Validity and accuracy of scoring systems POMP (predictive score of mortality in perforated peptic ulcer), PULP (peptic ulcer perforation), Boey Score and ASA to predict mortality in peptic ulcer perforation in Egyptian population

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Abstract

Background: Peptic ulcer disease (PUD) remains a common outpatient diagnosis. With the advent of proton pump inhibitors, improved hygienic conditions, and developing healthcare regimes, the prevalence of PUD has been decreased. However, the incidence of emergency surgery and the mortality associated with PUD has not decreased nearly so dramatically. Perforated peptic ulcer (PPU) represents the most frequent indication for emergency surgery for PUD. Accurate and early identification of high-risk surgical patients with perforated peptic ulcer (PPU) is important for triage and risk stratification. Therefore scoring systems have been developed to be used for prediction including (Boey, PULP, ASA, POMPP and MPI).

Aim: evaluating the validity and accuracy of scoring systems in predicting the morbidity and mortality associated with perforated peptic ulcers in correlation with the initial presentation of the patients.

Methods: This Prospective observational study has been carried on 148 patients admitted for peptic ulcer perforation at emergency department of general surgery from start of October 2020 to the end of February 2022 at kasr Alainy emergency hospital. Four scoring systems were applied on each patient preoperatively and follow up for 30 days postoperatively detecting mortality and morbidities. Comparative analysis of different score was done.

Results: Post-operative morbidity was 28 % and mortality rate was 12%. POMPP shows 78 % sensitivity and 100% specificity at cut off point >1, PULP shows 100% sensitivity and 87% specificity at cut off point >3, Boey shows 100% sensitivity and 80% specificity at cut off point >1 and ASA shows 67% sensitivity and 94% specificity at cut off point >2.

Receiver operating characteristic curve analysis showed that area under curve was 0. 99 for POMPP, 0.968 for PULP (but it is complex with more number of components), 0.936 for Boey and 0.822 for ASA.

Conclusion: POMPP score is based on objective data and its components are age and routinely measured values (BUN and serum albumin). It is simple and easily applicable scoring system for predicting mortality in PPU.

Keywords: Perforated Peptic Ulcer, risk stratification, 30 days mortality, POMPP, PULP, Boey, ASA

Introduction

Peptic ulcer disease (PUD) remains a common outpatient diagnosis. With the advent of proton pump inhibitors, improved hygienic conditions, and developing healthcare regimes, the prevalence of PUD has been decreased. However, the incidence of emergency surgery and the mortality associated with PUD has not decreased nearly so dramatically. Perforated peptic ulcer (PPU) represents the most frequent indication for emergency surgery for PUD. **(1)**

Complications of PUD include bleeding, perforation, and obstruction. Perforated peptic ulcer (PPU) represents the most frequent indication for emergency surgery for PUD.

Accurate and early identification of high-risk surgical patients with perforated peptic ulcer (PPU) is important for triage and risk stratification. Therefore, scoring systems have been developed to be used for prediction of high risk group including:

- Boey score
- PULP (peptic ulcer perforation) score
- ASA (American society of anesthesiology) score
- POMPP (predictive score of mortality in perforated peptic ulcer) score **(2)**

The Boey scoring system was the first scoring system specifically aimed at predicting mortality associated with PPU ***(3)***. It compromised three components upon which it was built upon:

a. Delay of surgery after onset of symptoms for more than 48 hours,
b. Shock upon admission (defined as BP <100 mmHg), and
c. Degree of comorbidity (defined as cardiorespiratory disease, renal failure, diabetes mellitus and hepatic precoma).

The Danish in 2012 devised the Peptic Ulcer Perforation or simply the PULP score in a large cohort study comprising 2668 patients. It incorporates elements of both the Boey score and ASA system. A detailed overview of this system can be seen in the table below. According to the PULP score a minimum score of 0 and a maximum score of 18 can be achieved. The optimal cut off point of this system was set at 7 points; above which the patient is considered to be high risk with mortality >25% and below that the risk is ≤ 25% **(4)**

The ASA scoring system was first devised in 1941 by three physicians. Their initial plan was to come up with a scoring system that determine predictors for operative risk; however, this was quickly dismissed as impossible and instead they came up with the physical status classification of preoperative patients for anesthetic risk assessment in 1963 ***(5)*.**

In 2015 and with aim of devising a scoring system that was both easy and accurate in depicting the mortality associated with PPU, ***Meneske et al. (6)*** introduced the Practical scoring system of mortality in patients with perforated peptic ulcer (POMPP) scoring system. The POMPP system, like the Boey system, is very simple and consists of only three elements ***(6)***: Age >65yrs, BUN >45mg/dL and Albumin <1.5g/l

We aimed at this study for evaluating the validity and accuracy of scoring systems in predicting the morbidity and mortality associated with perforated peptic ulcers in correlation with the initial presentation of the patients.

Subjects and Methods:

This Prospective observational study has been carried on 148 patients admitted for peptic ulcer perforation at emergency department of general surgery from start of October 2020 to end of February 2022 at kasr Alainy emergency hospital.

Inclusion criteria:

All cases of peptic ulcer perforation admitting in the surgery department were included.

