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RESEARCH ARTICLE

"COMPARISION OF THE LEVEL OF INFLAMMATORY AND ENDOCRINE MARKERS FOLLOWING LAPAROSCOPIC HERNIA REPAIR VERSUS LICHTENSTEIN REPAIR FOR INGUINAL HERNIA"

Vemula Subba Lakshmi[1], M.k. Maheshwari[2], Dhanesh kumar[3], Anita Pandey[4], Aditya Rastogi[5], Sunidhi mishra[6]

[1]Junior resident, General Surgery, Subharti Medical College, Swami Vivekananda Subharti University, Meerut, Uttar Pradesh
[2]Professor and Head, General Surgery, Subharti Medical College, Swami Vivekananda Subharti University, Meerut, Uttar Pradesh
[3]Professor, General Surgery, Subharti Medical College, Swami Vivekananda Subharti University, Meerut, Uttar Pradesh
[4]Professor, Microbiololgy, Subharti Medical College, Swami Vivekananda Subharti University, Meerut, Uttar Pradesh
[5]Associate Professor, General Surgery, Subharti Medical College, Swami Vivekananda Subharti University, Meerut, Uttar Pradesh
[6]Senior Resident, General Surgery, Subharti Medical College, Swami Vivekananda Subharti University, Meerut, Uttar Pradesh

*Corresponding Author
Vemula Subba Lakshmi*

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Abstract: ***Background:*** Inguinal hernia repair triggers an inflammatory and neuroendocrine stress response that varies with the surgical technique. Interleukin-6 (IL-6) and Adrenocorticotropic hormone (ACTH) serve as sensitive markers for assessing the extent of physiological stress. Comparative biochemical responses following laparoscopic TAPP and open Lichtenstein repair remain inadequately studied, particularly at the 48-hour postoperative interval. ***Aim:*** To evaluate and compare the rise in IL-6 and ACTH levels following laparoscopic TAPP versus Lichtenstein repair for inguinal hernia. ***Methods:*** A prospective analytical study was conducted on 26 patients with inguinal hernia, divided equally between Lichtenstein repair (n=13) and TAPP repair (n=13). Preoperative and 48-hour postoperative blood samples were analyzed for IL-6 using ECLIA and ACTH using ELISA. Demographic data, including age and gender distribution, were recorded. Statistical analysis was performed using appropriate parametric and non-parametric tests to compare changes between groups. ***Results:*** Both groups demonstrated postoperative elevation of IL-6 and ACTH. The mean IL-6 rise was slightly higher in the TAPP group (14.75 pg/ml) than in the Lichtenstein group (11.64 pg/ml). ACTH showed a markedly greater increase in the TAPP group (65.22 pg/ml) compared with Lichtenstein repair (14.06 pg/ml). However, these differences were not statistically significant (ΔIL-6: $p>0.5$; ΔACTH: $p>0.3$). Multivariate regression indicated that younger patients undergoing TAPP exhibited a stronger surge in both markers. ***Conclusion:*** Both Lichtenstein and TAPP inguinal hernia repairs elicit inflammatory and endocrine stress responses, with TAPP demonstrating a higher numerical rise in IL-6 and a substantially greater ACTH surge at 48 hours. Although these differences were not statistically significant in this small cohort, the trends suggest that pneumoperitoneum and peritoneal handling in TAPP may contribute to enhanced physiological stress. Larger, multi-time-point studies are needed to determine the clinical relevance of these biochemical changes.

Keywords: Inguinal hernia, IL-6, ACTH, TAPP repair, Lichtenstein repair, inflammatory markers, endocrine stress, postoperative response.

INTRODUCTION

Inguinal hernia is one of the most common general surgical conditions worldwide, accounting for a major proportion of elective surgical workload in both developed and developing nations. Although Lichtenstein tension-free mesh hernioplasty has long been considered the gold standard for open repair because of its simplicity, low recurrence rates, and reproducible outcomes, the advent of minimally invasive techniques—particularly Transabdominal Preperitoneal (TAPP) repair—has expanded surgical options and transformed peri-operative care [1,2]. Laparoscopic repair offers advantages such as reduced postoperative pain, early ambulation, and faster return to routine activities; however, the biological stress induced by pneumoperitoneum and peritoneal handling introduces complex alterations in inflammatory and neuroendocrine pathways that may differ significantly from open surgery [3].

