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Evaluation of POSSUM and P-POSSUM in pancreatic surgery

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Abstract

The POSSUM is a scoring system which is used for estimating mortality and morbidity risk in major operations. Its reliability on predicting and quantifying the impact of complications was proven in previous studies. P-POSSUM is better in predicting mortality after major surgery. The use of POSSUM and PPOSSUM after pancreatic surgery was evaluated previously with varied results.

Aim: The aim of the study was to evaluate the use of POSSUM and Portsmouth (P) POSSUM scoring systems to predict postoperative mortality after pancreatic surgery. POSSUM was also evaluated for predicting morbidity and major morbidity after pancreatic surgery.

Material and methods: This was a prospective study done in the Department of Surgical Gastroenterology, Nizam's Institute of Medical Sciences, Hyderabad between Feb 2007 and Jun 2009. POSSUM and P-POSSUM as predictors of morbidity and mortality was analysed. The observed morbidity and mortality were then compared with the predicted figure calculated using POSSUM and PPOSSUM. Linear method of analysis was used to calculate morbidity and mortality.

Results: One Hundred and Seven patients underwent elective pancreatic surgeries (pancreaticoduodenectomy in 64) between Feb 2007 to Jun 2009. POSSUM over predicted mortality (Observed: Expected = 0.5:1) and P-POSSUM under predicted mortality (Observed: Expected = 1.5:1) after pancreatic surgery. POSSUM under predicted morbidity (Observed: Expected = 1.6:1). However, when major morbidity alone is taken into consideration POSSUM over predicted mortality (Observed: Expected = 0.7:1). The mean Physiology score and operative score was similar in patients with morbidity and mortality compared with no morbidity and mortality. Similar results were found when only patients with pancreaticoduodenectomy were considered.

Conclusion: POSSUM and P-POSSUM did not accurately predict mortality and morbidity in patients undergoing pancreatic surgery.

Keywords: Evaluation, POSSUM, P-POSSUM

Introduction

The Physiologic and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) [1] is a scoring system used for estimating mortality and morbidity risk in major operations. Its reliability on predicting and quantifying the impact of complications was proven in previous studies [1-4]. Scores like Acute Physiology and Chronic Health Evaluation (APACHE) which measures only physiological status have a short coming when applied for surgical patients as they do not consider the severity of the surgical intervention. POSSUM combines a physiological score with an operative severity score to give a risk of mortality and morbidity. POSSUM has been criticized for overestimating mortality, particularly among lower risk patients [4, 5]. However, it has been validated in predicting postoperative morbidity in colorectal, hepatic, and vascular specialties [6-9]. The Portsmouth POSSUM (P-POSSUM), a modified method that is widely recognized as a more reliable scoring system for predicating mortality than the original POSSUM equation [4, 10]. Mortality rates after pancreaticoduodenectomy have decreased dramatically during the last two decades in high volume centers. However, despite a low mortality rate and improvements in perioperative care, morbidity rate is still high after pancreaticoduodenectomy. Pancreatic resections still have high morbidity and use of scoring systems to predict morbidity and mortality would be useful. Pratt *et al.* [11] in his study of 326 pancreatic resections showed POSSUM to be valuable perioperative scoring system for evaluating outcomes and suggested that it can be employed to guide management decisions that impact postoperative recovery.

Khan A.W *et al.* [12] in his study suggested that modifications in POSSUM are needed prior to its application for comparative audit in pancreatic surgery. We evaluated POSSUM and P-POSSUM in predicting morbidity and mortality after pancreatic surgery.

Aim

The aim of the study was to evaluate the use of POSSUM and Portsmouth (P) POSSUM scoring systems to predict postoperative mortality after pancreatic surgery. POSSUM was also evaluated for predicting morbidity and major morbidity after pancreatic surgery.

Materials and Methods

This was a prospective study done in the Department of Surgical Gastroenterology, Nizam's Institute of Medical Sciences, Hyderabad between Feb 2007 and Jun 2009.

Inclusion criteria

1. All patients who underwent elective pancreatic surgeries were included in this study.
2. Both benign and malignant conditions of pancreas for which pancreatic surgeries were done were included in the study.

