study. However, several mesh densities were evaluated during the model setup, and a global mesh corresponding to approximately five computational cells across the vessel diameter provided stable pressure-drop and velocity predictions. This limitation has been acknowledged in the manuscript and a comprehensive mesh-convergence study will be included in future work.

12. In the conclusion part, the CFD bifurcation finding is stated twice with nearly identical wording. Please remove the repetition and present the finding only once.

Thank you for your comment. We think we removed the sentence that was almost repeated for flow redistribution.

13. There are redundant sentences in the conclusion. For example, the statements regarding flow redistribution and increased hydraulic resistance are repeated. Please revise the paragraph to avoid redundancy.

Thank you for your comment. We decided to rewrite the whole conclusions to make it easier to understand and avoid repetitions.

14. In the conclusion, the expressions “preferential flow distribution observed in enlarged varicose branches” and “preferential flow through the enlarged varicose branch” are unclear and potentially inconsistent. Please revise the wording to clearly distinguish the initial flow distribution from the flow redistribution after introducing the embolization device.

Thank you for your comment. We decided to rewrite the whole conclusions to make it easier to understand and avoid repetitions.

15. The quantitative results are not sufficiently integrated into the conclusion. Please verify that the reported flow-rate units (mm^3/s) and the values (22,700 and 5,503 mm^3/s) are correct and appropriate for the computational model, and clearly explain their significance.

Thank you for your comment. The flow-rate values reported in the manuscript were verified and correspond to the CFD model and experimental configuration. Their significance lies in quantifying the effectiveness of the proposed embolization concept. Specifically, flow through the enlarged varicose branch decreased from 22,700 mm^3/s to 5,503 mm^3/s , while flow redistribution toward the healthy branch increased from 26% to 82%. These values were included in both the Abstract and Conclusions to better highlight the main outcome of the study.

16. Please carefully review the entire manuscript for proper grammar, scientific terminology, formatting, and consistency.

Thank you for your comment. We revised the whole manuscript for grammar, scientific terminology, formatting, and consistency

Comments of Reviewer #2

1. Technical Proofreading is necessary. Please correct terminology, chemical formulas, and typographical errors throughout....examples include 'Computer fluid dynamics,' 'medial device,' and the chemical notation 'NaOh.

We revised all terminology in current version of manuscript.

2. The 'with coil' values in Table 3 should be recalculated as it contains internally inconsistent velocity and Reynolds number values.

Thank you for identifying this issue. We reviewed Table 3 and added an explanation clarifying that the reported Reynolds number for the "with coil" configuration is a reference value calculated using the local flow conditions in the restricted passages created by the porous structure. The primary objective of the simulation is the assessment of flow redistribution rather than characterization of fully developed pipe flow within the porous region. The corresponding explanation has been added to the Results and Discussion section.

3. Check all citations. Eg. Citation [7] does not match the author named in the text.

Checked.

4. Avoid repetitive sentences in the conclusion section.

Thank you for your comment. We decided to rewrite the whole conclusions to make it easier to understand and avoid repetitions.

5. There is inconsistency of Reynolds-number equation. Equation (2) and the reported Reynolds numbers are inconsistent. Reynolds number for internal pipe flow is normally defined using hydraulic diameter. The equation currently uses radius, whereas the numerical results appear to use diameter. Please recheck all Reynolds numbers.

Thank you for spotting this typing mistake. Equations are ok in Excel and provide the right values for Table 2 first columns which can be easily checked. We have included in equations both radius and diameter versions.

6. The physiological relevance of the water-based validation requires stronger discussion. Blood is treated essentially as a Newtonian fluid with a constant viscosity scaling factor, while the experimental model uses steady water flow, simplified tubing, reversed flow direction, and no venous valves. These assumptions may be appropriate for an initial hydraulic study, but the conclusions should be limited accordingly and should not imply direct physiological validation.

Thank you for this important observation. We agree that the present work represents a hydraulic proof-of-concept rather than a physiological validation. To clarify this point, the manuscript now explicitly states that the experiments were conducted using water, simplified tubular geometries, reversed flow direction, steady-flow assumptions, and without venous valves. These simplifications were intentionally adopted to isolate and quantify the hydraulic resistance generated by the porous structures. The conclusions have been revised to avoid implying direct physiological validation, and future work will incorporate blood analogues, coagulation effects, venous valves, and patient-specific vascular geometries.

7. The manuscript repeatedly describes the proposed device as biodegradable and discusses its potential as an embolization implant. However, the present study uses commercial PLA and does not evaluate degradation kinetics, biocompatibility, hemocompatibility, sterilization, or suitability for intravascular implantation. The hydraulic proof of concept should be clearly distinguished from evidence supporting a clinically relevant biodegradable implant.

Thank you for this valuable comment. We agree that the present manuscript evaluates only the hydraulic feasibility of flow redistribution and does not demonstrate the clinical suitability of a biodegradable implant. We revised the manuscript to clearly distinguish between proof-of-concept hydraulic testing and future implant development. PLA was used solely as a convenient additive-manufacturing material for experimental validation and was not investigated with respect to degradation kinetics, biocompatibility, hemocompatibility, sterilization, or regulatory

considerations. The conclusions have been modified accordingly, and future work will address material selection, crimpability, implantation procedures, coagulation behavior, biodegradation, and in vitro biological validation.