Utility Of Angioembolization In Patients with Abdominal and Pelvic Traumatic Bleeding: Descriptive Observational Analysis From A Level 1 Trauma Center

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Abstract

Background: Massive bleeding is a major preventable cause of early death in trauma. It often requires surgical or endovascular intervention. We aimed to describe the utilization of angioembolization in patients with abdominal and pelvic traumatic bleeding at a level 1 trauma center.

Methods: We conducted a retrospective analysis for all trauma patients who underwent angioembolization post-traumatic bleeding between January 2012 and April 2018. Patients's data and details of injuries, angiography procedures and outcomes were extracted from the Qatar national trauma registry.

Results: A total of 175 trauma patients underwent angioembolization during the study period (103 for solid organ injury , 51 for pelvic injury and 21 for other injuries). The majority were young males. The main cause of injury was blunt trauma in 95.4% of patients. The most common indication of angioembolization was evident active bleeding on the initial CT scan (contrast pool or blushes). Blood transfusion was needed in two-third of patients. The hepatic injury cases had higher ISS, higher shock Index and more blood transfusion Absorbable particles (Gelfoam) was the most commonly used embolic material. The overall technical and clinical success rate was 93.7% and 95% respectively with low rebleeding and complication rates. The hospital and ICU length of stay were13 and 6 days respectively. The median injury to intervention time was 320 min while hospital arrival to intervention time was 274 min. The median follow-up time was 215 days. The overall cohort mortality was 15%.

Conclusion: Angioembolization is an effective intervention to stop bleeding and support nonoperative management for both solid organ injuries and pelvic trauma. It has a high success rate with a careful selection and proper implementation.

Introduction

Trauma is a leading cause of death and morbidity worldwide (1). It is considered the leading cause in the first four decades of life and the third across all ages (1). Massive bleeding is the most preventable cause of early death in trauma (2). It often requires surgical or endovascular intervention. The surgical intervention, whether with definitive intention or damage control, is well established (3). Nevertheless, surgery is not always the optimal solution, especially for arterial bleeding from pelvic fractures and solid organs injury (3). The management of trauma patients has evolved in recent decades, especially with advancements of imaging and endovascular interventions techniques like embolizations, stenting, filter placement, and Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) (4–6). The Computed tomography replaced diagnostic angiography to a great extent, but the best utilization of therapeutic angiography versus surgical intervention remains ill-defined in managing traumatic bleeding (3–5). Moreover, the associated complications of angioembolization, both early and late, are also of consideration. Angioembolization is challenging and region-specific, however, many factors influence its success such as the possible underlying anatomic variation, presence of multiple bleeding sources, institutional logistics, resources and physician experience and preferences. The ligation of bleeding vessels is a well-established option for surgical hemostasis. However, it might not be always possible or allowed; for all vessels primarily if they are end-arteries supplying a vital organ or in "difficult to access" areas or in the presence of abundant collaterals like the pelvic region (3). Such a non-selective control of bleeding should be used only as a last resort and on desperation. A more selective sort of control would make the best-case scenario for a saferand better outcome with preservation of organ function (6). The last points define the exact rationale behind the recommendation to use selective and superselective endovascular approaches (6).

Arteriography with angioembolization is a useful adjunct to support the success of non-operative management (NOM) of many injuries (5). It helps to evaluate and potentially treat bleeding of solid organs and other injuries as well as control of pseudoaneurysm and traumatic arterio-venous fistulae (AVF) (3–6). Angioembolization is appropriate in centers where experienced interventional radiologists are immediately available. Prior studies showed that angioembolization in trauma increases the success rate of NOM (3–11).

The present study aims to describe the utilization of angioembolization in patients with abdominal and pelvic traumatic bleeding at a level 1 trauma center. We hypothesize that angioembolization is effective and integral to the management of bleeding in such trauma patients.

Methods

Study Design

A retrospective study was conducted on trauma patients who admitted to Hamad Trauma Center (HTC); the level 1 trauma center in the country from January 2012 to April 2018 and underwent angioembolization. Inclusion criteria were adult patients who sustained abdominal or pelvic traumatic bleeding with subsequent angiography plus endovascular interventions. We excluded patients presented with cardiac arrest on arrival to the hospital.

