

Treatment of Acute Pancreatic Pseudocysts After Severe Acute Pancreatitis

Carlos Ocampo · Alejandro Oría · Hugo Zandalazini ·
Walter Silva · Gustavo Kohan · Luis Chiapetta ·
Juan Alvarez

Published online: 23 January 2007

© 2007 The Society for Surgery of the Alimentary Tract

Abstract Treatment of acute pancreatic pseudocysts (APP) after an episode of severe acute pancreatitis (SAP) remains controversial. Both population heterogeneity and limited numbers of patients in most series prevent a proper analysis of therapeutic results. The study design is a case series of a large, tertiary referral hospital in the surgical treatment of patients with APP after SAP. An institutional treatment algorithm was used to triage patients with complicated APP and organ failure based on Sequential Organ Failure Assessment scores to temporizing percutaneous or endoscopic drainage to control sepsis and improve their clinical condition before definitive surgical management. Over a 10-year period of study (December 1995 to 2005), 73 patients with APP after an episode of SAP were treated, 43 patients (59%) developed complications (infection 74.4%, perforation 21%, and bleeding 4.6%) and qualified for our treatment algorithm. Percutaneous/endoscopic drainage was successful in controlling sepsis in 11 of 13 patients (85%) with severe organ failure and allowed all patients to undergo definitive surgical management. The morbidity (7 vs 44.1%, $P=0.005$) and mortality rates (0 vs 19%, $P=0.04$) were significantly higher in complicated vs uncomplicated APP. Acute pancreatic pseudocysts after SAP are unpredictable and have a high incidence of complications. Once complications develop, there is a significantly higher morbidity and mortality rate. In complicated APP with severe organ failure, percutaneous/endoscopic drainage is useful in controlling sepsis and allowing definitive surgical management.

Keywords Acute pancreatic pseudocysts · Complicated acute pancreatic · Pseudocysts · Severe acute pancreatitis · Organ failure · Pancreatic necrosis

Introduction

Significant advances were made in the last 10 years in our understanding and treatment of patients with severe acute pancreatitis (SAP) and pancreatic necrosis.^{1–3} Despite this progress, the timing and treatment of patients who develop acute pancreatic pseudocysts (APP) after an episode of SAP remains controversial.^{4–6} Many of the reasons for this controversy reside in imprecise definitions, mixed case

series of treatment outcomes in both acute and chronic pancreatic pseudocysts, and the fact that the disease process of SAP with pancreatic necrosis represents a wide spectrum of tissue destruction, fluid sequestration, and systemic toxicity, which is often difficult to accurately categorize.^{1,7}

Acute pancreatic pseudocysts are defined as a collection of amylase-rich pancreatic fluid, enclosed in a well-circumscribed wall, that has been present for more than 4 weeks after the episode of SAP.⁸ Confusion often arises in discriminating pancreatic and peripancreatic necrosis with associated fluid sequestration from pancreatic necrosis with an APP. All patients with APP have some component of pancreatic necrosis,⁹ whereas not all patients with pancreatic and/or peripancreatic necrosis develop APP.⁷ Pancreatic pseudocysts that develop in this setting, particularly when greater than 6 cm in diameter and present for more than 4 weeks, have a high incidence of complications including infection, perforation, and bleeding if not recognized and treated expeditiously.^{7,10} Current clinical guidelines rec-

C. Ocampo (✉) · A. Oría · H. Zandalazini · W. Silva ·
G. Kohan · L. Chiapetta · J. Alvarez
Department of Surgery, Cosme Argerich Hospital,
Ayacucho 1485,
Ciudad de Buenos Aires, Argentina
e-mail: ocampoc@yahoo.com

commend that all patients with pancreatic necrosis be managed medically until documentation of infection in the pancreatic necrosis can be confirmed.³ Based on our clinical experience, we are in agreement with the Argentine Pancreas Club that APP should be distinguished from pancreatic necrosis with associated peripancreatic fluid collections and their presence should dictate surgical treatment.¹¹

Once identified, the timing and surgical treatment of patients with APP after an episode of SAP remains a topic of considerable debate.⁷ Some authors advocate treatment of all pancreatic pseudocysts, which remain present for more than 6 weeks after the onset of SAP, citing a dramatic increase in complication rates for longer periods of observation,¹² whereas others have shown no severe complications in carefully selective patients who were managed nonoperatively.^{13,14} There remains a paucity of evidence in the literature to guide surgical decision making in patients who develop APP after an episode of SAP. The aim of this study is to evaluate the clinical results of a treatment algorithm targeted at the surgical management of patients who develop APP after an episode of SAP.

