Original Article

Infected Pancreatic Necrosis – An Evaluation of the Timing and Technique of Necrosectomy in a Southeast Asian Population

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Abstract

Introduction: Acute pancreatitis appears to be less prevalent in multi-ethnic Southeast Asia, where the aetiology also appears to be influenced by ethnicity. As with acute pancreatitis elsewhere, however, pancreatic necrosis is a cause of significant mortality and the aim of this study was to review our institutional experience with pancreatic necrosectomy. Materials and Methods: The records of all patients who underwent pancreatic necrosectomy from January 2000 to December 2004 were analysed. Indications for surgery were the presence of infected necrosis, unresolving sepsis attributable to ongoing pancreatitis or the presence of gas in the pancreatic bed on imaging. Surgical debridement was achieved by debridement with closure over drains or by debridement with open packing. Results: The cohort comprised 14 of 373 patients admitted for acute pancreatitis (3.8%), with an overall mortality rate of 29%. All patients had infected necrosis with positive bacteriological cultures. Eight patients (57%) underwent debridement with closure over drains and 6 patients (43%) underwent debridement with open packing. All mortalities occurred in patients who underwent open packing, who were also associated with a higher mean Acute Physiology and Chronic Health Evaluation (APACHE) II score. The mortality rate in patients who underwent debridement less than 4 weeks after admission was 33% (2 of 6), compared with 25% (2 of 8) in patients who underwent debridement after 4 weeks. There were no mortalities in patients operated on after 6 weeks. Conclusion: Surgical debridement with closure of drains and a policy of performing delayed necrosectomy are viable in our population.

Ann Acad Med Singapore 2006;35:523-30

Key words: Necrosectomy, Necrotising pancreatitis, Surgery

Introduction

The management of necrotising pancreatitis has improved significantly over the last 2 decades, with a corresponding improvement in mortality rates.[1,2] This improvement is largely attributed to advances in supportive therapy, diagnostic radiology and a better understanding of the pathophysiology of necrotising pancreatitis. However, the mortality rate of pancreatic necrosis remains high, especially with infected necrosis.[2,3] Patients with pancreatic necrosis are frequently diagnosed with contrast-enhanced computed tomography (CT) and the bacteriological status can be established with fine-needle aspiration (FNA). While it is currently generally accepted that surgical debridement is the standard of care for infected pancreatic necrosis, controversies relating to the timing of surgery and the method of surgical debridement for necrosectomy remain unresolved. These controversies persist partly because of the lack of conclusive data and conflicting opinions and results from various reported series.

Acute pancreatitis appears to be less frequent in Southeast Asia, and here ethnicity is reportedly an important determinant of its aetiology.[4] Singapore, as a Southeast Asian country, with a population of 4 million people has a multi-ethnic make-up. In this study, we reviewed our institutional experience with patients with necrotising pancreatitis who underwent necrosectomy, focusing on the surgical outcomes.

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Materials and Methods

The records of consecutive patients with acute pancreatitis admitted to Singapore General Hospital from January 2000 through December 2004 were obtained through the computerised database of discharges from the hospital. The search was confined to patients with the International Classification of Disease-9 (ICD-9) code for acute pancreatitis (code 577.0).

The resultant cohort was subsequently narrowed to focus on patients who underwent pancreatic necrosectomy and debridement. Clinical and laboratory parameters were tabulated from medical records and Ranson's criteria and Acute Physiology and Chronic Health Evaluation (APACHE) II scores were then applied to these patients. The diagnosis of pancreatic necrosis was defined by radiological findings on contrast-enhanced CT scan. All scans were further assessed by 2 independent consultant radiologists and diagnosis arrived at by consensus. The severity of pancreatitis was graded using Balthazar's system of CT severity index (CTSI), which utilises 2 CT prognostic factors based on the severity of the inflammatory process and the degree of glandular necrosis.[5] The likely aetiology of the pancreatitis was determined after a review of the entire clinical scenario. When no obvious aetiology was evident, it was classified as idiopathic. Data pertaining to the course of illness were evaluated and the following determined: length of stay, time to necrosectomy, number of surgeries required and complications that arose. The presence or absence of infection was determined from cultures of necrotic pancreatic tissue on CT-guided aspiration and intraoperative cultures of debrided pancreatic tissue. The decision to perform pancreatic necrosectomy in all cases was based on the presence of infected pancreatic necrosis, unresolving sepsis attributable to ongoing pancreatitis (temperature >38ºC, total white count >12,000 cells/mm^3, heart rate >100 beats/min despite negative cultures) or the presence of gas in the pancreatic bed on imaging. Timing and type of surgical intervention in such patients varied widely and was at the discretion of the individual surgeon.

