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COMPARISON OF SURGICAL STRESS RESPONSE UNDER GENERAL ANAESTHESIA IN OPEN LAPAROTOMY VS. LAPAROSCOPIC ABDOMINAL SURGERIES

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HOW TO CITE THIS ARTICLE:

Gopal Reddy Narra, S. Manohar, Aparna, Miraz, Santhosh. "Comparison of Surgical Stress Response under General Anaesthesia in Open Laparotomy Vs. Laparoscopic Abdominal Surgeries". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 87, October 29; Page: 15125-15133, DOI: 10.14260/jemds/2015/2148

ABSTRACT: The stress response is the name given to the hormonal and metabolic changes which follow injury or trauma. The systemic reactions to surgical injury encompass a wide range of endocrinological, immunological and haematological effects. The ability of anaesthetic agents modifies the endocrine and metabolic responses have been studied enthusiastically. This research describes the endocrine and metabolic changes which occur during different types of surgical techniques, effects of anaesthetic and analgesic regimens to modify their responses. **OBJECTIVES:** The present study aimed to evaluate the effects of stress response on blood glucose levels and hemodynamics in patients undergoing open Laparotomy surgeries v/s laparoscopic surgeries. **METHODS:** Sixty surgical patients were enrolled in this clinical trial. The pulse, BP records were taken and blood sugar levels were tested peri-operatively. **RESULTS:** The results were analyzed and found that raise pulse rate, blood pressure and blood sugar levels due to stress in proportionate to surgical trauma, and duration of surgery under anaesthesia. Blood sugar levels gradually increased 90.5 ± 4.88 to 115 ± 7.18 and at post op 119.4 ± 6.93 in laparotomy group when compared to 91.07 ± 4.93 to 118.33 ± 5.06 and at post-op 120.1 ± 4.51 in laparoscopy group. **CONCLUSION:** Lap surgery causes minimum tissue injury and less stress response more so during postoperative period.

KEYWORDS: General surgery; Lap surgery, hormones, cortisol, sympathetic nervous system, catecholamines, general anaesthesia, blood sugars.

INTRODUCTION:

Key Points

- Surgery evokes a series of hormonal and metabolic changes commonly referred to as the stress response.
- There is increased secretion of pituitary hormones and activation of the sympathetic nervous system.
- Increased catabolism mobilizes substrates to provide energy by raising blood sugar levels.
- Attempts have been made to modify the stress response after surgery with various anaesthetic techniques but the results are inconclusive but definitely helpful.

The body reaction to surgery ranges from minor to massive both locally and generally. General response is in the form of widespread endocrinal, metabolic and biochemical reactions throughout the body. Neuro-endocrinal hormone system and inflammation mediators are involved and this process is called "Stress response".¹

ORIGINAL ARTICLE

Activation of the sympathetic nervous system, increase of catabolic hormone release and pituitary gland activation are considered as a response to surgical stress. The stress response to surgery is characterized by increased secretion of pituitary hormones and activation of the sympathetic nervous system.

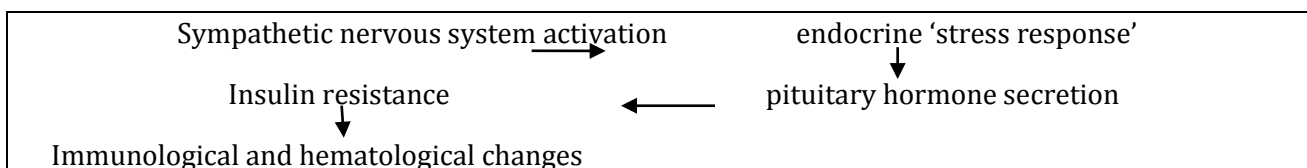
The changes in pituitary secretion have secondary effects on hormone secretion from target organs.² Physiological responses (Endocrine) and psychological stress (Anxiety and fear) of anesthesia and surgery increase secretion of cross-regulating hormones (Catecholamines, cortisol, glucagon and growth hormone) and resulting in plasma proteins augmentation, sodium retention, potassium loss and increase of blood glucose level.

