Section: General Surgery

Original Research Article

A STUDY OF STRESS RESPONSE IN OPEN AND LAPAROSCOPIC PROCEDURES AND POSTOP RECOVERY

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Abstract

Background: The surgical stress response is a physiological reaction to surgical trauma that impacts immune function, metabolism, and recovery. Minimally invasive laparoscopic procedures are believed to reduce stress responses compared to open surgeries. This study aimed to compare the stress responses and postoperative outcomes between open and laparoscopic procedures. **Materials and Methods:** This prospective observational study included 100 patients (50 open and 50 laparoscopic surgeries) at GMKMCH, Salem, between July 2022 and June 2023. Eligible patients aged 18-45 years underwent procedures for subacute appendicitis, inguinal hernia, or symptomatic cholelithiasis. Data collection included demographic details, surgical parameters, biochemical markers (cortisol, glucose, and CRP), and postoperative recovery indicators. **Result:** The mean age was significantly higher in the laparoscopic group (42.96±1.79 years) than in the open surgery group (33.60±7.94 years, p=0.001). The mean surgical duration was significantly shorter in the laparoscopic group (44.2±10.76 min) than in the open surgery group (78.26±12.69 min, p=0.001). Postoperative cortisol, glucose, and CRP levels were significantly lower in the laparoscopic group (14.34±1.46 µg/dL, 99.6±3.6 mg/dL, 6.02±0.48 mg/L) compared to the open surgery group (22.72±0.85 µg/dL, 14.3±5.8 mg/dL, 9.62±0.42 mg/L, p=0.001). Postoperative wound infection rates were slightly lower in the laparoscopic group (12%) than in the open surgery group (24%), although the difference was not significant (p=0.19). **Conclusion:** Laparoscopic procedures result in a significantly lower stress response, shorter surgical duration, and faster recovery than open surgeries, as shown by reduced levels of cortisol, glucose, and C-reactive protein compared to open surgeries.

INTRODUCTION

Surgical stress is a systemic response to surgical trauma, characterised by immune alterations, haematopoiesis changes, and sympathetic activation. The intensity of this stress is proportional to factors such as incision size and tissue handling, which impact recovery time. Laparoscopic surgery, also called keyhole or minimally invasive surgery, involves smaller incisions compared to open surgery, reducing tissue manipulation, stress response, and recovery time.[1]

A distinction exists between systemic and peritoneal immunity, both of which are crucial for preventing infection and tumour adhesion. Open surgery is known to suppress immune function more than laparoscopic surgery.[2] Laparoscopic cholecystectomy (LC) has become the preferred treatment for symptomatic cholelithiasis because of benefits such as shorter hospital stays, faster recovery, better cosmetic outcomes, and reduced immune suppression. However, debate remains regarding the proportional stress caused by laparoscopic versus open procedures.[3]

The term "stress response" describes the body's reaction to harmful stimuli that disrupt homeostasis. Surgery triggers significant physiological changes, including immune, endocrine, and haemodynamic changes. The response varies based on tissue damage and can be categorised into primary stress (due to the surgery itself) and secondary stress (from prior trauma). In emergency cases, initial resuscitation helps manage primary stress, while secondary stress follows in subsequent surgeries.[4]

General surgery encompasses a broad range of procedures, excluding brain, spine, and heart surgeries. It involves elective and urgent procedures, such as abdominal surgery, oncological treatments,

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soft tissue procedures, and trauma care.[5] Traditional open surgery requires large incisions for direct organ access, offering clear visibility and tactile feedback. Although effective for complex procedures, it is associated with longer recovery times and increased postoperative risks. Despite the rise of minimally invasive techniques, open surgery remains essential for certain cases.[6]

Laparoscopy has revolutionised surgery and is widely used across disciplines. This technique originated in the early 20th century, with major advancements in the 1980s and 1990s, including laparoscopic cholecystectomy. Robotic-assisted laparoscopy and innovations such as single-incision laparoscopic surgery (SILS) and natural orifice transluminal endoscopic surgery (NOTES) have further enhanced the field.[7,8] This minimally invasive approach to gallbladder removal, performed through small incisions, is preferred over open cholecystectomy because of reduced pain, faster recovery, and lower infection risks. However, open cholecystectomy remains necessary in certain cases.[9]

Both open and laparoscopic hernia repairs have comparable recurrence rates and hospital stays. Meta-analyses indicate slightly higher recurrence rates in laparoscopic procedures but overall similar outcomes.[10] Laparoscopic appendectomy is favoured for acute appendicitis due to fewer wound complications, shorter hospital stays, and lower analgesic requirements. However, it may carry a slightly higher risk of intra-abdominal abscesses. In pregnant women, laparoscopic appendectomy is generally preferred over open surgery.[11]

Aim

This study aimed to assess the stress response in patients undergoing open and laparoscopic surgical procedures.

