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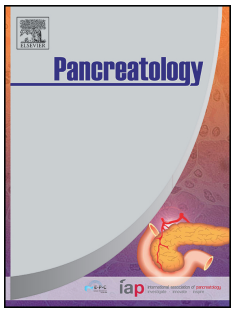

Predictors of outcome of percutaneous catheter drainage in patients with acute pancreatitis having acute fluid collection and development of a predictive model

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Title: Predictors of outcome of percutaneous catheter drainage in patients with acute pancreatitis having acute fluid collection and development of a predictive model

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Conflict of interest:

The authors declare that they have no conflict of interest.

Contributions

BLB: Acquisition and analysis of data and initial draft of the manuscript, Approval for final version

JS: Initial draft of the manuscript, interpretation of data and approval of final version

PG: Initial draft of the manuscript, interpretation of data and approval of final version

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Abstract:

Background

Percutaneous catheter drainage (PCD) is effective initial strategy in the step-up approach of management of acute pancreatitis (AP). The objective of this study was to identify factors associated with outcomes after PCD and develop a predictive model.

Method and materials

In a prospective observational study between July 2016 and Nov 2017, 101 consecutive AP patients were treated using a “step-up approach” in which PCD was used as the first step. We evaluated the association between success of PCD (survival without necrosectomy) and baseline parameters viz. etiology, demography, severity scores, C-reactive protein(CRP), and intra-abdominal pressure (IAP), morphologic characteristics on computed tomography(CT) [percentage of necrosis , CT severity index (CTSI), characteristics of collection prior to PCD (volume, site and solid component of the collection), PCD parameters (initial size, maximum size, number and duration of drainage) and factors after PCD insertion (fall in IAP, reduction in volume of collection).

Results

Among 101 patients, 51 required PCD. The success rate of PCD was 66.66 % (34/51). Four patients required additional surgical necrosectomy after PCD. Overall mortality was 29.4 % (15/51). Multivariate analysis showed percentage of volume reduction of fluid collection (p=0.016) and organ failure (OF) resolution (p=0.023) after one week of PCD to be independent predictors of success of PCD. A predictive model based on these two factors resulted in area under curve (AUROC) of 0.915. Nomogram was developed with these two factors to predict the probability of success of PCD.

Conclusion:

Organ failure resolution and reduction in volume of collection after one week of PCD are significant predictors of successful PCD outcomes in patients with fluid collection following AP

Introduction

Till late 1990's primary necrosectomy was considered the gold standard for the treatment of acute necrotising pancreatitis. However various studies demonstrated high morbidity and mortality rates with such an aggressive treatment.[1-3] The use of percutaneous catheter drainage (PCD) in patients with pancreatitis was first popularized by Freeny et al in 1998.[4] They demonstrated 47 % necrosectomy free survival rate in patients undergoing PCD. Subsequently, multiple other studies have reported encouraging results with the use of PCD.[5-9] In the landmark PANTER trial, Van Santvoort et. al. compared primary necrosectomy to a more conservative “step-up approach” in patients with infected necrotising pancreatitis.[10] The first step in the “step-up approach” was the use of catheter drainage (percutaneous or endoscopic), followed by videoscopic assisted retroperitoneal debridement (VARD) and if required open necrosectomy. This trial showed better survival with the step-up approach than with open necrosectomy. Two recent meta-analyses have reported success rates of 64%[11] and 55.7%[12] respectively with use of PCD alone. PCDs has, therefore, become the initial modality for treatment of infected pancreatic necrosis and helps avoid necrosectomy in a significant proportion of patients.

Although several studies have shown benefit of PCD, only a few studies have looked at the factors predicting success of PCD. Amongst the factors which have been studied in the literature to predict negative outcome with PCD are multiorgan failure (MOF),[13] amount of pancreatic necrosis, heterogeneous nature of fluid collection, higher CT severity index(CTSI), multiple infected collection[14] and higher mean CT density of necrotic fluid collection[15]. Most of these studies are retrospective in design and have not

incorporated certain important factors such as intraabdominal pressure (IAP), amount of solid component in the collection, size of the drainage catheter and number of drainage catheters placed. Hence this prospective study was planned to a) analyse the predictors of outcome of PCD in patients with AP who were managed with “step-up approach” and b) develop a predictive model based on these.

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Material and Methods

Study protocol

This was a prospective observational study conducted at a tertiary care center in North India between July 2016 and Nov 2017. All patients more than 18 years of age with AP admitted to the medical or surgical gastroenterology divisions (Dr VG), were considered for inclusion. We excluded patients with prior PCD at the time of admission and patients who had undergone any prior endoscopic/ radiological/ surgical intervention for AP, pregnant females, patients with known chronic pancreatitis and those who did not provide a written informed consent. The study was approved by Institute's ethics board (INT/IEC/2016/2496) and we followed the guidelines of Indian Council Medical Research[16] & Helsinki Declaration for conducting a human study. Written informed consent was taken from all patients prior to enrollment in this study.