The increased sympathetic activity and noradrenaline levels caused by surgical stress not only lead to decrease of insulin secretion, glucose consumption as well as gluconeogenesis augmentation, but also resulting in hyperglycemia increasing in postoperative infection and mortality due to immunity system weakness.³ Moreover, these hemodynamic changes lead to neural, renal and cardiovascular damage.

In clinical practice these activities cause changes in heart rate, blood pressure and biochemical fluctuations of noradrenaline, adrenaline, dopamine, and cortisol.⁴ In general, blood glucose concentration will increase after surgery. Cortisol and catecholamines increase glucose production via increasing gluconeogenesis as well as reducing the peripheral glucose consumption. Similarly, the common mechanisms for stabilizing blood sugar are ineffective during surgery.

The type of surgery and anesthesia are also involved in surgical stress.⁴ Above all, these fluctuations prolong hospitalization and delay patients discharge.⁵ In general, there are three main methods for balancing responses to stress during surgery including neural blockade by epidural or spinal anesthesia, which inhibit transmission of impulses from the site of trauma, intravenous administration of high-dose of strong opioid analgesics-which block hypothalamic pituitary gland function and infusion of anabolic hormones such as insulin that causes changes in the hormonal status of the patient.⁶

Systemic Response to Surgery:⁶



PATIENTS AND METHODS: This randomized clinical trial was conducted between 2014 Aug-2015 Aug on surgical patients aged between 20 to 60 years of ASA grade I and II. Persons with severe cardiovascular diseases, endocrine disorders, drug users, alcohol and steroids were excluded from the study.

After obtaining permission from the Institutional ethics committee of KIMS-NKP and written consent from all 60 persons, who were selected and they randomly divided into two groups; open Laparotomy surgery group (LOTS) and laparoscopic surgery group (LAPS). In this study, patients did not receive any anti-anxiety medication before entering to operating room and were NPO for about 8hours.

ORIGINAL ARTICLE

Standard multi-parameter monitoring was used including pulse rate, O₂ saturation, non-invasive blood pressure (NIBP), Etco₂ and 3lead electrocardiogram. As premedication all patients received midazolam 0.02 mg/kg, fentanyl 1.5µg/Kg and GA with propofol 2mg/kg, N2O-O2 50:50% and savoflorane.

During the surgery hemodynamic parameters such as blood pressure, heart rate and %O₂ saturation & Etco₂ were monitored continuously. In both groups heart rate, systolic (SBP) and mean arterial pressure (MAP), blood sugar and Etco₂ were measured at least six times (10minutes before and 10, 20, 40 and 60 minutes after the initiation of anesthesia) every hour till the end of surgery whenever it prolonged.

STATISTICAL ANALYSIS: The results were analyzed by SSS analysis. Results were considered and compared in each groups. All data were reported in terms of mean ± Standard Deviation (SD) and P values. Data were considered significant at the level of P<0.05.

RESULTS: Total numbers=60, Open Laparotomy surgery (LOTS) group=30, B. Laparoscopic surgery (LAPS) group=30. None of the patients were excluded from the study.

Variables	LOTS Group (n=30)	LAPS Group (n=30)	P Value
Age in years	41.9±9.64	40.87±9.65	0.6382
Weight in Kg	60.57±6.47	58.7±5.86	0.6068
Height in cm	163±5.55	162.03±5.08	0.5125
Duration of anaesthesia in minutes	102.07±21.81	111.8±22.56	0.0557
Table 1: The demographic characteristics and duration of the anesthesia in both groups			

*Values are presented as mean±SD (P >0.05). Longer time taken in lap surgeries was due to technical problems. According to Table 1 there were not statistically significant differences between two groups in terms of demographic characteristics (Age, height, and weight) and duration of anesthesia (P >0.05).

