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ORIGINAL ARTICLE

Factors predictive for a positive invasive mesenteric angiogram following a positive CT angiogram in patients with acute lower gastrointestinal haemorrhage

Ker-Kan Tan · Timothy Shore · David Hugh Strong · Mohammad Rafei Ahmad · Richard C Waugh · Christopher John Young

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Abstract
Introduction Computed tomographic mesenteric angiography (CTMA) is increasingly adopted in patients with massive lower gastrointestinal (LGI) bleeding. However, a positive computed tomography scan does not always translate to a positive invasive mesenteric angiography (MA) when performed. The aim of this study was to identify factors that could predict a positive invasive MA following a positive CTMA.
Methods A review of all patients with LGI haemorrhage who had a positive CTMA followed by an invasive MA was performed.
Results From July 2009 to October 2012, 33 positive CTMA scans from 30 patients were identified. Of the 33 bleeding points, 28 were in the colon, while 5 were in the small intestine. Diverticular disease accounted for 20 of the bleeding points. The median duration from the CTMA to the invasive MA was 165 (74–614)min. Of the 33 invasive MAs that were performed, only 14 demonstrated positive extravasation. Factors that were significant for a positive invasive MA included non-diverticular aetiology (odds ratio (OR), 6.75, 95 % confidence interval (CI), 1.43–31.90, p=0.029) and haemoglobin <100 g/l (OR, 14.44, 95 % CI, 1.56–133.6, p=0.009). When the invasive MA procedure was performed within <150 min of the positive CTMA scan, it was 2.89 (95 % CI, 0.69–12.12) times more likely to be associated with a positive invasive MA.
Conclusions Patients with non-diverticular aetiologies and lower haemoglobin levels are associated with a positive invasive MA following a positive CTMA. It is prudent to consider performing the invasive MA within 150 min after a positive CTMA.

Keywords CT scan · Bleeding · Angiography · Lower · Gastrointestinal

Introduction

Acute massive lower gastrointestinal (LGI) haemorrhage is a surgical emergency. Unlike upper gastrointestinal haemorrhage where endoscopic intervention can be effective, colonoscopic intervention is only successful in stopping the bleeding in a minority of patients [1, 2]. Emergency surgery on the other hand is associated with dismal morbidity and mortality rates [3, 4].

Because of the above issues, superselective embolisation of the bleeding vessels has been gaining popularity and is now integral to the management of acute LGI haemorrhage [5–9]. Technical success rates of up to 100 % have been reported, while complications such as bowel ischaemia and rebleeding remained acceptable [5–9]. However, numerous issues surround this treatment modality. To perform a superselective embolisation, an invasive mesenteric angiographic (MA) scan is necessary to accurately localise the bleeding site first. The preparation for this invasive procedure often consumes significant time and resources. Moreover, it is not infrequently the case that these bleeds are self-limiting and have ceased by the time an invasive MA is performed. The patients then risk undergoing an invasive

K.-K. Tan · T. Shore · D. H. Strong · M. R. Ahmad · C. J. Young (✉)
Department of Colorectal Surgery, Surgical Outcomes Research Centre (SOuRCe), Royal Prince Alfred Hospital, Missenden Road, Camperdown, Sydney, New South Wales 2050, Australia
e-mail: cyoungnsw@aol.com

R. C. Waugh
Department of Radiology, Royal Prince Alfred Hospital, Sydney, New South Wales, Australia

procedure with no apparent benefit. Hence, there is the need to improve this process in identifying the patients who are likely to gain from such a procedure.

Continuing advancement in technology has improved computed tomographic (CT) scanners by allowing high-contrast, temporal and spatial resolution and multiplanar reconstructive imaging, which enables technically robust imaging of the entire abdomen and pelvis during the arterial phase in sub-millimeter slices (multidetector-row CT) [10–12]. Coupled with the administration of an intravenous contrast through a peripheral cannula, it is now possible to identify the bleeding site in patients presenting with acute LGI haemorrhage.

The presence of positive extravasation of the contrast on the CT MA scan will then guide the interventional radiologist subsequently in the conduct of the invasive MA procedure to attempt embolising the bleeding vessel. But a positive CT MA scan does not always translate to a positive invasive MA when performed. If the latter is negative, the opportunity to embolise the bleeding vessel is then lost. Hence, the aim of our study was to identify factors that could predict a positive blush on invasive MA following a positive CT MA scan.

