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Identifying Predictors of Early Rebleeding Following Transcatheter Embolization in Acute Non-Variceal Upper Gastrointestinal Bleeding: A Retrospective Analysis

Akut Varis Dışı Üst Gastrointestinal Kanamada Transkateter Embolizasyonun Ardından Erken Tekrar Kanamanın Öngördürücülerinin Belirlenmesi: Retrospektif Bir Analiz

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Abstract: Acute non-variceal upper gastrointestinal bleeding (ANVUGIB) is a critical medical emergency. While transcatheter arterial embolization (TACE) is increasingly utilized when endoscopic hemostasis fails, the risk factors for early rebleeding post-TACE remain unclear. This study aimed to identify predictors of early rebleeding within 30 days of TACE in refractory ANVUGIB cases. A retrospective analysis was conducted on 56 TACE procedures performed between June 2020 and June 2023. Patients were included based on strict criteria, including failed endoscopic hemostasis or unsuitability for endoscopy. We assessed variables associated with early rebleeding and conducted univariate and multivariate analyses to identify significant predictors. Despite a technical success rate of 100%, 39.3% of patients experienced early rebleeding. Significant predictors of rebleeding included delayed angiography (P = 0.023), comorbidities (P = 0.048), failed endoscopic hemostasis (P = 0.010), and embolization of multiple vascular territories (P = 0.012). Timely angiographic embolization is essential for effective bleeding control in ANVUGIB. Delayed angiography, presence of comorbidities, failed endoscopic hemostasis, and embolization of multiple vascular territories were identified as significant predictors of early rebleeding. These findings highlight the importance of early and targeted intervention to improve clinical outcomes.
Keywords: Upper gastrointestinal hemorrhage, Endoscopy, Angiography, Embolization

Özet: Akut varis dışı üst gastrointestinal kanama (AVDÜGK), ciddi bir tıbbi acildir. Endoskopik hemostazın başarısız olduğu durumlarda transkateter arteriyel embolizasyon (TAKE) giderek daha fazla kullanılmakla birlikte, TAKE sonrası erken yeniden kanama risk faktörleri net değildir. Bu çalışma, dirençli AVDÜGK vakalarında TAKE'den sonraki 30 gün içinde erken yeniden kanama belirleyicilerini tespit etmeyi amaçlamıştır. Haziran 2020 ile Haziran 2023 arasında gerçekleştirilen 56 TAKE prosedürü üzerinde retrospektif bir analiz yapıldı. Hastalar, başarısız endoskopik hemostaz veya endoskopiye uygun olmama gibi katı kriterler doğrultusunda çalışmaya dahil edildi. Erken yeniden kanama ile ilişkili değişkenler değerlendirildi ve anlamlı belirleyicileri belirlemek için tek değişkenli ve çok değişkenli analizler yapıldı. Teknik başarı oranı %100 olmasına rağmen, hastaların %39,3'ünde erken yeniden kanama gözlendi. Yeniden kanamanın anlamlı belirleyicileri arasında gecikmiş anjiyografi (P = 0.023), eşlik eden hastalıklar (P = 0.048), başarısız endoskopik hemostaz (P = 0.010) ve birden fazla damar bölgesinin embolizasyonu (P = 0.012) yer almaktaydı. Bu bulgular, erken ve hedefe yönelik müdahalenin yeniden kanama riskini azaltmada önemli olduğunu göstermektedir. AVDÜGK'de başarılı kanama kontrolü için zamanında yapılan anjiyografik embolizasyon esastır. Gecikmiş anjiyografi, komorbiditeler, başarısız endoskopik hemostaz ve birden fazla damar bölgesine yapılan embolizasyon, erken yeniden kanama için anlamlı risk faktörleri olarak belirlenmiştir. Bu risk faktörleri, hasta sonuçlarını iyileştirmek amacıyla klinik karar süreçlerinde rehber olarak kullanılmalıdır.
Anahtar Kelimeler: Üst gastrointestinal kanama, Endoskopi, Anjiyografi, Embolizasyon

