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A Comparative Analysis of Hypocalcemia Incidence in Patients Undergoing Thyroidectomy: LigaSure Versus Conventional Ligation of Vessels by Knot Tying

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ABSTRACT

Hypocalcemia is a frequent postoperative complication after total thyroidectomy. It usually arises from unintentional injury to the parathyroid glands or disruption of their blood supply during surgery. Advanced vessel sealing technologies like LigaSure aim to lower this risk by ensuring greater surgical precision and reducing thermal injury to adjacent structures, particularly the parathyroid glands. **Objectives:** To compare the incidence of postoperative hypocalcemia between LigaSure and conventional knot-tying techniques in total thyroidectomy patients. **Methods:** A randomized controlled trial was conducted at the Surgical Department of Gulab Devi Hospital, Lahore, from April 2024 to March 2025. Seventy-six patients who underwent total thyroidectomy for benign thyroid disease were randomly allocated to the LigaSure (n=38) and conventional knot-tying (n=38) groups. Serum calcium levels were measured preoperatively and at 24/48 hours postoperatively. For statistical analysis, SPSS v24 was used, and non-parametric tests like the Mann-Whitney U and chi-square tests were used. **Results:** Incidence of hypocalcemia was higher in the LigaSure group (10.5%) as compared to the conventional group (7.9%), but of no statistical significance (p=0.692). **Conclusions:** Both techniques demonstrated comparable safety profiles with no statistically significant differences in postoperative outcomes. LigaSure offers a comparable alternative to conventional methods of vessel sealing/ligation.

INTRODUCTION

Thyroidectomy is the surgical removal of all or part of the thyroid gland, which is located in the front of the neck. Depending on how much thyroid tissue is removed, thyroidectomy could be classified into Total thyroidectomy, subtotal thyroidectomy, near total thyroidectomy and lobectomy. Thyroidectomy is a routinely performed operation for managing various thyroid disorders, both benign and malignant. Conditions such as multinodular goitre, Graves' disease, and thyroid tumors often require surgical intervention [1]. Complications of thyroidectomy include hoarseness or change in voice (33.3%), damage to parathyroid glands causing hypocalcaemia (54.4%), wound infection (3.4%), dysphagia (32.8%). Several risk factors may contribute to the occurrence of post-thyroidectomy complications, including age, gender, enlarged gland size, type of thyroid disease, presence of fibrosis and inflammation, extent of thyroidectomy, and lymph node dissection. Among these complications, hypocalcaemia and recurrent laryngeal nerve injury are the most frequently observed [2, 3]. This calcium imbalance typically arises from inadvertent injury, disruption of blood supply, or accidental excision of the

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parathyroid glands, which are essential for regulating calcium levels in the body through parathyroid hormone (PTH) secretion [4, 5]. Reported rates of transient hypocalcemia following thyroid surgery vary considerably, with literature citing figures from 20% to 60%. In contrast, permanent hypocalcemia is less common but more impactful [6]. Symptoms can range from mild tingling and muscle cramps to severe manifestations such as seizures or laryngospasm, which may prolong hospitalization and delay recovery. Several factors influence the risk of this complication, including the surgical method, extent of gland removal, the presence of lymph node dissection, and the surgeon's experience [7]. To mitigate these risks, technological advancements have led to the introduction of energy-based hemostatic devices. Among them, LigaSure, a bipolar vessel sealing system, has gained traction for its ability to provide precise vessel control with limited lateral heat dispersion. This minimizes inadvertent damage to adjacent structures like the parathyroid glands and recurrent laryngeal nerves. In addition to improving intraoperative safety, LigaSure may also reduce operative time and blood loss when compared to traditional knot-tying techniques involving sutures and artery forceps.

This study aims to evaluate the incidence of hypocalcemia in patients undergoing total thyroidectomy using either LigaSure or the conventional knot-tying technique. Additionally, operative duration, intraoperative blood loss, and length of hospital stay were assessed to provide a broader perspective on the comparative effectiveness of the two methods.