Data were obtained from a prospectively maintained trauma registry of the HTC. This national trauma registry is a mature database that participates in both the National Trauma Data Bank (NTDB) and the Trauma Quality Improvement Program (TQIP) of the American College of Surgeons-Committee on Trauma (ACS-COT). The HTC is the only tertiary facility in the country which admits around 1500–1700 trauma patients annually.

All patients were initially evaluated and resuscitated following Advance Trauma Life Support (ATLS) guidelines and by the trauma team attendance. The indications for angioembolization include the evidence of active extravasation (arterial blush), pseudoaneurysm and/or AVF on the initial admission CT scan. Also, subsequent scans after damage control surgery or repeat scans during the hospital stay as per our protocol for high-grade injuries in the case of solid organ injury (SOI). Hemoglobin drop/ or blood transfusion in NOM of SOI and pelvic fractures is also an indication in some cases with high grade injury suggestive of high risk of bleeding and failure of NOM.

Data collection

We recorded demographic information (age and gender), mechanisms of injuries, associated injuries including head, chest, abdomen, spine, upper and lower extremity; Glasgow Coma Score (GCS) at the emergency department, Abbreviated Injury Score (AIS), Injury Severity Score (ISS), initial vitals at ED such as systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR), shock index (SI), need for blood transfusion, number of blood units, massive transfusion protocol (MTP) activation, surgical intervention, angiography location, endovascular interventions (embolization and stenting), type of embolization (selective, non-selective, superselective, proximal or distal), the materials used and outcomes. Admission SI was define as HR divided by the SBP (12).

Technical Successful embolization was defined as cessation of vascular abnormality in post angioembolization (contrast medium extravasation, pseudoaneurysm and AVF) without any need for further endovascular or surgical interventions (6). The standard of care in hospital policy dictates repeating CT scan in 48 to 72 h in case of solid organ innury (SOI) and pelvis injury. Clinical success definition is radiologic and clinical evidence of bleeding control (6). Failure of angioembolization is defined as any unsuccessful arterial conulation due to pathological or anatomical variations, failure of safe injection of embolic agents; re-bleeding in the same artery or a new bleeding in the same organ or territory. The procedures choices were left to interventional radiologist discretion, and technical demands. In general, left femoral artery access was the most prevailing. The vascular sheath is left for 24 h considering the risk of rebledding or need to repeat the angioembolization.

Complications specific for the angioembolization

bleeding, ischemia, necrosis and contrast Induced nephropathy (CIN), coil migration, allergy and vascular access complications (Hematoma, bleeding, psudoaneurysm, infection, Arteriovenous fistula, thrombosis, arterial dissection and injuries).The study outcomes included the success of angioembolization, complications, and mortality (in-hospital and during one year follow up) .

The study was approved by the institutional review board (IRB#MRC-01-18-125) with a waiver of consent. The study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for observational study.

Statistical analysis

Data presented as proportions, medians with interquartile range (IQR), or mean ± standard deviation, as appropriate. Differences in categorical and continuous variables were analyzed using $\chi 2$ and student t-test, as necessary. Yates' corrected chi-square was used for categorical variables if the expected cell frequencies were below 5. Data are expressed by the odds ratio (OR) and 95% confidence intervals (CIs).

A two-tailed P value of < 0.05 was considered to be statistically significant. All data analyses carried out using the Statistical Package for the Social Sciences, version 18 (SPSS, Inc, Chicago, IL).

Results

During the five years study period, a total of 9000 patients sustained traumatic injuries admitted to the HTC. One hundred and seventy-five patients underwent angioembolization (1.9% of total trauma admissions). The majority were males (90%), and the mean age was 32.6±12.2 years. The most common mechanism of injury was blunt trauma in 95.4% of patients (**Table** 1).

The average ISS was 28±12.3. The majority presented initially with pulse rate 96.0±25.0 beat/min and the mean SI was 0.86±0.31. The median follow-up period was 215 days.

