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CLINIC OF RADIOLOGY

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LOWER GASTROINTESTINAL BLEEDING – RADIOLOGICAL DIAGNOSIS AND ENDOVASCULAR TREATMENT

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DEDICATION

I dedicate this work to my wonderful teachers and colleagues, and the staff which was committed to help with guidance and resourcing. Special thanks to the clinic of Interventional Radiology for the communicability and willingness to provide support.

DECLARATION

I, Ayal Zach hereby declare that this thesis on ‘Lower gastrointestinal bleeding – radiological diagnosis and endovascular treatment’ is original, and has been written by me. It is a record of my research work and has not been presented before in any previous publication.

Name:_____ Signature:_____

Date: _____

ABSTRACT

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Aim: To analyze radiological diagnostic tools and endovascular treatment options of lower gastrointestinal bleeding, and comparison of these options depending on location and etiology of gastrointestinal bleeding.

Objectives: 1. To determine diagnostic methods and endovascular treatments used for lower gastrointestinal bleeding 2. To establish whether embolization treatment clinical succession is dependent on the localization of the lower gastrointestinal bleeding 3. To establish whether embolization treatment clinical succession is dependent on the etiology of lower gastrointestinal bleeding.

Methodology: The research was performed in the Interventional Radiology unit of the Radiology department of LUHS hospital Kaunas Clinics from 2021-01-18 to 2021-05-01. The research method was retrospective. Over four years between 2017-01-01 to 2020-08-30 patients' book records were analyzed to find suitable patients for further evaluation to find out specifically patients who underwent interventional treatment for lower gastrointestinal bleeding.

Results: In the period between 2017/01 and 2020/08 we found in patient's hospital records 75 patients that were suffering from LGIB. The group of selected patients has consisted of 34 women and 41 men with a median age of 77. The main pathology of the admitted patients was diverticulosis with 29,33% of cases followed by colorectal cancer with 18,66% of cases, colitis with 13,33% of cases, rectal hemorrhoids with 9% of cases, colonic polyps with 5,33% of cases, and angiodysplasia with 2,67% of cases. On CT it was found that active LGIB was found mainly in descending colon with 35,55% of cases followed by rectum with 27,77% of cases, ascending colon with 15,55% of cases, small intestine with 12,22% of cases and transverse colon with 8,88% of cases. On CT angiography it showed extravasation most commonly from inferior mesenteric artery with 55,55% of cases followed by superior mesenteric artery with 36,66% and internal iliac artery with 7,77%. In total 90 embolization procedures were performed. Out of 75 patients that underwent embolization procedures we technically succeeded in 96% (n=73). Clinical success was established with 73,33% (n=55) of cases with no major complications or rebleeding within 30 days after the embolization while 18,66% (n=14) experienced rebleeding within 30 days and required additional embolization procedure.

Conclusions: The role of transcatheter arterial embolization in interventional radiology can be regarded as crucial in those patients whose lower GI bleeding persists even after conservative treatment options. The radiological field yields diagnostic imaging studies and endovascular therapeutic interventions that can be done safely and effectively with successful clinical outcomes.

Keywords: lower gastrointestinal bleeding; embolization; angiography; interventional radiology.

CONFLICTS OF INTERESTS

The author reports no conflicts of interest.

ETHICS COMMITTEE APPROVAL

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ABREVIATIONS

- LGIB – Lower gastrointestinal bleeding;
- IMA – Inferior mesenteric artery;
- SMA – Superior mesenteric artery;
- IIA – Internal illiac artery
- AVM – Arteriovenous malformation
- CT – Computed tomography;
- CTA – Computed tomography angiography;
- TAE – Transcatheter arterial embolization;
- NBCA – N butyl 2 cyanoacrylate;
- IR – Interventional radiology;
- OR – Odds ratio;
- CI – Confidence interval.

INTRODUCTION

Lower gastrointestinal bleeding is defined as bleeding originating at the level of the distal esophagus, stomach, and duodenum (distal to the ligament of Treitz). In the past ten years, the interventional radiology field has expanded radically and found new ways how to diagnose and cure lower gastrointestinal bleeding. The reasons for the increased occurrence of LGIB were associated with increased aging of the population and higher use of anticoagulant medications [1].

LGIB has an occurrence rate of approximately 30 cases per 100000 population per year and is considered by many hospitals as a serious disorder that should be dealt with quickly to avoid further complications [2].

The steps for the correct treatment of acute LGIB involve determining the source of bleeding to focus on the most appropriate intervention to achieve hemodynamic stability. There are multiple choices of diagnostic choices to localize LGIB, including colonoscopy, flexible sigmoidoscopy, computed tomographic angiography (CTA), catheter angiography, and nuclear scintigraphy.

Management of LGIB starts with the exclusion of upper gastrointestinal bleeding causes with initial endoscopy. When UGIB is ruled out, colonoscopy is regarded as the first diagnostic modality to evaluate for non – acute LGIB [3].

