

Original Research Article

STEP-UP MINIMALLY INVASIVE MANAGEMENT IN SEVERE ACUTE NECROTIZING PANCREATITIS: A RETROSPECTIVE COHORT STUDY

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ABSTRACT

Background: Severe acute necrotizing pancreatitis (SANP) is associated with systemic inflammation, organ failure, infected necrosis, and considerable morbidity and mortality. Minimally invasive “step-up” strategies have increasingly replaced traditional open necrosectomy.

Materials and Methods: A retrospective study was conducted on 64 patients with SANP between January 2021 and October 2022, managed with a standardized step-up protocol starting with supportive therapy and image-guided drainage, progressing to minimally invasive necrosectomy when indicated.

Results: Of the 64 patients, 39 (60.9%) improved with conservative management and pigtail drainage, while 25 (39.1%) required intervention: laparoscopic cholecystectomy with transgastric necrosectomy (n=12), VARD (n=7), and minimally invasive open necrosectomy (n=6). Mortality was 5% (n=3): 2.6% in the conservative group and 8% in the surgical group. Infected necrosis and persistent organ failure predicted need for surgery, while multi-organ failure independently predicted mortality.

Conclusion: A delayed, minimally invasive, step-up approach is safe and effective in SANP, reducing surgical morbidity while maintaining low mortality. Physiologic severity, rather than intervention method, determines outcomes.

Keywords: Severe Acute Necrotizing Pancreatitis, Pancreatitis

INTRODUCTION

Severe acute necrotizing pancreatitis represents the most critical form of acute pancreatitis and is associated with pancreatic and peripancreatic necrosis, persistent systemic inflammatory response, and a high risk of multi-organ failure. Reported mortality rates range from 8–20%, particularly in the presence of infected necrosis.^[1,2] Historically, open necrosectomy was widely practiced, but was associated with substantial morbidity, including bleeding, fistula formation, prolonged ICU stay, and recurrent sepsis.^[3,4]

The Revised Atlanta Classification standardized definitions of necrotizing pancreatitis and helped guide treatment decisions.^[5] Over time, a paradigm

shift has occurred toward step-up therapy, which begins with optimized supportive care and percutaneous or endoscopic drainage, progressing to minimally invasive necrosectomy for those with persistent sepsis.^[6-8] The landmark PANTER trial demonstrated that the step-up approach significantly reduces major complications compared to open necrosectomy,^[9] and the TENSION trial further showed clinical benefit of endoscopic-first drainage in appropriate anatomical settings.^[10]

Modern guidelines from AGA, WSES, and ESGE support delaying necrosectomy until collections are walled-off, usually after 3–4 weeks, to reduce procedural complications.^[11-13] However, disease severity varies widely, and individualized escalation remains essential. This study evaluates outcomes of a

structured step-up protocol for SANP, with emphasis on mortality, severity-related intervention needs, and predictors of escalation.

MATERIALS AND METHODS

This retrospective cohort study included all adult patients diagnosed with SANP at ESIC Hospital Hyderabad between January 2021 and October 2022. Diagnosis and severity stratification were based on the Revised Atlanta Classification.^[5] Initial management included fluid resuscitation, early enteral nutrition, organ support, and selective antibiotic therapy.^[14,15]

Image-guided pigtail drainage was used for drainable collections in patients with persistent sepsis. Surgical intervention was reserved for cases of infected necrosis or continued clinical deterioration despite adequate drainage. Minimally invasive necrosectomy techniques included laparoscopic transgastric necrosectomy, video-assisted retroperitoneal debridement (VARD), and minimally invasive open necrosectomy, chosen based on anatomy and clinical stability.^[16-18]

Outcomes assessed included mortality (primary endpoint), length of stay, ICU duration, need for necrosectomy, and re-intervention rate (secondary endpoints). Univariate and multivariate logistic regression analyses were performed to identify predictors of intervention and mortality.

RESULTS

A total of 64 patients with severe acute necrotizing pancreatitis were included in the analysis. The mean age of the cohort was 43.6 ± 12.1 years, with a male-to-female ratio of 2.3:1, indicating a male predominance. The mean BMI was 26.3 ± 3.1 kg/m². Gallstone disease was the most frequent etiology, accounting for 65% of cases, followed by alcohol-related pancreatitis (25%) and idiopathic causes (10%). Persistent organ failure (>48 hours) was present in 58% of patients at admission, while infected necrosis was confirmed in 47%, either by positive culture or radiological evidence of gas within collections. The mean ICU stay for the entire cohort was 10.4 ± 4.7 days.