Exclusion criteria

1. Extrapancreatic pseudocysts were excluded from this study.
2. Emergency pancreatic surgeries were also excluded.

A standardized preoperative workup was done in all cases. Mortality and morbidity after pancreatic resections and after Whipple's procedure was calculated. The pre-operative risk was ascertained from POSSUM and PPOSSUM score.

The POSSUM relies on 12 physiologic and 6 operative variables. Physiological variables included patient age, Glasgow coma score, the presence of cardiac and respiratory symptoms, vital signs (systolic blood pressure and pulse), serum biochemistry evaluation (urea nitrogen, sodium, potassium), hematological parameters (white blood cell count and hemoglobin), electrocardiograph, and chest radiograph findings. Operative variables are the magnitude of the operation, number of operations performed within 30 days, intraoperative blood loss, degree of peritoneal contamination, presence of malignancy, and the timing of surgical intervention. Scores for each variable were assigned to one of four grades based on exponentially increasing levels of severity (1, 2, 4, and 8). Separate physiologic and operative severity scores were then calculated, with minimum and maximum scores for each (physiologic: 12 to 88; operative: 6 to 48). Applying these derived severity scores, the risk of developing a postoperative complication (from 0% to 100%) was predicted for each patient using the following POSSUM score equation (PS indicates physiologic score; OS indicates operative score):

The predicted risk of morbidity was then estimated by the mean POSSUM score. Expected mortality was also estimated utilizing the Portsmouth POSSUM (P-POSSUM), a modified method that is widely recognized as a more reliable scoring system for predicating mortality than the original POSSUM equation [4, 10]. It similarly utilizes the Physiologic and Operative Severity scores to estimate the risk of operative mortality (from 0% to 100%) for each patient. The POSSUM predictive risk of morbidity and mortality was calculated for each patient using the logistic regression equations of Jones *et al.* [13]

Morbidity: $\ln R/1-R = -5.91 + (0.16 \times \text{physiological score}) + (0.19 \times \text{operative score})$

Mortality: $\ln R/1-R = -7.04 + (0.13 \times \text{physiological score}) + (0.16 \times \text{operative score})$

where 'R' is the predicted risk of mortality.

The Portsmouth modification of the mortality equation (P-POSSUM) was also evaluated.

P-POSSUM $\ln[R/ (1 \pm R)] = \pm 9.065 + (0.1692 \times \text{physiological score}) + (0.1550 \times \text{operative score})$

The observed morbidity and mortality were then compared with the predicted figure calculated using POSSUM and PPOSSUM. Linear method of analysis was used to calculate morbidity and mortality. For the operative score, PD with or without pylorus preservation was assigned as 'major' and where venous resection and/or resection of adjacent viscera occurred the 'complex major' category was assigned. In linear analysis, the mean predicted risk of patients in each risk group was calculated and multiplied by the number of patients in the group to give the predicted number of patients. Exponential analysis was not used.

Morbidity following pancreatic surgery was further classified based on a therapy-oriented severity grading system (Clavien dindo classification). Classification of Surgical Complication Adopted for Pancreatic Surgery¹⁴ was used. Perioperative mortality was defined as death within 30 days of surgery or during the hospitalization following surgery. Complications following pancreatic surgeries were classified based on a therapy-oriented severity grading system mentioned above. Pancreatic fistula, Delayed Gastric Emptying and Hemorrhage were also graded according to International Study Group for Pancreatic Surgery definition. Major Morbidity was defined as patients having grade III and above complications.

Statistical analysis

Statistical analysis was performed using SPSS 17 software. Categorical variables were compared by Fisher exact test or Chi-square test when applicable. Continuous variables were analyzed by student t test or Mann Whitney U test when applicable. Factors with a level of significance of ≤ 0.05 were considered to be significant risk factors.

Results

One Hundred and Seven patients underwent elective pancreatic surgeries between Feb 2007 to Jun 2009.

Pancreaticoduodenectomy was the commonest procedure. The procedures are summarized in Table 1.

