Original Articles

Chirurgia (2012) 107: 447-453
No. 4, July - August

POSSUM, a Potentially Useful Tool for Prediction of Morbidity in Patients Undergoing Central Pancreatectomy

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Rezumat

POSSUM, un instrument potențial util în predicția complicațiilor postoperatorii după pancreatectomia centrală

Scop: Pancreatectomia centrală face parte din categoria procedeelor chirurgicale conservatoare, propuse ca o alternativă la rezecțiile pancreatice standard, dar grevată de o morbiditate postoperatorie crescută. Scopul prezentului studiu este reprezentat de evaluarea scorului POSSUM în predicția apariției complicațiilor postoperatorii după pancreatectomia centrală, care astfel ar permite identificarea grupului de pacienți care prezintă cel mai mare risc de a dezvolta complicații.
Metodă: A fost efectuată o analiză retrospectivă a 24 de pacienți cărora li s-a practicat pancreatectomie centrală in perioada 2002 – 2010. Scorul POSSUM a fost calculat pentru fiecare pacient în parte și a fost corelat cu morbiditatea observată.
Rezultate: Scorul POSSUM mediu a fost 32, prezicând apariția complicațiilor la 9 dintre cei 24 de pacienți. Evaluarea riscului s-a dovedit destul de corectă dat fiind faptul că, în realitate, 13 pacienți (54%) au prezentat complicațiii postoperatorii (chi-squared = 3.2101, p = 0.073). Valoarea predictivă a scorului POSSUM a fost cea mai bună pentru grupele de risc ≤ 20%, 60 – 80% și ≥ 80% (O/ E ratio 1).
Concluzii: Identificarea unui sistem de predicție a apariției complicațiilor severe după pancreatectomia centrală ar putea conduce la stratificarea pacienților în grupe de risc și astfel la selecționarea cazurilor. Deși scorul POSSUM pare să evalueze corect riscul de apariție a complicațiilor postoperatorii după pancreatectomia centrală, sunt necesare studii ulterioare, pe un lot mai mare de pacienți, pentru a demonstra cu tărie acest fapt.

Cuvinte cheie: audit, evaluarea riscului, POSSUM, pancreatectomie, complicațiii postoperatorii

Abstract

Aim: Central pancreatectomy is a pancreas-sparing alternative to standard pancreatic resections, and it is associated with substantial morbidity. The aim of the present study is to assess the utility of the POSSUM scoring system in the prediction of the postoperative complications after central pancreatectomy, which would help identify the patients who are at the highest risk of developing complications.
Methods: A retrospective analysis of 24 patients who underwent central pancreatectomies (2002 – 2010) was performed. The POSSUM score was calculated for each patient and was correlated with observed morbidity.
Results: The mean POSSUM score was 32, thus predicting morbidity in 9 out of 24 patients. This risk assessment proved to be quite accurate, as 13 patients (54%) actually developed postoperative complications (chi-squared = 3.2101, p = 0.073). The predictive value of the POSSUM was strongest for the ≤ 20%, 60 – 80% and ≥ 80% morbidity risk cohorts (O/ E ratio 1).
Conclusions: The identification of a scoring system to predict the development of severe complications after

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central pancreatectomy may stratify the patients' risk and lead to a tailored approach of this surgical procedure. Although POSSUM seems to predict morbidity after central pancreatectomy, further studies involving larger numbers of patients should be conducted to confirm this effect.

Key words: audit, risk adjustment, POSSUM, pancreatectomy, operative morbidity

Introduction

The Physiologic and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) was first proposed by Copeland et al. in 1991 as a scoring system that could be used in surgical audit (1). Audit in surgery is mandatory to highlight problems with standards of care and to facilitate improvements in overall results (2). The score considers both pre- and intra-operative commonly measured parameters. Although POSSUM has been proven to be a reliable tool for estimating the postoperative morbidity in a number of major surgical procedures such as colorectal cancer surgery (3) and abdominal aortic aneurysm surgery (4), the literature data on pancreatic resections reveales conflicting results. Thus, some studies consider that POSSUM accurately predicts morbidity for pancreatic resections (5-8), while other studies consider that this scoring system underestimates the morbidity (9), especially in patients who are at low risk of complications (10,11). Nevertheless, in other studies POSSUM was found to overestimate morbidity after standard pancreatic resections (2).