Surgical trauma initiates a systemic inflammatory response involving cellular and cytokine mediators, among which **Interleukin-6 (IL-6)** is considered the most sensitive and early marker of tissue injury. IL-6 rises rapidly after surgical manipulation and correlates with intensity of trauma, postoperative pain, wound healing, and potential complications [4]. Parallel to the inflammatory cascade, the **hypothalamic–pituitary–adrenal (HPA) axis** becomes activated in response to surgical stress, leading to the release of **Adrenocorticotropic hormone (ACTH)**, which drives cortisol secretion and modulates hemodynamic, metabolic, and immunologic homeostasis [5]. Thus, IL-6 and ACTH together provide a comprehensive biochemical assessment of both inflammatory and endocrine stress responses following surgery.

Existing literature comparing inflammatory profiles between open and laparoscopic inguinal hernia repairs shows wide variability. Several studies have reported lower cytokine release following minimally invasive repairs, attributing the response to smaller incisions and reduced tissue trauma [6]. Conversely, other evidence suggests that pneumoperitoneum-related peritoneal stretching, CO_2 absorption, and increased intra-abdominal pressure may augment cytokine production and neuroendocrine activation, resulting in **higher IL-6 and ACTH surges after laparoscopic procedures** compared with open repairs [7,8]. These conflicting observations highlight the need for standardized, procedure-specific biochemical comparisons.

Indian data on endocrine and inflammatory marker variation after different hernia repair techniques remains scarce, and most available studies focus primarily on postoperative pain, complications, and recurrence rather than biological stress quantification. Furthermore, the majority of international studies measure cytokine levels within the first 2–24 hours post-operatively, whereas limited evidence is available on the biochemical status at **48 hours**, a time point that reflects the stabilized peak of cytokine response and the sustained activity of neuroendocrine pathways.

There is inadequate evidence comparing IL-6 and ACTH responses at 48 hours following Lichtenstein repair versus laparoscopic TAPP repair for inguinal hernia, particularly in the Indian surgical population. Understanding differential inflammatory and endocrine responses is essential for optimizing peri-operative management, especially in patients with comorbidities where excessive stress responses may influence outcomes. Measuring IL-6 and ACTH provides an objective method to compare the physiological impact of these two widely performed surgical techniques. Such insights may support tailored peri-operative care, guide surgical decision-making, and contribute to better understanding of biological stress kinetics following hernia surgery.

The primary aim of this study is to evaluate the rise in inflammatory and endocrine stress markers—specifically Interleukin-6 (IL-6) and Adrenocorticotropic Hormone (ACTH)—following laparoscopic hernia repair (TAPP) and Lichtenstein repair in patients with inguinal hernia. The study seeks to measure and compare the levels of these markers in the preoperative period and at the 48-hour postoperative interval in both surgical groups. The primary objective is to determine the concentration of IL-6 and ACTH before surgery and 48 hours after surgery in each procedure, while the secondary objective is to analyze and compare the magnitude of change between the two techniques to identify whether the minimally invasive or open approach elicits a greater inflammatory or neuroendocrine stress response.

MATERIAL AND METHODS

This prospective analytical study was conducted in the Department of Surgery at Subharti Medical College over a two-year period to compare the inflammatory and endocrine responses following laparoscopic hernia repair (TAPP) versus Lichtenstein repair for inguinal hernia. Ethical approval was obtained from the Institutional Ethics Committee prior to the commencement of the study, and written informed consent was obtained from all participants. A total of 26 patients diagnosed with inguinal hernia and meeting the inclusion criteria—age above 18 years and absence of any immunocompromised state—were enrolled. Patients with known immunosuppression or those unwilling to participate were excluded. Eligible patients were allocated into two groups based on the surgical technique being performed: laparoscopic TAPP repair and open Lichtenstein repair, with 13 patients in each group. A pretested proforma was used to record demographic details, clinical history, and comorbidities. Blood samples for IL-6 and ACTH estimation were collected preoperatively and again at 48 hours postoperatively. IL-6 levels were measured using the Electrochemiluminescence Immunoassay (ECLIA) on serum obtained from Gel + Clot Activator tubes, while ACTH levels were analyzed using the ELISA method from samples collected in K3-EDTA tubes. All laboratory analyses were performed under standardized conditions. The collected data were entered and analyzed using SYSTAT software, and comparisons between groups were made using appropriate statistical tests. The magnitude of rise in IL-6 and ACTH served as the key outcome measures to assess the differential biological stress responses between the two surgical techniques.