Statistical analysis was performed using SPSS version 10.0.1 (SPSS Inc, Chicago, IL, USA). Comparison between groups was made using Student's unpaired *t*-test for interval variables. Categorical data were compared with chi-square analysis of proportions or Fisher's exact test (two-tail) when appropriate. Probabilities ≤0.05 were considered significant.

Surgical exploration was undertaken in 2 main fashions at our institution – debridement with closure over drains and debridement with open packing. The decision to perform either of these techniques was made at the time of surgery and was dependant on the condition of the patient at that time. Surgery was performed either via a midline laparotomy or a rooftop incision. All devitalised and necrotic tissue was debrided and high-volume warm isotonic saline lavage performed. If adequate debridement was achieved, closure over drains was performed. Adequate debridement was not always feasible at first exploration as some patients were haemodynamically unstable, some were coagulopathic and some had necrotic material too densely adherent to vital structures to safely remove. In these patients, open packing was performed with a view to schedule re-exploration and debridement in 24 to 48 hours. The process was repeated until debridement was deemed adequate.

Results

A total of 14 patients who underwent pancreatic necrosectomy and debridement were identified, representing 3.8% of the 373 patients admitted to the hospital for acute pancreatitis from January 2000 to December 2004. The median age of patients was 48 years (range, 29 to 65 years) with a male-to-female ratio of 2.5:1. A total of 5 patients had been admitted to another hospital before transfer to our institution. The underlying aetiology of these cases of pancreatitis were biliary stones in 4 patients, alcohol abuse in 2 patients and iatrogenic (post-endoscopic retrograde cholangiopancreatography) in 3 patients. In the remaining patients, the aetiology was hyperlipidaemia in 1 patient and idiopathic in 4 patients. The ethnic breakdown in this series was 8 Chinese patients (57%), 4 Indian patients (29%) and 2 Malay patients (14%). The aetiology of pancreatitis by ethnic group is shown in Table 1.

Prophylactic broad-spectrum antibiotics were commenced in all 14 patients and early institution of enteral nutrition was possible in 7 patients (50%). All 14 patients had infected pancreatic necrosis at the time of surgery except for 1 patient, who underwent exploratory laparotomy for acute abdomen on the day of admission with intra-operative findings of acute pancreatitis. He subsequently developed infected pancreatic necrosis on day 11. The overall mortality rate in this series was 4 of 14 patients (29%).

Table 1. Ethnic Group and Aetiology of Pancreatitis

	Ethnic group		
	Chinese (n = 8)	**Indian (n = 4)**	**Malay (n = 2)**
Aetiology			
Biliary stones	2	0	2
Alcohol abuse	0	2	0
Iatrogenic (post-ERCP)	2	1	0
Hyperlipidaemia	1	0	0
Idiopathic	3	1	0

ERCP: endoscopic retrograde cholangiopancreatography

Severity of Pancreatitis

The median Ranson's score at admission was 3 (range, 2 to 6) in this group of 14 patients. The median APACHE II score at admission was 9 (range, 1 to 20). There was no difference in the median Ranson's score of 3 for survivors (range, 2 to 6) and of 4 for fatalities (range, 2 to 6) (P = 0.881). The median APACHE II score of 6 for survivors (range, 1 to 15) was, however, significantly lower than the median APACHE II score of 16 for fatalities (range, 13 to 20) (P = 0.007). There were 6 patients with a CTSI ≤6 and 8 patients with a CTSI of 7 to 10. The correlation of disease severity and mortality is shown in Table 2. We graded the patient who underwent laparotomy at day 1 as grade C (inflammatory process) with peripancreatic inflammation and glandular necrosis of more than 50% on CT scan performed on day 7, as we were unable to grade the presence of fluid collection after laparotomy.