Patient Management (Fig 1)

AP was diagnosed as per the revised Atlanta classification and the severity was also stratified using these criteria.[17] All patients underwent detailed clinical assessment which included general physical examination, assessment of vital parameters, and were monitored for development of local complications, organ failure and sepsis. Severity of the pancreatitis at presentation was assessed by acute physiology and chronic health evaluation (APACHE II), bedside index for severity (BISAP) and systemic inflammatory response syndrome (SIRS) scores. Organ failure assessment was done according modified Marshall scoring system for organ failure.[18] All patients received analgesics, intravenous fluid resuscitation and organ support as per requirement. In case of

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suspected infection (worsening clinical course and/or presence of air within the necrosis seen on CECT) and/or positive drain culture or extra pancreatic infection, antibiotics were administered. Contrast enhanced computed tomography(CECT) was done between day five and day seven after the onset of pain to see extent of necrosis and grade and to measure CT severity index (CTSI).[19] Volume and solid component in the fluid collection(s) was estimated by transabdominal ultrasonography (USG) prior to drainage. Solid component of the fluid collection was estimated by a trained radiologist and patients classified as having less than and more than 30% solid component in the whole collection. The volume of the collection was calculated using the ellipsoid formula ($\pi/6*L*B*H$).[20]

Management of acute fluid collections

As part of step-up approach, PCD was inserted by a trained interventional radiologist (having > 5 years' experience in abdominal intervention) under image guidance (USG or CT). Choice of imaging guidance, the site and route were chosen by the radiologist in accordance with the site of collection, extent and amount of necrosis. The indications of PCD were sepsis, suspected or proven infection, persistent organ failure, symptoms due compression of adjacent organs (gastric, biliary, or uncontrolled pain), increase in size or number of collection(s) after initial conservative management. Initial size of catheter used for the drainage was 12-14 Fr and the fluid/ material obtained was sent for microbiological analysis including cultures. Intraabdominal pressure, CRP levels, volume of collection and solid component in the collection on imaging were noted before PCD. After PCD insertion, drain was kept in the dependent position for gravity drainage. In addition, PCD catheter was flushed with 50 ml saline to maintain the patency two to three times a day

using sterile precautions.[21] Extra saline was used to flush the PCD catheter depending upon the size of collection and a drain chart was maintained. IAP was measured every 6 hourly for 48 hours after PCD and there-after once daily for 7 days and periodic assessment with complete blood count. Patients who had sterile collection before PCD and subsequently developed infection were on intravenous antibiotics during the procedure and after the procedure. Such patients were continued on antibiotics till the clinical condition warranted.

Patients were monitored in high dependency areas or ICU. Patients with worsening of organ failure or sepsis, or inadequate drainage were evaluated by ultrasonography for upgradation of PCD catheter (up to 24 Fr) or additional PCD placement 48-72 hours after the first PCD. Volume of collection was assessed by CECT abdomen or ultrasound after one week. Patients who were not improving with above treatment were considered for percutaneous endoscopic necrosectomy or surgical necrosectomy depending on clinical indication. Patients were discharged once they improved and followed up every 2 to 4 weeks for three months.

Complications

Complications of PCD like pain at the insertion site, blockade, and slippage or bleeding through the PCD were noted. International Study Group of Post-operative Pancreatic Fistulae[22] definition was used for external pancreatic fistulae (EPF). Patients with EPF were managed conservatively for 1 to 2 weeks and if EPF persisted, then patients underwent endoscopic retrograde cholangiopancreatography and pancreatic duct stenting. Other complications were managed accordingly.

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Outcome of PCD

We defined success of PCD as patients who survived without surgical necrosectomy[13] and divided the patients into PCD “success” and “failure” groups. The parameters which were compared between the two groups included demographic criteria(age, gender, and etiology), disease severity criteria (CRP levels, organ failure, BISAP scores, and APACHE II scores), characteristics of the collection (volume, number, location and amount of solid component), CT characteristics (amount of necrosis and CTSI) and PCD parameters (timing, size of the initial catheter, maximum size, total number of catheters in individual patient, and total duration of drainage) and parameters following insertion of PCD (fall in IAP, reduction in the volume of collection).

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Statistical analysis

Statistical analysis was performed using Statistical Product and Service Solutions version 23.0 (Chicago IL) and R software version 3.4.4. The additional packages which were used in R include rms, BootValidation, rmda, boot, DynNom, shiny and plyr.[23-31] Kolmogorov Smirnov test was used to check the normality of continuous variables. Mean and standard deviation was calculated for normally distributed variables, otherwise median and IQR were calculated. Categorical variables are presented in frequency and percentages. Independent t test was applied to compare means of normally distributed variable between the two groups (PCD success and failure groups). For skewed variables Mann Whitney U test was applied to compare the medians. For categorical variables Chi square test/ Fisher exact test was applied (as applicable).

