

The impact of the last ten minutes of surgery on hemorrhagic complications after laparoscopic sleeve gastrectomy.

Case-control study

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Abstract

Introduction: Hemorrhagic complications after laparoscopic sleeve gastrectomy (LSG) are among the most common adverse events. The last 10 min of LSG are essential in terms of hemostasis.

Aim: To assess the blood pressure profile in the last 10 min of LSG in patients who experienced hemorrhagic complications after laparoscopic sleeve gastrectomy.

Material and methods: We performed a retrospective case-control study. The medical records of 867 patients who underwent primary LSG were analyzed. Cases were defined as patients who required surgical revision due to hemorrhagic complications within 72 h. Controls were matched (1 : 1) with cases by age, body mass index, gender, staple line reinforcement, comorbidities and surgeon's experience. Comparison of the last three intraoperative blood pressure measurements at the end of surgery was made.

Results: The bleeding rate was 3.0%. A total of 24 subjects (12 matched pairs) were included in the study. Cases had statistically significant increased mean arterial blood pressure (mm Hg) 5 min before the end of surgery (87.8 ± 11.9 vs. 79.4 ± 8.8 mm Hg, $p = 0.049$) and at the end of surgery (89.2 ± 11.7 vs. 77.5 ± 11.8 mm Hg, $p = 0.011$). Higher diastolic blood pressure measurements were observed 5 min before the end (72.1 ± 10.7 vs. 62.8 ± 8.1 mm Hg, $p = 0.023$) and at the end of surgery (74.2 ± 10.0 vs. 60.8 ± 11.2 mm Hg, $p = 0.004$).

Conclusions: Compared with closely matched control subjects, patients with HC after LSG have increased mean arterial pressure in the last 5 min of surgery. This phenomenon has not been reported in the literature before.

Key words: laparoscopic sleeve gastrectomy, complications, bariatric surgery, bleeding.

Introduction

Laparoscopic sleeve gastrectomy (LSG) is the most popular bariatric procedure [1, 2]. It gained popularity amongst surgeons due to simplicity. The long term weight loss and metabolic outcomes of LSG are generally good [3–5]. Adverse events include gastric leak, stenosis and postoperative bleeding. The bleeding rate after LSG varies from 1% to 5% [6].

Although hemorrhagic complications are among the most common adverse events, the issue is not explored enough. Our previous study indicated that hypertension is a significant risk factor for postoperative bleeding in patients after LSG [7]. This finding leads us to further studies on bleeding complications and blood pressure measurements. The analysis of postoperative blood pressure profile showed opposite results to the popular belief that patients

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with hypertension in the postoperative period are more likely to have bleeding complications [8]. This case-control study of intraoperative blood pressure was undertaken to investigate the association between blood pressure at the end of the surgical procedure and postoperative bleeding.

Aim

The study aimed to assess the blood pressure profile in the last 10 min of LSG in patients who experienced hemorrhagic complications after laparoscopic sleeve gastrectomy.

Material and methods

Study design

We performed a retrospective case-control study. The medical records of 867 patients who underwent primary laparoscopic sleeve gastrectomy were analyzed. Patients underwent surgery between January 2013 and December 2017 in a single bariatric unit. Part of this cohort was used in our previous publications [9]. We decided to focus on the last 10 min of surgery – defined as 10 min before the end of anaesthesia. It is the time when a surgeon assesses a surgical field and performs homeostasis before the surgery ends. The period also includes the hemodynamic changes resulting from gas exsufflation and the changing of the patients' position.

Participants – subjects

Cases were defined as patients who required surgical revision due to hemorrhagic complications within 72 h. Hemorrhagic complications included bleeding from different sources, including the staple line, omentum, short gastric vessels and abdominal wall as well as the presence of a large hematoma [10]. We identified 26 cases of patients with hemorrhagic complications. Patients who were taking anti-coagulation drugs were excluded.

Participants – normal controls

Controls patients were taken retrospectively from the rest of the subjects who underwent LSG between January 2013 and December 2017 and did not experience any of the following complications: hemorrhagic complications, gastric leakage or sleeve stenosis. All controls identified as potential matched controls for the cases.

Matching

Controls were matched (1 : 1) with cases by age (± 3 year), BMI (± 4 kg/m²) gender (female versus male), staple line reinforcement (running suture versus hemostatic clips), comorbidities (diabetes, hypertension and obstructive sleep apnea) and surgeon's experience (> 50 or < 50 LSG procedures per year). A control subject was selected for each patient with HC using the algorithm described by Kawabata (1 : 1 matching method) [11]. Cases for whom we could not identify suitable matching control subjects were excluded from the study.

