Emergent embolization of the gastroduodenal artery in the treatment of upper gastrointestinal bleeding. The experience from a surgeon-initiated interventional program

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**Abstract**

**BACKGROUND:** Intractable nonvariceal upper gastrointestinal bleeding (UGIB) is associated with significant morbidity and mortality. Endovascular therapy is an alternative to surgery for high-risk patients.

**MATERIALS AND METHODS:** Review of prospectively collected data from patients who underwent emergent gastroduodenal artery embolization for UGIB.

**RESULTS:** Eight patients (mean age 68.5 years) were identified. They all had significant comorbidities and were deemed to be at high risk for surgical intervention. Endoscopy was performed in 7 patients. Active extravasation was present at the time of embolization in 5 (62.5%) patients. The technical success and clinical response rates were each 100%. The 30-day mortality rate was 8%. There were no procedure-related complications. During mean follow-up of 9 months, 1 patient developed recurrent bleeding that was managed conservatively.

**COMMENTS:** Endovascular embolization is a safe alternative to open surgical intervention after failed endoscopic treatment for UGIB. Surgeons with endovascular skills can perform this procedure with superior results.

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**KEYWORDS:** Gastroduodenal embolization; Gastrointestinal bleeding; Vascular surgeon

During past 2 decades, the treatment of peptic ulcer disease has undergone significant evolution. The introduction of pharmacotherapy for *Helicobacter pylori* and the use of endoscopy for bleeding ulcers have limited the need for further hemostatic measures in 98% of patients. Despite these measures, the mortality of massive upper intestinal hemorrhage remains high and has been reported to be between 6% and 15%. Increased mortality is related to advanced age, multiple comorbidities, and increased transfusion requirements.

Current treatment algorithms for massive upper gastrointestinal bleeding recommend aggressive correction of coagulopathy followed by endoscopy. Endoscopic combination therapy with adrenaline injection and heater probe provide the most reliable method of achieving hemostasis. Rebleeding is usually managed by a second endoscopic attempt. If the second treatment fails, surgical intervention is warranted.
When surgical intervention is warranted, approximately 10% of patients rebleed, and the mortality rate is 15% to 20%. Selective angioembolization has been proposed as an alternative to the open surgical approach, especially for high-risk patients. The obvious advantage to this approach is avoidance of laparotomy in the critically ill patient. With the advent of modern embolic agents, embolotherapy outcomes have been compared favorably with surgical intervention.

The purpose of this study was to assess the safety and effectiveness of embolotherapy as a first-line treatment for acute nonvariceal upper gastrointestinal bleeding (UGIB) in high-risk patients in the context of a surgeon-initiated interventional program.

**Methods**

Data collection was performed by way of retrospective review of a prospectively maintained database. All patients had significant bleeding (transfusion requirement of at least 4 units of blood/24 hours) or hemodynamic instability (hypotension with systolic pressure <90 mm Hg and heart rate >110/min or clinical shock secondary to blood loss); had failed to respond to conservative medical therapy consisting of volume replacement and proton pump inhibitors; and had documented duodenal ulcer as the cause of bleeding.

The procedures were performed by fellowship-trained vascular surgeons in the operating room by way of the femoral percutaneous approach. A mobile C-arm unit was used early in our experience. Fixed radiographic equipment has become more recently available in our facility and has been exclusively used for the procedure. Although the quality of the fixed unit is superior, we do not believe that its presence is a prerequisite for technical success. Selective catheterization of the celiac axis and the main hepatic artery with a 5F Cobra 2 catheter (Boston Scientific, Matic, MA USA) was the initial step, followed by baseline angiogram to confirm anatomy. Subsequently, supraselective catheterization of the gastroduodenal artery (GDA) was performed, and selective GDA angiography was performed to identify the bleeding source. Clips placed during the endoscopy in 3 patients did not appear to correlate with the location of the bleeding vessel on angiography. In those patients in whom contrast injection in the GDA failed to reveal active bleeding, selective cannulation of the left gastric and superior mesenteric artery was performed.

Follow-up information was gathered by telephone interviews and hospital visits. For each patient, the following variables were recorded: age, sex, comorbidities, coagulation status, transfusion requirements, etiology of UGI hemorrhage, angiographic or endoscopic identification of bleeding site, recent surgical or endoscopic treatment, embolic material used, complications, surgical conversion, short- and long-term recurrence of bleeding, and mortality. Cessation of bleeding was defined as the absence of red blood in nasogastric aspirate 24 hours after embolization or the absence of bleeding on endoscopic examination plus stabilization of the hemoglobin level within 48 hours of the embolization procedure. Early rebleeding was defined as either hematemia or melena with associated decrease in hemoglobin within 30 days of embolization. Long-term rebleeding was defined as recurrence of bleeding later than 30 days after embolization.

