

Efficacy and safety of empiric transcatheter arterial embolization for acute arterial upper gastrointestinal bleeding: A tertiary-care, single-center experience

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ABSTRACT

BACKGROUND: Upper gastrointestinal bleeding (UGIB) is a significant cause of morbidity and mortality. While endoscopy is the primary treatment modality, transcatheter arterial embolization (TAE) can be an effective alternative when endoscopic treatment fails. This study aims to evaluate the safety and efficacy of empiric TAE for acute UGIB.

METHODS: This retrospective, single-center study reviewed 20 consecutive patients referred to interventional radiology for embolization due to UGIB between August 2021 and November 2024. The mean patient age was 62.3±16.2 years. Clinical success was defined as devascularization of the target area resulting in clinical cessation of bleeding and stabilization of hemoglobin levels. Technical success was defined as occlusion of the feeding vessel and/or absence of extravasation following angiography.

RESULTS: Thirteen patients (65%) had duodenal bleeding and underwent gastroduodenal artery embolization. Seven patients (35%) had gastric bleeding and underwent left gastric artery embolization. Both the technical and clinical success rates of the procedure were 100%. Rebleeding occurred in one patient (5%) and was managed surgically. There was no procedure-related mortality. One major complication (5%), coil migration, was managed conservatively. One minor complication (5%), a groin hematoma, occurred and did not require transfusion.

CONCLUSION: Empiric transcatheter embolization is an effective and safe treatment option for acute upper gastrointestinal bleeding, demonstrating high technical and clinical success rates. The procedure shows favorable outcomes in terms of hemostasis, rebleeding rates, and complication profiles compared to surgical intervention.

Keywords: Transcatheter arterial embolization; upper gastrointestinal bleeding; gastroduodenal artery; therapeutic embolization; interventional radiology.

INTRODUCTION

Upper gastrointestinal hemorrhage (UGIB), originating from anatomical sites superior to the ligament of Treitz, is a significant contributor to morbidity and mortality worldwide.^[1]

Despite advances in endoscopic interventions and pharmacologic therapy, the mortality rate associated with UGIB remains approximately 5-10%, with no discernible change over the past two decades.^[2] The primary causes include peptic

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ulcer disease, erosive gastroduodenal mucosal lesions, Mallory-Weiss syndrome, and neoplastic conditions of the upper gastrointestinal tract.^[3]

Endoscopic therapy is the first-line treatment for UGIB. Bleeding can be managed with an 85-95% success rate using endoscopic methods.^[4] However, endoscopic management may fail in cases of massive bleeding, anatomically inaccessible lesions, or refractory bleeding despite initial hemostasis. In the past, surgery was considered the standard salvage therapy for failures of endoscopic procedures. However, surgical management is associated with significant morbidity rates ranging from 20% to 40% and mortality rates between 10% and 30%, especially in elderly patients with comorbidities.^[5,6] Transcatheter arterial embolization (TAE) has emerged as an alternative to surgery for patients with refractory UGIB. Advances in microcatheter technology, embolic agents, and imaging guidance have improved TAE's technical success and safety profile.^[7,8]

Despite the increasing adoption of TAE for UGIB, there remains debate regarding its efficacy compared to surgical intervention, particularly concerning rebleeding rates, long-term outcomes, and specific patient populations who might benefit most from each approach.^[9]

This study aimed to assess the technical success, clinical effectiveness, and safety profile of empiric TAE for UGIB and to compare these outcomes with those reported for surgical interventions in the current literature.

MATERIALS AND METHODS

Study Design and Patient Selection

This study was designed as a single-center, retrospective analysis. Ethics committee approval was granted for the study (16.01.2025/E-43012747-050.04-438245). Because of its retrospective design, the study was exempt from the requirement for informed consent. The study was conducted in accordance with the Declaration of Helsinki. We reviewed the electronic medical records of 33 consecutive patients referred to interventional radiology for embolization due to UGIB between August 2021 and November 2024. All patients included in the study were first evaluated with endoscopy. TAE was performed in patients whose bleeding could not be controlled by endoscopic interventions. The files of 33 patients referred to the interventional radiology department by the general surgery service for upper gastrointestinal (GI) bleeding were analyzed. Eight patients who were unsuitable for TAE and five who did not consent to TAE were excluded from the study. Twenty patients (6 males, 14 females) with a mean age of 62.3 years (range: 19-84 years) were included in the study (Fig. 1).

