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Predicting Pulmonary Complications Following Upper and Lower Abdominal Surgery: ASA vs. ARISCAT Risk Index

Sibel Kara[1], Elif Küpeli[2], Hatice Eylül Bozkurt Yılmaz[1], Hakan Yabanoğlu[3]

[1]Department of Chest Disease, Başkent University Adana Training and Research Center, Adana, Turkey
[2]Department of Chest Diseases, Başkent University School of Medicine, Ankara, Turkey
[3]Department of General Surgery, Başkent University Adana Teaching and Research Center, Adana, Turkey

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Abstract

Objective: Postoperative pulmonary complications (POPC) account for a substantial proportion of risk related to surgery and anaesthesia. The American Society of Anesthesiologists (ASA) classification and the Assess Respiratory Risk in Surgical Patients in Catalonia (ARISCAT) risk index correlate well with POPC. Here, we compared their accuracy in predicting pulmonary complications following upper and lower abdominal surgery.

Methods: We retrospectively reviewed the medical records of patients undergoing upper and lower abdominal surgery. We collected patients' demographic data, comorbidities, preoperative pulmonary risk score, laboratory results, surgical data, respiratory tract infection history within one month before surgery, surgical urgency, ASA scores and pulmonary complications within one month after the surgery.

Results: We evaluated 241 patients [upper abdominal surgery (UAS) n=121; lower abdominal surgery (LAS) n=120; mean age 55.7±3.1 years]. In the UAS, 55.8% of the patients were male. In LAS, all patients were female. In both groups, the most common POPC was pleural effusion with compressive atelectasis (CA). Regarding risk score, in both groups, patients with high-risk developed a higher rate of pulmonary complications [UAS (50%), LAS (40%)]. In patients with low-risk scores, the rate of pulmonary complications was significantly lower than the intermediate and high-risk groups ($p<0.001$). A positive correlation was observed between preoperative risk score and complications (UAS $r=0.34$; LAS $r=0.35$ $p<0.05$). No association was observed between the ASA scores and POPC ($p=0.8$).

Conclusion: The ASA classification was found to be a weaker modality than ARİSCAT risk index to predict pulmonary complications after the upper and lower abdominal surgeries.

Keywords: Abdominal surgery, ARISCAT, ASA, postoperative complications

Introduction

Postoperative pulmonary complications (POPC) are related to various risk factors. POPC are an important cause of morbidity and mortality in the postoperative period (1, 2). The American Society of Anesthesiologists (ASA) scale is commonly used to subjectively estimate preoperative health status. Although originally created to collect statistical data and reporting in anaesthesia, it is now used to predict perioperative risk (3-5). With this scale, patients are divided according to how their underlying medical problems produce functional impediments to their daily activities (Table 1). Risks inherent to a specific procedure are not incorporated into the ASA classification. The Assess Respiratory Risk in Surgical Patients in Catalonia (ARISCAT) risk index is another tool based on easily assessed seven factors. The index can be used to assess individual risk of POPC2 (Table 2).

Methods

Patient population

We retrospectively reviewed medical records of patients who underwent upper and lower abdominal surgery (LAS) in our institution between January and June 2017. Upper abdominal surgeries included cholecystectomy, gastrec-

Corresponding Author: Sibel Kara E-mail: sibelkarasb@hotmail.com

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Table 1. The American Society of Anesthesiologists Physical Status Classification System

ASA 1: A normal healthy patient
ASA 2: A patient with mild systemic disease ASA 3 A patient with severe systemic disease
ASA 4: A patient with severe systemic disease that is a constant threat to life ASA 5 A moribund patient who is not expected to survive without the operation ASA 6 A declared brain-dead patient whose organs are being removed for donor purpose

ASA: The American Society of Anesthesiologists Physical Status Classification System

Table 2. The Assess Respiratory Risk in Surgical Patients in Catalonia Risk Index: Independent predictors of postoperative pulmonary complications

Risk Factor	Risk Score
Age, years	
≤50	0
52–80	3
>80	16
Preoperative O2 saturation	
≥96%	0
96%–95%	8
≤90%	24
Respiratory infection in the last month	17
Preoperative anaemia, haemoglobin ≤10 g dL^{-1}	11
Surgical incision	
Upper abdominal	15
Intrathoracic	24
Duration of surgery	
≤2 hours	0
2–3 hours	16
>3 hours	23
Emergency surgery	8
Risk class; No. of points in risk score	(Pulmonary complication rate)
Low	<26 points (1.6%)
Intermediate	26–44 points (13.3%)
High	>44 points (42.1%)