METHODS

This study was a randomized controlled trial (RCT No. NCT06716632) carried out in the Department of Surgery at Gulab Devi Hospital, Lahore, from July 2024 to January 2025. Ethical approval was obtained from the Institutional Review Board (Approval No: AAMC/IRB/EA 41 2024). A total of 76 patients who were scheduled were recruited after obtaining written informed consent to undergo total thyroidectomy for benign thyroid disorders based on biochemical, radiological and cytological investigations. Neck dissection was not performed in any patient. Sample size calculation was performed using the WHO sample size calculator, incorporating a 95% confidence level, 5% margin of error, and 90% statistical power. The estimates were based on previously published data indicating hypocalcemia rates of 6.7% in LigaSure procedures and 32.4% in those performed with conventional techniques [8]. This yielded a required sample of 76 participants, with 38 in each group who underwent total thyroidectomy. Participants were divided into two equal groups using a lottery-based randomization technique. During total thyroidectomy, a collar incision was given on the skin, subcutaneous tissue and platysma was dissected, strap muscles of the neck were retracted to expose the thyroid gland, superior and inferior thyroid veins were ligated or sealed, superior and inferior thyroid arteries were carefully ligated or sealed and divided near the gland after identifying recurrent laryngeal nerve, both of the lobes of thyroid gland along with the isthmus was removed after identifying and preserving parathyroid glands, no neck dissection was done, than hemostasis was secured and layers were closed in reverse order using sutures. In Group A, vessel sealing was performed using the LigaSure™ Precise device (Medtronic) that involved isolating the target vessel, positioning it between the device jaws, activating bipolar energy to create a secure seal, and dividing the vessel using the built-in cutter or another instrument. At the same time, Group B underwent conventional ligation using 3-0 Vicryl sutures. The same team of experienced surgeons performed all surgeries to ensure consistency in technique and minimize operator-dependent variability. Patients requiring neck dissection or those with malignant/recurrent thyroid disease, retrosternal goiter, preoperative hypocalcemia, low vitamin D levels, abnormal PTH levels or who were already on calcium or vitamin D supplementation were excluded from the study. The primary endpoint was the occurrence of postoperative hypocalcemia, which was defined as a serum calcium level of less than 8.0 mg/dL, assessed at both 24 and 48 hours following surgery. Additional outcomes observed included the total operative time, volume of intraoperative blood loss, duration of hospital stay, and any complications such as wound infection, voice changes, or bleeding. All data were captured using a standardized proforma. Quantitative variables such as patient age, serum calcium levels, and operative time were analyzed using the Mann-Whitney U test due to their non-parametric distribution. Categorical variables, including gender, incidence of hypocalcemia, and occurrence of complications, were assessed using either the Chi-square test or Fisher's exact test, where appropriate. Statistical analysis was conducted using SPSS version 24, with significance defined as $p<0.05$ (Figure 1).

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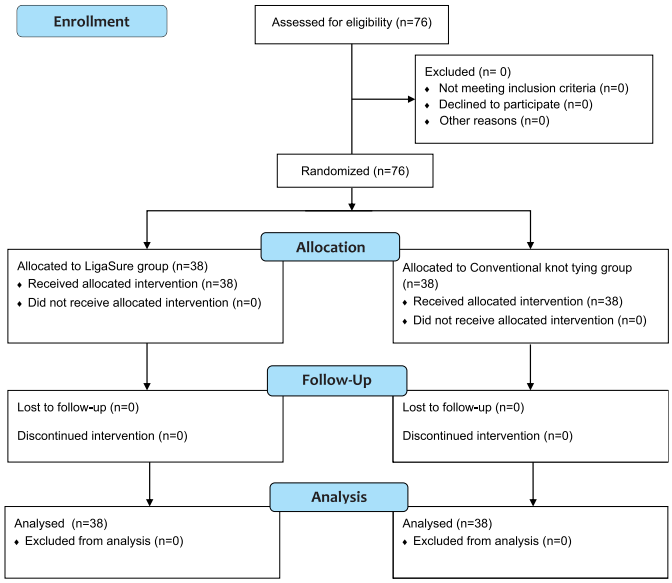

Figure 1: Consort Flow Diagram of Patient Recruitment and Allocation

RESULTS

A total of 76 patients were included in the study, with 38 patients in each group. In the LigaSure group, 4 patients (10.5%) developed hypocalcemia, compared to 3 patients (7.9%) in the conventional group. The difference was not statistically significant (p=0.692). A Chi-square test of association showed no statistically significant difference in hypocalcemia rates between the LigaSure and conventional knot-tying groups, $\chi^2(1) = 0.157$, p=0.692. Due to low expected cell counts, Fisher's exact test was applied and confirmed the result (p=1.000) (Table 1).