Endovascular angioembolization was used in SOI (liver, spleen, kidney, pancreas and adrenals) , for musculoskeletal injuries (pelvic , lumbar , retroperitoneal and others) and 2 cases of hollow viscus related bleeding (Gastric and superior mesenteric artery). The most common involved arteries were the splenic (31%), internal iliac artery (29%), and hepatic artery (25%). The rest of the places were sporadic or just a few.

Table 2 shows details of arterial embolization, timing, indication, location , type of embolic agent,complications and outcomes. Seventy-three percent of cases had successful NOM. In contrast, the pre-surgery angioembolization used in 10% and post-surgery in 15% and 2% had angioembolization before and after surgical interventions. The primary indication of angioembolization was based on CT findings i.e., active bleeding (51.7%) and blush (19.1%), presence of pseudo-aneurysm (12.6%) , and true aneurysm (1.7%) or intraoperative finding (active bleeding (14.9%).

Non-selective embolization (catheter placed in the main trunk) embolization in 23% , selective (catheter placed in 1st order) embolization of in 30% , superselective (catheter placed in 2nd or 3rd order) embolization in 34% and combined approach in 12%. In terms of the proximity to a given artery: proximal emboliztion was done in 47% and distal in 39% and both proximal and distal in 7%. **Figure** 1 shows examples of selectivity and proximity of angioembolization.

Table 2 shows the materials used for angioembolisation. Temporary material most commonly used in 57% (Gelfoam),while permanent materials such as coils was used in 23.1% .

The technical success rate was 93.7% correspond to the clinical success of 94.9% with a rebleeding rate of 5% (in 9 cases) .

The angioembolization complications included infarction (extensive necrosis) in 6 patients (16%) and requied surgical debridement, infection in 7 cases (3 had an abscess), one case developed gall bladder necrosis and gangrene demanded subsequent cholecystectomy, and 2 cases had bowel gangrene (**Table** 2).

Massive transfusion protocol was activated in 34% of the cases, while blood transfusion use reported in 75% of the cases, with an average of 8 (1-79) units transfused. The average length of stay in ICU was 6 (1-57) days and in hospital was 13 (1-106) days. The overall mortality was 15% (26 cases), and there was no reported angiography related mortality.

Table3 and 4 compare the demography, clinical characteristics, and outcomes based on the anatomical arteries angio-embolized (hepatic , splenic, renal and pelvic). The hepatic cases had highr ISS, higher need for surgery (laparotomy) and blood transfusion. Also, the hepatic group was more likely to be embolized prior to surgery and had prolonged ICU and hospital stay in comparison to other groups (p=0.001). On the other hand, one-third of the patients in renal group underwent embolization after surgery (p=0.001).

The splenic artery cases were the larger group but with lower ISS, only 2 needed laparotomy, 40% received blood and only 2 (4%) needed MTP. The pelvic group were the second lareger group, older in age, had lower male percentrage compared to others, laparotomy needed in12 (23.5%), MTP was needed in 49% and blood transfusion was used in 96% .

While the renal embolization was performed in 6 young male patients with higher blood unit usage, active bleeding on CT scan was the only indication for the angioembolization with higher mortality (33%) among the groups.

Technical failure reported in 3 of the hepatic (7.3%), and one of the splenic (1.9%), non reported in the pelvic or renal angioembolized patients. Shock index ≥0.80 was more evident with hepatic (63%), pelvic (58.5%), renal (50%) and splenic group (32%); p=0.04.

Single session of angioembolization was the most common in the cohort. The Absorbable embolic agent (Gelfoam) was the most commonly used material for embilization .

The technical and clinical success were 86% for hepatic cases, 100% for pelvic and 83.3% for renal injury cases. Few cases had a rebleed mainly in the hepatic group (6 cases), two patients in the splenic and one in the renal group.

Time to angioembolization in SOI and pelvic injury was given in **Table** 5.

Overall complications were rare; one case had femoral pseudoaneurysm and the procedure was well tolerated. Infarction demanding surgical intervention was noticed in 4 hepatic cases and one splenic case. All infarcted cases had a sort of infection and one of them had liver abscess. Only one case of hepatic angioemolization had gall bladder necrosis and needed open cholecystectomy and one case had bowel ischemia following mesenteric angioembolization. The open abdomen (Damage control surgery; DCS) approach was used in 9 of the hepatic cases , 8 of the pelvic cases and 2 of the renal while the splenic group had zero DCS. During the follow-up period (median 215 days), there was no reported mortality.

