View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Dadun, University of Navarra

Analysis of POSSUM score and postoperative morbidity in patients with rectal cancer undergoing surgery

V. Valenti & J. L. Hernandez-Lizoain & J. Baixauli & C. Pastor & F. Martinez-Regueira & J. J. Beunza & J. J. Aristu & J. Alvarez Cienfuegos

Abstract

Background The Physiological and Operative Severity Score for the enUmeration of Mortality andmorbidity (POSSUM) and later modifications (P-POSSUM y CRPOSSUM) have been used to predictmorbidity and mortality rates among patients with rectal cancer undergoing surgery. These calculations needsome adjustment, however. The aim of this study was to assess the applicability of POSSUM to a group ofpatients with rectal cancer undergoing surgery, analysing surgical morbidity by means of several variables.

Methods between January 1995 and December 2004, 273 consecutive patients underwent surgery forrectal cancer. Information was gathered about the patients, tumour and therapy. To assess the predictioncapacity of POSSUM, subgroups for analysis were created according to variables related to operativemorbidity and mortality.

Results The global morbidity rate was 23.6% (31.2% predicted by POSSUM). The mortality rate was 0.7% (6.64, 1.95 and 2.08 predicted by POSSUM, P-POSSUM and CR-POSSUM respectively). POSSUMpredictions may be more accurate for patients younger than 51 years, older than 70 years, with low anaesthetic risk (ASA I/II), DUKES stage C and D, surgery duration of less than 180 minutes and for thosereceiving neoadjuvant therapy.

Conclusion POSSUM is a good instrument to make results between different institutions and publicationcomparable. We found prediction errors for some variables related to morbidity. Modifications of surgicalvariables and specifications for neoadjuvant therapy as well as physiological variables including life stylemay improve future prediction of surgical risk. More research is needed to identify further potential riskfactors for surgical complications.

Keywords Rectal cancer. POSSUM score . Surgical morbidity

V. Valenti (*) : J. L. Hernandez-Lizoain: J. Baixauli : C. Pastor:
F. Martinez-Regueira : J. J. Beunza : J. J. Aristu:
J. Alvarez Cienfuegos
Department of General Surgery,
Clinica Universitaria de Navarra,
University of Navarra,
Avda Pio XII, 36.,
31080 Pamplona, Spain
e-mail: vvalenti@unav.es

J. L. Hernandez-Lizoain e-mail: jlhernande@unav.es

J. Baixauli
e-mail: jbaixauli@unav.es

C. Pastor
e-mail: cpastor@unav.es

F. Martinez-Regueira
e-mail: fmregueirar@unav.es

J. J. Beunza
e-mail: jjbeunza@unav.es
J. J. Aristu
e-mail: jjaristu@unav.es

J. Alvarez Cienfuegos e-mail: fjacien@unav.es

J. J. Beunza
Internal Medicine, Clinica Universitaria de Navarra,
University of Navarra,
Avda Pio XII, 36,
31080 Pamplona, Spain

J. J. Aristu
Radiotherapy, Clinica Universitaria de Navarra,
University of Navarra,
Avda Pio XII, 36,
31080 Pamplona, Spain

J. Alvarez Cienfuegos
Clinica Universitaria de Navarra, University of Navarra, Avda Pio XII, 36, 31080 Pamplona, Spain.

Introduction

Surgical evaluation processes are well-known medical procedures that help us detect and correct errors, as well as reinforce correct decisions taken about surgery. Surgical scoring systems must be capable of predicting morbidity and mortality and be fast, user friendly and applicable to a wide spectrum of situations. The Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (POSSUM) scoring system has been used to assess the quality of surgical results so as to estimate the probability of morbidity and mortality of patients according to their preoperative physiological status and the magnitude of surgery. Thus the POSSUM scoring system offers a way of comparing the results of surgical procedures presenting different degrees of complexity [1, 2].

The main value of this scoring system is the scientific method used for its development [3–5], together with its simplicity. Different validation studies carried out [6, 7] have found mortality overprediction, especially among patients with low surgical risk. In 1998, a new equation known as P-POSSUM was therefore created to more accurately predict surgical mortality.