Surgical technique and measurements

Surgical technique and postoperative management were described in our previous publications [9]. In all cases, we used 15 mm Hg intrabdominal pressure for pneumoperitoneum. The automatic blood pressure measurements were recorded within every 5 min. We compared the last three blood pressure measurements – (1st) ten and (2nd) 5 min before the end of surgery and at the end of the surgery (3rd). The first measurement corresponds with surgical field inspection for bleeding. The second and third measurements correspond with the hemodynamic changes resulting from exsufflation and change of reverse Trendelenburg to the supine position.

Bias

Observers were blind to the exposure, and the data were collected retrospectively from medical records by a single investigator. The risk of information bias is low. To minimize selection bias, we analyzed a large number of cases of primary LSG. Regarding the reports, LSG constitutes about 800 bariatric procedures per year in Poland [2]. Thus, our data are representative. All patients underwent the same procedure according to the standard surgical technique of LSG described before, which eliminate referral bias. The study size was dependent on the number of patients with HC who were matched with controls.

Statistical analysis

The analysis was performed using SAS software, University Edition (SAS Institute Inc., Cary, NC, USA). Continuous outcomes were analyzed using the paired *t*-test, or Wilcoxon signed ranks test. Dichot-

Table I. Demographic characteristics of analyzed patients (n = 867)

Characteristics	Mean (SD) or %
Age [years]	40.7 (11.8)
BMI [kg/m ²]	46.2 (7.4)
Gender (female)	487 (56.2%)
Hypertension	413 (50.8%)
Diabetes	161 (19.2%)
Dyslipidemia	87 (10.4%)
OSA	49 (5.9%)
LOS [days]	3.7 (1.6)
Mortality	1 (0.3)
Leak	3 (0.35)
HC (from 2013 to 2017):	26 (3.0%)*
2013	3/146 (2.0%)
2014	14 /188 (6.9%)
2015	4/175 (2.2%)
2016	3/198 (1.5%)
2017	2/137 (1.4%)

*The p-value for observed differences of HC incidence from 2013 to 2017 was significant (0.019).

omous outcomes were analyzed using McNemar’s test. The analysis of matched (dependent) data is different from unmatched (independent) data and is described in detail by Breslow and Day [12].

Results

The cumulative bleeding rate was 3.0%. However, we observed changes in this rate between years. The highest percentage (6.9%) was noted in 2014. It was associated with the beginning of the learning curve for new surgeons, who were introduced to the bariatric practice that year. A total of 24 subjects (12 matched pairs) were included in the study. Table I shows the descriptive characteristics of the patients. The groups were closely matched as expected (Table II). In 9 cases, the source of bleeding was identified. In 6 cases the bleeding was from the staple line, in 2 cases from short gastric vessels and in 1 case from splenic injury (Table III). Patients who experienced hemorrhagic complications after LSG had statistically significantly increased mean arterial blood pressure (mm Hg) 5 min before the end of surgery (87.7 ±11.9 vs. 79.4 ±8.8 mm Hg, p = 0.049) and the

Table II. Demographic characteristics of matched patients

Characteristics	Patients with HC (n = 12)	Controls subjects (n = 12)	P-value
Age [years]	42.0 ±11.2	42.5 ±11.3	0.437
BMI [kg/m ²]	43.5 ±5.9	43.6 ±4.8	0.970
Gender:			
Female	6 (50%)	6 (50%)	–
Male	6 (50%)	6 (50%)	
Comorbidities:			
Hypertension	6 (50%)	6 (50%)	–
Diabetes	2 (17%)	2 (17%)	–
Dyslipidemia	1 (8%)	1 (8%)	–
OSA	0 (0%)	0 (0%)	
Staple line reinforcement:			
Hemostatic clips	8 (67%)	8 (67%)	–
Running suture	4 (33%)	4 (33%)	
Surgeon’s experience:			
Low	5 (42%)	5 (42%)	–
High	7 (58%)	7 (58%)	

end of surgery (89.2 ±11.7 vs. 77.5 ±11.8 mm Hg, $p = 0.011$). The detailed analysis revealed significantly higher diastolic blood pressure measurements 5 min before the end (72.1 ±10.7 vs. 62.8 ±8.1 mm Hg, $p = 0.023$) and at the end of surgery (74.2 ±10.0 vs. 60.8 ±11.2 mm Hg, $p = 0.004$) (Table IV).

We observed a clear increasing tendency in mean arterial pressure, systolic and diastolic blood pressure in cases over the last 5 min of surgery, while in controls this tendency was the opposite (Figure 1).

Discussion

This study reports the blood pressure profile in the last 10 min of LSG in patients who experienced hemorrhagic complications, compared with closely matched controls. Data were extracted out of the retrospectively collected database of patients who underwent LSG between January 2013 and May 2017 in a single bariatric unit.

