Transarterial Embolization of Visceral Artery Aneurysms - A Literature Review and Two Case Reports

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Fig. 1: Post-interventional findings showing the gastro-duodenal artery without occlusion of collaterals

Abstract

The management of an aneurysm or pseudoaneurysm, including decisions regarding how, when, and with what method it should be treated, must always be determined through interdisciplinary consensus grounded in a thorough understanding of the existing literature. Consequently, today's preferred approach is embolization therapy or covered stenting. This method, performed in a minimally invasive manner, has been well-established due to its methodical low invasiveness and high effectiveness in achieving both technical and clinical success. It stands as a prominent choice among the available surgical and minimally invasive therapy options. The procedure, executed with advanced technology, utilizes the latest catheters and wires, coupled with expertise in various embolization methods. This comprehensive approach enables the treatment of acute bleeding in emergency cases, ensuring a nuanced and effective response (9-13).

***Keywords:**, ileocolic artery pseudoaneurysm, primary surgical hemostasis, micro coil embolization*

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Introduction

The inaugural identification and description of a visceral artery aneurysm occurred in 1770 when the French physician Beaussier documented such an occurrence in the splenic artery during an autopsy (33). Aneurysms are frequently discovered incidentally, with a prevalence of up to 6.9% on (CT-) angiography (29).

Stone et al. (29) categorized aneurysms in their study of 21 patients, identifying 14 male patients (67%) and 7 female patients (33%) in the observation period spanning from 1980 to 1998. In this cohort, aneurysms were documented at a frequency of 0.1-0.2%. Pitcher et al. reported an average size ranging from 2 to 3 cm in their study involving 144 aneurysms across 131 patients (15).

Pitton et al., in a comprehensive analysis of 233 patients with a total of 253 visceral aneurysms, identified 11 (6%) aneurysms in the main trunk of the superior mesenteric artery and its side branches. Notably, the rupture rate in this large patient population was significantly higher for pseudoaneurysms at 76.3%, compared to true aneurysms at only 3.1% (33).

The diagnosis and clinical manifestation of most aneurysms (1-4) typically occur after aneurysm hemorrhage. Two primary categories of causes contribute to aneurysm development:

1. Endogenic causes:
Degenerative arteriosclerotic changes in the vessel wall stand as the primary predisposing factors for the formation of aneurysms or pseudoaneurysms, frequently occurring in conjunction with prolonged arterial hypertension. This degenerative process serves as the primary cause of true aneurysms. Another subgroup within this cohort comprises infections / mycotic aneurysms, with mycotic aneurysms being the second most common etiology (27).

2. Exogenic causes:
Aneurysms may arise following direct vessel trauma, often presenting as pseudoaneurysms. Primary causes include iatrogenic factors such as surgery / punctures, as well as traumatic events like traffic accidents, impact injuries (blunt trauma), and vascular penetrating injuries caused by gunshot wounds or stabbings.

Treatment:

-Presently, the available treatment options for visceral aneurysms encompass:

1. Surgical Treatment:
- Resection of the aneurysm with vessel reconstruction, potentially performed laparoscopically in specific cases.

2. Minimally Invasive, Endovascular Transcatheter Treatment:
- Widely acknowledged as the method of choice, this approach is applied based on interdisciplinary consensus.

Within the realm of minimal invasive treatment, options include transcatheter aneurysm occlusion using covered stents or embolization employing macro- and microcoils, microvascular plugs (MVP), or a combination with liquid embolisates such as Onyx. In instances where coil-alone closure is inadequate, the packing technique is employed (5-7). A newly emerged subset of stents, known as flow diverters, originally from interventional neuroradiology, is utilized to line vessels and diminish flow within the aneurysm, leading to aneurysm thrombosis. Although these devices offer advantages in terms of smaller placement mechanisms and catheters, their widespread use is constrained by their high cost (8). Preserving vessel flow is achieved through various techniques, including stenting and coiling through the stent struts or balloon-protected aneurysm coiling. While covered stents and flow diverters maintain antegrade flow without embolizing the aneurysm, alternative techniques may mechanically occlude either the aneurysm alone or both draining and feeding vessels if they can be sacrificed.