To find out independent predictors for PCD success and failure, univariate analysis was performed. Significant variables in the univariate analysis were then taken for construction of binary logistic regression model. Results are presented as odds ratios (OR) with 95% confidence intervals (CI). A 2-tailed $P < 0.05$ was considered statistically significant. For internal validation of the obtained model, bootstrapping was done using 5000 resamples and a plot of the apparent & bias corrected curve was obtained. Area under the Receiver Operator Curve (AUROC) was performed to assess the predictive prowess of the model by taking the entire data. A nomogram was then constructed with the developed model using the rms package of R.[23] R shiny and DynNom package was

used for the development of the interactive nomogram for the developed model.[27,28]

Results

Patients and clinical outcomes

Among the enrolled 101 patients, 51 patients who underwent PCD as a primary intervention were included for analysis. The baseline parameters are represented in Table 1.

PCD parameters

A total of 87 PCDs were inserted with an mean of 1.70±0.80 PCDs per patient. Other PCD parameters (i.e. number of PCDs , maximum size of first and subsequent PCDs, total cumulative size of all PCD and duration of drainage of PCD) were comparable between the groups. The most common indication for the initial PCD was suspected/proven infection associated with organ failure in 32 (62.74 %) patients followed by suspected or proven infection in 11(21.56 %), and organ failure 5 (9.80 %). The rest had multiple indications. Out of 51 patients, 34 (66.66%) had a sterile collection, and 17 (33.33%) had an infected collection. Catheter size upgradation was required in 19 (37.2%) patients. Four patients underwent surgery and a total of 15 deaths occurred including two patients who died after surgery. A two-way repeated measure ANOVA performed for assessing change in IAP following PCD between the time points (0, 6, 12, 24 and 48 hours) with the outcome of the PCD (success or failure) was statistically not significant (p=0.730)(supplementry figure 1). Overall mortality was 29.4 %(n=15/51) and among these, 2 patients died in sterile group.

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Complications

Of the 34 patients who had sterile cultures of the initial aspirate, 16 (47.05%) patients showed a subsequent growth of organisms(s). External pancreatic fistulae (n=4), gastrointestinal fistulae (duodenal) (n=2), and minor bleed from the drain (n=1) were the other complications. Patients with EPF were considered for ERCP plus stenting. Transmural plastic stents were placed endoscopically for spontaneous duodenal fistulas and minor bleeds were managed conservatively.

Predictors of PCD success

Amongst 51 patients who underwent PCD, 34 (66.66%) patients had a successful PCD and 17 (33.33) patients had failed PCD. On univariate analysis, 5 predictors of PCD success were found and are presented in table 2. Other parametrs (i.e. APACHE II scores, CRP before PCD ,hospital stay, and sterile vs infected collection) were comparable between the groups. Age and gender were added as predictors to multivariate analysis due to their clinical importance, though both did not show significance in univariate analysis. Though ICU stay showed significance in the univariate analysis it was not included in the multivariate analysis due to lack of relevance as a predictive factor. On multivariate analysis, percentage reduction in the volume of collection after PCD (p=0.016) and organ failure resolution after PCD (p=0.023) were found to be significantly different between the two groups (table 3). Final logistic regression model was developed including volume of collection after PCD and organ failure resolution after PCD (supplementry table 1). The AUROC of the model was 0.915 (Fig 2) and the developed model was validated internally by bootstrapping with 5000 re-samples and the validated AUC after bootstrap was 0.906 (Fig 3). The optimism of

bootstrap was 0.009 which shows that the AUC after bootstrapping of the model was almost similar to the AUC of the originally developed model. This demonstrates the model is not over fitted and is well predictive of the sample. A nomogram was developed for the constructed model(Fig 4). A R shiny webserver containing the interactive nomogram of the developed model could be accessed at the following URL – https://gastropgiblbrk.shinyapps.io/PCDSuccess/

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Discussion

"Step-up approach" is now the preferred method of managing infected pancreatic necrosis and acute fluid collections. As an initial step, percutaneous or endoscopic drainage is done followed by VARD/ endoscopic necrosectomy. Surgical necrosectomy is reserved for cases with lack of improvement. Minimally invasive approaches have been shown to elicit a lesser inflammatory response when compared to surgical necrosectomy.[32] A recent randomized controlled study of endoscopic (EUS guided drainage followed by endoscopic necrosectomy) vs surgical (PCD followed by VARD) step up approach showed no difference in outcomes of infected pancreatic necrosis.[33] PCD is considered to be the initial step in management of collection at our centre. In a previous study we had a success rate around 60% in patients undergoing PCD.[34] Further, the placement of PCD is associated with reduction in levels of CRP and IL-6.[35] PCD helps in removal of the pancreatic collection/necrosis and infected debris thereby controlling the inflammatory cascade and also decreasing IAP. This results in decreasing serum inflammatory markers [36] which may postpone or even obviate need for surgical necrosectomy. [6,21,37]

Success of PCD has been defined variably by different authors. Definitions used by

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different authors include survival without the need of surgical necrosectomy[13], drainage of collection without need for surgery[38], improvement after initial PCD without need for necrosectomy , major complication or death [39] and clinical deterioration in spite of PCD[40]. In our study, we defined success of PCD as survival without need for surgical necrosectomy.[13]

Prediction of success or failure of PCD based approach is of importance so as to identify the subset of patients who require an aggressive approach at the outset. Further, identification of any modifiable factors (like the size or number of PCD) could help in improving the outcomes in these patients. This prospective study has identified the percentage volume reduction of fluid collection(s) following PCD and resolution of organ failure after PCD as predictors of PCD success. Interestingly the PCD related factors like size, number, and maximum size achieved did not seem to impact the outcomes in our patients. Also, the nature of collection (solid or liquid component and sterile or infected nature) or the site of collection did not affect the outcomes.

