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Evaluating liver function test alterations in laparoscopic right adrenalectomy with different retractors

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ABSTRACT

OBJECTIVE: Laparoscopic techniques have emerged as the preferred approach over traditional open surgery for the treatment of adrenal gland disorders. Right laparoscopic adrenalectomy (RLA) typically requires liver retraction for exposure, and various retractors can be used for this purpose. While studies have been conducted on liver injury during liver retraction in upper abdominal surgeries, no research has specifically addressed liver damage during laparoscopic adrenalectomy (LA). This study aims to evaluate the impact of two retractors used for liver retraction during RLA on liver function test results (LFTs) and their clinical significance.

METHODS: This retrospective study included 87 LA patients who underwent surgery for adrenal gland pathology at our institution between 01/01/2010 and 04/30/2024. The patients were divided into two groups: RLA (n=42) and left LA (LLA) (n=45). The RLA patients were further categorized into two subgroups based on the retractor used: 5-blade retractor (FB) (n=22) and full ring retractor (GF) (n=20). Clinicopathological findings, operative outcomes, and laboratory test results were compared across groups.

RESULTS: Postoperative levels of aspartate aminotransferase (AST), alanine aminotransferase, and alkaline phosphatase were significantly higher in the RLA groups (FB and GF) compared to the LLA group (p<0.001, p<0.001, p=0.001, respectively). Although no statistically significant difference was observed between groups, the median length of stay (LOS) was slightly shorter in the FB group (2 (2–3), p=0.058). There were no significant differences between FB and GF groups in terms of operation time, LFTs, complications, or mortality. Correlation analysis showed a statistically significant positive correlation between postoperative AST levels and lesion size (rho=0.31, p=0.045). Additionally, patients with functional adrenal pathologies had a significantly longer hospital stay compared to those with nonfunctional pathologies (2 (2–2.25) vs. 3 (2–3.5), p<0.001).

CONCLUSION: In RLA procedures, the LFT values were higher compared to LLA procedures. The effects of FB and GF retractors on surgical outcomes and LFT values were similar, indicating both retractors can be safely used during RLA surgeries. While no clinical impact was detected, caution is advised regarding potential liver injury during RLA procedures.

Keywords: 5-blade fan retractor; golden finger retractor; laparoscopic adrenalectomy; liver function tests; liver retractors.

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The first laparoscopic adrenalectomy (LA) was performed in 1992 by Gagner et al. [1]. Studies comparing LA to the traditional open approach have demonstrated that LA is associated with less pain, reduced bleeding, shorter hospital stays, faster return to normal activities, and a lower incidence of incisional hernias.

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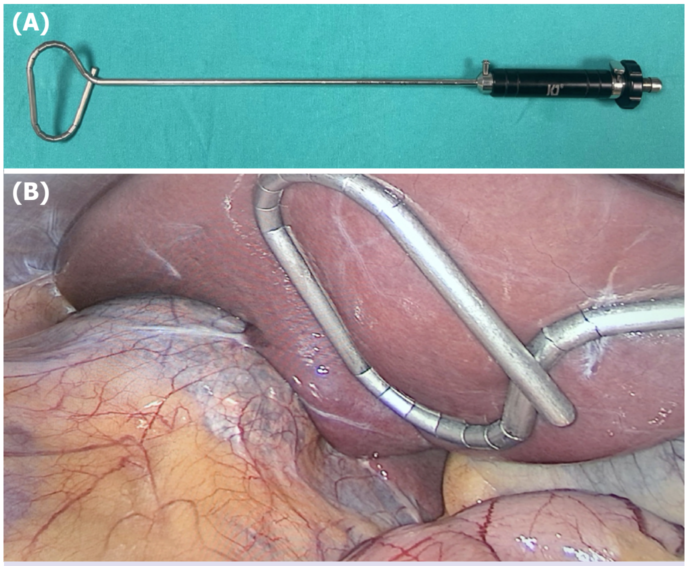

FIGURE 1. **(A)** Golden finger retractor. **(B)** Use of retractor during surgery.

Consequently, the laparoscopic approach has become the standard treatment for the surgical management of adrenal pathologies [2, 3]. Despite its benefits, carbon dioxide (CO_2) pneumoperitoneum has adverse effects on the circulatory and respiratory systems. One such effect is the reduction in portal blood flow, potentially leading to elevated serum transaminase levels [4]. Additionally, elevated liver function tests (LFTs) have been observed after laparoscopic cholecystectomy (LC) procedures, a phenomenon also associated with pneumoperitoneum [5, 6].