Table 1: Type of procedures

Type of procedure	Frequency (n)	%
Pancreaticoduodenectomy	64	59.8
LPJ/Freys	31	29.0
Distal pancreatectomy	4	3.7
Median pancreatectomy	2	1.9
Enucleation	3	2.8
DPPHR	1	.9
Subtotal pancreatectomy	1	.9
DP, enucleation	1	.9
Total	107	

Complications after Pancreatic surgery

Mortality

Three patients died after pancreatic surgeries. All were after Whipple's procedure. Mortality rate after pancreatic surgery was 2.8% (3/107) and that after Whipple's procedure was 4.68% (3/64). One patient died of ventricular tachycardia on POD2. He developed ventricular ectopics intraoperatively and was on antiarrhythmic drugs. The second patient died of postoperative

liver failure due to ischemic hepatitis. Third patient had Child A cirrhosis preoperatively and postoperatively he developed liver failure.

Morbidity

In our study a total of 58 of 107 (54.2%) patients developed complications after pancreatic surgery. Major morbidity defined as Grade III or more complication was seen in 24.2% (26/107).

Complications after Whipple's procedure was seen in 49 of 64 (76%) patients. Major morbidity (Grade III and more) was seen in 22 of 64 patients (34.3%). All complications following pancreatic surgeries were graded. The mean postoperative duration was 12.4 days (6 – 47 days).

Complications after all pancreatic surgeries and after Whipple's procedure are shown in Table 2.

Table 2: Complications after pancreatic surgeries and Whipple's procedure

Complications	All procedures n (%)	Whipples n (%)
Pancreatic fistula	18(16.8)	13(20.4)
I	4(22.2)	3(23.1)
II	5(27.7)	4(30.3)
IIIA	5(27.7)	3(23.1)
IVA	2(11.1)	2(15.3)
IVB	2(11.1)	1(7.6)
Hemorrhage	9(8.4)	7(10.9)
II	2(22.2)	1(14.3)
IIIB	2(22.2)	2(28.6)
IVA	5(55.6)	4(57.1)
Delayed Gastric Emptying	31(29)	29(45.3)
II	23(74.2)	23(79.3)
IIIA	6(19.4)	4(13.7)
IVA	2(6.5)	2(16.9)
Intra abdominal abscess	11(10.3)	7(10.9)
Grade IIIA	6(54.5)	4(57.1)
Grade IVA	4(36.4)	2(28.6)
Grade IVB	1(9.1)	1(14.3)
Bowel fistula IIIA	2(1.9)	1(1.5)
Biliary fistula	3(2.8)	3(4.6)
Grade I	2(1.9)	2
Grade II	1	1
Surgical Site Infections	33(30.8)	29(45.3)
Grade I	22(66.6)	20(68.9)
Grade II	2(6.1)	
Grade IIIA	9(27.2)	9(31.1)
Pancreatitis	2(1.9)	1(1.5)
Grade II	1	1
Grade IVA	1	
Wound dehiscence	4(3.7)	3(4.6)
Grade II	1	
Grade IIIA	3	3
Liver failure		
Grade V	2(1.9)	2(3.1)
Sepsis	15(14)	10(15.6)
Grade II	6(40)	4(40)
Grade IIIa	2(14.3)	1(10)
Grade IVa	3(21.4)	2(20)
Grade IVb	2(14.3)	1(10)
Grade V	2(14.3)	2(20)
Cardiac	2(1.9)	2(3.1)
Grade IVa	1	1
Grade V	1	1
Pulmonary	15(14)	12(18.7)
Grade II	7	7
Grade IIIa	2	1
Grade IVa	3	1
Grade IVb	1	1
Grade V	2	2
Renal	5(4.7)	4(4.7)
Grade II	3	1
Grade IVb	1	1
Grade V	1	1
CNS Grade II	1	
Thrombophlebitis Grade II	12(11.3)	7(14.1)

Numbers in parenthesis are percentages

POSSUM and PPOSSUM scoring in pancreatic surgery

The mean Physiology score (16 ± 0 vs. 20 ± 4 , $p = 0.3$) and operative score (13 ± 0 vs. 17 ± 2 , $p=0.06$) was higher in patients with mortality compared with no mortality. Of the 107 patients studied, there were 3 deaths (2.8%). Using the POSSUM score, the predicted mortality was 6.5% (7/107) using linear analysis. (Table 3). The observed to predicted mortality ratio was 0.42:1. Using the P-POSSUM equation for mortality the predicted mortality was 1.8% giving an observed to predicted mortality ratio of 1.5:1 (Table 4). The mean Physiology score (15 ± 1 vs