This new system applies linear instead of exponential equations and uses different constants and values for the same Physiological and Operative Scores. Both POSSUM and P-POSSUM scores have proved to be reliable mortality predictors for patients undergoing general and special surgery [1, 4, 5, 8]. When applied specifically to colorectal surgery, these scoring systems have been found to overpredict mortality in elective surgical procedures and to underpredict mortality in elderly patients and in cases of emergency surgery [9–12]. This fact led to the development, in 2004, of the CR-POSSUM, which is specific for colorectal surgery [13]. It seems to be the most accurate scoring system, compared with the previous ones [14–16].

Our aim was to evaluate the quality of care at our centre, assessing morbidity and mortality over several years. Therefore, we applied the three described scoring systems to a group of patients consecutively diagnosed with rectal adenocarcinoma and treated with long term preoperative chemoradiotherapy and surgery. Furthermore, we wanted to determine the relationship with other factors that may predict complications.

Patients and methods

Between January 1995 and December 2004, 273 patients diagnosed with rectal adenocarcinoma (tumour margin within 16 cm from the anal verge) were treated in our hospital. A multidisciplinary team made up of oncologists, radiotherapists and surgeons with a special interest in colorectal pathology attended them. A database was created with prospective information collected about the patients (age, gender, BMI and ASA) [17], the surgical procedures (type and duration of surgery, ileostomy, type of anastomosis and blood transfusion), the radiotherapy (dose, duration and interval between radiotherapy and surgery), and about the tumour (tumor, node, metastasis [TNM] staging [18] and location).

Patients were assigned to two different groups: group A was made up of 170 patients, who were given both chemoradiotherapy and surgery, and group B was made up of 103 patients treated with surgery alone. Chemoradiotherapy was prescribed for all patients whose preoperative staging revealed tumour infiltration deeper than the muscular layer (T3) or lymph nodes suspicious of metastasis (N+). All patients not fulfilling these criteria (71/ 103) as well as those with metastasis (M1) (24/103) were included in group B to avoid delay in systemic chemotherapy. Finally, patients who refused preoperative chemoradiotherapy were also assigned to group B (8/103).

Preoperative radiotherapy

External radiotherapy was applied in two, three and four fields according to the guidelines given in the 50th Report of the International Commission on Radiation Units and Measurements [19], including the primary tumour and regional, mesorectal, presacral and internal iliac (up to L5 S1) lymph nodes. Most of the patients (77/103) received a standard dose of between 45 and 50.4 Gy in 25 fractions over 5 weeks, associated with chemotherapy based on 5 fluorouracil (FU) boluses during the first and last week of radiotherapy. Fifteen patients received a reduced dose due to treatment intolerance and eleven received a dose over 50.4 Gy. All of them underwent surgery between the fourth and sixth week after completing radiotherapy.

Surgical procedures

All the patients underwent intestinal preparation the day before surgery, as well as intestinal decontamination with oral antibiotic therapy, antithrombotic prophylaxis, gastric protection and intravenous antibiotic prophylaxis against anaerobes and gram negative bacteria. The procedures employed were as follows: anterior rectal resection with stapled anastomosis, abdominoperineal resection and Hartmann's procedure. A protective ileostomy was created according to the surgeon's decision, taking into account technical factors, the general health of the patient and the use of neoadjuvant therapy with chemoradiotherapy. In all cases, information was gathered prospectively about the duration of the surgical procedure, blood loss and intra-operative blood transfusion requirements as decided by the anaesthetists.

Statistical analysis

Data collection was carried out using a computer database, and was supervised by the same surgeon throughout the whole study. The physiological and surgery parameters of the POSSUM score previous to the year 2000 were obtained from such a database, while more recent parameters were obtained prospectively. Data analysis was performed with the SPSS 11.0 program (SPSS, Inc, Chicago, IL, USA). Categorical variables were analysed using contingency tables and Chi-squared or Fisher exact probability, depending on the cases. Continuous variables were analysed with the Student t test. The association between independent variables and complications was analysed with a regression model. In same cases, variables were divided into categories and cutoff points for better analysis. Results between observed and predicted values (o/p index) were analysed according to this classification: 1.0±0.1: very good prediction; 1.0±0.25: good prediction. P values below 0.05 were considered to be statistically significant.

Results

Series analysis

The demographic characteristics of the 273 patients are shown in Table 1. The two groups are homogeneous for age, gender, BMI, ASA, type of surgery, need for blood transfusion, duration of surgery and hospital stay.

