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Intermittent Splenic Artery Occlusion Plus Gauze Compression Is a Simple and Effective Treatment for Iatrogenic Splenic Injury

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Data Interpretation D
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Background: The aim of this study was to evaluate the feasibility and safety of intermittent splenic artery occlusion plus gauze compression in treating iatrogenic splenic injury.

Material/Methods: We retrospectively analyzed 12 iatrogenic splenic injury cases (grade I to III) treated with intermittent splenic artery occlusion plus gauze compression. The hemostatic effect was then observed after unblocking and decompression. The total operation time, gauze compression time, total blood loss, blood loss from the injured spleen, and platelet counts of each patient before and 1 week after surgery were noted.

Results: The average operation time was 209.58±57.11 min, and the average gauze compression time after spleen artery occlusion was 23.75±4.33 min. The average total blood loss and blood loss due to iatrogenic spleen injury were 468.33±138.22 ml and 264.17±165.72 ml, respectively. Two cases (both grade I) had successful hemostasis after 15 min of splenic artery occlusion and wound compression. Another 9 cases (all grade II) and 1 case (grade III) attained hemostasis after 25 min and 30 min, respectively, of splenic artery occlusion and wound compression. The platelet counts of all patients were within the normal range before and 1 week after surgery. No postoperative complications occurred.

Conclusions: Intermittent splenic artery occlusion plus gauze compression is a simple and effective treatment for iatrogenic splenic injury.

MeSH Keywords: General Surgery • Iatrogenic Disease • Splenic Artery

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Background

Iatrogenic splenic injury can be caused by excessive traction of the stomach or greater omentum during surgery due to thickening bands of the greater omentum (splenic omental band) between the inferior pole of spleen, splenic hilum, and stomach [1]. This frequently occurs in surgery involving the left upper-abdominal quadrant, especially in procedures such as distal or total gastrectomy, radical left hemicolectomy, and sleeve gastrectomy [2,3]. Reported rates of incidental splenic injury range from 0.25% to 8% [4–7]. However, it is believed that the true incidence of splenic trauma as an iatrogenic complication is underestimated due to inaccurate operative recording or vague indications for splenectomy [8]. Nevertheless, once iatrogenic splenic injury occurs, it inevitably leads to increased blood loss, prolonged operation time and hospitalization, and even hemorrhagic shock [9]. Most splenic injuries in gastric operations are splenic capsule tears or small and shallow splenic parenchyma lacerations (<1 cm); mostly occurring in the upper or inferior pole of the spleen. For these superficial injuries, superficial hemostatic strategies like fibrin glue, gel foam, argon beam coagulation, diathermy, and topical thrombin may be used. However, injury occurring around the hilus, such as hilar tear or parenchyma injury, occur in some cases, and these can be difficult to treat with superficial hemostatic strategies such as diathermy. For more severe cases, other more aggressive spleen-preserving treatments (e.g., partial splenectomy) may be required [10,11].

In this study, we applied intermittent splenic artery occlusion combined with gauze compression in 12 cases of iatrogenic splenic injury from abdominal surgical procedures, for whom gauze compression alone was ineffective. We report the feasibility, safety, and therapeutic effect of intermittent splenic artery occlusion in iatrogenic splenic injury.

Material and Methods

General information

Using the therapeutic method of intermittent splenic artery occlusion combined with gauze compression, we retrospective analyzed a total of 12 iatrogenic splenic injury cases relating to abdominal surgery which occurred between January 2013 and December 2019. There were 8 male patients and 4 female patients, with age ranging from 29 to 72 years (60.42±12.79). The preoperative diagnosis was 1 case of liver cancer, 1 case of obesity, 1 case of colon cancer (splenic flexure of colon), and 9 cases of gastric cancer. The length of hospital stay after surgery of all cases was from 3 to 17 days. General patient information is shown in Table 1.