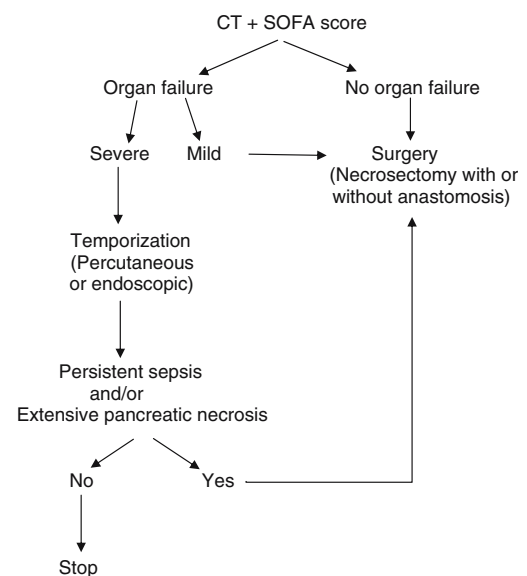
Materials and Methods

All patients hospitalized on the hepatopancreaticobiliary unit of the Argerich Hospital with the diagnosis of APP after a documented episode of SAP from December 1995 to 2005 were available for study. SAP was defined as the clinical diagnosis of pancreatitis (abdominal pain, nausea, vomiting, and hyperamylasemia) with a Ranson score >3 or acute physiology and chronic health evaluation (APACHE) II score >8 .⁸ A dynamic, contrast-enhanced computed tomography (CT) was done on all patients at admission and it was used to determine pseudocyst size, extent of pancreatic necrosis (categorized as $<30\%$, $30\text{--}50\%$, or $>50\%$), and presence of retroperitoneal gas indicative of infection. Diagnosis of APP was based both on clinical grounds and CT findings showing a dominant collection of fluid in the lesser sac surrounded by a well-circumscribed wall, associated with pancreatic parenchymal necrosis but no peripancreatic necrosis, and identified at least 4 weeks from the inciting episode of SAP.

Complicated APP were defined as APP that progressed to infection, rupture, and/or bleeding. Infection in a pseudocyst was confirmed by direct analysis or cultures taken at the time of surgical intervention or during percutaneous drainage. Rupture of the pseudocyst into the abdominal cavity was diagnosed by the onset of acute pain, and CT and abdominal ultrasound examinations showing new onset-free fluid in the abdomen in a patient with a previously documented pseudocyst. Rupture into the

gastrointestinal tract was defined as the drainage of a pseudocyst into a hollow viscus demonstrated either by endoscopy, radiographic investigation, or during surgery. Bleeding was defined as the presence of fresh blood or clots found in the pseudocyst cavity during operation, or as the development of high density debris seen by CT or ultrasound examination.

Patients with APP greater than 6 cm in diameter and present for more than 6 weeks after their episode of SAP had elective surgical treatment consisting of laparotomy, cyst cavity debridement, and internal anastomosis of their cyst wall into the gastrointestinal tract. Patients with complicated APP were treated based on our institutional algorithm (Fig. 1). Infected pancreatic pseudocysts in patients with no organ failure or mild organ dysfunction (Sequential Organ Failure Assessment [SOFA]¹⁵ <3) and who were acceptable surgical risks were treated by laparotomy and cyst cavity debridement; and if a thick-walled pseudocyst was found, an internal anastomosis to the stomach or small intestine was performed. Patients with thin-walled pseudocysts underwent debridement and external drainage or gauze packing depending on the extent of necrosis found in association with the pseudocyst. In patients with limited pancreatic necrosis and complete debridement, external drainage and abdominal closure was the preferred therapeutic option. In patients with extensive necrosis who had incomplete debridement of their cavity, gauze packing was done. When gauze packing was used, patients were returned to the operating room every 48 h for repeated debridement and washout until the cavity was clean. Final operation included external drainage and abdominal closure if feasible.