Significant differences in tumour location and tumour stage between groups results from the type of therapeutic procedure, the main reason for the selection treatment (p= 0.002). Most of the patients allocated to preoperative radiotherapy (group A) received a standard dose of 45 to 50.4 Gy, with conventional fractioning (1.8 Gy), during a 5 week period. The mean dose was 4700 cGy (range 3,696– 6,500 cGy). Chemotherapy with 5-FU (350 mg/m2/day) was given in the first and last week of the radiation period. The mean time between preoperative chemoradiotherapy and surgery was 38 days (range 30–61 days). The mean radiotherapy duration was 36 days (range 20–70).

The characteristics of the surgical procedures in both groups, with values of statistical significance, are also displayed in Table 1. Thirty-five per cent of patients were admitted to the ICU after surgery according to criteria of the anaesthetists and depending on the behaviour of the patient in theatres. The mean time of surgery in group A was 170 min (range 70–540) and was 150 min (range 45– 330) in group B, and there were no statistically significant differences. No statistically significant differences between the groups were found with regard to sphincter-preserving surgery (76.5% in group A vs 75.5% in group B) or blood transfusion (16.6% in group A vs 18.1% in group B). In group A, 38.3% of the patients underwent ileostomy vs 8.6% in group B ($p<0.001$). Other surgical procedures (cholecystectomy, hysterectomy, and hernia surgery) were combined with the tumour excision in 13% of the patients in group A vs 22.3% in group B ($p=0.045$).

Complications

The complications found in both groups are displayed in Table 2. It is important to note that, although statistically significant differences were not found between both groups, the number of patients suffering from complications was smaller in group A (23%) than in group B (32%) probably due to the more advanced tumour stage in group B (Table 1).

Global mortality in the series (30 days mortality) was found only in two patients (0.7%): one in each group. The patient (0.6%) in the group treated with radiotherapy died of severe myocardial ischemia during the early postoperative period and the patient (1%) in the group treated with surgery alone died of intra-abdominal haemorrhage.

The overall morbidity in our sample was 26.4% while that predicted by POSSUM was 31.2% (index observed/ predicted=0.84; Table 3). When analysing according to therapy groups, we found very good prediction for patients treated with surgery alone (group B) (O/P index=1.09), while for patients receiving neoadjuvant therapy (group A), POSSUM overpredicted the morbidity rate (O/P index= 0.71) (Table 4).

The results obtained for the surgical mortality rate and a comparison of them are displayed in Table 5. Mortality prediction for POSSUM, P-POSSUM and CR-POSSUM was 6.64, 1.95 and 2.08, respectively. The three scoring systems overpredicted mortality risk, although the PPOSSUM and CR-POSSUM showed higher accuracy. We should not forget that no cases of emergency surgery were included in this study.

POSSUM was applied to subgroups according to variables classically associated with surgical morbidity and mortality (age, ASA, type of surgical procedure, duration of surgery and Dukes staging). The results are shown in Table 6. When applied to different age groups, it accurately predicted the morbidity rate for middle-aged groups (51–60 and 61–70 years old). However, over-prediction for the other groups (<51 and >70 years old) was found. The sample was segmented by anaesthetic risk (ASA I/II and ASA III/IV) and duration of surgery (<180 min and >180 min). We obtained an appropriate POSSUM prediction for those patients with ASA I/II (O/P index=0.99) and an overprediction for patients with ASA III/IV (O/P index=0.75). Concerning the duration of surgery, the prediction was appropriate for surgical procedures lasting more than 3 h (O/P index=1.03), and morbidity was overpredicted in patients with a shorter duration of surgery (O/P index=0.68). Looking at the type of surgical procedure, we found an overprediction of the surgical complication rate for anterior rectal resection (O/P index=0.76) and for Hartmann's procedure (O/P index= 0.85), as well as an underprediction for abdomino-perineal resection (O/P index=1.15). Analysis by Dukes staging showed an appropriate prediction for patients with good prognosis; Dukes A and B (O/P index=1.04 and 0.98) and incorrect prediction for Dukes C and D (O/P index=0.73 and 1.29).

Finally, morbidity rates observed and expected through application of the POSSUM equation were compared for the different risk groups in our sample. For those groups with higher expected rates, the number of patients with complications observed was also higher. Analysing this fact we found a correct correlation between the proportion of patients with complications and the proportion of expected cases by POSSUM (Table 7).