Exclusion criteria:

Traumatic perforation to stomach or duodenum, Perforation due to malignant tumor, Children below age of 16 year old and Pregnant women were excluded from the study.

Four scoring systems were applied on each patient preoperatively and follow up for 30 days postoperatively detecting mortality and morbidities.

After resuscitation, the patient will be operated by exploratory laparotomy and closure of perforation with omental patch after thorough peritoneal lavage with warm normal saline. Intra-abdominal drains were placed. Post-operatively, intravenous antibiotics have been given for 5 days. During post-operative period, morbidity and mortality have been analyzed. Comparative analysis of different score have been done.

Table 1: Four scoring systems of the study

Age > 65 (3)	Normal health (1)	Medical illness(1)	Age > 65(1)
Comorbid active malign disease or AIDS (1)	Mild systemic disease(2)	Preoperative shock(1)	BUN > 45 mg/d (1)
Comorbid liver cirrhosis(2)	Severe systemic disease(3)	Duration of peptic ulcer perforation to surgery > 24 hours (1)	Albumin < 1.5 g/L (1)
Concomitant use of steroids (1)	Severe systemic disease with a constant threat to life (4)		
Preoperative shock (1)	Moribund not expected survival (5)		
Perforation time on admission >24 hours(1)			
Serum creatinine >1.47 mg/dl (2)			
ASA grading : Grade 2 (1) Grade 3(3)Grade 4(5) Grade (7)			

PULP	**ASA**	**Boey**	**POMPP**
High risk > 6	**High risk >3**	**High risk >1**	**High risk >1**
Total score 0-18	**Total score 1-5**	**Total score 0-3**	**Total score 0-3**

Statistical methods:

 Pre coded data was entered on the computer using the statistical package of social science software program, version 23 (SPSS)

 Data will be summarized using:

-Mean and SD for quantitative variables.

- Number and percent for qualitative variable.

 Shapiro test used to check data normality using and data was non normally distributed

 Chi square test used to compare between qualitative variable. Fisher exact test was used when one expected cell or more are less than 5

 Independent t test used to quantitative variables between two groups in normally distributed data while Mann-Whitney tests for quantitative variables which were not normally distributed.

 Spearman's rho test used to find linear relation between variables

 Roc curve analysis conducted using Stata to find the discriminant ability of different scores in relation to complication and mortality

 P value equal to or less than 0.05 was considered of statistically significant.

Results

<u>Demographic data are as following</u>:

A. According to age:

The age of the patients ranged between 20 and 81 year old. With a mean of 42.46 year old and SD 14.85

B. According to hemodynamic status on presentation:

46 out of 148 patients were shocked on presentation

C. According to time from perforation to surgery:

52 out of 148 patients presented delayed more than 24 hours from start of symptoms to surgery

D. According to postoperative morbidity:

42 out of 148 patients developed postoperative complications in the form of burst abdomen (4 cases), leakage (6 cases), pulmonary complications (14 cases) and wound infection (18 cases).

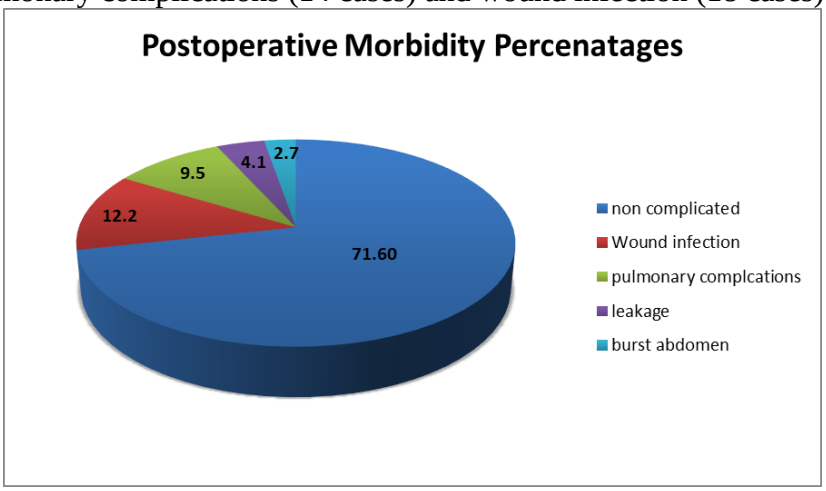

Figure 1: Postoperative Morbidity Percentages

E. According to postoperative mortality:

18 cases out of 148 patients had died with 30 days postoperative.