Various techniques have been described for LA, but the transabdominal approach is the most commonly preferred [7, 8]. Due to anatomical differences, surgical techniques vary between the right and left adrenal glands. The right adrenal gland is partially retrocaval and drains directly into the inferior vena cava (IVC). Additionally, it is in close proximity to the liver and the second portion of the duodenum. Right adrenal surgery is considered more challenging than left adrenal surgery due to anatomical features [9, 10].

In some upper abdominal minimally invasive surgeries, liver retraction is required to achieve adequate exposure, and various retractors are used for this purpose. Liver retraction is most frequently necessary during laparoscopic and robotic gastric surgeries. However, during these retractions, liver lacerations or ischemia may occur. Retractor-associated liver injury has been reported in laparoscopic gastrectomies performed for gastric cancer [11–14], Nissen fundoplication surgeries [15, 16], and bariatric surgeries for morbid obesity [17, 18]. Additionally, retractor-related liver injury has also been reported during right nephrectomy [19] and right laparoscopic adrenalectomy (RLA) procedures [20].

Highlight key points

- In laparoscopic right adrenalectomy, there is a risk of liver injury.
- Liver function tests are elevated in laparoscopic right adrenalectomy; however, no clinically significant negative effects on patients have been demonstrated.
- Both the 5-blade fan retractor® and the golden finger retractor® can be safely used with similar results for liver retraction.
- There is a correlation between the size of the adrenal lesion and liver function test results. Caution should be exercised in cases with larger lesions to prevent potential liver damage.

During RLA, liver injury or pressure-related localized liver ischemia may occur during exposure. To the best of our knowledge, in the literature, no study has examined the effects of different types of retractors used for liver retraction during RLA on LFTs. This study aims to evaluate the effects and clinical significance of two types of retractors used for liver retraction on LFTs.

MATERIALS AND METHODS

Study Design and Patient Selection

Patients who underwent LA at our institution between January 1, 2010, and April 30, 2024, were retrospectively analyzed. Inclusion criteria included all patients over 18 years old who underwent LA for adrenal gland pathology, with the procedure completed laparoscopically. Exclusion criteria comprised open surgeries, conversion to open surgery, concomitant procedures, preoperative abnormal LFTs, history of upper abdominal surgery, and patients with incomplete follow-up data.

A total of 87 patients were included in the study. The choice of retractor was based on the surgeon's preference. Due to the retrospective nature of the study, no randomization was performed; instead, groups were formed based on the types of retractors used. Patients undergoing RLA (n=42) were grouped based on the type of liver retractor used: full ring Golden Finger retractor® (GF-retractor group) (Kangji Medical Instrument Co., Zhejiang, China) (n=22) (Fig. 1) or five blade fan retractor® (FB-retractor group) (Covidien IIc, Massachusetts, USA) (n=20) (Fig. 2). Left laparoscopic adrenalectomy (LLA) patients (n=45) were included as the control group.

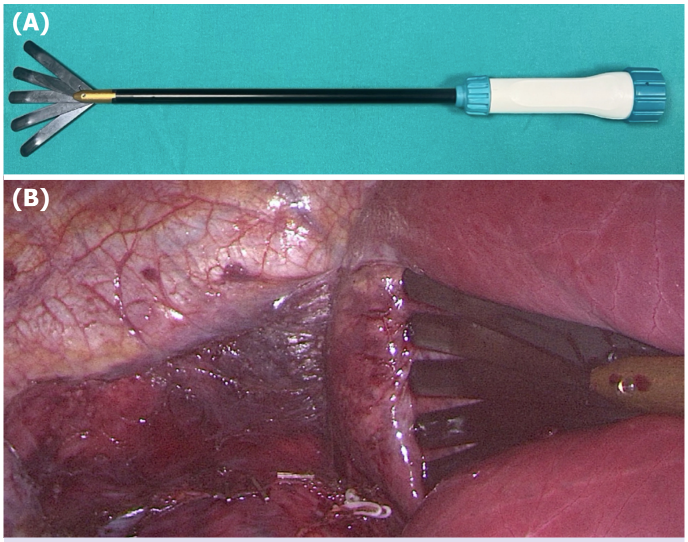

FIGURE 2. **(A)** 5-blade fan retractor. **(B)** Use of retractor during surgery.

