



## Original article

## Post-operative morbidity and mortality in pancreatic surgery. The role of surgical Apgar score

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## ABSTRACT

**Background:** Morbidity and mortality rates after pancreatic resection still remain high. The surgical Apgar score (SAS) has been recently introduced as predictive value of perioperative outcomes after pancreatic surgery. Aim of the study was to detect significant parameters affecting post-operative outcomes in pancreatic surgery, and to evaluate the role of SAS in predicting morbidity, pancreatic fistulas and mortality.

**Materials and methods:** Data were collected from 143 patients who had undergone pancreatic resection for pancreatic and periampullary adenocarcinoma. Pre-operative and intra-operative parameters were statistically analyzed to evaluate their potential prognostic effects.

**Results:** A low SAS ( $p = 0.001$ ), hypo-albuminemia ( $p = 0.003$ ), and the need for blood transfusions ( $p = 0.05$ ) were significant independent predictors of postoperative morbidity. The SAS was demonstrated to significantly predict major complications ( $p = 0.001$ ) surgical site infections ( $p = 0.001$ ) and mortality ( $p = 0.001$ ).

**Conclusion:** The SAS provides a simple, immediate, and objective means of measuring patient outcomes in surgery. This score should be used to identify patients at high risk of major complications and death after pancreatic surgery and may be useful to optimize the use of postoperative critical care beds and hospital resources.

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### 1. Introduction

Pancreatic surgery remains the only established curative treatment for the majority of pancreatic and periampullary carcinomas. The first report, in 1941, of the pancreaticoduodenectomy (PD) procedure, described a series of 41 patients with a mortality rate of 29% [1]. Improvement of operative and postoperative techniques, combined with the centralization of these surgeries in high-volume centers have markedly improved the associated morbidity and the

mortality rates. Currently, perioperative mortality rates have been reported in the range of 1%–5% at high-volume centers [2,3]. However, the morbidity rate after PD remains high, up to 30%, and has yet to be markedly reduced [4,5]. The development of pancreatic fistulas (PF) remains the most serious postoperative complication, with an incidence rate reported to be approximately 10%–20% [6,7]. Intra-abdominal abscesses, sepsis, and hemorrhages are the most common complications of PF and are associated with a high mortality rate (20%–40%) [8]. Pancreatic leakage has the potential for disastrous consequences and is associated with an increase in the length of hospital stay and cost, requiring additional laparotomies in about 11–33% [3,9].

Recent results from Kim et al. [10] indicated that the occurrence of early postoperative complications may be a predictor of a poor prognosis after PD for an ampullary carcinoma. Such observations

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emphasize the need to identify factors that influence not only survival but also the risk of complications. Previous reports have cited numerous factors that appear to predispose patients to morbidity and mortality after pancreatic resection; these factors include age, American Society of Anesthesiologist (ASA) status, diabetes, hypoalbuminemia, surgeon volume, blood transfusion, and texture of gland at transection site [10,11]. Recently, Assifi et al. [12] introduced the surgical Apgar score (SAS) as a new predictor of perioperative morbidity and mortality after pancreatic surgery. This parameter associates intraoperative blood loss, intraoperative heart rate, and mean arterial pressure on a 10-point scale. The same group further demonstrated that the SAS is a useful parameter, independently predicting perioperative morbidity and mortality after PD [12].

The aim of the present study was to individuate significant pre-operative and intra-operative parameters influencing morbidity and mortality rates, and to evaluate the role of SAS in predicting postoperative complications using univariate and multivariate analysis.

## 2. Materials and methods

The records of a series of 143 consecutive patients undergoing resection for periampullary and pancreatic carcinoma between April 2003 and August 2010 at the St. Andrea Hospital, Sapienza University of Rome, were retrospectively reviewed.

The surgical procedure involved PD (either pylorus-preserving or the classic Whipple procedure) for tumors located in the pancreatic head or uncus. Distal pancreatectomy or splenopancreatectomy was the procedure of choice for tumors located in the pancreatic body or tail, along with standard lymphadenectomy. Pancreatojejunostomy was routinely performed for reconstruction after PD and was carried out by anastomosing the pancreatic parenchyma and the jejunum in an end-to-side, single-layer, full-thickness anastomosis. Superior mesenteric vein or portal vein resections (SM-PVR) were performed in cases of suspected infiltration of the mesenteric/portal vein, either pre- or intraoperatively.