**Results**

Eight male patients (mean age 68.5 years [range 41 to 88]) who underwent emergent endovascular management of intractable UGIB were identified. They all had significant comorbidities (Table 1) and were deemed to be at high risk for open surgical intervention. Endoscopy had been performed in 7 patients, but recurrent bleeding developed in 24 hours to 48 hours, necessitating reintervention. The source of bleeding was the duodenal ulcer in all patients. An aggressive management approach was taken to minimize time with ongoing bleeding and avoid the development of hypovolemic shock. Mean time from the moment the interventional team was notified to time of embolization was

<table>
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<th>Sex</th>
<th>Age (y)</th>
<th>Comorbidities</th>
<th>Extravasation</th>
<th>Time to OR</th>
<th>INR</th>
<th>Pretransfusion</th>
<th>Posttransfusion</th>
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</table>

*CAD = coronary artery disease; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; INR = international normalized ratio; MI = myocardial infarction; OR = operating room.

*Includes demographic information, comorbidities, time from initial patient evaluation to embolization, coagulation status, and preprocedure and postprocedure transfusion requirements.
4.38 hours (range 2 to 8). Blood and blood products were administered to ensure hemodynamic instability and avoid the vicious cycle of coagulopathy and further bleeding. All but 1 patient had coagulation profiles within normal limits.

Active extravasation was present at the time of embolization in 5 (62.5%) of patients. The main GDA was the culprit vessel in 3 patients, and smaller muscular branches off the GDA were seen bleeding in 2 other patients. No extravasation was seen in 3 patients. Patients bleeding from the main GDA (Fig. 1), as well as those that demonstrated no active extravasation, underwent embolization using a “sandwich” technique. In this technique, platinum coils (2 to 4 mm in size) were placed in both ends of the GDA—first distally and then more proximally—to prevent “backdoor” bleeding from the superior mesenteric artery collaterals (Figs. 2 and 3). A small 2-mm platinum coil and blood clot was used to embolize muscular branches in the remaining 2 patients.

Endovascular embolization was successful in all patients, yielding a 100% technical success rate. In the subset of 3 patients without active extravasation, technical success was defined as successful cannulation and coil placement in the GDA. The clinical response rate was 100%, obviating the need for open surgical intervention. Two patients underwent transfusion of a total of 3 units packed red blood cells after the procedure. The overall 30-day mortality rate was 8% (there was 1 death in an elderly patient with chronic obstructive pulmonary disorder, coronary artery disease, and congestive heart failure who succumbed from pulmonary complications). There were no procedure-related complications. All patients were initially observed in the intensive care unit and were monitored by both the vascular surgery and general surgery services. Given the intermittent nature of the gastrointestinal bleeding, we planned to proceed with repeat embolization in case of rebleed in the subset of patients who underwent blind embolization, whereas open intervention was anticipated in case of recurrent bleeding in the patients who underwent embolization based on active extravasation.

During a mean follow-up of 9 months, 1 patient developed recurrent bleeding that was managed conservatively.
None of the 7 patients available for follow-up died. Furthermore, none of the patients who underwent embolization of muscular GDA branches developed symptoms indicative of duodenal obstruction.

**Comments**

Our series is notable because it demonstrates that embolotherapy performed by surgeons with endovascular skills is a safe and effective therapeutic option in patients who continue to bleed after endoscopic intervention. In addition, it indicates that adherence to principles of transarterial embolization can provide bleeding-free survival even in high-risk individuals.

The number of mesenteric interventions performed by surgeons with endovascular skills has been increasing, and the number of vascular surgeons who are trained in endovascular interventions has been expanding. In our facility, involving surgeons in the endovascular treatment of gastrointestinal (GI) bleeding has several distinct advantages. First, it has the potential to minimize time to intervention given the continuous in-house availability of surgical staff. Second, it offers a more streamlined continuity-of-care model because both intervention and perioperative patient care are assumed by a single surgical team. Last, and because of the 2 key points mentioned just mentioned, the patients undergo the procedure in a timely manner with minimal physiologic impairment, 2 factors of paramount importance for a successful clinical outcome.

