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AIM AND SCOPE

World Journal of Gastrointestinal Surgery (*World J Gastrointest Surg*, *WJGS*, online ISSN 1948-9366, DOI: 10.4240) is a peer-reviewed open access academic journal that aims to guide clinical practice and improve diagnostic and therapeutic skills of clinicians.

WJGS covers topics concerning micro-invasive surgery; laparoscopy; hepatic, biliary, pancreatic and splenic surgery; surgical nutrition; portal hypertension, as well as associated subjects. The current columns of *WJGS* include editorial, frontier, diagnostic advances, therapeutics advances, field of vision, mini-reviews, review, topic highlight, medical ethics, original articles, case report, clinical case conference (Clinicopathological conference), and autobiography. Priority publication will be given to articles concerning diagnosis and treatment of gastrointestinal surgery diseases. The following aspects are covered: Clinical diagnosis, laboratory diagnosis, differential diagnosis, imaging tests, pathological diagnosis, molecular biological diagnosis, immunological diagnosis, genetic diagnosis, functional diagnostics, and physical diagnosis; and comprehensive therapy, drug therapy, surgical therapy, interventional treatment, minimally invasive therapy, and robot-assisted therapy.

We encourage authors to submit their manuscripts to *WJGS*. We will give priority to manuscripts that are supported by major national and international foundations and those that are of great basic and clinical significance.

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ORIGINAL ARTICLE

Retrospective Study

Mortality and morbidity in necrotizing pancreatitis managed on principles of step-up approach: 7 years experience from a single surgical unit

Deshpande Aparna, Sunil Kumar, Shukla Kamalkumar

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Author contributions: Aparna D contributed to data collection, analysis, manuscript preparation and review; Kumar S contributed to data collection, tabulation, analysis; Kamalkumar S contributed to manuscript preparation, review.

Institutional review board statement: This was a retrospective review of existing database of patients hence a waiver from Institutional review board was requested for and was granted. Statement of the same is uploaded.

Informed consent statement: No informed consent document is available as this is a retrospective review of database. Care has been taken not to disclose identity of any patient.

Conflict-of-interest statement: None.

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Abstract

AIM

To determine percentage of patients of necrotizing pancreatitis (NP) requiring intervention and the types of interventions performed. Outcomes of patients of step up necrosectomy to those of direct necrosectomy were compared. Operative mortality, overall mortality, morbidity and overall length of stay were determined.

METHODS

After institutional ethics committee clearance and waiver of consent, records of patients of pancreatitis were reviewed. After excluding patients as per criteria, epidemiologic and clinical data of patients of NP was noted. Treatment protocol was reviewed. Data of patients in whom step-up approach was used was compared to those in whom it was not used.

RESULTS

A total of 41 interventions were required in 39% patients. About 60% interventions targeted the pancreatic necrosis while the rest were required to deal with the complications of the necrosis. Image guided percutaneous catheter drainage was done in 9 patients for infected necrosis all of whom required further necrosectomy and in 3 patients with sterile necrosis. Direct retroperitoneal or anterior necrosectomy was performed in 15 patients. The average time to first intervention was 19.6 d in the non step-up group (range 11-36) *vs* 18.22 d in the Step-up group

(range 13-25). The average hospital stay in non step-up group was 33.3 d *vs* 38 d in step up group. The mortality in the step-up group was 0% (0/9) *vs* 13% (2/15) in the non step up group. Overall mortality was 10.3% while post-operative mortality was 8.3%. Average hospital stay was 22.25 d.

CONCLUSION

Early conservative management plays an important role in management of NP. In patients who require intervention, the approach used and the timing of intervention should be based upon the clinical condition and local expertise available. Delaying intervention and use of minimal invasive means when intervention is necessary is desirable. The step-up approach should be used whenever possible. Even when the classical retroperitoneal catheter drainage is not feasible, there should be an attempt to follow principles of step-up technique to buy time. The outcome of patients in the step-up group compared to the non step-up group is comparable in our series. Interventions for bowel diversion, bypass and hemorrhage control should be done at the appropriate times.

Key words: Necrotizing pancreatitis; Nerosectomy; Morbidity and mortality in necrotizing pancreatitis; Step-up approach

Core tip: Necrotizing pancreatitis is a clinical challenge which requires aggressive conservative management in the early part of the attack. About 60% patients respond to conservative management. Patients who develop infection in the necrosis may require intervention. Delay, drain and debride if required, are the principles of step-up approach. Percutaneous drainage should be performed to be followed later by a step-up necrosectomy if required. If percutaneous drainage is not available or is technically unfeasible, surgical necrosectomy can yield equally good results when performed after an appropriate delay at least of 2 wk. With advent of minimally invasive modalities, infected as well as symptomatic sterile necrosis can be treated variably with radiological, surgical or endoscopic means. The modality selected depends upon the local morphology of the inflamed pancreas and availability of expertise.

Aparna D, Kumar S, Kamalkumar S. Mortality and morbidity in necrotizing pancreatitis managed on principles of step-up approach: 7 years experience from a single surgical unit. *World J Gastrointest Surg* 2017; 9(10): 200-208 Available from: URL: http://www.wjgnet.com/1948-9366/full/v9/i10/200.htm DOI: http://dx.doi.org/10.4240/wjgs.v9.i10.200

INTRODUCTION

Necrotizing pancreatitis (NP) evolves in 15% to 25% of cases of acute pancreatitis[1-3]. It is a challenging clinical problem and despite great advances in the understanding of pathophysiology and management, the mortality rates in pancreatitis especially those with infected necrosis (IN) remain high[4-6]. Traditionally, open necrosectomy was the only tool available for surgical treatment of pancreatic necrosis. This was found to be associated with high mortality rates up to 40%[7]. With the understanding of the biphasic nature of the illness, the treatment of pancreatitis has undergone a paradigm change from early operative intervention to aggressive conservative management with avoidance of intervention as much as possible. The landmark paper by Besselink *et al*[8] in 2006 laid out the principles of "step up "approach to pancreatic necrosis. "Delay" the intervention, "drain" where possible by minimally invasive means and "debride" only when necessary became the pillars of management[9]. A multidisciplinary approach is now becoming the key to managing these patients[10]. These patients have long hospital stay and are a drain on the economic resources of the hospital as well as family. Morbidity can be extreme and happens in various forms.

On the background of the changes that have happened in the management of NP over the last decade we planned to review our prospective database to evaluate management of patients of NP. The aim was to determine percentage of patients in whom intervention was performed and the types of interventions they underwent. We attempted to identify the overall success rate of percutaneous catheter drainage (PCD) and to compare the outcomes of patients of step up necrosectomy to those of direct necrosectomy. Operative mortality, overall mortality, various forms of morbidity and treatment offered for the same, and overall length of stay was determined.

MATERIALS AND METHODS

After taking clearance from the institutional review board with a waiver of consent, a retrospective review of a prospective database of patients diagnosed to have acute pancreatitis admitted over a 7 years period between 2008 to 2014 was carried out. All patients having pancreatic necrosis were included in the study. Patients who had non-necrotizing acute pancreatitis, pancreatic pseudocysts, acute-on-chronic pancreatitis, those who took discharge against medical advice and in whom the data was incomplete, were excluded. We also excluded the patients who were referred late in the course of their illness from other hospitals after multiple interventions.

Epidemiological details regarding age, sex, etiology, interval between onset of attack and hospitalization, were noted. The APACHE Ⅱ scores and the percentage of necrosis was noted. The severity of the episode was categorized as per the revised Atlanta guidelines into moderately severe or severe[11]. The computed tomography severity index (CTSI) was noted[12].

The management of patients was reviewed. Patie-

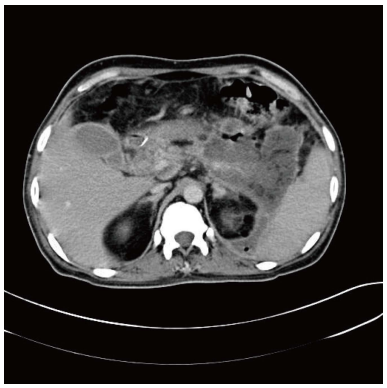

Figure 1 Air in pancreatic necrosis.