Central pancreatectomy has been proposed as a pancreas-sparing alternative to standard pancreatic resections (i.e., pancreatico-duodenectomy and distal pancreatectomy) for benign and low-grade malignant neoplasms located in the neck and body of the pancreas (12-16). It is widely accepted that central pancreatectomy is associated with an increased morbidity (13,15) mainly related to an increased postoperative pancreatic fistula rate although there are advantages like the lowest incidence of both endocrine and exocrine insufficiency rates (14,16,17).

The aim of the present study is to evaluate the accuracy of POSSUM in predicting morbidity after central pancreatectomy. To the best of our knowledge, this is the first study evaluating the POSSUM in central pancreatectomy. A recent study evaluating the POSSUM on pancreatic resections included a very small number of patients who underwent central pancreatectomy, precluding any accurate statistical analysis (5).

Patients and Methods

Patients

All patients who underwent central pancreatectomy for benign and malignant pathology between March 2002 and August 2010 at the Department of Surgery, Fundeni Clinical Institute, Bucharest (19 patients), and the IVth Surgical Clinic, Cluj-Napoca (5 patients), were included in this study. The data were retrospectively analysed from a prospectively gathered electronic database; complete data were available for all patients with both physiological and operative scores. Our technique of central pancreatectomy was previously described (15,18).

Postoperative morbidity was defined as in-hospital complications and was assessed according to the Dindo-Clavien classification of surgical complications (19). Pancreatic fistula, postoperative haemorrhage and delayed gastric emptying were classified according to the International Study Group for Pancreatic Surgery definitions (20-22).

Methods

The physiological and operative score was calculated for each patient according to the POSSUM scoring system, as defined by Copeland et al. in 1991(1)*(Table 1)*. The physiological score was assessed based on data collected no more than one week before surgery. The blood pressure and pulse were evaluated at rest, with the patient in a relaxed state. Although data were prospectively collected for each patient, the POSSUM scores were retrospectively calculated using a web-based calculator (http://www.vasgbi.com/riskpossum.htm).

All patients who underwent central pancreatectomy were stratified according to their individual POSSUM and related risk of morbidity: less than 20% (low risk), 20 – 40%, 40 – 60%, 60 – 80% and more than 80% (very high risk). The expected morbidity was estimated for each of the 24 consecutive patients. The mean POSSUM was calculated for each of the above strata and was multiplied by the number of patients in each cohort to predict the number of patients expected to develop a postoperative complication. The frequency of observed and expected complications (i.e., O/E ratio) was compared across cohorts (*Table 2*). The predicted risk of morbidity for the entire cohort was estimated based on the mean POSSUM. The observed morbidity was considered as the incidence of actual postoperative complications.

Statistical analysis

Differences between the observed and expected morbidity were assessed by the chi-squared test. A p value less than 0.05 was considered to be statistically significant.

Results

Patient demographics and Physiological Score

The median age of the patients was 40 years (range, 14 to 71 years). Prior to surgery, 5 patients were controlled with diuretics and anti-anginal or anti-hypertensive medication, while 2 patients presented with extensive cardiac disease (peripheral oedema or borderline cardiomegaly on chest ray). Respiratory symptoms (i.e., dyspnoea on exertion) were present in 2 patients. An elevated systolic blood pressure was noted in

Table 1. *POSSUM Score according to Copeland et al. (1)*

	Physiological score			
	Score			
	1	2	4	8
Age (years)	**≤ 60**	**61 – 70**	**≥ 71**	
Cardiac signs	No failure	Diuretic, digoxin, antianginal or hypertensive therapy	Peripheral edema, anticoagulant therapy	Raised jugular venous pressure
Chest radiograph			Borderline cardiomegaly	Cardiomegaly
Respiratory history	No dyspnoea	Dyspnoea on exertion	Limiting dyspnoea (one flight)	Dyspnoea at rest (rate ≥ 30/min)
Chest radiograph		Mild COAD*	Moderate COAD	Fibrosis or consolidation
Systolic blood pressure (mmHg)	110 – 130	131 – 170 100 – 109	≥ 171 90 – 99	≤ 89
Pulse (beats/min)	50 – 80	81 – 100 40 – 49	101 – 120	≥ 121 ≤ 39
Glasgow coma score	15	12 – 14	9 – 11	≤ 8
Haemoglobin (g/ 100 ml)	13 – 16	11.5 – 12.9 16.1 – 17	10 – 11.4 17.1 – 18	≤ 9.9 ≥ 8.1
White cell count (x 10^{12}/l)	4 – 10	10.1 – 20 3.1 – 4	≥ 20.1 ≤ 3	
Serum urea (mmol/ l)	≤ 7.5	7.6 – 10	10.1 – 15	≥ 15
Serum sodium (mmol/ l)	≥ 136	131 – 135	126 – 130	≤ 125
Serum potassium (mmol/ l)	3.5 – 5	3.2 – 3.4 5.1 – 5.3	2.9 – 3.1 5.4 – 5.9	≤ 2.8 ≥ 6
Electrocardiogram	Normal		Atrial fibrillation	Any other abnormal rhythm or ≥ 5 ectopics/ min, Q waves or ST/ T wave changes
	Operative severity score			
Operative severity†	Minor	Moderate	Major	Major +
Multiple procedures	1		2	> 2
Total blood loss (ml)	≤ 100	101 – 500	501 – 999	≥ 1000
Peritoneal soiling	None	Minor (serous fluid)	Local pus	Free bowel content, pus or blood
Presence of malignancy	None	Primary only	Nodal metastases	Distant metastases
Mode of surgery‡	Elective		Emergency resuscitation of > 2 h possible Operation < 24 h after admission	Emergency (immediate surgery < 2 h needed)