Table 2. Disease Severity and Associated Mortality

Grading of severity	Mortality rates No. (%)	*P* value
Ranson criteria		
≤3	2/8 (25)	
4-6	2/6 (33)	0.594
Apache II		
≤5	0/4 (0)	
6-10	0/4 (0)	
11-15	1/3 (33)	
>15	3/3 (100)	0.013
CT severity index (CTSI)		
≤6	2/6 (33)	
7-10	2/8 (25)	0.733

Bacteriology

Single organisms were obtained in 9 patients and multiple organisms in 5 patients. Gram-negative organisms were recovered in 9 patients, Gram-positive organisms in 7 patients, and yeast (*Candida sp*) in 3 patients.

Three patients underwent necrosectomy upon CT findings showing the presence of gas. Eight patients underwent CT-guided FNA; of these, 6 patients had positive cultures while the other 2 had positive intraoperative tissue cultures upon debridement for unresolving sepsis. The other 3 patients had positive intraoperative cultures. Five patients had positive blood cultures – 2 patients with methicillin-resistant *Staphylococcus aureus*, 1 patient with *Enterococcus* sp, 1 patient with candidemia and *Klebsiella* sp, and 1 patient with *Enterococcus* sp and *Acinetobacter baumanii*.

Surgical Management

The characteristics of patients who underwent debridement followed by closure over drains are shown in Table 3 and debridement followed by open packing in Table 4. Eight patients (57%) underwent debridement with closure over drains, and 6 patients (43%) underwent debridement with open packing. The median time to operative intervention from initial hospitalisation was 34 days (range, 11 to 94 days). There was a mortality rate of 33% (2 of 6) in patients who underwent debridement less than 4 weeks from the onset of pancreatitis and a mortality rate of 25% (2 of 8) in patients who underwent debridement after 4 weeks (P = 0.59). There was no mortality in patients who were operated on beyond 6 weeks. The median number of reoperations after the initial debridement was 2 (range, 0 to 5). Four patients required single debridements, 4 patients (29%) required 2 to 3 debridements, and 6 patients (43%) required 4 or more debridements before all devitalised tissue was completely removed. Of the 10 patients (71%) who had re-exploration, repeat surgery was planned in 5 patients, and in the remainder it was required because inadequate initial debridement led to poor clinical improvement. There was no intraoperative mortality. All fatalities were late mortalities as a result of multi-organ failure and occurred after a median of 52 days (range, 34 to 124 days) from the initial onset of necrotising pancreatitis. The median duration of postoperative stay was 32 days (range, 6 to 128 days) and median duration of in-hospital stay was 93 days (range, 9 to 152 days).

Complications and Outcome

There was significantly higher mortality in patients who underwent debridement with open packing (67%) compared to patients who underwent debridement with closure over drains (0%) (P = 0.015). The median APACHE II score of 15 for patients who underwent open packing (range, 6 to 20) was higher than a score of 6 (range, 1 to 15) for patients who underwent closure over drains (P = 0.023). The median time to surgery was 42 days (range, 13 to 94 days) in patients who underwent closure over drains compared to 23 days (range, 11 to 42) in patients who underwent open packing (P = 0.121). There is also a higher complication rate related to bleeding and fistula formation in patients undergoing open surgery, although this was not statistically significant in our series. The comparison of surgical outcomes in patients who underwent closure over drains (conventional) and open packing is shown in Table 5.

Discussion

Acute pancreatitis appears to be relatively uncommon in Southeast Asia when compared to the west.[6] The aetiology of acute pancreatitis in Southeast Asia also appears to be ethnic-based and is different from that of western countries.

Table 3. Characteristics of Patients Who Underwent Conventional Technique (Closure over Drains)

Age/sex	Ranson/ APACHE II	CTSI	Indication	Bacteriology	Time to surgery (days)	Complications	No of reoperations	LOS (days)	Outcome
57/F	3/5	6	Presence of gas	*Pseudomonas aeruginosa*	49	Retroperitoneal abscess	1	113	Well
35/F	3/1	10	Infected necrosis	MRSA	34	Loculated left pleural effusion requiring decortication, Retroperitoneal abscess	1	97	Well
44/F	6/7	10	Infected necrosis	*Citrobacter koseri*, *Klebsiella* sp	60	Common bile duct perforation requiring choledochojejunostomy, Insulin-dependent diabetes mellitus	1	89	Well
57/M	4/4	10	Unresolving sepsis	*Enterobacter* sp, *Klebsiella* sp	35	Complete gangrene of stomach, liver necrosis, oesophageal stump leak after total gastrectomy, Pancreaticocutaneous fistula	3	152	Well
43/M	2/4	6	Presence of gas	*Klebsiella* sp	16	Right iliac fossa abscess requiring percutaneous drainage	0	29	Well
65/F	6/15	6	Infected necrosis	*Enterococcus* sp, *Acinetobacter baumannii*, MRSA, *Stenotrophomonas maltophilia*	94	Pseudocyst	0	118	Well
54/M	3/6	10	Presence of gas	*Enterobacter* sp	60	NIDDM	0	9	Well
44/M	3/11	6	Unresolving sepsis	*Staphylococcus aureus*	13	Nil	0	28	Well