Management Outcomes

Of the 64 patients, 39 (60.9%) were managed successfully with supportive care and ultrasound/CT-guided pigtail drainage alone. The remaining 25 patients (39.1%) demonstrated either infected necrosis or persistent clinical deterioration requiring minimally invasive surgical intervention. Among

these, 12 (48%) underwent laparoscopic cholecystectomy with transgastric necrosectomy, 7 (28%) underwent video-assisted retroperitoneal debridement (VARD), and 6 (24%) required minimally invasive open necrosectomy. The mean time from initial symptoms to surgical intervention was 26 ± 6 days, reflecting adherence to delayed, walled-off necrosis management principles.

The mean hospital stay differed between groups: patients managed conservatively had a shorter hospitalization (mean 31 days), whereas those undergoing surgical intervention had a significantly longer stay (mean 46 days), consistent with greater disease severity and post-procedure monitoring needs.

Primary and Secondary Endpoints

The primary endpoint of the study was mortality. The overall mortality rate was 5% (n=3). Mortality was 1/39 (2.6%) in the conservative group and 2/25 (8.0%) in the surgical group. All deaths occurred in patients who had multi-organ failure at presentation and persistent septic physiology, suggesting that physiologic severity rather than intervention type influenced survival.

Secondary endpoints included need for surgical intervention, ICU stay, and re-intervention rates. Surgical patients demonstrated higher re-intervention rates (24%) compared to the conservatively managed group (10%), again correlating with increased disease burden rather than procedural complications.

Univariate and Multivariate Regression

On univariate analysis, the presence of infected necrosis ($p < 0.001$), persistent organ failure ($p = 0.02$), and necrosis involving >50% of the pancreas ($p = 0.04$) were significantly associated with the need for surgical intervention. Other factors such as age, BMI, and etiology were not statistically significant predictors.

On multivariate logistic regression, infected necrosis emerged as the strongest independent predictor of requiring necrosectomy (Adjusted Odds Ratio [AOR] 4.8; $p < 0.001$). Persistent organ failure beyond 48 hours was also independently associated with the need for surgical intervention (AOR 2.9; $p = 0.01$), while necrosis >50% continued to show a weaker but statistically relevant association (AOR 1.8; $p = 0.04$).

For mortality, multi-organ failure at presentation was the only significant independent predictor on multivariate analysis (AOR 6.2; $p = 0.002$). The type of surgical technique (laparoscopic vs. VARD vs. minimally invasive open) did not influence mortality ($p = \text{NS}$), reinforcing the principle that disease physiology—not the operative approach—drives survival outcomes.

Table 1: Demographic data

Parameter	Conservative Group (n=39)	Surgical Group (n=25)
Mean Age	42.8 ± 11.7 years	45.1 ± 12.9 years
Male : Female Ratio	2.1 : 1	2.5 : 1
Mean BMI	25.9 ± 3.0 kg/m ²	26.8 ± 3.3 kg/m ²
Etiology (Gallstones / Alcohol / Idiopathic)	66% / 23% / 11%	64% / 28% / 8%

Persistent Organ Failure >48h	46%	80%
Infected Necrosis	28%	78%
Mean ICU Stay	9.1 ± 3.8 days	12.9 ± 5.1 days
Mean Hospital Stay	31 ± 9 days	46 ± 12 days

univariate and multivariate analysis table

Table 2: ?

Predictor	Outcome Assessed	Univariate OR (95% CI)	p-value	Multivariate AOR (95% CI)	p-value
Infected Necrosis	Need for Surgical Necrosectomy	5.1 (2.3–11.4)	<0.001	4.8 (2.0–11.6)	<0.001
Persistent Organ Failure (>48 h)	Need for Surgical Necrosectomy	3.2 (1.4–7.1)	0.006	2.9 (1.3–6.7)	0.01
Necrosis >50% of gland volume	Need for Surgical Necrosectomy	2.1 (1.0–4.2)	0.048	1.8 (1.0–3.5)	0.04
Age > 60 years	Need for Surgical Necrosectomy	1.4 (0.6–3.4)	0.27	—	NS
Alcohol Etiology	Need for Surgical Necrosectomy	1.3 (0.5–2.9)	0.31	—	NS
Multi-Organ Failure at Presentation	Mortality	7.5 (2.1–20.9)	<0.001	6.2 (1.9–20.1)	0.002
Delay to Intervention >10 days	Mortality	2.0 (0.9–4.1)	0.07	1.9 (1.0–3.8)	0.06 (trend)
Type of Surgical Approach (Lap vs VARD vs Min-Open)	Mortality	—	NS	—	NS

Comparison of Management Outcomes Between Conservative and Surgical Groups

Table 3: ?

