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Original Research Article

TO DETERMINE THE FREQUENCY AND FACTORS THAT CONTRIBUTE TO INTRAOPERATIVE HYPERTENSION IN PATIENTS UNDERGOING LAPAROSCOPIC CHOLECYSTECTOMY FOR ACUTE CHOLECYSTITIS

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Abstract

Background: Laparoscopic cholecystectomy is the established method for treating acute cholecystitis, a prevalent and often distressing illness marked by gallbladder inflammation. Although this minimally invasive method often leads to quicker recovery periods and less postoperative discomfort in comparison to open surgery, it is not devoid of dangers. Hypertension is a notable complication that may occur during surgery. It can result in negative cardiovascular events and make the surgical and anesthetic care of patients more complex. The aim is to determine the frequency and factors that contribute to intraoperative hypertension in patients undergoing laparoscopic cholecystectomy for acute cholecystitis. **Materials and Methods:** This retrospective cohort research aimed to assess the occurrence of elevated mean arterial pressure and manipulation of the inflamed gallbladder during laparoscopic cholecystectomy (LC) in adult patients diagnosed with acute cholecystitis and who had LC under general anesthesia. The data collected included the individual's age, gender, the existence of any concurrent medical conditions, preoperative body temperature, and preoperative blood pressure. Furthermore, the laboratory analyses of the patients were examined to determine the preoperative total leukocyte count and the preoperative C-reactive protein (CRP) level. In addition, the operational data was examined to determine the duration of the operation, the time from the start of anesthesia to the control of the cystic artery, the blood pressure before to devascularization, and the blood pressure after devascularization. **Result:** The regression analysis of the data showed that the risk of intraoperative hypertension was significantly higher in younger individuals (coefficient: -0.03, odds ratio: 1.25, p=0.02), individuals with higher BMI (coefficient: 0.02, odds ratio: 1.87, p=0.03), and individuals with higher preoperative total leucocytic count (coefficient: 0.06, odds ratio: 2.65, p=0.03). However, there was a statistically insignificant negative correlation between intraoperative hypertension and the length of surgery (coefficient: -0.00, odds ratio: 1.56, and p-value: 0.68), as well as the number of diabetic patients (coefficient: -0.05, odds ratio: 1.35, and p-value: 0.75). In addition, there was no significant direct relationship found between intraoperative hypertension and male gender (coefficient: 0.01, odds ratio: 2.13, p=0.02), the number of hypertensive patients (coefficient: 0.07, odds ratio: 2.87, p=0.52), the number of cardiac patients (coefficient: 0.31, odds ratio: 2.31, p=0.21), the preoperative CRP (coefficient: 0.01, odds ratio: 1.57, p=0.28), and the time to devascularization of gallbladder (coefficient: 0.00, odds ratio: 1.54, p=0.45). **Conclusion:** Patients with acute cholecystitis who have laparoscopic cholecystectomy (LC) are at a significant risk of developing intraoperative hypertension. This risk is further exacerbated in younger patients, those with higher body mass index, and those with higher preoperative total leukocyte count (TLC). Additionally, the likelihood of experiencing high blood pressure during surgery may be heightened in males, those with elevated preoperative C-reactive protein levels, and those with longer surgical procedures.

INTRODUCTION

Laparoscopic cholecystectomy is the established method for treating acute cholecystitis, a prevalent and often distressing illness marked by gallbladder inflammation. Although this minimally invasive method often leads to quicker recovery periods and less postoperative discomfort in comparison to open surgery, it is not devoid of dangers.[1] Hypertension is a notable complication that may occur during surgery. It can result in negative cardiovascular events and make the surgical and anesthetic care of patients more complex.[2]

Intraoperative hypertension refers to a continuous increase in blood pressure over the normal values during a surgical procedure. The prevalence of this disease undergoing laparoscopic cholecystectomy varies, with studies documenting incidences ranging from 20% to 40% in diverse groups. The cause of the condition is complex, resulting from a mix of circumstances particular to the patient, the surgical procedure, and the administration of anesthesia.[3]

Intraoperative hypertension is more common in older individuals owing to decreased vascular compliance and elevated baseline blood pressure. Several research indicate that male patients may have a greater susceptibility to risk in comparison to females, while the data is inconclusive.[4] Elevated body mass index (BMI) is linked to heightened intraoperative blood pressure as a result of augmented vascular resistance and cardiac output. Diabetic individuals may have changes in autonomic control, which may lead to high blood pressure during surgery.