The expansion of endoscopic methods as well as interventional techniques and minimally invasive procedures decreased the requirement for surgical operations, resulting in cost-effective treatment for lower gastrointestinal bleeding and enhanced procedures aftermath. In an acute setting, it is shown that emergent CT and CTA are mostly utilized to identify the location of LGIB. It can be seen in CTA or catheter angiography extravasation of contrast media to identify bleeding source that is manageable by embolization treatment [4].

Transcatheter arterial embolization (TAE) is considered by most interventional radiologists as a safe and effective method to achieve hemodynamic stability in patients with acute LGIB. To accomplish embolization, interventional radiologists use either permanent microcoils with particles or gelatin sponges [5].

The aim of this study is to analyze radiological diagnostic tools and endovascular treatment options for lower gastrointestinal bleeding, and comparison of these options depending on location and etiology of lower gastrointestinal bleeding.

Objectives of this study:

1. To determine diagnostic methods and endovascular treatments used for lower gastrointestinal bleeding.

2. To establish whether embolization treatment clinical succession is dependent on the localization of the lower gastrointestinal bleeding.

3. To establish whether embolization treatment clinical succession is dependent on the etiology of the lower gastrointestinal bleeding.

1. LITERATURE REVIEW

1.1 Lower gastrointestinal bleeding in interventional radiology

Lower Gastro-intestinal bleeding:

Lower gastrointestinal bleeding (LGIB) is defined as bleeding originating distally from the suspensory ligament of the duodenum (ligament of Treitz) and is generally further divided into three important subcategories: massive, moderate, and occult bleeding. Hematochezia or bright red blood from the rectum are the most common presentations [1].

Epidemiology:

A vast overview of the epidemiology of LGIB found that the annual incidence of hospitalization for LGIB was estimated to be 20 to 30 per 100,000 population. This estimation increased dramatically with advancing age. As a result, the effect of this disorder shows promise to escalate in the elderly patient population. On the other hand, the annual occurrence of acute upper gastrointestinal bleeding was 100 per 100,000 per year making LGIB roughly one-fifth as common as UGIB. Lower GI hemorrhage in the younger population is most commonly caused by Meckel's diverticulum, inflammatory bowel disease, or bleeding polyps [2].

Etiology:

LGIB can occur due to a vast variety of reasons. The common causes of LGIB include diverticular bleeding, hemorrhoids, colorectal malignancies, inflammatory bowel disease, arteriovenous malformations, colitis and iatrogenic reasons. Retrospective reviews of hospital admission data have regularly showed diverticulosis to be the most common cause of LGIB in adult and elderly population, followed by anorectal disease, colitis, carcinoma and arteriovenous malformations. Diverticulosis is the prominent etiology of clinically significant LGIB, occurring in many LGIB patients. A diverticulum is a mucosal protrusion through the wall of the colon at areas of weakness where the penetrating vessel piercing through the muscular layer of the gut wall. The perforating vessels become exposed and making them susceptible to chronic trauma which leads to obstruction, injury and bleeding [6].

Colonic angiodysplasias are one of the more common vascular malformations found in the intestines. These are acquired lesions that become increasingly frequent past the sixth decade of life due to age-related systemic vascular changes. Most colonic angiodysplasias arise from colonic contraction which results in chronic venous congestion and capillary dilation with subsequent formation of AVM [7].

Ischemic colitis is a disease seen mainly in the elderly population and patients with numerous comorbidities such as heart disease, and arrhythmia increase the risk of ischemic events. The colon is most likely to be involved in ischemic insult and involves the watershed areas, which incorporate the splenic flexure and the rectosigmoid junction. Hypotension and vasoconstriction lead to mucosal weakness, wall shedding, edema, and bleeding [8].

Colorectal cancer is the third most common cancer in the United States and is the leading cause of neoplastic bleeding. The most common presentation is occult bleeding with iron deficiency anemia or low volume recurrent hematochezia [9].

Symptoms:

Classic manifestations of LGIB generally include hematochezia or melena. The clinical manifestation of LGIB changes with the anatomical origin of the bleeding. In patients with LGIB from the right side of the colon or cecal bleeding, melena might present. In patients with LGIB from the left side of the colon bright red blood per rectum might appear. In acute gastrointestinal bleeding, the hemoglobin levels would be initially normal but after some time, the levels would decrease due to constant per rectum bleeding [10].

1.2 Types of diagnostic tools used to detect lower gastrointestinal bleeding

Multidetector CT angiography:

CT angiography is an appealing diagnostic modality for patients who are hemodynamically stable with gastrointestinal bleeding that couldn’t be spotted by colonoscopy because CTA is extensively available in the acute setting, rapid, and minimally invasive. Furthermore, it yields crucial diagnostic details that may be helpful for subsequent interventions such as catheter angiography or endoscopy procedures. Bleeding at a rate of 0.3 to 0.5 mL/minute can be detected with CT angiography. One of the advantages of CTA is that it is capable of precisely localize the origin of arterial and venous GI bleeding, and to further distinguish underlying pathology that may be the cause of bleeding for the betterment of future management. In addition, CTA can outline the underlying vascular anatomy before embolization and indicate any anatomical alterations that may influence management. Disadvantages of CTA incorporate decreased sensitivity relative to radionuclide imaging, relatively high radiation dose, and the need for intravenous contrast [4,11].