Heart Rate	LOTS Group(n=30)	LAPS Group(n=30)	P value
10 min before anesthesia	82.28±5.21	83.23±4.35	0.4709
10 min after anesthesia	85.87±3.31	83.93±3.63	0.6099
20 min after anesthesia	84.0±4.75	85.53±3.04	0.2871
40 min after anesthesia	85.8±2.99	86.2±5.21	0.71255
60 min after anesthesia	83.73±3.30	81.79±4.80	0.0749
20 min after end of anesthesia	83.47±3.34	81.9±4.96	0.0148
Table 2: Changes in Heart Rate at Various Specified Timings in Two Groups			

ORIGINAL ARTICLE

*Values are presented as mean \pm SD ($P > 0.05$). There was an insignificant increase in heart rate starting from 20mts after Anaesthesia from the time of Pnemoperitoneum till the end of surgery, probably due to continuous distension of abdomen with Pnemoperitoneum. 20 minutes after end of surgery there is significant difference due minimal incision.

Mean Arterial Pressure	LOTS Group n=30	LAPS Group n=30	P value
10 min before anesthesia	90 \pm 5	89.6 \pm 4.3	0.6761
10 min after anesthesia	92.1 \pm 4.9	92.13 \pm 4.55	0.7464
20 min after anesthesia	90.13 \pm 7.92	95 \pm 4.51	0.0019
40 min after anesthesia	92.93 \pm 4.74	95 \pm 3.33	0.0039
60 min after anesthesia	91.7 \pm 4.87	92.97 \pm 4.22	0.2086
20 min after end of anesthesia	90.23 \pm 4.34	90.87 \pm 4.95	0.6612
Table 3: Mean arterial pressure changes in the LSS group and the LAS group			

*Values are presented as mean \pm SD ($P > 0.05$). There was a significant increase in mean arterial pressures starting from 20mts after Anaesthesia from the time of Pnemoperitoneum till the end of surgery, probably due to continuous distension of abdomen with Pnemoperitoneum.

Systolic Blood Pressure	LOTS Group n=30	LAPS Group n=30	P value
10 min before anesthesia	116.67 \pm 5.83	117.7 \pm 4.72	0.4536
10 min after anesthesia	119.87 \pm 5.86	122.67 \pm 4.61	0.0442
20 min after anesthesia	117.3 \pm 4.55	119.3 \pm 3.13	0.0521
40 min after anesthesia	118.47 \pm 3.53	120.17 \pm 2.89	0.0458
60 min after anesthesia	118.6 \pm 3.28	119.27 \pm 3.33	0.0438
20 min after end of anesthesia	116.17 \pm 3.24	116.27 \pm 3.56	0.9103
Table 4: The SBP changes in LOTS and LAPS groups			

Values are presented as mean \pm SD ($P > 0.05$). There was a significant increase in systolic blood pressures level starting from 20 mts after anaesthesia from the time of Pnemoperitoneum till the end of surgery except during skin suturing period probably due to continuous distension of abdomen with Pnemoperitoneum. After the end of anaesthesia also there is no significant difference.

Etco 2	LOTS Group n=30	LAPS Group n=30	P value
10 min after anesthesia	32.77 \pm 2.08	33.03 \pm 2.34	0.569
20 min after anesthesia	34.2 \pm 2.01	34.6 \pm 2.33	0.398
40 min after anesthesia	34.17 \pm 1.57	34.57 \pm 1.91	0.382
60 min after anesthesia	35.27 \pm 0.85	35.37 \pm 0.81	0.646
20 min after end of anesthesia breathing mask	34.5 \pm 1.68	33.23 \pm 1.94	0.034
Table 5: Etco2 levels at various time intervals and p-values			

*At the end of the operations the p-value is significant due to small incision less post-operative pain.

ORIGINAL ARTICLE

Blood Sugars	LOTS Group n=30	LAPS Group n=30	P value
10 min before anesthesia	90.5 ±4.88	91.07±4.93	0.663
20 min after anesthesia	90.33±4.20	91.05±4.85	0.5648
40 min after anesthesia	111.6±4.2	112.2±5.99	0.6577
60 min after anesthesia	115±7.18	118.33±5.06	0.0127
20 min after end of anesthesia	119.4±6.93	120.1±4.51	0.5578
<i>Table 6: Blood sugars of patients during 10 minutes before, and 20 and 60 minutes after initiation of anesthesia in both groups and 20 minutes after the end of surgery</i>			

*Values are presented as mean±SD (P >0.05). There was a significant increase in blood sugar level at the end of one hour, probably due to continuous distension of abdomen with Pnemoperitoneum.