17 ± 1 , $p = 0.03$) and operative score (16 ± 0 vs 17 ± 1 , $p = 0.38$) was higher in patients with morbidity compared with no morbidity. The mean physiology score (11 ± 1 vs 14 ± 0 , $p = 0.001$) and operative score (12 ± 0 vs 14 ± 1 , $p = 0.05$) was higher in patients with major morbidity compared with no major morbidity. Using POSSUM, the predicted morbidity was 33.6% by linear analysis giving an observed to predicted ratio of 1.6: 1 (Table 5). Using POSSUM, the predicted major morbidity was 24.2% by linear analysis giving an observed to predicted ratio of 0.72: 1 (Table 6).

Table 3: POSSUM: Comparison of observed and predicted mortality after pancreatic surgery using linear analysis

Mortality	No. of patients	Mean risk %	Predicted risk	Observed	O:P ratio
0-5	54	2.7	1	0	0
5.1-10	24	7.5	2	2	1:01
10.1-15	15	11.7	2	0	0
15.1-20	5	16.9	1	0	0:01
20.1-25	5	22.3	1	0	0:01
25.1-30	1	27.3	0	0	0
30.1-35	1	32.7	0	0	0
35.1-40	1	35.1	0	0	0
40.1-45	1	41.9	0	1	1:00
	107		7	3	0.42:1

Table 4: P-POSSUM: Comparison of observed and predicted mortality after pancreatic surgery

Mortality	No. of patients	Mean risk %	Predicted risk	Observed	O:P ratio
0-5	94	1.4	1	2	0
5.1-10	9	6.9	1	0	0:01
10.1-15	3	12.8	0	0	0
15.1-20	1	19.8	0	1	1:00
	107		2	3	1.5:1

Table 5: POSSUM: Comparison of observed and predicted morbidity after pancreatic surgery using linear analysis

Morbidity group	No. of patients	Mean risk %	Predicted risk	Observed	O:P ratio
0 to 9	13	8.6	1	3	3:01
10 to 19	26	13.4	3	7	2.3:1
20 to 29	17	23.5	4	13	3.25:1
30 to 39	13	35.6	5	9	1.8:1
40 to 49	12	47	6	7	1.16:1
50 to 59	10	53.7	5	7	1.4:1
60 to 69	7	65	5	4	0.8:1
70 to 79	5	75	4	5	1.25:1
80 to 89	3	84	2	2	1:01
90 to 100	1	90	1	1	1:01
	107		36	58	1.6:1

Table 6: POSSUM: Comparison of observed and predicted major morbidity after pancreatic surgery using linear analysis

Morbidity group	No. of patients	Mean risk %	Predicted risk	Observed	O:P ratio
0 to 9	13	8.6	1	2	2:01
10 to 19	26	13.3	3	3	1:01
20 to 29	17	23.5	3	5	1.6:1
30 to 39	13	35.6	5	4	0.8:1
40 to 49	12	47.1	6	5	0.83:1
50 to 59	10	53.7	5	2	0.4:1
60 to 69	7	64.8	5	2	0.4:1
70 to 79	5	75	4	2	0.5:1
80 to 89	3	84	2	0	0:02
90 to 100	1	90	1	1	1:01
	107		36	26	0.72:1

POSSUM and PPOSSUM scoring in Whipples procedure

The mean Physiology score and operative score was not significantly different between patients with mortality and no mortality. Of the 64 patients studied, there were 3 deaths

(4.68%). Using the POSSUM score, the predicted mortality was 9.3% (6/64) using linear analysis (Table 7). The observed to predicted mortality ratio was 0.5:1. Using the P-POSSUM equation for mortality the predicted mortality was 3.1% giving

an observed to predicted mortality ratio of 1.5:1 (Table 8). Patients with and without morbidity and major morbidity had similar physiology and operative score. Using POSSUM, the predicted morbidity was 46.8% by linear analysis giving an

observed to predicted ratio of 1.6: 1 (Table 9). Using POSSUM, the predicted major morbidity was 46.8% by linear analysis giving an observed to predicted ratio of 0.7: 1 (Table 10).

