J Gastrointest Surg
DOI 10.1007/s11605-009-1069-2

ORIGINAL ARTICLE

Can Superselective Embolization be Definitive for Colonic Diverticular Hemorrhage? An Institution's Experience over 9 Years

Ker-Kan Tan · Vigneswaran Nallathamby · Daniel Wong · Richard Sim

Received: 31 August 2009 / Accepted: 6 October 2009
© 2009 The Society for Surgery of the Alimentary Tract

Abstract
Introduction Superselective mesenteric embolization is effective in arresting colonic diverticular hemorrhage with minimal complications, but long-term results are lacking. We aimed to review the short- and long-term outcome of superselective embolization in arresting colonic diverticular hemorrhage in an Asian population.
Methods A retrospective review of all patients who underwent superselective embolization for bleeding colonic diverticula from December 2000 to March 2009 was performed. These cases were drawn from a database of embolization for active gastrointestinal hemorrhage. Short-term outcomes (≤30 days from procedure) identified included rebleeding, ischemia, or any further intervention for any of these two complications. Readmission for rebleeding and/or definitive surgery after 30 days (long-term outcome) was also documented.
Results Twenty-three patients, median age 65 years (range 41–79 years), formed the study group. Nineteen (82.6%) patients had active hemorrhage from right colonic diverticula while four (17.4%) had left-sided diverticular bleeding. Technical success was achieved in all 23 (100%) patients.
Short-term outcome Five (21.7%) patients rebled within the same admission, and all underwent surgery. One patient perished from ensuing anastomotic dehiscence and septic shock and accounted for the only mortality (4.3%) in our series. There was no patient with ischemic complications. Another two (8.7%) patients underwent elective surgical resection on the advice of their surgeons in the absence of rebleeding.
Long-term outcome The median follow-up was 40 months (5–99 months). Of the remaining 16 (69.6%) patients for whom the procedure was definitive initially, four (25.0%) rebled within 2 years from the primary procedure, and elective surgery was performed in one of them. Another had repeat embolization, while the other two were successfully managed conservatively. These three patients refused surgical intervention. One patient was lost to follow-up, and the remaining 11 patients had no further complications.
Conclusion Superselective embolization for active colonic diverticular hemorrhage is safe and effective and should be considered as a first line treatment if possible and available. The procedure could act as a bridge to a subsequent more definitive elective surgery or be definitive as seen in over 50% of our patients over a period of 40 months.

Keywords Embolization · Colonic · Diverticular · Hemorrhage · Definitive · Treatment

K.-K. Tan (✉) · V. Nallathamby · R. Sim
Department of General Surgery, Tan Tock Seng Hospital,
11 Jalan Tan Tock Seng,
Singapore 308433, Singapore
e-mail: kerkan@gmail.com

D. Wong
Department of Diagnostic Radiology, Tan Tock Seng Hospital,
Singapore, Singapore

Introduction

Colonic diverticular bleeding is one of the common causes of lower gastrointestinal hemorrhage. Though the bleeding ceases spontaneously in most patients, life-threatening hemorrhage is not uncommon, and any ensuing emergency surgery is often fraught with abysmal results.[1]

The dismal morbidity and mortality rates from emergency surgery had led to the advent of superselective embolization as an alternative to rapidly arrest the active

Published online: 20 October 2009

hemorrhage in these high-risk patients. Numerous reports had cited its high-safety profile and efficacy rates.[2–4]

As most of the literature has been focused on the complications of left-sided colonic diverticulosis as right-sided disease is rare in the West, contrary to its high prevalence in Asians,[5] limited data exist on the implications of right colonic diverticulosis. However, right-sided diverticulosis has been shown to be associated with more massive hemorrhage than left-sided disease.[6]

While some institutions had advocated superselective embolization as a temporary measure before more definitive resection of the diseased segments can be performed, recent data have suggested that this technique could be definitive without any further surgical intervention.[7,8] All the above issues prompted us to review our institution's experience in superselective embolization for colonic diverticular hemorrhage in an Asian population, with special emphasis on the short- and long-term outcomes.