Inclusion criteria were: (1) patients with endoscopically confirmed or clinically suspected UGIB; (2) failure of or contra-indication to endoscopic management; (3) referral for inter-

ventional radiological management; and (4) patients who gave consent to endovascular treatment.

Exclusion criteria were: (1) lower gastrointestinal bleeding; (2) incomplete medical records; (3) patients who underwent prophylactic embolization before elective surgery; and (4) patients who did not give consent to endovascular treatment.

Data Collection

Patient demographic data, clinical parameters, procedural details, and outcomes were collected from electronic medical records. The following parameters were recorded: age, sex, pre- and post-procedure hemoglobin levels, indication for embolization, target vessel, embolic agent, technical success, clinical success, complications, and endoscopic findings.

Embolization Procedure

All interventions were conducted by experienced interventional radiologists in a specialized angiography suite. Following the administration of local anesthesia, access to the femoral artery was achieved using a 5F femoral sheath (Shunmei, China). An initial abdominal aortography was performed by selective catheterization of the celiac trunk and superior mesenteric artery using a 5-French diagnostic catheter (Performa, Merit Medical, Ireland). Thereafter, super-selective catheterization of the gastroduodenal artery (GDA) or left gastric artery (LGA) was carried out using a microcatheter system (Progreat, Terumo, Japan).

Embolization was performed once the bleeding site was identified or prophylactically based on endoscopic findings. Embolic materials included microcoils (Interlock, Boston Scientific, USA) for the GDA and particles (Embosphere, Merit Medical, Ireland) for the LGA. Clinical success was defined as target-area devascularization resulting in clinical cessation of bleeding and stabilization of hemoglobin levels. Technical success was defined as occlusion of the feeding vessel and/or absence of extravasation following angiography.

Outcome Measures

The primary outcome measures included the rate of technical success (successful placement of embolic agents in the intended vessel) and clinical success (cessation of bleeding without signs of rebleeding within 30 days). Secondary outcome measures encompassed changes in hemoglobin levels, complication rates, duration of hospitalization, and mortality rates within 30 days.

The reporting guidelines established by the Society of Interventional Radiology classified complications as either minor or major. Minor complications were defined as those requiring only observation without intervention or hospitalization. In contrast, major complications were those necessitating prolonged hospitalization, an unplanned increase in the level of patient care, or resulting in sequelae or death. Rebleeding was defined as hematemesis, melena, or a decrease in hemoglobin concentration of ≥ 2 g/dL following initial stabilization.^[10]