Methods

The records of all patients who underwent an invasive MA for massive LGI bleeding in the Royal Prince Alfred Hospital, Sydney, Australia, between July 2009 and October 2012 were reviewed. This series was obtained from a dedicated database of interventional radiological procedures. We then narrowed the study group to patients who had undergone a prior CT MA for their bleeding which demonstrated active contrast extravasation. The decision to carry out the initial CT scan was at the discretion of the treating physician who would have deemed the patient to be bleeding considerably with the aim to detect an active site of contrast extravasation. In these cases, intravenous contrast was given to all patients and the scans were read by a trained radiologist. As our institution is a tertiary referral centre for invasive angiographic procedures, it was not practical to document the technical details of all the CT scanners that were used, or the scanning protocol that were adopted, by the various peripheral hospitals. In such cases, surgeons from the Department of Colorectal Surgery and the interventional radiologists would both review the prior CT scans to verify its findings.

During the study period, invasive mesenteric angiography and possibly embolisation of an active bleeding site were the standard procedures adopted in our institution for all patients with suspected massive LGI haemorrhage. The decision to send a patient with LGI haemorrhage for a CT MA scan was made by the attending clinician. Following a positive demonstration of the contrast extravasation, the decision to send the patient for an invasive MA was made after discussion between the attending clinician, interventional radiologist and the patient. The time taken from the CT MA scan to the performance of the invasive MA was documented.

Data collected included age, usage of antiplatelet or anticoagulant medications, history of LGI haemorrhage and the pre-MA haemoglobin level. The site of bleeding and the underlying aetiologies were also recorded. The materials used for the subsequent mesenteric embolisation following a positive blush on the invasive MA included microcoils, gel foams and polyvinyl alcohol particles (Fig. 1 demonstrates the successful deployment of microcoils). Selection from among these was left at the discretion of the interventional radiologists. All the interventional radiologists who performed the procedure were of consultant grade.

Data analysis was performed using the Fisher's exact test for categorical variables with their odds ratio (OR) and 95 % confidence interval (CI) reported. Statistical analysis was performed using the SPSS 17.0 statistical package (Chicago, IL).

Results

From July 2009 to October 2012, 33 positive CT MA scans were performed on 30 patients who had acute LGI haemorrhage. The median age of the study group was 73 (range, 31–95) years. Nineteen patients were on antiplatelet therapy, while seven were on anticoagulation therapy.

There were three patients who had a second positive CT MA scan. One occurred 3 days after the initial embolisation. The same bleeding site was successfully embolised again. He was subsequently discharged well with no associated complications. In the other two patients, one had a recurrence

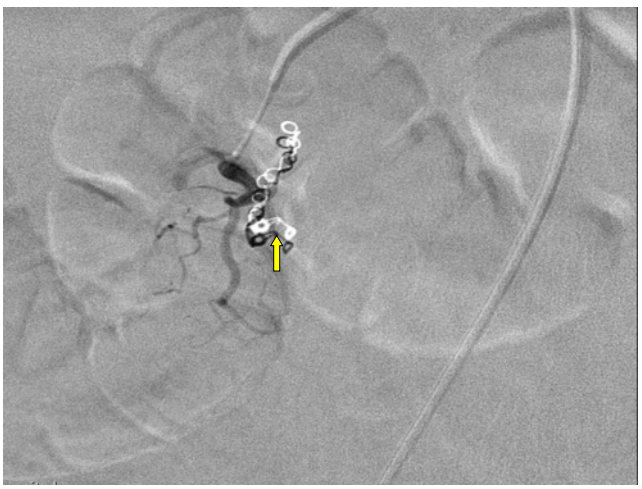

Fig. 1 Image demonstrating the successful deployment of microcoils (*arrowed*) in a patient presenting with active lower gastrointestinal haemorrhage

of the bleeding from his advanced neoplasm 1 month after the initial embolisation. The bleeding was stopped after a repeat embolisation. He subsequently underwent an extended right hemicolectomy, distal pancreatectomy and gastrectomy with splenectomy a few days later after optimization of his condition. The other patient was an 82-year-old woman who had a recurrence of the bleeding from her right-sided colonic diverticulosis 14 months after an earlier successful embolisation. She was also subsequently discharged well.