Measurement of IAP has gained increasing attention in the management and assessment of AP. However changes in IAP after PCD insertion did not seem to impact the outcomes. The findings of our study broadly suggest that neither the nature of collection nor the PCD related parameters affect the outcomes. This could be a consequence of the aggressive management wherein the patients were reassessed at third day for upsizing of the catheters and catheter size upgradation or second drain inserted. This may have rendered the initial catheter size and nature of collection meaningless as far as the final outcomes were concerned. However, our study does suggest the need for a dynamic assessment of patients who have undergone PCD for

resolution of organ failure and reduction in size of collection so as to identify those who will have a successful outcome.

Different studies have looked into factors which might predict the outcome of PCD. In a couple of studies, CT mean density/ heterogeneity of the collection was reported as a predictor of outcome.[13-15]Guo et al reported that lower mean CT density of the necrotic fluid collection predicted improvement.[15]Holleman et al and Li et al found that heterogeneous collection on CT scan was a predictor of PCD failure.[13,14] We evaluated the solid component in fluid collection before PCD using ultrasonography. However we did not find any impact of amount of solid component on the PCD outcome. The reason for these findings could be related to the choice of imaging modality i.e. ultrasound rather than CT to quantify solid debris. Ultrasound is a better modality to determine the solid contents in a pancreatic collection whereas CT may identify only those collections which have extensive solid component.[41] Some studies also found other CT parameters like the percentage of necrosis, CTSI and multiple collections as predictors of PCD outcome[13,14,40]. However we did not find any significance for these parameters.

It is apparent from our study as also from other previous reports that organ failure is the driver of outcomes in patients with necrotising pancreatitis. Presence of MOF, as noted previously[13,40], seemed to predict worse outcomes in univariate analysis. However, resolution of organ failure after PCD was a strong predictor of PCD success [31(91.2%) vs 6(35.3 %), P=0.018)]. Some studies have reported that the size of collection did not affect the success of PCD drainage[39,40]; While our findings also support the contention that initial size of the collection does not predict the outcomes, however the percentage volume reduction after PCD emerged as a predictor of PCD success. Cao et al[40] reported

that reduction in volume of collection > 50 % was a predictor of PCD success and Liu et al[39] noted that volume reduction in successful group was 85.6% vs 21.8% in failure group(p=0.001). We calculated the volume reduction at the end of 7 days after initial PCD insertion, which Cao et al noted volume reduction at 3rd day and Liu et al noted the collection at the end of 20 days. The reduction in size of the pancreatic collections is helpful in improving the outcomes by reduction in abdominal pressure, improvement in infection,[21] and reducing the inflammatory response by decreasing interleukins/cytokines levels [35,39]

Finally, we constructed a prognostic nomogram with the percentage of volume reduction and organ failure resolution after PCD which were significant on multivariate analysis to detect the probability of successful PCD. We also designed a web page where the prediction could be done based on the model predictors. This would be helpful for external validation of the model by clinicians and researchers.

The limitations of our study include recruitment of patients from a single centre and a relatively smaller number of subjects. However, the study has important strengths which include a protocolised management of the pancreatic fluid collections, and evaluation of multiple parameters which could have affected success of the PCD including those related to the nature of collections and the PCD related factors.

To conclude, organ failure resolution and reduction in volume of collection after one week of PCD are significant predictors of successful PCD in patients with pancreatic fluid collection. Multi centric studies with larger sample size are required to validate this study.

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Legends for figures:

Figure 2: Receiver operating characteristic curve of multivariable regression model for predicting PCD success in necrotizing pancreatitis and area under curve is 0.915. Predictors are volume reduction and organ failure resolution after PCD

Figure 3: Predictors of PCD success were volume reduction and organ failure resolution after PCD. Further internally validated by bootstrapping of 5000 resamples. The idle cure and bias corrected curve was close to each other.

