

Evaluation of Efficacy of Ligation versus Bipolar Diathermy for Management of Intraoperative Haemostasis in Tonsillectomy: A Prospective Interventional Study

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Abstract

Background: Tonsillectomy is one of the most commonly performed surgical procedures in otorhinolaryngology. Effective intraoperative haemostasis is essential for minimizing blood loss, improving surgical visualization, reducing operative time, and preventing postoperative complications. Ligation and bipolar diathermy are widely used haemostatic techniques; however, their relative advantages and postoperative outcomes remain subjects of ongoing debate.

Aim: To compare the efficacy of ligation and bipolar diathermy for achieving intraoperative haemostasis during tonsillectomy and to evaluate their impact on operative outcomes, postoperative recovery, and complications.

Materials & Methods: This prospective randomized interventional study was conducted in the Department of Otorhinolaryngology. A total of 120 patients aged 5–40 years with chronic tonsillitis undergoing elective tonsillectomy were randomly allocated into two groups: ligation group (n = 60) and bipolar diathermy group (n = 60). Conventional cold dissection tonsillectomy was performed in all patients, followed by haemostasis using either 3-0 Vicryl ligatures or bipolar diathermy. Intraoperative blood loss, haemostasis time, postoperative pain scores, haemostatic efficacy, postoperative haemorrhage, healing time, recovery parameters, and postoperative complications were compared. Statistical analysis was performed using IBM SPSS Statistics version 27.0, with $p < 0.05$ considered statistically significant.

Results: Baseline demographic and clinical characteristics were comparable between the two groups ($p > 0.05$). The bipolar diathermy group demonstrated significantly lower intraoperative blood loss (27.81 ± 8.47 mL vs. 48.24 ± 10.63 mL; $p < 0.001$) and shorter haemostasis time (4.82 ± 1.12 min vs. 8.63 ± 1.54 min; $p < 0.001$) than the ligation group. Effective haemostasis on the first attempt was achieved more frequently with bipolar diathermy (96.7% vs. 83.3%; $p = 0.015$). However, postoperative pain scores were significantly lower in the ligation group on postoperative days 1, 3, and 7 ($p < 0.001$ for all comparisons). Complete healing of the tonsillar fossa occurred earlier in the ligation group (13.42 ± 2.11 days vs. 16.13 ± 2.47 days; $p < 0.001$). Patients undergoing ligation resumed a normal diet and routine daily activities significantly earlier than those managed with bipolar diathermy ($p < 0.001$). Although primary and secondary postoperative haemorrhage rates did not differ significantly between groups, delayed healing and severe postoperative pain were significantly more frequent in the bipolar diathermy group ($p < 0.05$).

Conclusion: Bipolar diathermy provides superior intraoperative haemostatic efficiency, resulting in significantly reduced blood loss, shorter haemostasis time, and higher first-attempt haemostatic success during tonsillectomy. However, ligation is associated with lower postoperative pain, faster wound healing, earlier functional recovery, and fewer postoperative complications. While bipolar diathermy may be preferred when rapid haemostasis is required, ligation offers more favourable postoperative outcomes and patient comfort.

Keywords: Tonsillectomy; Haemostasis; Ligation; Bipolar Diathermy; Chronic Tonsillitis; Intraoperative Blood Loss; Postoperative Pain.

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Introduction

Tonsillectomy remains one of the most frequently performed otorhinolaryngological surgical procedures worldwide and is indicated primarily for recurrent tonsillitis, chronic tonsillitis, obstructive sleep-disordered breathing, and recurrent peritonsillar abscesses. Despite advances in surgical techniques and perioperative care, achieving effective intraoperative haemostasis remains a critical determinant of surgical success, operative duration, postoperative recovery, and complication rates. Excessive intraoperative bleeding can obscure the surgical field, prolong operative time, increase tissue trauma, and contribute to postoperative morbidity, including secondary haemorrhage and delayed healing.[1]