Table 1: Frequency of Hypocalcaemia in Each Group

Treatment Group	Hypocalcemia No	Hypocalcemia Yes	Total
Conventional Knot Tying	35 (92.1%)	3 (7.9%)	38
Ligasure	34 (89.5%)	4 (10.5%)	38
Total	69 (90.8%)	7 (9.2%)	76

The mean serum calcium levels at 24 hours postoperatively were 8.51 ± 0.21 mg/dL in the conventional group and 8.41 ± 0.28 mg/dL in the LigaSure group. At 48 hours, they were 8.49 ± 0.29 mg/dL and 8.47 ± 0.27 mg/dL, respectively. In addition, the mean operative time was 109.34 ± 24.88 minutes in the conventional group and 100.0 ± 24.82 minutes in the LigaSure group (p = 0.106). Median intraoperative blood loss was 92.37 ± 45.46 ml in the conventional group and 91.58 ± 36.13 ml in the LigaSure group (p = 0.933). Hospital stay was 5.18 ± 1.33 days in the conventional group and 5.0 ± 0.61 days in the LigaSure group (p = 0.443). No significant postoperative complications were noted in either group (Table 2).

Table 2: Postoperative Calcium Levels and Secondary Outcomes

Variables	Conventional Knot Tying (Mean ± SD)	LigaSure (Mean ± SD)	p-value
Time Postop			
24 Hours	8.51 ± 0.21 mg/dL	8.41 ± 0.28 mg/dL	0.106
48 Hours	8.49 ± 0.29 mg/dL	8.47 ± 0.27 mg/dL	0.411
Secondary Outcomes			
Intraoperative Blood Loss	92.37 ± 45.46 ml	91.58 ± 36.13 ml	0.933
Operative Time	109.34 ± 24.88 min	100.0 ± 24.82 min	0.106
Hospital Stay	5.18 ± 1.33 days	5.0 ± 0.61 days	0.443

The mean age in the conventional group was 39.29 ± 8.64 years, while in the LigaSure group it was 37.89 ± 8.14 years (p=0.471). There were 20 (52.6%) males and 18 (47.4%) females in the conventional group and 16 (42.1%) males and 22 (57.9%) females in the LigaSure group (Table 3).

Table 3: Age and Gender Distribution of Patients

Treatment Groups	Gender	n (%)	Age (Years) (Mean ± SD)
Conventional Knot Tying	Male	20 (52.6%)	39.29 ± 8.64 Years
	Female	18 (47.4%)	
Ligasure	Male	16 (42.1%)	37.89 ± 8.14 Years
	Female	22 (57.9%)	

One case of wound Infection occurred in the LigaSure group and none in the conventional group. This was not statistically significant (p = 1.000). One patient in the conventional group had a postoperative voice change, and none in the LigaSure group. No cases of RLN Injury occurred in either group. Due to the low frequency of complications, Fisher's exact test was used instead of the Chi-square. p-values>0.05 indicate no statistically significant difference in complication rates between the groups (Table 4).

Table 4: Postoperative Complications

Complications	Conventional Group	LigaSure Group	p-value
Wound Infection	0 (0%)	1 (2.6%)	1.000 (Fisher's)
Voice Changes	1 (2.6%)	0 (0%)	

This study consolidates the key statistical test results applied to categorical variables in the study. Chi-square test showed no significant difference in hypocalcemia Incidence between groups (p=0.692). Verified Gender Distribution balance between groups using Chi-square (p=0.361). Complication Frequency summarizes results, confirming with Fisher's test that no group had significantly more complications (Table 5).

Table 5: Statistical Comparison (Chi-Square Test Results)

Variables	Conventional Group, n (%)	LigaSure Group, n (%)	Test	p-value	Result
Hypocalcemia Incidence	3 (7.9%)	4 (10.5%)	Chi-square	0.692	Not Significant
Gender Distribution (Male) / (Female)	20 (52.6%) / 18 (47.4%)	16 (42.1%) / 22 (57.9%)	Chi-square	0.361	Not Significant

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Complication Frequency	1(2.6%)	1(2.6%)	Fisher's exact	>0.05	Not Significant