Of the 33 bleeding sites, 28 were located in the colon (12 left sided and 16 right sided), while 5 were in the small bowel. Diverticular disease accounted for 20 of the underlying pathologies, of which 8 were left sided and 12 were right sided. There were four patients who bled from ulcerations, two were from the rectum and two were from the small bowel (both were confirmed on enteroscopy 8 and 10 days following their successful embolisation). Two patients bled following a bowel resection: the first was a 31-year-old who bled 3 days after a right hemicolectomy for a perforated right-sided diverticulitis, while the second patient was a 68-year-old who bled 4 days after a small bowel resection. Table 1 highlights the demographic and details of the study group.

The median haemoglobin of the study group just before the invasive MA was 86 (range, 61–137) g/l, while the median duration from the CT MA to the invasive MA was 165 (74–614) min. There were no patients who suffered any reported complications from the CT scans. There was only one notable complication reported from the invasive MA after the puncture of the femoral artery. The patient complained of pain in the lower limb and this was associated with decreased distal pulses in the corresponding leg after the femoral sheath was removed. He was subsequently diagnosed with common femoral artery stenosis and this was treated conservatively.

Of the 33 invasive MAs that were performed, only 14 demonstrated positive extravasation. When we analysed the various factors that were associated with a positive invasive MA following a positive CT MA (Table 2), non-diverticular aetiology (OR, 6.75, 95 % CI, 1.43–31.90, $p=0.029$) and haemoglobin <100 g/l (OR, 14.44, 95 % CI, 1.56–133.6, $p=0.009$) were the only variables that were statistically significant. Although small bowel aetiology (OR, 7.20, 95 % CI, 0.71–73.53) and anti-coagulation therapy (OR, 1.50, 95 % CI, 0.30–7.43) were also associated with an increased probability of a positive invasive MA, the differences were not statistically significant.

Interestingly, when the invasive MA procedure was performed <150 min of the positive CT MA scan, it was 2.89 (95 % CI, 0.69–12.12) times more likely to be associated with a positive invasive MA. This difference was not statistically significant.

Table 1 Demographic and details of the study group

Characteristics	
Number of patients on	
Anticoagulation therapy	−7 (23.3)
Antiplatelet therapy	−19 (63.3)
Dual therapy	−9 (30)
Site of haemorrhage ($n=33$)	
Right colon	−16 (48.5)
Left colon and rectum	−12 (36.4)
Small bowel	−5 (15.2)
Underlying aetiology for haemorrhage ($n=33$)	
Diverticular disease	−20
Neoplasm	−3
Ulcer	−4
Likely angiodysplasia	−4
Post-surgical haemorrhage	−2
Median age, range (years)	73 (31–95)
Median haemoglobin before invasive mesenteric angiography, range (g/l)	86 (61–137)
Median time taken from CT MA to the invasive MA procedure, range (min)	165 (74–614)
Number of invasive MA that demonstrated positive extravasation	14 (42.4)

Discussion

We have identified several factors that could predict a positive blush on the invasive MA following a positive CT MA. These included non-diverticular pathology, small bowel aetiology and patients with a lower haemoglobin level. But perhaps, the most interesting finding from our study was that performing the invasive MA within 150 min of the CT MA may increase the likelihood of identifying the bleeding site on the invasive MA. Although this difference was not statistically significant, we believe it is likely due to the small number of patients in our study. But this finding does make perfect sense as the earlier the invasive MA occurs, the higher the probability that the procedure will be successful in identifying the bleeding site and hence also the chances of a successful embolisation. We accordingly believe that work should be undertaken to further investigate this relationship between the times from CT MA to invasive MA so that a clinical algorithm can be established in the management of acute LGI haemorrhage.