Treatment strategies differ for mycotic aneurysms (14), necessitating surgical intervention due to the introduction of foreign bodies such as stents, coils, or liquid embolisates being unsuitable for primarily infected tissue (25,26). In critical conditions where general anesthesia or surgical procedures are not viable, the minimally invasive endovascular procedure may be the preferred method, even for mycotic aneurysms (17,18).

Overall, transarterial treatment is currently administered in over 95% of cases, demonstrating both technical and, in many

instances, primary clinical success rates of a similar magnitude in patients (19,20).

In 2020, the American Society for Vascular Surgery issued clinical practice guidelines on visceral aneurysm management. Chaer et al. presented treatment recommendations based on factors such as type (true and false aneurysms), localization, and the clinical course of the aneurysm (36).

Case 1:

In April 2023, a 64-year-old patient (Fig. 1 and 2) presented with hemodynamically significant retroperitoneal hemorrhage stemming from a branch of the gastroduodenal artery, necessitating surgical intervention. Subsequent postoperative CT imaging revealed a 4mm aneurysm in a mesenteric branch in the upper abdomen, likely corresponding to a side branch of the right gastroepiploic artery.

Considering a prior episode of bleeding within the same vascular territory, the interdisciplinary team recommended embolization to the patient. The procedure was conducted electively, commencing with retrograde ultrasound-guided access to the right common femoral artery. Following the insertion of a 6-F sheath, probing and visualization of the celiac trunk were undertaken using a SIM 1 selective catheter. Selective and superselective visualization of the aneurysm at the vessel branch in the region of the gastroduodenal/right gastroepiploic artery revealed a 3.5 x 4 mm true aneurysm. Subsequently, probing and an attempt at superselective embolization using detachable coils were performed. Due to the anticipated risk of coil dislocation attributed to the wide neck of the aneurysm and its location involving three vessel branches, partial anchoring of a 5mm coil (5/150 mm Concerto 3D) in one of the collaterals was executed. Cautious