*COAD – chronic obstructive airways disease; † central pancreatectomy was assessed as a major + procedure; ‡ all the operations were performed electively

Table 2. *Morbidity risk stratification for 24 patients with central pancreatectomy*

POSSUM score	Patients	Predictive risk (%)	Expected morbidity	Observed morbidity	O/E ratio	
≤ 20 %	9	18	2	2	1	chi-square = 0.098 p=0.753
20 – 40 %	10	24	3	6	2	chi-square = 3.307 p=0.069
40 – 60 %	2	58	1	2	2	chi-square = 0.220 p=0.638
60 – 80 %	1	76	1	1	1	chi-square = 0.315 p=0.574
≥ 80 %	2	86	2	2	1	chi-square = 0.325 p=0.568
Overall	24	32	9	13	1.4	chi-square = 3.210 p=0.073

7 patients (130 – 170 mmHg in 5 patients, ≥ 171 mmHg in 2 patients). An abnormal pulse was present in 2 patients. All patients had normal Glasgow coma scores (equal to 15). Decreased haemoglobin levels were noted in 5 patients (11.5 – 12.9 g/dl in 3 patients, 10 – 11.4 g/dl in one patient and ≤ 9.9 g/dl in one patient). The white blood cell count was within normal limits in all patients except one. The serum urea level was elevated in 5 patients (136.8 – 180 mg/ dl in one patient and 181.8 – 270 mg/dl in 4 patients). The serum potassium level was elevated in 4 patients (5.1 – 5.3 mEq/l in 3 patients and 5.4 – 5.9 mEq/l in one patient). The serum sodium level was decreased in 4 patients (131 – 135 mEq/l). All patients demonstrated normal findings on electrocardiogram, except one who presented with ST depression. Overall, the mean physiologic score was 15 (range, 12 to 36).

Operative factors

All central pancreatectomies were performed electively and were considered "major +" surgery, according to the POSSUM scoring system (1). Four patients had associated procedures: liver hemangioma enucleation, liver biopsy, viscerolysis and lymph node dissection, and pulmonary lobectomy (one case each). The median estimated intraoperative blood loss was 100 ml (range, 50 to 500 ml); in 7 patients, the estimated intraoperative blood loss was between 101 and 500 ml. The final pathology revealed serous cystadenoma in 7 patients, mucinous cystadenoma in 3 patients, insulinoma in 3 patients, non-functioning neuroendocrine tumours in 4 patients, intra-ductal papillary mucinous neoplasia – branch type in 2 patients, solid pseudopapillary tumour in one patient, metastases in 2 patients (colon and ocular melanoma as primary sites), pancreatoblastoma in one patient and chronic pancreatitis in one patient. Thus, benign and low-grade malignant lesions were encountered in 20 patients (83%), while 4 patients had malignancies. Overall, the mean operative score was 14 (range, 13 to 17).

Postoperative outcome

One or more complications were encountered in 13 patients, resulting in a morbidity rate of 54%. The most common postoperative complication was pancreatic fistula, which occurred in 10 patients (41%): 2 patients (8%) – grade C, 5 patients – grade B and 3 patients – grade A. Thus, the rate of clinically significant pancreatic fistula (grade B + C) was 29%. Other complications included the followings: postpancreatec-tomy haemorrhage – grade B (2 patients), intra-abdominal collection (1 patient), splenic infarction (1 patient), wound infection (2 patients) and delayed gastric emptying – grade A (1 patient). The rate of the second look was 20% (5 patients), and it was performed for the following reasons: haemostasis (2 patients), drainage of abdominal collection (1 patient), splenectomy for splenic infarction (1 patient) and completion of pancreatectomy for distal pancreatic stump pancreatitis (1 patient) *(Table 3)*. According to the Dindo-Clavien classification, 8 patients were grade I (33%) and 5 patients were grade IIIb (21%). No hospital readmission was necessary, and the post-operative mortality was nil. Thus, the estimation of mortality based on the POSSUM was not performed in the present study. Overall, the mean POSSUM was 32 (range, 18 to 91).