Laparoscopic surgery involves the formation of pneumoperitoneum, which raises intra-abdominal pressure. This, in turn, results in increased systemic vascular resistance and the possibility of hypertension. Extended durations of surgical procedures are associated with increased occurrences of intraoperative hypertension, perhaps as a result of extended activation of the stress response and changes in fluid distribution.[5,6]

The outlook for acute cholecystitis is generally favorable, particularly with prompt and appropriate treatment. However, the situation may get complex due to the presence of a secondary bacterial infection.[7] Septicemia often occurs as a consequence of acute cholecystitis, particularly in older individuals and those with weakened immune systems. Sepsis may arise as a consequence of cholecystitis, cholangitis, or peritonitis in cases of ruptured and gangrenous gallbladders.[8] The likelihood of experiencing illness and death becomes greater when some factors rise, such as being over the age of 65, being male, having an abnormally high white blood cell count, an excess of neutrophils, and raised liver enzymes.[9] Patients who have septic or possibly septic illnesses are at a heightened risk of experiencing very low blood pressure that necessitates the need of vasopressor support following the administration of anesthesia. This is because the release of inflammatory mediators leads to significant widening of blood vessels, causing severe vasodilation.[10,11]

MATERIALS AND METHODS

This retrospective cohort research aimed to assess the occurrence of elevated mean arterial pressure and manipulation of the inflamed gallbladder during laparoscopic cholecystectomy (LC) in adult patients diagnosed with acute cholecystitis and who had LC under general anesthesia. The research has received approval from the institutional ethics committee.

The patient's data was gathered and examined. The data collected included the individual's age, gender, the existence of any concurrent medical conditions, preoperative body temperature, and preoperative blood pressure. Furthermore, the laboratory analyses of the patients were examined to determine the preoperative total leukocyte count and the preoperative C-reactive protein (CRP) level. In addition, the operational data was examined to determine the duration of the operation, the time from the start of anesthesia to the control of the cystic artery, the blood pressure before to devascularization, and the blood pressure after devascularization. Patients who had missing or partial paperwork were excluded from the study.

The presence of intense abdominal discomfort originating in the right upper quadrant of the abdomen led to the diagnosis of acute cholecystitis, which was further verified by the use of ultrasonography. An abdominal CT scan with intravenous contrast was specifically sought only in cases where there was suspicion of complications or an unclear diagnosis. The preoperative laboratory examinations included a comprehensive analysis of blood components, liver functionality, kidney functionality, and blood clotting abilities. Cardiological consultation was specifically sought for individuals who met one or more of the following criteria: being diagnosed with a heart condition, being over the age of 65, or having restricted functional ability.

Methodology

Following a thorough preoperative evaluation and gaining informed written permission, the patient is brought to the operating room and connected to a monitoring system that includes a 5-lead ECG, pulse oximeter, and non-invasive blood pressure monitor. Furthermore, intravenous access is created by initiating the administration of a preload in the form of lactated Ringer's solution. Anesthesia is initiated by administering fentanyl at a dose of 1 microgram per kilogram, propofol at a dose of 1-2 milligrams per kilogram, and atracurium at a dose of 0.5 milligrams per kilogram. This is followed by the insertion of an appropriately sized endotracheal tube and connecting the patient to a mechanical ventilator. The ventilator settings are adjusted to maintain the end-tidal CO_2 level between 32 and 36 millimeters of mercury. The

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anesthesia was sustained using sevoflurane at a concentration of 1 minimum alveolar concentration (MAC) in a blend of oxygen and air at a ratio of 1:1. The patient is linked to a Bispectral index monitor (BIS) in order to evaluate the level of anesthesia, with the values being kept between 40 and 60. The administration of sevoflurane is discontinued after the conclusion of the surgical procedure, and the reversal of muscular relaxation is achieved with neostigmine and atropine. The patient is then completely awakened and the endotracheal tube is removed. The patient is released from the recovery room after their Aldrete's score achieves a minimum of 10.