Figure 2 Cast of pancreatic necrosis.

nts responding to conservative management with no further admissions were identified. In the rest, total interventions performed and indications for the interventions were noted. Intervention for abdominal compartment syndrome and endoscopic retrograde cholangiography with sphincterotomy and stenting if any was excluded. Interventions were categorized as those directed to pancreatic and perpancreatic necrosis and those performed for complications associated with necrosis or treatment. Timing of the primary intervention for the necrosis from the onset of illness was recorded. Patients undergoing necrosectomy were categorized into those with step-up necrosectomy and those with direct retroperitoneal or anterior necrosectomy. These two categories were compared for timing of intervention, mortality and hospital stay. Mortality in operated patients and the overall mortality was studied. Cause of death and timing of death in relation to onset of the attack was noted. The morbidity was recorded in terms of bowel fistulation, bowel obstruction and hemorrhage. The interventions required for the same were noted. Total duration of hospital stay was noted.

Treatment protocol

Intensive early management is instituted in all patients suspected to have severe acute pancreatitis. Adequate fluid resuscitation, oxygenation, electrolyte maintenance, pain relief are given. Great emphasis is placed on caloric support and early naso-jejunal feeding is instituted as soon as possible. In addition, chest physiotherapy and supplemental tapping of pleural fluid when necessary are used as measures to keep the oxygen saturation above 97%-98%. Ventilatory support is used whenever necessary.

Interventions for the pancreatic necrosis are avoided in the early period. Release of abdominal compartment is performed in the early phase when indicated, but there is no attempt to open the lesser sac at this stage. If patients respond to conservative management, no further intervention is planned. They are discharged once they are hemodynamically stable and enteral nutrition is established.

If there is suggestion of IN in the form of rising white cell count, febrile episodes not related to other sources (central venous catheters or pulmonary consolidation), tachycardia, tachypnea, sicker patient with weight loss, or evidence of gas in the area of necrosis on contrast enhanced computed tomography (CECT) scan (Figure 1), then intervention is planned based upon the principles of step-up approach. The approach to IN in order of preference is: (1) Image guided catheter through the flank directly into the retroperitoneum with step-up to retroperitoneal necrosectomy, if required; (2) direct retroperitoneal necrosectomy (video 1); (3) image guided catheter through anterior abdominal wall followed by focused anterior necrosectomy, if required (4) direct anterior laparotomy with necrosectomy and closed lavage of lesser sac. Open Abdomen approach is used in extreme cases. Irrespective of the approach, we try to enter the necrosis through minimal dissection. During necrosectomy, the loose necrotic tissue is removed and sharp dissection is avoided. The necrotic tissue sometimes is delivered as a cast (Figure 2) or piecemeal (Figure 3). The cavity is flushed with copious amount of warm saline which removes as much nonviable tissue as possible. This is followed by placement of an indigenously created irrigation system where a 12 Fr Ryle's tube is inserted into a 32 Fr abdominal tube drain through a side cut near its outer end. The number of drains depends upon the space available. The necrotic cavity can be irrigated through the Ryles' tube and the fluid is allowed to return through the tube drain. Because the drain is placed deep within the cavity, general peritoneal contamination is avoided even in anterior necrosectomy. Any overflow of fluid into the peritoneal cavity is removed by another drain placed in the pelvic cavity. Postoperatively, the intra-cavitary Ryles' tube is used to lavage the cavity till all the solid necrotic elements are removed with further liquefaction. The lavage is performed either continuously or at intervals. The irrigation is discontinued when the drain stops showing pieces of solid debris or purulent fluid.

When patients with presumed sterile walled off necrosis (WON) have symptoms like gastric outlet obstruction, failure to thrive or pain, depending upon the thickness of the wall of the necrotic sac, percutaneous

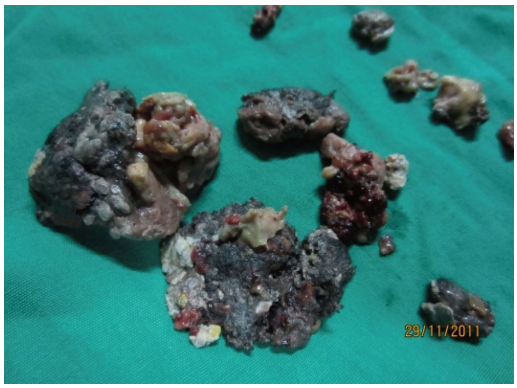

Figure 3 Piecemeal pancreatic necrosis.

drainage by catheters or trans-gastric debridement with cysto-gastrostomy for internal drainage is performed. In some cases, intervention is required due to obstruction of the bowel or suspected bowel fistulation. Bypass of the obstructed bowel and proximal diverting enterostomy is performed accordingly. Hemorrhage within the necrotic area is another indication for intervention. Trans-catheter embolization is used as the first choice of treatment for such cases.

RESULTS

During the 7 year period amongst all patients of acute pancreatitis (n = 276), 84 were identified as NP. Seven patients were excluded as per the exclusion criteria. The baseline characteristics of the patients included in the study (n = 77) are given in Table 1.

Forty-seven patients (61%) responded to conservative management and required no further intervention during that admission or later.

A total of 41 interventions were carried out in 30 (39%) patients. The details of intervention are given in Table 2. Of these 41 interventions, 32 interventions targeted the pancreatic necrosis while 9 were required for dealing with the complications of the necrosis.

Indications for intervention were infection (n = 30), bowel obstruction (n = 1), bowel fistulization (n = 6), hemorrhage (n = 2), persistent organ failure (n = 1), pain, failure to thrive (n = 4). The interventions were chiefly surgical and radiological. Image guided PCD and embolization were the radiologic interventions.

PCD was performed in 9 patients for IN based upon the inclusion criteria. In all these patients a step-up necrosectomy was required. In 3 patients PCD was performed for indication other than infection where a 100% result was achieved and no other intervention was required. Thus the overall success rate for PCD was 25% (3/12).

Direct retroperitoneal necrosectomy (n = 3) or anterior necrosectomy (n = 12) was performed in 15 patients. Thus necrosectomy was required in 24 patients in all, 9 following PCD (step-up) and 15 without prior catheter drainage (Non step-up). All these were

Table 1 Epidemiologic and Radiologic characteristics of patients *n* (%)

Total patients	77
Age range	15-65
Average age	35.65
M:F	6:01
Etiology	
Alcohol	55 (71.5)
Gall stones	16 (20.8)
Ascariasis	1 (1.2)
Idiopathic	5 (6.5)
Severity	
Moderately severe	59 (76.6)
Severe	18 (23.4)
Extent of involvement	
> 90%	27 (35.06)
50%-90%	38 (49.35)
30%-50%	9 (11.68)
Peripancreatic necrosis	3 (3.89)
APACHE Ⅱ score range	8-19
Average APACHE score	12.4
CTSI range	6-10
CTSI average	8

CTSI: Computed tomography severity index. M: Male; F: Female.

cases of IN. On comparing these two groups, the average time to first intervention was 19.6 d in the non step-up group (range 11-36) *vs* 18.22 d in the step-up group (range 13-25). The average hospital stay in non step-up group was 33.3 d *vs* 38 d in step up group. The difference between the two groups using the *T*-test was non significant for both these parameters. The mortality in the step-up group was 0% (0/9) *vs* 13% (2/15) in the non step up group. Using the fischer's exact test, the difference was statistically not significant (P = 0.5). In all, 6 interventions were performed in first 2 wk compared to 18 in over 2 wk. Both the operative deaths occurred in patients undergoing direct necrosectomy within the first 2 wk though the difference was not statistically significant. In all patients after necrosectomy, closed lavage of the lesser sac was performed for an average duration of 16.5 d with a range of 12 to 32 d.

In 5 patients intervention was required for large persistent symptomatic WON without evidence of infection. Depending on the wall maturity they underwent either trans-gastric debridement and internal drainage of the necrosis in the form of cysto-gastrostomy (n = 2, 1 laparoscopic) or PCD (n = 3) (Figure 2) under image guidance. The average time for intervention in these patients was 60 d with a range of 42-90 d. These patients had an average post- intervention stay of 7.4 d.

Morbidity was seen in the form of bowel obstruction in 3 patients. In 2 cases, transient colonic obstruction occurred with air fluid levels on X-ray Abdomen. In both cases, it resolved with extended conservative management. One patient of duodenal obstruction required a duodenojejunostomy.