Analysis of POSSUM

The average POSSUM for all patients with central pancreatectomy was 32%, thus predicting morbidity in 9 of the 24 patients. This risk assessment proved to be quite accurate, as 13 patients (54%) actually developed postoperative complications, with an overall observed-to-expected morbidity ratio of 1.4 (chi-squared = 3.2101, p = 0.073). A detailed analysis of each stratum further validates POSSUM as a potential predictive scoring system for postoperative morbidity *(Table 2)*. Most of the patients presented with POSSUM scores less than or equal to 40% (19 patients). The observed-to expected morbidity ratios ranged from 1 to 2, being the highest for the 20 – 40% and 40 – 60% morbidity risk cohorts. The predictive value of the POSSUM was stronger for the ≤ 20%, 60 – 80% and ≥ 80% morbidity risk cohorts (O/ E ratio 1). Although there was a tendency of POSSUM to underestimate the risk of developing complications after central pancreatectomy in the 20 – 40% and 40 – 60% morbidity risk groups, the chi-squared analysis comparing the actual morbidity with the estimated morbidity across the above mentioned risk strata showed no significant lack of fit (chi-squared = 3.307, p = 0.069 and chi-squared = 0.220, p = 0.638, respectively).

Table 3. *Morbidity classified for severity in 24 patients with central pancreatectomy*

Major complications	**No patients**	**Intervention**
Pancreatic fistula grade C	2	• Surgical drainage of peripancreatic abscess • Completion of pancreatectomy for pancreatitis
Postpancreatectomy hemorrhage – grade B	2	Surgical hemostasis
Abdominal collection	1	Surgical drainage
Spleen infarctization	1	Splenectomy
Minor complications		
Pancreatic fistula grade A and B	8	
Wound infection	2	
Delayed gastric emptying – grade A	1	

The mean POSSUM for the patients with benign pathology was 29%, thus predicting morbidity in 6 of the 20 patients. In the benign pathology group, 10 patients actually developed postoperative complications, with an overall observed-to-expected morbidity ratio of 1.6 (chi-squared = 3.810, p = 0.051). The mean POSSUM for the patients with malignancies was 48%, thus predicting morbidity in 2 of the 4 patients. In the malignancies group, 3 patients developed postoperative complications, with an overall observed-to-expected morbidity ratio of 1.5 (chi-squared = 1.000, p = 0.317). Thus, POSSUM seems to better predict morbidity after central pancreatectomy in the group of patients with malignancies, while in patients with benign pathology, there is a tendency towards an underestimation of the morbidity. However, this difference did not reach statistical significance (p = 0.051).

Discussion

Several risk scoring systems have been evaluated for pancreatic resections with the aim of a surgical audit and to assist the patients and surgeons in making informed decisions regarding the risks and benefits of surgical procedures (2,5,9-11,23-26). The role of these scoring systems is not only to estimate the risk for developing postoperative complications after pancreatic surgery but also to allow an objective assessment between different surgical centres or pancreatic surgeons (5,23). Approaches that mitigate the impact of preoperative and intraoperative risks may be associated with better postoperative outcomes in pancreatic surgery (7). High-risk patients should not be excluded from surgery, but there is a need for a close, case-by-case selection (6).

POSSUM has been assessed as a reliable scoring system for estimating morbidity in a number of surgical procedures, such as colorectal cancer resections (3), liver resections (24) or major vascular surgery (4).

A study in hepato-biliary-pancreatic surgery had shown that the POSSUM score was superior in multivariate analysis at predicting postoperative morbidity compared with the American Society of Anesthesiologists (ASA), APACHE (Acute Physiology and Chronic Health Evaluation) or Child-Pugh scores (24). However, that study included only a small number of patients with pancreatic resections. A recent study found that the POSSUM has a limited role as an outcome score in pancreatic resection; the Glasgow Prognostic Score has been proposed as a novel and better alternative (11). Nevertheless, a prospective study concluded that the surgeon's gut feeling is a better predictor than the POSSUM for postoperative outcome after major elective hepato-biliary and gastrointestinal surgery (27).