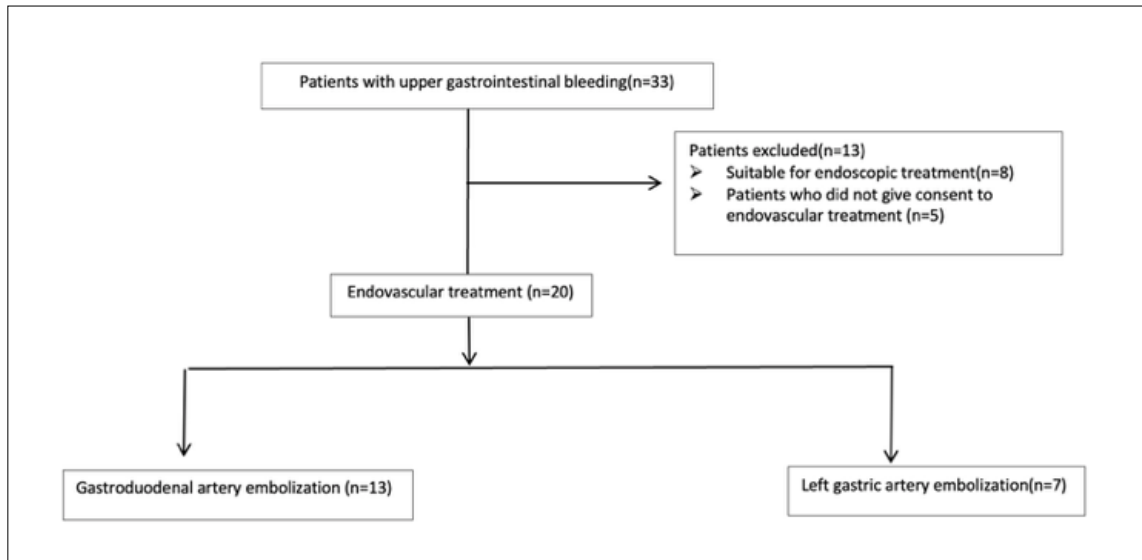


Figure 1. Study flowchart.

Statistical Analysis

Descriptive statistics were employed to describe patient demographics and clinical outcomes. Continuous variables were tested for normality using the Shapiro–Wilk test. As the data did not follow a normal distribution, pre- and post-procedure hemoglobin levels were compared using the Wilcoxon signed-rank test for paired samples. A p-value of <0.05 was considered statistically significant. Continuous variables were presented as mean±standard deviation, depending on distribution. Categorical variables were summarized as counts and percentages. All analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

RESULTS

The most common indications for embolization were duodenal ulcers (n=5, 25%), gastric malignancies (n=5, 25%), and gastric ulcers (n=4, 20%). Other indications included esophageal varices with gastric ulcer (n=1, 5%), post-surgical anastomotic bleeding (n=1, 5%), and undocumented indications (n=4, 20%). Table 1 summarizes the baseline characteristics of the study population.

Technical Outcomes

Of the 20 patients who underwent embolization, 13 (65%) had duodenal bleeding, for which gastroduodenal artery embolization was performed. The remaining seven patients (35%) had gastric bleeding and were treated with left gastric artery embolization. The procedure was successful in all patients (100%), achieving both technical and clinical success.

Coils were exclusively used in patients with duodenal bleeding (n=13, 65%), while particles were the embolic agents of choice in all gastric artery embolization cases (n=7, 35%). This approach was tailored to the specific site of bleeding and

the vascular anatomy of the patients (Fig. 2).

Rebleeding was observed in one patient (5%) and was managed surgically. A major complication, coil migration, was noted in one patient (5%) and was resolved with conservative management. Additionally, one patient (5%) experienced a minor complication, a groin hematoma, which did not require transfusion. No procedure-related deaths occurred.

Clinical Outcomes

Before the procedure, the average hemoglobin level was 7.9 ± 1.9 g/dL, increasing to 8.3 ± 1.2 g/dL post-procedure, representing a mean increase of 0.4 g/dL (p=0.15). Clinical success, defined as cessation of bleeding without rebleeding within 30 days, was achieved in 19 of the 20 patients (95%), although follow-up data were limited for some patients.

Complications occurred in two patients (10%), including coil migration in one patient (5%) and a groin hematoma in another (5%). These complications did not necessitate further

Table 1. Baseline characteristics of the study population

Characteristic	Value
Pre- and post-procedure hemoglobin levels (g/dL, mean±SD)	7.9 ± 1.9 vs. 8.3 ± 1.2 g/dL (p=0.15)
Indication for embolization, n (%)	
Duodenal ulcer	5 (25%)
Gastric malignancy	5 (25%)
Gastric ulcer	4 (20%)
Esophageal varices with gastric ulcer	1 (5%)
Post-surgical anastomotic bleeding	1 (5%)
Not clearly documented	4 (20%)