It is also not surprising that there were several factors other than duration that played a role in determining the outcome of an invasive MA. Pathologies such as neoplasm and post-surgical complications are more likely to have persistent bleeding as the anatomy and physiology necessary to achieve haemostasis have been disrupted [6, 13–16]. The

Table 2 Analysis of the factors predicting the outcome of invasive mesenteric angiography following a positive blush on CT mesenteric angiography

Characteristics	Negative blush on mesenteric angiography (n=19)	Positive blush on mesenteric angiography (n=14)	p value	Odds ratio (95 % confidence interval)
Small bowel aetiology	1 (5.3 %)	4 (28.6 %)	>0.05	7.20 (0.71–73.53)
On anticoagulation therapy	4 (21.1 %)	4 (28.6 %)	>0.05	1.50 (0.30–7.43)
Duration from CT mesenteric angiography <150 min	6 (31.6 %)	8 (57.1 %)	>0.05	2.89 (0.69–12.12)
Non-diverticular aetiology	4 (21.1 %)	9 (64.3 %)	0.029	6.75 (1.43–31.90)
Haemoglobin pre-invasive angiography <100 g/l	9 (47.4 %)	13 (92.9)	0.009	14.44 (1.56–133.6)

differences in vasculature between the small and large bowel could also account for the higher probability of ongoing haemorrhage and even rebleeding after previous embolisation in small bowel pathologies [6, 17].

Over 70 % of our patients were on antiplatelet and/or anticoagulant therapy. The indications of such medications are often the patients' underlying cardiac and vascular diseases. The authors believe that this will definitely increase the incidence of patients presenting with acute LGI haemorrhage in the future due to the derangement in the clotting mechanism. Ceasing the medication when a patient presents with an episode of gastrointestinal haemorrhage is sensible [2]. But to determine the right timing to restart them is rather more perplexing. On one hand, the risks of developing complications from the underlying cardiovascular issues are significant and potentially life threatening, but the risks of rebleeding and its associated complications in such high-risk patients are not negligible [18–20]. A multidisciplinary approach to each individual is advised.

A negative invasive MA procedure following a positive CT MA scan poses various clinical dilemmas. Some may argue for a surgical intervention since the underlying bleeding site has already been identified by the CT scans. But the associated peri-operative complications are considerable. To adopt a wait-and-see approach instead is not unwise as these patients may actually never bleed again, and several non-operative options are available to stop the haemorrhage should it recur.

Then what about patients who have undergone a successful embolisation? Surgery is no longer recommended in patients who have been successfully embolised as the incidence of rebleeding or other complications does not justify its role [8, 21, 22]. Even if patients do rebleed, they can either be safely embolised again or operated when optimised. That said, surgery is still necessary in certain situations. In patients with underlying neoplastic disease, surgical intervention can be curative or palliative in preventing future exsanguinating bleeding. Surgery has also been recommended for small bowel aetiologies due to the propensity to rebleed even after embolisation [6]. Perhaps more debatable is the role of surgery in high-risk patients who cannot withstand a second massive haemorrhage. The clinical indicators supporting a significant index haemorrhage episode included the need to transfuse more than 6 units of red blood cells, the need for inotropic support, lengthy stay in the intensive care/high dependency unit and the development of a myocardial ischaemic event from the resulting anaemia [2, 23]. And these are usually patients who have numerous underlying medical conditions, especially ischaemic heart disease and heart failure [2, 23]. The indications become stronger if these patients also reside far from any tertiary healthcare institutions that can provide services such as blood transfusion, intensive care, interventional radiologists and surgical expertise.

Although the benefit of a negative CT MA is to spare a patient an immediate invasive MA, the complications from CT scans cannot be dismissed [24–28]. While there were no patients in our series who developed acute renal impairment or anaphylactic reactions from the contrast medium following the scans [24, 25], these are known risks, in addition to the lifetime risk of developing a malignancy as a result of the ionising radiation [26–28]. A study to evaluate factors that could predict a positive CT MA scan in patients with acute LGI haemorrhage would be useful to clinicians in identifying those who would really benefit from the procedure. Improvements along these lines would minimise the aforementioned complications and help to conserve resources.

The small number of patients in our study is a significant limitation. There was also no fixed algorithm in guiding the decision making of our patients who had a positive CT MA scan. As our hospital is a tertiary healthcare institution with interventional radiology capability, there were several patients who were transferred from peripheral hospitals after a positive CT MA scan there. This accounted for the lengthy delay seen in some of our patients. Nevertheless, our study highlighted numerous issues surrounding this complex issue that may help guide clinicians in their management of acute LGI haemorrhage.

Conclusions

Following a positive CT MA for lower gastrointestinal bleeding, patients with non-diverticular aetiologies and lower

haemoglobin levels are associated with a positive invasive MA. It is prudent to consider performing the invasive MA within 150 min upon detection of the bleeding point on the CT MA.

Conflict of interest None.

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