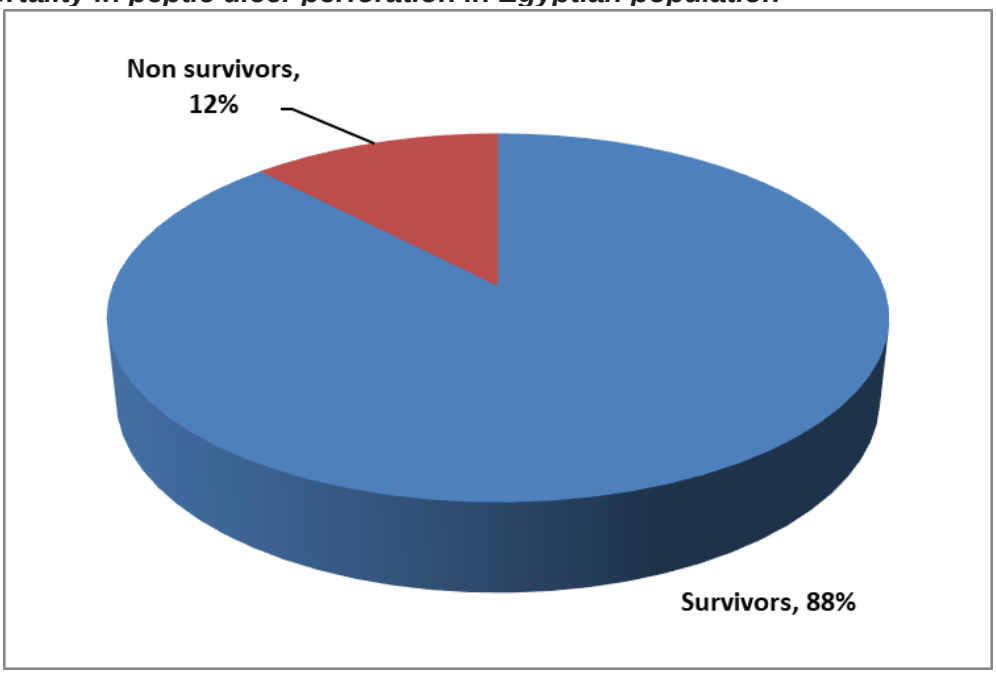

Figure 2 : Percentage of postoperative mortality

F. According to preoperative Comorbidities:

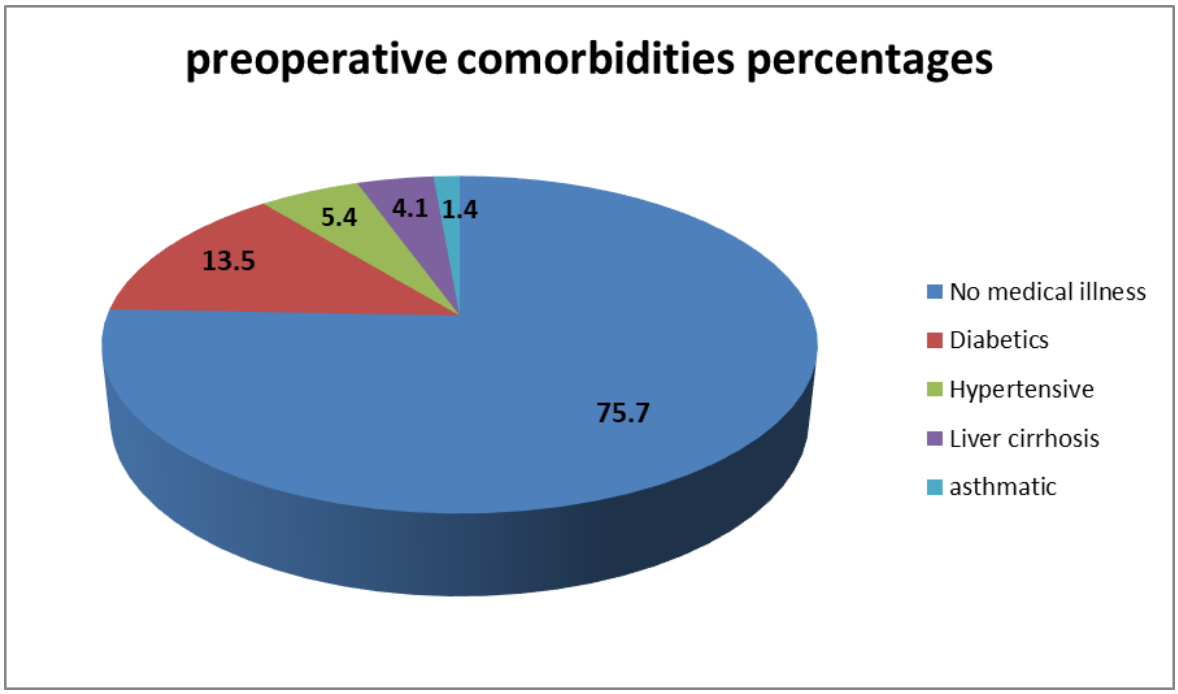

Figure 3: preoperative comorbidities percentages

Table 2: Relation between qualitative variables and postoperative mortality:

	Postoperative Mortality		
	No	**Yes**	**p value**
Shock on admission	**N(%)**	**N(%)**	
No	102(78.5)	0(0)	<0.001
Yes	28(21.5)	18(100)	
Steroids use	**N(%)**	**N(%)**	
No	128(98.5)	18(100)	*1
Yes	2(1.5)	0(0)	
Active malignancy or aids	**N(%)**	**N(%)**	
No	130(100)	16(88.9)	*0.014
Yes	0(0)	2(11.1)	
Liver cirrhosis	**N(%)**	**N(%)**	
No	124(95.4)	18(100)	*0.609
Yes	6(4.6)	0(0)	
Post-operative complication	**N(%)**	**N(%)**	
None	106(81.5)	0(0)	<0.001
Burst abdomen	4(3.1)	0(0)	*1
Leakage	0(0)	6(33.3)	*<0.001
Pulmonary complications	4(3.1)	10(55.6)	*<0.001
Wound infection	16(12.3)	2(11.1)	1*
Preoperative comorbidity	**N(%)**	**N(%)**	
None	106(81.5)	6(33.3)	*<0.001
Diabetes mellitus	12(9.2)	8(44.4)	*0.001
Hypertension	4(3.1)	4(22.2)	*0.008
Liver disease	6(4.6)	0(0)	*0.609
Asthmatic	2(1.5)	0(0)	*1
Time from Perforation to admission	**N(%)**	**N(%)**	
Less than 24 hours	96(73.8)	0(0)	<0.001
More than 24 hours	34(26.2)	18(100)	

P value of chi-square test in all table except (*) p value of exact correction

28 cases out of 42 patients who died within 30 days postoperatively, have been presented with preoperative shock on admission.

34 cases out of 52 patients who died within 30 days postoperative, have been presented after 24 hours of onset of symptoms.

Preoperative shock and delayed presentation more than 24 hours of perforation are statistically significant determinant of the mortality in patients with perforated peptic ulcers with P value <0.001.

Table 3: Relation between qualitative variables and postoperative morbidity:

	Postoperative Morbidity		
	No	**Yes**	**p value**
Shock	**N(%)**	**N(%)**	
No	88(83)	14(33.3)	<0.001
Yes	18(17)	28(66.7)	
Steroids use	**N(%)**	**N(%)**	
No	104(98.1)	42(100)	*0.591
Yes	2(1.9)	0(0)	
Active malignancy or aids	**N(%)**	**N(%)**	
No	106(100)	40(95.2)	*0.079
Yes	0(0)	2(4.8)	
Liver cirrhosis	**N(%)**	**N(%)**	
No	104(98.1)	38(90.5)	*0.055
Yes	2(1.9)	4(9.5)	
Preoperative comorbidity	**N(%)**	**N(%)**	
None	92(86.8)	20(47.6)	<0.001
Diabetes mellitus	6(5.7)	14(33.3)	<0.001
Hypertension	4(3.8)	4(9.5)	*0.224
Liver disease	2(1.9)	4(9.5)	*0.055
Asthmatic	2(1.9)	0(0)	*0.591
Time from perforation to admission	**N(%)**	**N(%)**	
Less than 24 hours	84(79.2)	12(28.6)	<0.001
More than 24 hours	22(20.8)	30(71.4)	

P value of chi-square test in all table except(*) p value of exact correction

28 cases out of 42 patients developed postoperative complications was presented with shock on admission
30 cases out of 52 patients developed postoperative complications was presented after more than 24 hours from onset of symptoms
Shock on admission and delayed presentation in PPU patients are statistically significant determinant of postoperative morbidity.

Table 4: Relation between quantitative variables and postoperative mortality:

	Mortality		
	Survivors	**Non-survivors**	**P value**
	Mean± SD	**Mean± SD**	
Age	39±11.4	67.6±12.5	<0.001
Serum creatinine	1.1±0.4	2.2±0.6	<0.001
BUN	23.8±9.4	51.2±14.6	<0.001
Albumin	3.4±0.6	1.4±0.4	<0.001

Age was statistically significant determinant of the mortality PPU patients where the median and IQR of age was higher in the non survivors in comparison to survivors (39±11.4 versus 67.6±12, p value <0.001). Biochemical labs (**creatinine and BUN**) were significantly higher in no-survivors versus survivors while **albumin** found to be statistically significant lower in non-survivors (3.4±0.6 versus 1.4±0.4, p value <0.001).

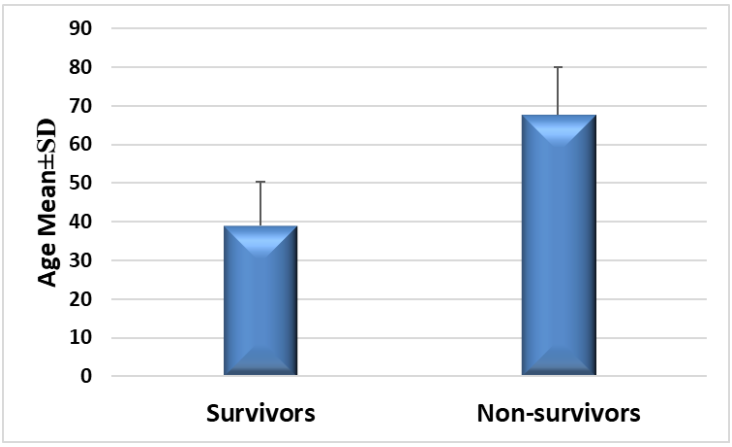

Figure 4: Mean age of survivors and non survivors

Table 5: Relation between qualitative variables and postoperative morbidity:

	Morbidity		
	No	**Yes**	**p value**
	Mean± SD	**Mean± SD**	
Age	39.51±11.3	49.9±19.59	**<0.001**
Serum creatinine	1.07±0.32	1.7±0.7	**<0.001**
BUN	22.7±7.44	38.19±18.39	**<0.001**
Albumin	3.5±0.56	2.36±0.98	**<0.001**

Age was statistically significant determinant of morbidity in PPU patients where the median and IQR of age was higher in the non survivors in comparison to survivors (39.51±11.3 versus 49.9±19.59, p value <0.001). Biochemical labs (**creatinine and BUN**) were significantly higher in non-survivors versus survivors while **albumin** found to be statistically significant lower in non-survivors (3.5±0.56 versus 2.36±0.98, p value <0.001).