Main Points:

- As it is known, ASA is already a method used to predict pulmonary complications. ARISCAT is another method used. We compared this study with ASA and ARISCAT in terms of efficacy in determining the risk in abdominal surgery. .Our study is the first study in this field.
- In our study, we found ARISCAT to be more effective.
- As a result; Although further studies are needed in this area, we have demonstrated that ASRISCA can also be used effectively in determining the risk of pulmonary complications.

tomy, non-traumatic splenectomy, liver segmentectomy, distal pancreotectomy, liver abscess drainage and partial small bowel resection. Lower abdominal surgeries included corpus uteri, cervix uteri neoplasm, ovarian and vaginal malignancy. We recorded patient demographics, smoking history, comorbidities, preoperative pulmonary risk scores (age, oxygen saturation, haemoglobin level, type of incision, length of the surgery, history of lower respiratory tract infection one month before the surgery, urgency of surgery), ASA classification, and type of pulmonary complications that occurred in the first month after the surgery. Review board and the ethics committee of the university approved this study.

Assessment of postoperative pulmonary risk

Documented surgical information, including an ASA scale assigned by an anaesthesiologist in the operating room, was reviewed for all patients. The ARISCAT risk index was used to predict the overall incidence of POPC (of any severity), by assigning a weighted point score to seven independent risk factors. These risk factors are advanced age, low oxygen saturation at rest, preoperative low haemoglobin level, type of incision, length of surgery and history of respiratory tract infection one month before the surgery.

Statistical analyses

We analysed the data using commercially available software (Statistical Product and Services Solutions, version 20.0, IBM SPSS Corp.; Armonk, NY, USA). The Kolmogorov-Smirnov and Shapiro-Wilk tests and histograms were used as tests of normality. Continuous data were presented as means ± standard deviation. Chi-squared test was used to compare the qualitative variables. For investigation of associations between non-normally distributed or ordinal variables, correlation coefficients and their significance were calculated with the Spearman test. All p values are two-tailed, and p values <0.05 were considered statistically significant.

Definitions of POPC

We recorded types of pulmonary complications within one month after the surgery. Lower respiratory tract infection was defined as presence of cough with purulent sputum, temperature higher than 38°C and leucocytosis with response to appropriate antimicrobial therapy. Pneumonia was defined as

Table 3. Patient demographics (n=241)

	UAS (n=120)	LAS (n=121)
Age	54.61±2.73	56.97±1.95
Sex (F/M), n (%)	67/53 (55.8/44.2)	121/0 (100/0)
Smoking history, n (%)	37 (30.80)	20 (16.50)
Smoking history (range: pack/years)	0–52	0–45
Comorbidity, n (%)		
Hypertension	47 (39.2)	44 (36.4)
DM	7 (5.8)	7 (5.8)
Asthma	4 (3.3)	5 (4.1)
CAD	2 (1.7)	-
Obesity	2 (1.7)	3 (2.5)
COPD	1 (0.8)	1 (0.8)
Chronic renal failure	1 (0.8)	-
None	56 (46.7)	61 (50.4)

DM: diabetes mellitus; CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease

Table 4. Pulmonary complications within one month after surgery

	UAS, n (%)	LAS, n (%)
Pulmonary complication	12 (10)	22 (18.2)
Pleural effusion + CA	7 (5.8)	8 (6.6)
Atelectasis	2 (1.6)	7 (5.8)
Pleural effusion	2 (1.6)	6 (4.9)
Pneumonia	1 (0.8)	1 (0.8)

CA: compressive atelectasis; UAS: upper abdominal surgery; LAS: lower abdominal surgery

presence of the above symptoms along with new lung infiltrates on chest radiographs (6).

Pulmonary embolism was suspected based on the patient's clinical and laboratory data (D-dimer, chest X-ray, arterial blood gases); and computerised tomography was objectively verified using pulmonary angiography.