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1. Introduction

Acute non-variceal upper gastrointestinal bleeding (ANVUGIB) is a severe and potentially fatal condition that originates from the distal esophagus, stomach, and duodenum, extending up to the proximal ligament of Treitz [1]. It may manifest due to various diseases, with an average reported mortality rate of up to 10% [2]. Various etiologies can cause upper gastrointestinal bleeding, including tumors (benign or malignant), gastritis, duodenitis, Mallory-Weiss tears, vascular malformations (Dieulafoy lesions), with peptic ulcers being the most common cause. [1, 3]. The primary treatment approach involves conservative medical management and endoscopic hemostasis. [4]. Nevertheless, up to 20% of cases may not achieve hemorrhage control with these interventions [5]. In these situations, alternative treatments such as surgery or transcatheter arterial embolization (TACE) are necessary. Although surgical intervention is invasive and has a mortality rate of up to 40%, it is traditionally favored when endoscopic hemostasis fails [6-7]. TACE has become a rapid and safe option for treating refractory ANVUGIB and is considered the primary treatment method in some centers. [8, 9, 10, 11]. Previous studies have provided limited data on the predictors of early rebleeding after TACE, making this an area that warrants further investigation [12, 13].

This study aims to identify these predictors to enhance clinical decision-making and improve patient outcomes in managing refractory ANVUGIB.

2. Materials and Methods

2.1 Patient Cohort

Patients with acute upper gastrointestinal (GI) bleeding who underwent endoscopy, either failing to achieve hemostasis or where endoscopy was not feasible (prior Whipple surgery or gastrectomy), were treated at our institution. Patients were referred for embolization before considering surgery for reasons such as being unsuitable for surgery, patient or family refusal of surgery, failure of endoscopic hemostasis, or the decision of the endoscopy specialist. A total of 56 patients meeting specific criteria underwent angiographic embolization. Eligible patients met the following stringent criteria: [1] significant hemorrhage necessitating transfusion of a minimum of 4 units of blood within a 24-hour period or hemodynamic instability marked by hypotension with a systolic pressure below 100 mm Hg and a heart rate exceeding 100 beats per minute, or clinical shock attributable to blood loss, [2] inadequate response to conservative medical management, which included volume replacement, acid suppressants, H2-receptor blockers, or proton pump inhibitors, and [3] Failure to achieve hemostasis despite at least one endoscopic intervention [13]. Patient were recruited between June 2020 to June 2023.

Upper gastrointestinal bleeding was defined as bleeding occurring above the ligament of Treitz. (12). Bleeding sites were identified based on endoscopy, computed tomography angiography (CTA), angiography findings, and clinical data. Patients with variceal bleeding, hemobilia, or bleeding into the peritoneal or retroperitoneal spaces were excluded. Collected data included demographics, clinical characteristics, initial endoscopic findings, details of the embolization procedure, and outcomes following embolization. The study received approval from the local ethics committee (approval date: 22.06.2023, approval number: 2023-275).

2.2 Procedural Details

All angiographic procedures were performed by two interventional radiologists with 5 and 8 years of experience, using standard transfemoral catheterization with a 5-F sheath. Routine catheterization and imaging of the celiac trunk were conducted using a 5-F Simmons 2 or Cobra catheter (Cordis Medical).

Subsequently, super-selective arteriography of the left gastric artery and/or gastroduodenal artery was performed using 2.7-F or 2.4-F coaxial microcatheter systems as needed. The superior mesenteric artery and splenic artery were examined by angiography using a 5-Fr Cobra or Simmons 2 catheter (Cordis Medical). Relevant arteries were super-selectively catheterized with a 2.7-F or 2.4-F coaxial microcatheter (Progreat; Terumo, Leuven, Belgium) when necessary. Embolization therapy was applied upon observing aneurysm/pseudoaneurysm, vessel irregularity, vessel cutoff, shunt presence, or contrast extravasation [14]. Empirical or prophylactic embolization was also performed based on definitive identification of the bleeding source by endoscopy or CTA, even if no bleeding signs were detected on

angiography. Embolization therapy was performed as selectively as possible.