Discussion

Surgical results are classically measured in terms of morbidity and mortality rates and hospital stay [3]. However, it may be misleading to establish comparisons based only on these variables. We should take into account that not all cases present the same degree of complexity and that reference hospitals usually have a concentration of the most complex ones, therefore registering higher rates of morbidity and mortality, and hospital stay [20]. This issue has been widely described in the literature [3, 21–23] and that is why several scoring systems for prediction and quality care control have been developed over the years. The only way to objectively compare surgical teams, hospitals and surgeons is by estimating morbidity and mortality rates adjusted according to the risk of each patient or group of patients [3].

In our study, we wanted to assess all these aspects, so as to fully comprehend our situation and to be able to analyse it as a part of the health system.

The principal investigator was present during the data collection process and supervised data input in the different models and scoring systems. Physiological and Operative Severity Scores were similar to series previously analysed, allowing us to compare them with the results of other institutions (Table 8). The mean Physiological and Operative Severity Scores were 16.07 (range 12–35) and 13.03 (range 8–30), respectively. Predicted mean morbidity was 31.2% and predicted mean mortality was 6.64% with the POSSUM score. Observed morbidity was 26.4% and observed mortality was 0.7%. The number of emergency surgical procedures in our study was zero since the few patients who presented as emergencies were stabilized and later referred for elective surgery. This decrease in morbidity and mortality rates among emergency patients treated electively was described by Tekkis et al. where mortality rates were reduced from 20 to 12.9% in patients treated for obstructive colorectal cancer [13].

It is well-known that POSSUM and P-POSSUM overpredict general mortality and morbidity, and that the creation of subgroups is needed to more accurately estimate risk values [9–12]. CR-POSSUM is a specific scoring system for colorectal cancer and is more reliable but still needs further adjustment [15, 16]. In an attempt to improve the validity of POSSUM, we analysed the effect it has over different variables classically associated with surgical morbidity.

The classification of the American Society of Anesthesiology (ASA) has been used since 1961 to easily quantify surgical morbidity and mortality risk [24]. It has proven to be an accurate predictor of surgical risk, with an added predictive value when taking into account the age of the patients [25]. ASA staging, being a simple method, is partially open to subjective interpretation by the specialists and that is why it has been incorporated in other predictive indexes. In our analysis, we found an overprediction of the surgical morbidity rates for those patients with low anaesthetic risk (ASA I/II; 20.6% vs 27.3%) and a precise prediction for those with high anaesthetic risk (ASA III/IV; 40.5% vs 40.9%). In line with this, we also found an overprediction of the morbidity risk for the extreme age groups (<51 and >70 years old), and an accurate prediction for those age groups where colorectal cancer is more common (51–60 and 61–70 years old). Similar to other published studies [26–28], we did not find a higher incidence of complications among elderly patients. Therefore, we consider that similar surgical procedures can be done without increasing the number of complications.

Traditionally, radiotherapy has been associated with higher postoperative morbidity and mortality rates, principally due to a higher incidence of anastomotic leak. However, evidence for this is derived only from scientific experiments [29, 30]. According to our experience and that of other studies [31–35], the morbidity rates are not increased in patients treated with neoadjuvant therapy (group A), compared to those patients treated with surgery alone (group B) (22.9% vs 26.4%). When applying POSSUM to the groups created with this variable, we observed an overprediction of morbidity rates in patients receiving neoadjuvant therapy (group A) (22.9% vs 32.05%) and an accurate prediction in patients treated with surgery alone (group B) (32% vs 29.1%). This disparity could be explained by the absence of this variable (neoadjuvant therapy) among the physiological and operative parameters considered in POSSUM. We believe it is important to incorporate this variable in future predictive models.

The POSSUM scoring system includes in the Operative Severity Score the type of surgical procedure and the degree of tumour malignancy, classified from less to more (minor, intermediate, major and major+) and into lack of malignancy, primary neoplasia, lymph node metastasis and distant metastasis. Most of the surgical procedures were classified as major procedures. However, we analysed them according to the type of surgical procedure (anterior rectal resection, abdominoperineal resection and Hartmann's procedure) and the duration of surgery (<180 min and >180 min), noting an overprediction of the risk of complications for the anterior rectal resection and for Hartmann's procedure as well as an underprediction for the abdominoperineal resection. Similarly, when surgical time measured from the first incision up to the closure of the laparotomy was longer than 3 h, POSSUM correctly predicted the operative morbidity rate. It was, however, overpredicted for shorter surgical procedures. It is well known that abdominoperineal resection carries a higher incidence of operative complications, compared to anterior rectal resection [36, 37]. In our experience, we found a higher rate of wound infection and of abdominal abscess among patients undergoing rectal amputation, especially due to delayed perineal wound healing (5.0% vs 19.6%; p= 0.02) and (2.5% vs 8.9%; p=0.03). From these results, we consider it useful to define the domain "type of surgery" according to type of surgical procedure. Our results show a good correlation for low stages (Dukes A and B) and an underprediction for those cases with worse prognosis (Dukes C and D). The original POSSUM, as we saw above, categorises the domain "malignancy stage" according to the degree of malignancy; later modifications (CRPOSSUM) incorporate Dukes classification in the domain, probably correcting this potential error.

