POSSUM and P-POSSUM: Predictors of Morbidity and Mortality in Laparoscopic Roux-En-Y Gastric Bypass?

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Abstract

Background: Evidence to support the use of Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (POSSUM) and Portsmouth-POSSUM (P-POSSUM) to predict outcomes in bariatric surgery is sparse.

Objectives: The aim of this study is prospectively evaluate their usefulness in laparoscopic gastric bypass.

Setting: University Hospital

Methods: All patients undergoing primary laparoscopic gastric bypass between November/14 and September/15 in our institution were included. POSSUM and P-POSSUM scores were applied preoperatively. The observed to expect ratios for morbidity and mortality at 30 days after surgery were calculated. Chi-square and binomial tests were used to compare observed and expected outcomes. A p-value <0.05 was considered significant.

Results: Ninety-four patients (76 female) were included, mean age of 45.5years, 66 patients were ASA 2. Mean BMI was 43.9Kg/m^2. Estimated morbidity by POSSUM score was 24.1%. Estimated mortality was 4.4% by POSSUM, 1.0% by P-POSSUM. Observed morbidity was 23.4%. No patient died. Both scores resulted in over predicted outcomes. In contrast to P-POSSUM, POSSUM expected outcomes were statistically different from the ones observed.

Conclusion: POSSUM was not a good predictor of morbidity and mortality in the sample. The use of these scores in bariatric surgery has to be careful. These results should be assessed further in larger, multicenter, studies.

Keywords: Obesity; Morbidity; POSSUM; P-POSSUM; Laparoscopic Gastric Bypass

Introduction

Obesity is currently considered a serious public health problem. In 2008, the World Health Organization (WHO) estimated that, globally, there were more than 1.4 billion overweight adults, which represents more than 10% of the world population [1]. Worldwide there has been a significant increase in the number of obese patients undergoing bariatric surgical interventions.

Laparoscopic Roux-en-Y gastric bypass (LRYGB) has a very low incidence of mortality. Although it presents a low morbidity incidence, the large number of surgeries performed every year makes this outcome an important issue to take into account in anesthetic and surgical planning. Young et al. found a 30 day mortality of 0.15% and an incidence of serious morbidity of 5.8% in a review of 19 172 patients, submitted to laparoscopic gastric bypass [2].

Preoperative prediction of the risk of complications is a key instrument for the best intraoperative and immediate postoperative anesthetic planning. This can also be used to audit the quality of care provided to patients.

In a recent systematic review, Moonesinghe et al. showed that, of 34 postoperative risk stratification tools, POSSUM score (Physiological and Operative Severity Score for the Enumeration of Mortality and morbidity) is one of the most credible to predict morbidity and mortality in the postoperative period [3].

POSSUM score, described by Copeland et al. (1991), is a system based on 12 physiological (age, Glasgow Coma Score, hemoglobin concentration, white cell count, serum sodium, potassium and urea concentrations, heart rate, systolic blood pressure, respiratory and cardiac co-morbidities, electrocardiographic abnormalities) and six operative variables (operative severity, degree of cancer spread, peritoneal soiling, number of procedures required, blood loss and urgency of surgery) that estimate the risk of mortality and morbidity at 30 days after surgery (Table 1) [4].

This score differs from others risk stratification tools because it also includes variables related to the surgical procedure. Each variable is sub-divided into three or four levels with different severities, weighted to a value of 1, 2, 4 or 8. The physiological parameters are taken at the time of surgery. The inclusion of operative values precludes its use in the preoperative setting.

Physiological Parameters	Operative parameters
Age	Operative magnitude, number of procedures, timing of operation
Cardiac and respiratory signs, electrocardiographic findings	Blood loss
Systolic arterial pressure, heart rate	Peritoneal contamination
Glasgow Coma Scale	Presence of malignancy
Urea, sodium, potassium	
Hemoglobin, white cell count	
POSSUM - Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity; P-POSSUM - Porthmouth-POSSUM.	

Table 1: Variables included in the determination of morbidity and mortality by scores POSSUM and P- POSSUM.

Several studies have shown that POSSUM overestimates morbidity mainly in low-risk patients [5-7]. P-POSSUM (Portsmouth-POSSUM) uses the same variables but estimates the risk of postoperative mortality through a linear regression model, increasing its predictive value [7-9]. However, it is not validated to estimate morbidity and has some limitations like the underestimation of mortality in the elderly and in emergent procedures [5]. Both scores were already validated for colorectal (CR-POSSUM), vascular (V-POSSUM) and gastroesophageal (O-POSSUM) surgeries [10].

There is a small number of studies looking at risk assessment scores for bariatric surgery, and all of them have important limitations regarding the way in which POSSUM and P-POSSUM were applied and their sample size, raising questions about their external validity in the current bariatric practice [11,12].