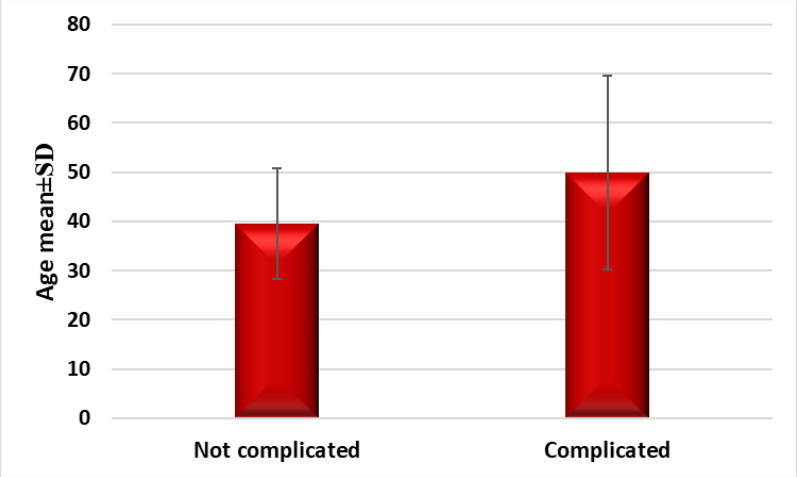

Figure 5: Mean age of complicated and non-complicated cases

Table 6: Relation between different scores and postoperative mortality:

	Mortality		
	Survivors	**Non-survivors**	**P value**
	Median(IQR)	**Median(IQR)**	
Boey score	0(0:1)	3(2:3)	<0.001
POMPP	0(0:0)	2(2:3)	<0.001
ASA score	1(1:2)	3(2:3)	<0.001
PULP Score	0(0:2)	10(8:10)	<0.001

POMPP, PULP,Boey and ASA scores showed statistically significant association with mortality where higher median and IQR of different scores in non- survivors than survivors.

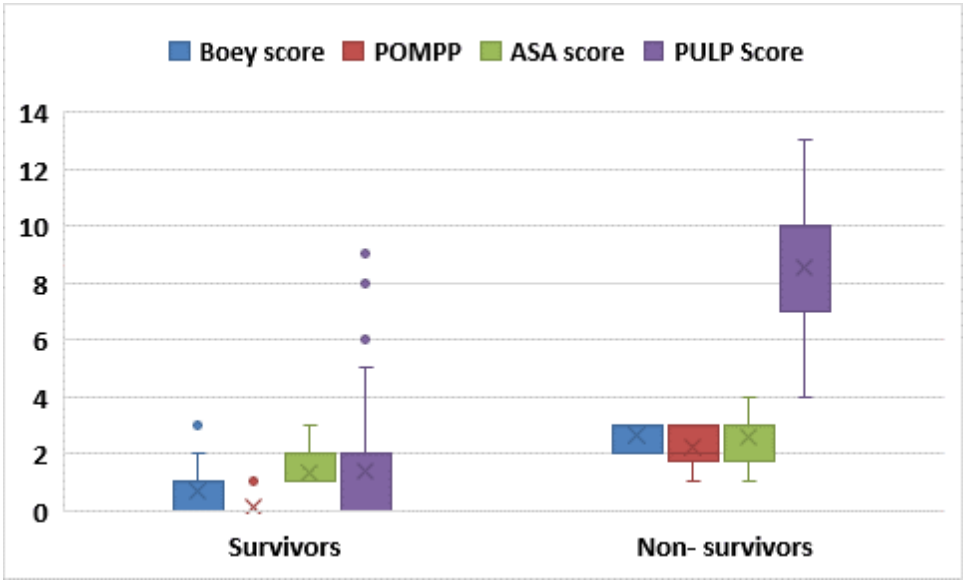

Figure 6: Relation between different scores and postoperative morbidity

Table 7: Relation between different scores and postoperative morbidity:

	Complications		
	No	**Yes**	**P value**
	Median(IQR)	**Median(IQR)**	
Boey score	0(0:1)	2(1:3)	**<0.001**
POMPP	0(0:0)	1(0:2)	**<0.001**
ASA score	1(1:2)	1(1:3)	**<0.001**
PULP Score	0(0:1)	4(2:8)	**<0.001**

POMPP, PULP,Boey and ASA scores showed statistically significant association with morbidity where higher median and IQR of different scores in non- survivors than survivors.