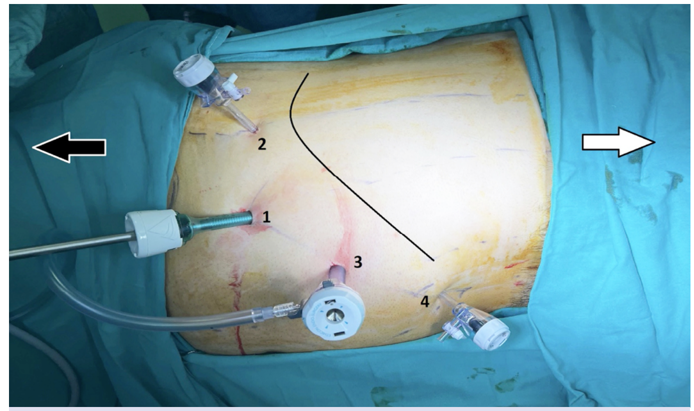

FIGURE 3. Patient position and trocar sites in laparoscopic right adrenalectomy. White arrow, patient's head; Black arrow, patient's feet; black line, subcostal line; 1, camera port; 2 and 3, working ports; 4, liver rectactor port.

Demographic, Clinical, and Laboratory Features

Clinicopathological findings, operative outcomes, and laboratory test results were analyzed between groups. Clinicopathological findings included demographic characteristics, body mass index (BMI), Charlson Comorbidity Index (CCI), lesion location, size, and preoperative diagnosis. The evaluated operative outcomes were operation time, estimated blood loss (EBL), complications classified according to the Clavien-Dindo Classification (C-D), length of hospital stay (LOS), mortality, and re-admission rates.

Laboratory findings included preoperative and postoperative day-1 levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), and bilirubin. The reference ranges in our institution's laboratory are as follows: AST 0–50 U/L, ALT 0–50 U/L, ALP 30–120 U/L, GGT 0–55 U/L, and bilirubin 0.3–1.2 mg/dL.

Definitions

The Charlson Comorbidity Index is a reliable, simple, and widely used scoring system for assessing mortality risk associated with comorbid conditions [21]. It predicts 1-year mortality by assigning weighted scores to comorbid diseases, ranging from 1 to 6, with the total score representing the cumulative risk. Higher CCI scores indicate increased mortality risk and more severe of comorbidities.

The Clavien-Dindo Classification is a widely utilized tool for evaluating postoperative complications, encompassing both morbidity and mortality [22]. The C-D grades range from Grade I to Grade V as follows:

- Grade I: Any deviation from the normal postoperative recovery not requiring pharmacological or invasive interventions.
- Grade II: Deviations requiring pharmacological treatment.
- Grade III: Deviations necessitating surgical, endoscopic, or radiological interventions (IIIa without general anesthesia; IIIb under general anesthesia).
- Grade IV: Life-threatening complications requiring intensive care management (IVa single organ dysfunction; IVb multiorgan dysfunction).
- Grade V: Death of the patient because of postoperative complications.

Surgical Technique

In our institution, a 4-trocar technique is used for RLA (Fig. 3). Under general anesthesia, the patient is positioned in the left lateral decubitus position. A 10-mm trocar is inserted using the Hasson technique (open technique) at the anterior axillary line, approximately 3–4 cm below the subcostal line. After establishing pneumoperitoneum with an intraabdominal pressure of 12 mmHg, under direct vision, a 5-mm trocar is inserted at the midaxillary line, and a 10-mm trocar is placed at the midclavicular line.

The right triangular ligament of the liver is divided using the laparoscopic LigaSure™ vessel sealing system (Medtronic, Minneapolis, USA) to allow medial retraction of the liver. If a GF retractor is used, an additional 5-mm trocar is inserted at the xiphoid area, while a 10-mm trocar is inserted if an FB retractor is employed. The liver is retracted medially to expose the IVC. The peritoneum overlying the IVC is incised, and the right adrenal gland is visualized. Dissection is carried out in the plane between the gland and the IVC, identifying the central vein draining directly into the IVC. The central vein is looped, clipped with hemoclips, and divided.

The adrenal gland is retracted laterally for traction, dissected from the retroperitoneum using the LigaSure™, and placed in a specimen bag. The adrenal gland is removed through one of the trocar sites, which is widened as necessary.