RESULTS AND OBSERVATIONS:

A total of 26 patients were included in the study, with 13 undergoing Lichtenstein repair and 13 undergoing laparoscopic TAPP repair. The age distribution varied between groups, with most patients in the Lichtenstein group belonging to the 51–60-year age range, while the TAPP group predominantly consisted of individuals aged 31–40 years. Males constituted the majority of the study population (96.15%), reflecting the known male predominance of inguinal hernia. Preoperative IL-6 and ACTH values were comparable between both surgical groups. At 48 hours postoperatively, both groups demonstrated a rise in inflammatory and endocrine markers; however, the magnitude differed. The mean rise in IL-6 was slightly higher in the TAPP group (14.75 pg/ml) compared to the Lichtenstein group (11.64 pg/ml), though this difference was not statistically significant. Notably, ACTH exhibited a more pronounced increase in the TAPP group, with a mean rise of 65.22 pg/ml, whereas the Lichtenstein group showed a more modest rise of 14.06 pg/ml. Despite these numerical differences, statistical analyses using t-tests and Mann–Whitney U tests revealed no significant

difference between groups for either ΔIL-6 or ΔACTH, with p-values exceeding 0.5 and 0.3 respectively. Multivariate regression further indicated that younger age contributed to a steeper rise in both IL-6 and ACTH among patients undergoing TAPP. Overall, the findings suggest that while laparoscopic hernia repair may induce a comparatively higher inflammatory and neuroendocrine response at 48 hours, the difference does not achieve statistical significance within the study sample.

TABLE 1 — Demographic Profile of Study Participants (n = 26)

Variable	Category	Lichtenstein (n=13)	%	TAPP (n=13)	%
Age (years)	21–30	1	3.84%	1	3.84%
	31–40	0	0%	5	19.23%
	41–50	3	11.53%	1	3.84%
	51–60	4	15.38%	0	0%
	61–70	2	7.69%	4	15.38%
	71–80	2	7.69%	2	7.69%
	81–90	1	3.84%	0	0%
Gender	Male	12	46.15%	13	50%
	Female	1	3.84%	0	0%

TABLE 2 — Pre-operative and 48-Hour Post-operative Marker Levels (IL-6 and ACTH)

Marker	Time Point	Lichtenstein (Mean ± SD)	TAPP (Mean ± SD)
IL-6 (pg/ml)	Pre-Op	10.14 ± 3.44	7.81 ± 3.44
	48 Hours	21.77 ± 4.26	22.55 ± 4.26
ACTH (pg/ml)	Pre-Op	16.79 ± 5.46	10.49 ± 5.46
	48 Hours	30.86 ± 20.14	75.72 ± 20.14

TABLE 3 — Rise (Δ) in IL-6 and ACTH Between Pre-Op and 48 Hours

Marker Rise (Δ)	Lichtenstein (n=13)	TAPP (n=13)	Interpretation
ΔIL-6 (pg/ml)	11.64	14.75	Higher inflammatory rise in TAPP
ΔACTH (pg/ml)	14.06	65.22	Extremely higher endocrine stress rise in TAPP