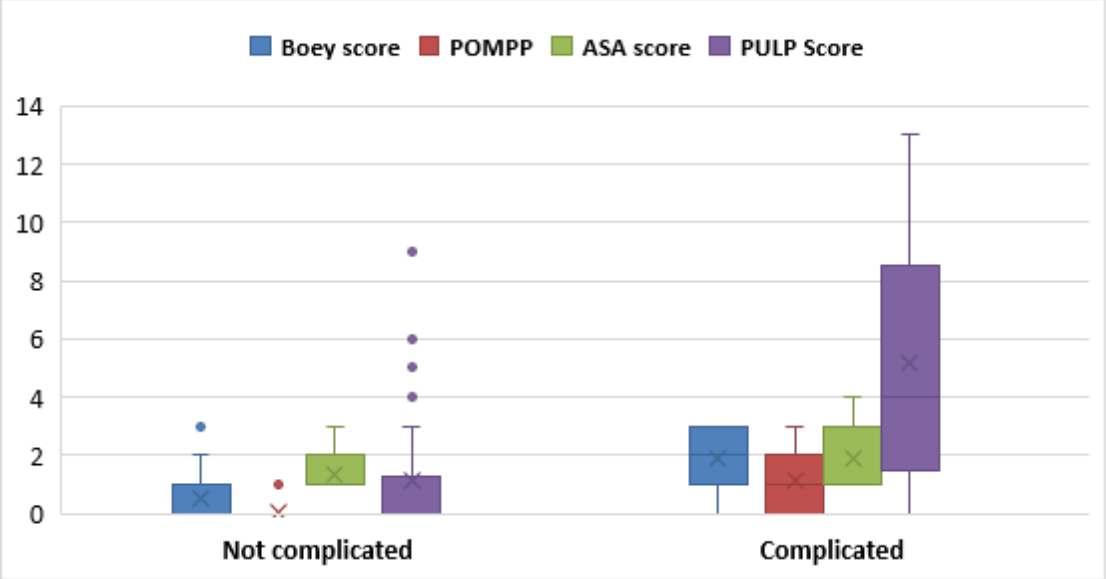

Figure 7: Relation between different scores and postoperative morbidity

Table 8: Discriminant power of different scores in relation to postoperative mortality:

Markers	AUC	95th CI	Cut off point	Sensitivity	Specificity	+PV	-PV
ASA	0.822	0.751- 0.880	>2	66.67	93.85	60	95.3
Boey	0.936	0.884 - 0.970	>1	100	80	40.9	100
POMPP	0.99	0.957 - 0.999	>1	77.78	100	100	97
PULP	0.968	0.925 - 0.990	>6	100	84.62	47.4	100

POMPP shows 78 % sensitivity and 100% specificity at cut off point >1, PULP shows 100% sensitivity and 87% specificity at cut off point >3 , Boey shows 100% sensitivity and 80% specificity at cut off point >1 and ASA shows 67% sensitivity and 94% specificity at cut off point >2.

So, the discriminant power of different scores in relation to mortality where all scores showed excellent discriminant power. But POMP score shows the highest AUC 0.99