For LLA, liver retraction is not required. Instead, the spleen and pancreas are medialized to access the adrenal gland, and the procedure is completed following the same principles as RLA.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables were presented as frequencies and percentages. The distribution of continuous variables was assessed using the Shapiro–Wilk test. Variables with a normal distribution were reported as mean±standard deviation, whereas non-normally distributed variables were presented as median and interquartile range (Q1–Q3).

Comparisons between categorical variables were conducted using the chi-square test. For continuous variables, one-way analysis of variance (ANOVA) was used when the data were normally distributed, while the Kruskal–Wallis test was applied for non-normally distributed variables. When significant differences were found, post hoc comparisons were conducted using the Mann–Whitney U test. Correlations between variables were analyzed using Spearman's rank correlation coefficient. A two-tailed p-value of <0.05 was considered statistically significant.

Sample size estimation was conducted using G*Power software (version 3.1.9.7, Heinrich Heine University, Düsseldorf, Germany). A power analysis, assuming a medium effect size (Cohen's d = 0.5), an alpha level of 0.05, and a statistical power of 0.80 with equal group allocation (N1/N2=1), determined that a total sample size of 84 patients (42 per group for RLA and LLA) is adequate.

Ethical Approval

The Institutional Review Board of Medicine, Hacettepe University, approved this study (SBA 24/55; 2024/09-19).

RESULTS

Of the 87 patients included in the study, 23 (26.44%) were male. Characteristics such as age, BMI, ASA score, CCI, and past surgical history were similar among the groups (p=0.47, 0.32, 0.13, 0.49, and 0.83, respectively). Hormonal activity was observed in 45% of patients in the FB-retractor group, 54.5% in the GF-retractor group, and 53.3% in the LLA group, with no statistically significant difference between the groups (p=0.79). The median long-axis dimensions of adrenal lesions were also similar among the groups (p=0.99).

In the FB-retractor group, the most common surgical indications were adrenal adenoma (50%), Conn syndrome (25%), and Cushing syndrome (15%). In the GF-retractor group, they were adrenal adenoma (27.3%), Conn syndrome (22.7%), and pheochromocytoma (18.2%). In the LLA group, the leading indications were adrenal adenoma (44.4%), Cushing syndrome (22.2%), and Conn syndrome (20%) (p=0.52) (Table 1).

The median operation times were 101.8±21.3 minutes for the FB-retractor group, 114.3±24.5 minutes for the GF-retractor group, and 116.1±32.7 minutes for the LLA group. Statistical analysis revealed no significant differences among the three groups. (p=0.17). Intraoperative bleeding occurred in five patients overall. No bleeding was observed in the FB-retractor group, while two patients in the GF-retractor group (100 mL and 150 mL) and three patients in the LLA group (30 mL, 50 mL, and 350 mL) experienced intraoperative bleeding.

The median length of hospital stay was slightly higher in the GF-retractor group (3 (2–4)), but it was not statistically significant (p=0.058). Two patients needed a one-day ICU stay, both from the LLA group. No mortality or re-operation occurred in any group. Re-admission occurred in only one patient from the LLA group. The C-D score was two in only one patient; all others had a score of one.

Regarding pathological outcomes, the most common diagnoses were adrenal adenoma (75%) and pheochromocytoma (15%) in the FB-retractor group, adrenal adenoma (54.5%) and pheochromocytoma (18.2%) in the GF-retractor group, and adrenal adenoma (77.8%) and