Table 7: POSSUM: Comparison of observed and predicted mortality after Whipples procedure using linear analysis

Mortality	No. of patients	Mean risk %	Predicted risk	Observed	O/P ratio
0-5	18	3.7	1	0	0/1
5.1-10	20	7.6	2	2	1
10.1-15	12	11.9	1	0	0/1
15.1-20	5	16.9	1	0	0/1
20.1-25	5	22.3	1	0	0/1
25.1-30	1	27.3	0	0	0
30.1-35	1	32.7	0	0	0
35.1-40	1	35.1	0	0	0
40.1-45	1	41.8	0	1	10
	64		6	3	0.5/1

Table 8: P-POSSUM: Comparison of observed and predicted mortality after Whipples procedure using linear analysis

Mortality	no. of patients	mean risk %	Predicted risk	Observed	O/P ratio
0-5	51	1.9	1	2	2
5.1-10	9	6.9	1	0	0/1
10.1-15	3	12.8	0	0	0
15.1-20	1	19.8	0	1	1
	64		2	3	1.5/1

Table 9: POSSUM: Comparison of observed and predicted morbidity after Whipples procedure using linear analysis

Morbidity group	No. of patients	Mean risk %	Predicted risk	Observed	O/P ratio
0 to 9	0	0	0	0	0
10 to 19	6	15.9	1	5	5
20 to 29	14	23.8	3	12	4
30 to 39	10	35.38	4	8	2
40 to 49	9	47	4	6	1.5/1
50 to 59	9	53.27	5	6	1.2/1
60 to 69	7	64.8	5	4	0.8/1
70 to 79	5	75	4	5	1.25/1
80 to 89	3	84.06	3	2	0.67/1
90 to 100	1	90.1	1	1	1
	64		30	49	1.63/1

Table 10: POSSUM: Comparison of observed and predicted major morbidity after Whipples procedure using linear analysis

Morbidity group	no. of patients	mean risk %	Predicted risk	Observed	O/P ratio
0 to 9	0	0	0	0	0
10 to 19	6	15.9	1	2	2
20 to 29	14	23.8	3	5	1.66/1
30 to 39	10	35.3	4	3	0.75/1
40 to 49	9	47	4	4	1
50 to 59	9	53.2	5	2	0.4/1
60 to 69	7	64.8	5	2	0.4/1
70 to 79	5	75	4	2	0.5/1
80 to 89	3	84	3	0	0/3
90 to 100	1	90.1	1	1	1
	64		30	21	0.7/1

Discussion

Mortality after pancreatic surgery

Elective pancreatic resections have developed into safe surgical procedures in specialized centers with mortality rates less than 5%. Mortality rate after pancreatic surgery in our series was 2.8% (3/107) and that after Whipples procedure was 4.68% (3/64). There was no mortality related to pancreatic fistula or reoperations. Previously mortality was primarily attributed to complications from pancreatic anastomosis [15, 16]. Presently mortality due to surgical complications have decreased. Buchler

et al. [17] in a series of 617 pancreatic resections had an overall mortality of 1.6% with 4 mortalities related to surgical complications. Six patients died of systemic complications. DeOliveira *et al.* [14] in his series of 633 patients had a mortality of 2% of which half are related to systemic complications (myocardial infarction and ventricular arrhythmia in 3, thromboembolism in 2, and mesenteric ischemia in 1 patient). In our series there was 1 mortality related to ventricular arrhythmia. One patient developed hepatic artery thrombosis and developed fatal hepatic ischemia. Vascular injuries, usually due

to a large tumor size or peripancreatic inflammation, have been reported in literature with an incidence ranging from 0.5% to 2.7% [18, 19]. Overall, ischemic complications probably represented up to 36% of the operative mortality in some series [21-23].

Morbidity following pancreatic surgery

There has been a lot of discrepancy in reported literature about the morbidity following pancreatic surgery. There are numerous definitions for various complications in the reported literature and complications are variedly classified as major or minor. We used the classification proposed by Clavien-Dindo *et al.* [24] to classify postoperative complications. By this classification first each recorded complication was easily converted into a complication grade. Second the grading system provided an effective format to analyze the incidence and severity of different complications, and their impact on overall morbidity. The risk factors for morbidity, as well as for specific complications, could be identified. We also used the standard definitions by International study group for pancreatic surgery to define and grade pancreatic fistula, DGE, and haemorrhage.