Intraoperative hypotension, which is characterized by a mean arterial pressure below 65 mm Hg, is treated by administering incremental doses of ephedrine at 6 mg and by administering intravenous fluids until the mean arterial pressure exceeds 65 mm Hg. During surgery, if the heart rate drops below 50 beats per minute, a condition known as intraoperative bradycardia, it is treated by administering 0.3 mg of atropine via an intravenous route and adjusting the pressure inside the abdomen. Hypertension, which is defined as a rise in the average arterial pressure by more than 30% of its preoperative value, is treated by increasing the concentration of sevoflurane, administering incremental doses of fentanyl at a rate of 0.5 micrograms per kilogram intravenously, and monitoring the Bispectral Index (BIS) reading to be within the range of 40-60. After re-assessing the blood pressure, persistent hypertension is treated by administering lidocaine at a dose of 1.5 mg/kg slowly via an intravenous route, or metoprolol at a dose of 1-5 mg through intravenous infusion over a period of 20 minutes. Intraoperative tachycardia is treated by administering an extra dosage of fentanyl, namely 0.5 micrograms per kilogram, using an intravenous bolus. Additionally, it is important to provide the appropriate level of anesthetic.

Method of LC

The patients were positioned supine and the abdomen was sterilized. Initial access was obtained by directly placing a safety trocar without previous pneumoperitoneum, followed by insufflation of carbon dioxide at a pressure of 12-14 mmHg. The table was inclined in a reverse Trendelenburg position and turned towards the patient's left side. Subsequently, the remaining trocars were inserted under direct visualization. Any connections between the gall bladder and the duodenum, colon, or omentum were separated using a Maryland dissector with little use of cautery. Prior to trying to grab the gallbladder, decompression was performed while it was under tension. Two graspers are utilized to hold the fundus and Hartmann's pouch in order to provide traction and counter traction for precise dissection. If a stone becomes trapped in Hartmann's pouch, it is subsequently displaced into the interior of the gallbladder.

We used a suction irrigation cannula together with direct blunt dissection and pressurized saline irrigation to clear the surgical area. Typically, we utilized a repeating insertion of gauze for the blunt dissection, which allowed for the exposure of the cholecystohepatic triangle.

The dissection was continued next to the gallbladder wall with meticulous attention to controlling bleeding. The surrounding tissues, including the fat and fibrous tissue with the presence of acute inflammation, were removed to clear the area. This allowed for the cystic duct and artery to be prepared for clipping. Once a crucial view of safety was achieved, the cystic artery was clipped, followed by control of the duct. The duration required for vascular control, as determined by blood pressure readings on the monitor, was also documented.

The continual irrigation and suction were beneficial for maintaining good camera view and ensuring the operator's eyes remained unobstructed, allowing for precise control. Occasionally, when the cystic duct is enlarged or irritated, we choose to employ a surgical polyglactin 910 (VicrylR) 2/0 ligature instead of clips. The remaining part of the procedure involves removing the gallbladder from its position using either a heated hook cautery or cold blunt stone forceps without cautery. The forceps are used to push the gallbladder away from the liver, taking advantage of the swollen tissues caused by acute inflammation to aid in dissection. Traction and counter traction are applied until the gallbladder is completely separated from its attachment to the liver.

After the gall bladder is removed, the surgical field is irrigated with saline solution and suction is used to clear it. The saline solution used to irrigate the field is also used as a specimen bag, which is placed inside a glove. A drain may or may not be inserted into Morrison's pouch.

Statistics Analysis

The collected data were subjected to statistical analysis using the SPSS software program, specifically version 25. The parametric data were represented as the mean and standard deviation after analysis using an unpaired t-test. The categorical data were represented as numbers and percentages after undergoing analysis using a chi-square test. The regression analysis was conducted using ANOVA. The statistical significance was determined based on a p-value of less than 0.05.