CT: Computed Tomography, **SOFA:** Sequential Organ Failure Assessment
Figure 1 General algorithm and treatment of complicated APP.

Table 1 Demographic and Clinical Characteristics of 43 Patients with Acute Complicated Pseudocysts

Age (mean, range)	52.4 years (21–78)
Sex (M/F)	24/19
Initial APACHE II score (mean)	7.2
SOFA score (mean)	4.3
Biliary pancreatitis	39 (90%)
Alcohol pancreatitis	2 (5%)
Idiopathic pancreatitis	2 (5%)
Time from onset to admission (mean)	53.2 days

In patients with severe organ dysfunction (SOFA ≥ 3) and/or high surgical risk (American Society of Anesthesiologist [ASA] $\geq IV$), percutaneous or endoscopic drainage was performed as a temporizing measure. This approach was designed to control sepsis and improve a patient's clinical condition sufficiently to allow definitive surgery to be undertaken at a later time. Patients who presented with signs and symptoms of an acute abdomen and evidence on CT or ultrasound of pseudocyst rupture into the abdominal cavity were treated by percutaneous drainage of their ascites in an attempt to control the pancreatic fistula externally. Pseudocysts that ruptured into the stomach were managed medically with supportive care. Pseudocysts that ruptured into the colon had laparotomy, diverting ileostomy, and Hartmann's procedure with external drainage of their pseudocyst.

Variables including age, sex, APACHE II score, time from onset of SAP to admission, location and type of pancreatic pseudocyst, and SOFA scores were recorded. A SOFA score of less than 3 was considered mild organ dysfunction whereas a SOFA score of 3 or greater was considered severe organ dysfunction.¹⁴ All patients were categorized according to the ASA risk stratification. All procedures, including obtaining written informed consent from the patient or a responsible relative, were conducted in accordance with the recommendations of the Ethics Committee of the Cosme Argerich Hospital.

Statistical analysis of the groups was performed using the Student's *t* test for continuous data, and the two-tailed chi-square or Fisher's exact tests for ordinal data. Probability values <0.05 were considered significant.

Results

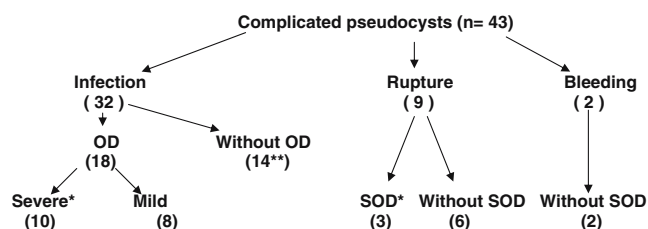
Seventy-three patients with APP after an episode of SAP treated in our hospital qualified for study. Thirty patients (41%) had uncomplicated APP and 43 patients (59%) had complicated APP based on the findings of infection ($n=32$), perforation ($n=9$), or bleeding ($n=2$). Thirty-nine patients (90.6%) with complicated APP had been treated in

conservatively form at other hospitals; these patients were transferred to our unit once the complication was established.

All patients with uncomplicated APP greater than 6 cm in size were operated on electively regardless of symptoms after 6 weeks of medical management. Their mean age was 53.75 years and the mean time from their onset of SAP to admission to our facility was 60.6 days. The mean sizes of the pseudocysts were 10.07 cm (range 7–15 cm) and their mean APACHE II score was 5.5. Pancreatic necrosis was judged to be $<30\%$ in 10 patients (33.3%) and $>30\%$ in 20 patients (66.6%). All patients had laparotomy, cyst cavity debridement, and internal anastomosis of their cyst wall into the gastrointestinal tract (cystojejunostomy Roux-en-Y in 11 patients and cystogastrostomy in 19 patients). There postoperative morbidity was 7% (one patient developed pneumonia and the others wound infection) and there was no postoperative mortality.