Finally, in an attempt to assess the internal consistency of POSSUM scoring system and guided by the work of Ramkumar [15], we validated the precision of POSSUM, using stratified risk intervals (Table 7). We have seen that when the expected proportion of complications in POS SUM increases, the number of patients with complications in our study increased also.

In conclusion, according to our experience, we think that the profit of these scores is to make results between institutions and publication comparable. POSSUM score should not be the only instrument to decide the best surgical option for patients according to our investigated results. The POSSUM scoring system and its later modifications (P-POSSUM and CR-POSSUM) overpredict the risk of operative mortality. In spite of that, POSSUM has permitted an important advance in the evaluation of colorectal cancer surgery, correctly estimating the probability of surgical morbidity in most cases. The described predictive models could also be used as a further step in the patient's preoperative informed consent. It could also be used to compare the clinical practice among several institutions and to detect and correct errors. So far, a precise scoring system for colorectal surgery has not been developed. However, successive modifications will bring it closer to reality. We consider that modifications in operative parameters according to the type of surgical procedure and specifications for neoadjuvant therapy, as well as modifications in physiological parameters including life style habits, could improve prediction of surgical risk in future. Further studies on these lines are needed to more accurately identify potential risk factors for surgical complications.

References

1. Prytherch DR, Whiteley MS, Higgins B, Weaver PC, Prout WG, Powell SJ (1998) POSSUM and Portsmouth POSSUM for predicting mortality. Physiological and operative severity score for the enumeration of mortality and morbidity. Br J Surg 85 (9):1217–1220
2. Oomen JL, Engel AF, Cuesta MA (2006) Mortality after acute surgery for complications of diverticular disease of the sigmoid colon is almost exclusively due to patient related factors. Colorectal Dis 8(2):112–119
3. Copeland GP, Jones D, Walters M (1991) POSSUM: a scoring system for surgical audit. Br J Surg 78(3):355–360 Mar
4. Neary WD, Heather BP, Earnshaw JJ (2003) The physiological and operative severity score for enumeration of mortality and morbidity (POSSUM). Br J Surg 90:157–165
5. Copeland GP (2002) The POSSUM system of surgical audit. Arch Surg 137:15–19
6. Tekkis PP, Kessaris N, Kocher HM, Poloniecki JD, Lyttle J, Windsor AC (2003) Evaluation of POSSUM and P-POSSUM scoring systems in patients undergoing colorectal surgery. Br J Surg 90(3):340–345
7. Whitely MS (1996) An evaluation of the POSSUM surgical scoring system. Br J Surg 83:812–815
8. Wijesinghe LD, Mahmood T, Sacott DJ, Berridge DC, Kent PJ, Kester RC (1998) Comparison of POSSUM and the Portsmouth predictor equation for predicting death following vascular surgery. Br J Surg 85:209–212
9. Poon JT, Chan B, Law WL (2005) Evaluation of P-POSSUM in surgery for obstructing colorectal cancer and correlation of the predicted mortality with different surgical options. Dis Colon Rectum 48(3):493–498
10. Menon KV, Farouk R (2002) An analysis of the accuracy of PPOSSUM scoring for mortality risk assessment after surgery for colorectal cancer. Colorectal Dis 4(3):197–200
11. Khoury G (2003) Evaluation of POSSUM and P-POSSUM scoring systems in patients undergoing colorectal surgery (Br J Surg 2003; 90: 340–345). Br J Surg 90(8):1021 author reply, Aug.