Only one study was published about the usefulness of these scores in gastric bypass surgery [13]. It was a retrospective study in which POSSUM and P-POSSUM scores were applied to patients undergoing laparoscopic gastric bypass or sleeve gastrectomy. The investigators concluded that both scores overestimated 30 day morbidity and mortality. However the study was retrospective, with the physiologic variables collected few weeks before surgery rather than on the day of the procedure. It also evaluated two procedures with different operative magnitudes and as such, with distinct incidence of postoperative complications.

The purpose of this study was to prospectively assess the usefulness of POSSUM and P-POSSUM scores in morbidity and mortality prediction at 30 days after surgery, in patients undergoing elective laparoscopic gastric bypass, in our hospital.

Methods

After Hospital Ethics Committee approval, all patients scheduled for elective LRYGB from November 2014 to September 2015 were enrolled in the study. In our hospital, laparoscopic gastric bypass is usually performed for patients with a body mass index (BMI) ≥ 40 kg/m^2 or ≥ 35 kg/m^2 in association with obesity-associated comorbidities. The great majority of patients are maintained with a balanced general anesthesia with remifentanil, desflurane and rocuronium. Demographic data and physiological parameters were recorded the day before surgery. The perioperative surgical parameters were recorded by the anesthetist in the anesthesia sheet. Blood loss was evaluated considering the volume of blood in surgical aspirator and the weight of surgical dressings. According to other authors, LRYGB were graded as a "major +" surgery [13]. The Clavien-Dindo classification was used for the stratification of postoperative morbidity events [14,15]. It is described in Table 2.

Grade	Complications definition
I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions. Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgesics, diuretics and electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside.
II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are included.
III	Requiring surgical, endoscopic or radiological intervention.
IIIa	Intervention not under general anesthesia.
IIIb	Intervention under general anesthesia.
IV	Life-threatening complication (including CNS complications)‡ requiring IC/ICU-management.
IVa	Single organ dysfunction (including dialysis).
IVb	Multi-organ dysfunction.
V	Patient death.
Suffix "d"	If the patients suffer from a complication at the time of discharge, the suffix "d" (for 'disability') is added to the respective grade of complication. This label indicates the need for a follow-up to fully evaluate the complication.

Table 2: Clavien-Dindo Classification of post-operative morbidity (adapted from) [14,15].

POSSUM equations for morbidity (ln (R/1-R)=5.19+0.16 PS+0.19 OS) and mortality (ln (R/1R)=7.04+0.13 PS+0.16 OS) were applied for each patient. Estimated mortality was also calculated by the equation of P-POSSUM score (ln (R/1-R)=-9.065+0.1692 PS+0.155 OS). In these equations PS and OS represent the physiological and operative total scores, respectively, and R is the probability of event occurrence.

Patients were stratified into estimated mortality (A,B,C,D) and morbidity risk groups (I,II,III,IV).

The mean estimated morbidity (ME) and mortality (MTE) were calculated for each risk group. With this value the estimated number of cases of morbidity and mortality for each group (n1) was calculated. The ratio of observed and estimated cases (O/E) for each risk group was determined. Considering that O/E=1, the predictive ability of the score is good if O/E<1 its predictive ability is low and if O/E>1 the score overestimates the outcome.

Continuous variables were presented as mean ± standard deviation (SD). Results related to the morbidity and mortality is shown in absolute value and/or in percentage.

Chi-square test or Fisher exact test were used as a measure of calibration or goodness of fit to assess if a relationship could be found between the observed and the predicted outcomes. As these p-values do not show if the score is accurate to predict if the expected low or high risk groups are the ones that indeed have the lowest or the highest observed outcomes, respectively, we performed a non-parametric binomial test to see whether the values of the observed outcomes were significantly different from the expected ones for each group. A *p*-value of less than 0.05 was taken to be significant.

Statistical analysis was performed using SPSS 21˚ IBM˚ software.

Results

A total of 94 patients, of whom 76 (81%) were females, were included in the study. There were no conversions from laparoscopic to open surgery, and all the patients were submitted only to one procedure-LRYGB.

Mean age was 45.5 ± 10.1 (range 21 to 64 years). According to the American Society of Anesthesiologists (ASA) physical status classification, 66 patients (70.2%) were ASA 2 and the remaining was ASA 3. The mean ± SD of BMI was 43.9 ± 6.7 Kg/m^2. Mean length of stay after surgery was two days.

According to Clavien-Dindo Classification of surgical complications, at 30 days after surgery there were 22 patients with postoperative complications (23.4% of the sample), of which 12 were grade I (persistent postoperative vomiting postponing discharge), eight were grade II (two cases of surgical wound infection, 1 of dysrythmia, 2 of respiratory insufficiency with need of noninvasive ventilation, 1 of digestive hemorrhage with need of transfusion, 1 patient with respiratory tract infection and another with acute kidney injury with dehydration) and two were a high grade complication (Clavien-Dindo IIIb - gastrointestinal suture dehiscence needing urgent surgical repair). No patient died during follow-up period.