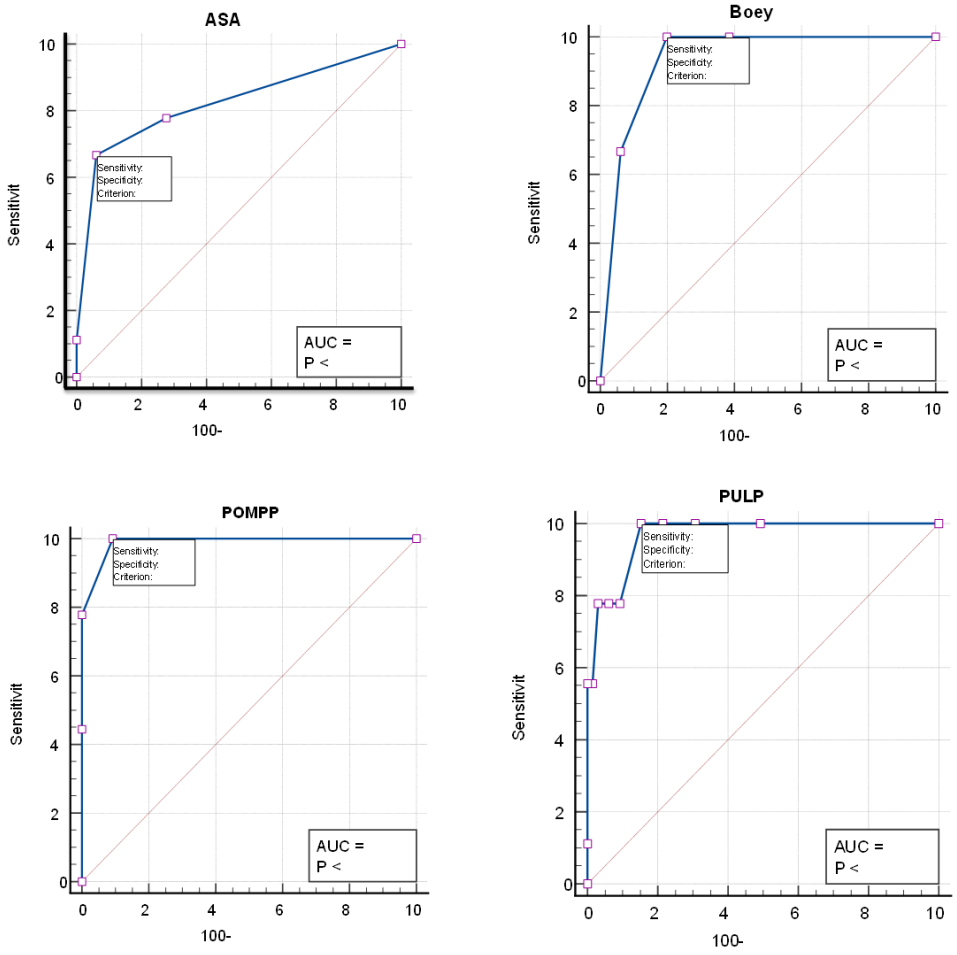

Figure 8: ROC curves in relation to postoperative mortality

Table 9: Discriminant power of different scores in relation to postoperative complication

Marker	Cut off point	AUC	95% Confidence interval	Sensitivity	Specificity	+PV	-PV
ASA	>2	0.642	0.560 to 0.719	38.1	96.23	80	79.7
BOEY	>1	0.83	0.759 to 0.886	66.67	84.91	63.6	86.5
POMPP	>1	0.797	0.723 to 0.859	33.33	100	100	79.1
PULP	>6	0.784	0.709 to 0.848	66.67	90.57	73.7	87.3

This table shows the discriminant power of different scores in relation to post-operative complications where ASA scores poor discriminant power AUC 0.642 while BOEY score showed the excellent AUC 0.83. POMP and PULP scores were moderate (AUC 0.79 and 0.78 respectively).

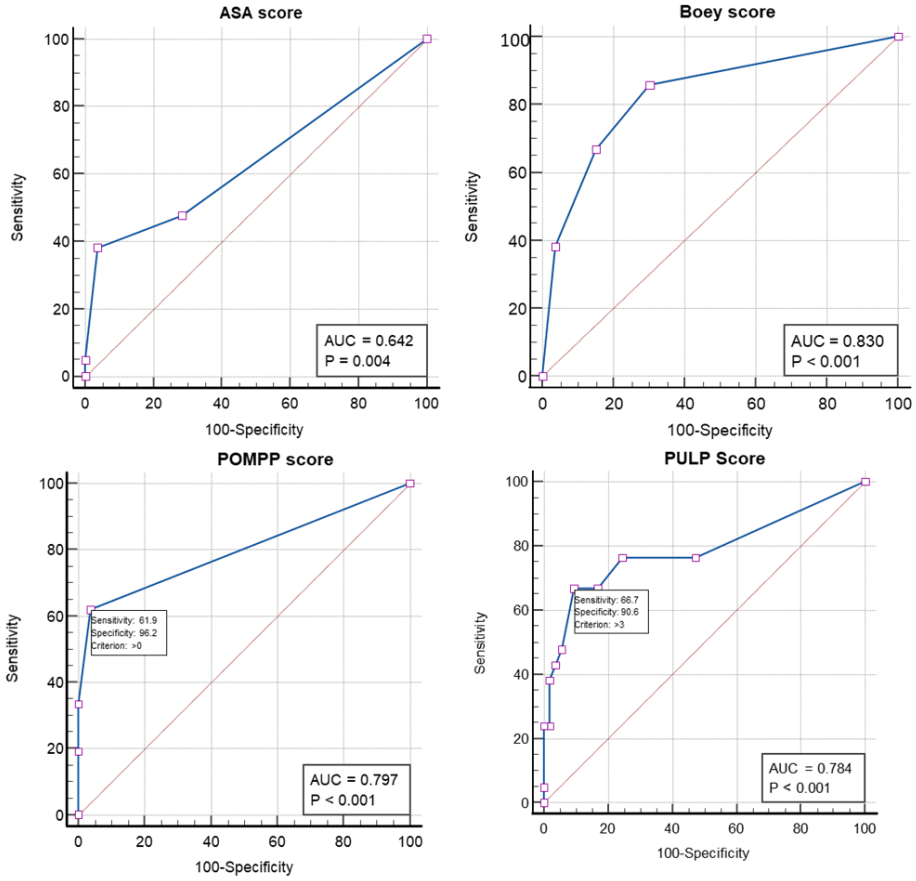

Figure 9: ROC curves in relation to postoperative complications

Discussion

This study was conducted in Kasr Al ainy Emergency Hospital for 17 months duration among 148 patients. The mean age was 42.46 ± 14.85 (range from 20 to 81) years.

In the present study, post-operative mortality rate was 12 .2% (18 patients) and morbidity was 28 % (42 patients). In the literature, overall post-operative complication rate was reported from 17 to 63%. **(7)**

In Menekse et al study, the mortality and morbidity rates were 10.1% and 24.2% respectively. **(6)**

In the present study, wound infection was the most common post-operative complication (12.2%), followed by pulmonary complication (9.5%), leakage (4.1%) and wound dehiscence (2.7%).