Cold steel dissection followed by ligation of bleeding vessels has traditionally been regarded as the standard technique owing to its minimal thermal tissue injury and lower incidence of postoperative pain and secondary haemorrhage. However, this technique may require longer operative time and greater surgical expertise to achieve meticulous haemostasis.[2]

Bipolar diathermy achieves haemostasis through localized thermal coagulation of blood vessels using electrical current passed between two electrodes. This technique offers the advantages of rapid bleeding control, improved visualization of the operative field, and reduced operative duration. Nevertheless, thermal injury to surrounding tissues has been associated with increased postoperative pain, delayed wound healing, and a potentially higher risk of secondary haemorrhage.[3] Consequently, the choice between ligation and bipolar diathermy remains a subject of ongoing debate among otolaryngologists. Recent studies have attempted to compare the efficacy and safety of different haemostatic techniques during tonsillectomy. Al-Qahtani et al. (2021) reported that bipolar diathermy significantly reduced operative time compared with conventional ligation methods but was associated with increased postoperative pain scores during the early recovery period.[4] Similarly, Khan et al. (2022) observed superior intraoperative haemostatic efficiency with bipolar cautery, although postoperative discomfort and delayed return to normal diet were more frequent in patients undergoing bipolar coagulation.[5] In contrast, Singh et al. (2023) demonstrated that ligation techniques resulted in lower postoperative morbidity and reduced secondary haemorrhage rates despite requiring longer operative duration.[6]

A systematic review by Mitchell and Archer (2022) emphasized that while electrosurgical techniques offer improved intraoperative efficiency, concerns

persist regarding thermal tissue damage and postoperative outcomes. The authors highlighted the need for further prospective randomized studies comparing conventional ligation with bipolar diathermy, particularly in resource-limited settings where both techniques continue to be commonly employed.[7]

Aim & Objectives

Aim: To compare the efficacy of ligation and bipolar diathermy for achieving intraoperative haemostasis during tonsillectomy and to evaluate their impact on operative outcomes, postoperative recovery, and complications.

Objectives

- To compare intraoperative blood loss between ligation and bipolar diathermy techniques.
- To compare the time required to achieve haemostasis during tonsillectomy.
- To evaluate postoperative pain scores following both haemostatic techniques.
- To compare the effectiveness of haemostasis achieved on the first attempt.
- To assess the incidence of primary and secondary postoperative haemorrhage.
- To evaluate the time required for complete healing of the tonsillar fossa.
- To compare postoperative recovery parameters, including return to normal diet and daily activities.
- To compare postoperative complications associated with the two haemostatic methods.

Materials & Methods

Study Design: This was a hospital-based, prospective, randomized interventional study conducted to compare the efficacy of ligation versus bipolar diathermy for achieving intraoperative haemostasis during tonsillectomy in patients with chronic tonsillitis.

Study Setting: The study was conducted in the Department of Otorhinolaryngology (ENT) at Nalanda Medical College & Hospital, Patna, Bihar, India., a tertiary care teaching hospital catering to a large urban and rural population. The department provides comprehensive otorhinolaryngological services, including routine and advanced surgical management of chronic tonsillitis and related disorders.

Study Period: The study was carried out over a period of 9 months, from February 2025 to October 2025, during which patient recruitment, surgical intervention, postoperative follow-up, data collection, and analysis were completed.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethics Committee. Written informed consent was obtained from all adult participants and from parents or legal guardians of pediatric patients prior to enrolment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Study Population: A total of 120 patients diagnosed with chronic tonsillitis and scheduled for elective tonsillectomy were enrolled in the study. Eligible participants were randomly allocated into two equal groups:

- **Ligation Group:** Haemostasis achieved using 3-0 Vicryl ligatures (n = 60)
- **Bipolar Diathermy Group:** Haemostasis achieved using bipolar diathermy (n = 60)

Randomization was performed for distribution of patients using a table of random numbers, with even numbers assigned to Ligation Group and odd numbers assigned to Bipolar Diathermy Group.