12. Brooks MJ, Sutton R, Sarin S (2005) Comparison of surgical risk score, POSSUM and p-POSSUM in higher-risk surgical patients. Br J Surg 92(10):1288–1292
13. Tekkis PP, Kinsman R, Thompson MD, Stamatakis JD (2004) The association of coloproctology of Great Britain and Ireland study of large bowel obstruction caused by colorectal cancer. Ann Surg 240:76–81
14. Law WL, Lam CM, Lee YM (2006) Evaluation of outcome of laparoscopic colorectal resection with POSSUM, Portsmouth POSSUM and colorectal POSSUM. Br J Surg 93(1):94–99
15. Ramkumar T, Ng V, Fowler L, Farouk R (2006) A comparison of POSSUM, P-POSSUM and colorectal POSSUM for the prediction of postoperative mortality in patients undergoing colorectal resection. Dis Colon Rectum 49(3):330–335
16. Senagore AJ, Warmuth AJ, Delaney CP, Tekkis PP, Fazio VW (2004) POSSUM, p-POSSUM, and Cr-POSSUM: implementation issues in a United States health care system for prediction of outcome for colon cancer resection. Dis Colon Rectum 47(9):1435–1441
17. American Society of Anesthesiologists (1963) New classification of physical status. Anesthesiology 24:111
18. AJCC (2002) Cancer staging handbook: TNM classification of malignant tumors. 6th edn. Sixth ed. Springer, New York
19. International Commission on Radiation Units and Measurements Report 50 (1993) Prescribing, recording, and reporting photon beam therapy. International Commission on Radiation Units

20. Molina GO, Garrido LO, Manterola CD (2005) Evaluación de resultados quirúrgicos. Validación inicial del escore POSSUM. Rev Chilena de Cirugía 57(4):291–296
21. Isbister WH (2000) Study populations and case mix: influence on analysis of postoperative outcomes. Aust NZ J Surg 70:279–284
22. Murray GHC, Fowler S, Dunn DC (1995) Presentation of comparative audit data. Br J Surg 82:329–332
23. Jones HJS, de Cossart L (1999) Risk scoring in surgical patients. Br J Surg 86:149–157
24. Dripps RD, Lamont A, Eckenhoff JE (1961) The role of anesthesia in surgical mortality. J Am Med Assoc 178:261–266
25. Hall JC, Hall JL (1996) ASA status and age predict adverse events after abdominal surgery. Journal for Quality in Clinical Practice 16 (2):103–108
26. Bufalari A, Giustozzi G, Burattini MF, Servili S, Bussotti C, Lucaroni E et al (2006) Rectal cancer surgery in the elderly: a multivariate analysis of outcome risk factors. J Surg Oncol 93 (3):173–180 Mar 1
27. Bold RJ (2006) Re: Rectal cancer surgery in the elderly: A multivariate analysis of outcome risk factors, by Bufalari A, Giustozzi G, Burattini MF, et al. J Surg Oncol 93(3):167–168
28. Puig la Calle J, Quayle J, Thaler HT, Shi W, Paty P, Quan SH et al (2000) Favorable short-term and long-term outcome after elective radical rectal cancer resection in patients 75 years of age or older. Dis Col Rectum 43(12):1704–1709
29. Kuzu MA, Koksoy C, Akyol F, Uzal D, Kale T (1998) Effects of preoperative fractionated irradiation on left colonic anastomoses in the rat. Dis Colon Rectum 41:370–376
30. Dominuez J, Jakate S, Speziale S, Savin M, Altringer WE, Saclarides TJ (1996) Intestinal anastomotic healing at varying times after irradiation. J Surg Res 61:293–299
31. Pucciarelli S, Toppan P, Friso ML, Fornasiero A, Vieceli G, Marchiori E et al (1999) Preoperative combined radiotherapy and chemotherapy for rectal cancer does not affect early postoperative morbidity and mortality in low anterior resection. Dis Colon Rectum 42(10):1276–1283 discussion 83–84.
32. Marijnen CA, Kapiteijn E, van de Velde CJ, Martijn H, Steup WH, Wiggers T et al (2002) Acute effects and complications after short term preoperative radiotherapy combined with total meso-rectal excision in primary rectal cancer: report of a multicenter randomized trial. J Clin Oncol 20:817–825.
33. Hyams DM, Mamounas EP, Petrelli N, Rockette H, Jones J, Wieand S et al (1997) A clinical trial to evaluate the worth of preoperative multimodality therapy in patients with operable carcinoma of the rectum. A progress report of national surgical adjuvant breast and bowel project protocol R.03. Dis Col Rectum 40(2):131–139
34. Shumate C, Rich T, Skibber J, Ajani J, Ota D (1993) Preoperative chemotherapy and radiation therapy for locally advanced primary and recurrent rectal carcinoma. A report of surgical morbidity. Cancer 71:3690–3696
35. Stryker SJ, Kiel KD, Rademaker A, Shaw J, Ujiki G, Poticha S (1996) Preoperative "chemoradiation" for stages II and III rectal cancer. Arch Surg 131:514–518.
36. Zaheer S, Pemberton JH, Farouk R, Dozois RR, Wolff BG, Ilstrup D (1998) Surgical treatment of adenocarcinoma of the rectum. Ann Surg 227(6):800–811.
37. Rosen L, Veidenheimer MC, Coller JA, Corman ML (1982) Mortality, morbidity, and patterns of recurrence after abdomino perineal resection for cancer of the rectum. Dis Colon Rectum 25:202
38. Isbister WH, Naser S (2002) POSSUM: A re-evaluation in patients undergoing surgery for rectal cancer. Aust NZ J Surg 72:421-425
39. Menon KV, Whiteley MS, Burden P, Galland RB (1999) Surgical patients with methicillin resistant staphylococcus aureus infection: An analysis of outcome using P-POSSUM. J R Coll Surg Edinb 44:161–163