We hypothesized that low blood pressure at the end of surgery might lead to inadequate assessment of bleeding, which should be stopped before the procedure is ended. However, in the first measurement, there was no significant difference. It means that during the bleeding assessment, the blood pressure was comparable. Our hypothesis failed. Surprisingly, we observed an increasing tendency in mean arterial pressure, and diastolic blood pressure in cases over the last 5 min of surgery, while in controls this tendency was opposite. Even though the results were statistically significant, the observed changes were not clinically meaningful. The differences were too small to be useful in daily practice. In our opinion,

Table III. Source of bleeding ($n = 12$)

Source of bleeding	N	%
Unknow	3	25.00
Staple line	6	50.00
Short gastric vessels/Omentum	2	16.66
Spleen	1	8.33

the phenomenon indicates that the two groups differ in the way they react to gas exsufflation. The observation may indicate the next direction for future studies on the hemodynamic changes during exsufflation.

Altered physiology has been demonstrated during laparoscopy in obese patients. The physiological changes are a result of patient position, absorption of CO₂, and increased intra-abdominal pressure due to pneumoperitoneum. Pneumoperitoneum affects intraoperative hemodynamics and cardiac function in morbidly obese patients. Heart rate, mean arterial pressure and central venous pressure increased [13]. At the end of laparoscopic bariatric surgery, there are two main events which provoke hemodynamic changes – exsufflation and change of reverse Trendelenburg to the supine position. A study group investigating the effect of laparoscopy in cholecystectomy on hemodynamics observed that the fall in mean arterial pressure after exsufflation could result from the reversal of the impact of CO₂ pneumoperitoneum [14]. There were no similar studies on bariatric procedures.

Interestingly, in our study patients who experienced hemorrhagic complications after LSG tended

Table IV. Blood pressure measurements of last 10 min of surgery

Variable	Last 15 min of surgery		
	10 min before the end	5 min before the end	15 min before the end
Mean arterial pressure [mm Hg]:			
Cases	84.4 (7.7)	87.7 (11.9)*	89.2 (11.7)**
Control	83.6 (9.6)	79.4 (8.8)*	77.5 (11.8)**
Systolic blood pressure [mm Hg]:			
Cases	117.5 (13.4)	119.2 (19.5)	119.2 (17.3)
Control	120.0 (15.2)	114.2 (12.8)	110.8 (15.0)
Diastolic blood pressure [mm Hg]:			
Cases	67.9 (7.5)	72.1 (10.7)* [§]	74.2 (10.0) [§]
Control	65.4 (7.8)	62.8 (8.1)* [§]	60.8 (11.2) [§]

*Paired t-test ($p = 0.049$); **paired t-test ($p = 0.011$); **Wilcoxon signed ranks test ($p = 0.023$); [§]paired t-test ($p = 0.004$).

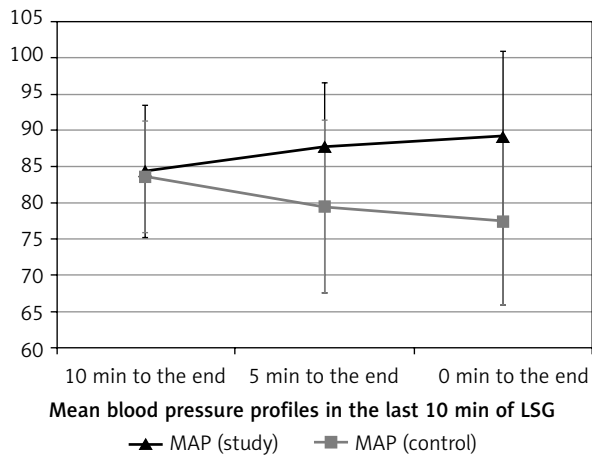


Figure 1. Mean arterial blood pressure measurements of the last 10 min of surgery for patients with HC ($n = 12$) and their matched controls ($n = 12$)

to show increased mean arterial blood pressure in the last 10 min of surgery. The population which reacts to exsufflation by increasing the mean arterial blood pressure is more prone to experience HC in the postoperative period. This mechanism is not precisely known and needs to be investigated.

Our observation supports widespread practice for bleeding assessment at the end of surgery. Exsufflation of the pneumoperitoneum for 5 to 10 min leads to all physiologic changes, which may reveal significant bleeding. The main limitations of our study are the retrospective character of the research and the size of the study group. Bleeding complications in our study occurred in 3.0% of all cases, and it matches the rates in other studies, ranging from 3% to 5% [6]. Considering that the database includes data on 867 patients, the amount of cases that qualified for the survey is acceptable.

Conclusions

Compared with closely matched control subjects, patients with HC after LSG have increased mean arterial pressure 5 min before the end of surgery. This phenomenon has not been reported in the literature before. However, the observed changes were not clinically significant.

Conflict of interest

The authors declare no conflict of interest.

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