Bowel fistulation was apparent in 4 patients spontaneously and in 2 patients after a necrosectomy (one

Table 2 Details of interventions done in 30 patients

Name of procedure	No. of patients
Percutaneous catheter drainage	12
Step-up retroperitoneal necrosectomy	3
Direct retroperitoneal necrosectomy	3
Direct anterior necrosectomy	12
Transgastric debridement with internal drainage (Cystogastrostomy)	2
Diverting stoma	6
Duodenojejunal bypass	1
Embolisation for bleeding pseudoaneurysms	2

each from the retroperitoneal and anterior necrosectomy group). A proximal diversion was carried out in all these patients. The diverting stoma was closed in all patients 5-6 mo later without any further morbidity. Hemorrhage of visceral artery pseudoaneurysm occurred in 2 patients which was treated by radiologic embolization.

Overall mortality 10.38%. Five patients succumbed within first 4 d due to fulminant respiratory failure (n = 4) and sudden severe hemorrhage within pancreatic necrosis (n = 1). In the remaining 3 patients, the cause of death was new onset respiratory failure in the second week (n = 1) and sepsis with multi-organ failure (n = 2). The timing of death in these patients was 14th, 18th and 32nd day respectively. Excluding the early deaths, the mortality was 4.1%. Two out of these 3 patients were subjected to operative necrosectomy. Mortality in all patients undergoing necrosectomy (step-up or non step-up) was 2/24, *i.e.*, 8.3%.

The average duration of stay was 22.25 d with a range of 7 to 110 d. The patients who responded to conservative management required an average 11.26 d of hospitalization. In the patients requiring intervention, the average hospital stay increased to 31.76 d.

DISCUSSION

Gallstones and alcohol are the commonest causes of pancreatitis worldwide, with gallstones having a larger role in the western population[13]. In Indian population alcohol is a more common etiological factor as seen in previous studies[14]. The revised Atlanta guideline of 2012 stratifies patients in three categories: Mild, moderately severe and severe depending upon the presence or absence of necrosis and transient or persistent organ failure. Moderately severe pancreatitis was proposed by Vege *et al*[15] who identified the large group of such patients in their patient population. We find similar distribution in our patients, with a nearly 77% of patients in the moderately severe category.

At the onset of the attack, it is difficult to determine the subgroup of patients likely to develop significant pancreatic necrosis. Since pancreatic necrosis increases mortality significantly, diagnosing it is imperative in management. CECT is the gold standard for diagnosing NP and is especially helpful if done after the 4th to 5th day of onset[13]. Studies have demonstrated that AP patients with a CTSI higher than 5 had 8 times higher mortality, 17 times more likelihood of a prolonged hospital course and were 10 times more likely to require necrosectomy than those with CTSI score < 5[16]. In our study group, more than 50% of pancreatic necrosis was seen in 38 patients and in additional 27 patients it was near total necrosis. This is also indicated by the high CTSI (average 8) in our patients. Clinically, this can lead to more local complications. Exclusively Peri-pancreatic necrosis was seen in 3 of our cases.

Due to better understanding of the initial systemic inflammatory response phase, the focus of initial management has shifted to an aggressive conservative one. Standard protocol for management should be established for all suspected cases of acute pancreatitis even before stratifying the patients. A significant number of patients respond to this management. In our series, 61% patients completely settled with conservative treatment and did not need any intervention either in the same admission or later. The role of intervention in NP is becoming more refined. With studies showing that early surgery is associated with higher mortality and that a large number of patients will respond to conservative management[1,17], the current recommendation is to delay the intervention to as late as possible.

Early intervention is required most often for IN. The mortality increases from 5%-25% in patients with sterile necrosis to 15%-28% when infection occurs[13]. Issues in managing IN are threefold. First issue is establishing the diagnosis of infection. A definite diagnosis requires Fine needle aspiration from the necrosis with gram staining. However with many studies showing recovery of some patients of IN with conservative management, the role of FNA is increasingly limited[18]. We have never used FNA to detect infection in the necrosis. Clinical signs can raise suspicion of infection and the CT scan may sometimes reveal air inside the necrotic area.

The second issue is the timing of intervention. IAP guidelines of 2002 recommended avoiding intervention till 14 d for better outcomes[19]. Subsequent studies have recommended further delaying this to the 28th or 29th day[20]. This is highly desirable as by this time the systemic inflammatory response subsides and patients are in a better condition to withstand interventions. The risk of iatrogenic injuries and hemorrhage becomes less as the necrosis is well separated from viable tissue[21]. The definition of delay varies between studies[19,22]. However, prolonging intervention beyond a certain time may entail overuse of antibiotics, increased incidence of resistant organisms as well as fungal superinfections[23,24]. In our patients, the average time to first intervention for IN whether radiological or surgical was 19.21 d, with the earliest intervention being the 12th day. Balancing this decision to intervene at the right time before the patient becomes too ill for any recovery is a clinical challenge. Though we have not found statistically significant difference between the mortality when intervention was performed below 2 wk and over 2 wk, it is still important to note that both the operative deaths occurred when

procedure was performed in the first 2 wk.

The third issue in managing IN is the approach. IN till recently was considered as an indication for a traditional necrosectomy. However, this approach also has the reputation of being very morbid with a high mortality rate upto 40%[7]. Newer minimally invasive modalities have evolved over the last few years with an aim to reduce this morbidity and mortality. The step-up approach described by Santvoort *et al*[25], has changed the management of IN. Image guided PCD either through the retroperitoneal or transabdominal route now plays an important role as the first line drainage in IN. The success rate of PCD in IN varies and ranges from 0% to 78%[25,26]. In a meta-analysis, including 384 patients from 11 studies of PCD as a primary treatment for NP, surgical necrosectomy could be avoided in 56% of the patients and the overall mortality rate was 17%[27]. The incidence of IN in this group was 71%. Thus, PCD either causes sepsis reversal or allows complete recovery avoiding surgical intervention[23]. In 9 patients with clinically suspected IN we used PCD as the first line of management. In all these patients, a step-up necrosectomy was later required. So, our success rate for complete drainage was 0% in IN. However sepsis control was achieved and it allowed delay of surgery. The catheter tracts were used to perform focused necrosectomies. This allowed smaller incisions and prevented contamination of the general peritoneal cavity. The average time to insertion of PCD in the 9 patients with IN was 18.22 d.

Though it is desirable to use step-up approach in all patients of IN, it is sometimes not feasible to do so due to the morphology of the local area or lack of expertise. In such an event direct necrosectomy (retroperitoneal or anterior) may sometimes be necessary. We had to perform a direct necrosectomy in 15 patients. We prefer the retroperitoneal route to access the necrosis through the lienorenal ligament. The video assisted (VARD) or minimal access (MARPN) retroperitoneal necrosectomy is widely described mode for retroperitoneal necrosectomy. We have used the direct retroperitoneal access *via* a flank incision. This is possible when the inflammatory fluid tracks along the lienorenal ligament. This approach has the advantage of avoiding incisions on the abdominal wall thus reducing the chances of later wound dehiscence, hernia and pulmonary complications[28]. A retrospective analysis of 394 patients undergoing minimal access retroperitoneal necrosectomy compared with open necrosectomy showed MARPN to be superior in terms of postoperative complications and outcome[29]. Both MARPN and VARD have been shown at times to need open necrosectomy for better drainage. We have performed retroperitoneal necrosectomy in 3 patients as a step-up procedure and in 3 patients primarily and there was no further need for traditional necrosectomy in any of these patients. This approach should be used whenever feasible.

When the retroperitoneal route is not possible, anterior necrosectomy is performed. Historically traditional necrosectomy is associated with high morbidity and mortality rates. However, this needs to be reviewed in view of newer concepts of delaying intervention to at least 3rd week[27]. The average timing from onset to direct necrosectomy (both retroperitoneal and anterior) in our group of patients was 19.67 d.

Direct Endoscopic trans-gastric necrosectomy (DEN) is now performed across various centres to treat infected WON[30]. Using DEN, a stoma is created endoscopically between the enteric lumen and the necrotic collection, which allows for an endoscopic necrosectomy. There is no clarity in literature about the patients selected for this intervention. Current literature suggests that DEN is a less invasive and less risky alternative to open surgical necrosectomy for managing infected WON and infected pseudocyst with solid debris[31]. Two randomized trials have resulted in a high success rate at the beginning[32,33].