MATERIALS AND METHODS

This prospective observational study included 100 patients in the general surgical ward, trauma ward, and OP of the Department of General Surgery, GMKMCH, Salem, between July 2022 and June 2023. The study was conducted following approval from the Institutional Ethics Committee, and informed consent was obtained from all the patients.

Inclusion Criteria

Patients aged 18–45 years diagnosed with subacute appendicitis, inguinal hernia, or symptomatic cholelithiasis undergoing open or laparoscopic procedures with a surgical duration of less than 2 h were included.

Exclusion Criteria

Patients with diabetes, hypertension, asthma, tuberculosis, epilepsy, or psychiatric disorders; those receiving medications for chronic illnesses; and those positive for HIV, HBsAg, or anti-HCV antibodies were excluded.

Methods: This study included 100 patients who underwent 50 open and 50 laparoscopic surgeries in the general surgical, trauma, and OP wards. Data were collected on age, demographic characteristics, socioeconomic status, patient complaints, and symptom duration. A detailed history, including past medical conditions such as diabetes mellitus, systemic hypertension, tuberculosis, asthma, epilepsy, previous surgeries, and jaundice, was obtained. A personal history of smoking, alcohol consumption, and drug addiction was also noted. The initial assessment included vital parameters, such as pulse rate, blood pressure, respiratory rate, and temperature. General examination findings, including pallor, tongue and skin changes, icterus, cyanosis, and lymphadenopathy were documented. A thorough systemic examination of the cardiovascular, respiratory, central nervous, and abdominal systems was conducted.

Relevant investigations included haemoglobin percentage/packed cell volume, platelet count, total count, blood grouping and typing, bleeding time/clotting time, random blood sugar, urea, creatinine, HBsAg, anti-HCV antibodies, HIV, urine analysis, electrocardiogram, chest X-ray (posteroanterior view), and abdominal X-ray (erect view). Details of the operative procedure, including the type of anaesthesia, patient positioning, incision site, and surgical approach, were documented. Patients were followed up until discharge and at periodic intervals after discharge.

Statistical analysis: Data are presented as mean, standard deviation, frequency, and percentage. Continuous variables were compared using the independent sample t-test. Categorical variables were compared using Pearson's chi-square test. Significance was defined as p values less than 0.05 using a two-tailed test. Data analysis was performed using IBM SPSS version 21.0.

RESULTS

The mean age of patients who underwent laparoscopic surgery was significantly higher (42.96 ± 1.80 years) than that of patients who underwent open surgery (33.6 ± 7.95 years; p = 0.001). The mean duration of surgery was significantly longer in the open surgery group (78.26 ± 12.69 min) than in the laparoscopic group (44.2 ± 10.76 min; p = 0.001). The mean postoperative cortisol level was significantly higher in the open surgery group (22.72 ± 0.85 µg/dL) than in the laparoscopic group (14.34 ± 1.46 µg/dL; p = 0.001). Similarly, postoperative glucose levels were markedly higher following open surgery (14.32 ± 5.86 mmol/L) than those following laparoscopic surgery (99.60 ± 3.62 mg/dL; p = 0.001). Furthermore, postoperative CRP levels were significantly higher in the open surgery group (9.624 ± 0.421 mg/L) than in the laparoscopic group (6.026 ± 0.486 mg/L; p = 0.001) [Table 1].

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Table 1: Comparison of age, surgical duration, and postoperative biomarkers between the groups.

	Group (Mean±SD)		P-value
	Open surgery	Laparoscopic	
Age	33.6±7.949	42.96±1.795	0.001
Duration of surgery	78.26±12.69	44.2±10.76	0.001
Post-operative cortisol level	22.72±0.85	14.34±1.46	0.001
Post-operative glucose level	14.32±5.86	99.60±3.620	0.001
Post-operative CRP level	9.624±0.421	6.026±0.486	0.001

In terms of gender distribution, males constituted 37 (74%) and 41 (82%) patients in the open surgery and laparoscopic groups, respectively, while females accounted for 13 (26%) and 9 (18%) patients in the two groups, respectively (p = 0.334).

A significant difference was observed between the two groups in terms of the surgical procedure performed (p = 0.029). Subacute appendicitis was more frequently managed with laparoscopic surgery 31 (62%) than with open surgery 18 (36%). Inguinal hernia repair was more commonly performed using open surgery 23 (46%) than laparoscopic surgery 15 (30%). Symptomatic cholelithiasis was managed surgically in 9 (18%) patients in the open surgery group and 4 (8%) in the laparoscopic group.

Postoperative wound infection was observed in 12 (24%) patients who underwent open surgery and 6 (12%) in the laparoscopic group, although this difference was not significant (p = 0.19) [Table 2].