Demographic and clinical characteristics of the 43 patients with complicated APP are shown in Table 1. The mean size of pseudocysts as measured by CT scanning was 10.28 cm (range 6–18 cm). Pancreatic necrosis was judged to be $<30\%$ in 8 patients (18.6%), 30–50% in 21 patients (48.8%), and $>50\%$ in 14 patients (32.6%). Complications consisted of infection in 27 patients (62.7%), infection plus rupture in 5 patients (11.6%), rupture in 9 patients (21%), and bleeding in 2 patients (4.6%) (Fig. 2). Sepsis was suspected in 18 patients (42%) with complicated APP clinically at the time of their admission. Unsuspected sepsis was diagnosed operatively in an additional 14 patients: 10 had purulent, foul smelling fluid and 4 had positive pseudocyst fluid cultures.

Infected Pseudocysts Initial organ failure based on SOFA scores was found in 18 of 32 patients (56.2%) with infected pseudocysts. Organ dysfunction was classified as severe (SOFA ≥ 3) in 10 patients (56%) and mild (SOFA <3) in 8 (44%) (Fig. 2). All patients with severe organ dysfunction underwent initial percutaneous ($n=9$) or endoscopic drain-



OD: Organ Dysfunction, SOD: Severe Organ Dysfunction,
 * treated initially with percutaneous or endoscopic drainage
 ** 5 of 14 patients had infection plus rupture

Figure 2 Complications and treatments in the 43 patients with complicated acute pseudocysts.

Table 2 Treatment and Results in 18 Patients with Infected Pseudocysts and Organ Failure

	Drainage (%)	No Drainage (%)	P Value
Number of patients	10	8	
APACHE II score (mean)	10.1	6.37	<0.05
Necrosis			
<30%	0	1 (12)	
30–50%	5 (50)	3 (38)	NS
>50%	5 (50)	4 (50)	
SOFA score (mean)	7.3	3.6	<0.05
Cystoenteric anastomosis (n)	3	0	NS
Morbidity (n)	7 (70)	7 (88)	NS
Mortality (n)	3 (30)	2 (25)	NS

age ($n=1$) and intravenous antibiotics. Definitive surgical intervention was delayed in this group for, on average, 8.9 days after initial drainage, and this temporization was effective at sepsis control and allowed clinical improvement in eight (80%). All 10 patients managed in this fashion eventually underwent definitive operation: 3 patients (30%) had debridement followed by cystoenteric anastomosis, 3 patients (30%) had debridement and external drainage, and 4 patients (40%) had debridement and abdominal packing. Of the 22 patients with either no organ failure or mild organ dysfunction, 12 (54.4%) had cystoenteric anastomosis, 7 (31.8%) had debridement and external drainage, and 3 (13.6%) had debridement and abdominal packing.

Table 2 compares patients with infected pseudocysts and organ failure treated with or without temporizing drainage. Although patients managed by initial drainage had higher APACHE II and SOFA scores than those who did not undergo drainage, there were no differences in overall mortality rates between the groups. In patients with infected pancreatic pseudocysts without organ dysfunction ($n=14$), cyst cavity debridement and cystoenteric anastomosis ($n=12$) or external drainage ($n=2$) was done with no operative mortality and a 19% perioperative morbidity.

Ruptured Pseudocysts Of 14 patients (isolated rupture in 9 and infection plus rupture in 5 patients) with pseudocyst rupture, 8 (57%) ruptured freely into the abdominal cavity, 4 (29%) ruptured into the stomach, and 2 (14%) ruptured into the colon. Pseudocyst rupture into the abdomen produced acute pain and a systemic inflammatory response in 7 patients. Rupture into a hollow viscus was associated with milder clinical symptoms. Improvement in abdominal pain and pseudocyst resolution was noted in three patients, two of whom had evidence on CT scan pseudocyst resolution and new onset retroperitoneal gas, whereas one patient had pseudocyst resolution and the development of

turbid, amylase-rich fluid from the nasogastric tube. Abdominal pseudocyst rupture was confirmed by surgery in five patients and by CT in three. Rupture into the stomach was corroborated by endoscopy, surgery, nasogastric tube fluid analysis, and gastroduodenal radiographs (one case each). Rupture into the colon was confirmed by radiographs or surgery (one case each). The surgical treatment and clinical course of 14 patients with ruptured APP are shown in Table 3. In three patients with rupture into the abdomen and severe organic failure, initial percutaneous drainage was performed (Fig. 2). All eight patients who ruptured freely into the abdominal cavity ultimately had definitive operation and three were able to have cystoenteric anastomosis. Two patients with rupture into the stomach had necrosis debridement and cystogastric anastomosis, and in two patients no further treatment was necessary. Rupture into the colon required diverting ileostomy, debridement, and abdominal packing in one patient, and diverting ileostomy and external drainage in another. Mortality rate in these complex patients was 50%.