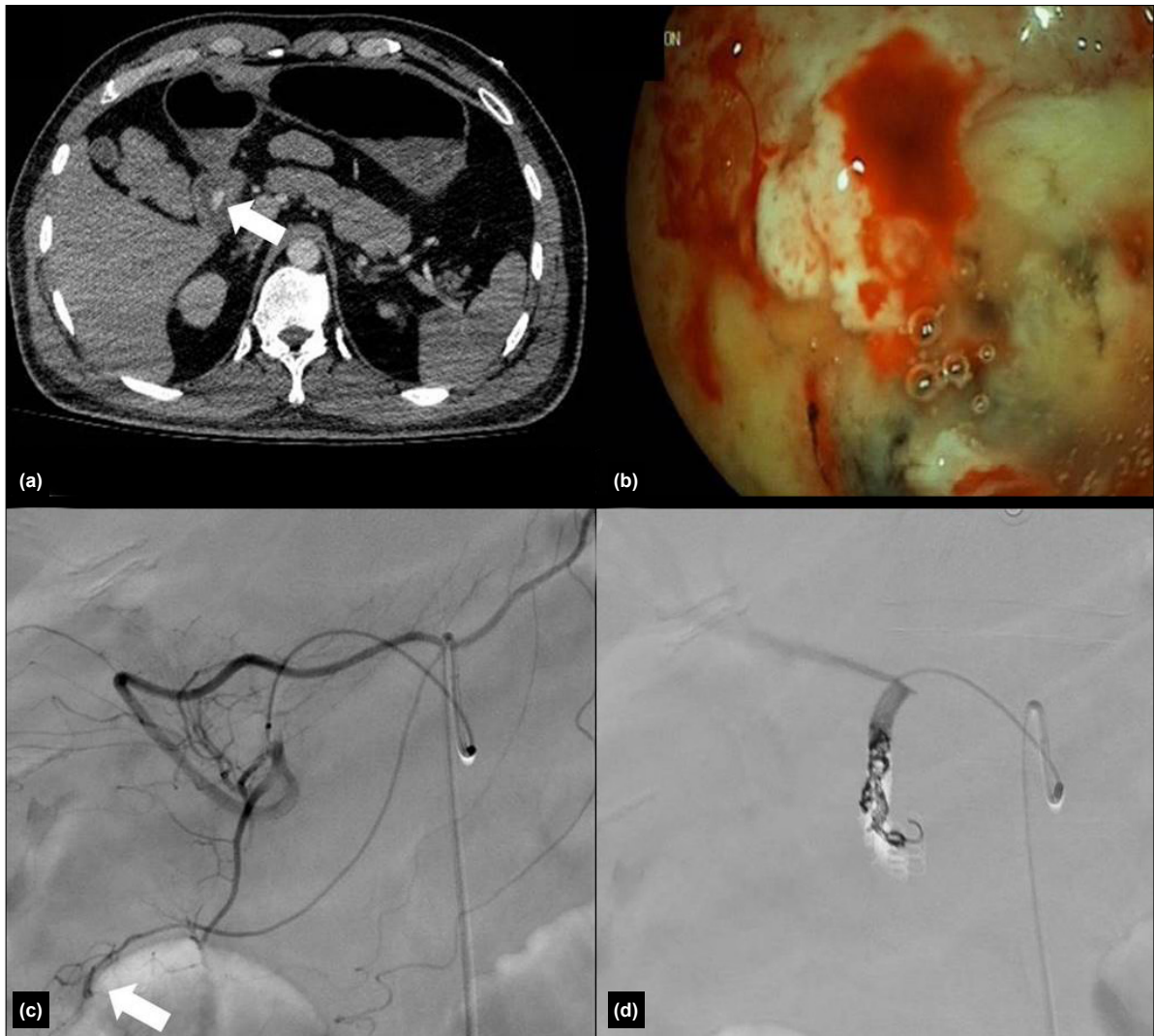


Figure 2. A 73-year-old man presenting with a bleeding duodenal ulcer. An axial contrast-enhanced computed tomography (CT) image (a) reveals active bleeding in the duodenum (arrow). Although the bleeding ulcer was identified on endoscopy, attempts to control the hemorrhage were unsuccessful (b). Celiac angiography (c) demonstrated active bleeding from the gastroduodenal artery (arrow). The bleeding was successfully managed by embolization of the gastroduodenal artery using microcoils (d).

interventions or result in clinical deterioration. No procedure-related deaths were recorded.

