

Original Article

Comparison of surgical outcomes in adrenal vein control between advanced bipolar vessel sealer and titanium clips in laparoscopic transperitoneal adrenalectomy for aldosterone-producing adenoma: A retrospective cohort study

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Laparoscopic adrenalectomy, titanium clip, LigaSure™, aldosterone-producing adenoma

Abstract

Objective: To compare the outcomes of laparoscopic adrenalectomy carried out for aldosterone-producing adenoma (APA) with a focus on the controlled manipulation of the adrenal vein using LigaSure™ versus titanium clips.

Materials and Methods: This retrospective study included patients diagnosed with APA undergoing laparoscopic adrenalectomy from January 1, 2015, to October 30, 2023. A total of 84 patients were divided into two groups. In the first 42 patients (Group 1) titanium clips were used for adrenal vein control, while in the subsequent 42 patients (Group 2) LigaSure™ (clipless) was used. Procedures were performed by a single surgeon at Rajavithi Hospital. The primary outcomes used to evaluate the overall effectiveness of adrenal vein control were operative time, estimated blood loss, and duration of hospital stay.

Results: Statistically significant differences were observed favoring the LigaSure™ group in operative time (100.83 ± 21.26 minutes vs. 128.69 ± 29.85 minutes, $p < 0.001$), estimated blood loss (9.10 ± 8.50 ml vs. 38.69 ± 40.84 ml, $p < 0.001$), and hospital stay (4.19 ± 0.89 days vs. 5.57 ± 1.81 days, $p < 0.001$).

Conclusion: LigaSure™ demonstrated superior efficacy over titanium clips with regard to adrenal vein control during laparoscopic adrenalectomy in patients with APA, offering shorter surgery time, reduced blood loss, and shorter hospital stays.

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Introduction

Effective control of the adrenal vein during laparoscopic adrenalectomy is essential to minimize the risk of intraoperative complications and optimize surgical outcomes. Inadequate control of the adrenal vein may lead to significant hemorrhage, prolonged surgery, and postoperative complications. Given the increasing prevalence of aldosterone-producing adenomas (APA), it is crucial to evaluate the best practices for adrenal vein management.¹⁻⁴

Two primary methods for adrenal vein control are the use of titanium clips and the advanced bipolar vessel sealer, LigaSure™ (Medtronic, Minneapolis, MN, USA). LigaSure™ effectively seals blood vessels and tissues using controlled energy, causing efficacious sealing. It offers advantages including reduced time in surgery, a reduced incidence in complications, and precise sealing of vessels up to 7 mm in diameter. Its use has significantly improved surgical outcomes and safety in urological procedures. However, the comparative effectiveness of these two techniques in laparoscopic adrenalectomy has not been thoroughly explored, particularly in a specific population such as APA.⁵⁻⁷

The focus of this study is on APA due to it being a common cause of primary hyperaldosteronism, often requiring surgical intervention. Other adrenal tumors, such as pheochromocytomas or adrenocortical carcinomas, exhibit different biological behaviors, hemodynamic risks, and surgical considerations. Therefore, isolation of the APA population allows for a highly controlled and accurate comparison of the two vessel-sealing methods.³

The aim of this study is to compare the surgical outcomes of laparoscopic adrenalectomy for APA, focusing on the controlled manipulation of the adrenal vein using either LigaSure™ or titanium clips. By identifying the more effective technique, this research seeks to enhance surgical practice and increase patient safety in adrenal surgery.

Materials and Methods

This retrospective study included patients diagnosed with aldosterone-producing adenoma undergoing laparoscopic adrenalectomy from January 1, 2015, to October 30, 2023. The study protocol was approved by the Ethical Committee of Rajavithi Hospital with the study number

67005, approved January 19, 2024. A total of 84 patients were divided into two groups. In the first 42 patients (Group 1) titanium clips were used for adrenal vein control, while in the subsequent 42 patients (Group 2) LigaSure™ (clipless) was used for adrenal vein control. Procedures were performed by a single surgeon at Rajavithi Hospital. The primary outcomes of the study were the efficacy of adrenal vein control, assessed using the following parameters: blood loss, operative time, and duration of hospital stay.

Operative technique

All procedures were performed via a standard transperitoneal laparoscopic approach. *Titanium Clip Technique* (Group 1): The surgeon utilized scissors and bipolar diathermy to meticulously separate the adrenal gland from surrounding tissues. Once the adrenal vein was identified and skeletonized, titanium clips were applied using a laparoscopic clip application procedure to securely control the vessel before transection.

LigaSure™ Technique (Group 2): Dissection was performed using the LigaSure™ device, which coagulates and cuts tissues simultaneously. The jaws of the device were placed across the adrenal vein to deliver controlled energy, sealing the vessel effectively before transection, thereby eliminating the need for separate clip application.