Discussion

This is the first report on the use of angioembolization in the national trauma center of Qatar.

The overall number of angioembolization was 1.9% among the total trauma admission in the present study. The majority were young male, and had blunt poly-trauma with high ISS. The most common aniogioembolized organ was the spleen followed by pelvis and liver. Previous studies showed that shock index ≥ 0.80 after injury can be used to predict the early need for MTP, laparotomy and mortality (12). The current study showed that the mean shock inex for the cohort was greater than 0.80 and this figure was more likely seen post- hepatic (SI = 0.91) and pelvic (SI = 0.90) injury.

The majority of patients in this study had initial CT scan based on the hemdynamic status. The indication for angioembolization as part of the NOM was considered according to the CT findings in the majority of cases. Some cases with hemodynamic unstability underwent DCS followed with angioembolization based on the intraoperative findings. The blush as an indication for angioembolization is still debatable. However, it remains a high-risk factor for failure of NOM for SOI (13–25). However, Diamond et al; reported that nearly half of patients may not need any interventions especially in the retroperitoneum and the pelvis areas regardless of the size or volume of the bleed (26, 27).

Selection of embolic agents in trauma patients is guided by the size of the vessels to be occluded and permenance of the desired occlusion. Coils are also commonly used for trauma patients, most often when permenant occlusion is desired. The most common technique was the use of a micro-catheter system to achieve the super selective or the selective approaches in our cohort. Sclafani et al., introduced the concept of proximal splenic embolization with high success rate 97% (28). This was preferably proximal to achieve hemostasis with clotting and decrease pressure while preserving the tissues and function through collaterals and decrease complications but to restrict the subsequent super-selective embolization for re-bleeding cases. The super-selective approach which is more demanding from a skill perspective and time consuming represents a technical challenge and explains in part the lower percentage of this approach in unstable cases. Our overall success rate was 95% which relatively higher than Velmahos et al series in Los Angeles who reported 91% success rate but with more pelvic injury cases (29). Overall, the high success rates (clinical and technical) correspond to the reported range (77%-100%) with an average of 93% (30). Recurrent bleeding after the initial attempt at angioembolization can be treated successfully with repeated angioembolization. We have relatively low complication rates like re-bleeding, necrosis, and infection.

Limitations

We acknowledge the boundaries of our study. The retrospective study design and single trauma center experience are limitations with possible selection bias and missing information. Although time to intervention is important, it was lacking in many cases.

Conclusions

Angioembolization is an effective intervention to stop bleeding and support nonoperative management for both solid organ injuries as well as pelvic fracture. It has a high success rate with a careful selection and proper implementation.

Abbreviations

ISS: injury severity score

NOM: non-operative management

DCM: damage control managment

Declarations

Ethics approval and consent to participate: This observational study was approved with a waiver of consent by the Institutional Review Board (IRB#MRC-01-18-125) at Medical Research Center, Hamad Medical Corporation Doha, Qatar.

Consent for publication: not applicable

Availability of data and materials: all data were shown in the study analysis and tables. Further data need approval from the Qatar national trauma registry and medical research center (contact: mrcinfo@hamad.qa).

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Tables

Table 1: demographics, associated injuries and clinical characteristics of trauma patients requiring angioembolization (n=175)

Variables	Values	Variables	Values
Age (mean±SD)	32.6±12.2	**Arterial embolization**	
Males	158 (90.3%)	Facial	3 (1.7%)
Mechanism of injury		Gastric	1 (0.6%)
Motor vehicle crash	60 (34.3%)	Hepatic	43 (24.9%)
Motor cycle crash	8 (4.6%)	Splenic	54 (31.2%)
All-terrain vehicle	4 (2.3%)	Internal Iliac	50 (28.9%)
Pedestrian	36 (20.6%)	Intercostal	2 (1.2%)
Fall from height	49 (28.0%)	Lumber	6 (3.5%)
Fall of heavy object	10 (5.7%)	Renal	6 (3.5%)
Others	8 (4.6%)	Retroperitoneal	1 (0.6%)
Injuries		Superior mesenteric artery	1 (0.6%)
Head	54 (30.9%)	Subclavian artery	1 (0.6%)
Chest	135 (77.1%)	Sacral	1 (0.6%)
Abdomen	151 (86.3%)	Others	4 (2.3%)
Injury severity score	28.0±12.3	**Follow-up**	101(1-365)
Initial vitals			
Pulse rate	96.0±25.2		
Systolic Blood Pressure	117.4±26.9		
Diastolic blood pressure	75.4±21.7		
Glasgow coma scale	12±3.0		