In all, initial percutaneous or endoscopic drainage was used as a temporizing measure in 13 patients (30.2%) with complicated APP. The pseudocysts complications in these patients were infection ($n=10$) and rupture into the abdomen ($n=3$). There were no complications related to the initial drainage procedure. Sepsis control and clinical improvement was achieved in 11 of 13 patients (85%). Mortality rates were 31% (4/13) for patients treated initially with percutaneous or endoscopic drainage and 13.3% (4/30) for those who had no percutaneous or endoscopic drainage, a difference which did not reach statistical significance ($P=0.36$).

Eight patients (19%) with complicated pseudocysts died because of sepsis and multiple organ failure. Four patients had infected pancreatic pseudocysts, two patients had rupture into the abdomen, one patient had both infection and rupture into the abdomen, and one patient had rupture into the colon. Table 4 compares patients with complicated and uncomplicated APP. Patients with complicated pseudocysts showed higher APACHE II scores at admission,

Table 3 Treatment and Results in 14 Patients with Ruptured Pseudocysts

	Abdomen (n=8)	Stomach (n=4)	Colon (n=2)
Infection	2	1	2
Drainage	3	0	0
Necrosis excision	7	2	2
Cystoenteric anastomosis	3	2	0
Morbidity (%)	5 (63)	0	2 (100)
Mortality (%)	3 (38)	0	1 (50)

Table 4 Comparison of Treated Uncomplicated and Complicated Pseudocysts

	Uncomplicated (<i>n</i> =30)	Complicated (<i>n</i> =43)	<i>P</i> Value
Age (mean in years)	53.75	52.4	NS
Time from onset to admission (mean in days)	60.6	53.2	NS
APACHE II score (mean)	5.5	7.2	<0.05
SOFA score (mean)	0.58	4.3	<0.05
Mean size (cm)	10.07	10.28	NS
Length of Hospital Stay (mean in days)	14.7	37.7	<0.05
Necrosis			
<30%	10	8	NS
>30%	20	35	
Morbidity (<i>n</i>)	2	19	<0.05
Mortality (<i>n</i>)	0	8	<0.05

more severe organ dysfunction, longer hospital stays, and a higher morbidity and mortality rate. Age of patients, pseudocyst size, extent of pancreatic necrosis, and time from the initial episode of pancreatitis to admission were not significantly different.

Discussion

Surgical treatment of APP that develop after an episode of SAP remains controversial and incompletely defined.⁷ This study demonstrates that when the treatment of APP secondary to SAP is delayed until complications develop, morbidity and mortality rates rise significantly (0 vs 19%, $P<0.001$). In this series, we could identify no clinical variable or imaging findings that would reliably differentiate patients with pseudocysts who developed complications from those who did not.

Our results differ dramatically from those of previous case series where asymptomatic pancreatic pseudocysts were treated conservatively with reported success rates using nonoperative management of 48 and 60%.^{13,14} Surgery in these series was performed only for persistent abdominal pain, pseudocyst enlargement, or complications. In the group managed without operation, 60% had complete resolution of their cysts in the series from Johns Hopkins¹⁴ whereas in the Mayo Clinic series,¹³ 83% of pseudocysts less than 5 cm in diameter while only 50% of pseudocysts greater than 5 cm in diameter resolved. In both of these series, over three fourth of patients had pseudocysts secondary to chronic pancreatitis. This is in striking contrast to our experience where only 2 of 73 (2.7%) had pseudocysts secondary to alcoholic causes and 90% of patients had APP secondary to biliary pancreatitis, an

etiology that has been shown to carry a significantly higher complication rate and mortality rate than alcoholic pancreatitis.¹⁶ Reasons for this discrepancy lie in the fact that the pathogenesis and clinical course of pseudocysts in patients with chronic pancreatitis differs significantly from those after an episode of SAP.^{7,10,16,17} Chronic pseudocysts or retention cysts result from calcification or stenosis of the pancreatic duct secondary to parenchymal fibrosis and pancreaticolithiasis, leading to duct dilatation, hypertension, and duct blowout.¹⁸ As a consequence of this process, these pseudocysts remain clinically stable and characteristically have a duct–cyst communication. In contrast, pseudocysts secondary to an episode of SAP result from an acute inflammatory process with necrosis and the collection of pancreatic secretions and the products of the inflammatory response with or without major duct disruption.⁷ These APP, particularly those with neck or body pancreatic necrosis with viable upstream pancreatic tissue, are more prone to develop complications.¹⁹ This observation is supported by the 59% incidence of complications identified in APP in our series.