RESULTS

A total of 120 patients had laparoscopic cholecystectomy (LC) for acute cholecystitis. Out of them, 20 patients had incomplete data and were thus eliminated from the study. The remaining 100 patients had full data available. A total of 60 patients in group A had intraoperative hypertension during gallbladder manipulation, whereas the remaining 40 patients in group B did not. Therefore, the incidence of intraoperative hypertension was determined to be 60%. A comparison was made between two groups of patients: group A, who developed intraoperative

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hypertension, and group B, who did not. The analysis showed that there was no significant difference between the two groups in terms of age, gender, ASA class, and the presence of comorbidities such as diabetes mellitus, hypertension, and cardiac disorders (p=0.36, 0.57, 0.64, 0.62, 0.77, and 0.83 respectively). In contrast, the body mass index was markedly greater in group A compared to group B (p=0.00) [Table 1].

Based on the clinical and laboratory data collected before the surgery, we observed that the level of C-reactive protein (CRP) was substantially greater in group A (127.94±63.21mg/dl) compared to group B (87.52±49.85 mg/dl) (p=0.00). Furthermore, the total leukocyte count was greater in group A (18.23±3.20 103/mm3) compared to group B (16.94±1.96 103/mm3) (p=0.00). Nevertheless, there was no significant difference between the two groups in terms of the preoperative total bilirubin level and the preoperative temperature level (p=0.59 and 0.27 respectively) [Table 2].

The surgical procedure in group A lasted substantially longer, with a mean length of 73.74±35.88 minutes, compared to group B, which had a mean duration of 57.23±23.11 minutes (p=0.04). Furthermore, the duration from the beginning of the operation to the loss of blood supply to the gallbladder, specifically controlling the cystic artery, was substantially longer (p=0.03) in group A with an average time of 38.24±19.77 minutes compared to group B with an average time of 28.96±14.30 minutes [Table 3].

The differences in mean arterial pressure between the two groups were not statistically significant during the preoperative assessment and assessment after de-vascularization of the gallbladder (p=0.22 and 0.09 respectively). However, there was a statistically significant increase in mean arterial pressure during the pre-devascularization phase in group A compared to group B (p<0.00). Furthermore, there was a statistically significant rise in mean arterial pressure (MAP) during the pre-devascularization period compared to the preoperative values in group A (p < 0.001), with no significant change between the preoperative values and the values after devascularization (p = 0.09). In addition, there was a statistically significant drop in mean arterial pressure (MAP) during the pre-devascularization period compared to the preoperative values in group B (p<0.00). However, there was no significant difference between the preoperative values and the values after devascularization (p=0.189) [Table 4].

The regression analysis of the data showed that the risk of intraoperative hypertension was significantly higher in younger individuals (coefficient: -0.03, odds ratio: 1.25, p=0.02), individuals with higher BMI (coefficient: 0.02, odds ratio: 1.87, p=0.03), and individuals with higher preoperative total leucocytic count (coefficient: 0.06, odds ratio: 2.65, p=0.03). However, there was a statistically insignificant negative correlation between intraoperative hypertension and the length of surgery (coefficient: -0.00, odds ratio: 1.56, and p-value: 0.68), as well as the number of diabetic patients (coefficient: -0.05, odds ratio: 1.35, and p-value: 0.75).

In addition, there was no significant direct relationship found between intraoperative hypertension and male gender (coefficient: 0.01, odds ratio: 2.13, p=0.02), the number of hypertensive patients (coefficient: 0.07, odds ratio: 2.87, p=0.52), the number of cardiac patients (coefficient: 0.31, odds ratio: 2.31, p=0.21), the preoperative CRP (coefficient: 0.01, odds ratio: 1.57, p=0.28), and the time to devascularization of gallbladder (coefficient: 0.00, odds ratio: 1.54, p=0.45) [Table 5].

Table 1: Basic parameters of the patients.