Inclusion Criteria

- Patients aged 5–40 years undergoing elective tonsillectomy.
- Patients with chronic tonsillitis with or without adenoid hypertrophy.
- Patients willing to participate and provide written informed consent.

Exclusion Criteria

- Patients aged >40 years.
- Acute tonsillitis or peritonsillar abscess at the time of surgery.
- Chronic systemic illnesses affecting surgical outcomes.
- Patients with anaemia or immunocompromised status.
- Patients undergoing concomitant surgical procedures such as myringotomy, grommet insertion, lymph node biopsy, or other head and neck surgeries.
- Patients unwilling to participate in the study.

Preoperative Evaluation and Investigations: All patients underwent detailed history taking, comprehensive clinical examination, and routine preoperative evaluation, including complete blood count, bleeding and clotting time, prothrombin time/international normalized ratio, random blood sugar, renal function tests, viral marker screening where indicated, and pre-anaesthetic fitness assessment.

The diagnosis of chronic tonsillitis was established based on clinical history and otorhinolaryngological examination.

Methodology

After enrolment, demographic and clinical data were recorded in a structured case record form. Participants were randomized into either the ligation or bipolar diathermy group. All surgeries were performed under general anaesthesia by experienced otorhinolaryngologists following a standardized surgical protocol.

Intraoperative and postoperative parameters were prospectively recorded and compared between the two groups.

Surgical Procedure

Tonsillectomy Technique: Patients were operated under general anaesthesia with oral endotracheal intubation. Conventional cold dissection tonsillectomy was performed in all patients.

Ligation Technique: Following removal of the tonsil, bleeding vessels in the tonsillar fossa were identified and secured using 3-0 Vicryl ligatures until complete haemostasis was achieved.

Bipolar Diathermy Technique: Following tonsillectomy, bleeding points were identified and coagulated using bipolar diathermy forceps until complete haemostasis was achieved.

Outcome Measures

Primary Outcome

- Effectiveness of intraoperative haemostasis.

Secondary Outcomes

- Intraoperative blood loss (mL).
- Time required to achieve haemostasis (minutes).
- Postoperative pain assessed using the Visual Analogue Scale (VAS).
- Incidence of primary postoperative haemorrhage (within 24 hours).
- Incidence of secondary postoperative haemorrhage (24 hours–14 days).
- Time required for complete healing of the tonsillar fossa.
- Time to return to normal diet.
- Time to resume routine daily activities.
- Postoperative complications including severe pain, infection, mucosal injury, delayed healing, and haemorrhage.

Assessment of Variables

Intraoperative Blood Loss: Blood loss was measured by summing:

- Volume collected in the suction container after subtracting irrigation fluid.
- Estimated blood absorbed by surgical gauze and swabs.

Time Required for Haemostasis: The haemostasis time was measured using a stopwatch

from identification of the first bleeding point following tonsil removal until complete haemostasis was achieved.

Postoperative Pain Assessment: Pain was assessed using a 10-point Visual Analogue Scale (VAS) on:

- Postoperative Day (POD) 0
- POD 3
- POD 5

Higher scores indicated greater pain severity.

Postoperative Follow-up: Patients were evaluated for postoperative haemorrhage, healing status, pain, infection, and recovery during follow-up visits up to 14 days after surgery.

Statistical Analysis: Data were entered into Microsoft Excel 365 and analysed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean $\pm$ standard deviation (SD), whereas categorical variables were presented as frequency and percentage (%). Normality of continuous variables was assessed using the Shapiro–Wilk test. Intergroup comparisons of normally distributed continuous variables were performed using the independent samples Student's t-test. Categorical variables were compared using the Chi-square test or Fisher's exact test, wherever appropriate. All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant.

Results

A total of 120 patients with chronic tonsillitis undergoing elective tonsillectomy were enrolled in the study and randomly allocated into the ligation group (n = 60) and bipolar diathermy group (n = 60).