It is important to bear in mind that this series is highly selected and does not represent the majority of patients with APP. Most patients admitted to our hospital have large pseudocysts and associated severe pancreatic necrosis requiring a highly specialized surgical unit. Treatment of these high risk patients is associated with an increased mortality rate.^{10,20} Our series compares favorably with that of Behrman et al.¹⁰ who reported a morbidity rate of 65% and mortality rate of 25%, treating a similar group of patients. The clinical paradox remains in differentiating an APP from benign peripancreatic fluid collections, which are often coincident to pancreatic necrosis, contain little or no amylase-rich fluid, and require no definitive treatment.

The severity of the episode of SAP and the extent of associated pancreatic necrosis was also found to influence the rate of spontaneous pseudocyst resolution and need for surgical intervention.²¹ In our series, necrosis by contrast-enhanced CT was calculated to be <30% in 18 (24.6%) and >30% in 55 (75.4%), findings indicative of a high rate of main pancreatic duct disruption in this series and the need for eventual operative intervention. It should be emphasized that all patients in this series had been managed medically for at least 4 weeks after their episode of SAP before intervention. This period of time allows the demarcation of necrotic tissue, maturation of the pseudocyst wall, and abatement of the initial systemic inflammatory response syndrome associated with SAP.^{1–3} After 4 weeks of medical management, however, in patients with APP, their high rate of complications (59% in this series) and elevated morbidity (44.1%) and mortality rates (19%) once complications develop (vs morbidity rates of 7% and mortality rate of 0% for uncomplicated APP) argues for

pseudocyst directed surgical management as previously recommended.¹¹

Accurate diagnosis of an infected pancreatic pseudocyst before either percutaneous or operative intervention remains imprecise. Whereas the definition of an infected pseudocysts states that it is characterized by organisms in a fluid collection secondary to acute pancreatitis, present for more than 4 weeks, surrounded by a nonepithelialized wall, and associated frequently to pancreatic necrosis seems clear, its clinical distinction from a noninfected pancreatic pseudocyst or peripancreatic fluid collection is difficult. Infection should be suspected in all patients with a known pancreatic pseudocyst and clinical signs or symptoms of sepsis. Diagnosis is confirmed by a CT scan showing gas and/or the finding of organisms in the fluid or necrosis collected by pseudocyst puncture or surgery. Definitive operation is based on the persistence of sepsis and/or the findings of residual necrosis based on dynamic CT evaluation. In patients with infected pancreatic pseudocysts, which were present for more than 6 weeks after the initial episode of pancreatitis, have CT images showing a well-developed cavity with a thick wall, and have absent or mild organ failure, definitive surgical treatment consists of fluid drainage, necrosis debridement, and cystoenteric anastomosis. We have previously established the importance of necrosis debridement in both infected and noninfected pancreatic pseudocysts.²² Debridement of necrotic debris from a pseudocyst cavity should be carried out at the time of definitive drainage to avoid retroperitoneal sepsis and its attendant high morbidity and mortality rates.^{23,24}

Once complications develop in APP, systemic sepsis and organ failure often preclude definitive surgical management. In this series, we followed an institutional algorithm in which patients with objective criteria for severe organ dysfunction as assessed by a SOFA score >3 and/or a high surgical risk, defined as an ASA $\geq$ IV, were treated by initial percutaneous or endoscopic drainage and systemic antibiotics as a temporizing measure. This intervention was done to control sepsis and improve a patient's clinical condition sufficiently to allow subsequent definitive surgery at a later time. This strategy was utilized in 13 patients (18%) in this series with complicated APP and organ dysfunction and was successful in controlling sepsis and allowing for clinical improvement in 86% of patients in whom it was applied. Our results with percutaneous drainage were similar to those previously reported by Criado et al.²⁵ In their series of 42 patients with pancreatic pseudocysts, percutaneous drainage was effective for sepsis control and clinical improvement in all 23 patients with infected pseudocysts. In our subgroup of patients with infected pseudocysts, despite the fact that those treated with initial percutaneous drainage had greater organ failure as assessed by SOFA score than those who did not undergo initial drainage,

mortality rates for both groups were not significantly different ($P=0.633$). The clinical benefits derived from both of these experiences suggest that the indication for initial drainage could be extended to patients with infected pseudocysts and mild organ dysfunction.

