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Role of surgical setting and patients-related factors in predicting the occurrence of postoperative pulmonary complications after abdominal surgery

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Abstract. – OBJECTIVE: The aim of this retrospective study was to evaluate the role of surgical setting (urgent *vs*. elective) and approach (open *vs*. laparoscopic) in affecting postoperative pulmonary complications (PPCs) prevalence in patients undergoing abdominal surgery.

PATIENTS AND METHODS: After local Ethical Committee approval, 409 patients who had undergone abdominal surgery between January and December 2014 were included in the final analysis.

PPCs were defined as the development of one of the following new findings: respiratory failure, pulmonary infection, aspiration pneumonia, pleural effusion, pneumothorax, atelectasis on chest X-ray, bronchospasm or un-planned urgent re-intubation.

RESULTS: PPCs prevalence was greater in urgent (33%) *vs*. elective setting (7%) (χ^2 with Yates correction: 44; p=0.0001) and in open (6%) *vs*. laparoscopic approach (1.9%) (χ^2 with Yates correction: 12; p=0.0006). PPCs occurrence was positively correlated with in-hospital mortality (Biserial Correlation r=0.37; p=0.0001). Logistic regression showed that urgent setting (p=0.000), Ariscat (Assess Respiratory Risk in Surgical Patients in Catalonia) score (p=0.004), and age (p=0.01) were predictors of PPCs. A cut-off of 23 for Ariscat score was also identified as determining factor for PPCs occurrence with 94% sensitivity and 29% specificity.

CONCLUSIONS: Patients undergoing abdominal surgery in an urgent setting were exposed to a higher risk of PPCs compared to patients scheduled for elective procedures. Ariscat score fitted with PPCs prevalence and older patients were exposed to a higher risk of PPCs. Prospective studies are needed to confirm these results.

Key Words:
Postoperative pulmonary complications, Abdominal surgery, surgical setting, Urgent, Elective, Open, Laparoscopic, Patients-centered care, Prediction, Personalized risk profile, Surgical approach.

Introduction

Postoperative pulmonary complications (PPCs) significantly contribute to the overall risk of surgery with a prevalence of 2-19%. PPCs are also associated with a prolonged length of hospital stay and a high in-hospital mortality[1-3].

Several scores for PPCs occurrence likelihood have been proposed[3,4]. Ariscat (Assess Respiratory Risk in Surgical Patients in Catalonia) score represents the most valuable tool to stratify PPCs risk[5,6].

Another crucial topic is the surgical setting in which procedures are performed. It is well known that all postoperative complications occur more frequently after emergent surgery[6,7]. Conversely, the role of the type of approach, open *vs*. laparoscopic, has not been methodically evaluated in literature.

The aim of this retrospective study was to evaluate the role of surgical setting (urgent *vs*. elective) and approach (open *vs*. laparoscopic) in affecting PPCs prevalence in patients undergoing abdominal surgery.

Patients and Methods

After local Ethical Committee approval, 464 patients who had undergone abdominal surgery (inclu-

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ding right/left hemicolectomy; partial/total colectomy; Hartmann's procedure; colostomy/ileostomy; abdominal abscess drainage; cholecystectomy for cholecystitis; splenectomy for non-traumatic causes; gastrectomy; liver resection; gastro-enterostomy; pancreatico-duodenectomy) between January and December 2014 were retrospectively studied.

Inclusion criteria were: age ≥18 years; elective or urgent (surgery required within <48h) abdominal surgery; general anesthesia; protective lung ventilation (tidal volume <8 ml/kg with positive end-expiratory pressure ranging from 8 to 12 cmH_2O); monitoring of neuromuscular block throughout the surgical procedure.

Exclusion criteria included: chronic or acute respiratory diseases, body mass index >35 kg/m^2, acute respiratory distress syndrome, persistent hemodynamic instability, severe cardiac disease, recent immunosuppressive medication (within the last 2 months), ASA physical status >3, diseases expected to require postoperative mechanical ventilation; emergent surgery; blood loss >20% of patients' blood volume; epidural analgesia; planned or unplanned intensive care admission.

PPCs were defined as the development of one of the following new findings: respiratory failure (SpO_2< 90% despite supplemental oxygen or a PaO_2< 60 mmHg or need for non–invasive or invasive mechanical ventilation), pulmonary infection (chest X-ray demonstrating unilateral or bilateral infiltrates), aspiration pneumonia, pleural effusion, pneumothorax, atelectasis on chest X-ray, bronchospasm, or un-planned urgent re-intubation.

Ariscat score was calculated for each patient were 0 points was assigned to the laparoscopic approach.

Statistical Analysis

Student's *t*-test or chi-square test with Yates correction were used as appropriate. Odds ratios (OR) were calculated for PPCs prevalence in open *vs*. laparoscopic approach or urgent *vs*. elective setting. The biserial correlation was run between PPCs occurrence and in-hospital mortality. Logistic regression was used to identify possible PPCs predictors. Ariscat score cut-off was calculated establishing a sensitivity > 0.9 (post-regression analysis).

A significance level of $p<0.05$ was used. Statistical analyses were performed using Statistica Version 6.1 software (StatSoft, Tulsa, OK, USA).

Results

Fifty-five patients were excluded because they did not meet inclusion/exclusion criteria. 409 patients [age 57.7±20.6; gender (M/F): 223/186); ASA physical status I, II, III (146/189/74)] were included in the final analysis. PPCs prevalence was greater in urgent than that found in elective surgery (33% *vs*. 7%, $p<0.0001$; OR=6.4) and in case of open *vs*. laparoscopic approach (6% *vs*. 1.9%, $p<0.001$; OR=4.3) (Table I).