Outcome Measure	Conservative Group (n = 39)	Surgical Group (n = 25)	p-value
Mortality	1 (2.6%)	2 (8.0%)	0.28 (NS)
Mean Hospital Stay (days)	31 ± 9	46 ± 12	<0.001
Mean ICU Stay (days)	9.1 ± 3.8	12.9 ± 5.1	0.004
Re-intervention Rate	4 (10%)	6 (24%)	0.03
Persistent Organ Failure (>48 h)	18 (46%)	20 (80%)	<0.001
Infected Necrosis	11 (28%)	19 (78%)	<0.001
Mean Time to First Intervention (days)	24 ± 5	31 ± 6	—
Type of Intervention	Pigtail Drainage Only	Lap TG (12), VARD (7), Min-Open (6)	—

DISCUSSION

The findings of this study support the contemporary principle that the management of severe acute necrotizing pancreatitis should follow a step-up, minimally invasive strategy, beginning with optimized organ support and radiologically guided drainage, and progressing to necrosectomy only if clinically necessary. More than 60% of patients in our cohort improved with conservative management and pigtail drainage alone, reinforcing the evidence that early aggressive supportive therapy, careful monitoring, and targeted drainage can control sepsis in a substantial proportion of cases without the need for operative intervention. This is consistent with the results of the PANTER trial, which first demonstrated that a drainage-first step-up approach significantly reduces major postoperative complications compared with upfront open necrosectomy.^[9]

One of the key determinants in deciding when to intervene surgically is the presence of infected necrosis, which has long been recognized as a major driver of morbidity and mortality in necrotizing pancreatitis.^[1,2] Infected necrosis triggers persistent

systemic inflammation and multi-organ dysfunction, often necessitating source control. In our cohort, infected necrosis and persistent organ failure were the strongest independent predictors of requiring necrosectomy. This aligns with international guidelines and multicentric cohort data emphasizing that source control, rather than necrosis extent alone, should guide intervention.^[12,13]

Timing of intervention also plays a critical role. Interventions performed earlier than 3–4 weeks are associated with greater tissue friability, increased bleeding risk, and more frequent postoperative fistula formation.^[7,8,22] Our clinical practice adhered closely to the principle of delayed intervention, with most necrosectomies occurring after the necrosis had matured into walled-off collections. This likely contributed to the low overall mortality rate (5%) observed in our study, which compares favorably with reported international mortality rates of 8–20% in severe necrotizing pancreatitis.^[1,2,20]

The mortality difference between the conservative group (2.6%) and surgical group (8%) in our series reflects disease severity rather than treatment effect. Patients selected for surgical intervention generally had more severe disease, higher inflammatory

burden, and more persistent sepsis. Multiple prior studies have demonstrated that physiologic severity and multi-organ failure at presentation are the primary predictors of mortality, rather than the operative technique used.^[14,18,19] Our multivariate analysis confirmed that multi-organ failure at admission was the strongest predictor of death, consistent with previous critical care literature emphasizing the central role of systemic inflammation in determining outcomes.^[14,21]

The choice of minimally invasive necrosectomy approach should be individualized, depending on anatomical characteristics of necrosis, institutional expertise, and patient stability. Transgastric endoscopic necrosectomy is well-suited for central retroperitoneal necrosis abutting the stomach, while VARD provides effective access to left retroperitoneal collections, with lower morbidity than open surgery.^[17,18] Our outcomes across the three minimally invasive techniques (laparo-transgastric, VARD, minimally invasive open) were comparable, supporting the principle that technique selection should be anatomy-driven rather than prescriptive.

Overall, this study adds to the growing clinical evidence supporting the delayed, minimally invasive, step-up approach as the optimal management strategy for severe necrotizing pancreatitis. By minimizing physiological insult, reducing need for open surgery, and focusing intervention timing around infection control and organ stability, patient outcomes can be significantly improved.

CONCLUSION

The minimally invasive step-up approach is safe and effective in the management of severe acute necrotizing pancreatitis. More than half of patients can be successfully treated without surgical necrosectomy. Infection and prolonged organ failure predict need for intervention, while physiologic severity predicts mortality. Delayed intervention and minimally invasive strategies should be standard of care when feasible.

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