The underlying pathophysiologic mechanism for pseudocyst rupture is unclear. Many factors may be involved, including increasing intracystic pressure, infection, pancreatic enzyme activation with wall digestion, wall necrosis, or abdominal trauma.⁷ Because most APP in the setting of SAP are associated with necrosis, pancreatic duct with subsequent accumulation of pancreatic fluid may lead to progressive growth and rupture. Viable pancreatic tissue proximal to the area of duct disruption was found in 14 of 16 patients (88%) in this series who had ruptured pseudocysts. This disconnected pancreatic duct syndrome was implicated in persistent pancreatic fistulas after pancreatic debridement and external drainage in SAP.²⁶ Increased pressure may also affect the blood supply, leading to necrosis and rupture. Morbidity and mortality rates for ruptured pseudocysts in our series were 50 and 29%, respectively, figures which are similar to those previously reported.^{6,27}

Conclusion

In summary, APP associated with pancreatic necrosis after an episode of SAP requires careful evaluation and treatment. In patients with complicated APP and organ failure, percutaneous or endoscopic drainage should be performed as a temporizing measure to alleviate sepsis and improve the patient's condition. Definitive therapies depend on the clinical course and residual pancreatic necrosis assessed by dynamic CT. Complications in APP in this setting are unpredictable and when conservative measures fail, surgical treatment as salvage carries a high morbidity and mortality rate. Based on these observations, we recommend that APP of more than 6 cm in diameter, resulting from acute biliary pancreatitis, and associated with pancreatic necrosis should be treated electively before complications develop, usually 6 weeks after onset, regardless of symptoms.

Acknowledgments The authors thank Dr. Thomas J. Howard, Department of Surgery, Indiana University School of Medicine, Indianapolis, Indiana, for his useful cooperation in the revision and preparation of the present study.

References

1. Baron, T. H., & Morgan, D. E. (1999). Acute necrotizing pancreatitis. *The New England Journal of Medicine*, 340, 1412–1417.