Typically, embolization involved the use of metallic coils with diameters ranging from 3 to 8 mm. 0.035-inch steel coils were used in the sandwich technique, and 0.018-inch soft platinum multiple-curled microcoils were used in the super-selective technique (Cook Medical, Bloomington, IN, USA). Additional materials used for embolization included polyvinyl alcohol (PVA) particles measuring 355–500 µm or 500–710 µm (Contour, Boston Scientific, Watertown, MA, USA). Cyanoacrylate surgical glue (n-butyl-2-cyanoacrylate, Histoacryl, B. Braun, Melsungen AG) mixed with ultra-fluid lipiodol (Lipiodol® Ultra-Fluide, Guerbet) at a 1:5 ratio was also used. Two patients received graft stents. These agents were used either singly or in combination. In cases with endoscopic evidence of active bleeding in the duodenal region and negative angiography (without indirect signs of bleeding), prophylactic/blind embolization of the gastroduodenal artery was performed using the sandwich technique. Post-embolization arteriography was conducted for all patients. Following the procedure, manual compression was applied at the sheath insertion site to achieve hemostasis.

2.3 Data Collection and Definitions

Demographic data, comorbidities, history of coagulopathy (including International Normalized Ratio [INR], partial thromboplastin time, and platelet count), lactate levels, hemoglobin and hematocrit levels, use of anti-inflammatory, antiplatelet, or anticoagulant drugs, transfusion requirements, time from bleeding onset to angiography, endoscopic and angiographic findings, embolized vessels, embolizing materials, complications, procedural and clinical outcomes, rebleeding within 30 days, and mortality rates were obtained and evaluated from medical records for all patients.

Coagulopathy was defined as an INR value greater than 1.5, a partial thromboplastin time exceeding 45 seconds, or a platelet count below 50,000/ml [15]. Successful endoscopic hemostasis was defined as the absence of bleeding in the treated area after irrigation and 3 minutes of observation following the endoscopic procedure [16]. Technical success was defined as the immediate and complete occlusion of all target vessels involved in the hemorrhage [17]. Rebleeding was defined as bleeding occurring within 30 days, accompanied by a hemoglobin drop of more than 2.0 g/dl and/or the failure of conservative medical treatment to control bleeding.

2.4 Statistical Analysis

The relationship between early rebleeding and variables such as patient demographics, medical history, treatment details, and clinical outcomes was investigated. Statistical analyses were performed using SPSS for Windows version 18.0. Data distribution was assessed using histograms, probability plots, and the Shapiro-Wilk test. Descriptive statistics included means, standard deviations, medians, and frequencies. Non-normally distributed data were analyzed with the Mann-Whitney U test, while categorical comparisons utilized Pearson's chi-square and Fisher's exact tests.

3. Results

3.1 Patient Demographics

The study included 56 patients, comprising 44 males and 12 females, with a mean age of 55.5 ± 15.8 years (range: 16–88 years) (Table 1). Many patients were at high surgical risk due to advanced age and comorbidities. The primary sources of bleeding were peptic ulcers (n = 24) and malignancies (n = 13). Among the cohort, 29 patients (51.8%) had comorbidities, with 10 (17.9%) having two or more. The most common initial presentation was melena, observed in 31 cases (55.4%), followed by hematemesis in 15 cases (26.8%), and a combination of both in 3 cases (5.3%). Additionally, seven patients (12.5%) experienced bleeding from postoperative drainage catheters. Endoscopic hemostasis was attempted in 37 patients (66.1%), while 19 patients did not undergo endoscopy prior to TACE; eleven refused, two had advanced gastric cancer and were sent for angiography, and six experienced post-surgical bleeding, primarily after Whipple surgery.