Intraoperative data

Of the 12 cases of iatrogenic splenic injury, 4 occurred during laparoscopic radical distal gastrectomy (LRDG), 3 occurred during laparoscopic radical total gastrectomy (LRTG), 2 occurred during laparotomic radical distal gastrectomy (RDG), 1 occurred during laparoscopic left hemicolectomy (LLHC), 1 occurred during laparoscopic sleeve gastrectomy (LSG) for obesity, and 1 occurred during left lateral hepatic lobe resection (LLHLR) for cancer. Three cases occurred in the upper pole of the spleen, 1 case occurred near the splenic hilum, and the other 8 cases were in the inferior pole of the spleen. According to the American Association for the Surgery of Trauma (AAST) splenic injury grading scale [12], 9 cases were grade II, 2 cases were grade I, and 1 case was grade III. All cases were due to either inappropriate retraction, left upper-abdominal cavity adhesion, or injury caused by instruments (Table 2).

Table 1. The general information on all 12 patients.

No.	Gender	Age	Preoperative diagnosis	Hospitalization days after surgery
1	F	29	Obesity	3
2	M	45	Liver cancer	9
3	M	71	Colon cancer	10
4	M	54	Gastric cancer	11
5	M	66	Gastric cancer	10
6	M	62	Gastric cancer	10
7	M	67	Gastric cancer	17
8	M	64	Gastric cancer	11
9	F	56	Gastric cancer	5
10	M	72	Gastric cancer	11
11	F	72	Gastric cancer	10
12	F	67	Gastric cancer	16

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Table 2. Information of intraoperation.

No.	Type of operation	ASST Spleen injury scale (total 5)	Blood loss of injured spleen (ml)	Total blood loss (ml)	Compression time (min)	Total operation time (min)
1	LSG	2	500	550	25	105
2	LLHLR	3	600	700	30	110
3	LLHC	2	120	280	25	165
4	RDG	1	150	360	15	190
5	RDG	2	130	380	25	220
6	LRTG	2	350	500	25	285
7	LRTG	1	100	240	15	255
8	LRTG	2	150	420	25	235
9	LRDG	2	110	530	25	260
10	LRDG	2	340	460	25	235
11	LRDG	2	290	620	25	240
12	LRDG	2	330	580	25	215
Mean		1.92	264.17	468.33	23.75	209.58
SD		0.51	165.72	138.22	4.33	57.11

LSG – laparoscopic sleeve gastrectomy; LLHLR – left lateral hepatic lobe resection; LLHC – laparoscopic left hemicolectomy; RDG – laparotomic radical distal gastrectomy; LRTG – laparoscopic radical total gastrectomy; LRDG – laparoscopic radical distal gastrectomy.

In addition, we collected and compared the platelet counts from routine blood testing of each patient before and 1 week after surgery. Two patients who were discharged within 1 week after surgery were checked by blood testing at the Outpatient Department 1 week after surgery.

Three surgical procedures

After gauze compression with no hemostatic effect, pinching or pressing of the splenic artery was immediately performed to control the bleeding. This was then followed by identifying the degree and location of splenic injury and determining whether there was a laceration of the splenic portal vessels. A 1-cm length of the splenic artery was dissected free about 3–5 cm proximal to the hilum, followed by intermittent occlusion at the dissected point using non-traumatic Bulldog arterial clamping along with gauze compression of the bleeding part (Figure 1). The splenic artery occlusion time was 15 min at first and then the occlusion was released for about 1–2 min, after which we determined whether there was still active bleeding at the injury site after the compressed gauze was removed. If the bleeding continued, we repeated the above steps one by one, but the splenic artery occlusion and gauze compression time was reduced to 10 min and then 5 min, respectively, after pausing for 1–2 min between splenic artery occlusions. The criterion of successful hemostasis was that there was no bleeding at the injured site for at least 10 min after the splenic artery occlusion and gauze compression were released.