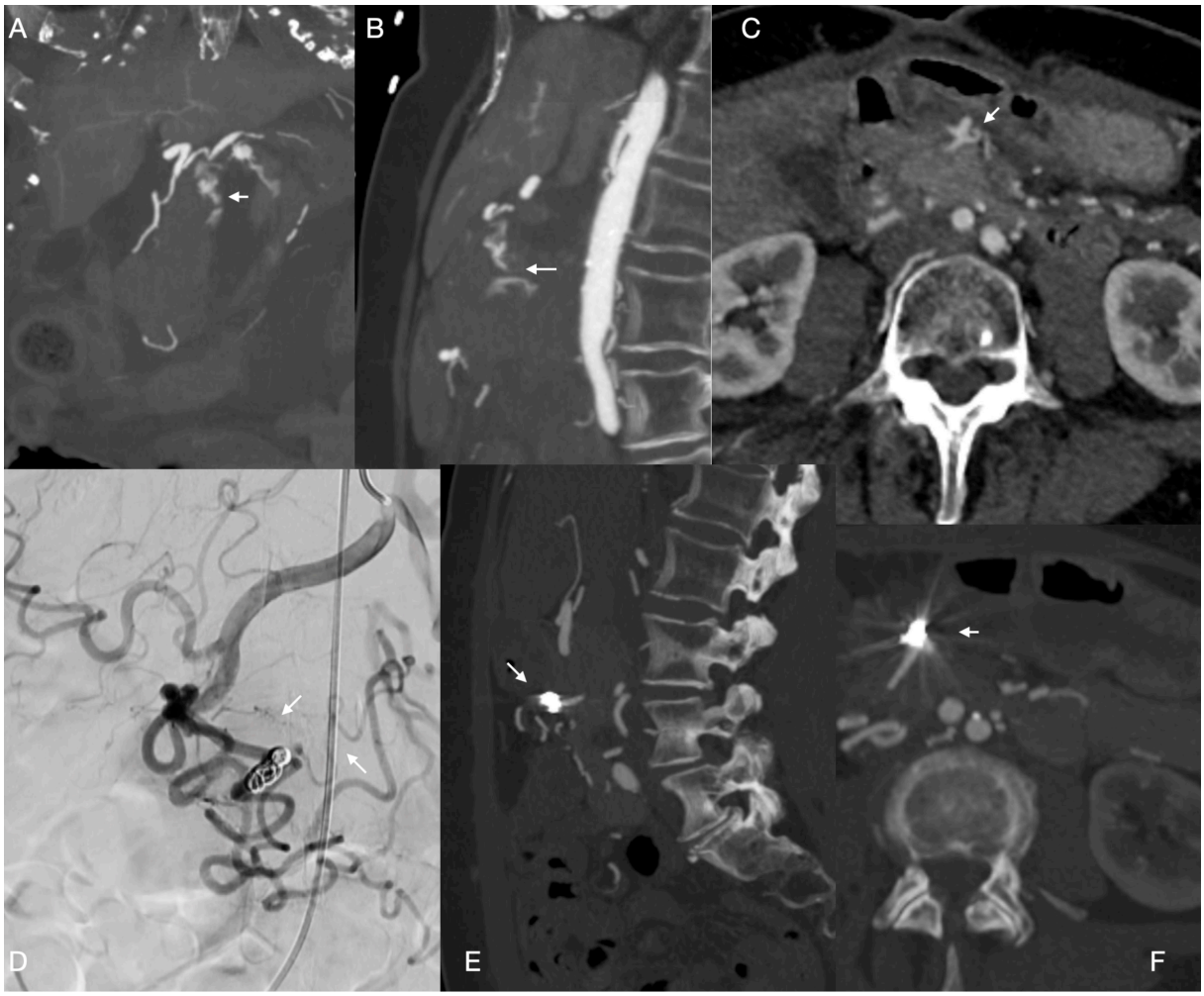

Fig. 2: A) and **B)** CT axial and sagittal with active bleeding from gastro-duodenal artery - Arrowheads. **C)** Persistent aneurysm verum after bleeding from cranially located branch of gastro-duodenal artery Arrowhead. **D)** Angiographic control of gastro-duodenal artery with patent collaterals after coiling of aneurysm. Arrows. **E)** and **F)** CT-control after successful coiling. Arrowheads.

retraction of the microcatheter facilitated the retrograde placement of the main portion of the coil within the aneurysm. A second 4mm detachable coil (4/80 mm Concerto 3D) was then successfully utilized to pack the aneurysm.

The final control angiography exhibited a densely packed aneurysm sac, devoid of residual perfusion. The anchoring coil segments in the gastric collateral minimally impacted collateral flow. The preserved antegrade perfusion of vessels traversing the aneurysm indicated a technically successful embolization without the threat of ischemia in adjacent vessels. The overall procedure duration was 62 minutes.

The patient was discharged in good general condition after two days, with unremarkable local findings following puncture in the right groin. Subsequent clinical follow-up revealed no new bleeding incidents. A CT scan performed four months post-embolization demonstrated the absence of residual aneurysm perfusion and patent collateral vessels.

Case 2:

A 68-year-old patient with dilated arteriopathy, following juxtarenal aortic replacement with a Y-prosthesis, underwent a series of visceral surgical interventions, including sigmoid resection, multiple laparotomies, adhesiolysis, and ultimately, stoma relocation after left hemicolectomy (Fig. 3 and 4). Subsequent follow-up revealed the presence of a pseudoaneurysm in a branch of the superior mesenteric artery (SMA) in the right mid-lower abdomen, likely resulting from iatrogenic or clamping damage to the mesentery.

After interdisciplinary consultation, embolization was recommended. Retrograde puncture of the right femoral artery was performed using the Seldinger technique under local anesthesia, with the introduction of a 5-F sheath. In the overview angiography of the SMA using a 4 French C1 catheter, an amputated side-branch of the SMA was observed. A slow-perfused pseudoaneurysm, likely originating from the ileocolic artery, was identified after superselective catheterization using a 2.4 CH microcatheter, measuring 17 x 7 mm. Successful selective probing of the aneurysm neck was performed.

Peripheral evidence of retrograde contrast in a presumably dissected branch in a small arcade was observed. Coiling of the aneurysm neck was accomplished using a 2/80 mm detachable microcoil (Concerto helix, Medtronic), leading to immediate occlusion with contrast stasis. Catheterization of the distal retrograde arcade branch was also carried out. Although no perfusion of the aneurysm was visible, the small side branch was coiled using a 2/20 mm microcoil (Concerto helix, Medtronic). Control angiography confirmed complete aneurysm occlusion without flow impairment in adjacent vessels. The intervention time totaled 56 minutes.