We have not used endoscopy as a modality in any of our cases. We are skeptical about transgressing the gastric lumen to enter into an area of IN with inadequate demarcation and increased vascularity. There are other limitations of endoscopic procedure as well, namely inadequate drainage and closure of the communication.

Our results with direct necrosectomy with postoperative lavage have been very good. We have performed anterior necrosectomy in 12 patients with no prior PCD with a mortality of 16.66%. The overall mortality in all patients undergoing necrosectomy with or without prior catheter drainage is 8.3%. This shows that inspite of newer minimal invasive modalities, there is still a role for traditional surgical intervention as also voiced by Gou *et al*[34].

The best sub-group of patients is those who respond to conservative management and then follow-up later after a period of 2-3 mo with a persistent symptomatic WON. In this group, a trans-gastric necrosectomy with internal drainage by cysto-gastrostomy offers a perfect single step cure if the wall is mature. This internal drainage can be performed by standard open technique, laparoscopically or by endoscopic route depending upon the local expertise available[35,36]. The results from any of these modalities are comparable[36]. We had the opportunity to perform this procedure for WON only in 2 of our 77 patients. In one of them, it was performed laparoscopically. In the same subset, when the wall of WON is not mature and the content is more fluid, PCD can effectively drain most of the necrotic fluid. In three of our patients, we used this approach. Whether such cases with intermediate characteristics can be treated with endoscopic cysto-gastrostomy is question which may need randomized controlled trials to establish the answers[1]. In sterile necrosis, the mortality has been shown to be time dependent after intervention and nearing 0% by the stage of sterile WON[35].

The mortality of NP has a bimodal pattern[37]. Early deaths (within the first week) occur due to severe systemic inflammatory response leading to organ failure. In our series there were 4 early deaths related to uncontrolled respiratory failure. One death occurred due to sudden severe hemorrhage in the pancreatic necrosis

on day 6 of admission. Late mortality (occurs after 2 to 3 wk) is secondary to sepsis related organ failure. Three of our patients succumbed to multi-organ failure secondary to sepsis late in the course of illness.

In one patient there was a new onset respiratory failure on day 12 which led to death. This new onset organ failure led us to intervene in this patient with a traditional necrosectomy, which was probably avoidable. All the patients who died were severe pancreatitis. The overall mortality rate is 10.38% in our patient group. Patients of NP have high morbidity. This exists in terms of bowel obstruction, fistulation, hemorrhage, extended hospitalization. Colonic complications associated with pancreatitis occur infrequently (< 1% of cases). These can vary from reactive ileus to severe obstruction, necrosis or perforation[10]. Two of our patients had colonic obstruction with air fluid levels and both these patients responded to conservative management. Duodenal obstruction was encountered in one patient which persisted even after necrosectomy and required duodeno-jejunal bypass.

Bowel fistulation was seen in 6 patients requiring diversion stoma. Fistulation into the bowel can happen spontaneously due to severe inflammation or can be iatrogenic after extensive debridement. It is imperative that the necrosectomy is done with utmost care to prevent iatrogenic injury to bowel. Sharp dissection should be avoided and only loose nonviable tissue should be removed. Hydro-dissection is a good way to improve scope of necrosectomy compared to sharp dissection. High index of suspicion is required for the possibility of bowel fistulation. Early decision for proximal diversion helps reduce the morbidity.

Gastroduodenal or pancreaticoduodenal artery pseudo-aneurysms occur after significant inflammation of the pancreas and can lead to hemorrhage, which has been reported in 2.4% to 10% of cases[38]. Embolization is the treatment of choice. This was seen in two patients and radiologic embolization was successful in both. Patients of NP pose a significant financial burden on the healthcare systems. Multiple interventions may be required and this increases the hospital stay significantly.

In management of NP, early conservative management plays an important role. Having a standard management protocol is essential. In about 60% cases, conservative management is successful. In the rest, multidisciplinary management is required for the best outcome. Approach used, timing of intervention is based upon the clinical condition and local expertise available. Delayed intervention using minimally invasive techniques is desirable. The step-up approach should be used whenever possible. Using image guided PCD to reduce the sepsis followed by necrosectomy is desirable. The outcome of step up approach and direct surgical approach is comparable if intervention is delayed. Interventions for bowel diversion, bypass and hemorrhage control should be done at the appropriate times. An overall mortality of 10.38% is achieved by following all the above principles which is a very low figure. Good outcome of the patient is the primary objective.

COMMENTS

Background

Necrotizing pancreatitis is a challenging clinical condition. At present, avoiding surgical intervention whenever possible and using various minimally invasive modalities if intervention is absolutely necessary are the chief practice guidelines. Different centres have their own protocol for treating these patients and the modality that a particular centre will follow depends upon the expertise available. The outcome of the patient is most important. It is essential to have published data from various centres in order to know the different modalities followed.

Research frontiers

Currently, minimal invasive retroperitoneal necrosectomy and endoscopic approach to pancreatic necrosis are being researched widely. Also, the subgroup of patients with infected necrosis who can be treated without intervention is also an area of research. There are papers evaluating outcomes with operative necrosectomy and comparing them with minimal invasive necrosectomy.

Innovations and breakthroughs

Most of the techniques are standard techniques described in literature. One essential modification the development of an indigenous sump drain system whereby small ryles' tube is inserted into the larger drain which is then used as a continuous irrigation system. Also, the focused abdominal necrosectomy, which uses the previously placed pigtail catheter is used to enter the area of necrosis is an important advance to keep the procedure less invasive.

Applications

Every patient of pancreatitis needs to be approached with a tailored management. Initial conservative management should be standardized. Whenever intervention is required, one should apply the various minimally invasive modalities whenever feasible. Operative necrosectomy should not be withheld in case such expertise is not available. Principles of appropriate delay should be followed strictly. If local conditions are not conducive for minimal invasive procedures, in such cases also operative necrosectomy may be offered. Comparative studies between minimal invasive necrosectomy and operative necrosectomy may be planned as multicenter studies.

Terminology

All terms used in the paper are standard terms well known to physicians dealing in patients of acute pancreatitis.

Peer-review

This manuscript shows the valuable experience of a tertiary referral center on severe acute pancreatitis.

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REFERENCES

1 **Karakayali FY**. Surgical and interventional management of complications caused by acute pancreatitis. *World J Gastroenterol* 2014; **20**: 13412-13423 [PMID: 25309073 DOI: 10.3748/wjg.v20.i37.13412]

2 **Lowenfels AB**, Maisonneuve P, Sullivan T. The changing character of acute pancreatitis: epidemiology, etiology, and prognosis. *Curr Gastroenterol Rep* 2009; **11**: 97-103 [PMID: 19281696]

3 **Freeman ML**, Werner J, van Santvoort HC, Baron TH, Besselink MG, Windsor JA, Horvath KD, vanSonnenberg E, Bollen TL, Vege SS; International Multidisciplinary Panel of Speakers and Moderators. Interventions for necrotizing pancreatitis: summary of a multidisciplinary consensus conference. *Pancreas* 2012; **41**: 1176-1194