Table 2: details of arterial embolization , complications and outcomes

Variables	Values	Variables	Values
Timing of embolization		- Polyvinyl alcohol	1 (0.6%)
No surgical intervention	128 (73.1%)	- Onyx	1 (0.6%)
Embolization before surgery	18 (10.3%)	**Gel foam & coil (both)**	28 (16.2%)
Embolization after surgery	26 (14.9%)	**Stents**	1 (0.6%)
Both	3 (1.7%)	**Number of sessions**	1 (1-2)
Indications for embolization (n=174)		**Number of arteries/branches embolized (n=167)**	1 (1-4)
Active bleeding on CT	90 (51.7%)	**Technical success**	164 (93.7%)
Blush on CT scan	33 (19.1%)	**Clinical success**	166 (94.9%)
Pseudoaneurysm	22 (12.6%)	**Re-bleed**	9 (5.1%)
True aneurysm	3 (1.7%)	**Complications & management (n=38)**	
Intraoperative active bleeding	12 (6.9%)	Infarction needs surgical intervention	6 (15.8%)
Active bleeding and pseudoaneurysm	14 (8.0%)	Hepatic failure	0 (0.0%)
Embolization type (n=172)		Abscess	3 (7.9%)
Failure of angioembolization	1 (0.6%)	Infection	4 (10.5%)
Non-selective	39 (22.7%)	Gallbladder infarction needs cholecystectomy	1 (2.6%)
Selective	53 (30.8%)	bowel Ischemia	2 (5.3%)
Highly selective	59 (34.3%)	Dislodgement of coil in the common femoral artery repaired by snare	1 (2.6%)
Combination	20 (11.6%)	Pseudoaneurysm of common femoral artery treated with thrombin injection	1 (2.6%)
Location of embolization (n=171)			

No embolization due to technical failure	5 (2.9%)	**Exploratory laparotomy**	47 (26.9%)
Proximal	79 (46.2%)	Damage control with open abdomen	20 (42.6%)
Distal	68 (39.8%)	**MTP Activation**	59 (33.7%)
Both	12 (7.0%)	**Blood transfusion**	131 (74.9%)
Embolization to more than one area	5 (2.9%)	**Number of blood units**	8 (1-79)
Embolization to more than site in different organs	2 (1.2%)	**ICU length of stay**	6 (1-57)
Embolic agents (n=173)		**Ventilatory says**	9 (1-53)
No embolization due to technical failure	5 (2.9%)	**Hospital length of stay**	13 (1-106)
Temporary		**Mortality**	26 (14.9%)
- Gel foam	98 (56.6%)	**Follow-up (days)**	215 (1-365)
Permanent			
- Coils (Pushable/injectable/detachable)	40 (23.1%)		

Table 3: demographics, clinical characteristics and outcome based on anatomical location and timing of arterial angioembolization