Catheter angiography:

Catheter angiography is usually reserved for patients in whom colonoscopy or endoscopy is impossible due to severe bleeding with hemodynamic instability. The superior mesenteric artery is generally inspected first in patients with suspicion of lower gastrointestinal bleeding and without previous attempts of localization. In case this test is negative, the inferior mesenteric and celiac vessels are examined. The success rate differs widely from 25 to 70 percent, depending on the timing relative to the episode of bleeding and the local expertise of the treating physician. The advantages of angiography over other tests for lower GI bleeding are that it does not require bowel preparation and anatomic localization is accurate. Moreover, it also permits therapeutic intervention. The main disadvantage of catheter angiography is that it is an invasive and time-consuming approach with a potentially high radiation dose. In addition, patients may have falsely negative studies if GI bleeding is recurring and they are not actively bleeding during the angiogram which is required for accurate results [10].

Endoscopic measurements:

Endoscopic measurements would be the principal intervention tool as it grants bleeding area localization and causes distinguishing by visual exploration and biopsy extraction. Endoscopic hemostasis modalities for acute lower gastrointestinal bleeding include contact and noncontact thermal devices such as bipolar electrocoagulation, heater probe, argon plasma coagulation, and mechanical therapies such as endoscopic clips and band ligation. Firstly, diluted epinephrine injection facilitates primary hemostasis of active bleeding but should be used in combination with a second method such as mechanical or contact thermal therapy to achieve definitive hemostasis. The choice of hemostasis method is generally guided by the cause and location of bleeding, the ability to access the site, and operator skills. Diverticulosis, angiodysplasias, and post polypectomy bleeding are the most likely sources of LGIB to benefit from endoscopic hemostasis [3].

When an upper gastrointestinal bleeding source is excluded via initial upper endoscopy, colonoscopy is the first-line examination of choice for potential lower gastrointestinal bleeding in a non-emergent setting. Not only colonoscopy might be used for diagnosing the bleeding source, but it also serves as a therapeutic option for the diagnosis and also treatment of acute lower GI bleeding. Choosing the right evaluation of patients with lower GI bleeding is based mainly on clinical presentation on admission and the features of the individual tests of the patient. Advantages of colonoscopy in comparison with other evaluation measures for lower GI bleeding include its potential to precisely localize the site of the bleeding nevertheless of the etiology or rate of bleeding, the ability to collect specimens for biopsy, and the potential to treat the problem immediately [13].

Disadvantages of colonoscopy include the requirement for complete bowel cleansing, poor visualization in an unprepared or poorly prepared colon, and the adverse effects of sedating agents in a profoundly bleeding patient. Complications are reported in fewer than 2 percent of colonoscopies performed for lower GI bleeding [14].

The colonic mucosa should be inspected during both introduction and withdrawal to reduce the risk for iatrogenic injuries. Aggressive lavage may be needed to localize the bleeding site making it not suitable for patients presenting with emergent acute LGIB. A definitive or potential bleeding source is visualized in 45 to 90 percent of patients undergoing colonoscopy for lower GI bleeding [15].

Flexible sigmoidoscopy probe can assess the rectum and left side of the colon and can be done with enemas or even in an unprepared colon. This may be an appropriate initial diagnostic and feasibly therapeutic method in younger patients whose bleeding is highly suggestive of a distal colon or rectal source. Furthermore, it can be utilized in patients suspected of having a solitary rectal ulcer, ulcerative colitis, radiation proctitis, infectious colitis, ischemic colitis, post-polypectomy bleeding in cases of polyps removed only from the rectum and/or left colon, or internal hemorrhoids [16].

Radiographic imaging:

Radionuclide scanning distinguishes bleeding that is occurring at a rate of 0.1 to 0.5 mL/minute, and it is the most sensitive radiographic test for GI bleeding. Two types of nuclear scans have been used: technetium-99m (99mTc) sulfur colloid and 99mTc pertechnetate-labeled autologous red blood cells. Both techniques are noninvasive and sensitive for GI bleeding. Angiography must be performed promptly after a positive radionuclide scan. The advantage of all radiographic tests for GI bleeding is the ability to diagnose bleeding throughout the GI tract, including small bowel sources. Nonetheless, these tests all require active bleeding to detect the origin of the bleeding and also are not used in acute settings for patients presenting with acute LGIB [17].

1.3 Types of treatments used in interventional radiology for lower gastrointestinal bleeding

Intra-arterial vasopressin injection:

Vasopressin induces generalized vasoconstriction via direct action upon vessel walls, in particular the arterioles, capillaries, and venules. injection of vasopressin produces a rapid drop in local blood flow that slowly returns to normal several hours after the infusion has been discontinued. This

procedure aims to decrease the perfusion pressure to allow time for the blood to clot at the bleeding area. Nonetheless, reoccurring bleeding, once the vasopressin has been stopped, is frequent, and its use can be correlated with notable ischemic events and arrhythmias. As a result, patients suffering from gastrointestinal bleeding mainly treated with angiographic embolization modalities to avoid these complications. Furthermore, its use has become less common after the establishment of microcatheters and microcoils, as it prolongs and the extent of post-procedure care [18].