Results

Our study included 241 patients (UAS, n=121; LAS, n=120). In the UAS group, 55.8% of the patients were male. In the LAS group, all patients were female. Hypertension was the most common comorbidity in both groups (UAS, n=39.2%; LAS, n=36.4%). Demographic characteristics of the patients are shown in Table 3. Thirty-four patients [UAS, n=12 (10%); LAS, n=22 (18.2%)] developed pulmonary complication within first month after the surgery. In both groups, the most common POPC was pleural effusion with compressive atelectasis (CA) [UAS, n=7 (5.8%); LAS, n=8 (6.6%)] (Table 2). There were no deaths directly attributed to pulmonary complications. The number of complications according to ASA scale is depicted in Table 5.

Table 5. Complication rates in one month according to ASA scale

ASA level	N	Complications in one month, n (%)
UAS		
ASA 1	18	-
ASA 2	62	7 (11.3)
ASA 3	39	5 (12.8)
ASA 4	1	-
ASA 5	-	
ASA 6	-	
LAS		
ASA 1	27	4 (14.8)
ASA 2	76	14 (18.4)
ASA 3	18	4 (22.2)
ASA 4	-	
ASA 5	-	
ASA 6	-	

UAS: upper abdominal surgery; LAS: lower abdominal surgery

Table 6. Pulmonary complication incidence according to assess respiratory risk in surgical patients due to ARISCAT risk index

Upper abdominal surgery		
ARISCAT Risk Index	**n=120**	**Pulmonary complication within first month, n (%)**
Low	95 (%)	5 (5.3)
Intermediate	23 (%)	6 (26.1)
High	2 (%)	1 (50)
Lower abdominal surgery		
ARISCAT Risk Index	**n=120**	
Low	17	-
Intermediate	99	20 (20.2)
High	5	2 (40)

ARISCAT: Assess Respiratory Risk in Surgical Patients in Catalonia

The UAS group had a high pulmonary risk score in 50% of patients, and the rest were the low-risk scored ones with low pulmonary complications. In this study, 35.6% of patients had haemoglobin levels less than 10 g dL^{-1}, and no complications occurred in these patients.

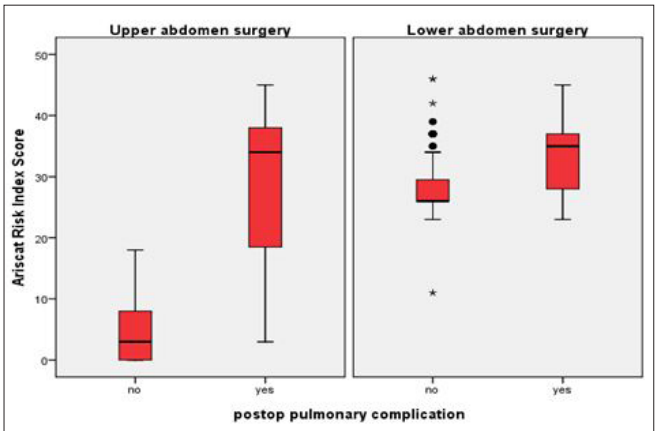

Figure 1. ARISCAT Risk Index Score and Pulmonary Complication Incidence

In the LAS group, pulmonary complications developed in 40% of patients with high preoperative pulmonary risk score, and no pulmonary complications occurred in patients with low risk. Patients with low-risk scores had lower rates of pulmonary complications than those in the intermediate- and high-risk groups with a statistically significant difference (Table 6). A positive correlation was observed between the preoperative pulmonary risk score and the POPC (UAS, r=0.345; LAS, r=0.359; $p<0.05$; Figure 1). No positive correlation was observed between age and development of POPC in all patients.

No significant association was observed between the ASA scores and POPC (p=0.7). There was little concordance between the ASA scores and ARISCAT risk index.

Discussion

To our knowledge, the value of the ASA scale has not been compared against the ARISCAT risk index to estimate the POPC in upper and LAS. In this study, the ASA scale was found to be a weaker modality to predict the pulmonary complications after upper and lower abdomen surgery, whereas the ARISCAT risk index was found to be more reliable.

The ASA scale is commonly used to subjectively observe preoperative health status. Most reliability studies of the ASA demonstrated a lack of interrater reliability in assigning ASA score, thus raising concerns about the scale's reliability (7, 8). Sankar et al. (9) showed that ASA scale has moderate interrater reliability in clinical practice (9).