Variables	Hepatic (n=43)	Splenic (n=54)	Pelvic (n=51)	Renal (n=6)	P value
Age	30.4±10.9	32.3±13.6	33.6±11.2	24.5±5.6	0.02
Males	40 (93.0%)	53 (98.1%)	40 (78.4%)	6 (100%)	0.007
Injury severity score	31.3±10.7	24.2±11.2	30.2±12.2	29.1±10.6	0.03
Shock index ≥0.80	63%	32%	58.5%	50%	0.04
Exploratory laparotomy	27 (62.8%)	2 (3.7%)	12 (23.5%)	2 (33.3%)	0.001
MTP Activation	21 (48.8%)	2 (3.7%)	25 (49.0%)	3 (50.0%)	0.001
Blood transfusion	38 (88.4%)	22 (40.7%)	49 (96.1%)	5 (83.3%)	0.001
Number of blood units	10 (1-73)	2 (1-18)	10 (1-42)	13 (2-26)	0.001
ICU length of stay	14 (2-57)	2 (1-41)	6.5 (1-47)	5 (2-15)	0.001
Hospital length of stay	25 (2-102)	8 (4-106)	22 (1-102)	8.5 (2-52)	0.001
Surgical intervention					
No surgical intervention	19 (44.2%)	51 (94.4%)	37 (72.5%)	4 (66.7%)	0.001 for all
Embolization before surgery	9 (20.9%)	3 (5.6%)	4 (7.8%)	0 (0.0%)	
Embolization after surgery	12 (27.9%)	0 (0.0%)	10 (19.6%)	2 (33.3%)	
Both (pre and post surgical intervention)	3 (6.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Follow-up (days)	126 (1-346)	109 (6-342)	102 (1-365)	6 (2-154)	0.24
Mortality	7 (16.3%)	1 (1.9%)	10 (19.6%)	2 (33.3%)	0.008
Other sporadic vessels were excluded from this comparative analysis (n=19 cases)					

Table 4: Timing, indication, type and location of embolization based on anatomical location

	Hepatic (n=43)	Splenic (n=54)	Pelvic (n=51)	Renal (n=6)	P value
Indications for embolization					
Active bleeding on CT	17 (39.5%)	21 (38.9%)	36 (72.0%)	4 (66.7%)	0.001 for all
Blush on CT scan	9 (20.9%)	14 (25.9%)	6 (12.0%)	0 (0.0%)	
Pseudoaneurysm	8 (18.6%)	11 (20.4%)	1 (2.0%)	0 (0.0%)	
True aneurysm	0 (0.0%)	3 (5.6%)	0 (0.0%)	0 (0.0%)	
Intraoperative active bleeding	6 (14.0%)	0 (0.0%)	6 (12.0%)	0 (0.0%)	
Active bleeding and pseudoaneurysm	3 (7.0%)	5 (9.3%)	1 (2.0%)	2 (33.3%)	
Embolization type					
Non-selective	6 (14.3%)	26 (49.1%)	3 (5.9%)	2 (33.3%)	0.001 for all
Selective	12 (28.6%)	4 (7.5%)	24 (47.1%)	2 (33.3%)	
Highly selective	18 (42.9%)	12 (22.6%)	22 (43.1%)	1 (16.7%)	
Combination	5 (11.9%)	11 (20.8%)	2 (3.9%)	1 (16.7%)	
Location of embolization					
Proximal	13 (31.7%)	22 (41.5%)	30 (58.8%)	2 (33.3%)	0.005 for all
Distal	18 (43.9%)	21 (39.6%)	20 (39.2%)	3 (50.0%)	
Proximal and distal both	3 (7.3%)	8 (15.1%)	1 (2.0%)	0 (0.0%)	
Embolization to more than one area	3 (7.3%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	
Embolization to more than site in different organs	1 (2.4%)	0 (0.0%)	0 (0.0%)	1 (16.7%)	
No embolization due to technical failure	3 (7.1%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0.001 for all
Temporary agent	25 (59.5%)	14 (26.4%)	45 (88.2%)	4 (66.7%)	
Permanent agent	4 (9.5%)	31	1 (2.0%)	0 (0.0%)	

		(58.5%)			
Both agents	10 (23.8%)	7 (13.2%)	5 (9.8%)	2 (33.3%)	
Stents	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0.68
Number of sessions	1 (1-2)	1 (1-2)	1 (1-1)	1 (1-2)	0.02
Number of embolized vessel	1 (1-4)	1 (1-3)	1 (1-2)	1.5 (1-3)	0.71
Technical success	37 (86.0%)	51 (94.4%)	51 (100%)	5 (83.3%)	0.06
Clinical success	37 (86.0%)	53 (98.1%)	51 (100%)	5 (83.3%)	0.01
Re-bleed	6 (14.0%)	2 (3.7%)	0 (0.0%)	1 (16.7%)	0.01