The mean ± SD of physiological score was 14.2 ± 1.7 (range 12 to 20). All the patients had a score of 13 in operative variables.

Mean (range) estimated morbidity by POSSUM score for the sample was 29.4% (17.9-41.4%). Mean (range) estimated mortality was 4.4% (3.2-8.6%) by POSSUM and 1.0% (0.7-2.5%) by P-POSSUM equations.

Table 3 shows the results obtained by the use of POSSUM exponential analysis to estimate morbidity for each risk group. Eighty-five patients (90.4%) had an estimated morbidity lower than 30%. Three groups had an O/E ratio<1 which means that the score over predicted morbidity in the entire sample.

Risk group (expected morbidity - %)	No. of patients (n)	Mean predicted risk of morbidity (%)	No. of expected cases (E)[a]	No. of observed cases (E)	Clavien-Dindo classification of complications (n)	O/E ratio	p-value[b]
I (5.47˚-20)	9	17.9	1.6	1	Grade I: 1	0.62	0.33
II (20-30)	76	23.3	17.7	17	Grade I: 10	0.96	0.11
					Grade II: 6		
					Grade III: 1		
III (30-40)	6	35.2	2.1	3	Grade I: 1	1.42	0.24
					Grade II: 2		
					Grade III: 1		
IV (40-100)	3	41.4	1.2	1	Grade I:1	0.81	0.43
Total (5.47-100)	94	29.4	27.6	22	Grade I: 12	0.97	0.04
					Grade II: 7		
					Grade III: 2		

Abbreviations: POSSUM: Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity; No: Number; n: Absolute Frequency; O: Observed Cases; E: Expected Cases; O/E: Observed to Expected Morbidity Ratio. ˚Minimum expected morbidity by POSSUM is 5.47%.
[a] Expected morbidity was calculated by multiplying the effective patient number per risk group by the expected percentage of morbidity by POSSUM. [b] P-value obtained by binomial test.

Table 3: Group-specific comparisons of expected and observed morbidity by POSSUM.

This does not happened in group III, in which there were more complications than expected. Using Chi-square test for the entire sample it turns out that there was a statistically significant difference between estimated morbidity and the observed outcome (p=0.0235). So in our sample, observed morbidity was significantly different from the one expected by POSSUM score. This result is supported by the low probabilities obtained when comparing the observed and expected morbidity for each risk group using binomial test.

Table 4 shows the analysis of POSSUM estimated mortality.

Risk group (expected mortality-%)	No. (nP)	Mean predicted risk of mortality (%)	No. of expected cases (E)[a]	No. of observed cases (O)	O/E ratio	p-value[b]
A (1.1*-4)	36	3.58	1.29	0	0	0.27
B (4-6)	49	4.46	2.23	0	0	0.11
C (6-8)	8	6.84	0.55	0	0	0.57
D (8-100)	1	8.6	0.09	0	0	0.91
Total	94	5.87	4.14	0	0	0.07

POSSUM: Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity; No: Number; nP : Absolute Frequency; O/E: Observed to Expected mortality ratio; *Minimum expected mortality by POSSUM is 1.1%. [a]: Expected mortality was calculated by multiplying the effective patient number per risk group by the expected percentage of mortality by POSSUM; [b]: p-value obtained by binomial test.

Table 4: Group-specific comparisons of expected and observed mortality by POSSUM.

As could be expected, knowing the very low incidence of mortality described in LRYGB, the majority of patients had a low expected mortality. Indeed, in 79 patients POSSUM score for mortality was lower than 5%. A total of 4 deaths were predicted by POSSUM score. In our sample there were no deaths. So, POSSUM over predicted mortality in the sample. As with morbidity, POSSUM was not a good predictor of mortality (p=0.07). The same results were obtained analyzing each risk group with binomial test, except in the group whose expected mortality was 8-100%. However this group had only one patient.

Table 5 shows the analysis of POSSUM estimated mortality. In our sample, expected mortality for each risk group do not significantly differ from the one observed (p=0.33). In our sample mortality prediction by P-POSSUM seems to be more close to the actual one. The expected number of deaths in our sample by P-POSSUM was lower than one patient.