40. Parinkh D, Johnson M, Chagla L, Lowe D (1996) Lessons from a prospective audit of the learning curve. Br J Surg 83:1595–1599
41. Sagar PM, Hartley MN, Mancey-Jones B, Sedman PC, May J, Macfie J (1994) Comparative audit of colorectal resection with the POSSUM scoring system. Br J Surg 81:1492–1494
42. Jones HJS, Foster GE, de Cossart L (1999) Colorectal surgery: does POSSUM predict outcome? Dis Col Rectum 42:A18
43. Cagigas JC, Escalante CF, Ingelmo A et al (1999) Application of POSSUM system to bariatric surgery. Obesity Surg 9:279–281.

Table 1 Patient demographics

	Group A	Percent	Group B	Percent	Total	Percent	p
	170		103		273		
<51	37	21.7	13	12.6	50	18.3	0.274
51–60	46	27.1	30	29.1	76	27.8	
61–70	60	35.3	39	37.8	99	36.2	
>70	27	15.9	21	20.4	48	17.5	
Sex							
M	116	68.2	68	66	184	67.4	0.705
F	54	31.7	35	34	89	32.6	
BMI							
<25	55	32.3	36	34.9	91	33.3	0.737
25–30	89	52.3	49	47.5	138	50.5	
>30	26	15.3	18	17.4	44	16.1	
ASA							
I/II	118	69.4	76	73.8	194	71.1	0.440
III/IV	52	30.6	27	26.2	79	28.9	
Location							
Inferior rectum<6 cm	89	52.3	33	32	122	44.6	0.002
Middlerectum 6–11 cm	54	31.8	39	37.9	93	34.0	
Superior rectum>11 cm	27	15.9	31	30.1	58	21.2	
Tumour stage							
T0	25	14.7	–	–	25	9.1	<0.001
T1	13	7.6	8	7.9	21	7.8	
T2	44	25.8	43	41.6	87	31.8	
T3	80	47.1	42	40.6	122	44.7	
T4	8	4.8	10	9.9	18	6.6	
N0	116	68.2	71	68.9	187	69.2	0.449
N1	42	24.7	21	20.3	63	23.3	
N2	12	7.1	11	10.6	23	8.4	
M0	158	92.9	79	76.7	237	87	0.001
M1	12	7	24	23.3	36	13	
Type of surgery							
AR	120	70.6	81	78.6	201	73.6	0.308
APR	41	24.1	16	15.5	57	20.9	
Hartmann	9	5.3	6	5.8	15	5.5	
Mean surgical duration	170		150				0.405
(range)	70–540		45–				
Mean hospital stay (days)	10		10			10	0.287
(range)	5–25		3–45			3–45	
Ileostomy	46	38.3	7	8.6	53	19.4	<0.001
Associated surgery	22	12.9	23	22.3	45	16.4	0.045
Blood transfusion	28	16.4	17	16.5	45	16.4	0.754

AR rectal anterior resection, APR abdominoperineal resection.