We placed 1 or 2 abdominal drainage tubes in all 12 patients according to the type of surgery. The drainage tubes were usually removed 2–7 days after the operation according to the quantity (<20 ml/d) and characteristics of drainage fluid.

Results

All 12 cases of iatrogenic splenic injury (all cases were ineffective using gauze compression alone for at least 10 min in the beginning) achieved successful hemostasis and splenic preservation by application of intermittent splenic artery occlusion combined with the gauze compression. Two cases (splenic injury of grade I) achieved successful hemostasis after 15 min of splenic artery occlusion with gauze compression, 9 cases (splenic injury of grade II) achieved successful hemostasis after 25 min of splenic artery occlusion with gauze compression, and 1 case (grade III) achieved successful hemostasis after 30 min of splenic artery occlusion with gauze compression (Table 2).

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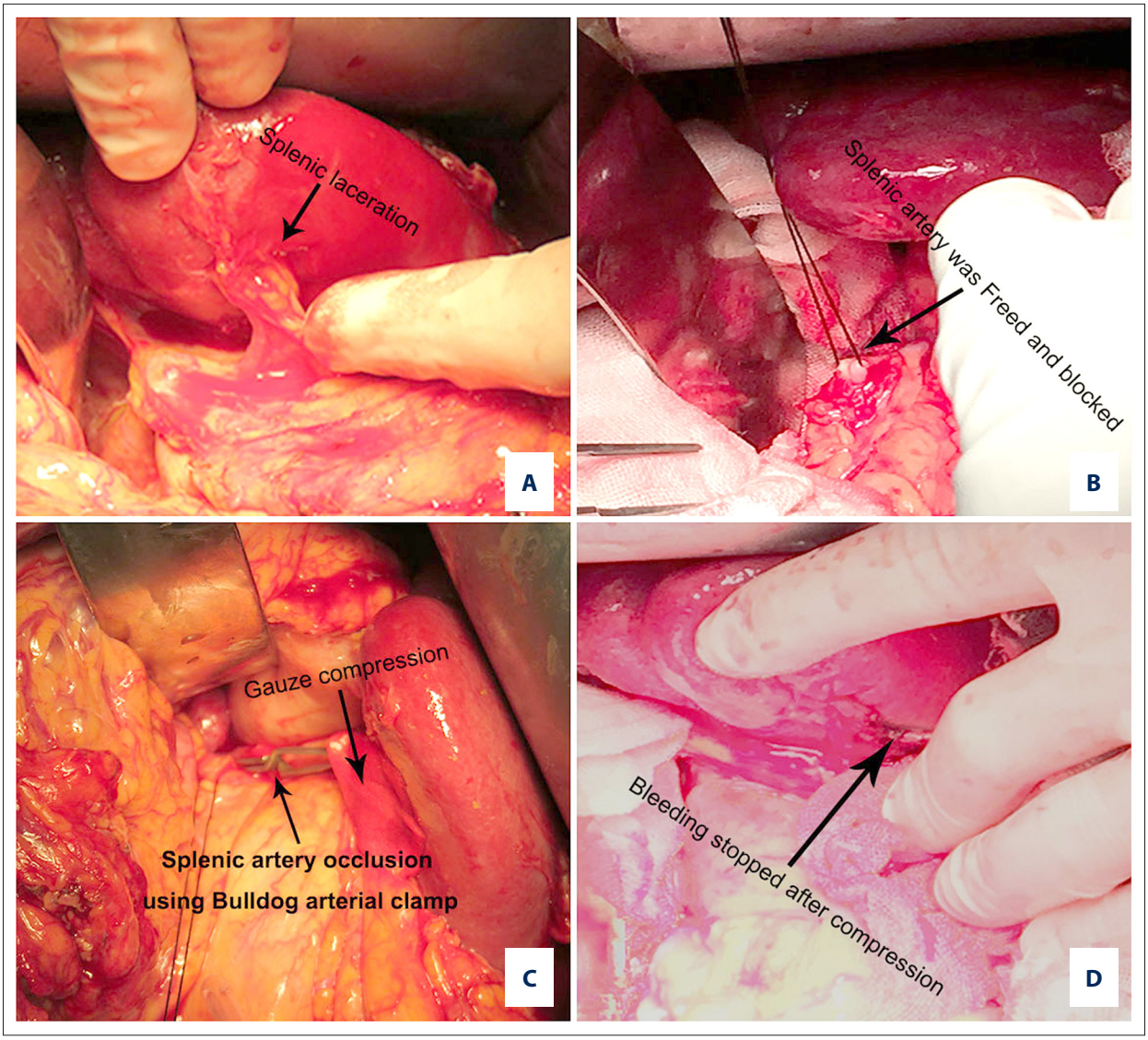