Table 1. Demographic and clinicopathological characteristics of patients

	Right adrenalectomy (n=42)		Left adrenalectomy (n=45)	p
	5-blade fan retractor (n=20)	Golden finger retractor (n=22)		
Age (years) (mean±SD)	49±9.7	45±12.7	48.4±12.5	0.469[1]
Sex, male (%)	25	36.4	22.2	0.461[3]
Body mass index (median Q1–Q3)	22.9 (22–29.67)	25.5 (22.65–32.93)	24.6 (22.75–31.75)	0.323[2]
ASA score (%)				0.125[3]
1				
2	40	13.6	15.6	
3	45	72.7	60	
Comorbidities, (%)	15	13.6	24.4	
None				0.216[3]
Diabetes mellitus	10	31.8	20	0.775[3]
Hypertension	15	13.6	20	0.114[3]
Cardiovascular disease	80	50	57.8	0.488[3]
Hyporthyroidism	15	4.5	13.3	0.515[3]
Other	20	9.1	11.1	0.370[3]
Charlson comorbidity index (median, Q1–Q3)	10	22.7	11.1	0.487[3]
Past surgical history, (%)	1 (0–1.75)	0 (0–1)	1 (0–1)	0.830[3]
Hormonal status (functionality), (%)	30	36.4	37.8	0.787[3]
Length of longer axis of the lesion (median Q1–Q3)	45	54.5	53.3	0.990[2]
Preoperative diagnosis, (%)	30 (18–48.5)	32 (16.5–45.5)	30 (21.5–41)	
Adrenal adenoma				0.523[3]
Adrenal adenoma	50	27.3	44.4	
Conn syndrome	25	22.7	20	
Adrenal nodular hyperplasia	0	4.5	0	
Adrenal cyst	0	4.5	2.2	
Cushing syndrome	15	13.6	22.2	
Pheochromocytoma	5	18.2	11.1	
Myelolipoma	5	4.5	0	
Metastasis	0	4.5	0	

1: ANOVA; 2: Kruskal-Wallis Test; 3: Chi-Square; SD: Standard deviation; Q: Quartile; ASA: American Society of Anesthesiologist; ANOVA: Analysis of variance.

endothelial cyst (8.9%) in the LLA group. There were no statistically significant differences observed among the groups ($p=0.4$) (Table 2).

Analysis of LFTs revealed significant differences in postoperative AST, ALT, and ALP levels among the groups ($p<0.001$, $p<0.001$, and $p=0.001$, respectively) (Table 3). Post-hoc analysis using the Mann-Whitney U test showed significant differences between the FB-retractor and LLA groups (postoperative AST, ALT, and ALP; $p<0.001$, $p<0.001$, and $p=0.001$, respectively) and between the GF-retractor and LLA groups (postoperative AST, ALT, and ALP; $p<0.001$, $p<0.001$, and $p=0.001$, respectively). However, no differences were observed between the FB-retractor and GF-retractor groups for postoperative AST, ALT, and ALP levels ($p=0.52$, $p=0.88$, and $p=0.88$, respectively).

Table 2. Operative and pathological examination results of the patients

	Right adrenalectomy (n=42)		Left adrenalectomy (n=45)	p
	5-blade fan retractor (n=20)	Golden finger retractor (n=22)		
Duration of operation (minutes), mean±SD	101.8±21.3	114.3±24.5	116.1±32.7	0.167[1]
Length of hospital stay (days), median (Q1-Q3)	2 (2–3)	3 (2–4)	2 (2–3)	0.058[2]
Pathological report, (%)				0.398[3]
Adrenal adenoma	75	54.5	77.8	
Adrenal nodular hyperplasia	0	4.5	0,0	
Adrenocortical carcinoma	0	9.1	2.2	
Endothelial cyst	5	4.5	8.9	
Pheochromocytoma	15	18.2	6.7	
Myelolipoma	5	4.5	0,0	
Other	0	4.5	4.4	

1: ANOVA; 2: Kruskal-Wallis Test; 3: Chi-Square; SD: Standard deviation; Q: Quartile.

Among RLA patients, a statistically significant positive correlation was found between postoperative AST levels and the lesion's long-axis size (rho=0.31, p=0.045). However, there was no significant relationship between lesion size and operation time (p=0.79) (Table 4).

Patients with functional adrenal lesions had significantly longer LOS in the hospital compared to those with non-functional lesions (3 (2–3.5) vs. 2 (2–2.25), respectively, p<0.001) (Table 5).

DISCUSSION

This study demonstrated that postoperative day-1 AST, ALT, and ALP levels were significantly higher in RLA surgeries compared to LLA surgeries. It also showed that the GF and FB retractors had similar effects on LFTs elevation during RLA, and that these increases in LFTs values did not result in any clinically adverse consequences. Additionally, a statistically significant positive correlation was found between lesion size and AST levels. It was also observed that patients with functional lesions had longer LOS compared to those with non-functional lesions.