DISCUSSION: The endocrine response is activated by afferent neuronal impulses from the site of injury. These impulses travel along sensory nerve roots through the dorsal root of the spinal cord, up the spinal cord to the medulla to activate the hypothalamus.⁷ Sedation reduces psychological stress prior to surgery.⁸

By using Opioid –fentanyl.^{9,10} Midazolam and propofol.¹¹ and inhalation agents stress response was modified and pulse and BP levels controlled to large extent. There has been a great deal of interest in the modification of the stress response with respect to the potential beneficial effects on surgical outcome.

The extent to which the responses are modified depends on the choice of the analgesic techniques used. Inflammatory responses were reduced by a laparoscopic approach and by exposure to CO₂.^{12,13} there was a significant increase in systolic blood pressures level starting from 20mts after Anaesthesia from the time of Pnemoperitoneum till the end of surgery except during skin suturing period probably due to continuous distension of abdomen with Pnemoperitoneum. After the end of Anaesthesia also there is no significant difference.

As per table: 1 duration of operation prolonged in Laparoscopic group (LAPS) 111.8±22.56 due to technical regions when compared open laparotomy group 102.07±21.81 and p' value 0.0557 value is nearer to significance. The demographic figures were not significant.

As per table: 2 heart rate changes were not significant in both the group during operation. There was an insignificant increase in heart rate starting from 20mts after Anaesthesia from the time of Pnemoperitoneum till the end of surgery, probably due to continuous distension of abdomen with Pnemo- peritoneum in laparoscopy group.

20minutes after end of surgery (Post-operatively) there was significant difference in laparoscopy group 81.9±4.96 to open laparotomy group 83.47±3.34 and p' value 0.0148 is significant due minimal incision.

Table: 3 shows there was a significant increase in mean arterial pressures starting from 20mts after Anaesthesia from the time of Pnemoperitoneum LOS group 90.13±7.92 to LAS group 95±4.51, with significant p' value 0.0019 to till the end of surgery LOS group 92.93±4.74 to LAS group, 95±3.33,

ORIGINAL ARTICLE

with significant p' value 0.0039 probably due to continuous distension of abdomen with Pnemoperitoneum.

Table: 4 shows there was a significant increase in systolic blood pressures level starting from 20mts after Anaesthesia from the time of Pnemoperitoneum till the end of surgery except during skin suturing period probably due to continuous distension of abdomen with Pnemoperitoneum.

After the end of Anaesthesia also there is no significant difference. As per table-5 at the end of the operations the p-value 0.034 is significant due to small incision less post-operative pain LAPS group.

After completing the surgery operative stress part (Major part) completely reduced except injury and pain stress still continued indicating blood sugar level raise in more so in laparotomy group. Table-6, Blood sugar levels gradually increased from 90.5 ± 4.88 to 115 ± 7.18 and at post op 119.4 ± 6.93 in Laparotomy group when compared to 91.07 ± 4.93 to 118.33 ± 5.06 and at post-op 120.1 ± 4.51 in laparoscopy group.

Thoral et al advocated that during the surgical stress response the amount of insulin secreted does not adequately meet the body's increased needs and cells become resistant to the reduced amount of insulin secreted.¹⁴ Sato et al demonstrated this contributes to a net catabolic state with an uncorrected hyperglycemia.

Clinically, this is important as it has been shown in some studies that patients in whom insulin sensitivity is reduced by 50% after surgery suffer major complications and severe infections 6 to more than 10-fold, respectively, compared with controls.¹⁵

Jeschke et al in their study found large operations and large burn wounds has similar effects on insulin homeostasis. One randomized clinical study found that intensive insulin therapy significantly decreased the incidence of infections and sepsis, improved organ function, remedied insulin resistance, and reversed the posttraumatic catabolic state and, euglycemia within a reasonable range decreases morbidity and healing time in the postoperative patient.^{16,17,18} Insulin concentrations may decrease after the induction of Anaesthesia, and during surgery there is a failure of insulin secretion to match the catabolic, hyperglycemic response.