Table 1: Comparison of Sociodemographic and Clinical Characteristics of Study Participants Between the Ligation and Bipolar Diathermy Groups

Variable	Ligation Group (n = 60)	Bipolar Diathermy Group (n = 60)	Test Statistic	p-value
Age (years), Mean $\pm$ SD	17.82 $\pm$ 7.46	18.37 $\pm$ 7.91	t = 0.39	0.698
Male, n (%)	34 (56.7)	32 (53.3)	$\chi^2 = 0.13$	0.715
Female, n (%)	26 (43.3)	28 (46.7)		
Duration of symptoms (years), Mean $\pm$ SD	3.72 $\pm$ 1.84	3.91 $\pm$ 1.69	t = 0.59	0.556
Recurrent sore throat episodes per year, Mean $\pm$ SD	6.82 $\pm$ 1.63	7.04 $\pm$ 1.78	t = 0.71	0.479
Presence of adenoid hypertrophy, n (%)	18 (30.0)	20 (33.3)	$\chi^2 = 0.15$	0.699

Table 1 present the mean age of patients in the ligation group was 17.82 $\pm$ 7.46 years compared to 18.37 $\pm$ 7.91 years in the bipolar diathermy group, with no statistically significant difference between the groups (t = 0.39, p = 0.698).

Male participants constituted 56.7% of the ligation group and 53.3% of the bipolar diathermy group, while females accounted for 43.3% and 46.7%, respectively ($\chi^2 = 0.13$, p = 0.715). The mean duration of symptoms was comparable between the ligation group (3.72 $\pm$ 1.84 years) and the bipolar

diathermy group (3.91 $\pm$ 1.69 years) (t = 0.59, p = 0.556). Similarly, the mean number of recurrent sore throat episodes per year was 6.82 $\pm$ 1.63 and 7.04 $\pm$ 1.78, respectively (t = 0.71, p = 0.479).

Adenoid hypertrophy was present in 30.0% of patients in the ligation group and 33.3% of those in the bipolar diathermy group ($\chi^2 = 0.15$, p = 0.699). These findings indicate that both groups were comparable at baseline, with no statistically significant differences in demographic or clinical characteristics.

Table 2: Comparison of Intraoperative Blood Loss and Time Required for Haemostasis Between the Ligation and Bipolar Diathermy Groups

Variable	Ligation Group (n = 60), Mean $\pm$ SD	Bipolar Diathermy Group (n = 60), Mean $\pm$ SD	t-value	p-value
Intraoperative blood loss (mL)	48.24 $\pm$ 10.63	27.81 $\pm$ 8.47	11.67	<0.001*
Time required for haemostasis (minutes)	8.63 $\pm$ 1.54	4.82 $\pm$ 1.12	15.51	<0.001*

Table 2 show the mean intraoperative blood loss was significantly higher in the ligation group (48.24 $\pm$ 10.63 mL) compared with the bipolar diathermy group (27.81 $\pm$ 8.47 mL). This difference was highly statistically significant (t = 11.67, p < 0.001). Likewise, the mean time required to achieve haemostasis was significantly

longer in the ligation group (8.63 $\pm$ 1.54 minutes) than in the bipolar diathermy group (4.82 $\pm$ 1.12 minutes), with a highly significant difference between the groups (t = 15.51, p < 0.001). These findings suggest that bipolar diathermy was more efficient in achieving intraoperative haemostasis with less blood loss and reduced operative time.