Table 1. Comparison of Demographic Characteristics, Diagnosis, and Comorbidities Between Individuals with and without Relapse

Variable	All patients (n=56)	Rebleeding No (n=34)	Rebleeding Yes (n=22)	P value
Age (years)	Mean ± SD: 55.57 ± 15.81 Median (IQR): 57.00 (42.50–66.75)	Mean ± SD: 54.50 ± 16.34 Median (IQR): 56.50 (41.75–66.00)	Mean ± SD: 57.22 ± 15.17 Median (IQR): 58.00 (43.50–69.00)	0,712[a]
Sex - Female	12 (21,4%)	10 (29,4%)	2 (9,1%)	0,067[b]
Sex - Male	44 (78,6%)	24 (70,6%)	20 (90,9%)	
Comorbidities				
Diabetes mellitus	7 (24,1%)	4 (28,6%)	3 (20,0%)	
Hypertension	5 (17,2%)	2 (14,3%)	3 (20,0%)	
Malignancy	13 (44,8%)	4 (28,6%)	9 (60,0%)	
Acute renal failure	1 (3,4%)	-	1 (6,7%)	
Chronic renal failure	3 (10,3%)	2 (14,3%)	1 (6,7%)	
Hematological disease	3 (10,3%)	1 (7,1%)	2 (13,3%)	
Coronary heart disease	5 (17,2%)	3 (21,4%)	2 (13,3%)	
Rheumatic disease	1 (3,4%)	1 (7,0%)	-	
Pancreatic pseudocyst	1 (3,4%)	1 (7,0%)	-	
COPD*	1 (3,4%)	-	1 (6,7%)	
Diagnosis				
Peptic ulcer	24 (42,8%)	16 (47,0%)	8 (36,3%)	
Malignancy	13 (23,2%)	5 (14,7%)	8 (36,4%)	
Idiopathic	6 (10,7%)	4 (11,8%)	2 (9,1%)	
Whipple surgery	6 (10,7%)	4 (11,8%)	2 (9,1%)	
Gastric ulcer	5 (8,9%)	3 (8,8%)	2 (9,1%)	

[a] Mann-Whitney U; [b] Fisher Exact test; * Chronic obstructive pulmonary disease

3.2 Procedural and Clinical Outcomes

Selective embolisation was performed in 51 patients (86.4%) based on angiographic findings. This revealed direct contrast extravasation in 6 patients (10.7%) and indirect signs of haemorrhage in 34 patients (60.7%) (Fig. 1, Fig. 2). In the remaining 16 patients (28.6%), angiography did not reveal any evidence of bleeding.

Fig 1. A 65-year-old patient with a periampullary region tumor. (a) T2-weighted MR imaging revealed a mass in the periampullary region (black arrow). (b,c) Superior mesenteric angiography depicts contrast enhancement (blush) suggestive of the tumor, originating from the inferior pancreaticoduodenal artery (white arrow). (d) Post-coil embolization imaging (asterisk) confirms the absence of tumoral contrast enhancement.

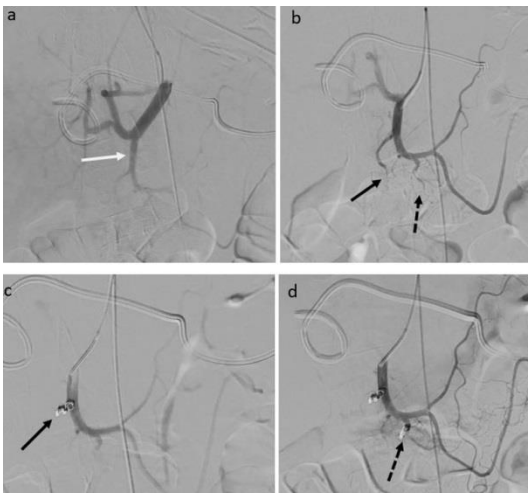

Fig 2. 67-year-old male patient consulted us due to an unresponsive duodenal ulcer bleeding post-endoscopy. Angiographic evaluation revealed contrast filling of the gastroduodenal artery (a, white arrow). Subsequent images after catheterization displayed irregularities and abrupt discontinuation in the superior pancreaticoduodenal artery (black arrow) and the right gastro-omental artery (dotted arrow, b). In (c), coil embolization of the superior pancreaticoduodenal artery (black arrow) and in (d), coil embolization of the right gastro-omental artery (dotted arrow) were carried out, which could effectively control the massive upper gastrointestinal bleeding.

Nevertheless, prophylactic/blind embolization was conducted on the artery associated with the endoscopically identified bleeding site or based on radiographic or clinically suspicious findings (Fig. 3).