Methods

Study Population

Tan Tock Seng Hospital is a 1,300-bed hospital, the second largest in Singapore, and provides secondary and tertiary medical care for about 1.5 million people. Our department managed an average of 100 patients yearly who presented with lower gastrointestinal hemorrhage from colonic diverticulosis.

A retrospective review of all patients who underwent superselective embolization for bleeding colonic diverticula from December 2000 to March 2009 was performed. These cases were drawn from a database of superselective embolization for active gastrointestinal hemorrhage. Diagnosis of diverticular disease was confirmed through colonoscopy, computed tomographic (CT) scans or barium enema, or a combination of the above, either pre- or post-embolization. Right-sided pathologies were regarded if it was located from the cecum until the transverse colon, while left-sided lesion commenced from the splenic flexure.

The data collected included age, gender, comorbid conditions, presenting signs and symptoms, and clinical parameters. Investigations such as full blood count, gastroscopy, or colonoscopy were also documented. Technical success was defined as the cessation of bleeding seen on completion angiography. The type of embolic agent was determined by the interventional radiologist with both microcoils and polyvinyl alcohol particles used in our series.

The following short-term outcomes (≤30 days from procedure) were identified: rebleeding, evidence of ischemia, or any further intervention such as surgery or repeat embolization for any of these two complications. Readmission for rebleeding and/or definitive surgery after 30 days (long-term outcome) was also documented.

Rebleeding was defined as a drop in hemoglobin ≥1 g/dL in the presence of overt gastrointestinal hemorrhage, while ischemic event was defined as bowel ischemia or infarction that necessitated surgery

Results

Study Group

Twenty-three patients, median age 65 years (range 41–79 years), formed the study group. All these patients presented with hematochezia and ten (43.5%) patients were hypotensive, while 12 (52.2%) were tachycardic just prior to the procedure. Sixteen (69.6%) patients had at least two comorbid conditions. Eight (34.8%) patients had previous admissions for lower gastrointestinal hemorrhage from presumptive colonic diverticulosis and were successfully treated conservatively.

Laboratory Values and Investigations

Pre-embolization gastroscopy and colonoscopy were performed in 14 (60.9%) and ten (43.5%) patients, respective-

Table 1 Characteristics of these 23 Patients Who Underwent Superselective Embolization for Colonic Diverticular Hemorrhage

Characteristic	Results
Median Age (years)	65 (41–79)
Median Follow Up (months)	40 (5–99)
Gender	
Male	−15 (65.2%)
Female	−8 (34.8%)
Type of comorbidities	
Hypertension	−20 (87.0%)
Diabetes mellitus	−9 (39.1%)
Ischemic heart disease	−10 (43.5%)
Cerebrovascular accident	−4 (17.4%)
Renal impairment	−2 (8.7%)
Number of comorbidities	
≤1 Comorbid condition	−7 (30.4%)
≥2 Comorbid conditions	−16 (69.6%)
Previous admission for bleeding gastrointestinal tract	8 (34.8%)
Hypotensive (Systolic BP<90 mmHg) just before the procedure	10 (43.5%)
Tachycardia (Heart rate >100 bpm) just before the procedure	12 (52.2%)

Table 2 Details of the Superselective Embolization

Embolic agents used	
Microcoils only	−21 (91.3%)
Microcoils and particles	−1 (4.3%)
Particles	−1 (4.3%)
Site of bleeding	
Right side	−19 (82.6%)
Left side	−4 (17.4%)
Technical success	23/23 (100%)

ly. Their median hematocrit before the procedure was 22.6% (range 10.4–44.3%) (Table 1).

Superselective Embolization

Microcoils alone were used in the majority of the patients (n=21, 91.3%). Nineteen (82.6%) patients had active hemorrhage from right colonic diverticula, while four (17.4%) bled from left-sided disease. Technical success was achieved in all 23 (100%) patients. None of the patients experienced significant complications from the procedure apart from groin hematoma in one patient that resolved spontaneously (Table 2; Figs. 1 and 2).