In 2021, Gupta et al study showed higher incidence of complications, Wound infection was the most common post-operative complication (20%), followed by pulmonary complication (16%) and wound dehiscence (0.5%). **(8)**

These findings can be explained by the fact that surgery for peptic perforation peritonitis is considered as contaminated or dirty operation, which has a high wound infection rate of 15–40%. **(9)**

In present study, ROC curve analysis of four scoring systems shows that POMP score shows the highest AUC 0.99, followed by PULP score (AUC 0.968) ,Boey score (AUC 0.936) and ASA (AUC 0.822)

Compared to Gupta et al study, ROC curve analysis showed that the diagnostic utility for PULP score was the best as it had highest AUC (0.980), followed by POMPP score (0.964), Boey score (0.960), and ASA score (0.906). **(8)**

In current study, regarding prediction of mortality, POMPP shows 78 % sensitivity and 100% specificity at cut off point >1, PULP shows 100% sensitivity and 87% specificity at cut off point >3, Boey shows 100% sensitivity and 80% specificity at cut off point >1 and ASA shows 67% sensitivity and 94% specificity at cut off point >2.

In Gupta et al study, PULP score had 100% accuracy in predicting mortality but at different cut off value (> 6). POMPP scoring system had 80% accuracy for predicting mortality at the same cut off value of present study (> 1). **(8)**

In 2012, In nationwide cohort study of 2668 patients surgically treated for PPU from February 2003 through August 2009, Møller et al found that a clinical prediction rule – the PULP score – predicted 30-day mortality better than the Boey score and ASA score. **(4)**

However, the present study shows that the discriminant power of different scores in relation to post-operative morbidity where ASA scores poor discriminant power AUC 0.642 while BOEY score showed the excellent AUC 0.83. POMPP and PULP scores were moderate (AUC 0.79 and 0.78 respectively).

While Saafan et al study showed that ROC analysis for PULP score with AUC was 72% at cut off value of ≥3 with sensitivity and specificity of 64.71% and 74.63% respectively but ASA and Boey exhibited similar slightly less AUCs (both 69%, P=0.009 and 0.01 respectively). Shows that Boey exhibited the highest sensitivity (76.47% at cutoff value ≥1), while ASA displayed the highest specificity (75.56% at cutoff value ≥3) in predicating postoperative morbidity. **(10)**

While Menekse et al study showed ASA is not specific scoring system for PPU patients and it is mainly based on the co-morbid diseases and their severity. Although co-morbidities are important risk factors for mortality, under diagnosed or unknown chronic diseases on emergency admission can result to underscoring of ASA. Hence, the main problem of the ASA score has been the inter-observer variability. **(6)**

In present study, biochemical labs (creatinine and BUN) were significantly higher in non-survivors versus survivors while albumin found to be statistically significant lower in non-survivors (3.5±0.56 versus 2.36±0.98, p value <0.001).

In Gupta et al study, it was found that one component of POMPP score (serum albumin < 1.5 g/L) had 100% accuracy in predicting mortality; i.e., all 8 patients died with serum albumin < 1.5 g/L. Hypoalbuminemiawas the strongest single predictor of mortality in PPU patients. **(8)**

In 2014, Thorsen et al study shows hypoalbuminaemia was strongly associated with increased mortality, and this is in line with previous reports on perforated peptic ulcer**. (11)**

The current study shows age is statistically significant determinant of the mortality PPU patients where the median and IQR of age was higher in the non survivors in comparison to survivors (39±11.4 versus 67.6±12, p value <0.001).

Similarly, to POMPP system, PULP and Boey score found that age over 65 or 60 was an independent risk factor for mortality. Advanced age had been reported in several studies as an independent risk factor on mortality in PPU patients. **(4)**

In current study, Preoperative shock and delayed presentation more than 24 hours of symptoms to admission are statistically significant determinant of the mortality and morbidity in patients with perforated peptic ulcers with P value <0.001.

In Møller et al 2012, perforation time longer than 24 hours was defined as > 24 h time from start of symptoms to the time of emergency hospital admission, like the current study and different from the original study of the Boey score it is defined as > 24 hours from perforation to time of surgery. Therefore, slightly fewer and more severely ill patients may have been categorized as having high Boey scores in current study and Møller et al study compared Boey's original study, and the evaluation of the Boey score performance should be read while keeping these discrepancies in mind. **(4)**

Buck DL et al study found that every hour of surgical delay was associated with a 2.4 percent decreased probability of surviving 30 days. The survival rate was 95.7 percent when surgery was initiated within 1 hour of hospital admission, 88.9 percent when initiated within 2 hour, 81·8 percent when started within 3 hours, decreasing to 50 percent after a surgical delay of 7 hour. **(12)**

In 2019, Safaan et al study showed shock on admission and preoperative comorbidities were both significantly associated with 30-day morbidity, Conversely, perforation on admission>24 h, malignancy and liver cirrhosis were not associated with post repair 30-day morbidity. **(10)**

Conclusion

POMPP score is based on objective data and its components are age and routinely measured values (BUN and serum albumin). It is simple and easily applicable scoring system for predicting mortality in PPU.

Conflicts of Interest: The authors declare no conflict of interest.

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