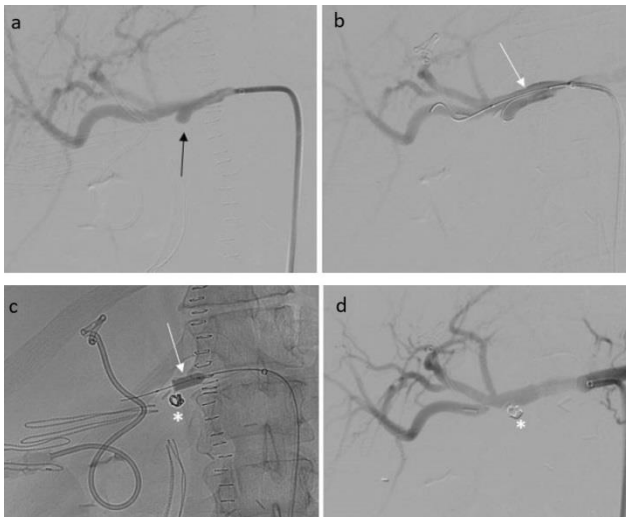

Fig. 3 A 53-year-old male patient was referred to us on the 3rd day post-Whipple procedure due to gastrointestinal bleeding. Despite no pathological findings on preoperative endoscopy and receiving three units of packed red blood cell transfusions, the patient exhibited hemodynamic instability. (a) Angiographic evaluation did not reveal any distinct pathology at the stump of the gastroduodenal artery (black arrow). (b) Given the broad base of the stump, a decision was made for balloon-assisted coil embolization (white arrow). (c) Following balloon inflation at the level of the stump (white arrow), the stump was successfully embolized with coils (asterisks). (d). Subsequent imaging showed no filling at the embolized stump.

Single embolic agents were used more often than combinations (17.9% vs. 82.1%), with the most common combination being coils and PVA particles (Table 2). Rebleeding occurred in 22 patients (39.3%); of these, four underwent successful surgery, and four received endoscopic intervention. Two patients continued to bleed post-endoscopy and subsequently underwent palliative gastrectomy. Re-embolization was performed in four rebleeding cases, achieving hemostasis in one instance through endoscopy. Twelve patients with multiple comorbidities received conservative care only. Within 30 days, 27 of 56 patients died, leading to a mortality rate of 48.2%, with 17 deaths attributed to hemorrhage and 10 due to underlying conditions (6 malignancy, 4 septicemia).

Table 2. Summary of embolization

Categories	n (%)
Rationale for embolization	
Bleeding source visualized	40 (71,4)
Blind/prophylactic embolization	16 (28,6)
Angiographic findings	
Vascular irregularity	17 (30,3)
Stump embolization	7 (12,5)
Contrast extravasation	6 (10,7)
Tumoral blush	5 (7,9)
Pseudoaneurysm	3 (5,4)
Vascular interruption	2 (3,6)
Arteries embolized	
GDA	23 (41,1)
SMA	10 (17,9)
Splenic artery	4 (7,1)
LGA	3 (5,4)
Hepatica propria	2 (3,6)
GDA+LGA	6 (10,7)
GDA+SMA	2 (3,6)
GDA+ Splenic artery	2 (3,6)
LGA+ Splenic artery	2 (3,6)
GDA+LGA+RGA	1 (1,8)
SMA+ Splenic artery+ Lumbar artery	1 (1,8)
Embolic agents	
Coils only	46 (82,1)
Coil+ PVA particles	6 (10,7)
Coil+ glue	1 (1,8)
Coil+ covered stent	1 (1,8)
Covered stent	2 (3,6)

Despite successful embolization, rebleeding occurred in 22 patients (39.3%). The management of these patients with recurrent bleeding is detailed in Fig. 4.