APACHE II: Acute Physiology and Chronic Health Evaluation II; CTSI: computed tomography severity index; LOS: length of stay; MRSA: methicillin-resistant *Staphylococcus aureus*; NIDDM: non-insulin-dependent diabetes mellitus; sp: species

Table 4. Characteristics of Patients Who Underwent Open/Semi-open Technique

Age/sex	Ranson/ APACHE II	CT severity index	Indication	Bacteriology	Time to surgery (days)	Complications	No of reoperations	LOS (days)	Outcome
46/M	4/16	8	Unresolving sepsis	*Candida* sp, *Klebsiella* sp	42	Dehisced cystogastrostomy, Pancreatico-cutaneous fistula, Haemorrhage	5	124	Died/ MOF
29/M	6/6	10	Infected necrosis	*Enterococcus* sp	20	Colonic fistula requiring defunctioning ileostomy, Haemorrhage, IDDM	4	128	Well
56/M	6/13	6	Unresolving sepsis	*Candida* sp	22	Haemorrhage	3	59	Died/ MOF
59/M	2/16	6	Infected necrosis	*Stenotrophomonas maltophilia*	33	Pseudocyst	2	44	Died/ MOF
*49/M	3/10	8	Infected necrosis	MRSA	11	Infected pseudocyst with necrosis requiring cystogastrostomy	4	128	Well
42/M	3/20	8	Unresolving sepsis	MRSA, *Candida* sp	23	Retroperitoneal abscess	3	34	Died/ MOF

CTSI: computed tomography severity index; IDDM: insulin-dependent diabetes mellitus; LOS: length of stay; MOF: multi-organ failure; MRSA: methicillin-resistant *Staphylococcus aureus*; sp: species

* Patient underwent exploratory laparotomy on day 1 for acute abdomen with the intraoperative findings of acute pancreatitis with no evidence of fluid collection for which cholecystectomy and peritoneal lavage was done. There was no preoperative CT scan prior to laparotomy, and CT scan done postoperatively on day 7 revealed >50% glandular necrosis, which became infected on day 11.

Table 5. Comparison of Conventional Versus Open Technique

	Conventional (n = 8)	Open (n = 6)	*P* value
Median age in years (range)	49 (35-65)	48 (29-59)	0.593
Median Ranson's score (range)	3 (2-6)	4 (2-6)	0.773
Median APACHE II score (range)	6 (1-15)	15 (6-20)	0.023
Median time to surgery (range)	42 (13-94)	23 (11-42)	0.121
Median no. of reoperations (range)	1 (0-3)	4 (2-5)	0.004
Mortality – no. (%)	0 (0)	4 (67)	0.015
Major complications – no. (%)	3 (38)	3 (50)	0.640
Complications – no. (%)			
Bleeding	0 (0)	3 (50)	0.055
Fistula	1 (13)	2 (33)	0.538
Abscess	4 (50)	1 (17)	0.301
Pseudocyst	2 (25)	3 (50)	0.580
Diabetes	2 (25)	1 (17)	0.707
Wound dehiscence	0 (13)	1 (17)	0.429

Kandasami et al[4] reported that alcohol abuse is the predominant aetiology amongst ethnic Indians while biliary stones was the commonest aetiology for ethnic Malays and Chinese. We similarly note that alcohol abuse was the aetiology of pancreatitis amongst ethnic Indians in our cohort, and the aetiology in Malay patients was biliary stones. However, amongst the Chinese in our cohort, the aetiology was heterogeneous.

This is the first paper focusing on necrotising pancreatitis in a multi-ethnic Southeast Asian population. Singapore has a multi-ethnic population, with the main ethnic groups being Chinese (76.8%), Malay (13.9%) and Indian (7.9%).[7] The ethnic breakdown of the patients in this series was 8 Chinese patients (57%), 4 Indian patients (29%) and 2 Malay patients (14%). The Indian ethnic minority thus appears to be over-represented in this group of patients.