Short-Term Outcome

Five (21.7%) patients rebled during the same admission and all underwent surgical resection of the diseased colonic segment. All except one were discharged well. Superselective embolization for bleeding caecal diverticular disease was performed for this patient initially, but when bleeding recurred, he underwent emergency right hemicolectomy. This was complicated by an anastomotic leak due to ischemic segments for which further surgery was performed. This patient eventually succumbed from the ensuing septicemia and accounted for the only mortality (4.3%) in our series (Table 3).

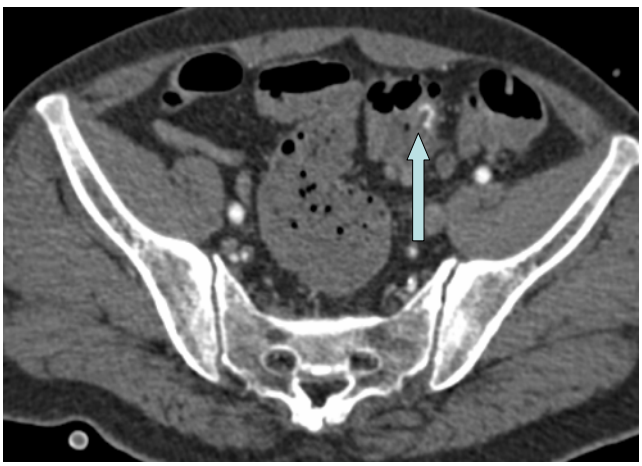

Fig. 1 CT angiography showing extravasation of contrast into sigmoid diverticula.

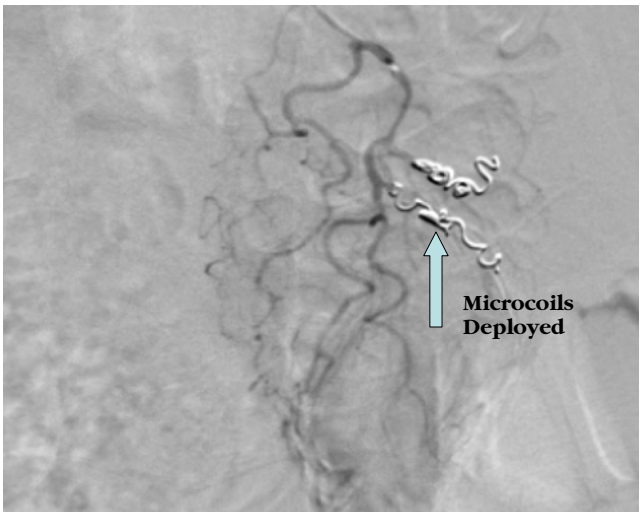

Fig. 2 Completion angiogram showing cessation of hemorrhage and coil deployment.

The remaining two (8.7%) patients underwent surgical resection on the advice of their surgeons in the absence of rebleeding. One patient already had previous episodes of lower gastrointestinal hemorrhage but refused any prior surgery, while the other patient had numerous comorbidities and presented with a very low hematocrit level of 15.4% before the procedure.

The median amount of red blood cells transfused in our series was 2,756 ml (range 389–5,635 ml), and the median length of stay in the hospital was 8 days (range 4–57 days).