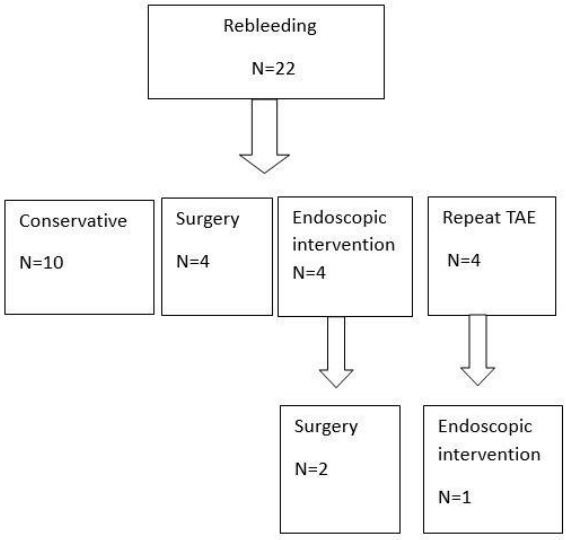

Fig 4. Flow diagram showing interventions carried out in subjects with suspected rebleeding within 30 days.

3.3 Predictors of Early Rebleeding:

Comparisons between patients with successful treatment and those who experienced rebleeding indicated significant associations with comorbidities (p = 0.048), embolization of two or more territories (p = 0.012), failure to achieve endoscopic hemostasis (p = 0.010), and time from bleeding onset to embolization (p = 0.023). Other factors, including age, sex, immune suppression, and types of embolization material, did not predict early rebleeding (Table 3,4).

Table 3. Predictors of rebleeding within 30 days of embolization.

Variables	**All patients n (%)**	**No (n=34)**	**Yes (n=22)**	**p**
Comorbidity				
No	27 (48,2)	20 (58,8)	7 (31,8)	**0,048**[c]
Yes	29 (51,8)	14 (41,2)	15 (68,2)	
Number of comorbidities (n=29)				
One	19 (65,5)	11 (78,6)	8 (53,3)	0,150[c]
Two or more	10 (34,5)	3 (21,4)	7 (46,7)	
Surgery in last month				
No	35 (62,5)	21 (61,8)	14 (63,6)	0,888[c]
Yes	21 (37,5)	13 (38,2)	8 (36,4)	
Coagulopathy				
No	40 (71,4)	26 (76,5)	14 (63,6)	0,299[c]
Yes	16 (28,6)	8 (23,5)	8 (36,4)	
Immune suppression				
No	51 (91,1)	33 (97,1)	18 (81,8)	0,072[c]
Yes	5 (8,9)	1 (2,9)	4 (18,2)	
Embolization				
Blind	16 (28,6)	8 (23,5)	8 (36,4)	0,299[c]
Bleeding source visualized	40 (71,4)	26 (76,5)	14 (63,6)	
Embolized vessel				
Only GDA	21 (38,9)	14 (41,2)	9 (40,9)	0,984[c]
Other variations	33 (61,1)	20 (58,8)	13 (59,1)	
Count of embolized vessels				
One	43 (76,8)	30 (88,2)	13 (59,1)	**0,012**[c]
Two or more	13 (23,2)	4 (11,8)	9 (40,9)	
Embolic material				
Only coil	48 (85,7)	29 (85,3)	19 (86,4)	0,616[b]
Two or more materials	8 (14,3)	5 (14,7)	3 (13,6)	
Embolization time				
In first 24 hours	29 (51,8)	20 (58,8)	9 (40,9)	0,190[c]
After 24 hours	27 (48,2)	14 (41,2)	13 (59,1)	
Number of PRBC transfusions				
Less than 6	34 (60,7)	24 (70,6)	10 (45,5)	0,060[c]
6 and above	22 (39,3)	10 (29,4)	12 (54,5)	
Complication				
No	52 (92,9)	31 (91,2)	21 (95,5)	0,485[b]
Yes	4 (7,1)	3 (8,8)	1 (4,5)	
Whipple surgery				
No	50 (89,3)	30 (88,2)	20 (90,9)	0,560[b]
Yes	6 (10,7)	4 (11,8)	2 (9,1)	
Preop endoscopic failure of hemostasis				
No	19 (33,9)	16 (47,1)	3 (13,6)	**0,010**[c]
Yes	37 (66,1)	18 (52,9)	19 (86,4)	

b Fisher's Exact test; c Pearson Chi-square test. PRBC = Packed Red Blood Cells.