Table 2: Comparison of gender, procedures, and postoperative wound infection between the groups

		Group, N (%)		P-value
		Open	Laparoscopic	
Gender	Male	37 (74%)	41 (82%)	0.334
	Female	13 (26%)	9 (18%)	
Procedures	Sub-acute appendicitis	18 (36%)	31 (62%)	0.029
	Inguinal hernia	23 (46%)	15 (30%)	
	Symptomatic cholelithiasis	9 (18%)	4 (8%)	
Post-operative wound infection	Present	12 (24%)	6 (12%)	0.19
	Absent	38 (76%)	44 (88%)	

DISCUSSION

Our study demonstrated significant differences between open and laparoscopic surgical procedures in terms of patient characteristics, surgical duration, and postoperative biochemical markers. Notably, patients who underwent laparoscopic surgery were significantly older (42.96 ± 1.79 years) than those who underwent open surgery (33.60 ± 7.94 years). This aligned with findings by Khattak et al., who reported an average age of (36.09 ± 8.10) years in their study on cholecystectomy.[11] Similarly, Kothari et al. found a mean age of 43.1 years in male patients undergoing surgical procedures, showing the tendency for laparoscopic techniques to be preferred in older individuals.[12]

The duration of surgery was significantly shorter in the laparoscopic group (44.2 ± 10.76 min) than in the open surgery group (78.26 ± 12.69 min). These findings are consistent with Rather et al., who reported a mean operative time of 45 minutes for laparoscopic appendectomy versus 75 minutes for open appendectomy.[13] Furthermore, Surabhi et al. reported that laparoscopic procedures remain efficient even in complex cases, reporting an average operative time of 87.9 minutes for complicated laparoscopic appendectomies.[14]

Postoperative biochemical markers also varied significantly between the two surgical techniques. Cortisol levels were significantly higher in the open surgery group (22.72 ± 0.85 µg/dL) than in the laparoscopic group (14.34 ± 1.46 µg/dL). Elevated cortisol levels indicate a greater physiological stress response, which is supported by previous studies, such as Barband et al., who found that laparoscopic surgery led to lower postoperative pain levels and shorter hospital stays. Additionally, CRP levels were significantly lower in the laparoscopic group (6.02 ± 0.48 mg/L) compared to the open surgery group (9.62 ± 0.42 mg/L), suggesting a reduced inflammatory response with minimally invasive procedures.[15] Sartelli et al. similarly emphasized that laparoscopic surgery reduces postoperative inflammation and accelerates recovery.[16]

The open surgery group showed significantly higher glucose levels (14.32 ± 5.86 mmol/L) than the laparoscopic group (99.60 ± 3.62 mg/dL). This difference suggests that laparoscopic procedures are associated with reduced postoperative metabolic stress. Jeon et al. reported that elevated postoperative glucose levels correlate with increased surgical stress and a higher risk of infection, further supporting the advantages of laparoscopic techniques.[17]

Regarding surgical indications, laparoscopic surgery was the preferred approach for subacute appendicitis (62% vs. 36%), whereas open surgery was more commonly performed for inguinal hernia repair (46% vs. 30%). These findings aligned with Masoomi et al., who reported improved outcomes in elderly patients undergoing laparoscopic appendectomy.[18]

Postoperative wound infection rates were lower in the laparoscopic group (12%) than in the open surgery group (24%), although the difference was not significant. This aligned with Wang et al.'s meta-analysis, which demonstrated a significant reduction

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in surgical site infections with laparoscopic surgery.[19] Additionally, Surabhi et al. reported an extremely low drain site infection rate (1.14%) in their laparoscopic cohort, further emphasising the lower risk of postoperative complications associated with minimally invasive techniques.[14]

Our study emphasises the benefits of laparoscopic surgery, including shorter operative times, lower inflammatory and metabolic stress responses, and potentially reduced postoperative complications. The significant differences observed in cortisol, glucose, and CRP levels further validate the advantages of minimally invasive techniques, aligning with prior research by Gambhir et al., who also reported substantial variations in postoperative biochemical markers between open and laparoscopic procedures.[1] These findings emphasise the broader adoption of laparoscopic techniques in eligible patients to enhance surgical outcomes and recovery.

CONCLUSION

Our findings indicate that laparoscopic surgery is associated with a significantly lower stress response, as evidenced by reduced postoperative cortisol, glucose, and CRP levels, compared with open surgery. Additionally, laparoscopic procedures have shorter operative times and lower rates of postoperative wound infections. Proper management of haemodynamic parameters, hydration, glucose levels, and anxiolytics, along with the avoidance of stress-inducing procedures such as laryngoscopy and intubation, minimises stress responses. Additionally, early recovery following surgery has emerged as the new standard for preventing postoperative complications.

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