Renewed superselective probing of the suspected dissected branch revealed evidence of retrograde inflow just short of the aneurysm. The patient's post-interventional course was uneventful, allowing for discharge after 3 days in an age-appropriate and subjectively well state. A follow-up CT scan conducted 3 months post-embolization demonstrated persistent occlusion of the pseudoaneurysm with a decreasing size, and no signs of coil migration or bowel ischemia were observed.

Discussion:

Aneurysms and pseudoaneurysms pose a considerable risk of rupture, leading to potentially life-threatening bleeding when they reach a size of 2-3 cm (33). In cases of sudden onset bleeding, immediate and efficient therapy, guided by interdisciplinary guidelines and consensus, is imperative (21-24). Emergency angiography, performed super-selectively with embolization readiness, is considered the first-line treatment, showing high technical success rates up to 100% and a low complication rate of 0.1-0.2% for treated ruptured visceral aneurysms after embolization (33).

Before the advent of minimally invasive transcatheter treatments, the primary options were surgical clamping, vessel reconstruction, or resection of the affected vessel. While these methods remain prevalent for mycotic aneurysms, percutaneous endovascular embolization (PAE) (28) has gained prominence for ruptured aneurysms,

exhibiting a 30-day mortality rate of 6.7% compared to 0% for non-ruptured aneurysms (30-33). Interdisciplinary guidelines now guide the elective treatment decisions for incidental aneurysms, and embolization techniques have evolved with the introduction of new catheters and guide wires.

In cases where the exact bleeding localization can be determined by angio-CT before the minimally invasive procedure, it proves beneficial for subsequent emergency angiography. In critical conditions, emergency angiography can be performed as an overview, followed by selective and superselective imaging to locate the bleeding source, leading to immediate embolization (34,35).

With the continuous development of endovascular transcatheter embolization techniques, careful consideration is given to the