In our study, 58 of 107 (54.2%) patients developed complications after pancreatic surgery. Major morbidity defined as Grade III or more complication was seen in 24.2% (26/107). Complications after Whipples procedure was seen in 49 of 64 (76%) patients. Major morbidity (Grade III and more) was seen in 22 of 64 patients (34.3%). The mean postoperative hospital stay was 12.4 days (6–47 days). Complications after pancreaticoduodenectomy occurs in upto 60% of patients in various reports [22, 25-29]. More than 50% of our complications were Grade I and II. DeOliveira *et al.* [14] in his series of 663 patients classified all complications after pancreatic surgery according to Clavien-Dindo system and found a complication rate of 58.5% (Grade I complications occurred in 10.0%, Grade II in 30.0%, Grade IIIa in 10.5%, and Grade IIIb in 3.0%, Grade IVa in 2.5%, IVb in 0.5%, Grade V complication rate in 2.0%). Grobmyer *et al.* [26] by using a similar grading System reported a morbidity of 47%.

POSSUM and PPOSSUM in pancreatic surgery

Possum over predicted mortality (Observed: Expected =0.42:1) and P-POSSUM under predicted mortality (Observed: Expected = 1.5:1) after pancreatic surgery. POSSUM also under predicted morbidity (Observed: Expected = 1.6:1). However, when major morbidity alone is taken into consideration POSSUM over predicted it (Observed: Expected = 0.72:1). The mean Physiology score and operative score were higher in patients with morbidity and mortality compared with no morbidity and mortality.

POSSUM and PPOSSUM scoring in Whipples procedure

Possum over predicted mortality (Observed: Expected =0.5:1) and P-POSSUM under predicted mortality (Observed: Expected = 1.5:1) after pancreatic surgery. POSSUM also under predicted morbidity (Observed: Expected = 1.6:1). However, when major morbidity alone is taken into consideration POSSUM over predicted mortality (Observed: Expected = 0.7:1). The mean Physiology score and operative score was similar in patients with morbidity and mortality compared with no morbidity and mortality.

The POSSUM was developed for comparative audit in general surgical patients. It has also been found to be reliable for audit in colorectal, thoracic and vascular surgery with minor modifications. But the value of POSSUM & PPOSSUM in

pancreatic surgery is not proven. Khan W *et al.* [12] in his study showed that P-POSSUM appeared satisfactory for predicting mortality risk but POSSUM overestimated morbidity and mortality for PD. In another study [30] P-POSSUM underestimated the mortality rate. Wande Pratt [11] in his study of 326 consecutive pancreatic resections showed that POSSUM is a valuable perioperative scoring system for evaluating variance in pancreatic surgical methods and outcomes, and can be employed to guide management decisions that impact postoperative recovery. In the operative score patients with malignancy and nodal metastasis are given a higher score than benign conditions. The presence of malignancy and nodal metastasis may not be a useful discriminant for the operative score of PD as they would alter the score but may not actually affect the morbidity and mortality of PD. Similar results were observed by Khan A.W [12] *et al.* Modifications are needed prior to its application for comparative audit in pancreatic surgery [12]. The lowest physiological and operative scores are 12 and 6 respectively, which when applied to the POSSUM mortality predictor equation give a minimum risk of death of 1.1 per cent. The P-POSSUM mortality equation gives a minimum risk of mortality of 0.2 per cent [4]. For simple surgeries like hernia the risk is still unacceptable. The lowest physiology score in pancreaticoduodenectomy is 13 and lowest operative score will be 11 with predicted mortality of 2.7% and morbidity of 14.9%. Most of the morbidity in pancreaticoduodenectomy is due to pancreatic texture and pancreatic anastomosis. So, POSSUM and P-POSSUM may not accurately predict mortality and morbidity.

Conclusions

POSSUM and P-POSSUM did not predict mortality and morbidity in patients undergoing pancreatic surgery.

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