Table 5 : time to angioembolization

	SOI (n=56)	**Pelvis (n=32)**	**P value**
Hospital arrival to intervention time (min)	273 (46-1259)	220 (79-997)	0.12
Hospital arrival to intervention time <180	15 (27.3%)	10 (31.3%)	0.69 for all
Hospital arrival to intervention time ≥180	40 (72.7%)	22 (68.8%)	
Injury to intervention time (min)	418 (96-1397)	275.5 (168-1057)	0.01
Injury to intervention time <180	4 (9.8%)	3 (13.6%)	0.64 for all
Injury to intervention time ≥180	37 (90.2%)	19 (86.4%)	
Intervention time (min)	67 (11-185)	59 (29-165)	0.67

Figures

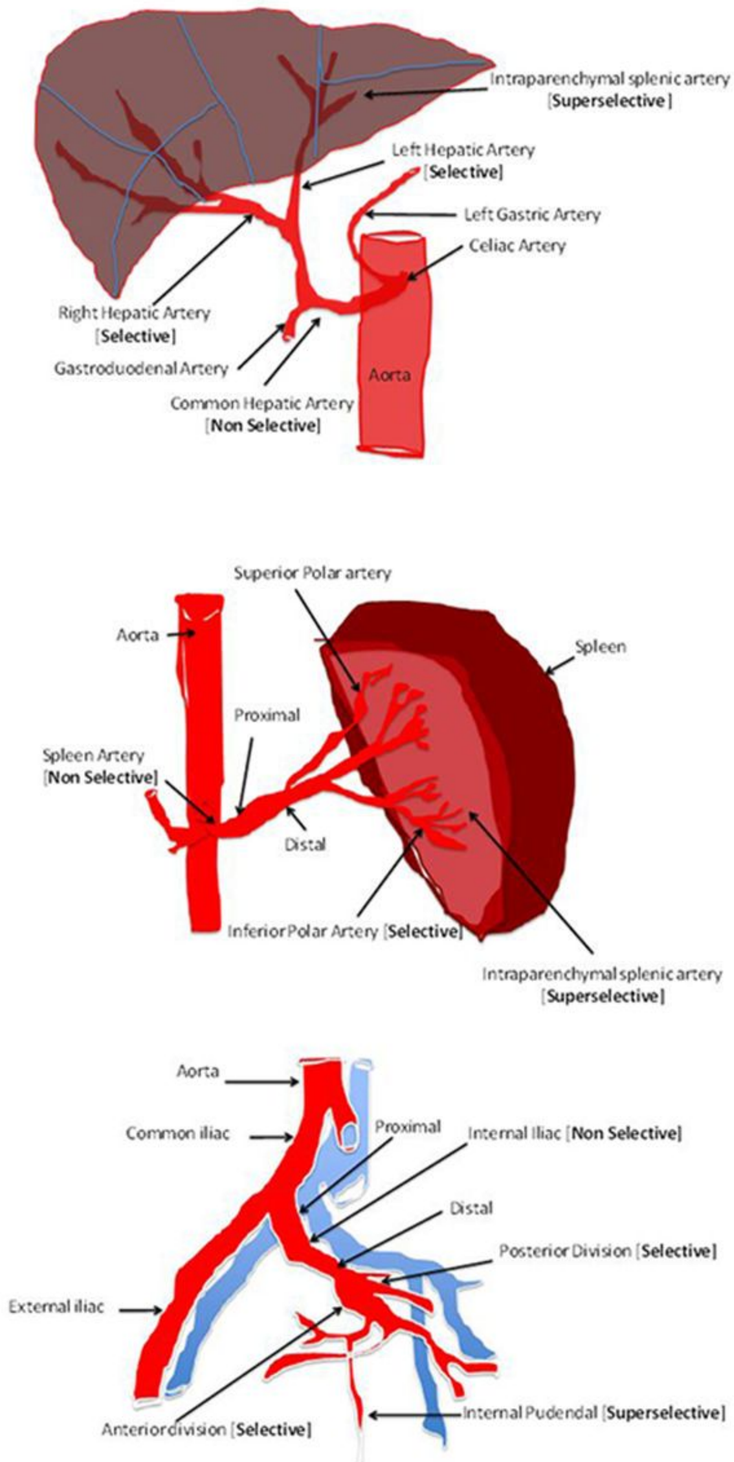

Figure 1

examples of selectivity and proximity of angioembolization: Liver(upper panel), Spleen (middle panel) and pelvis (lower panel)