Table 4. Comparison of Patients' Blood Values, Number of PRBC transfusions, and Time Intervals Between Angio and Bleeding

Variables	All patients Median±SD Median (1st-3rd Quartile)	Rebleeding status No (n=34) Median±SD Median (1st-3rd Quartile)	 Yes (n=22) Median±SD Median (1st-3rd Quartile)	p[a]
Hgb (g/dl)	7,40 (6,72-8,10)	7,40 (7,00-8,10)	7,40 (6,00-8,20)	0,551
Hct	22,15 (6,72-8,10)	23,15 (20,47-26,25)	22,00 (17,30-24,45)	0,179
Lactat (mmol/L)	1,80 (1,32-3,00)	1,70 (1,47-2,17)	2,20 (0,95-3,32)	0,737
Number of PRBC transfusions	4 (3-8)	4 (3-6)	7 (3-11)	0,085
Interval between embolization and bleeding (day)	1 (1-4)	1 (1-2)	2 (1-8)	**0,023**

[a] Mann-Whitney U test
PRBC = Packed red blood cell.

Univariate analysis revealed that rebleeding within 30 days was significantly associated with the presence of comorbidities (p = 0.048), embolization of two or more territories (p = 0.012), failure to achieve endoscopic hemostasis prior to embolization (p = 0.010), and the duration between the onset of bleeding and embolization (p = 0.023).Early rebleeding could not be predicted by age, sex, immune suppression, count of comorbidities, anticoagulation, extravasation at angiography, or the type of embolization material used. Additionally, early rebleeding was not found to be associated with empirical or selective embolization, hemoglobin levels, hematocrit levels, lactic acid levels, red blood cell unit replacement count before embolization, previous surgery within the last month, prior Whipple surgery, complication presence or bleeding etiologies.

3.4 Complications

Adverse events, categorized using the Cardiovascular and Interventional Radiology Society of Europe Classification System, showed no major complications [18]. However, minor complications, specifically hematomas at the entry site, were observed in three patients.

4. Discussion

ANVUGIB is a serious condition that can be fatal, with mortality rates of up to 10% reported [2]. While gastroduodenoscopy is the primary diagnostic and therapeutic tool, failure may necessitate surgery, which carries significant mortality rates ranging from 20% to 40% [19,20]. Transcatheter arterial embolization has gained traction as a viable alternative, especially in high-risk patients [21]. This study assesses the outcomes and factors associated with rebleeding following TACE in patients with ANVUGIB that could not be managed through endoscopy. TACE stands out as a minimally invasive treatment with high technical success rates. In this study, we attained a 100% technical success rate, consistent with previous research reporting success rates between 62% and 100% [13]. Factors contributing to procedural failure include complex vascular anatomy, arterial dissection, vasospasm, false-negative angiogram results, multiple bleeding sites, and bleeding associated with tumors [13,21]. Our study confirms TACE as a safe procedure with low complication rates, with only 2 groin hematomas (3.6%) observed.

The absence of rebleeding within the first month after TACE is considered a clinical success [21]. Rebleeding rates vary between 9% and 56%, and 30-day mortality rates between 4% and 46%, likely due to heterogeneous sample sizes, etiologies, and procedural details [13,22]. The rebleeding rate in our study was 39.2%, with a 30-day mortality rate of 48.2%. These relatively high rates likely reflect the complexity and comorbidity burden of our patient population. Significant predictors of early rebleeding included the presence of comorbidity (p=0.048), embolization of two or more vessels (p=0.012), failure of endoscopic hemostasis before embolization (p=0.010), and delay between bleeding and angiography (p=0.023). These findings underscore the importance of early and targeted intervention in high-risk patients.

Recurrent bleeding has been associated with comorbidities, as reported by Loffroy et al. [21]. A study reported a 34.6% periprocedural mortality rate, which was primarily attributed to underlying conditions such as cirrhosis and malignancy [15]. Even a single comorbidity was significant for recurrent bleeding in our study. Surgery is a high-risk option for patients with comorbidities; thus, TACE is often chosen, though the risk of rebleeding and potential mortality may also be influenced by underlying diseases [9,21]. Our findings add to this body of evidence, highlighting the need for heightened surveillance and supportive care in comorbid patients undergoing TACE.