Risk group (expected mortality - %)	No.(nP-P)	Mean predicted risk of mortality (%)	No. of expected cases (E)[a]	No. of observed cases (O)	O/E ratio	p-value[b]
A (0.2*-1)	62	0.83	0.51	0	0	0.95
B (1-2)	29	1.27	0.37	0	0	0.69
C (2-100)	3	2.23	0.07	0	0	0.93
Total	57	1.05	0.6	0	0	0.36

P-POSSUM: Portsmouth-POSSUM; No: number; nP-p: absolute frequency; O/E: Observed to Expected mortality ratio; *Minimum expected mortality by POSSUM is 0.2%. [a]:Expected mortality was calculated by multiplying the effective patient number per risk group by the expected percentage of mortality by P-POSSUM; [b]: p-value obtained by binomial test.

Table 5: Group-specific comparisons of expected and observed mortality by P-POSSUM.

However, analysis of the usefulness of the scores to predict mortality is limited due to the absence of deaths and to the very low incidence of mortality expected for LRYGB.

Discussion

Morbidity and mortality rates found in our sample are within the ranges described for LRYGB.

POSSUM score was not a good predictor of 30 day morbidity and mortality in the sample. In contrast, P-POSSUM expected mortality was not statistically different from the one observed. As expected, mortality rate predicted by POSSUM was larger than the one predicted by P-POSSUM. Still, given the fact that there were no deaths in the sample (which is consistent with what is described for LRYGB), it was not possible to detect significant differences in the performance of the two scores to predict mortality.

POSSUM and P-POSSUM scores are not specific for a specific surgical procedure, with no discrimination of potential variables specific to certain surgical contexts, POSSUM and P-POSSUM scores have proven useful across different surgical specialties [5,7,16,17]. Like other scores their use in clinical practice requires time and they do not allow for an accurate preoperative risk estimation because they are dependent on operative variables that can only be obtained during and after surgery. So they just permit to do a prediction based on the presumptive values of operative values. However the impact of intraoperative variables in the patient outcome is unquestionable. Besides, they can be used as indirect indicators of the quality of health care by allowing comparison of the outcomes expected and observed in the institution for a specific surgical procedure for which those scores they are validated.

The results of POSSUM analysis are in agreement with those obtained recently by Charalampakis et al. who found a statistically

significant difference between the expected compared to the observed complications. In the study both scores over predicted the outcomes [13]. In our study P-POSSUM mortality was not different from the one observed in the sample. This result is not in accordance with the conclusions of Charalampakis. The median expected mortality by P-POSSUM in our sample is 1.0 ± 0.34%. Literature describes a lower incidence of deaths, around 0.15% [2,18]. So P-POSSUM ability to predict mortality has to be further investigated, preferentially by a multicentric study.

Our study is pioneer because it was done only in LRYGB patients, with assessment of POSSUM and P-POSSUM variables through direct reporting from the patient clinical evaluation in perioperative setting, as described by Copeland in his original work. There were no estimates of any variable. As recently described by Young et al., LRYGB has a higher risk-adjusted 30-day serious morbidity compared to laparoscopic sleeve gastrectomy [2]. As such, the inclusion of these two different surgical procedures with different expected morbidity can influence the assessment of the predictive ability of the scores, as 24% of patients had sleeve gastrectomy in the study of Charalampakis. However that study had a higher number of patients, so its results had to be taken into account. Another important difference that has to be considered is the lower mean BMI found in our sample (45 versus 51.8 kg/m^2). ASA classification was not described in the study but it also could be another factor influencing outcome.

POSSUM and P-POSSUM scores lack some specificity for surgeries in bariatric patients. For example they do not take into account body mass index, which has been shown to correlate with morbidity and mortality after bariatric surgery [2]. Also they include some variables that are not very important in LGRYB, like blood loss (in our patients it was always lower than 100 mL), emergency of the procedure and Glasgow Coma Scale. Obesity Surgery Mortality Risk Score (OS-MRS), Longitudinal Assessment of Bariatric Surgery consortium risk stratification system and Metabolic Acuity Score and a nomogram include some obesity specific variables and comorbidities in their equations. Only OS-MRS was validated to predict mortality by multiple centers but it is not validated to estimate morbidity, which is more relevant to predict because of its higher incidence in LRYGB. In a previous study we evaluated the performance of OS-MRS as a predictor of postoperative complications in obese patients submitted to LRYGB and we had evidence that it could be a good tool to use with that goal [19].

Conclusion

This study denotes that POSSUM score does not fit to predict morbidity and mortality in LRYGB patients. The usefulness of P-POSSUM has to be confirmed in other multicenter and larger studies. It seems that, in laparoscopic bariatric surgery, there is the need to use specific scores, which take into account, specific features of the patients (like body mass index, previous medical history, and physical status) and of the procedure. Other multicenter studies, with a higher number of patients are needed to confirm our results. Another suggestion of research could be to compare other assessment methods of postoperative morbidity and mortality, like OS-MRS, with POSSUM and P-POSSUM to assess the ability to predict those variables.

Grants, Financial Support and Conflicts of Interest

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