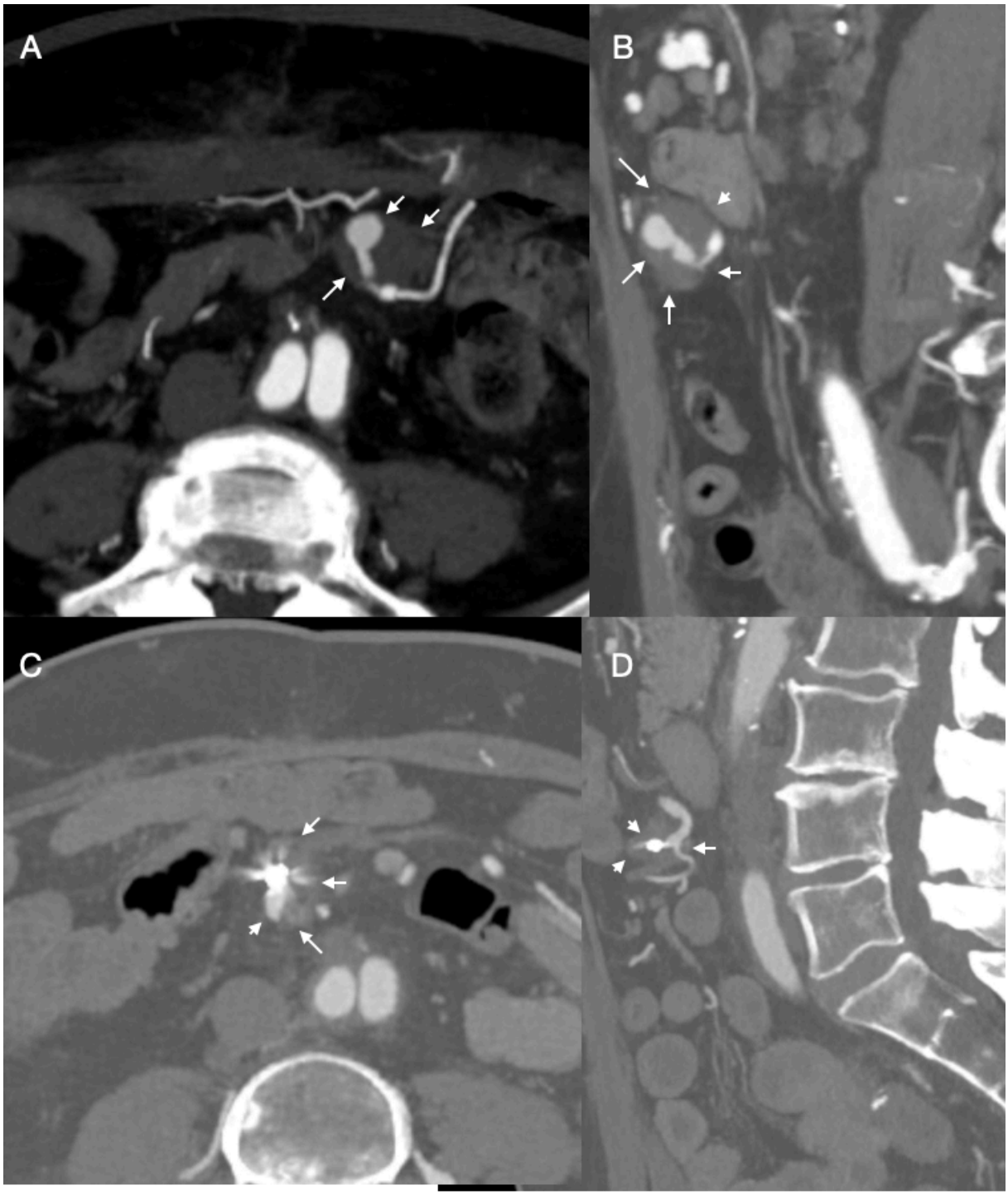

Fig. 3: A) and **B)** CT axial & sagittal showing a big aneurysm spurium of a branch of colic medial artery with partial thrombosis - Arrows. **C)** and **D)** Complete thrombosis of shrinking aneurysm after coiling - Arrows.

placement of embolization material, primarily coils, alone or in combination with liquid embolics. The risk of complications, such as embolism dislocations causing intestinal wall ischemia, demands vigilant attention. Historical studies by Nöldge et al. in the 1980s provided insights into vascular compensation mechanisms, emphasizing the importance of superselective placement to avoid complications.

bination with corpuscular and liquid embolic materials, to prevent the risk of intestinal wall ischemia. Complications in the SMA are estimated to vary between 6-15.6%, depending on sub-cohorts, highlighting the importance of meticulous intervention.
Pitcher's recent retrospective evaluation sheds light on the predominance of vascular surgery therapy over endovascular minimally invasive approaches for SMA aneurysms. Special considerations and