Table 2 Complications

	Group A	Percent	Group B	Percent	Total	Percent	p
Number of patients with complications	39	22.9	33	32.0	72	26.4	0.098
Wound infection	15	8.2	7	7.8	22	8.1	0.89
Abdominal abscess	8	4.7	5	4.9	13	4.8	0.955
Anastomotic leak	5	4.2	3	3.8	8	3.6	0.797
Haemorrhage	7	3.5	4	3.9	11	3.7	0.88
Urinary disturbances	12	6.5	5	4.9	17	5.9	0.582
Postoperative ileus	15	8.9	10	9.7	25	9.2	0.818
General complications	13	7.1	10	9.6	23	8.1	0.39
Mortality	1	0.6	1	1	2	0.7	0.719

Table 3 POSSUM observed and predicted morbidity and mortality

N	Number of complications	Number of deceased patients	Observed morbidity (%)	Observed mortality (%)	Mean predicted morbidity rate by POSSUM (%)	Mean predicted mortality rate by POSSUM (%)	Observed/predicted ratio	
273	72	2	26.4	0.7	31.2	6.64	0.84	0.10

POSSUM Physiologic and operative severity score for enumeration of morbidity and mortality

Table 4 POSSUM results by groups of therapy

Groups	Number of patients with complication	Observed morbidity (%)	Mean predicted morbidity rate by POSSUM (%)	Observed/predicted ratio
Group A (Rt +S), N = 170	39	22.9	32.05	0.71
Group B (S), N = 103	33	32	29.1	1.09

POSSUM Physiologic and Operative Severity Score for EnUmeration of Morbidity and Mortality, Rt Radiotherapy, S Surgery

Table 5 Comparison between observed and expected mortality by POSSUM, P-POSSUM and CR-POSSUM

N	Observed mortality (%)	POSSUM predicted mortality(%)	POSSUM O/P (%)	P-POSSUM expected mortality (%)	P-POSSUM O/P (%)	CR-POSSUM expected mortality (%)	CR-POSSUM O/P (%)
273	0.7	6.64	0.10	1.95	0.35	2.08	0.33

O/P Observed/predicted rate, *POSSUM* Physiologic and Operative Severity Score for EnUmeration of Morbidity and Mortality, *P-POSSUM* Portsmouth, *CR-POSSUM* colorectal

Table 6 POSSUM results according to type of surgery, age, Dukes and ASA

Interval (N)	Number of patients with complications	Observed morbidity (%)	Mean predicted morbidity rate by POSSUM (%)	Observed/ predicted ratio
Type of surgery				
AR (201)	46	23.1	30.3	0.76
AAP (56)	20	35.7	31.0	1.15
Hartmann (15)	6	40.0	46.8	0.85
Duration of surgery				
<180 min (194)	32	19.9	29.2	0.68
>180 min (79)	35	35.4	34.2	1.03
Age				
<51 (50)	10	19.9	26.9	0.73
51–60 (76)	18	28.9	27.2	1.06
61–70 (99)	29	34.8	32.0	1.08
>70 (48)	15	16.4	40.5	0.40

Dukes				
Dukes A (39)	13	33.3	31.9	1.04
Dukes B (129)	32	24.8	25.1	0.98
Dukes C (59)	15	25.4	34.6	0.73
Dukes D (6)	4	66.6	51.6	1.29
ASA				
ASA I/II (161)	40	20.6	27.3	0.75
ASA III/IV (99)	32	40.5	40.9	0.99

POSSUM Physiologic and Operative Severity Score for EnUmeration of Morbidity and Mortality

Table 7 Results according to risk intervals stratification by POSSUM (%)

Interval of POSSUM predicted risk (%)	Number of patients with complications	Total number of patients	Percentage (%)
0–25	30	131	22.9
25–50	28	105	26.6
50–75	11	31	35.4
75–100	3	6	50.0

POSSUM Physiologic and Operative Severity Score for EnUmeration of Morbidity and Mortality

Table 8 Studies using POSSUM [38]

Study	Physiological Score	Operative Score	Statistical parameter	Test
General surgery	20.9	15.6	Unknown	P-POSSUM
nMRSA [39]	17.4	9.2	–	–
Gastrectomy D2 [40]	14–16	18.5–21	Median	POSSUM
Colorectal surgery [41, 42]	20	13.5	Median	POSSUM
Bariatric surgery [43]	13.95	9.4	Mean	POSSUM
Rectal cancer [38]	14.6	18.3	Mean	P-POSSUM
CUN	16.07	13.03	Mean	POSSUM, P-POSSUM CR-POSSUM

MRSA methicillin-resistant Staphylococcus aureus.