The main pitfalls of POSSUM include the time period of the data set to be analysed, missing data sets, the classification of electrocardiography abnormalities and the problems with accurate assessment of intraoperative blood loss (28). Based on the overprediction results for some surgical procedures, the POSSUM may not only give the impression of favourable performance, but it may also fail to identify poor performance (29).

For pancreatic resections, the POSSUM was evaluated in a relatively small number of studies, most of which included pancreaticoduodenectomies (2,5-11,24). A recent study suggested that the POSSUM is more accurate for pancreaticoduodenectomy than for distal pancreatectomy due to the higher potential for morbidity with the former (5). Accordingly, because central pancreatectomy is largely accepted to have the highest risk for developing postoperative complications of all the pancreatic resections, the evaluation of the POSSUM in predicting morbidity after central pancreatic resection seems to be of interest.

The centralisation of pancreatic resections in high-volume centres was certainly associated with a decrease in mortality rate. (30) The morbidity after pancreatic resections still remains high even at high volume centres, although the rate of severe complications rate was significantly lowered (25,31-35). Quality improvement assessments have contributed to selective regionalisation of pancreatic resections (7).

Central pancreatectomy is an infrequent pancreatic resection and has been criticised for its high morbidity rate (36,37). The most frequent complication after central pancreatectomy is represented by pancreatic fistula, which is reported to occur in up to 44% of cases (13). The pancreatic fistula rate after central pancreatectomy is reported to be higher than that after standard pancreatic resections (17) and may lead to life-threatening complications such as intra-abdominal sepsis with organ failure or haemorrhage. Thus, the postoperative outcome of these patients could be jeopardised. Nevertheless, the development of postoperative complications implies increased costs of care (36). The actual morbidity rate of 54% in the present study is consistent with the reported morbidity from other high-volume centres (12-14). Although central pancreatectomy is mainly indicated for benign pathology (38), some special malignancies (i.e., metastases to the pancreas of other neoplasia and pancreatoblastoma) were safely treated with this approach (13,16,18,39).

A recent study testing the value of POSSUM as a predictive index for morbidity and mortality after pancreatic resections demonstrated its accuracy in the prediction of morbidity, suggesting its usefulness for guiding management decisions that impact postoperative recovery (5). However, these findings are available only for standard pancreatic resections because the number of patients with central pancreatectomy was too low to reach statistical significance. The same conclusion was obtained in other studies (8) in which the POSSUM appeared to be particularly good in patients with pancreaticoduodenectomy for benign pathology compared with malignancies. The first study in the literature analysing the POSSUM in pancrea-tic resections had shown that malignancy along with blood loss are the only discriminatory factors for operative scores and that although these factors alter the score, they may not actually affect morbidity (2). In the present study, it was noticed that POSSUM seems to better predict morbidity in patients who underwent central pancreatectomy for malignancies, while in the benign pathology group of patients, there is a tendency that POSSUM underestimated morbidity. Although that finding did not

reach statistical significance, it may raise questions about the accuracy of the POSSUM in predicting morbidity after central pancreatectomy in large series of patients because central pancreatectomy is mainly performed for benign pathology.

Other studies showed that the POSSUM underestimates morbidity after pancreaticoduodenectomy in low morbidity risk groups (9-11) and overestimates morbidity in the high risk groups (10,11). Thus, the reproducibility of the POSSUM in highly specialised operative techniques is considered to be doubtful, and the need for modifications prior to its application for surgical audit has been highlighted (9,10). Furthermore, the POSSUM was found to over-predict morbidity after by-pass procedures for unresectable pancreatic cancer, although it was assessed as an independent predictor of survival (10). In the present study, a tendency of POSSUM toward underestimation of developing postoperative complications after central pancreatectomy in low and low-to-medium morbidity risk groups was noted. However, statistical significance was not achieved. Thus, although central pancreatectomy could be considered as a highly specialised operative procedure, the POSSUM score seems to accurately predict the development of postoperative complications in the present cohort of patients.

The results from the present study should be regarded with caution because the accuracy might be impaired by the relatively small number of patients and the retrospective design. It is possible that the statistical tests were insufficiently powered to detect differences between variables.

Conclusion

Central pancreatectomy is an infrequent parenchyma-sparing pancreatic resection that is associated with an increased postoperative morbidity. The identification of a scoring system for predicting the development of severe complications after central pancreatectomy may stratify the patients' risk and could lead to a tailored approach for this surgical procedure. Although the POSSUM seems to predict morbidity after central pancreatectomy, this feature should be confirmed with further studies involving larger numbers of patients.

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