There are no guidelines on how a patient's age should be considered when assigning ASA scores. On the other hand, in a systematic review, age was considered as an independent risk factor for POPC (1). The ARISCAT risk index has a similar classification of age as an independent risk factor. Küpeli et al. (10) demonstrated a positive correlation between age and POPC in patients undergoing renal transplantation. In our study, we scored the patients accordingly, but no positive correlation was observed between age and the development of POPC.

So much variation was observed between individual anaesthetist's assessments when describing common clinical problems that the ASA grade alone cannot be considered to satisfactorily describe the physical status of a patient (11). Saklad noted that the ASA scores were not related to surgeon, the ability of the surgeon, anaesthetist or the type of anaesthesia the patient received (12). Nonetheless, many anaesthesiologists still consider the ASA scale as an anaesthesia risk predictor (8). Although upper and LAS is a major surgery, in UAS group, we had only one patient who had ASA scale 4 and developed no pulmonary complications.

In the literature, little data exist regarding the relation between ASA scale and POPC. Nevertheless, the scale does have a moderate ability to predict postoperative mortality and cardiac complications (9). Küpeli et al. (10) demonstrated no relation between ASA and POPC following renal transplants. This study also demonstrated no association between ASA and POPC; however, larger cohorts studies are required to confirm these findings.

The ARISCAT risk index is useful to classify risks to preoperative consulted patients and, in some cases, identifying the most likely patients to benefit from risk reduction interventions. In this study, patients with low-risk scores in both groups had fewer pulmonary complications than those in the intermediate- and high-risk groups. A positive correlation was also observed between the preoperative pulmonary risk score and POPC.

Preoperative arterial oxyhaemoglobin saturation is an easy and objective measure to determine the level of risk for cardiorespiratory dysfunction. It is important as a risk factor in the ARISSCAT risk index (13, 14). In our study, only nine patients (3.7%) had low oxygen saturation. No complications occurred in these patients.

Data regarding the risk of POPC among adults with recent upper respiratory infections are limited. It has been shown that children with active upper respiratory infection have more minor postoperative respiratory events such as oxygen desaturation, but no apparent increase in morbidity or long-term sequelae (15). Whether the same applies to surgical outcomes in adults is still unknown. However, it would seem wise to defer elective surgery in this setting. In this study, patient with a recent upper respiratory tract infection was not detected.

Several large-scale retrospective studies have reported that preoperative anaemia is associated with an increased risk of 30-day postoperative mortality (16, 17). Preoperative assess-

ment and correction of haemoglobin concentrations to normal value might reduce mortality in upper and LAS. In this study, 35.6% of patients had a haemoglobin levels less than 10 g dL^{-1}, and these patients did not develop any complication.

The surgical side that risk factor according to the ARISCAT is the single most important factor in predicting the general risk of POPC, the incidence of complications is inversely proportional to the distance of the surgical incision from the diaphragm. In our study, pulmonary complication rate was 10% in the UAS group and 18% in the LAS group. There may be a few reasons why fewer POPC are seen in the UAC group. First, it may be because the UAS group is less likely to have POPC, and more than half of the patients have undergone laparoscopic surgery. In the LAS group, more open surgery was used. A recent study by Perilli et al. (18) found that patients who underwent laparoscopic abdominal surgery had fewer pulmonary complications than those with open surgery. In the literature, it has been shown that surgical procedures more than four hours in three years are associated with higher risk of pulmonary complications (19).

A few limitations are worth discussing in this study. First, it was a retrospective study from a single institution. Second, our patient population was low. Third, the number of patients with ASA 4 and 5 was low in both groups. Thus, we cannot predict the complication rate with high ASA scores.

Conclusion

All health professionals who are interested in abdominal surgery should be aware of possible risk factors before surgery. Although ASA scale is commonly used to subjectively estimate preoperative health status, ARISCAT risk index is a stronger tool to predict POPC in both the upper and lower abdomen surgeries. It also has the advantage of being simple to manually calculate at the bedside with clinical information.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Baskent University (12/28/2018-KA18/432).

Informed Consent: Since this study was planned and performed retrospectively, we do not have a patient consent form.

Peer-review: Externally peer-reviewed.

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