Figure 4: Nomogram for predictor of PCD success in managing fluid collection in patients with necrotizing pancreatitis. Total points line indicates total points obtained from predictors and which is synchronized with probability of PCD success line which indicate probability of PCD success. PCD, percutaneous catheter drainage

Supplementary figure 1:

Intra-abdominal pressure (IAP) over time trend in success and failed PCD group, PCD, percutaneous catheter drainage

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Table 2: Comparison between successful and failed PCD groups

		Success group (n=34)	Failure group (n=17)	P value
Onset of symptom to admission to hospital (days) (median, IQR)		9.0(14.8)	20 (19.0)	0.280
Age (years)(mean±SD)		37.52±12.74	38.11±10.68	0.87
Gender (males)		27(58.8%)	10(79.4%)	0.112[&]
Etilogy of pancreatitis	Alcohol	17(50)	8(47.1%)	0.37[&]
	GSD	10(29.4%)	8(47.1%)	
	Both GSD and alcohol	3(8.8%)	1(5.9%)	
	others	4(11.8%)	0	
APACHE II score (median, IQR)		8 (4.3)	8(3.5)	0.349
CRP before PCD(mg/L) (median, IQR)		327(968)	141(443)	0.646
Hospital stay(days) (mean±SD)		30.94±12.23	35.41±18.56	0.377
ICU stay (days) (median, IQR)		3.5(10)	12(20)	**0.042***
MOF before PCD		1(2.9%)	4(23.5%)	**0.037***[&]
CTSI (median, IQR)		8(4)	8(3)	0.726
Amount of pancreatic necrosis	<30%	11(32.4%)	3(17.6%)	0.67[&]
	30-50%	7(20.6%)	5(29.4%)	
	>50%	15(44.1%)	8(47.1%)	
Site of collection	Peripancreatic	18(52.9%)	6(35.3%)	0.21[&]
	Extended peripancreatic	0	1(5.9%)	
	Both	16(47.1%)	10(58.8)	
Gross volume of collection Before PCD (ml) (median, IQR)		380(547)	517(483)	0.11
Solid component before PCD	>30%	14(41.2%)	8(47.1%)	0.458[&]
Volume of collection before PCD	≤750 ml	27	9	0.05[&]
OF resolution after PCD		31(91.2%)	6(35.3%)	**0.000***[&]
Percentage of volume reduction after PCD(mean±SD)		74.35±21.35	44.49 ±31.02	**0.002***
PCD parameters				
Number of PCD(median, IQR)		1.5(1)	2.0(2.0)	0.189
day of first PCD(days)		19.5(19.8)	20(17)	0.992
First PCD size(Fr) (median, IQR)		14(4)	12(1)	**0.028***
Maximum size of first PCD catheter (median, IQR)		14(4)	14(4)	0.534
Drainage duration of first PCD(days) (median, IQR)		46(38.3)	38(33.5)	0.07
Total cumulative size of all PCD (Fr)		23.47±9.67	26.11±16.40	0.672

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(mean±SD)			

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Table 1: Baseline data of 51 patients included in the study

Parameter	Results

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$: median and IQR, SIRS: systemic inflammatory response syndrome, APACHE II: acute physiology and chronic health evaluation, CRP: C-reactive protein, CTSI: CT severity index, IAP: intra-abdominal pressure, n: number of patients, PCD: percutaneous catheter drainage, EPF: external pancreatic fistulae, GI: gastrointestinal

Age (years)	37.72 ± 11.98
Males (%)	37 (72.5%)
Etiology of pancreatitis Alcohol Gall stone disease Alcohol+ gall stone disease Others	 25(49%) 18(35.3) 4(7.8%) 4(7.8%)
Severity parameters SIRS APACHE II score APACHE II score > 8 CRP levels	 3.45±0.67 8(4)$^{\$}$ 37.3 % 246(771)$^{\$}$
CT parameters *CTSI score* *Site of collection* Peripancreatic Distant peripancreatic Peripancreatic + distant *Site of necrosis* Pancreatic Extra pancreatic Pancreatic+ extra-pancreatic	 8.23±1.87 24(47.1%) 1(2%) 26(51%) 2(3.9%) 1(2%) 48(94.1%)
Volume of collection before PCD (ml)	405(515)$^{\$}$
Solid component in collection before PCD	34.40±20.22
IAP before PCD (mm Hg)	16.70±5.01
PCD parameters	
Number of PCD(s) One Two Three or more	 24(47.1 %) 20(39.2%) 7(13.7%)
Interval between onset of pain and first PCD (days)(median, IQR)	20(18)
First PCD size (Fr)	13.49±2.22
Upgradation of first PCD	12(23.5%)
Maximum size of first PCD (Fr)	14.58± 2.69
Cumulative size of all PCD (Fr)(median, IQR)	24 (16)
Total duration of PCD (days)(median, IQR)	46(36)
Indications for PCD (n) Suspected/proven infection & organ failure Suspected/proven infection Organ failure	 32 (62.74%) 11 (21.56%) 5 (9.80%)
Complications of PCD(n) EPF GI fistulae Minor Bleed	 4 2 1

Table 2: Comparison between successful and failed PCD groups

		Success group (n=34)	**Failure group (n=17)**	**P value**
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Gender (males)		27(58.8%)	10(79.4%)	0.112$^{\&}$
Etiology of pancreatitis	Alcohol	17(50)	8(47.1%)	0.37$^{\&}$
	GSD	10(29.4%)	8(47.1%)	
	Both GSD and	3(8.8%)	1(5.9%)	