Previous studies have discussed that anesthetic agents, the pneumoperitoneum created during laparoscopy, patient positioning, and manipulation of the liver during surgery may lead to occult liver damage, resulting in postoperative elevation of LFTs [23–26]. During pneumoperitoneum, when intra-abdominal pressure is increased from 10 mmHg to 15 mmHg, splanchnic circulation slows, and hepatic blood flow decreases by 39% [4]. While some studies suggest that LFT elevation occurs without clinical significance [5, 27, 28], Meierhenrich et al. [29] demonstrated increased liver blood flow during laparoscopic surgery using transthoracic echocardiography. Furthermore, another study comparing high-pressure and low-pressure laparoscopic surgeries noted that high pressure had a negative effect on LFTs [6]. In our study, both RLA and LLA surgeries were performed with an intra-abdominal pressure set at 12 mmHg, a level considered low pressure, to minimize the impact of pneumoperitoneum on LFTs.

A study on the effect of patient positioning during laparoscopic colectomy surgeries, without liver manipulation, found no significant difference in abnormal LFT elevation between head-up and head-down positions (4.4% vs. 5.5%, respectively) [30]. Although temporary liver dysfunction may occur after general anesthesia, it is generally accepted that anesthesia does not have a clinically significant impact on LFTs [5, 31]. In our study, similar anesthetic agents were used for all patients, which helped homogenize the potential effects of anesthesia on LFTs across both groups. Additionally, the absence of elevated LFTs in the LLA group—despite liver compression in the lower abdominal region—further supports the notion that patient positioning does not significantly affect LFTs.

Table 3. Preoperative and postoperative liver function test results of the patients

	Right adrenalectomy (n=42)		Left adrenalectomy (n=25)	p
	5-blade fan retractor (n=20)	Golden finger retractor (n=22)		
Preoperative				
AST, median (Q1–Q3)	17.5 (15–21.75)	21.5 (16–26.25)	19 (16–23)	0.3192
ALT, median (Q1–Q3)	20.5 (14.25–24.75)	21.5 (18.25–34.25)	20 (14–26)	0.8152
ALP, median (Q1–Q3)	72 (55.75–89.75)	71 (52–98.25)	67 (61–76,5)	0.3182
GGT, median (Q1–Q3)	19 (11.25–30)	23 (18.75–31.5)	19 (15,5–31)	0.3032
Total bilirubine, median (Q1–Q3)	0.48 (0.4–0.72)	0.43 (0.36–0.57)	0.51 (0.39–0.64)	0.8662
Direct bilirubine, median (Q1–Q3)	0.09 (0.04–0.12)	0.09 (0.07–0.12)	0.09 (0.06–0.12)	0.8662
Postoperative day 1				
AST, median (Q1–Q3)	159 (57.75–223.75)	94.5 (75–126.75)	21 (18.5–26.5)	<**0.001**[2]
ALT, median (Q1–Q3)	110 (51–220)	114 (71–177.5)	19 (14.5–26)	<**0.001**[2]
ALP, median (Q1–Q3)	68.5 (53.25–88)	71 (54–82.25)	50 (40.5–63)	**0.001**[2]
GGT, median (Q1–Q3)	27.5 (16–42.25)	22 (16–29.25)	19 (15–25)	0.1052
Total bilirubine, median (Q1–Q3)	0.66 (0.5–1.29)	0.99 (0.46–1.06)	0.61 (0.09–0.2)	0.4572
Direct bilirubine, median (Q1–Q3)	0.22 (0.09–0.47)	0.13 (0.1–0.21)	0.14 (0.09–0.2)	0.3842

1: ANOVA; 2: Kruskal–Wallis Test; 3: Chi–Square; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; ALP: Alkaline phosphatase; GGT, Gamma glutamyl transferase; Q: Quartile.

Table 4. Correlation analysis of lesion long axis length between liver function tests and duration of operation

	Lesion long axis length	
n=42	Rho	p
AST	**0.311**	**0.045**
ALT	0.192	0.223
ALP	0.104	0.511
Duration of operation	0.042	0.793

AST: Aspartate Aminotransferase; ALT: Alanine Aminotransferase; ALP: Alkaline phosphatase.

Table 5. The relationship between the functionality of lesions and the length of hospital stay

	Nonfunctional (n=42)	Functional (n=45)	p
Length of hospital stay, median (Q1–Q3)	2 (2–2.25)	3 (2–3.5)	<**0.001**

Q: Quartile.