While the management of necrotising pancreatitis remains a challenging surgical problem, there has been significant improvement in its management over the past 2 decades resulting in lower mortality rates in the range of 12% to 17%.[8-10] Yet, 80% of deaths from acute pancreatitis arise from complications related to pancreatic necrosis, especially with infected necrosis.[2,3] The current recommended practice is that infected pancreatic necrosis should undergo surgical debridement.

We have attempted to examine if time of surgery in the management of necrotising pancreatitis is related to outcomes in our patients. The timing of surgery is better understood in the context of the pathophysiology of necrotising pancreatitis. Advocates of early surgery suggest

that the reduction of multi-systemic complications related to enzymes and toxic substances released by the necrosed pancreas can be accomplished with early debridement.[11,12] The proponents of delayed surgery suggest delaying surgery till proven infection or complications occur. They also add that delayed surgery allows easier identification of demarcation of necrotic from vital tissues,[13,14] potentially limiting the number of repeat unplanned debridements.

There appears to be 2 phases in the natural history of necrotising pancreatitis.[2] In the first phase (the first 2 weeks), systemic inflammatory response syndrome (SIRS) with the release of inflammatory mediators can lead to organ failure and general derangements such as hypovolaemia, third spacing, and increased capillary permeability. In the second phase, the clinical picture is that of septic-related complications with multi-organ failure. It appears prudent then that early management should comprise intensive supportive therapy and the prevention of infection, while late management consists of treatment of local complications and the aggressive debridement of devitalised tissues. A prospective randomised trial of early versus late necrosectomy has shown an increased mortality rate of 56% in early necrosectomy (within 48 to 72 hours) versus 27% in late necrosectomy (beyond 12 days of the onset of pancreatitis).[15] The authors conclude that early, intensive, conservative treatment should be the line of management, with late necrosectomy for selected cases. Our series reflect this management policy through delayed necrosectomy with a median time to operative intervention of 34 days (range, 11 to 94). There appears to be a higher mortality rate in our patients who underwent debridement less than 4 weeks after the onset of pancreatitis (33%) compared to patients who underwent debridement after 4 weeks (25%). This figure was not, however, statistically significant and patients with earlier debridement may be those who are more ill. In addition, we observed that there were no mortalities in patients who underwent surgery beyond 6 weeks.

One of two surgical approaches was utilised. One involves debridement with closure over drains, with or without continuous lavage, which is the technique first proposed by Altemeier[16] over 30 years ago. It has been suggested that most surgeons have abandoned this technique because of a higher mortality of approximately 40%.[8,17] Improved mortality rates of approximately 20% or lower have been shown with the open/semi-open technique[18] compared with the closed technique.[8,19] In the open/semi-open technique, necrosectomy was performed with scheduled reoperation or open packing. The distinct disadvantage of this technique is the relatively high rate of bleeding and fistula formation from repeated dressing changes and reoperation, which appears consistent with our experience. The closed technique involves necrosectomy with continuous closed lavage. Drains are placed in the lesser sac and continuous lavage is performed till the effluent is clear. The rate of enteric fistula and bleeding complications is lower with a concomitant decrease in the need for reoperations.[8,10]

While we found that more than half of our patients (8/14) could be managed by debridement with closure over drains, these appear to be patients who were less sick. The rest, who appeared to be more ill, required an open/semi-open technique using a policy of delayed surgery. In this group of more ill patients, open packing is frequently the only feasible surgical approach. The results of our analysis of surgical deaths and complication rates do not differ significantly from other published series; our mortality rate was 29% and the rate of reoperation was 71%. If patients who underwent open packing were excluded, the rate of reoperation was 35%. In our cohort, stratification of disease severity by Ranson's criteria and APACHE II revealed a higher mortality rate with higher grading of severity. However, this was not observed with CTSI grading, possibly due to the small number of patients in our series.