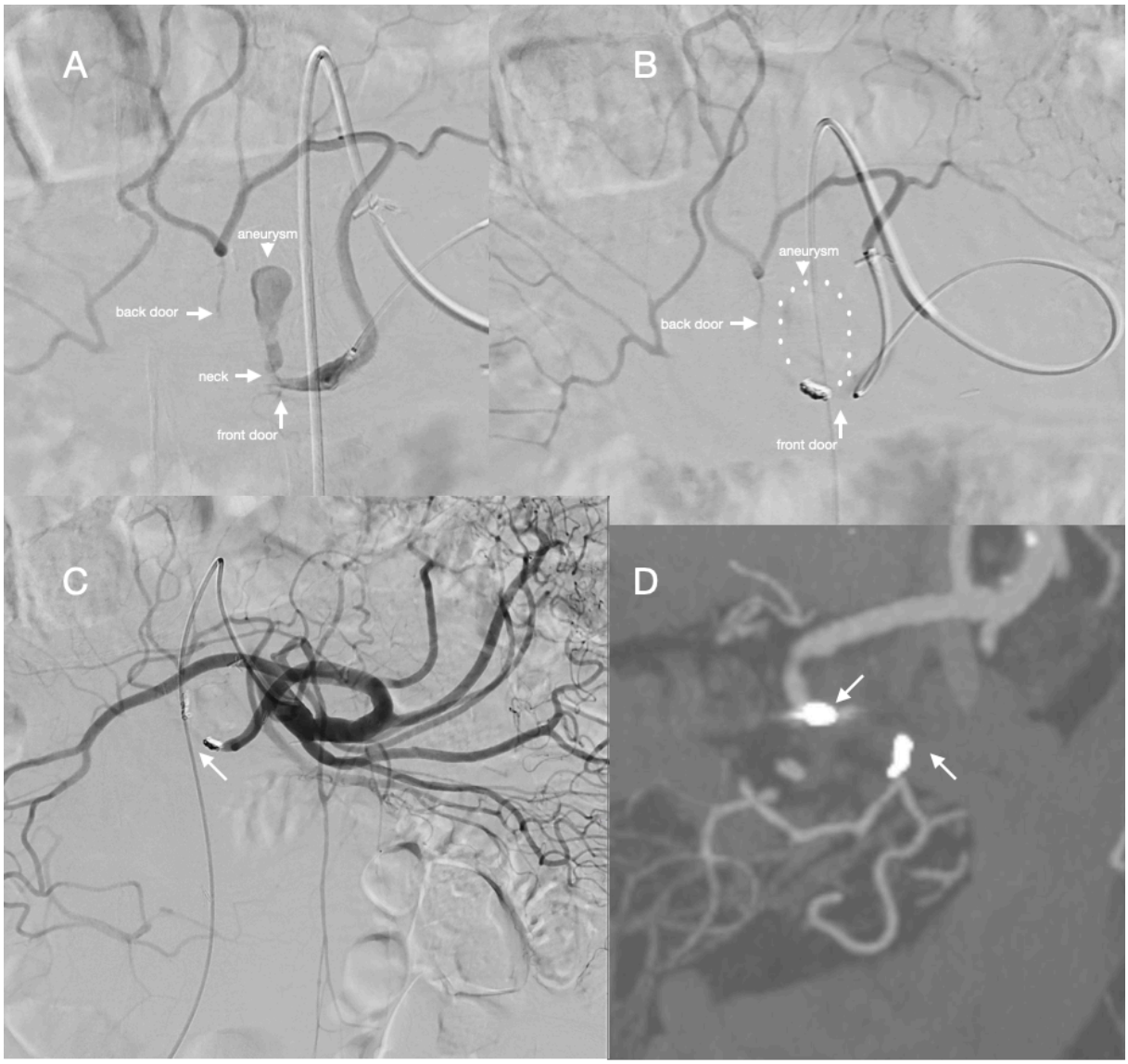

Fig. 4: A) and **B)** superselective angio showing arcade distally of aneurysm spurium due to back door collaterals - Arrows. **C)** and **D)** Complete occlusion of aneurysm with coils in side branches of medial colic artery and in the neck region - Arrows.

In the specific context of the superior mesenteric artery (SMA), embolization therapy for aneurysms or pseudoaneurysms has reported high technical and clinical success rates of up to 99.8% (33). However, careful consideration is required when placing coils, particularly in com-

challenges are outlined for specific locations, including occluding the celiac trunk in cases involving the pancreatic-duodenal artery. Additionally, rare occurrences of aneurysms in Crohn's disease underscore the importance of tailored treatment strategies.

The success of embolization therapy is contingent upon the correct interdisciplinary indication, angiographic expertise, preinterventional imaging, and the appropriate choice of embolization material based on the anatomical and bleeding characteristics. Covered stents are favored in straight vessel sections, while macro and micro coils, alone or in combination with liquid embolisates, are preferred in cases lacking a suitable anatomical neck. Special precautions must be taken, particularly in cases without a neck, to prevent complications such as embolic material dislocation. The two cases presented here exemplify the effectiveness of embolization therapy when performed with meticulous care and expertise.

Conclusion

The decision-making process regarding the treatment approach for an aneurysm or pseudoaneurysm necessitates a thorough interdisciplinary consensus, taking into account the existing body of literature. Currently, embolization therapy or covered stenting stands out as the preferred method. Performed in a minimally invasive manner, this approach boasts methodically determined low invasiveness and exhibits high effectiveness in terms of both technical and clinical success. It has firmly established itself as a key modality within the spectrum of available surgical and minimally invasive therapeutic options.

Leveraging advanced technology, state-of-the-art catheters, wires, and comprehensive expertise in various embolization methods, the treatment of acute bleeding in emergency cases has become feasible. However, it is imperative for the radiological interventionist to prioritize vigilance against the risk of over embolization and the potential complication of embolization material dislocation. This precautionary measure is crucial to prevent such occurrences in every case, as underscored by the experience with our patients.

Conflict of interest:

The authors declare that there were no conflicts of interest within the meaning of the recommendations of the International Committee of Medical Journal Editors when the article was written.

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