Long-Term Outcome

The median follow-up was 40 months (5–99 months). Of the remaining 16 (69.6%) patients for whom the procedure was definitive initially, 11 (68.8%) were well without any further complications, one (6.3%) was lost to follow-up while the remaining four (25.0%) were readmitted for rebleeding. The first patient rebled 2 years post-procedure and required repeat embolization as emergency surgery was

Table 4 Long-Term Outcome of the 16 Patients with Successful Initial Superselective Embolization

Readmission for rebleeding	4 (25.0%)
Underwent elective surgery	−1 (6.3%)
Require re-embolization	−1 (6.3%)
Conservative management	−2 (12.5%)
Lost to follow-up	1 (6.25%)
No further complication	11 (68.8%)

Table 3 Short-Term Outcome of the Study Group

Rebleeding	5 (21.7%)
Ischemic complications	0 (0.0%)
Surgical intervention	7 (30.4%) (5 for rebleeding, 2 on advice of surgeons)
Mortality rate	1 (4.3%)
Median amount of red blood cells transfused	2,756 ml (389–5635)
Median length of stay in hospital	8 days (4–57)

deemed too high risk. Fortunately, the repeat embolization was successful, and the patient was discharged well (Table 4).

Another patient rebled about 8 months post-procedure and was managed conservatively. He underwent right hemicolectomy several months after optimization of his pre-morbid conditions. The other two patients who rebled were successfully managed conservatively without requiring blood transfusion. Both refused definitive surgery. All these three patients had repeat colonoscopy to exclude any other pathology. The six (26.1%) patients (excluding the one that died) who had surgery initially had no further complications.

Review of Our Experience

Figure 3 illustrates our institution's experience in superselective embolization for colonic diverticular hemorrhage. Also seen in Table 5, we reviewed our institution's experience over two time periods. It would appear that patients from the first time period (2000–2004) had worse short-term outcome compared to patients from the second time period (2005–2009). There were higher incidences of rebleeding and associated surgical intervention.

Discussion

Angiographic diagnosis and treatment of gastrointestinal hemorrhage has been described since 1974,[9] but initial attempts were met with high recurrence rates and complications.[10] Significant advances in micro-catheter technology, digital fluoroscopy, and increased technical expertise of the interventional radiologists have resulted in vast improvement and increased adoption of superselective embolization for massive gastrointestinal hemorrhage. Numerous recent reports have cited its high-safety profile and efficacy rates.[2,3,11] Also seen in our series, we were able to achieve a technical success rate of 100%, while the mortality rate was only 4.3%.

Though there were no ischemic complications in our series, we had several patients who rebled after the procedure. Interestingly, all the patients who rebled within 30 days had right-sided diverticula. The authors postulated