Figure 1: Rise in ▲IL-6 Between Pre-Op and 48 Hours

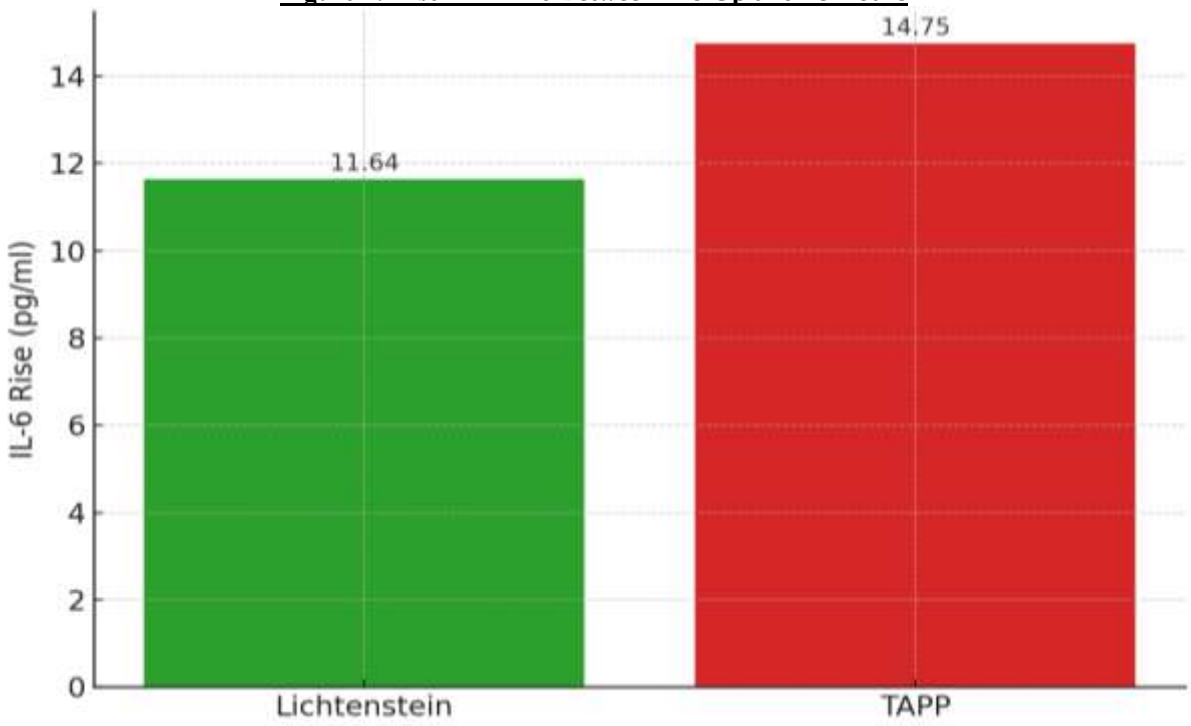
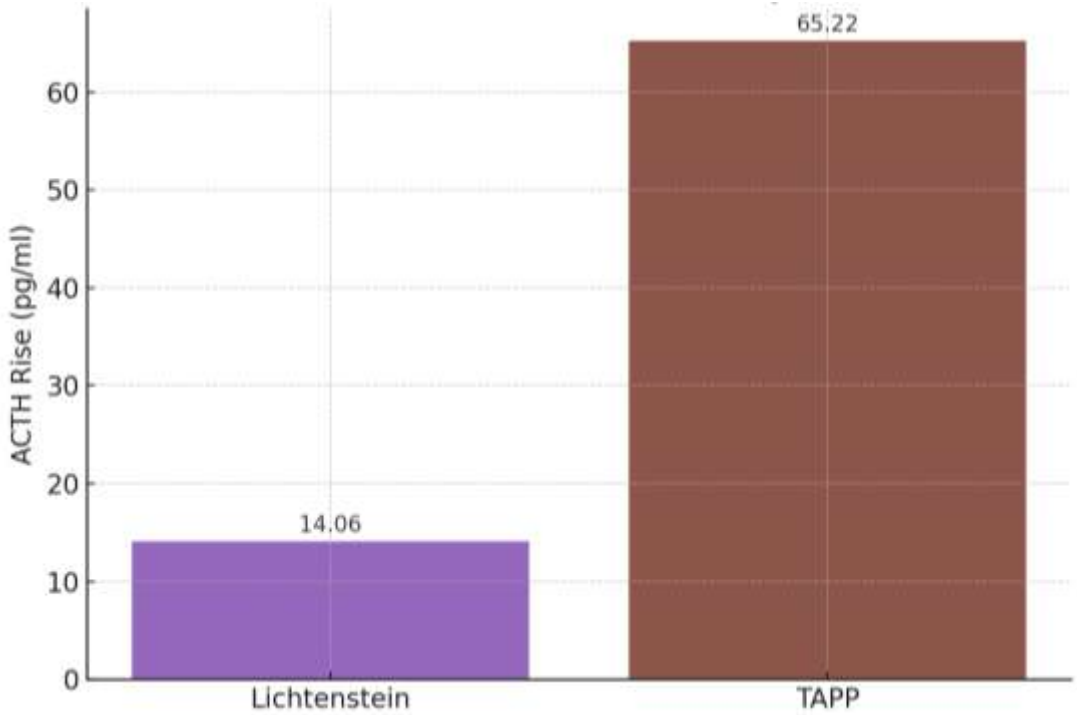