[PMID: 23086243 DOI: 10.1097/MPA.0b013e318269c660]
4 **Maheshwari R**, Subramanian RM. Severe Acute Pancreatitis and Necrotizing Pancreatitis. *Crit Care Clin* 2016; **32**: 279-290 [PMID: 27016168 DOI: 10.1016/j.ccc.2015.12.006]
5 **Haney JC**, Pappas TN. Necrotizing pancreatitis: diagnosis and management. *Surg Clin North Am* 2007; **87**: 1431-1446, ix [PMID: 18053840]
6 **Frossard JL**, Steer ML, Pastor CM. Acute pancreatitis. *Lancet* 2008; **371**: 143-152 [PMID: 18191686 DOI: 10.1016/S0140-6736(08)60107-5]
7 **Bugiantella W**, Rondelli F, Boni M, Stella P, Polistena A, Sanguinetti A, Avenia N. Necrotizing pancreatitis: A review of the interventions. *Int J Surg* 2016; **28** Suppl 1: S163-S171 [PMID: 26708848 DOI: 10.1016/j.ijsu.2015.12.038]
8 **Besselink MG**, van Santvoort HC, Nieuwenhuijs VB, Boermeester MA, Bollen TL, Buskens E, Dejong CH, van Eijck CH, van Goor H, Hofker SS, Lameris JS, van Leeuwen MS, Ploeg RJ, van Ramshorst B, Schaapherder AF, Cuesta MA, Consten EC, Gouma DJ, van der Harst E, Hesselink EJ, Houdijk LP, Karsten TM, van Laarhoven CJ, Pierie JP, Rosman C, Bilgen EJ, Timmer R, van der Tweel I, de Wit RJ, Witteman BJ, Gooszen HG; Dutch Acute Pancreatitis Study Group. Minimally invasive 'step-up approach' versus maximal necrosectomy in patients with acute necrotising pancreatitis (PANTER trial): design and rationale of a randomised controlled multicenter trial [ISRCTN13975868]. *BMC Surg* 2006; **6**: 6 [PMID: 16606471 DOI: 10.1186/1471-2482-6-6]
9 **Kokosis G**, Perez A, Pappas TN. Surgical management of necrotizing pancreatitis: an overview. *World J Gastroenterol* 2014; **20**: 16106-16112 [PMID: 25473162 DOI: 10.3748/wjg.v20.i43.16106]
10 **Aranda-Narváez JM**, González-Sánchez AJ, Montiel-Casado MC, Titos-García A, Santoyo-Santoyo J. Acute necrotizing pancreatitis: Surgical indications and technical procedures. *World J Clin Cases* 2014; **2**: 840-845 [PMID: 25516858 DOI: 10.12998/wjcc.v2.i12.840]
11 **Banks PA**, Bollen TL, Dervenis C, Gooszen HG, Johnson CD, Sarr MG, Tsiotos GG, Vege SS; Acute Pancreatitis Classification Working Group. Classification of acute pancreatitis--2012: revision of the Atlanta classification and definitions by international consensus. *Gut* 2013; **62**: 102-111 [PMID: 23100216 DOI: 10.1136/gutjnl-2012-302779]
12 **Balthazar EJ**, Robinson DL, Megibow AJ, Ranson JH. Acute pancreatitis: value of CT in establishing prognosis. *Radiology* 1990; **174**: 331-336 [PMID: 2296641 DOI: 10.1148/radiology.174.2.2296641]
13 **Tonsi AF**, Bacchion M, Crippa S, Malleo G, Bassi C. Acute pancreatitis at the beginning of the 21st century: the state of the art. *World J Gastroenterol* 2009; **15**: 2945-2959 [PMID: 19554647 DOI: 10.3748/wjg.v15.i24.2945]
14 **Barreto SG**, Rodrigues J. Acute pancreatitis in Goa--a hospital-based study. *J Indian Med Assoc* 2008; **106**: 575-576, 578 [PMID: 19552084]
15 **Vege SS**, Gardner TB, Chari ST, Munukuti P, Pearson RK, Clain JE, Petersen BT, Baron TH, Farnell MB, Sarr MG. Low mortality and high morbidity in severe acute pancreatitis without organ failure: a case for revising the Atlanta classification to include "moderately severe acute pancreatitis". *Am J Gastroenterol* 2009; **104**: 710-715 [PMID: 19262525 DOI: 10.1038/ajg.2008.77]
16 **Werner J**, Uhl W, Hartwig W, Hackert T, Müller C, Strobel O, Büchler MW. Modern phase-specific management of acute pancreatitis. *Dig Dis* 2003; **21**: 38-45 [PMID: 12837999]
17 **Amano H**, Takada T, Isaji S, Takeyama Y, Hirata K, Yoshida M, Mayumi T, Yamanouchi E, Gabata T, Kadoya M, Hattori T, Hirota M, Kimura Y, Takeda K, Wada K, Sekimoto M, Kiriyama S, Yokoe M, Hirota M, Arata S. Therapeutic intervention and surgery of acute pancreatitis. *J Hepatobiliary Pancreat Sci* 2010; **17**: 53-59 [PMID: 20012651 DOI: 10.1007/s00534-009-0211-6]
18 **da Costa DW**, Boerma D, van Santvoort HC, Horvath KD, Werner J, Carter CR, Bollen TL, Gooszen HG, Besselink MG, Bakker OJ. Staged multidisciplinary step-up management for necrotizing pancreatitis. *Br J Surg* 2014; **101**: e65-e79 [PMID: 24272964 DOI: 10.1002/bjs.9346]
19 **Uhl W**, Warshaw A, Imrie C, Bassi C, McKay CJ, Lankisch PG, Carter R, Di Magno E, Banks PA, Whitcomb DC, Dervenis C, Ulrich CD, Satake K, Ghaneh P, Hartwig W, Werner J, McEntee G, Neoptolemos JP, Büchler MW; International Association of Pancreatology. IAP Guidelines for the Surgical Management of Acute Pancreatitis. *Pancreatology* 2002; **2**: 565-573 [PMID: 12435871]
20 **Besselink MG**, van Santvoort HC, Boermeester MA, Nieuwenhuijs VB, van Goor H, Dejong CH, Schaapherder AF, Gooszen HG; Dutch Acute Pancreatitis Study Group. Timing and impact of infections in acute pancreatitis. *Br J Surg* 2009; **96**: 267-273 [PMID: 19125434 DOI: 10.1002/bjs.6447]
21 **Bello B**, Matthews JB. Minimally invasive treatment of pancreatic necrosis. *World J Gastroenterol* 2012; **18**: 6829-6835 [PMID: 23239921 DOI: 10.3748/wjg.v18.i46.6829]
22 **Hungness ES**, Robb BW, Seeskin C, Hasselgren PO, Luchette FA. Early debridement for necrotizing pancreatitis: is it worthwhile? *J Am Coll Surg* 2002; **194**: 740-744; discussion 744-745 [PMID: 12081064]
23 **De Waele JJ**, Blot SI, Vogelaers D, Colardyn F. High infection rates in patients with severe acute necrotizing pancreatitis. *Intensive Care Med* 2004; **30**: 1248 [PMID: 15105982 DOI: 10.1007/s00134-004-2232-6]
24 **De Waele JJ**, Vogelaers D, Blot S, Colardyn F. Fungal infections in patients with severe acute pancreatitis and the use of prophylactic therapy. *Clin Infect Dis* 2003; **37**: 208-213 [PMID: 12856213 DOI: 10.1086/375603]
25 **van Santvoort HC**, Besselink MG, Bakker OJ, Hofker HS, Boermeester MA, Dejong CH, van Goor H, Schaapherder AF, van Eijck CH, Bollen TL, van Ramshorst B, Nieuwenhuijs VB, Timmer R, Laméris JS, Kruyt PM, Manusama ER, van der Harst E, van der Schelling GP, Karsten T, Hesselink EJ, van Laarhoven CJ, Rosman C, Bosscha K, de Wit RJ, Houdijk AP, van Leeuwen MS, Buskens E, Gooszen HG; Dutch Pancreatitis Study Group. A step-up approach or open necrosectomy for necrotizing pancreatitis. *N Engl J Med* 2010; **362**: 1491-1502 [PMID: 20410514 DOI: 10.1056/NEJMoa0908821]
26 **Lee JK**, Kwak KK, Park JK, Yoon WJ, Lee SH, Ryu JK, Kim YT, Yoon YB. The efficacy of nonsurgical treatment of infected pancreatic necrosis. *Pancreas* 2007; **34**: 399-404 [PMID: 17446837 DOI: 10.1097/MPA.0b013e318043c0b1]
27 **van Baal MC**, van Santvoort HC, Bollen TL, Bakker OJ, Besselink MG, Gooszen HG; Dutch Pancreatitis Study Group. Systematic review of percutaneous catheter drainage as primary treatment for necrotizing pancreatitis. *Br J Surg* 2011; **98**: 18-27 [PMID: 21136562 DOI: 10.1002/bjs.7304]
28 **Babu RY**, Gupta R, Kang M, Bhasin DK, Rana SS, Singh R. Predictors of surgery in patients with severe acute pancreatitis managed by the step-up approach. *Ann Surg* 2013; **257**: 737-750 [PMID: 22968079 DOI: 10.1097/SLA.0b013e318269d25d]
29 **Gomatos IP**, Halloran CM, Ghaneh P, Raraty MG, Polydoros F, Evans JC, Smart HL, Yagati-Satchidanand R, Garry JM, Whelan PA, Hughes FE, Sutton R, Neoptolemos JP. Outcomes From Minimal Access Retroperitoneal and Open Pancreatic Necrosectomy in 394 Patients With Necrotizing Pancreatitis. *Ann Surg* 2016; **263**: 992-1001 [PMID: 26501713 DOI: 10.1097/SLA.0000000000001407]
30 **Seewald S**, Groth S, Omar S, Imazu H, Seitz U, de Weerth A, Soetikno R, Zhong Y, Sriram PV, Ponnudurai R, Sikka S, Thonke F, Soehendra N. Aggressive endoscopic therapy for pancreatic necrosis and pancreatic abscess: a new safe and effective treatment algorithm (videos). *Gastrointest Endosc* 2005; **62**: 92-100 [PMID: 15990825]
31 **Ang TL**, Kwek AB, Tan SS, Ibrahim S, Fock KM, Teo EK. Direct endoscopic necrosectomy: a minimally invasive endoscopic technique for the treatment of infected walled-off pancreatic necrosis and infected pseudocysts with solid debris. *Singapore Med J* 2013; **54**: 206-211 [PMID: 23624447]
32 **Seifert H**, Biermer M, Schmitt W, Jürgensen C, Will U, Gerlach R, Kreitmair C, Meining A, Wehrmann T, Rösch T. Transluminal endoscopic necrosectomy after acute pancreatitis: a multicentre study with long-term follow-up (the GEPARD Study). *Gut* 2009; **58**: 1260-1266 [PMID: 19282306 DOI: 10.1136/gut.2008.163733]
33 **Gardner TB**, Coelho-Prabhu N, Gordon SR, Gelrud A, Maple JT, Papachristou GI, Freeman ML, Topazian MD, Attam R, Mackenzie TA, Baron TH. Direct endoscopic necrosectomy for the treatment of