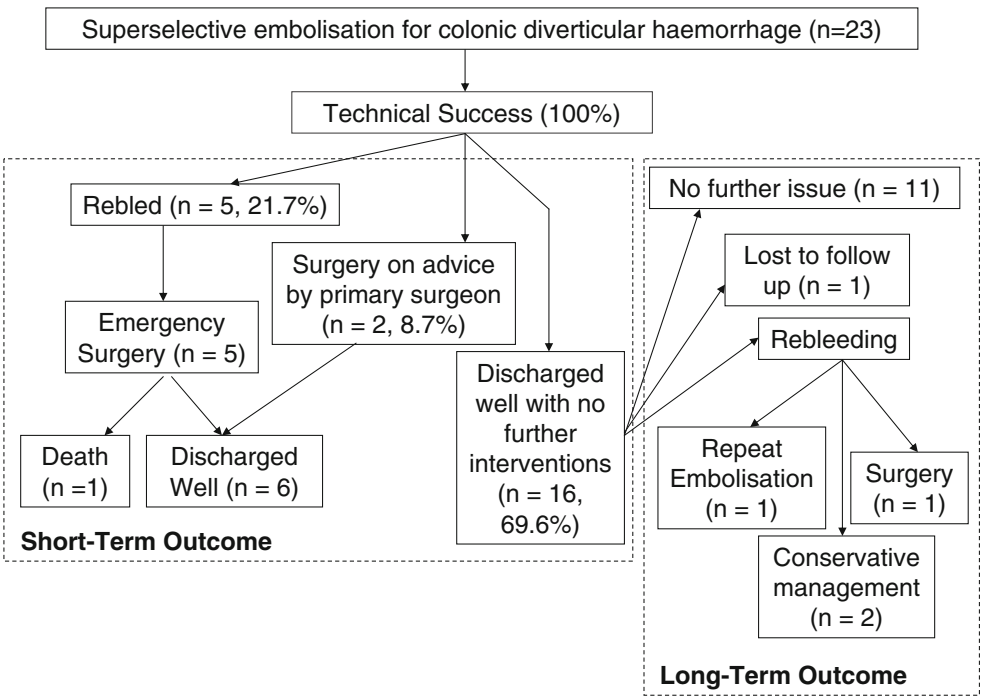

Fig. 3 Summary of short- and long-term outcome of using superselective embolization in colonic diverticular hemorrhage in our institution.

Table 5 Overview of our Institution's Experience over the Two Time Periods

Time period	Technical success	Rebleeding (short-term)	Surgery (short-term)	Rebleeding (long-term)	Surgery (long-term)
1st 5 years (2000–2004)	8/8 (100%)	4/8 (50.0%)	6/8 (75.0%)	1/2 (50.0%)	0/2 (0.0%)
2nd 4 years (2005–2009)	15/15 (100%)	1/15 (6.7%)	1/15 (6.7%)	3/15 (20.0%)	1/15 (6.7%)

that this propensity might actually be genetically linked. While right-sided diverticulosis has been shown to be much more prevalent in Asians, one local study actually highlighted that right-sided diverticula often resulted in more massive bleeding than left-sided lesions.[6] This tendency of right-sided diverticula to bleed more massively has also been reported in the Western population.[12,13] This observation has been postulated to be due to the thinner colonic wall in the right colon resulting in the vessels being more vulnerable to injury and bleeding.[6]

The exact role of superselective embolization in colonic diverticular hemorrhage has been controversial. While some advocate the procedure as a bridge to a subsequent more definitive elective surgical procedure, others had suggested that it could be definitive obviating the need for surgery entirely.[13,14]

As shown in our series, three of our patients (two during the first admission, while the third was readmitted for rebleeding 8 months after the procedure) had elective surgery after successful embolization of the bleeding site and were all discharged well. Superselective embolization allowed ongoing resuscitation, closer monitoring, and preoperative optimization of the numerous risk factors often seen in these patients. This is exemplified by our series, with over 69% of our patients having at least two comorbid conditions.

On the other hand, mesenteric embolization was shown to be definitive in over half of our patients without the need for surgery or any rebleeding episodes. This is an attractive option as it eliminates the risk of surgery in these high-risk patients.

From our series, it was interesting to note that over the two time periods, patients in the earlier period (2000–2004) had worse short-term outcome, with higher incidences of rebleeding and surgery. The authors postulated that this could be because of the continual improvement in embolization technology such as better micro-catheters, advancement of digital fluoroscopy technology, and increased experience and expertise of our interventional radiologists.

Based on our results, superselective embolization was definitive in selected patients and eliminated the need for surgical intervention. However, this must be weighed