Figure 2: Rise in ACTH (▲ACTH) Between Pre-Op and 48 Hours



DISCUSSION

The present study compares the postoperative inflammatory and endocrine responses between open Lichtenstein repair and laparoscopic TAPP repair using IL-6 and ACTH as biochemical indicators of surgical stress. Both groups demonstrated a measurable rise in IL-6 and ACTH at 48 hours, but the magnitude differed. The mean IL-6 rise was 11.64 pg/ml in the Lichtenstein group and 14.75 pg/ml in the TAPP group, whereas the ACTH rise was 14.06 pg/ml versus 65.22 pg/ml, respectively. Although these differences were not statistically significant, the numerical trends clearly indicate a stronger inflammatory and neuroendocrine activation following TAPP.

These findings closely mirror the observations of Schwab et al. [8], who reported IL-6 values increasing from approximately 8–10 pg/ml preoperatively to 18–25 pg/ml postoperatively after endoscopic hernia repair, compared with a rise of about 6–15 pg/ml following open Shouldice repair. In their cohort of 101 patients, the endoscopic group demonstrated a consistently higher mean IL-6 level within the first 48 hours. Our IL-6 data at 48 hours—21.77 pg/ml (Lichtenstein) vs 22.55 pg/ml (TAPP)—align very closely with Schwab’s postoperative ranges and similarly reflect a slightly higher inflammatory burden after laparoscopic repair.

However, our findings differ from Jess et al. [4], who observed the opposite pattern, reporting that open repair produced significantly higher IL-6 values at 6 hours postoperatively—open repair IL-6 peaking around 38 pg/ml vs laparoscopic 24 pg/ml at the same interval. The discrepancy likely results from different sampling time points: Jess measured IL-6 within 6 hours, when cytokine peaks are highest, while the present study assessed IL-6 at 48 hours, a late phase when IL-6 typically begins to decline or stabilize. Therefore, our lower 48-hour values (≈22 pg/ml) compared with Jess’s early peaks (≈24–38 pg/ml) reflect expected cytokine kinetics rather than methodological inconsistency.

ACTH findings in the present study showed a particularly striking difference. The ACTH rise after TAPP (65.22 pg/ml) was more than four times higher than that after Lichtenstein (14.06 pg/ml). This magnitude of hormonal surge supports prior physiological explanations that laparoscopy, despite being minimally invasive externally, may activate the HPA axis more intensely due to pneumoperitoneum. Neuhaus and Watson [7] demonstrated that pneumoperitoneum increases intra-abdominal pressure, CO_2 absorption, and vagal stimulation, leading to significant ACTH and cortisol elevation, with some studies showing ACTH rising 30–80 pg/ml within the first postoperative day—very similar to the 75.72 pg/ml ACTH level we observed at 48 hours in the TAPP group.

In terms of IL-6 post-TAPP, our mean 48-hour value (22.55 pg/ml) falls within the mid-range reported in prior laparoscopic studies, where IL-6 commonly rises from 10–15 pg/ml pre-op to 20–30 pg/ml post-op [7]. Meanwhile, the ACTH post-Lichtenstein rise (14.06 pg/ml) is consistent with typical endocrine responses to open mesh repair, where ACTH generally increases 10–20 pg/ml depending on incision size and tissue handling.