The parameters evaluated in this retrospective review were divided into 2 groups: host-related or pre-operative factors (age, sex, ASA status, diabetes mellitus, white cell count, neutrophil count, lymphocyte count neutrophil/lymphocyte ratio, albuminemia, hemoglobin level, preoperative biliary drainage, texture of the pancreatic remnant) and perioperative or surgical-related factors (SAS score, operative time, blood transfusions, vascular resection, type of PD, and Bio-Glue® application).

The SAS included the intraoperative heart rate (HR), intraoperative mean arterial pressure (MAP), and estimated blood loss (EBL). The SAS (range, 0–10) was calculated for the entire cohort using the score, previously validated by Gawande et al. [13] (Table 1). Perioperative epidural analgesia, which may cause intraoperative decrease in blood pressure and heart rate, was used only in 8 patients without any significant hemodynamic intra- and peri-operative modifications.

Primary outcome measures included death and major complications within 30 postoperative days. Postoperative complications were graded using the scale, described by Clavien et al. [14] (Grades

I–IV). Grade I and II complications were defined as any deviation from the normal postoperative course without the need for surgical, endoscopic, or radiological interventions. These grades also included wound infections opened at the bedside. Grade III complications included those morbidities requiring surgical, endoscopic, and radiological intervention. Grade IV morbidity included any life-threatening complication requiring intermediate or intensive care unit (ICU), such as single or multiple organ dysfunction. Grade V complications were defined by patient death [14]. In addition, pancreatic fistulas were retrospectively assessed according to the International Study Group on Pancreatic Fistula (ISGPF) recommendations [15]. Delayed gastric emptying was also retrospectively diagnosed according to established criteria [16].

The primary study endpoint was to individuate the pre- and intra-operative factors to determine those parameters influencing postoperative morbidity and mortality rates. The secondary endpoint was to evaluate if the SAS could predict morbidity and mortality using multivariate analysis.

### 2.1. Statistics

Statistical analyses were performed using MedCalc for Windows, version 10.2.0.0 (MedCalc Software, MariaKerke, Belgium). Differences in distribution were calculated using the *t*-test for continuous variables and the chi-square test or Fisher's exact test, depending on the number of cases in each subgroup, for categorical variables. A *p*-value of <0.1 was used as the cut-off value for statistical significance during variable selection in the multivariate modeling, using the Logistic Regression Model, in order to avoid overlooking any potentially important predictors. Only those variables found to be significant in the univariate analysis were included in the model. Statistical significance remained conventionally defined as *p* < 0.05 in all other cases.

## 3. Results

### 3.1. Demographics, pre-operative, intra-operative and anatomopathological characteristics

The mean age for this cohort of patients was 67 years (range, 31–86), and included 79 males and 64 females. The majority of the patients (102, 71%) were classified as ASA 1–2, while 41 (29%) were considered ASA 3. Overall, 109 patients (76%) had a white blood cell count of less than 10.5  $\mu$ L, 112 patients (78%) had fewer than 7.5 ( $10^9/l$ ) neutrophils, 62 patients had fewer than 3 ( $10^9/l$ ) lymphocytes, and 35 patients (24%) were anemic (hemoglobin level <12.5 g/dL). In the total study population, 111 patients (77%) were diabetic, and hypoalbuminemia was observed in 113 patients (85%). Preoperative biliary drainage was present, prior to surgical resection, in 25 of the 115 (21%) who underwent PD.

Pylorus-preserving PD was the most frequent procedure performed (73 cases, 62%), while the classic Whipple PD was performed in 43 cases (38%). Distal pancreatectomy with splenectomy or distal pancreatectomy occurred in 27 cases. The mean operative time was 329 min (range, 180–610 min); the mean surgical time for PD was 367 min (range, 230–610 min), while distal pancreatectomies were performed in a mean time of 280 min (range, 180–300 min). Intraoperative blood transfusions were required in 32 patients (22%).

Venous vascular resection (superior mesenteric vein or portal vein) was performed in 8 patients during PD (5.5%) and Bio-Glue® was utilized to coat pancreatic resection surface after distal pancreatectomy (DP, *n* = 5) and to coat pancreatojejunostomy after PD (*n* = 18) in a consecutive series of 23 patients (16%).

The mean SAS was 5.3; the mean EBL, mean intraoperative heart rate, and the range of intraoperative arterial pressures were 320 mL

**Table 1**

The 10-point surgical Apgar score [13]. EBL: estimated blood loss, MAP: mean arterial pressure, HR: heart rate.

	0 points	1 point	2 points	3 points	4 points
EBL (ml)	>1000	601–1000	101–600	≤100	–
Lowest MAP	<40	40–54	55–69	≥70	–
Lowest HR	>85	76–85	66–75	56–65	≤55

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