Endoscopic evaluation after the procedure was performed in 12 patients (60%) and demonstrated resolution of active bleeding in all cases, although some patients had persistent ulcers or malignant lesions.

DISCUSSION

This retrospective analysis demonstrates that TAE is an effective and safe treatment for UGIB, showing excellent technical and clinical success rates and a manageable complication profile. A unique aspect of our study is the inclusion of gastroduodenal artery and left gastric artery treatments, as well as the use of both coils and microspheres. Our findings are consistent with previous studies reporting technical success

rates ranging from 82% to 100% and clinical success rates from 65% to 93% for TAE in UGIB cases.^[11,12]

Our technical success rate of 100% is comparable to other published series. The single technical failure occurred due to instability of a coil in the gastroduodenal artery stump, highlighting the importance of careful coil selection and deployment techniques. Alternative embolic agents, such as gelatin sponge particles or liquid embolic agents, may be employed when coil deployment is challenging.^[13]

The clinical success rate of 100% is at the higher end of the range reported in the literature. This may reflect appropriate patient selection, technical expertise, and the use of suitable embolic agents based on bleeding characteristics. The choice of embolic agent remains somewhat controversial, with microcoils preferred for their precision and permanence. At the

same time, particles allow more distal embolization but carry a theoretical risk of ischemic complications.^[14]

Regarding safety, our complication rate of 15% is consistent with published rates of 9-20%.^[15] The observed complications were related to coil placement and were managed conservatively without clinical sequelae. Our series did not observe major complications such as bowel ischemia, which has been reported in 0-5% of cases in the literature. This may be attributed to careful technique with super-selective catheterization and embolization, preserving collateral circulation.^[16]

When comparing TAE with surgery for UGIB, our results suggest that TAE is similarly effective but carries a better safety profile, particularly for high-risk patients. Surgical interventions may have slightly higher technical success rates but are associated with increased morbidity (30-50%) and mortality (5-15%).^[17-19] The less invasive nature of TAE makes it an ideal option for elderly patients or those with significant comorbidities who may not be suitable candidates for major surgery.

Numerous studies have sought to identify variables that predict the efficacy or inefficacy of TAE in treating UGIB. Factors such as coagulopathy, multiple comorbid conditions, hemodynamic instability, and corticosteroid use have been associated with increased rebleeding rates after TAE.^[20] Appropriate patient selection is paramount, with some authors advocating surgical intervention as the primary treatment modality for young, healthy individuals with significant hemorrhage, while recommending TAE for older patients or those with substantial comorbidities.^[21-24]

The anatomical location of bleeding may also influence the success of TAE. Gastroduodenal and left gastric artery embolization have shown higher success rates than embolization of other vessels, likely due to the rich collateral circulation in these regions.^[25] In our series, most embolizations involved the gastroduodenal artery, which may have contributed to the favorable outcomes.

Recent innovations in embolization methodologies have further enhanced TAE's effectiveness and safety profile. The use of advanced microcatheters, detachable coils, and liquid embolic agents has improved procedural accuracy. Furthermore, the incorporation of cone-beam computed tomography within the angiography suite facilitates improved visualization of subtle hemorrhage and allows for more precise catheter placement.^[26] In addition to methodology, patient selection, pre-procedural evaluation, and post-procedural care are critical to effectiveness and safety.^[27]

The minimally invasive approach offers clear benefits, particularly for high-risk patients with comorbidities, compared to the significant physiological stress imposed by traditional surgery. However, it is important to acknowledge the vital role of surgical intervention in the management of upper gastrointestinal hemorrhage. Surgery continues to be an essential treat-

ment option due to its ability to achieve complete and lasting bleeding control through direct intervention at the hemorrhage site, particularly when transcatheter arterial embolization cannot be performed because of anatomical constraints or has failed to achieve the desired outcome. The successful surgical management of the 5% rebleeding rate observed in our study confirms that these two disciplines are not alternatives but complementary. Modern hemorrhage management should adopt a hybrid, patient-tailored approach, recognizing the strengths of both methods and fostering close collaboration between interventional radiology and surgery to achieve optimal patient outcomes.^[17,28]