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	alcohol			
	others	4(11.8%)	0	
APACHE II score (median, IQR)		8 (4.3)	8(3.5)	0.349
CRP before PCD(mg/L) (median, IQR)		327(968)	141(443)	0.646
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Solid component before PCD	>30%	14(41.2%)	8(47.1%)	0.458&
Volume of collection before PCD	≤750 ml	27	9	0.05&
OF resolution after PCD		31(91.2%)	6(35.3%)	**0.000*&**
Percentage of volume reduction after PCD(mean±SD)		74.35±21.35	44.49 ±31.02	**0.002***
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Drainage duration of first PCD(days) (median, IQR)		46(38.3)	38(33.5)	0.07
Total cumulative size of all PCD (Fr) (mean±SD)		23.47±9.67	26.11±16.40	0.672

*: significant value, &: Chi square test/Fishers exact test, GSD: gall stone disease, APACHE II: acute physiology and chronic health evaluation, CRP: C-reactive protein, CTSI: CT severity index, OF: organ failure, MOF: multiorgan failure, ALI: acute lung injury, CVSF: cardiovascular failure.

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Table 3: Multivariate analysis for prediction of PCD

	Beta co-efficient	**P value**	**OR**	**95% CI of OR**
Age	-0.033	0.435	0.967	0.890-1.051
Gender	1.046	0.387	2.84	0.26-30.48
Multiorgan failure before PCD	0.363	0.818	1.43	0.066-31.44
Organ failure resolution after PCD	-3.788	**0.023**	0.023	0.001-0.589
Percentage of volume reduction of collection after PCD	0.050	**0.016**	1.05	1.009-1.094
Total volume of collection before PCD (750 ml cutoff)	0.039	0.976	1.040	0.082-13.15
First PCD size	0.576	0.133	1.77	0.840-3.76

PCD: percutaneous catheter drainage

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Supplementary table 1: Final logistic regression model

	Beta co-efficient	**P value**	**OR**	**95% CI of OR**
Intercept	-4.833	0.003	0.008	
Organ failure resolution after PCD (Yes)	3.339	0.001	28.20	3.90-203.87
Percentage of volume reduction of collection after PCD	0.053	0.005	1.055	1.06-1.095

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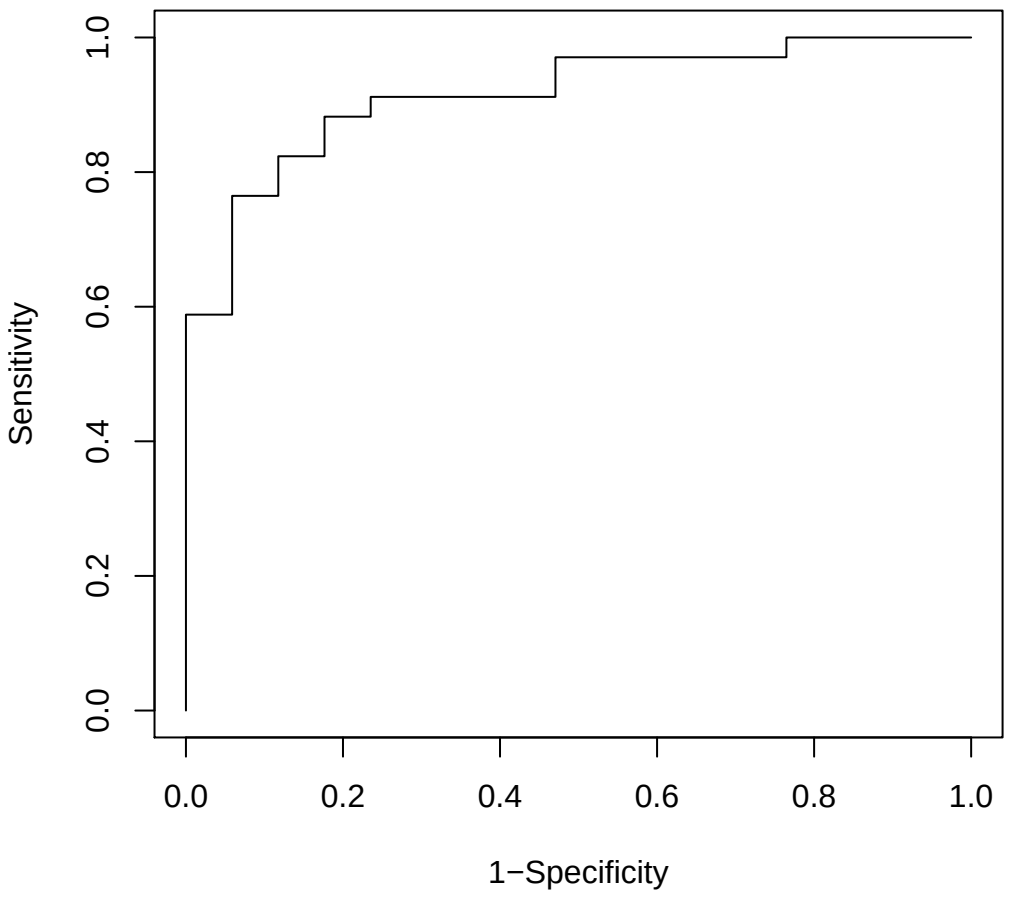