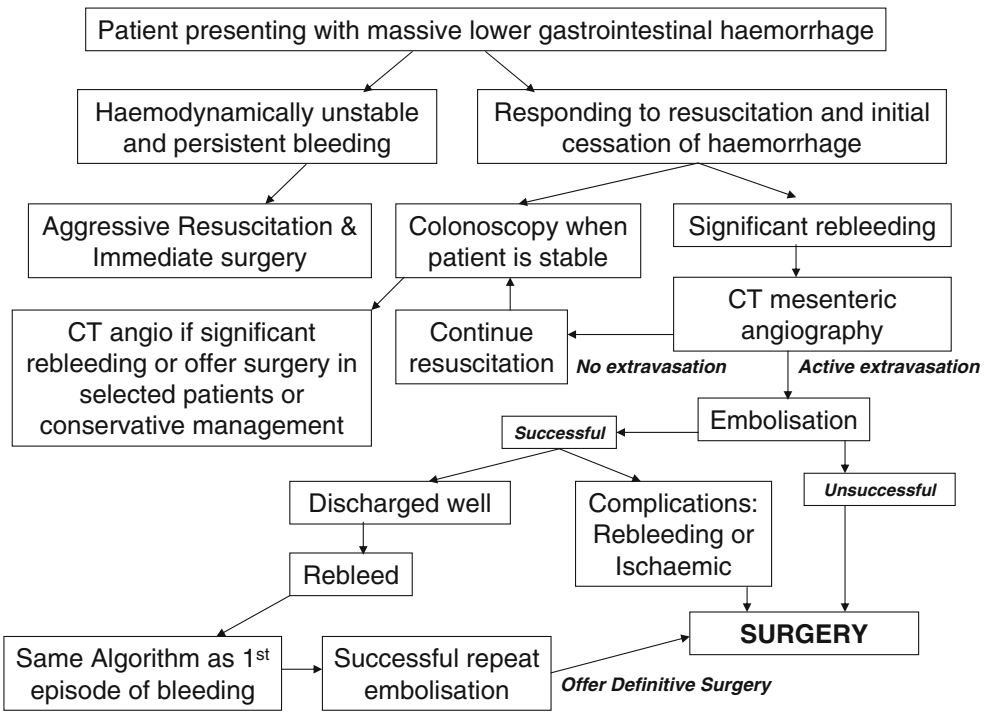

Fig. 4 Suggested algorithm in the management of massive lower gastrointestinal hemorrhage.

against the risks of a second episode of massive gastrointestinal hemorrhage and its ensuing complications in these high-risk patients. Hence, considering all the risks of nonoperative management against that of surgical intervention, our institution has currently adopted superselective embolization as the first-line treatment of active colonic diverticular hemorrhage, if possible, reserving definitive surgery for those patients who rebleed.

In addition, one of our patients had a successful repeat embolization and did not suffer from any ischemic complications. The role of repeat embolization has been briefly mentioned in the literature, but more information would be required to achieve any definitive conclusion on its role.[7,8,13,14]

Based on information from our series and data from the literature, our institution has currently adopted the following algorithm as shown in Fig. 4 below in the management of massive lower gastrointestinal hemorrhage.

Similar to our institution, numerous institutions have also adopted multidetector CT angiography as the radiological investigation of choice in patients with massive gastrointestinal hemorrhage.[15,16] Some of its advantages would include its rapidity, noninvasiveness, high sensitivity, and ease of operation. Apart from localizing the bleeding site accurately, it could also determine the underlying cause of the bleeding lesion and help guide subsequent management, which may include surgery or embolization.[15,16] On the other hand, catheter-directed angiography is more invasive and associated with several complications arising from the vascular access or the catheter. But it does allow immediate therapeutic intervention upon detection, which is the main drawback of CT mesenteric angiography in such situations.[15,16] The data from the literature and our experience led us to include this in the algorithm (Fig. 4).

As with most studies, there were several limitations in the present study. This series of patients was enrolled from a single institution, and any retrospective study has inherent flaws. Even though our study is one of the larger series in the literature analyzing the long-term durability of mesenteric embolization for colonic diverticular hemorrhage in an Asian population, the sample size is still extremely small. Furthermore, there was no prior fixed protocol adopted in our institution in the management of these patients. Moreover, right-sided colonic diverticulosis was the underlying pathology in most of our patients which is much rarely seen in the West. However, several reports based on the Western population have also cited the high prevalence of right-sided colonic diverticulosis in massive lower gastrointestinal hemorrhage and also reinforced the high-safety profile and efficacy of superselective embolization in such situations, even in left colonic diverticula.[12–14]

Though the limitations are significant, our series reinforced the limited data in the current literature on the high-safety profile and long-term durability of superselective embolization in colonic diverticular hemorrhage. Even if surgical resection is deemed necessary for rebleeding or surgeons' advice, this procedure is still invaluable as it allows adequate resuscitation of the patients, proper preoperative optimization, and appropriate preparation for the subsequent surgery. It can also limit the extent of resection. All these serve to reduce the resultant morbidity and mortality in these patients. The authors believed that with the increased awareness and adoption of superselective embolization, more data would be available to reaffirm its long-term efficacy in the management of colonic diverticular hemorrhage.