Nevertheless, our study has several limitations. First, its retrospective nature introduces potential selection and information biases. Second, the relatively modest sample size limits statistical power and the ability to extrapolate our findings. Thirdly, follow-up data were not systematically collected for all patients, which may have resulted in underreporting of rebleeding incidences. Fourthly, our comparative analysis of surgical outcomes relied on published literature rather than direct comparisons, which may introduce confounding factors. Finally, the absence of consistent long-term follow-up beyond 30 days precludes the evaluation of late rebleeding or other delayed complications.

CONCLUSION

Transcatheter arterial embolization represents an effective and safe therapeutic modality for patients presenting with upper gastrointestinal hemorrhage, characterized by high technical and clinical success rates and a manageable complication profile. Our findings support the use of TAE as a primary intervention for patients with UGIB who do not respond to endoscopic management, particularly those at high surgical risk.

Ethics Committee Approval: This study was approved by the Sakarya University Ethics Committee (Date: 16.01.2025, Decision No: E-43012747-050.04-438245).

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Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - ÖZ

Akut arteriyel üst gastrointestinal kanamada empirik transkateter arteriyel embolizasyonun etkinliği ve güvenliği: Üçüncü basamak, tek merkez deneyimi

AMAÇ: Üst gastrointestinal sistem kanamaları (UGIB), önemli morbidite ve mortalite nedenlerinden biridir. Endoskopi birinci basamak tedavi yöntemi olmakla birlikte, başarısızlık durumunda transkateter arteriyel embolizasyon (TAE) etkili bir alternatif sunabilir. Bu çalışmada, akut UGIB tedavisinde empirik TAE yönteminin güvenilirliği ve etkinliği değerlendirilmektedir.

GEREÇ VE YÖNTEM: Bu retrospektif, tek merkezli çalışmada, Ağustos 2021 ile Kasım 2024 tarihleri arasında üst gastrointestinal sistem kanaması nedeniyle girişimsel radyolojiye embolizasyon amacıyla yönlendirilen ardışık 20 hasta değerlendirildi. Hastaların ortalama yaşı 62.3 ± 16.2 idi. Klinik başarı; hedef bölgedeki devaskülarizasyon sonrası kanamanın klinik olarak durması ve hemoglobin düzeyinin stabil hale gelmesi olarak tanımlandı. Teknik başarı ise; besleyici damarların tıkanması ve/veya anjiyografi sonrası ekstrasvazasyonun izlenmemesi şeklinde tanımlandı.

BULGULAR: On üç hastada (%65) duodenal kanama mevcuttu ve gastroduodenal arter embolizasyonu uygulandı. Yedi hastada (%35) ise gastrik kanama vardı ve sol gastrik arter embolize edildi. İşlemin teknik ve klinik başarı oranı %100 olarak belirlendi. Bir hastada (%5) tekrar kanama gelişti ve cerrahi ile tedavi edildi. İşleme bağlı mortalite saptanmadı. Bir hastada (%5) gelişen ciddi komplikasyon (coil migrasyonu) konservatif olarak yönetildi. Bir diğer hastada (%5) gelişen minör komplikasyon (kasık hematomu) ise transfüzyon gerektirmedi.

SONUÇ: Empirik transkateter embolizasyon, akut üst gastrointestinal sistem kanamalarının tedavisinde yüksek teknik ve klinik başarı oranlarıyla etkili ve güvenli bir yöntemdir. Hemostaz, tekrar kanama ve komplikasyon profili açısından cerrahi müdahaleye kıyasla avantajlı sonuçlar sunmaktadır.

Anahtar sözcükler: Girişimsel radyoloji; gastroduodenal arter; terapötik embolizasyon; transkateter arteriyel embolizasyon; üst gastrointestinal kanama.

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