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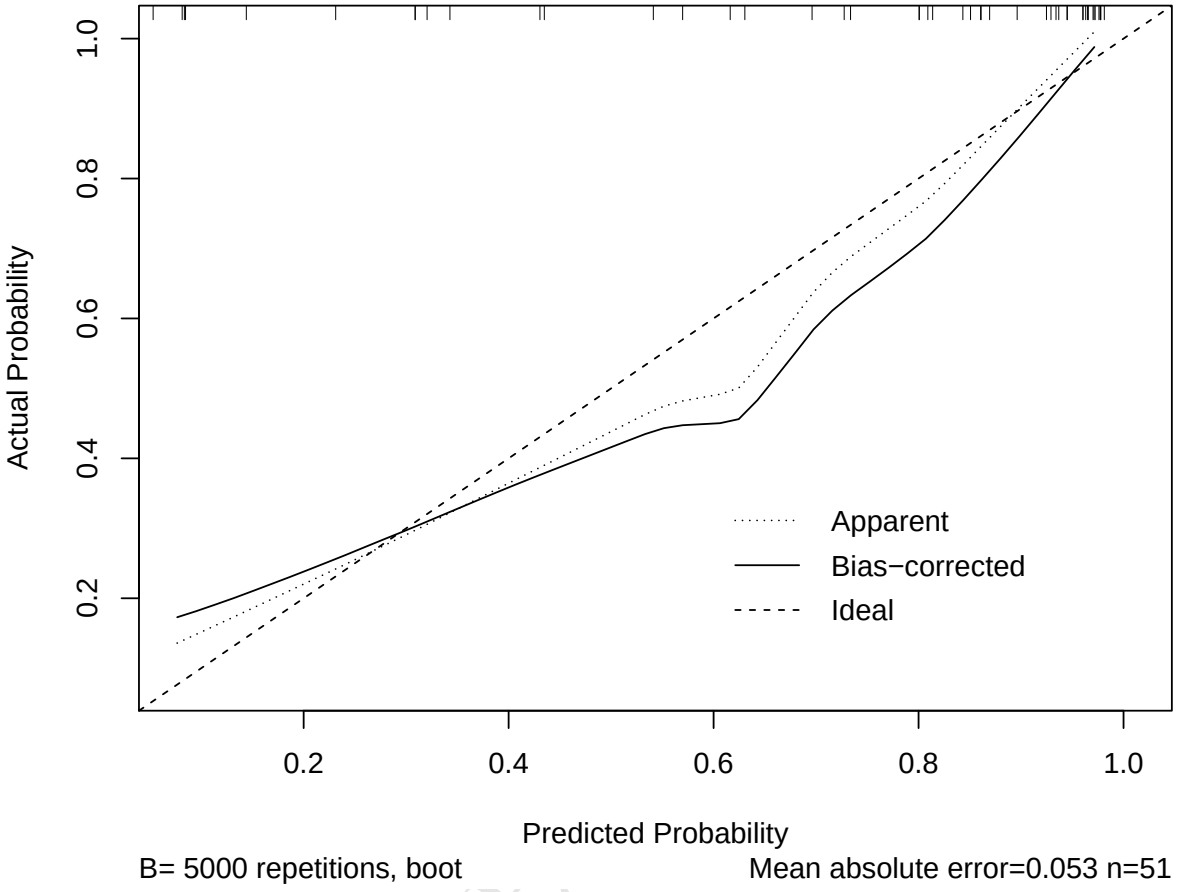

B= 5000 repetitions, boot Mean absolute error=0.053 n=51

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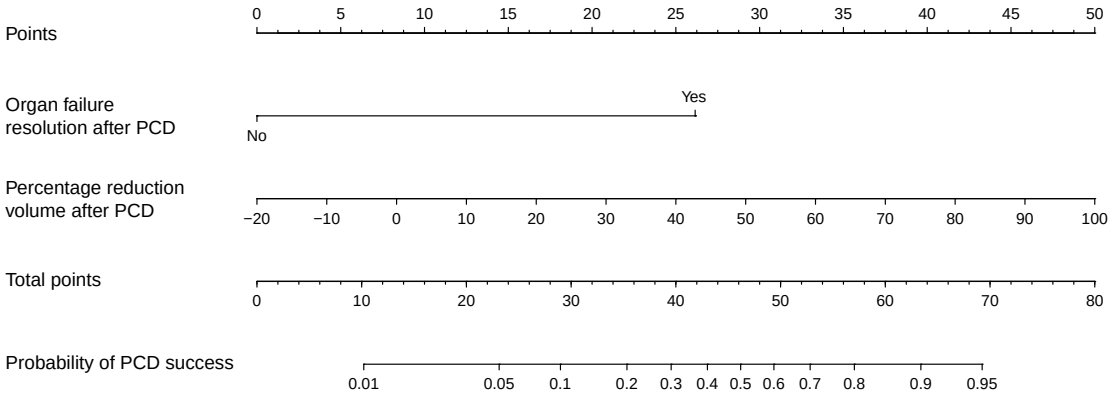