The presence of coagulopathy has been a recognized risk factor that accounts for clinical failure after a technical successful embolization for UGIB. This may occur because of inadequate resuscitation, failure to correct the coagulopathy once established, or delayed intervention despite persistent hemorrhage. In fact, there is a tendency to avoid intervention in patients with multiple comorbidities because of the high risk for postsurgical complications. This strategy is justifiable when open surgical management is the only alternative to conservative treatment. Transarterial embolization offers a minimally invasive approach that can be performed expeditiously and safely, thus terminating ongoing blood loss and optimizing the patient’s physiologic status. In our series of high-risk patients, early endovascular intervention had superior results in part because of rapid control of the bleeding vessel and avoidance of the vicious cycle of bleeding and coagulopathy.

The concept of arterial embolization as a means of controlling GI bleeding has been explored in several case series and a variety of clinical settings. Kramer et al introduced data regarding a variety of causes of upper and lower GI bleeding. With the use of a combination of coils, Ethibloc, tissue adhesive, Gelfoam particles, and polyvinyl alcohol particles, 17 patients underwent embolization for upper GI bleeding. An 88% success rate was achieved with the first intervention. During embolization of the lower GI tract, 4 patients developed intestinal ischemia associated with the use of Ethibloc. No ischemia was noted in the patients who underwent embolization of the upper GI tract. Ljungdahl et al embolized 13 patients who were treated after endoscopy failed to create hemostasis. Five patients had already undergone open surgery and bled afterward. Bleeding ulcers were localized endoscopically, and the procedure was a technical success in all 13 patients who underwent angiography after failed endoscopy. One patient rebled after embolization and required emergent surgery. Two additional patients bled at 3 and 25 days after embolization and were successfully treated with repeat endovascular approach. Overall, embolization resulted in a substantial decrease in transfusion requirements and improved stabilization of the patients. Ripoll presented a comparative series of patients who were treated with either embolization or surgery for bleeding peptic ulcer. The embolization arm comprised 31 patients versus 39 patients who were managed surgically. Patients who received embolotherapy were older by an average of 10 years and had higher incidences of cardiac disease and previous anticoagulation treatment. The incidence of technical failure and recurrent bleeding in the embolization group was 6.5% (n = 2) and 29% (n = 9) respectively. Four of the patients who continued to bleed underwent surgical exploration. Recurrent bleeding occurred in 23.1% (n = 9) of the patients who had surgical intervention. Five of these patients underwent re-exploration to control the hemorrhage, and 7 more patients were reoperated because of complications from the initial surgery. Holme et al reported 40 patients who were referred for embolotherapy after unsuccessful endoscopic or surgical treatment. Long-term hemorrhage control was achieved in 65% of patients. Initial hemostasis was achieved in 83% of these patients, and prolonged hemostasis was achieved in 75% of patients. Twenty-eight patients who did not have active extravasation on angiography underwent GDA coil embolization. Thirty-nine percent of these patients rebled. Inability to precisely visualize and selectively embolize the culprit vessel in this group of patients is the most likely cause of the high rebleeding rate. The group that had active hemorrhage at the time of the angiography had a higher likelihood of lasting hemostasis (75% vs. 66%), indicating that blind coil embolization of the GDA does not always achieve long standing hemostasis. A synopsis of published series that includes technical and clinical success, complications, and outcomes is listed in Table 2.

GDA embolization can be a technically demanding procedure. Basic endovascular training is essential before an interventionalist attempts to master the skills required to successfully perform angiography and embolization in the visceral territory. Given the early recognition of the importance of endovascular training, we believe that most of the recent graduates of vascular fellowship programs should possess that basic skill set. Further mentoring with a person experienced in this kind of intervention is of paramount importance. A minimum of 5 mentored procedures, possibly
more depending on baseline skill level and experience, seems to be necessary before one feels comfortable enough to start performing the intervention. One cannot overemphasize the importance of early communication with the hospital administration and familiarity with local policies that dictate minimum requirements before credentialing.

As a case series, our study is limited by the small number of patients. In addition, the follow-up time was short, and complications—such as duodenal stenos and recurrent bleeding from peptic ulcer disease—may have not had adequate time to develop. Furthermore, all the patients we encountered had a diagnosis of duodenal ulcer, which is well managed medically after an acute event has ended. The natural history of bleeding from gastric ulcer or malignancy, or from trauma, may be different. Therefore, the previously mentioned results cannot be generalized for those subgroups of patients.

In conclusion, transarterial embolization for upper gastrointestinal hemorrhage is a safe and effective treatment strategy that can be employed with success in high-risk patients who present with persistent bleeding caused by duodenal ulcer. The procedure is minimally invasive and can be performed expeditiously by surgeons who have been trained to use endovascular techniques. The role of this modality in the treatment algorithm of gastrointestinal bleeding in patients who do not fall into the high-risk category merits further investigation.

References