Figure 1. Illustrations of surgical procedure of intermittent splenic artery occlusion combined with gauze compression in iatrogenic splenic injury during radical gastrectomy. (**A**) Splenic laceration occurred in the inferior pole during surgery. (**B**) The splenic artery was separated. (**C**) The splenic artery was intermittently occluded using non-traumatic Bulldog arterial clamping, and the injured part of the spleen was compressed using gauze. (**D**) Active bleeding of the injured part stopped after releasing compression.

In all cases, the average total blood loss during surgery was 468.33±138.22 ml, the average blood loss due to iatrogenic spleen injury was 264.17±165.72 ml, the average operation time was 209.58±57.11 min, and the average time for hemostasis with gauze compression after spleen artery occlusion was 23.75±4.33 min. The data are shown in Table 2.

The platelet counts of all patients were within the normal range before and 1 week after surgery: 273.83±56.22×10^9/L before surgery and 227.83±48.59×10^9/L 1 week after surgery (Figure 2).

Three patients had mild fever or abdominal distention 3 days after the operation and all were checked for abdominal ultrasound and were found to have a small amount of ascites in the pelvic cavity, but did not need additional treatment. There was no recurrence of bleeding, abdominal abscess, spleen necrosis, or other complications, and all patients were uneventfully discharged.

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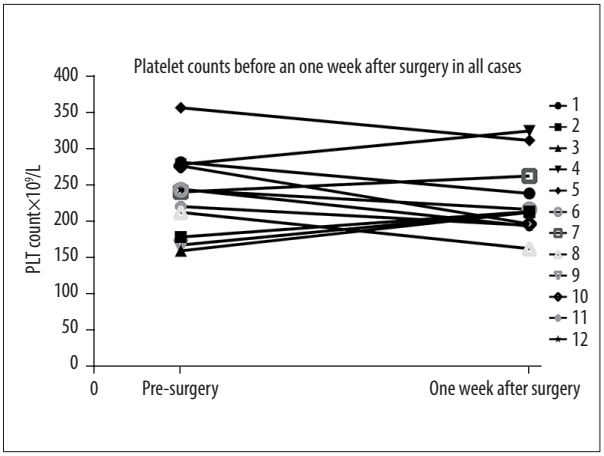

Figure 2. Platelet counts before and 1 week after surgery in all patients. The platelet counts in all patients were within the normal range before and 1 week after surgery, and was 273.83±56.22×10⁹/L before surgery and 227.83±48.59×10⁹/L 1 week after surgery.

Discussion

All 12 patients with iatrogenic splenic injury achieved successful hemostasis by intermittent splenic artery occlusion combined with gauze compression for at least 10 min after failure of the gauze compression alone. The range of total blood loss during surgery was 240–700 ml (468.33±138.22 ml) and the range of blood loss due to iatrogenic spleen injury was 100–600 ml (264.17±165.72 ml). No blood transfusions were performed intraoperatively. Therefore, our method effectively controlled bleeding caused by iatrogenic spleen injury.