walled-off pancreatic necrosis: results from a multicenter U.S. series. *Gastrointest Endosc* 2011; **73**: 718-726 [PMID: 21237454 DOI: 10.1016/j.gie.2010.10.053]

34 **Gou S**, Xiong J, Wu H, Zhou F, Tao J, Liu T, Wang C. Five-year cohort study of open pancreatic necrosectomy for necotizing pancreatitis suggests it is a safe and effective operation. *J Gastrointest Surg* 2013; **17**: 1634-1642 [PMID: 23868057 DOI: 10.1007/s11605-013-2288-0]

35 **Gibson SC**, Robertson BF, Dickson EJ, McKay CJ, Carter CR. 'Step-port' laparoscopic cystgastrostomy for the management of organized solid predominant post-acute fluid collections after severe acute pancreatitis. *HPB* (Oxford) 2014; **16**: 170-176 [PMID: 23551864 DOI: 10.1111/hpb.12099]

36 **Khreiss M**, Zenati M, Clifford A, Lee KK, Hogg ME, Slivka A, Chennat J, Gelrud A, Zeh HJ, Papachristou GI, Zureikat AH. Cyst Gastrostomy and Necrosectomy for the Management of Sterile Walled-Off Pancreatic Necrosis: a Comparison of Minimally Invasive Surgical and Endoscopic Outcomes at a High-Volume Pancreatic Center. *J Gastrointest Surg* 2015; **19**: 1441-1448 [PMID: 26033038 DOI: 10.1007/s11605-015-2864-6]

37 **Fu CY**, Yeh CN, Hsu JT, Jan YY, Hwang TL. Timing of mortality in severe acute pancreatitis: experience from 643 patients. *World J Gastroenterol* 2007; **13**: 1966-1969 [PMID: 17461498 DOI: 10.3748/wjg.v13.i13.1966]

38 **Martin RF**, Hein AR. Operative management of acute pancreatitis. *Surg Clin North Am* 2013; **93**: 595-610 [PMID: 23632146 DOI: 10.1016/j.suc.2013.02.007]

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CASE REPORT

Mesenteric vein thrombosis following impregnation *via in vitro* fertilization-embryo transfer

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Abstract

Pregnancy is an acquired hypercoagulable state. Most patients with thrombosis that develops during pregnancy present with deep vein leg thrombosis and/or pulmonary embolism, whereas the development of mesenteric vein thrombosis (MVT) in pregnant patients is rare. We report a case of MVT in a 34-year-old woman who had achieved pregnancy *via in vitro* fertilization-embryo transfer (IVF-ET). At 7 wk of gestation, the patient was referred to us due to abdominal pain accompanied by vomiting and hematochezia, and she was diagnosed with superior MVT. Following resection of the gangrenous portion of the small intestine, anticoagulation therapy with unfractionated heparin and thrombolysis therapy via a catheter placed in the superior mesenteric artery were performed, and the patient underwent an artificial abortion. Oral estrogen had been administered for hormone replacement as part of the IVF-ET procedure, and additional precipitating factors related to thrombosis were not found. Pregnancy itself, in addition to the administered estrogen, may have caused MVT in this case. We believe that MVT should be included in the differential diagnosis of a pregnant patient who presents with an acute abdomen.

Key words: Mesenteric vein thrombosis; Pregnancy; *In vitro* fertilization-embryo transfer; Oral estrogen

Core tip: Pregnancy is a hypercoagulable state that

can lead to mesenteric vein thrombosis (MVT). Those symptoms are often nonspecific. Certain signs of MVT can be interpreted as normal changes during the progression of pregnancy; therefore, it is important to recognize the possibility of the development of MVT in the differential diagnosis of a pregnant patient with an acute abdomen. Estrogen can also cause thrombosis and is often administered for hormone replacement as part of an assisted reproductive technology (ART) procedure, particularly *in vitro* fertilization-embryo transfer. With further development of ART, the number of women taking oral estrogen during pregnancy may increase.

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INTRODUCTION

It is well known that pregnancy and estrogen are risk factors for thrombosis. The development of thrombosis during pregnancy is multifactorial, occurring due to physiological changes associated with pregnancy and the additional impact of inherited or acquired thrombophilia[1]. Deep vein leg thrombosis and/or pulmonary embolism are the presentations of most events in affected patients. However, mesenteric vein thrombosis (MVT) that develops during pregnancy is rare; only 10 known cases involving this condition have previously been reported.

We present here a case of MVT in a 34-year-old pregnant woman at 7 wk of gestation. Pregnancy had been achieved *via in vitro* fertilization-embryo transfer (IVF-ET), and oral estrogen had been administered for hormone replacement as part of that procedure. This is the first report of MVT that developed after impregnation achieved *via* IVF-ET.

CASE REPORT

At 7 wk of gestation, a 34-year-old Japanese woman, gravida 0, para 0, was referred to our emergency department from a reproductive clinic for abdominal pain that had lasted for 12 h and was accompanied by vomiting and hematochezia. Nausea had appeared 4 d prior and was treated as hyperemesis gravidarum. The patient had a history of infertility related to endometriosis, and pregnancy was achieved after her first IVF procedure with frozen-thawed embryo transfer. As part of that procedure, oral conjugated equine estrogen (3.75 mg/d) was administered for hormone replacement for 49 d; the patient also received intramuscular injections of progesterone (50 mg/4 d) and a vaginal progesterone suppository (800 mg/d). She was a nonsmoker and had no prior history suggestive of thrombosis. She had no family history of coagulopathies or thromboembolic events. The patient underwent a laparoscopic ovarian cystectomy for endometriosis 4 years prior to her presentation at our hospital. Her body mass index was 24 kg/m^2.

Figure 1 Abdominal computed tomography image obtained at the initial examination. Acute mesenteric vein thrombosis extending into the portal vein (arrow) was demonstrated.