Transcatheter Arterial Embolization:

Transcatheter arterial embolization works by mechanically plugging the arterial blood supply into the bleeding area. Substances used for embolization are either temporary such as absorbable gelatin sponge or permanent such as coils, particles, glue, and ethylene-vinyl alcohol copolymer. The main goal of the embolization procedure is to minimize the bloodstream to the bleeding area enough to reach hemostasis while preserving collateral perfusion to adjoining tissues. This procedure is being performed only by skilled interventional radiologists because of the chance of producing bowel wall ischemia or infarction [5].

Microcoils are the most commonly used embolic agent option for treating GI bleeding by most interventional radiologists. Moreover, it can be installed selectively into the distal bleeding artery and can preserve the collateral blood supply to the site [5]. Another example of permanent embolic agents which are widely used are particles such as polyvinyl alcohol. A Permanent blockage is achieved through mechanical impaction. Particles should be used with vigilance in the mesenteric circulation as they cause distal blockade, escalating the risk of bowel ischemia and infarction. Gelatin sponges cause hemostasis upon exposure with blood when injected into a vessel. It comes as a powder or as small blocks that are cut to the desired size. Advantages of using gelatin sponge as embolization agent include universal availability, cost-effectiveness, and temporary blockade of the targeted vessels when required. The indications for embolization include the requirement for massive lower gastrointestinal bleeding, hemodynamic instability manifesting as hypotension with systolic pressure less than 100mmHg, failure to respond to previous therapeutic modalities, and evidence of active bleeding shown by radiographic measures [19].

Liquid agents that have been showing promising evidence are also used for embolization. These agents include N-butyl 2-cyanoacrylate (NBCA) and ethylene-vinyl alcohol copolymer [19, 20]. Once injected, these agents mixing with blood and consolidate which leads to the arterial blockage. A possible advantage of NBCA is that the time needed for embolization is shorter than that with other agents. However, its use requires significant training and skilled personnel and has been associated with ischemic events [20]. On the other hand, Ethylene-vinyl alcohol is nonadhesive,

has high radiopacity, and has long consolidation periods that permit for more manageable and predictable embolization [21].

2. RESEARCH METHODOLOGY

2.1 Design, patient selection and distribution:

This research is a retrospective study of 75 patients, who were admitted with acute refractory lower gastrointestinal bleeding to the interventional radiology at “Kaunas Clinics” hospital.

The study was conducted over 5 months (Jan. 2021 – May. 2021).

The patients’ records were divided into three groups according to localization of the embolization procedure: embolization of inferior mesenteric artery, embolization of superior mesenteric artery, and embolization of internal iliac artery.

After the evaluation of the data, it was determined that the median age of the patients is 77. According to the median, patients were characterized by age and gender. The youngest patient was 38 years old and the oldest patient was 100 years old.

The results showed that out of 75 patients that underwent in total 90 embolizations procedures, 26,66% (n=24) of men and 31,11% (n=28) of women had embolization of inferior mesenteric artery, 23,33% (n=21) of men and 11,11% (n=10) of women had embolization of superior mesenteric artery and 5,55% (n=5) of men and 2,22% (n=2) of women had embolization of internal iliac artery. The further distribution of patients’ age and gender is shown in the table below [Table 1].

Table 1: Characterization of gender and age of participants.

Localization of procedure	Gender	Age group		Total (n)	Percentage (%)
		Less than 77	Greater than 77		
Embolization of IMA	Male	14	10	24	26,66 %
	Female	7	21	28	31,11 %
Embolization of SMA	Male	18	3	21	23,33 %
	Female	8	2	10	11,11 %
Embolization of IIA	Male	3	2	5	5,55 %
	Female	1	1	2	2,22 %

2.2 Statistical data analysis

The statistical analysis was performed using “SPSS” (Statistical Package for the Social Science), version 20.0 and Microsoft Excel. To determine the dependency of clinical succession based on localization and etiology of LGIB the Pearson’s chi-square test was used. Two hypotheses were created:

1. Null Hypothesis: Clinical succession of embolization procedure is independent of localization and etiology of lower gastrointestinal bleeding.
2. Alternative Hypothesis: Clinical succession of embolization procedure is dependent on localization and etiology of lower gastrointestinal bleeding.

Statistical significance was determined as if the p-value was less than 0,05. Microsoft Excel program was used to collect, analyze the data, and make a graphic presentation of the data.

2.3 Ethical aspects of the research

During the research the main ethical aspects were kept:

1. Minimizing the risk of harm;
2. Obtaining the informed consent;
3. Protecting anonymity and confidentiality;
4. Avoiding deceptive practices;
5. Providing the right to withdraw.

To perform the research the Lithuanian university of health sciences bioethical center confirmation was obtained Nr. BEC – MF – 182.

The data was taken from the medical history of “Kaunas Clinics” Interventional Radiology department records. All the patients were introduced before the treatment with the principals of the university hospital and gave the consent that their medical information will be used for further researches anonymously.