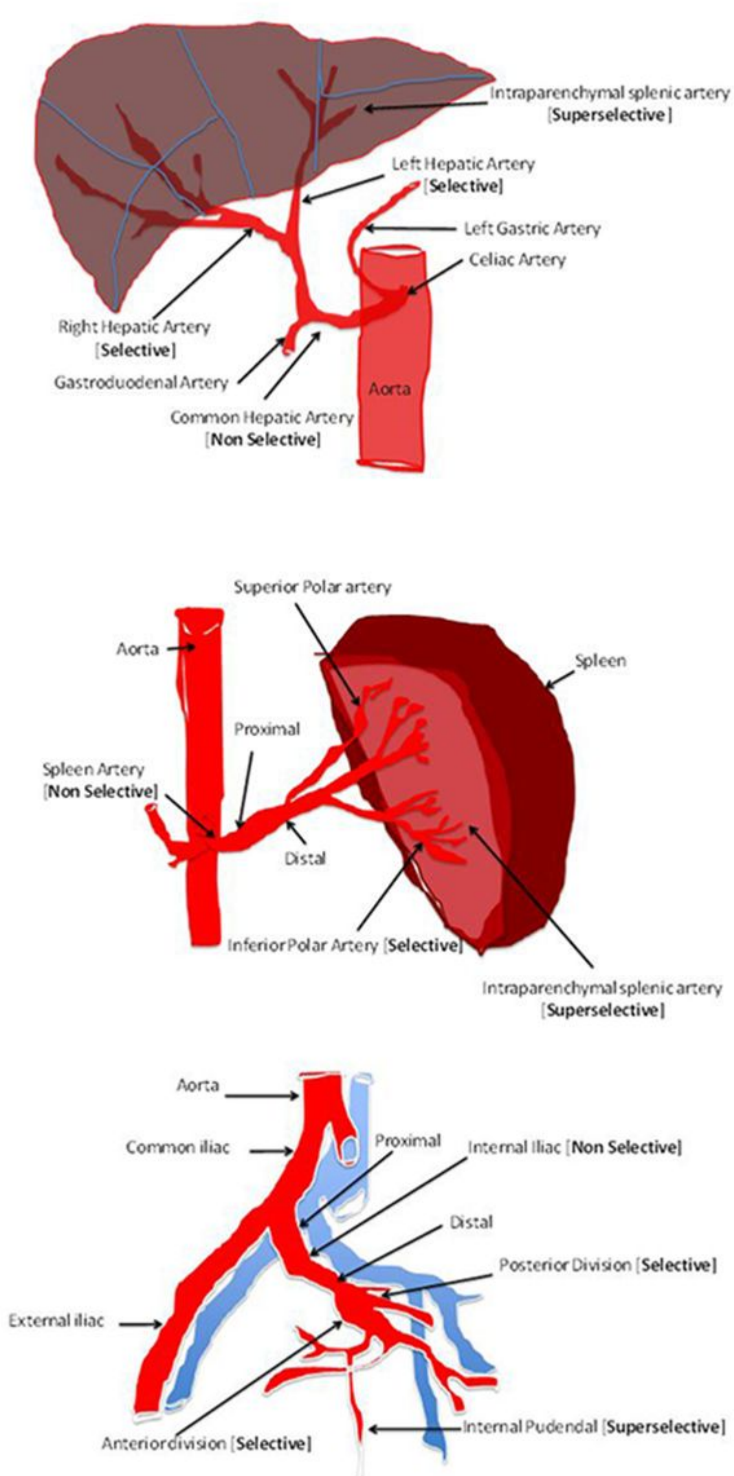

Figure 1

examples of selectivity and proximity of angioembolization: Liver(upper panel), Spleen (middle panel) and pelvis (lower panel)