DISCUSSIONS

When it comes to thyroid surgery, there's still an ongoing debate about whether newer tools like LigaSure™ offer real benefits over the traditional method of tying knots with sutures. Our study aimed to explore this question by comparing both approaches in a clinical setting using a standardized surgical technique. Based on our results, it appears that while there may be minor differences, both methods are generally safe and effective in experienced hands. The study noticed a slightly higher rate of temporary hypocalcemia in patients operated on with LigaSure (10.5%) compared to those treated with conventional knot-tying (7.9%). However, this difference wasn't statistically significant (p=0.692), which means that both methods performed similarly in terms of preserving parathyroid function. Our findings are consistent with those reported by an earlier study, 12.5% versus 10% (p=0.60), that also found no significant difference in hypocalcemia rates between these techniques in a group of 80 thyroidectomy patients [9]. Looking at calcium levels more closely, both groups showed very similar trends in the immediate postoperative period. At 24 hours, the average serum calcium levels were around 8.4 to 8.5 mg/dL, and by 48 hours, they remained stable with very little variation between the two groups. Another study also reported comparable outcomes, reinforcing the idea that both approaches are equally reliable when it comes to preventing this common complication [10]. These findings suggest that neither method significantly disrupts calcium balance in the short term. Similar results were reported by an earlier study, 8.5 ± 0.3 mg/dL for both techniques at both time points, which also concluded that early postoperative calcium levels don't vary much depending on the sealing method used [11]. Some studies have indicated a lower incidence of hypocalcemia with LigaSure, which might be explained by variations in surgeon experience, technique consistency, or differences in the patient populations studied [12]. Similar trends were observed in other studies, which suggested that energy-based vessel sealing devices do not significantly impact early postoperative calcium levels [13]. This study also investigated how efficient each method was during surgery. While the LigaSure group showed a reduction in operative time. Still, this time saving has been echoed in larger studies like the meta-analysis conducted earlier, which found that energy-based devices could reduce operating time, a 34.1% reduction, particularly in high-volume surgical settings [14]. That said, the difference is modest and may not be enough to justify the higher cost of these devices on that basis alone. In terms of complications, both groups had very few issues. Some patients in the LigaSure group developed a minor wound infection, while some in the conventional group had temporary voice changes. The low complication rates reported earlier, which highlighted the safety of both techniques when surgeries are done properly and on appropriately selected patients [15]. No study is without limitations. Our sample size of 76 patients was reasonable for a single-center trial but may not be large enough to detect rare complications like permanent hypocalcemia or RLN injury. This limitation is common in surgical studies and has been discussed in recent literature, which stressed the need for larger datasets to detect such events [16]. Also, since this study only followed patients for the first 48 hours after surgery, we can't say whether there might be longer-term differences in calcium levels or parathyroid function. From a practical point of view, these findings suggest that both techniques are good options, and the choice may come down to factors like availability, cost, and surgeon experience. In well-equipped hospitals where time efficiency is important, LigaSure might offer some benefit in terms of reducing operating time. However, in hospitals where cost is a bigger concern, conventional knot-tying remains a reliable, safe, and cost-effective method. While earlier studies have reported that LigaSure may help reduce operative time and blood loss due to better hemostasis. These study findings suggest that the surgeon's skill level may play a more decisive role in these outcomes than the choice of instrument [17, 18]. The nearly identical calcium levels we observed between the two surgical approaches make more sense when we consider some recent breakthroughs in parathyroid research. A fascinating 2023 study used advanced imaging technology to visualize blood flow to the parathyroid glands during surgery. Their findings showed that whether surgeons used LigaSure or traditional techniques, about 88-89% of parathyroid glands maintained good blood supply, as long as surgeons carefully preserved them during the procedure. This matches perfectly with what our patients experienced [19]. The similar calcium levels in both our groups (8.41 vs 8.51 mg/dL at 24 hours) tell the same story - the sealing method itself doesn't seem to make or break parathyroid function. A research team came to the same conclusion in their 2023 study of 84 patients [20]. Researchers tracked parathyroid hormone levels after surgery and found nearly identical recovery patterns regardless of which technique was used. By 24 hours post-op, both groups had regained about 70-80% of their normal PTH levels. In summary, both LigaSure and conventional knot-tying are safe and effective options for vessel sealing during thyroidectomy for benign disease. Our study shows that neither technique holds a clear advantage in terms of hypocalcemia rates or other perioperative outcomes. The

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decision between them should be guided by local circumstances, available resources, and the surgeon's comfort with the technique.

CONCLUSIONS

This randomized trial found no significant differences in hypocalcemia incidence or other perioperative outcomes between LigaSure and conventional knot-tying techniques in total thyroidectomy for benign thyroid disease. Both methods appear equally safe when performed by skilled surgeons.

Authors Contribution

Conceptualization: IA
Methodology: HBA, NP, IA
Formal analysis: ZH
Writing review and editing: MM, UAR

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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