This may be caused partly by α -adrenergic inhibition of β cell secretion. In addition, there is a failure of the usual cellular response to insulin, the so-called 'Insulin resistance', which occurs in the perioperative period.¹⁹ Laparoscopic surgery causes less tissue injury than conventional procedures.

One of the limitations of this study was lack of measurement of serum stress hormones levels such as cortisol as well as bispectral index (BIS) for assessment of patients with depth of general anesthesia. The positive aspect of this study was the simultaneous investigation of hemodynamic changes and blood sugar levels as surgical stress responses in patients undergoing surgery. Based on limitation, data assessed on the benefits and priorities of surgical techniques, further studies are recommended.

RECOVERY FROM SURGERY: Many factors other than analgesic regimens influence recovery from major surgery and the ability of the patient to return home and resume work.²⁰ Laparoscopic procedures gained rapid acceptance based on faster recovery, decreased pain, early discharge from hospital and quicker return to normal activities.

Use of minimally invasive surgical techniques will reduce the effects of tissue injury. Hospital stay was shorter in the laparoscopic group. Convalescence regarding work leave is quicker after laparoscopic cholecystectomy, work leave and return to normal activity.²¹ Intraperitoneal carbon

ORIGINAL ARTICLE

dioxide insufflation attenuates peritoneal immunity, but laparoscopic surgery is associated with a lower systemic stress response than open surgery.²²

INTENSIVE INSULIN AND GLYCEMIC CONTROL: Hyperglycemia is associated with increased inflammation, infectious complications (including sepsis), ventilator dependence, length of hospital stay, and mortality.²³ Low blood sugar is equally dangerous. Tight glycemic control is necessary for rapid wound healing and patient outcome.²³ Aggressive glycemic control in line with these intensive insulin protocols reduces insulin resistance and hyperglycemia.

CONCLUSIONS: The hormonal and metabolic response to surgical and other physiological stresses is complex. It is important to reduce the deleterious effects of hypertension and tachycardia during surgery, particularly in patients with ischemic heart disease. Modern anaesthetic practice strives to suppress sympathetic responses and maintain cardiovascular stability, Blood glucose and hemodynamic changes caused by surgical stress. So tight glycemic control measures with reduced duration of the surgery, minimal invasion and control of sepsis improves outcome.

REFERENCES:

1. Iveta Golubovska¹/ Indulis Vanags¹: Anaesthesia and Stress Response to Surgery; Proceedings of the Latvian Academy of Sciences. Section B. Natural, Exact, and Applied Sciences. Volume 62, Issue4-5, Pages141–147, ISSN (Print) 1407-009X, DOI:10.2478/v10046-008-0017-y, November 2008.
2. Ledowski T, Bein B, Hanss R, Paris A, Fudickar W, Scholz J, et al. Neuroendocrine stress response and heart rate variability: a comparison of total intravenous versus balanced anesthesia. *Anesth Analg*. 2005; 101(6):1700–5.
3. Vriesendorp TM, Morelis QJ, Devries JH, Legemate DA, Hoekstra JB. Early post-operative glucose levels are an independent risk factor for infection after peripheral vascular surgery. A retrospective study. *Eur J Vasc Endovasc Surg*. 2004; 28(5):520–5. Doi: 10.1016/j.ejvs.2004.08.006.
4. Gulec H, Cakan T, Yaman H, Kilinc AS, Basar H. Comparison of hemodynamic and metabolic stress responses caused by endotracheal tube and Proseal laryngeal mask airway in laparoscopic cholecystectomy. *J Res Med Sci*. 2012; 17(2):148–53.]
5. Agarwal A, Ranjan R, Dhiraaj S, Lakra A, Kumar M, and Singh U. Acupressure for prevention of pre-operative anxiety: a prospective, randomised, placebo controlled study. *Anaesthesia*. 2005; 60(10):978–81. Doi: 10.1111/j.1365-2044.2005.04332.x.
6. Desborough JP, Hall GM. Modification of the hormonal and metabolic response to surgery by narcotics and general anaesthesia. *Baillieres clin anaes*. 1989; 3(2):317–34.
7. Huiku M, Uutela K, van Gils M, Korhonen I, Kymalainen M, Merilainen P, et al. Assessment of surgical stress during general anaesthesia. *Br J Anaesth*. 2007; 98(4):447–55. Doi: 10.1093/bja/aem004.
8. Caumo W, Schmidt AP, Schneider CN, Bergmann J, Iwamoto CW, Bandeira D, et al. Risk factors for preoperative anxiety in adults. *Acta Anaesthesiol Scand*. 2001; 45(3):298–307.
9. Moore RA, Allen MC, Wood PJ, Rees LH, Sear JW, Feldman D. Perioperative endocrine effects of etomidate. *Anaesthesia* 1985; 40: 124–30.