2.4 Strategy of the research

Electronic databases PubMed, NCBI, Elsevier, UpToDate, ResearchGate, Medline, Embase, CINAHL, Cochrane and Web of Science were evaluated. The search strategy expanded and involved key phrases which are relevant to the concepts; to reach maximum sensitivity, a combination of the terms “lower gastrointestinal bleeding”; “embolization”; “angiography”; and “interventional radiology” were involved. 540 studies and articles were retrieved and screened for most updated information and after the exclusion of 515 articles and studies, 25 relevant studies were involved after reading the title and abstract of the study. Further studies were examined by the

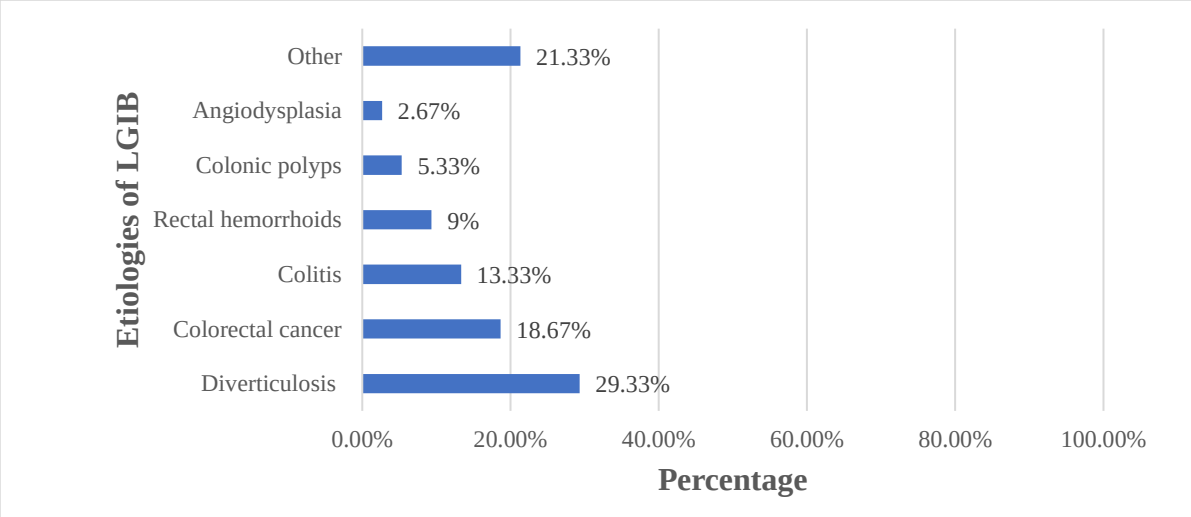
author furthermore via the reference lists of selected articles for research of supplementary beneficial articles and studies.

3. RESULTS

3.1 Lower gastrointestinal diseases which provoked LGIB in patients

According patients' hospital records, out of 75 cases, diverticulosis was the most common reason for hospitalization with 29,33% (n=22) of cases followed by colorectal cancer with 18,67% (n=14), colitis with 13,33% (n=10), rectal haemorrhoids with 9% (n=7), colonic polyps with 5,33% (n=4) and angiodysplasia with 2,67% (n=2). The rest 21,33% (n=16) of cases were patients with complications of disorders not related to lower gastrointestinal diseases [figure 1].

Figure 1. Distribution of LGIB etiologies patients most commonly had on arrival to hospital



3.2 Diagnostic methods and endovascular treatments used for lower gastrointestinal bleeding

Diagnostic Tool 1: CT angiography

The CT angiography diagnostic tool was used in 100,00% of cases (n=90) to diagnose extravasation from superior mesenteric, inferior mesenteric and internal illiac arteries. The number of diagnostic investigations is higher than number of patients (n=75) due to the fact that 14 patients experienced recurrent episode of LGIB and required repeated CT angiography within 30 days after initial treatment at the clinic and one additional patient with deteriorating status underwent secondary angiography to evaluate the integrity of the bowel circulation post initial treatment. The results showed that extravasation from IMA was found in 57,77% (n=52) cases, extravasation from SMA was found in 34,44% (n=31) cases, extravasation from IIA was found in 7,77% (n=7) cases by using the CT angiography [Table 2].

Table 2. Findings of using diagnostic tools - CT angiography

Findings	***Total***	
	Total (n)	**Percentage (%)**
Extravasation from SMA	31	33,44%
Extravasation from IMA	52	57,77%
Extravasation from IIA	7	7,77%
Total	**90**	**100,00 %**

Diagnostic Tool 2: Abdominal and pelvic CT

The Abdominal and Pelvic CT diagnostic tool was used in 100% (n=90) of procedures before using CT angiography to generally localize the origin of bleeding in the lower gastrointestinal tract. The number of investigations is higher than the number of patients due to the fact 14 patients experienced rebleeding within 30 days after initial treatment and one additional patient with deteriorating status underwent additional CT imaging to evaluate for major complications post initial embolization procedure. The results showed that active bleeding was most commonly originating from descending colon with 35,55% of cases followed by rectum with 27,77% of cases, ascending colon with 15,55% of cases, small intestine with 12,22% of cases and transverse colon with 8,88% of cases by using the Abdominal and Pelvic CT [Table 3].