Patients with PPCs (n=74) had the following drawbacks: pulmonary infection (n=34), atelectasis (n=13), pleural effusion (n=12), respiratory failure (n=5), bronchospasm (n=5), pneumothorax (n=2), aspiration pneumonia (n=2), and unplanned urgent re-intubation (n=1).

There was a positive correlation between PPCs occurrence and in-hospital mortality; out of 26 deceased patients, 19 had PPCs (Biserial Correlation r=0.37; $p=0.0001$). No correlation was found between surgery duration (178.7±98.2) and PPCs (Pearson r: -0.035; $p=0.484$).

Logistic regression showed that urgent setting ($p=0.0001$), age ($p=0.01$) and Ariscat score (30.7±15.9) ($p=0.004$), but not open approach ($p=0.135$), were predictors of PPCs (Model Log-Likelihood=302; Likelihood Ratio=84.7; $p<0.0001$).

Moreover, a cut-off of 23 for Ariscat score was identified as a determinant for the occurrence of PPCs, with 94% sensitivity and 29% specificity (Figure 1).

Discussion

The main finding of this study was that urgent setting, increased age, and higher Ariscat score were predictors of PPCs occurrence. PPCs were also positively correlated with the in-hospital mortality, as also showed by previous studies[1-3].

The emergent surgical setting is considered one of the main procedure-related risk factors for PPCs[1-3,8]. Difference between emergent and urgent surgery setting exists, as they are immediately and potentially life-threatening, respectively. Patients undergoing emergent surgery are hypovolemic and require early aggressive resuscitative efforts[8]. For this reason, the risk of postoperative complications in an emergent setting is easily anticipated. On the other hand, the prevalence of postoperative complications in an urgent setting is less known.

As regards surgical approach, our study showed that there was a significantly greater PPCs prevalence in open *vs*. laparoscopic approach with an OR of 4.3. However, open approach did not affect the risk of PPCs in the regression

Table I. PPCs prevalence and OR in urgent *vs*. elective setting and in open *vs*. laparoscopic approach.

	PPCs (yes/no)	χ^2 with Yates correction	OR	*p*
Urgent setting	57/115	43.61	6.4 (CI: 3.6-11.5) z=6.2	<0.0001
Elective setting	17/220			
Open approach	68/242	11.71	4.3 (CI: 1.8-10.4) z=3.3	<0.001
Laparoscopic approach	6/93			

CI= 95% confidence interval; OR=odds ratio.

model. According to this finding, most of the previous studies did not reach sufficient statistical power to detect differences in PPCs rates between the two approaches[7].

In this study, increased age was found to predicting PPCs. It has been previously showed that advanced age (>60 years) is an important predictor of PPCs, despite adjustment for comorbid conditions[1].

Finally, Ariscat score was able to predict PPCs occurrence with a cut-off (23) near to that (26) reported by previous studies[5,6].

In this study, protective lung ventilation and monitoring of neuromuscular block were considered as criteria for including patients in the final sample. These two strategies seem to have a key role in improving patients' outcome[9-12].

The main limit of this study remains its retrospective design that leads to possible bias. Another limit is the use of Ariscat score which does not take into account laparoscopic approach[5].

Conclusions

Patients undergoing abdominal surgery in an urgent setting were exposed to a higher risk of PPCs compared to patients scheduled for elective operations. Ariscat score fitted with PPCs prevalence and older patients were exposed to a higher risk of PPCs.

Further prospective studies are needed to confirm the role of surgical setting and to clarify the importance of surgical approach in affecting PPCs occurrence.

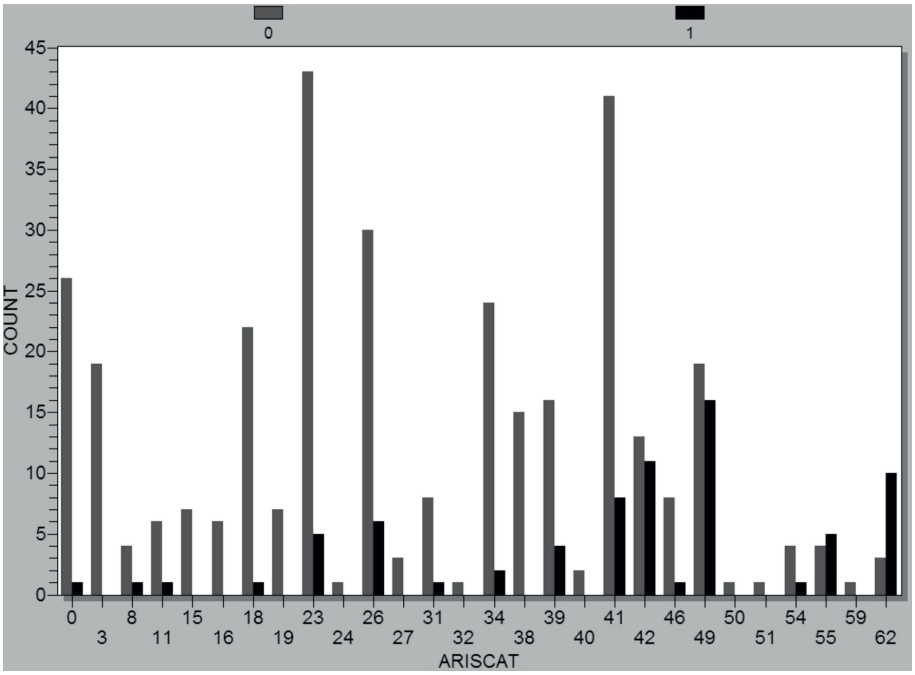

Figure 1. Plot of patients (n) experiencing (1) or not (0) PPCs for each value of Ariscat score.

Conflict of interest

The authors declare no conflicts of interest.

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