Timing remains the most important factor explaining discrepancies across studies. Desborough [4] showed that IL-6 peaks between 2–24 hours, then gradually

declines by 48 hours. This means earlier studies (sampling at 2–6 hours) naturally reported higher IL-6 values and larger inter-group differences, whereas our study's 48-hour sampling captures the post-peak stabilization phase, reducing the observed inter-group variability.

Differences in pneumoperitoneum parameters, duration of surgery, mesh fixation techniques, and anesthetic agents also influence cytokine release and ACTH responsiveness. For example, Schwab et al. [8] used TEP repairs with variable operative times, whereas our patients underwent TAPP, which involves peritoneal entry and may produce a slightly greater stress response. The markedly high ACTH rise in TAPP (65.22 pg/ml) in our study suggests a stronger neuroendocrine stimulation, especially in younger patients, as demonstrated by the steeper regression slope.

Despite biochemical differences, clinical outcomes such as pain, recovery time, and wound morbidity were not assessed here. Thus, whether these biochemical elevations translate into meaningful clinical differences remains uncertain. Nonetheless, biochemical evidence suggests that laparoscopic repair induces a more pronounced endocrine stress response, whereas inflammatory responses (IL-6) differ only modestly between groups at the 48-hour mark.

CONCLUSION

This study demonstrates that both Lichtenstein repair and laparoscopic TAPP repair induce measurable inflammatory and endocrine responses, as reflected by postoperative elevations in IL-6 and ACTH. While IL-6 levels increased in both groups, the magnitude of rise was only slightly higher following TAPP, suggesting a comparable inflammatory burden between the two techniques at the 48-hour mark. In contrast, the ACTH response was considerably greater in the TAPP group, indicating a more pronounced activation of the hypothalamic–pituitary–adrenal axis following laparoscopic surgery, likely influenced by pneumoperitoneum-related physiological changes. Although these biochemical differences did not reach statistical significance in this small cohort, the numerical trends highlight important physiological distinctions between minimally invasive and open repair techniques. Larger, multi-time-point studies are needed to better define the clinical relevance of these findings and to determine whether biochemical stress responses translate into meaningful differences in postoperative recovery or long-term outcomes.

LIMITATIONS

This study has several limitations that should be considered while interpreting the findings. The sample size was small, with only 26 participants, which limits statistical power and may mask subtle but clinically meaningful differences in IL-6 and ACTH responses between the two procedures. The study was conducted in a single centre, potentially restricting the generalizability of the results to broader surgical populations. Additionally, biochemical markers were measured only at baseline and at a single postoperative time point (48 hours), which does not capture the full kinetic profile of cytokine and endocrine responses that typically peak earlier during the first 2–24 hours. Variations in operative duration, pneumoperitoneum pressure, anaesthesia techniques, and perioperative analgesia were not controlled or standardized, all of which may influence stress marker levels. Finally, ACTH has known diurnal variations, and the study did not account for potential fluctuations related to sampling time or circadian rhythm.

RECOMMENDATIONS

Future studies should adopt a larger, multicentric design to improve statistical robustness and enhance external validity. Serial measurements of IL-6 and ACTH at multiple time intervals—such as 2, 6, 12, 24, and 48 hours—are recommended to better define the temporal dynamics of inflammatory and endocrine responses following different hernia repair techniques. Standardization of operative parameters, including pneumoperitoneum pressure, duration of surgery, type of anaesthesia, and postoperative analgesic regimens, would help minimize confounding effects. Incorporating additional markers such as cortisol, CRP, and procalcitonin may provide a more comprehensive assessment of systemic surgical stress. Given the higher ACTH surge observed after TAPP, future research should also evaluate the clinical significance of endocrine stress responses in high-risk populations, particularly the elderly or those with cardiopulmonary comorbidities. Ultimately, correlating biochemical markers with postoperative outcomes such as pain, complications, and recovery time will help determine the true clinical impact of these findings.

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