***Table 3. Findings of using diagnostic tool* - Abdominal and pelvic CT**

Findings	***Total***	
	Total (n)	**Percentage (%)**
Bleeding from Ascending colon	14	15,55%
Bleeding from Transverse colon	8	8,88%
Bleeding from Descending colon	32	35,55%
Bleeding from Rectum	25	27,77%
Bleeding from Small intestine	11	12,22%
Total	**90**	**100,00%**

Other diagnostic Tools: Colonoscopy and Nuclear scintigraphy

The colonoscopy diagnostic tool was used in 39 cases in order to evaluate lower gastrointestinal tract diseases and bowel integrity after acute LGIB was addressed with initial emergent CT and CTA

followed by embolization procedure. A Diagnostic colonoscopy was utilized in patients that exhibited additional clinical signs suggesting other comorbidities which required further diagnosis for confirmation. In addition, nuclear scintigraphy diagnostic method is also being used in non-acute setting in the IR clinic but all 75 patients didn't require the use of this technique as all of them presented with clinical signs of acute LGIB.

Treatment modality: Transcatheter arterial embolization

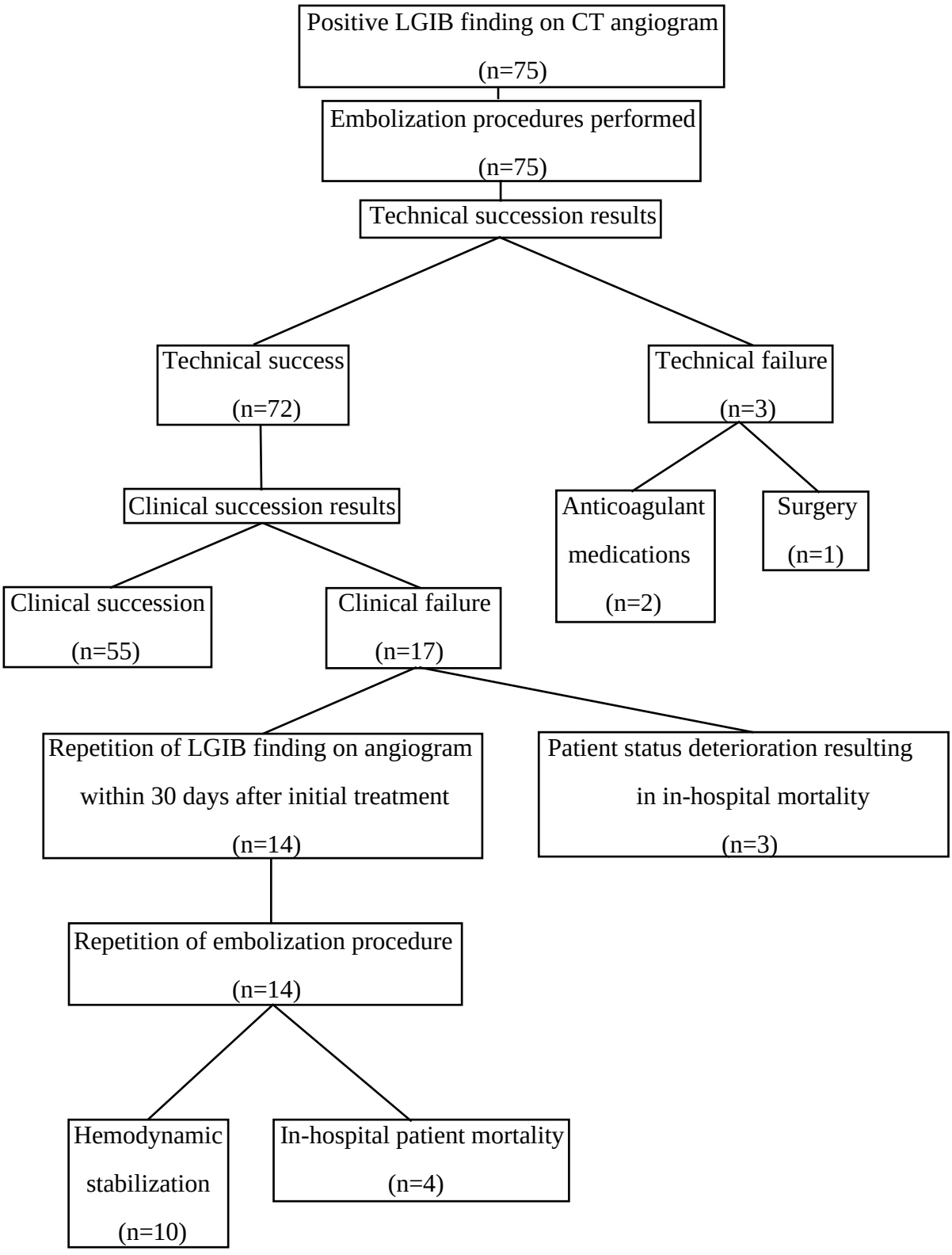
Transcatheter arterial embolization procedure was utilized in all the patients (n=75) that presented to interventional radiology clinic with acute LGIB to achieve hemodynamic stability. The patients that suffered from rebleeding (n=14) had to undergo additional embolization within 30 days. To achieve embolization in all the procedures (n=90), the interventional radiologists used permanent microcoil embolization to create a clot at the site of the LGIB. In addition to microcoils, the interventional radiologists discussed creating embolization using particles as an additional permanent solution to create clots. Nevertheless, in all the patients in this study microcoil embolization was utilized as using particles in the interventional radiology clinic was quite rare.