In this series, the median time to surgery was 42 days for patients who underwent the closed technique compared to 23 days for patients who underwent open packing. In addition, patients who underwent open packing had a significantly higher APACHE II score and consequently a higher risk of mortality. While these 2 observations might suggest a more favourable outcome if delayed necrosectomy was performed notwithstanding a positive bacteriological culture, the decision to perform earlier intervention and open packing may represent a subset of more severely ill patients. As such, it is difficult to conclusively attribute the better results obtained in patients who underwent conventional closed technique to the technique of surgery. The subset of patients with better physiological scores were more likely to undergo later surgery and adequate debridement was possible in a single operation with the conventional technique. While open packing is associated with higher morbidity of bleeding and fistula formation, it is the only feasible surgical technique in the subgroup of more severely ill patients where repeated planned debridements are necessary.

All the patients in this series had infected pancreatic necrosis. The indication for debridement was the presence of gas in 3 patients, infected necrosis in 6 patients diagnosed by CT-guided aspiration, and unresolving sepsis in the remaining 5 patients. Tissue and fluid cultures obtained at the time of debridement subsequently proved to be positive for infection for these 5 patients. This underscores the importance of recognising clinical parameters which may indicate likely infected necrosis despite negative initial

cultures. We do not have a definite protocol for the timing of FNA. Eight patients underwent CT-guided FNA prior to debridement. The median time to first FNA was 11.5 days (range, 8 to 31 days) and of these, 2 had positive cultures. Four patients had positive FNA cultures 14.5 days (range, 9 to 30 days) after the initial sterile FNA and the remaining 2 patients had positive tissue cultures upon surgical debridement. Percutaneous drainage was performed in 2 patients. One patient had drainage 10 days after admission at another hospital prior to transfer to our hospital, and cultures were negative. The cultures became positive after 4 weeks. Another patient had percutaneous aspiration during CT-guided FNA draining 250 mL of fluid. The cultures were negative.

Prophylactic antibiotics are important in reducing the incidence of infection in necrotising pancreatitis. Imipenem has been shown to reduce the rate of pancreatic sepsis from 30% to 12% because of better tissue penetration.[20] The routine use of prophylactic antibiotics is, however, not without risk because of fungal superinfection and drug-related adverse effects. Prophylactic antibiotics are therefore only recommended in patients with a high risk of pancreatic infection.[21] In our series, 3 patients developed fungal infections with positive fungal cultures (*Candida* sp), and all succumbed to multi-organ failure.

Sterile pancreatic necrosis can be safely managed conservatively, as reported by Bradley.[1] More recent reports reflect this shift in strategy towards a more conservative stance while achieving comparable mortality rates.[2,22] As infection is an important predictor of outcome, FNA is a useful tool in our decision-making process. CT-guided FNA has been shown to be safe and accurate, with a sensitivity of 96% and a specificity of 99%.[23] However, the claim that FNA is 96% sensitive is misleading as sterile necrosis may not necessarily remain sterile and multiple aspirates may be necessary to prove infection. Our experience with 2 patients who had positive tissue and fluid cultures at the time of debridement despite negative CT-guided FNA cultures underscores this point, and stresses the importance of recognising deteriorating clinical parameters as important guides in our diagnosis of likely infected necrosis.

Our results appear to suggest that despite the absence of a well-defined protocol, conservative strategies with intensive supportive therapy can be utilised successfully. Surgical debridement was required in 3.8% of the total number of patients admitted for acute pancreatitis during the study period, and we believe that this low rate of debridement is a reflection of improved and aggressive supportive therapy for severe acute pancreatitis. The strategy for surgical debridement should be aimed at patients with infected necrosis and the goal is to debride as much devitalised pancreatic and peripancreatic tissue as possible.

Surgical debridement with closure over drains is a viable option among less ill patients in our practice. Fernandez-del Castillo et al[24] has shown similar excellent results with debridement and closed packing with a reported mortality rate of 6.2%. In very ill patients, adequate debridement may not be possible at initial surgery because of continued haemodynamic instability and coagulopathy, and the surgical team may be compelled to resort to packing and scheduled re-operation. Mortality would be expected in this group of patients and our data suggest that this may be the case.

We believe that early recognition of infection with adequate debridement may improve the outcome in this group of patients. Our small series suggests that it remains important to be vigilant of likely infected necrosis by recognising deteriorating clinical parameters, in addition to utilising CT-guided FNA to diagnose infection.

In conclusion, our study supports the importance of the diagnosis of infected necrosis with CT-guided FNA. Recognition of clinical parameters which may suggest likely infected necrosis despite negative initial cultures remains important. Surgical debridement with closure of drains is a viable option in stable patients and a policy to perform delayed necrosectomy may be prudent.

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