Conclusion

Superselective embolization for active colonic diverticular hemorrhage is safe and effective and should be considered as a first line treatment if possible and available. The procedure could act as a bridge to a subsequent more definitive elective surgery or be definitive as seen in over 50% of our patients over a period of 40 months.

References

1. Chen CY, Wu CC, Jao SW, Pai L, Hsiao CW. Colonic diverticular bleeding with comorbid diseases may need elective colectomy. J Gastrointest Surg 2009;13:516–520.
2. Gordon RL, Ahl KL, Kerlan RK, Wilson MW, LaBerge JM, Sandhu JS, Ring EJ, Welton ML. Selective arterial embolization for the control of lower gastrointestinal bleeding. Am J Surg 1997;174:24–28.
3. Silver A, Bendick P, Wasvary H. Safety and efficacy of superselective angioembolization in control of lower gastrointestinal hemorrhage. Am J Surg 2005;189:361–363.
4. Funaki B. Endovascular intervention for the treatment of acute arterial gastrointestinal hemorrhage. Gastroenterol Clin North Am 2002;31:701–713.
5. Lee YS. Diverticular disease of the large bowel in Singapore. An autopsy survey. Dis Colon Rectum 1986;29:330–335.
6. Wong SK, Ho YH, Leong AP, Seow-Choen F. Clinical behavior of complicated right-sided and left-sided diverticulosis. Dis Colon Rectum 1997;40:344–348.
7. Lipof T, Sardella WV, Bartus CM, Johnson KH, Vignati PV, Cohen JL. The efficacy and durability of super-selective embolization in the treatment of lower gastrointestinal bleeding. Dis Colon Rectum 2008;51:301–305.
8. DeBarros J, Rosas L, Cohen J, Vignati P, Sardella W, Hallisey M. The changing paradigm for the treatment of colonic hemorrhage: superselective angiographic embolization. Dis Colon Rectum 2002;45:802–808.
9. Bookstein JJ, Chlosta EM, Foley D, Walter JF. Transcatheter hemostasis of gastrointestinal bleeding using modified autogenous clot. Radiology 1974;113:277–285.

10. Funaki B, Kostelic JK, Lorenz J, Ha TV, Yip DL, Rosenblum JD, Leef JA, Straus C, Zaleski GX. Superselective microcoil embolization of colonic hemorrhage. AJR Am J Roentgenol 2001;177:829–836.
11. Tan KK, Wong D, Sim R. Superselective embolization for lower gastrointestinal hemorrhage: an institutional review over 7 years. World J Surg 2008;32:2707–2715.
12. Luchtefeld MA, Senagore AJ, Szomstein M, Fedeson B, Van Erp J, Rupp S. Evaluation of transarterial embolization for lower gastrointestinal bleeding. Dis Colon Rectum 2000;43:532–534.
13. Ahmed TM, Cowley JB, Robinson G, Hartley JE, Nicholson AA, Lim M, Ettles DF, Monson JR. Long term follow up of transcatheter coil embolotherapy for major colonic hemorrhage. Colorectal Dis 2009, in press.
14. Koh DC, Luchtefeld MA, Kim DG, Knox MF, Fedeson BC, Vanerp JS, Mustert BR. Efficacy of transarterial embolization as definitive treatment in lower gastrointestinal bleeding. Colorectal Dis 2009;11:53–59.
15. Anthony S, Milburn S, Uberoi R. Multi-detector CT: review of its use in acute GI hemorrhage. Clin Radiol 2007;62:938–949.
16. Laing CJ, Tobias T, Rosenblum DI, Banker WL, Tseng L, Tamarkin SW. Acute gastrointestinal bleeding: emerging role of multidetector CT angiography and review of current imaging techniques. Radiographics 2007;27:1055–1070.