In upper gastrointestinal bleeding, the first invasive option for diagnosis and treatment is endoscopy. However, in approximately 5–10% of patients, endoscopy cannot be performed due to altered anatomical structures, esophageal strictures, hemodynamic instability, or profuse bleeding [23,24]. Studies have shown that endoscopic hemostasis is attempted in 90–100% of cases prior to embolization, with patients subsequently referred to interventional radiology [13]. At our tertiary center, due to frequent oncological surgeries like Whipple and issues such as rapid hemodynamic instability, pre-embolization endoscopy could not be performed in 34% (n=19/56) of our patients. We found a higher rebleeding rate in cases where preoperative endoscopic hemostasis was attempted but failed, suggesting that failure of endoscopic control may reflect a more aggressive bleeding profile.

The relationship between the embolic agent used, embolized vessels, and rebleeding has been studied, but limited data exists on the number of embolized vessels [12,13,21,25]. A study of 59 patients revealed that the rebleeding rate was higher in those who underwent embolization of two or more vessels [12]. In our study, 13 out of 56 patients had embolization of two or more vessels, significantly associated with rebleeding. This may be due to multiple vascular anastomoses or more extensive vascular pathology, making complete embolization challenging. This suggests that embolization of multiple vascular territories could be considered a procedural risk factor, warranting closer follow-up.

Timing of embolization is another crucial factor. We observed a higher rebleeding rate when the median time to embolization was longer (2 days in patients who experienced rebleeding vs. 1 day in those who did not). Delayed embolization could lead to worsening coagulopathy or indicate that patients were inherently sicker [21,26]. Therefore, early embolization is essential to reduce rebleeding and enhance clinical success. These findings advocate for expedited angiographic evaluation in refractory bleeding cases, particularly when endoscopy has failed or is not feasible.

Accurate detection of the bleeding site through angiography is challenging due to its transient nature, often caused by unstable bleeding, hypotension, tamponade by formed hematoma, and vasospastic changes [27]. In 16 out of 56 patients, no active extravasation or indirect signs of bleeding were observed, leading to blind embolization based on prior findings. Blind TACE, which is defined as performing embolization without direct angiographic evidence of bleeding, is considered safe and effective [13,21,27,28]. Our findings showed no significant difference in rebleeding between blind and target embolization groups, further supporting the reliability of empiric embolization in well-selected patients.

TACE is preferred for post-surgical or post-traumatic upper gastrointestinal bleeding, as these cases are not amenable to safe endoscopic approaches [29,30]. In our study, embolization was the primary intervention for bleeding control in 19 patients, with 13 deemed not feasible for endoscopy. Specifically, patients who underwent Whipple surgery often associated with pancreatic hemorrhage—a critical condition with high mortality [31–33]—were treated successfully. Rebleeding occurred in two out of four patients, both of whom were managed with repeat embolization. While our sample size was small, the absence of complications supports TACE as a first-line option in these challenging scenarios.

Interestingly, other variables including age, sex, coagulopathy, immune suppression, embolic material, and pre-procedural PRBC transfusions were not significantly associated with rebleeding. While these results might reflect true neutrality, they may also be due to sample size limitations. Nonetheless, recognizing which factors are not predictive is equally important in guiding clinical risk stratification and avoiding unnecessary concern over non-contributory variables.

This study is subject to several limitations. Firstly, it was conducted retrospectively and lacked randomization, which may have introduced potential selection bias. Furthermore, the absence of long-term follow-up data limits our understanding of the durability of TACE outcomes. The relatively small sample size and heterogeneity in diagnoses and treatments may affect the generalizability of the

findings. The study also did not account for all potential confounders, including specific types or severity of comorbidities. Future research should aim to validate these findings in larger, more homogeneous cohorts through prospective trials.

5. Conclusion

TACE is a highly effective intervention for managing refractory ANVUGIB, but careful attention must be paid to risk factors that predispose patients to early rebleeding. By recognizing these predictors, clinicians can optimize patient management strategies, potentially reducing the incidence of rebleeding and improving overall outcomes in this high-risk population.

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