3.3 Embolization procedure clinical succession rate based on localization and etiology of LGIB

The results of embolization procedures were analyzed and interpreted as technical success and clinical success. Technical success was defined as the vanishing of any clinical signs of LGIB immediately after the completion of the embolization treatment. Cases defined as a technical failure when embolization treatment was ineffective and patients continued to have clinical signs of LGIB on angiogram. Patients that were released home stable and didn't have a recurrence of LGIB or major complications such as ischemia or infarction post – embolization within 30 days were defined as clinical success. Clinical failure was established as patients experiencing rebleeding within 30 days or in-hospital patient mortality. As shown in figure 2, out of 75 initial embolization procedures that were performed in interventional radiology clinic, we technically succeeded in 96% (n=72) while 4% (n=3) resulted in technical failure and patients in-hospital mortality eventually. Reasons for technical failure included anticoagulant medications consumption in 2 patients that suffered from other comorbidities and the need for emergent surgery in 1 patient due to deterioration of patient condition during the embolization procedure due to the progressive nature of the disease. loss of blood and other complications due to the progressive nature of their diseases. Patients' status post-hospital discharge was evaluated and it was shown that out of 69 cases of technical success we clinically succeeded in 73,33% (n=55) of cases and 18,66% (n=14) had a recurrence of lower gastrointestinal bleeding and required additional hospitalization and interventional treatment. All patients with a

recurrent episode of LGIB underwent repeat embolization. The results of embolization procedure repetition were assessed and divided between resolution of any LGIB symptoms with 13,33% (n=10) and failure to achieve hemodynamic stability which resulted in patients' mortality with 5,33% (n=4).

Figure 2. Technical and clinical succession rate of embolization procedure flowchart



The results were further analyzed to determine the clinical succession of embolization procedure dependency on localization and etiology of LGIB. To show statistical significance wherein clinical succession of embolization treatment is dependent on localization and etiology of LGIB, Pearson's chi-square test was utilized to compare between "Colon" localization group and "Small bowel and Rectum" localization group. Statistical significance was defined as $p < 0.05$ and the confidence interval was set to 95%. In addition to clinical succession rate, rebleeding rate and mortality rate dependency on localization of LGIB were also analyzed to determine the long-term efficacy of embolization as a permanent solution for LGIB. As shown in table x, the p-value of the clinical success rate of embolization treatment is higher than 0.05 which means clinical succession rate is independent of the localization of LGIB and is an effective modality of treatment equally. Furthermore, rebleeding rate and mortality rate of embolization treatment also showed statistical insignificance which indicates rebleeding and mortality in patients that underwent embolization procedure occur independently of the location of LGIB as well.

Table 4. Embolization procedure clinical succession rate, rebleeding rate and mortality based on localization of LGIB.

	Locations	**Yes**	**No**	**P value**	**OR (95% CI)**
Clinical succession rate	Colon	32	13	**0.59**	**0.75 (95% CI)**
	Small Bowel and Rectum	23	7		
	Locations	**Yes**	**No**	**P value**	**OR (95% CI)**
Rebleeding rate	Colon	10	35	0.33	1.86 (0.52 - 6.58)
	Small Bowel and Rectum	4	26		
	Locations	**Yes**	**No**	**P Value**	**OR (95% CI)**
Mortality rate	Colon	5	40	0.49	15.63 (4.11 - 59.47)
	Small Bowel and Rectum	5	25		

Moreover, the dependency of the clinical succession of embolization procedure on etiology of LGIB was also analyzed with “Diverticulosis” etiology group compared to “Others” etiology group. As shown in Table 5, the p-value of clinical succession rate based on etiology of LGIB is higher than 0.05 which expresses independence of clinical succession rate of embolization procedure in etiology of LGIB and effectiveness of embolization procedure equally in all etiologies. Rebleeding rate and mortality rate were also calculated showing as well that the p-value is higher than 0.05 which indicates localization and etiology of LGIB did not affect rebleeding and mortality in the patients.

Table 5. Embolization procedure clinical succession rate, rebleeding rate and mortality based on etiology of LGIB.

