

Abstract in English

„Vascular Interventions: Optimization of Splenic Artery Aneurysm Treatment and Follow-up”

Splenic artery aneurysms are the dominant category of pathology within the spectrum of visceral aneurysms, representing 50-60% of all cases in this vascular group. Other locations include the superior mesenteric artery, celiac trunk, hepatic artery, and gastroduodenal artery along with their branches. In the context of abdominal anatomy, splenic aneurysms rank third in terms of prevalence, surpassed only by abdominal aortic aneurysms and iliac artery aneurysms. Epidemiological data indicate the prevalence of visceral aneurysms in the general population to be between 0.1-2%, making them a relatively rare yet clinically significant disease entity.

The most dangerous complication of splenic aneurysms remains their rupture, characterized by high mortality rates ranging from 10-25% of cases. This alarming statistic underscores the imperative for early identification and appropriate therapeutic intervention. According to current guidelines from the European Society for Vascular Surgery, indications for intervention include aneurysms exceeding 3 cm in diameter, all cases in women of reproductive age, patients eligible for liver transplantation, and all pseudoaneurysms regardless of size.

The evolution of endovascular techniques has led to a fundamental shift in the therapeutic paradigm, making endovascular methods the preferred treatment option for splenic aneurysms. The resulting advantage is based on high clinical efficacy combined with a significant reduction in the risk of periprocedural complications. The contemporary endovascular approach offers two distinct therapeutic strategies: selective embolization preserving the patency of the splenic artery, and non-selective occlusion involving both the aneurysm sac and the parent vessel. The selective methodology, characterized by a reduction in the incidence of post-embolization syndrome and minimization of the risk of splenic ischemia, requires the implementation of a systematic observation protocol due to the potential risk of recanalization.

Current literature shows a significant gap in clear guidelines regarding the optimal therapeutic strategy and standardization of imaging methodologies in post-procedural surveillance. This lack of protocol clarity presents a considerable clinical challenge, particularly in the context of long-term monitoring of treatment effectiveness.

This doctoral dissertation presents a comprehensive publication cycle documenting the results of endovascular treatment of splenic aneurysms and a comparative analysis of the diagnostic effectiveness of various imaging modalities, including magnetic resonance angiography, Doppler ultrasound, and digital subtraction angiography in post-procedural follow-up protocols. All studies presented were conducted at the author's home institution in collaboration with the Department of General, Vascular, Endocrine, and Transplant Surgery, ensuring methodological consistency and continuity of clinical observation.

Additionally, the dissertation includes a thematically related publication analyzing the impact of coil packing density on the incidence of reperfusion following selective treatment of splenic aneurysms using detachable microcoils, as well as defining a monitoring protocol utilizing contrast-enhanced magnetic resonance imaging. A detailed discussion of this analysis can be found in the chapter dedicated to publications thematically related to the main focus of the dissertation.

Publication No. 1 included in the series:

Can Color Doppler Ultrasound Be Effectively Used as the Follow-Up Modality in Patients Undergoing Splenic Artery Aneurysm Embolization? A Correlational Study between Doppler Ultrasound, Magnetic Resonance Angiography and Digital Subtraction Angiography

Authors: **Lamparski K**, Procyk G, Bartnik K, Korzeniowski K, Maciąg R, Matsibora V, Sajdek M, Dryjańska A, Wnuk E, Rosiak G, Maj E, Januszewicz M, Gąsecka A, Ostrowski T, Kaszczewski P, Gałązka Z, Wojtaszek M

The aim of the study was to assess the effectiveness of Doppler ultrasonography as a follow-up method in patients after selective embolization of splenic artery aneurysms, in comparison with digital subtraction angiography and contrast-enhanced magnetic resonance imaging. The retrospective study included twenty patients, fifteen of whom were women, who underwent selective embolization with detachable coils. Follow-up was performed three months after the initial embolization or reintervention, using all three imaging modalities during the same hospitalization period.

Primary clinical success, defined as Class I aneurysm occlusion at three-month follow-up, was observed in sixteen patients (80.0%). Four patients required re-embolization procedures due to aneurysm reperfusion. When compared to DSA as the reference standard, DUS demonstrated a sensitivity of 94.4% and specificity of 42.9% for identifying complete aneurysm occlusion. In comparison to MRA, DUS showed a sensitivity of 92.3% and specificity of 30.0%. The positive predictive value of DUS for identifying the need for re-embolization was 75.0%, while the negative predictive value reached 90.5%.

The study revealed that DUS exhibited high sensitivity in detecting successful aneurysm occlusion but demonstrated poor specificity, particularly in identifying small residual leaks. Visualization conditions were classified as poor in 25% of patients, primarily due to aneurysm location in the middle segment of the splenic artery, where adequate acoustic windows were difficult to obtain. Additionally, abdominal obesity and bowel artifacts constituted significant acoustic barriers affecting the reliability of the assessment.