2. Beger, H. G., & Isenmann, R. (2002). Acute pancreatitis: Who needs an operation? *Journal of Hepato-biliary-pancreatic Surgery*, 9, 436–442.
3. Werner, J., Feuerbach, S., Uhl, W., & Büchler, M. W. (2005). Management of acute pancreatitis: From surgery to interventional intensive care. *Gut*, 54, 426–436.
4. Grace, P. A., & Williamson, R. C. N. (1993). Modern management of pancreatic pseudocysts. *British Journal of Surgery*, 80, 573–581.
5. Shatney, C., & Lillehei, R. (1981). The timing of surgical treatment of pancreatic pseudocysts. *Surgery, Gynecology and Obstetrics*, 152, 809–814.
6. Walt, A. J., Bouwman, D. L., Weaver, D. W., & Sachs, R. J. (1990). The impact of technology on the management of pancreatic pseudocyst. *Archives of Surgery*, 125(6), 759–763.
7. Ådrén-Sandberg, Å., & Dervenis, C. (2004). Pancreatic pseudocysts in the 21st century. Part I: Classification, pathophysiology, anatomic considerations, and treatment. *Journal of the Pancreas (online)*, 5, 8–24.
8. Bradley, E. R. III (1993). A clinically based classification system for acute pancreatitis. *Archives of Surgery*, 128, 586–590.
9. Frey, C. F. (1998). Peripancreatic fluid collections. In H. G., Beger, A. L., Warshaw, M. W., Buchler, et al. (Eds.). *The Pancreas* (vol. 1., pp. 423–437). London, England: Blackwell Science Ltd.
10. Behrman, S., Melvin, S., & Ellison, C. (1996). Pancreatic pseudocysts following acute pancreatitis. *American Journal of Surgery*, 172, 228–231.
11. Club del Páncreas (2000). Reunión de Consenso. Pancreatitis Aguda. *Acta Gastroenterológica Latinoamericana*, 30(4), 249–252.
12. Bradley, E. L., Clemens, J. L., & Gonzalez, A. C. (1979). The natural history of pancreatic pseudocysts: A unified concept of management. *American Journal of Surgery*, 137, 135–141.
13. Vitas, G. J., & Sarr, M. G. (1992). Selected management of pancreatic pseudocysts: Operative versus expectant management. *Surgery*, 111, 123–130.
14. Yeo, C. T., Bastidas, J. A., Lynch-Nyhan, A., Fishman, E. K., Zinner, M. J., & Cameron, J. L. (1990). The natural history of pancreatic pseudocysts documented by computed tomography. *Surgery, Gynecology & Obstetrics*, 170, 411–417.
15. Arts, D. G., de Keizer, N. F., Vroom, M. B., & de Jonge, E. (2005). Reliability and accuracy of Sequential Organ Failure Assessment (SOFA) scoring. *Critical Care Medicine*, 33(9), 1988–1993.
16. Imrie, C., Buist, L., & Shearer, M. (1998). Importance of cause in the outcome of pancreatic pseudocysts. *American Journal of Surgery*, 156, 159–162.
17. D'Edigio, A., & Schein, M. (1991). Pancreatic pseudocysts: Proposed classification and its management implications. *British Journal of Surgery*, 78, 981–984.
18. Nealon, W. H., & Walser, E. (2003). Duct drainage alone is sufficient in the operative management of pancreatic pseudocysts in patients with chronic pancreatitis. *Annals of Surgery*, 237, 614–622.
19. Tann, M., Maglinte, D., Howard, T. J., Sherman, S., Fogel, E., Madura, J. A., et al. (2003). Disconnected duct syndrome (DPDS): Imaging findings and therapeutic implications in twenty-six surgically corrected patients. *Journal of the Centre for Advanced Television Studies*, 27, 577–582.
20. Heider, R., Meyer, A., & Berhns, K. (1999). Percutaneous drainage of pancreatic pseudocysts is associated with a higher failure rate than surgical treatment in unselected patients. *Annals of Surgery*, 229, 782–789.
21. Neoptolemos, J. P., London, N. H., & Carr-Locke, D. L. (1993). Assessment of main pancreatic Duct integrity by endoscopic retrograde pancreatography in patients with acute pancreatitis. *British Journal of Surgery*, 80, 94–99.
22. Oria, A., Ocampo, C., Zandalazini, H., Chiappetta, L., & Moran, C. (2000). Internal drainage of giant acute pseudocysts: The role of video-assisted pancreatic necrosectomy. *Archives of Surgery*, 135, 136–139.
23. Baron, T. H., Thaggard, W. C., Morgan, D. E., & Stanley, R. J. (1996). Endoscopic therapy for organized pancreatic necrosis. *Gastroenterology*, 111, 755–764.
24. Feig, W. C., Pomeranz, R. A., Vogelzang, R., Rege, R. V., Nahrwold, D. L., & Joehl, R. I. (1992). Treatment of peripancreatic fluid collections in patients with complicated acute pancreatitis. *Surgery, Gynecology and Obstetrics*, 175, 429–436.
25. Criado, E., De Stefano, A., Weiner, T., & Jaques, P. (1992). Long term results of percutaneous catheter drainage of pancreatic pseudocysts. *Surgery, Gynecology & Obstetrics*, 175, 293–298.
26. Howard, T. J., Rhodes, G. F., Selzer, D. J., Sherman, S., Fogel, E., & Lehman, G. A. (2001). Roux-en-Y internal drainage is the best surgical option to treat patients with the disconnected duct syndrome following severe acute pancreatitis. *Surgery*, 130, 714–721.
27. Stanley, J. H., Gobien, R. P., Schabel, S. I., Andriole, J. G., Anderson, M. C., & Smith, R. W. (1988). Percutaneous drainage of pancreatic and peripancreatic fluid collections. *Cardiovascular & Interventional Radiology*, 11(1), 21–25.