ORIGINAL ARTICLE

10. Wagner RL, White PF. Etomidate inhibits adrenocortical function in surgical medical customers. *Anesthesiology* 1984; 61: 647–51.
11. S.-H. Kang¹, Y.-S. Kim², T.-H. Hong³, M.-S. Chae², M.-L. Cho⁴, Y.-M. Her⁴ and J. Lee^{2,*} Effects of dexmedetomidine on inflammatory responses in patients undergoing laparoscopic cholecystectomy *Acta Anaesthesiologica Scandinavica* Volume 57, Issue 4, pages 480–487, April 2013.
12. Ost MC¹, Patel KP, Rastinehad AR, Chu PY, Anderson AE, Smith AD, Lee BR. *J Endourol.* 2008 Jan; 22(1):105–12. Doi: 10.1089/end.2007.9858.
13. Thorell A, Nygren J, Ljungqvist O. Insulin resistance: a marker of surgical stress. *Curr Opin Clin Nutr Metab Care.* 1999; 2(1):69–78.
14. Sato H, Carvalho G, Sato T, Lattermann R, Matsukawa T, Schricker T. The association of preoperative glycemic control, intraoperative insulin sensitivity, and outcomes after cardiac surgery. *J Clin Endocrinol Metab.* 2010; 95(9):4338–4344.
15. Desborough JP, Hall GM. Endocrine response to surgery. In: Kaufman L. *Anaesthesia Review*, Vol. 10. Edinburgh: Churchill Livingstone, 1993; 131–48.
16. Jeschke MG, Kulp GA, Kraft R, et al. Intensive insulin therapy in severely burned pediatric patients: a prospective randomized trial. *Am J Respir Crit Care Med.* 2010; 182(3):351–359.
17. Jeschke MG, Finnerty CC, Herndon DN, et al. Severe injury is associated with insulin resistance, endoplasmic reticulum stress response, and unfolded protein response. *Ann Surg.* 2012; 255(2):370–378.
18. Lacoumenta S, Yeo TH, Burrin JM, Bloom SR, Paterson JL, Hall GM. Fentanyl and the β -endorphin, ACTH and glycoregulatory hormonal responses to surgery. *Br J Anaesth* 1987; 59: 713–20.
19. Ure BM¹, Niewold TA, Bax NM, Ham M, van der Zee DC, Essen GJ. Peritoneal, systemic, and distant organ inflammatory responses are reduced by a laparoscopic approach and carbon dioxide versus air. *Surg Endosc.* 2002 May; 16(5):836–42. Epub 2002 Feb 8.
20. Chumbley GM, Hall GM. Recovery after major surgery: does the anaesthetic make any difference? *Br J Anaesth* 1997; 78: 347–8.
21. Grande M, Tucci GF, Adorisio O, Barini A, Rulli F, Neri A, et al. Systemic acute-phase response after laparoscopic and open cholecystectomy. *Surgical Endoscopy* 2002; 16(2):313–6.
22. Buunen M¹, Gholghesaei M, Veldkamp R, Meijer DW, Bonjer HJ, Bouvy ND. Stress response to laparoscopic surgery: a review. *Surg Endosc.* 2004 Jul; 18(7):1022–8. Epub 2004 May 12.
23. Van den Berghe G, Wouters P, Weekers F, et al. Intensive insulin therapy in the critically ill patients. *N Engl J Med.* 2001; 345:1359–1367.

ORIGINAL ARTICLE

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Date of Submission: 07/10/2015.
Date of Peer Review: 08/10/2015.
Date of Acceptance: 17/10/2015.
Date of Publishing: 27/10/2015.