The authors propose a modified surveillance protocol where DUS could be used in conjunction with MRA at three months post-procedure, with subsequent follow-up potentially relying on DUS alone in cases of complete occlusion confirmed by both modalities under good visualization conditions.

The study acknowledges several limitations, including the small cohort size due to the relatively low prevalence of splenic artery aneurysms, single-center design, and lack of long-term follow-up data. Nevertheless, the authors emphasize the potential economic and practical benefits of using ultrasonography as a monitoring method,

especially in situations where other modalities are contraindicated, such as in patients with renal failure or in pregnant and breastfeeding women. The results suggest that Doppler ultrasonography may be useful in selected cases, although this requires confirmation in larger, multicenter prospective studies.

Publication No. 2 included in the series:

Imaging modalities used in the follow-up after coil embolization of splenic artery aneurysm – a systematic review

Authors: **Lamparski K**, Procyk G, Sajdek M, Gąsecka A, Maj E, Januszewicz M, Wojtaszek M

This systematic review was conducted in accordance with the PRISMA 2020 guidelines to assess the utility of various imaging modalities in post-procedural follow-up of patients after coil embolization of splenic artery aneurysms. Five databases were searched, including Embase, Medline Ultimate, PubMed, Scopus, and Web of Science, identifying a total of 1,704 records. After removing duplicates and applying inclusion and exclusion criteria, 20 original studies meeting the defined methodological assumptions were included in the analysis.

Digital subtraction angiography, while historically considered the reference standard, demonstrated significant limitations as a routine follow-up tool. The invasive nature of the procedure, requirement for ionizing radiation, and potential for radio-opaque coils to obscure small instances of aneurysmal sac reperfusion make it unsuitable for routine surveillance. The review highlighted that DSA should be reserved for cases requiring immediate reintervention rather than routine monitoring.

Computed tomography angiography proved to be an appropriate diagnostic method for patients immediately after the procedure, especially when serious complications such as bleeding or organ ischemia are suspected. However, significant beam-hardening artifacts generated by endovascular devices—mainly coils and tantalum-based embolic agents—have led many authors to question the reliability of this method in assessing persistent aneurysm sac reperfusion or coil compaction.

Magnetic resonance angiography demonstrated superior performance characteristics across multiple studies, emerging as the most promising non-invasive follow-up modality. Several investigations demonstrated a 33% superiority in patients requiring reintervention. The non-invasive nature, absence of ionizing radiation, and ability to evaluate collateral circulation make MRA particularly attractive for long-term surveillance protocols.

Although Doppler ultrasonography is characterized by low cost, non-invasiveness, and safety, it has significant limitations due to its operator dependency and reduced effectiveness in patients with obesity or intestinal gas. One study demonstrated a positive predictive value of seventy-five percent in identifying cases requiring re-embolization, suggesting its potential usefulness as a follow-up tool in selected low-risk patients. The addition of contrast-enhanced ultrasonography to standard Doppler ultrasound presents a promising solution; however, there is a lack of evidence supporting the superiority of this combination over conventional ultrasonography in post-procedural monitoring.

The systematic review revealed significant limitations in the available scientific evidence regarding optimal imaging methods for post-embolization monitoring of splenic artery aneurysms treated with coils. Most of the analyzed studies were retrospective in nature, involved small patient groups, and exhibited a low level of methodological quality. The recommendations are based on low-quality studies that do not directly address the issue of the most appropriate follow-up imaging modality.

Summary of the Publication Cycle

The presented publication cycle, which forms the basis of the doctoral dissertation, aimed to comprehensively evaluate contemporary endovascular techniques for the treatment of splenic artery aneurysms and to systematically analyze the effectiveness of various imaging modalities in post-procedural monitoring. In light of the lack of clear

guidelines regarding optimal patient monitoring protocols after endovascular treatment, the studies focused on identifying the most effective diagnostic methods.

The analyses conducted confirm that endovascular techniques, particularly embolization with detachable coils, represent a safe and highly effective method for treating splenic artery aneurysms. A selective approach that maintains the patency of the parent artery demonstrates superiority over non-selective methods, minimizing the risk of complications. An important finding is the identification of a coil packing density of at least 29% of the aneurysm volume as a critical factor determining long-term treatment effectiveness.

In terms of post-procedural diagnostics, magnetic resonance angiography (MRA) shows an advantage over other imaging modalities. MRA has a higher sensitivity in detecting reperfusion of the aneurysm sac compared to digital subtraction angiography, while also offering non-invasiveness and no exposure to ionizing radiation. This modality should be regarded as the gold standard in scheduled post-procedural follow-ups.

Computed tomography angiography should be limited to emergency situations when serious post-procedural complications are suspected due to significant beam hardening artifacts. Doppler ultrasound may serve as an adjunctive modality for patients at low risk of reintervention and in cases where other imaging methods are contraindicated.

The studies presented fill an important gap in the medical literature, providing evidence-based guidelines for clinical practice. The identified post-procedural monitoring protocols may contribute to improving patient safety and optimizing the use of diagnostic resources within the healthcare system.