Upon arrival, the patient exhibited the following vital signs: A temperature of 36.8 ℃, a heart rate of 119 beats/min, a blood pressure of 89/76 mmHg, a respiratory rate of 28/min, and oxygen saturation of 97% in room air. A physical examination showed tenderness without guarding, rigidity or rebound tenderness throughout the entire abdomen, and a hematologic examination revealed leukocytosis with a left shift (white blood cell count, 21000/μL; segmented neutrophils, 94.9%). The platelet count was 142000/μL. The patient had a C-reactive protein level of 5.13 mg/dL, aspartate aminotransferase level of 23 U/L (normal, 13-30 U/L), alanine aminotransferase level of 29 U/L (normal, 7-23 U/L), serum creatinine level of 0.58 mg/dL, and blood urea nitrogen level of 14.3 mg/dL. Her D-dimer level was elevated (46.8 μg/mL; normal, < 1.0 μg/mL), the prothrombin time was 13.4 s (normal, 10.2-13.6 s), and the activated partial thromboplastin time was 24.1 s (normal, 23.0-36.0 s). The findings of a hypercoagulability workup, including results for protein S, protein C, and antithrombin, were within normal limits. Anticardiolipin antibodies, antiphospholipid antibodies, and lupus anticoagulant were not detected. She refused screens of the FV Leiden mutation and FII G20210A mutations, which are not found in Japanese people. JAK2 V617F mutation was also not screened because hemoglobin and platelets were in the normal range.

Obstetric ultrasound indicated that the embryo had a normal appearance compatible with its gestational age. Computed tomography (CT) scanning demonstrated thrombosis in the superior mesenteric vein (SMV) extending into the portal vein (Figure 1). A moderate amount of ascites was observed, and the affected small bowel had an edematous and thickened wall with decreased enhancement, which suggested bowel ischemia.

Emergency surgical exploration was performed; this exploration found hemorrhagic fluid and a gangrenous portion of the small intestine extending from 80 cm

Figure 2 Gangrenous portion of the small intestine. A gangrenous portion of the small intestine extending from 80 cm distal to the ligament of Treitz to 160 cm proximal to the ileocecal valve was found.

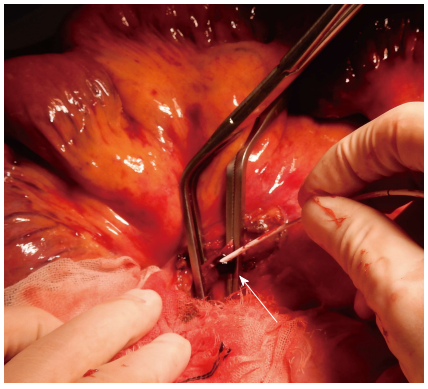

Figure 3 Surgical removal of superior mesenteric vein thrombi with a Fogarty catheter. A Fogarty catheter was inserted from superior mesenteric vein proximal to the ileocolic vein (arrow). The thrombus was removed and blood flow was confirmed.

distal to the ligament of Treitz to 160 cm proximal to the ileocecal valve (Figure 2). After the surgical removal of SMV thrombi (Figure 3), the necrotic portion of the small bowel, which was approximately 170 cm in length, was resected, and end-to-end anastomosis was performed. Following surgery, the patient was transferred to the intensive care unit, and anticoagulation therapy with unfractionated heparin was started immediately. We confirmed cardiac activity in the embryo by ultrasonography.

The subsequent postoperative course was not favorable. CT scanning on postoperative day 4 demonstrated re-occlusion of the SMV and portal vein and no improvement in small bowel congestion. Thrombolysis therapy *via* a catheter placed in the superior mesenteric artery (SMA) was performed by continuously administering unfractionated heparin with urokinase *via* the SMA at a dose of 240000 units/d for 5 d. In addition to thrombolysis therapy, we discussed artificial abortion with the patient; after obtaining consent, we performed this procedure due to the early pregnancy stage and the recurrence of thrombosis despite heparin administration. Following the artificial abortion, the patient's condition improved, and she was discharged on postoperative day 18 with bridging to warfarin from unfractionated heparin.

Figure 4 Abdominal computed tomography image obtained four months after surgery. The portal vein recanalized completely, and the superior mesenteric vein was completely occluded from the distal to the first jejunal branches (arrow).

Four months later, the patient continued to receive anticoagulation therapy uneventfully, and a follow-up CT scan revealed complete recanalization of the portal vein, and the SMV was completely occluded from the distal to the first jejunal branches (Figure 4). The first jejunal vein was expanding and functioning as a collateral pathway. The follow-up laboratory data were as follows: Platelet count, 260000/μL; aspartate aminotransferase level, 19 U/L (normal, 13-30 U/L); alanine aminotransferase level, 17 U/L (normal, 7-23 U/L); serum creatinine level, 0.54 mg/dL; blood urea nitrogen level, 11.1 mg/dL; D-dimer level, 0.5 μg/mL (normal, < 1.0 μg/mL); prothrombin time on warfarin, 19.3 s (normal, 10.2-13.6 s); and activated partial thromboplastin time, 31.5 s (normal, 23.0-36.0 s). She had normal liver function, no symptoms of portal hypertension, and had no ascites. We plan to continue anticoagulation therapy for one year.

DISCUSSION

This article provides the first description of MVT that developed following impregnation achieved *via* IVF-ET. We could not identify factors related to inherited or acquired thrombophilia in this case. We believe that the relative hypercoagulability induced by pregnancy, in addition to the administration of oral estrogen during hormone replacement as part of the IVF-ET procedure, may have caused MVT in this patient, who lacked other precipitating factors.

The overall rate of venous thromboembolic events during pregnancy is 200 per 100000 deliveries[2]. Deep vein leg thrombosis and pulmonary embolism have been recognized as related events, whereas MVT is rare, with only 10 previously documented cases of MVT occurring in pregnant patients.

MVT is a life-threatening form of bowel ischemia, with an estimated mortality rate ranging from 20%-50%[3]. Symptoms of MVT are often nonspecific and include colic, progressive abdominal pain, anorexia, and abdominal distention. In pregnant patients, signs related to MVT are

Table 1 Clinical features of mesenteric vein thrombosis during pregnancy

Case	Ref.	Year	Age	Gestation (wk)	Additional risk	Intestinal resection	Pregnancy outcome
1	Van Way *et al*[7]	1970	33	12	-	Yes	ND
2	Graubard *et al*[8]	1987	30	14	Oral contraceptives by mistake	Yes	ND
3	Engelhardt *et al*[9]	1989	32	ND	-	Yes	Live birth
4	Foo *et al*[10]	1996	27	6	-	–	Artificial abortion
5	Sönmezer *et al*[11]	2004	32	27	Factor V Leiden mutation	–	Live birth
6	Terzhumanov *et al*[12]	2005	33	ND	Hemoglobinopathy	Yes	Miscarriage
7	Atakan *et al*[13]	2009	35	20	Protein S deficiency	Yes	Maternal death
8	Lin *et al*[14]	2011	31	34	-	Yes	Live birth
9	García-Botella *et al*[15]	2016	29	7	Antithrombin deficiency	Yes	Live birth
10	Reiber *et al*[16]	2016	30	ND	-	Yes	Live birth
11	Present case	2017	34	7	Oral estrogen associated with IVF-ET	Yes	Artificial abortion

ND: Not described; IVF-ET: *In vitro* fertilization-embryo transfer.

most likely interpreted as normal changes associated with the progression of pregnancy; as a result, MVT is difficult to accurately diagnose. In the present case, nausea appeared 4 d prior to the development of abdominal pain and, might have been a prodromal symptom rather than an indication of hyperemesis gravidarum. For accurate diagnosis, careful observation is necessary with MVT in mind, and abdominal enhanced CT scanning is recommended[3]. A delay in diagnosis may lead to unfavorable results for both the mother and the fetus. Once a diagnosis of MVT is established, immediate treatment with anticoagulation therapy and/or surgical exploration is necessary if an ischemic bowel is suspected. Thrombolysis therapy *via* a catheter placed in the SMA may be managed if thrombosis worsens despite anticoagulation therapy with heparin, although urokinase carries the risk of fetal hemorrhagic complications. Thrombosis due to underlying prothrombotic states, including pregnancy, begins in small vessels and progresses to involve larger vessels. Considering this pathogenesis, thrombolysis therapy at the SMA may be recommended.

In this case, we also selected artificial abortion for the following three reasons. First, screens for inherited thrombotic disorders were negative, and pregnancy itself may have caused the thrombosis. Second, thrombosis may have recurred during pregnancy because of the diagnosis during early pregnancy. Third, the health of the mother is given priority.

Life-long anticoagulation is warranted in patients with inherited thrombophilia, whereas anticoagulation therapy for at least 6 mo to one year is recommended for patients with reversible predisposing causes, including pregnancy[3]. Therefore we planned to continue anti-coagulation therapy for one year.