	Etiology	**Yes**	**No**	**P Value**	**OR (95% CI)**
Clinical succession rate	**Diverticulosis**	16	6	0.80	0.87 (0.28 - 2.68)
	Others	40	13		
	Etiology	**Yes**	**No**	**P Value**	**OR (95% CI)**
Rebleeding rate	**Diverticulosis**	5	17	0.56	1.44 (0.43 - 4.91)
	Others	9	44		
	Etiology	**Yes**	**No**	**P Value**	**OR (95% CI)**
Mortality rate	**Diverticulosis**	2	20	0.49	0.56 (0.11 - 2.89)
	Others	8	45		

4. DISSCUSION

This research aim was to analyze different diagnostic tools and endovascular treatment modalities used in the interventional radiology department of “Kaunas clinics” hospital, Lithuania.

Between Jan.2017-Aug.2020, 75 patients who suffered from lower gastrointestinal bleeding were selected from the department’s patients records to evaluate which diagnostic method and endovascular treatment option were utilized to reach hemodynamic stability. The study revealed that concerning diagnostic measurements, the patients with acute clinical signs of LGIB underwent emergent abdominal and pelvic CT to localize generally the origin of LGIB. To localize specifically which artery of the lower gastrointestinal tract was involved CT angiography was utilized. Furthermore, it was shown that some of the patients that reached hemodynamic stability also underwent diagnostic colonoscopy to evaluate for lower gastrointestinal tract integrity after the interventional procedure that all selected patients were treated with embolization procedure in various locations depending on etiology and localization of LGIB.

The research exhibited that out of 75 cases, the most common etiologies for lower gastrointestinal bleeding were diverticulosis with 29,33% of cases followed by colorectal cancer with 18,67% of cases and colitis with 13,33% which stands in contrast with results of a study published in 2013 which demonstrated that out of 163 cases the most common etiologies for LGIB were diverticulosis with 23,3% of cases, colitis with 16% of cases and rectal hemorrhoids with 10,4% of cases [22].

The research results have shown that the main diagnostic tools that were utilized to detect lower gastrointestinal bleeding by the interventional radiologists were emergent abdominal and pelvic CT and CT angiography. These diagnostic tools were used in all of the patients which presented with clinical signs of acute lower gastrointestinal bleeding and were utilized additionally in patients which experienced rebleeding within 30 days after initial embolization treatment. Furthermore, the treatment modality of choice was embolization procedure with microcoils as shown in a study performed in 2015, patients presented with clinical signs of unstable acute lower gastrointestinal bleeding underwent initial emergent diagnosis with CT angiography to localize extravasation and treated afterward with transcatheter microcoil embolization [23].

This study results showed that out of the 90 angiographies performed, the most common extravasation was found from inferior mesenteric artery with 57,77% of cases followed by superior mesenteric artery with 34,44% of cases and internal iliac artery with 7,77% of cases. Moreover, the most common bleeding site as shown in CT was descending colon with 35,55% of cases followed by rectum with 27,77% of cases, ascending colon with 15,55% of cases, small intestine with

12,22% of cases, and transverse colon with 8,88% of cases. The research noted embolization procedure technical success in 96% of cases while 4% technically failed due to anticoagulant medication consumption or requirement of emergent surgery. Embolization procedure clinical success was noted in 73,33% of cases while 18,66% of cases experienced rebleeding within 30 days and required additional hospitalization. No major complications were noted post embolization in all patients. Mortality of patients was noted in 13,33% of cases due to rapid deterioration of the patient's hemodynamic status. In comparison to this data, a study performed in 2014 exhibited that out of 108 embolization procedures performed technical success was noted in 96.4% of the cases, clinical succession was noted in 74,5% of patients, recurrent bleeding within 30 days was noted in 17,4% of the cases, major complications post embolization procedure was noted in 4.6% of cases, and mortality of patients was noted in 25% of cases [24].

Embolization procedure clinical succession dependency on localization and etiology of lower gastrointestinal bleeding was evaluated in the research. No statistical significance was found to support this data and it was concluded that clinical succession of embolization treatment with microcoils is independent of localization and etiology of lower gastrointestinal bleeding and is equally successful in managing lower gastrointestinal bleeding. In correlation with this conclusion, in a study performed in 2018, it was found NBCA embolization procedure was used more frequently than other embolization methods and was clinically saucerful [25].

CONCLUSIONS

1. In this study we found out that the main diagnostic tools to detect LGIB in acute setting are emergent abdominal and pelvic CT and CT angiography. In the case of any uncertainties, diagnostic colonoscopy is also utilized after hemodynamic stability is achieved. Furthermore, the study showed that the main treatment method that the interventional radiology clinic utilized was transcatheter arterial embolization procedure to manage patients with acute LGIB.
2. In regards to effectiveness of embolization procedure, the research showed that we achieved technical success in 96% of patients and clinical success was achieved in 73,33% of patients. The statistical analysis showed that clinical succession rate was independent of location and etiology of LGIB.
3. It can be concluded that microcoil embolization treatment was safe and effective method to treat acute LGIB.

LIMITATIONS

The research has few limitations.

1. First of all, the retrospective nature of the most of included studies leads to an inevitable selection bias.
2. Secondly, the decision of radiological intervention choice was made on an individual basis per patient by the attending physician, thus creating difficulty to accomplish randomization of patients' selection process.
3. Thirdly, all selected patient underwent microcoil embolization procedure making it difficult to determine efficacy of microcoils compared to other types of embolization techniques.

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