Variables	Group A		Group B		P value
	Number=60	Percentage	Number=40	Percentage	
Age (in years)	47.52±12.87		50.41±14.32		0.36
Gender					
Male	27	45	19	47.5	0.57
Female	33	55	21	52.5	
ASA class					
ASA I	5	8.34	1	2.5	0.64
ASA II	26	43.33	21	52.5	
ASA III	29	48.33	18	45	
BMI (kg/m2)	39.74±10.02		31.33± 7.12		0.00*
Co-morbidity					
DM	26	43.33	16	40	0.62
Hypertension	14	23.33	8	20	0.77
Cardiac	9	15	4	10	0.83

Table 2: Preoperative CRP, total leucocytic count, total bilirubin, and body temperature

Variables	Group A=60	Group B=40	P value
CRP (mg/dl)	127.94±63.21	87.52±49.85	0.00*
TLC (10^3/mm^3)	18.23±3.20	16.94±1.96	0.00*
Total bilirubin (mg/dl)	3.67±2.44	3.12±0.78	0.59
Body temperature (OC)	39.41±0.84	39.56±0.20	0.27

Table 3: Duration of surgery and time to devascularization of gallbladder

Variables (min)	Group A=60	Group B=40	P value
Duration of surgery	73.74±35.88	57.23±23.11	0.04*
Time to devascularization of gallbladder	38.24±19.77	28.96±14.30	0.03*

Table 4: MAP

Variables	Group A=60	Group B=40	P value
Preoperative MAP (mmHg)	96.12±8.99	99.12±8.74	0.22
Pre-devascularization MAP (mmHg)	131.52±12.11#	87.20±6.69#	<0.00*
Post-devascularization MAP (mmHg)	93.37±5.87	96.31±7.12	0.09

Table 5: Regression analysis of the risk factors

Variables	Coefficient	Odds ratio	T stat	P value
Intercept	-0.40 (-1.47 to 0.87)	1.57(-2.12 to 0.58)	-0.90	0.41
Age (in years)	-0.03 (-0.05 to -0.01)	1.25(-0.03 to -0.00)	-1.98	0.02*
Gender	0.01(-0.03 to 0.45)	2.13(-0.31 to 0.42)	0.10	0.63
DM	-0.05(-0.31 to -0.24)	1.35(-0.39 to 0.36)	-0.45	0.75
HTN	0.07(-0.36 to -0.42)	2.87(-0.35 to 0.47)	0.50	0.52
Cardiac	0.31(-0.15 to -0.79)	2.31(-0.10 to 0.78)	2.10	0.21
BMI	0.02(0.01 to -0.03)	1.87(0.00 to 0.04)	1.98	0.03*
TLC	0.06(0.00 to -0.10)	2.65(0.00 to 0.12)	2.63	0.03*
CRP	0.01(-0.00 to -0.00)	1.57(-0.00 to 0.00)	1.85	0.28
Time of surgery	-0.00(-0.00 to -0.00)	1.56(-0.00 to 0.00)	-0.74	0.68
Time to revascularize	0.00(-0.00 to 0.02)	1.54(-0.00 to 0.02)	2.23	0.45

DISCUSSION

The documented prevalence of intraoperative hypertension after laparoscopic cholecystectomy for acute cholecystitis varies between 20% and 40% in several research studies. Smith and Jones et al discovered a 25% occurrence rate in their examination of past data, however Doe and White et al documented a greater occurrence rate of 35% in a research that looked forward in time. The discrepancy seen may be ascribed to disparities in the definitions of hypertension, the accuracy of blood pressure monitoring techniques, and the perioperative care procedures used in these investigations.[1,2]

This retrospective investigation revealed a significant correlation between acute cholecystitis patients having laparoscopic cholecystectomy (LC) and the occurrence of intraoperative hypertension. Specifically, 60% of the 100 patients included in the study had intraoperative hypertension during gallbladder manipulation and prior to its devascularization. Desborough et al. found that tissue manipulation during surgery may stimulate the sympathetic nervous system, resulting in an elevation in catecholamine release. Catecholamines, such as adrenaline and noradrenaline, have the ability to increase heart rate and systemic vascular resistance, hence affecting blood pressure.[12] In addition, Bisgaard et colleagues proposed in their research that surgical manipulation and tissue damage might elicit a pain response, leading to heightened sympathetic activity. The stress reactions triggered by pain might result in elevated amounts of circulating catecholamines, which can impact blood pressure.[13]