The development of MVT during pregnancy is multi-factorial, occurring due to physiological changes related to pregnancy and the additional impact of inherited or acquired thrombophilia. Clinical features noted in the 10 previously reported cases and the present case of MVT in a pregnant patient are shown in Table 1. Causes of the development of MVT in these cases were pregnancy itself in 5 patients, hypercoagulopathy in 3 patients, and hemoglobinopathy in 1 patient. Oral estrogen was administered during pregnancy in 2 cases, including the present case.

MVT development in our patient was associated with pregnancy achieved *via* IVF-ET, which is the most common assisted reproductive technology (ART) procedure used for infertility. In this case, IVF and frozen-thawed embryo transfer were performed; during this process, exogenous steroids (estrogen and progesterone) are often administered to prepare the endometrium to receive the thawed embryos and to ensure that the timing of endometrial preparation and embryo development coincide. Among steroids, oral contraceptives (OC) are known to be a risk factor for MVT[3], and OC accounts for 9%-18% of episodes of MVT in young women[4,5]. It is difficult to compare the effects of conjugated equine estrogen with those of OC because of differences in dosage and biological effects. However, in the present case, the administration of conjugated equine estrogen, in addition to pregnancy itself, might have caused similar MVT-related effects to those observed for OC. With the development of ART, the number of pregnant women taking estrogen during pregnancy may increase, which could lead to the more frequent development of thrombosis, including MVT.

Antepartum thrombo-prophylaxis is generally recommended for pregnant women with prior thrombosis[6]. However, findings regarding the risk of thrombosis in women with prior thrombosis who undergo ART are lacking, and dosage and thrombo-prophylaxis duration after ART have not been well investigated. For the present patient, another pregnancy may be difficult to achieve because infertility treatment without estrogen will be necessary.

In conclusion, pregnancy can increase the risk of MVT, which should be considered in the differential diagnosis of a pregnant patient with an acute abdomen. In cases of pregnancy achieved *via* IVF-ET, particularly frozen-thawed embryo transfer, the risk of thrombosis, including MVT, may be further increased due to the administration of estrogen for hormone replacement.

COMMENTS

Case characteristics

A 34-year-old woman was referred to the authors' hospital because of abdominal pain accompanied by vomiting and hematochezia.

Clinical diagnosis
The patient was diagnosed with acute mesenteric ischemia.

Differential diagnosis
The different diagnosis was hyperemesis gravidarum.

Laboratory diagnosis
An elevated D-dimer level suggested thrombosis.

Imaging diagnosis
Computed tomography scanning demonstrated thrombosis in the superior mesenteric vein extending into the portal vein.

Pathological diagnosis
Ischemic changes, including necrosis of the small bowel, were observed.

Treatment
The administered treatment was resection of the necrotic portion of the small bowel, anticoagulant therapy with unfractionated heparin, and urokinase continuously administered *via* the superior mesenteric artery.

Related reports
Mesenteric vein thrombosis (MVT) that develops during pregnancy is rare; only 10 known cases of this condition have previously been reported. This article provides the first report of MVT that developed following impregnation achieved *via in vitro* fertilization-embryo transfer.

Experiences and lessons
MVT should be included in the differential diagnosis of a pregnant patient who presents with an acute abdomen.

Peer-review
This is an interesting case highlighting the potential for a serious albeit infrequent complication of ART.

REFERENCES

1 **Battinelli EM**, Marshall A, Connors JM. The role of thrombophilia in pregnancy. *Thrombosis* 2013; **2013**: 516420 [PMID: 24455235 DOI: 10.1155/2013/516420]
2 **Heit JA**, Kobbervig CE, James AH, Petterson TM, Bailey KR, Melton LJ 3rd. Trends in the incidence of venous thromboembolism during pregnancy or postpartum: a 30-year population-based study. *Ann Intern Med* 2005; **143**: 697-706 [PMID: 16287790 DOI: 10.7326/0003-4819-143-10-200511150-00006]
3 **Kumar S**, Sarr MG, Kamath PS. Mesenteric venous thrombosis. *N Engl J Med* 2001; **345**: 1683-1688 [PMID: 11759648 DOI: 10.1056/NEJMra010076]
4 **Abdu RA**, Zakhour BJ, Dallis DJ. Mesenteric venous thrombosis--1911 to 1984. *Surgery* 1987; **101**: 383-388 [PMID: 3563882]
5 **Harward TR**, Green D, Bergan JJ, Rizzo RJ, Yao JS. Mesenteric venous thrombosis. *J Vasc Surg* 1989; **9**: 328-333 [PMID: 2918628 DOI: 10.1016/0741-5214(89)90053-0]
6 **Bates SM**, Greer IA, Middeldorp S, Veenstra DL, Prabulos AM, Vandvik PO. VTE, thrombophilia, antithrombotic therapy, and pregnancy: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest* 2012; **141**: e691S-e736S [PMID: 22315276 DOI: 10.1378/chest.11-2300]
7 **Van Way CW 3rd**, Brockman SK, Rosenfeld L. Spontaneous thrombosis of the mesenteric veins. *Ann Surg* 1971; **173**: 561-568 [PMID: 5573649 DOI: 10.1097/00000658-197104000-00013]
8 **Graubard ZG**, Friedman M. Mesenteric venous thrombosis associated with pregnancy and oral contraception. A case report. *S Afr Med J* 1987; **71**: 453 [PMID: 3563797]
9 **Engelhardt TC**, Kerstein MD. Pregnancy and mesenteric venous thrombosis. *South Med J* 1989; **82**: 1441-1443 [PMID: 2814633 DOI: 10.1097/00007611-198911000-00028]
10 **Foo E**, Sim R, Ng BK. Case report of acute splenic and superior mesenteric vein thrombosis and its successful medical management. *Ann Acad Med Singapore* 1996; **25**: 755-758 [PMID: 8924023]
11 **Sönmezer M**, Aytaç R, Demirel LC, Kurtay G. Mesenteric vein thrombosis in a pregnant patient heterozygous for the factor V (1691 G --> A) Leiden mutation. *Eur J Obstet Gynecol Reprod Biol* 2004; **114**: 234-235 [PMID: 15140521 DOI: 10.1016/j.ejogrb.2003.09.014]
12 **Terzhumanov R**, Uchikova E, Paskaleva V, Milchev N, Uchikov A. [Mesenteric venous trombosis and pregnancy--a case report and a short review of the problem]. *Akush Ginekol* (Sofiia) 2005; **44**: 47-49 [PMID: 16028394]
13 **Atakan Al R**, Borekci B, Ozturk G, Akcay MN, Kadanali S. Acute mesenteric venous thrombosis due to protein S deficiency in a pregnant woman. *J Obstet Gynaecol Res* 2009; **35**: 804-807 [PMID: 19751348 DOI: 10.1111/j.1447-0756.2008.01003.x]
14 **Lin H**, Lin CC, Huang WT. Idiopathic superior mesenteric vein thrombosis resulting in small bowel ischemia in a pregnant woman. *Case Rep Obstet Gynecol* 2011; **2011**: 687250 [PMID: 22567515 DOI: 10.1155/2011/687250]
15 **García-Botella A**, Asenjo S, De la Morena-Barrio ME, Corral J, Bolaños E, Carlin PS, López ES, García AJ. First case with antithrombin deficiency, mesenteric vein thrombosis and pregnancy: Multidisciplinary diagnosis and successful management. *Thromb Res* 2016; **144**: 72-75 [PMID: 27304580 DOI: 10.1016/j.thromres.2016.05.011]
16 **Reiber BM**, Gorter RR, Tenhagen M, Cense HA, Demirkiran A. [Mesenteric venous thrombosis during pregnancy; a rare cause of acute ischaemia of the small intestine]. *Ned Tijdschr Geneeskd* 2016; **160**: A9898 [PMID: 27353154]

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CORRECTION

Correction to "Acute calculous cholecystitis: Review of current best practices"

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REFERENCES

1 Gomes CA, Junior CS, Di Saverio S, Sartelli M, Kelly MD, Gomes CC, Gomes FC, Corrêa LD, Alves CB, Guimarães SF. Acute calculous cholecystitis: Review of current best practices. *World J Gastrointest Surg* 2017; **9**: 118-126 [PMID: 28603584 DOI: 10.4240/wjgs.v9.i5.118]

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