We chose to occlude the splenic artery for 15, 10, or 5 min because use of gauze alone to compress the injured part for 10 min was ineffective. Therefore, we decided to free and occlude the splenic artery and use splenic artery occlusion plus gauze compression for 15 min at first. The injured part in 2 cases stopped bleeding completely after 15 min of splenic artery occlusion plus gauze compression, and the bleeding was significantly less than before in the other 10 patients. Therefore, we decided to use the same method again for 10 and 5 min to achieve successful hemostasis and minimize the time of spleen ischemia. This was only based on our experience with a limited number of cases. Of course, we might have found other more appropriate occlusion and compression times if more cases were included in the study, but this is difficult due to the relatively low incidence of iatrogenic splenic injury.

Lord and Gourevtieh [1] found that there are bands of thickened parts within the inferior pole of the spleen and the greater omentum between the splenic hilum and the stomach based on autopsy, which is called the splenic omental band. When the stomach is pulled to the lower right or forward, or to the left side of the omentum, tension is concentrated in the band, resulting in laceration of the splenic hilum and inferior pole of the spleen. Olsen reported iatrogenic splenic injury accounted for about 21% of splenectomies and that 3/4 of the iatrogenic splenic injuries directly involve pulling of the splenic omentum band [13].

With more intensive study of the spleen, other important functions have been found, such as filtration, anti-infection and antitumor effects, and production of coagulation factor VIII [14], which further support the need for spleen-preserving surgery. Most iatrogenic splenic injuries that occur during abdominal surgery are capsule tears or small and shallow lacerations, and tearing of the splenic hilum and parenchymal damage is rare, so spleen preservation is feasible in most cases. At present, the methods commonly used in treating iatrogenic splenic injury include local compression hemostasis, electrocoagulation hemostasis, biochemical hemostatic glue, splenic artery ligation, partial splenectomy, splenic blood flow occlusion, and splenic artery-limiting surgery [15–18]. Local compression can effectively stop bleeding due to small, superficial lacerations. Splenic segment artery ligation or partial splenectomy can stop bleeding when compression is ineffective.

The splenic artery becomes the main blood supply to the spleen when splenic injury occurs due to ligation of left gastroepiploic vessels and parts of the short gastric vessels during distal gastrectomy. The preserved segments of short gastric vessels become the main blood supply for the gastric remnant. Therefore, ligation of the splenic artery can significantly decrease blood supply to the gastric remnant and can result in the need for total gastrectomy, which increases the risk and difficulty of the surgery.

When the splenic artery is occluded, the splenic arterial pressure decreases significantly and the spleen becomes soft and small, with reduced blood flow [19]. Therefore, intermittent splenic artery occlusion combined with gauze compression is effective in achieving hemostasis following iatrogenic splenic injury after the failure of gauze compression alone. We found no adverse effects or related complications associated with the procedure.

The platelet counts of some patients began to rise at about 1 week after splenectomy, based on our many previous splenectomy cases due to spleen injury (data not shown). To prevent venous thrombosis, the patients were given drugs that inhibit platelet aggregation, such as aspirin. However, using our spleen-preserving method to treat iatrogenic spleen injury, the platelet counts of all patients did not obviously increase and all were within the normal range at 1 week after surgery, so we did not have to worry about the problem of venous thrombosis due to platelet elevation after surgery.

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Conclusions

In conclusion, this clinical study shows that the application of intermittent splenic artery occlusion combined with gauze compression in iatrogenic splenic injury is simple and effective. There was no obvious ischemia of the spleen tissue, thus providing the basis for its clinical application. Obviously, other available material used in the treatment of iatrogenic splenic injury such as fibrin glue, gel foam, argon beam coagulation, and topical thrombin have also proven effective, but these materials are not necessarily cheap and may not always be available, especially in low-income settings. Therefore, our method, which is also low cost but very effective, may be very useful.

An important limitation of our study is the lack of comparison of our method with other available hemostatic materials/methods used in the treatment of iatrogenic splenic injury, but given the relatively infrequent occurrence of iatrogenic splenic injury, such a comparison would be challenging.

Conflict if interests

None.

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