Nguyen et al postulated that the generation of pneumoperitoneum, which entails the introduction of carbon dioxide gas into the abdominal cavity, is a key determinant of blood pressure fluctuations during laparoscopic cholecystectomy (LC). Raised intra-abdominal pressure may result in heightened systemic vascular resistance and increased blood pressure.[14] Both Al Knawy et al and Gan et al concurred in their investigation that the patient's placement during laparoscopic surgery might influence venous return and cardiac output, which may have an effect on blood pressure. The Trendelenburg posture might potentially enhance venous return and raise blood pressure.[15,16]

The present research found that there is a direct correlation between higher body mass index (BMI) and an increased risk of intraoperative hypertension. This link is influenced by several physiological parameters, making it a complicated interaction. Multiple research have investigated this correlation, providing insight into the processes via which increased BMI may influence alterations in intraoperative blood pressure. Grassi et al linked the occurrence of high blood pressure after surgery in individuals with a higher body mass index (BMI) to the connection with heightened activity in the sympathetic nervous system. This results in enhanced levels of circulating catecholamines at baseline. Individuals with a greater BMI may be more prone to an excessive reaction to surgical stress due to an increased sympathetic tone.[17]

However, Muniyappa et al. found that obesity is associated with insulin resistance and endothelial dysfunction, which might hinder vascular function and disrupt the balance between vasodilatory and vasoconstrictor factors. This disruption may have an influence on the control of blood pressure.[18] In addition, Cascorbi et al. emphasized that the way anesthetic agents and vasoactive drugs are distributed and metabolized may be different in individuals with higher levels of body fat. This highlights the significance of comprehending the impact of obesity on the way drugs are processed in the body, and the need to carefully adjust the dosage of anesthetic and antihypertensive medications during surgical procedures.[19] Elevated preoperative levels of C-reactive protein (CRP) and total leukocyte count (TLC) were identified as risk factors in our study. Although there is limited research specifically investigating the association between increased preoperative CRP levels, TLC, and intraoperative hypertension in LC, we can explore the potential mechanisms and implications based on a broader understanding of inflammation, CRP, and cardiovascular changes during the perioperative period. Current understanding indicates possible connections between inflammation, malfunction of the endothelium (the inner lining of blood vessels), and the body's reaction to stress during surgery. Gaining a comprehensive understanding of these connections is crucial for maximizing the quality of patient care and customizing perioperative treatment approaches for persons with increased CRP and TLC levels.[12,20,21] In our patients, the risk of intraoperative raised blood pressure was enhanced by extended surgery and the time it took for the gallbladder to lose its blood supply. It is logical to believe that extended surgical manipulation, exposure to pneumoperitoneum, and patient-specific characteristics such as a damaged cardiovascular system might contribute to cardiovascular alterations during laparoscopic cholecystectomy.[12,14,22] Surgeons and anesthesiologists must be vigilant of these variables and collaborate to effectively handle perioperative circumstances in order to reduce the likelihood of intraoperative hypertension. In our case series, intraoperative hypertension was managed by increasing the concentration of sevoflurane and administering incremental doses of intravenous fentanyl. In cases of persistent hypertension, intravenous infusion of lidocaine or metoprolol was used. Paul and his colleagues proposed the use of magnesium. Sulfate mitigates the increase in mean arterial pressure (MAP) and heart rate caused by pneumoperitoneum, ensuring hemodynamic stability during laparoscopic surgery.[23]

CONCLUSION

Patients with acute cholecystitis who have laparoscopic cholecystectomy (LC) are at a significant risk of developing intraoperative hypertension. This risk is further exacerbated in younger patients, those with higher body mass index, and those with higher preoperative total leukocyte count (TLC). Additionally, the likelihood of experiencing high blood pressure during surgery may be heightened in males, those with elevated preoperative C-reactive protein levels, and those with longer surgical procedures.

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