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Figure 1: Flow chart of the study

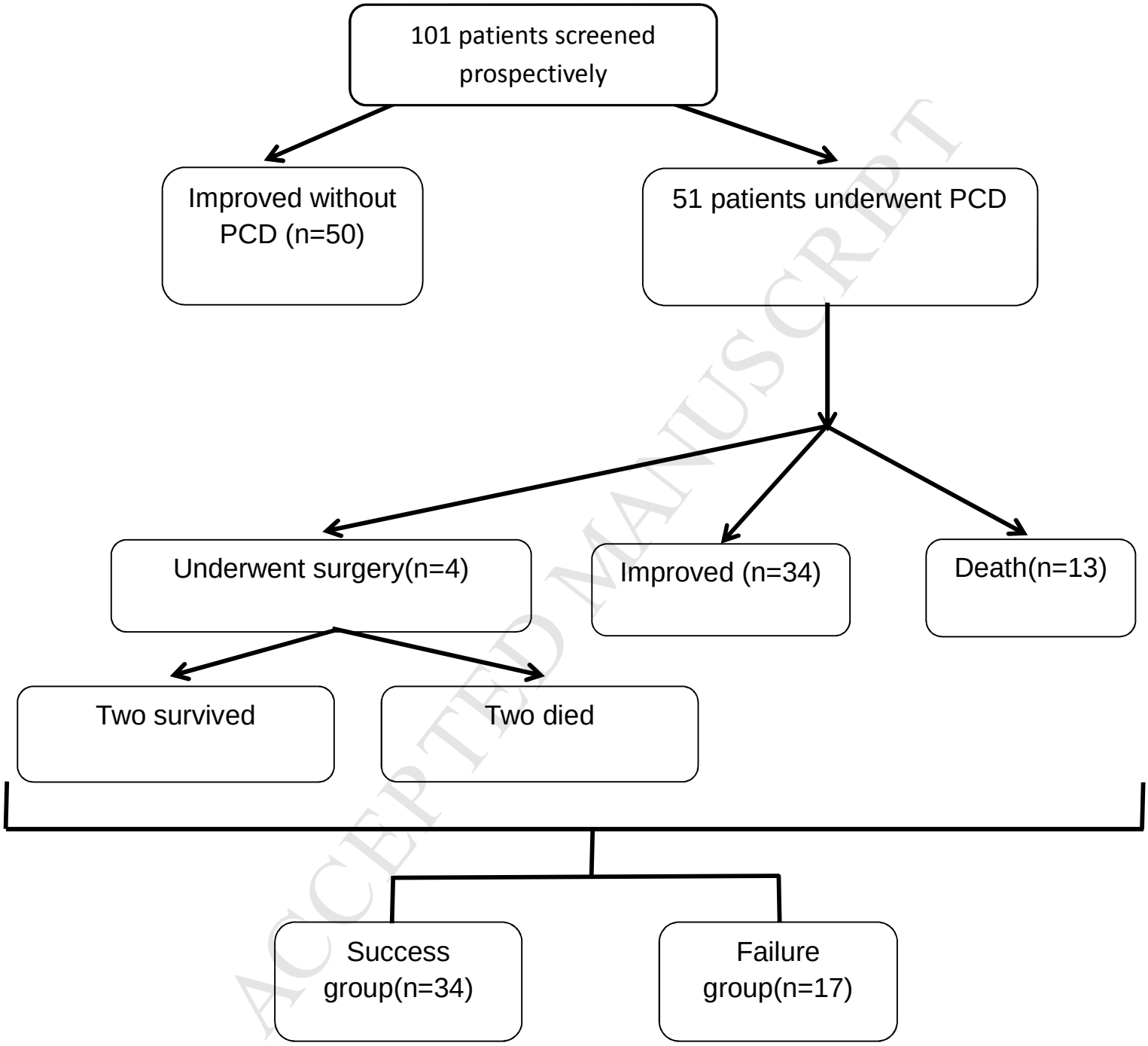

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Figure 2: Receiver operating characteristic curve of multivariable regression model for predicting PCD success in necrotizing pancreatitis and area under curve is 0.915. Predictors are volume reduction and organ failure resolution after PCD

Figure 3: Predictors of PCD success were volume reduction and organ failure resolution after PCD. Further internally validated by bootstrapping of 5000 resamples. The idle cure and bias corrected curve was close to each other.

Figure 4: Nomogram for predictor of PCD success in managing fluid collection in patients with necrotizing pancreatitis. Total points line indicates total points obtained from predictors and which is synchronized with probability of PCD success line which indicate probability of PCD success. PCD, percutaneous catheter drainage

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