Liver retraction is essential in RLA surgeries because of the anatomical proximity, necessitating the use of various retractors for this purpose. There are reports in the literature, particularly in gastric surgeries, indicating that liver compression caused by retractors can lead to elevated LFTs or liver injury [11, 20]. Mechanically induced liver damage during laparoscopy has been classified into two types [19]. The first type is retraction-associated injury, where the retractor directly causes parenchymal damage. Over-retraction of tissues can lead to tears. The second type is compression-associated liver damage, where prolonged compression causes parenchymal congestion. This results in transient asymptomatic elevation of LFTs, which is often clinically insignificant. Some studies have described this type of damage as retraction transaminitis [16]. However, Tamhankar et al. [32] reported a case of retraction-related liver necrosis. Additionally, cases of retraction-related acute liver failure [19], liver hematoma [15], subcapsular hematoma [20], and liver atrophy [33] have been reported. It is recommended that the retractor be loosened and its position be adjusted every 30 minutes in order to prevent such injuries [12, 34]. In our study, we observed no instances of direct liver injury in any of the patients, suggesting that the elevated LFTs seen in RLA patients are likely attributable to the secondary mechanism described above. However, the absence of liver injury is also directly related to the experience of the surgeon handling the retractor. Considering the average surgical time of around two hours for our RLA patients, following Hiramatsu et al.'s [12] recommendation of loosening the retractor every 30 minutes may help prevent LFTs elevation.

Different types of retractors have been recommended in various surgeries to reduce retractor-related liver injury [34–36]. These efforts aim to prevent liver damage. In our study, the effects of two different retractor types on LFTs were compared. When comparing operation time, C-D score, LOS, and postoperative LFTs elevation, no significant differences were found between the two retractor types. Based on current data, no definitive conclusion has been reached that would influence retractor selection in clinical practice. Nonetheless, we believe that both GF and FB retractors can be safely used in RLA surgeries.

In right LA surgeries, exposure is more challenging due to factors such as the short length of the adrenal vein, its direct drainage into the IVC, and its location behind the liver [9, 10]. In LA procedures, injuries to the IVC, adrenal vein, or accessory veins may occur in 5–10% of cases [37]. In our study, no major vascular injuries were observed. In the RLA group, two patients experienced bleeding (100 ml and 150 ml), while in the LLA group, three patients experienced bleeding (30 ml, 50 ml, and 350 ml). Although the primary aim of our study was not to investigate adrenalectomy outcomes, the finding that only one patient had a C-D score of two, while the others had a score of one, along with similar operative times, EBL, and LOS durations compared to the literature, suggests that LA surgeries can be safely performed in cases of adrenal gland pathology.

The findings of the present study revealed a statistically significant increase in AST levels as the size of the right adrenal gland increased (rho=0.311, $p=0.045$). As the size of the adrenal gland increases, longer and more powerful retraction of the liver with retractors is required to dissect the adrenal gland. For this reason, we believe that compression-related liver injury, as previously mentioned, occurs more frequently, leading to an increase in AST levels. Therefore, during the preoperative evaluation, it should be considered that patients with a larger right adrenal gland may be at potential risk for liver damage. Additionally, we observed that patients with functional adrenal pathology had a statistically significantly longer postoperative LOS compared to those with nonfunctional pathology ($p<0.001$). The observed difference can be attributed to the protracted postoperative medical treatments necessary for patients with functional pathology.

Our study had some limitations. The major limitations included its retrospective design, being a single-center study, and the small sample size. Additionally, the lack of preoperative assessment of hepatosteatosis was another limitation of our study.

Conclusion

This study is the first to explore the impact of different retractor types on LFTs during various LA procedures. Although postoperative LFT levels are higher in patients undergoing RLA than in those undergoing LLA, the type of retractor used during RLA appears to have a comparable impact on the degree of LFT elevation. Therefore, the available data are insufficient to warrant a change in clinical practice regarding retractor selection in RLA procedures, and both retractors can be considered safe for use. In addition, since a significant correlation was observed between lesion size and high LFT levels, liver retractors should be used more carefully in large-scale adrenal gland surgeries. While no major clinical effects were noted, it remains crucial to monitor for potential liver injury during RLA surgeries.

Ethics Committee Approval: The Hacettepe University Health Sciences Research Ethics Committee granted approval for this study (date: 21.05.2024, number: 2024/09-19).

Informed Consent: Written informed consents were obtained from patients who participated in this study.

Conflict of Interest: No conflict of interest was declared by the authors.

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Authorship Contributions: Concept – HAD; Design – HAD, IA; Data collection and/or processing – HAD, IA; Analysis and/or interpretation – DD, NA; Literature review – HAD, IA; Writing – HAD, OC; Critical Review – ABD.

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