Statistical analysis

Data were analyzed using SPSS version 22.0. Continuous data were reported as mean $\pm$ standard deviation. The Student's t-test or Mann-Whitney U-test were used to compare continuous variables, while Chi-square or Fisher's exact tests for the evaluation of categorical data. A p-value of < 0.05 was considered statistically significant.

Results

The study included 84 patients with an average age of 45.86 years. Comparisons between the demographic characteristics and clinical outcomes between the LigaSure™ (n = 42) and titanium clip (n = 42) groups revealed significant differences in operative efficiency (Table 1).

Statistically significant differences were observed favoring the LigaSure™ group with regard to operative time (100.83 ± 21.26 minutes vs. 128.69 ± 29.85 minutes, $p < 0.001$) and estimated

Table 1. Demographic characteristics and surgical outcomes of the patients

Characteristics	LigaSure™ (n=42)	Titanium clip (n=42)	P-value
Age (years)	46.36±11.33	45.36±10.03	0.670
Gender (Male/Female)	10/32	14/28	0.469
BMI (kg/m ²)	26.89±5.01	26.78±6.27	0.928
Preoperative SBP (mmHg)	139.02±16.87	141.17±17.58	0.570
Tumor size (cm)	1.80±0.60	1.79±0.57	0.912
Operative time (minutes)	100.83±21.26	128.69±29.85	< 0.001
Estimated blood loss (ml)	9.10±8.50	38.69±40.84	< 0.001
Hospital stay (days)	4.19±0.89	5.57±1.81	< 0.001

BMI = body mass index, SBP = systolic blood pressure

blood loss (9.10 ± 8.50 ml vs. 38.69 ± 40.84 ml, $p < 0.001$). Length of hospital stay was also significantly shorter in the LigaSure™ group (4.19 ± 0.89 days vs. 5.57 ± 1.81 days, $p < 0.001$). In addition, left-sided procedures were associated with longer operative times (120.54 ± 31.43 minutes vs. 107.76 ± 25.22 minutes, $p = 0.042$) in compared to those carried out on the right-side.

Discussion

Laparoscopic adrenalectomy requires meticulous control of the adrenal vein. While studies have demonstrated the safety of clip-less techniques using bipolar cautery, specific comparative efficacy in APA patients has been underexplored.¹⁻³ Our results confirm that the use of the LigaSure™ technique significantly optimizes surgical parameters. The shorter operative time is attributed to the ability of the device to efficiently seal and cut simultaneously, bypassing the time-consuming skeletonization required for clip placement. The superior hemostatic properties of LigaSure™ also minimized blood loss, lowering the risk of hemodynamic instability and contributing to an accelerated hospital discharge.

Safety, device reuse, and bleeding management

LigaSure™ utilizes a combination of pressure and energy to create a permanent seal. However, safety concerns persist regarding vessel malfunction or inadequate sealing. This risk is amplified if the device is reused. The reusability of vessel-sealing devices raises valid concerns about diminished performance due to wear, tear, and sterilization stress.^{4,5} Therefore, the need for strict inspection and testing before any reuse is paramount.

If bleeding occurs due to device malfunction or seal failure during surgery, the surgeon must act swiftly. Initial management involves attempting to reseat the vessel or adjusting the energy settings. If bleeding persists immediate conversion to traditional methods, specifically application of direct pressure, deploying of titanium or polymer clips, or the use of topical hemostatic agents, is required to prevent catastrophic hemorrhage.^{6,7}

Pros, cons, and alternative devices

The primary advantages of LigaSure™ include reduced blood loss, shorter operative times, and enhanced recovery. However, potential disadvantages include device malfunction, risks of overheating, and lateral thermal tissue damage if the energy settings are inappropriate or if used too close to adjacent critical structures for example the vena cava. A comparative study by Lee et al.⁸ found that while LigaSure™ is highly effective, ultrasonic devices like the Harmonic scalpel showed a slightly lower incidence of minor bleeding in specific patient populations, albeit with marginally longer operative times. This suggests that device selection should be tailored to surgeon preference and specific anatomical considerations.

Limitations

This study is constrained by the retrospective nature of its design and relatively small sample size. Notably, the sequential allocation method introduces a learning curve bias. As all procedures were performed by a single surgeon, the shorter operative times observed in the later LigaSure™ group may be partially attributed to the increased overall proficiency of the surgeon in laparoscopic adrenalectomy over time.

Conclusions

LigaSure™ demonstrates superior efficacy over titanium clips for adrenal vein control during laparoscopic adrenalectomy in patients with aldosterone-producing adenoma. It facilitates shorter operative time, minimizes blood loss, and promotes faster postoperative recovery. While safety concerns regarding device malfunction or reuse exist, appropriate training and adherence to backup hemostatic protocols make it a highly valuable surgical tool.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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