Table 3: Comparison of Postoperative Pain Scores (Visual Analogue Scale) Between the Ligation and Bipolar Diathermy Groups

Postoperative Day	Ligation Group (Mean $\pm$ SD)	Bipolar Diathermy Group (Mean $\pm$ SD)	t-value	p-value
Day 1	4.86 $\pm$ 1.02	6.28 $\pm$ 1.14	7.19	<0.001*
Day 3	3.94 $\pm$ 0.88	5.17 $\pm$ 1.01	7.12	<0.001*
Day 7	2.73 $\pm$ 0.81	3.88 $\pm$ 0.95	7.11	<0.001*

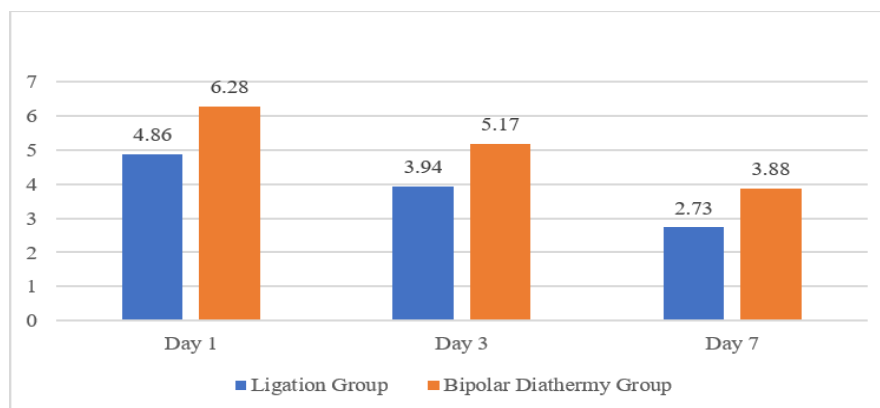
**Figure 1: Postoperative Pain Scores (Visual Analogue Scale) Between the Ligation and Bipolar Diathermy Groups**

Table 3 and figure I, show that on postoperative day 1, the mean pain score was significantly lower in the ligation group (4.86 $\pm$ 1.02) than in the bipolar diathermy group (6.28 $\pm$ 1.14) ($t = 7.19$, $p < 0.001$). Similar findings were observed on postoperative day 3, where the mean pain scores were 3.94 $\pm$ 0.88 and 5.17 $\pm$ 1.01, respectively ($t =$

7.12, $p < 0.001$). On postoperative day 7, the ligation group continued to demonstrate significantly lower pain scores (2.73 $\pm$ 0.81) compared with the bipolar diathermy group (3.88 $\pm$ 0.95) ($t = 7.11$, $p < 0.001$). Thus, postoperative pain was consistently and significantly lower among patients undergoing ligation.

Table 4: Comparison of the Effectiveness of Intraoperative Haemostasis Between the Ligation and Bipolar Diathermy Groups

Haemostatic Outcome	Ligation Group (n = 60), n (%)	Bipolar Diathermy Group (n = 60), n (%)	χ^2 -value	p-value
Effective haemostasis achieved on first attempt	50 (83.3)	58 (96.7)	5.93	0.015
Additional haemostatic measures required	10 (16.7)	2 (3.3)		

Table 4 show that effective haemostasis on the first attempt was achieved in 50 patients (83.3%) in the ligation group compared with 58 patients (96.7%) in the bipolar diathermy group. Conversely, additional haemostatic measures were required in

16.7% of patients in the ligation group and only 3.3% of patients in the bipolar diathermy group. This difference was statistically significant ($\chi^2 = 5.93$, $p = 0.015$), indicating superior haemostatic efficacy of bipolar diathermy during tonsillectomy.

Table 5: Comparison of the Incidence of Primary Postoperative Haemorrhage (Within 24 Hours) Between the Study Groups

Primary Postoperative Haemorrhage	Ligation Group (n = 60), n (%)	Bipolar Diathermy Group (n = 60), n (%)	χ^2 -value	p-value
Present	2 (3.3)	1 (1.7)	0.34	0.559
Absent	58 (96.7)	59 (98.3)		

Table 5 show that primary haemorrhage was observed in 2 patients (3.3%) in the ligation group and 1 patient (1.7%) in the bipolar diathermy group. Although the incidence was numerically lower in the bipolar diathermy group, the difference

was not statistically significant ($\chi^2 = 0.34$, $p = 0.559$). Therefore, both techniques demonstrated comparable safety with respect to primary postoperative bleeding.

Table 6: Comparison of the Incidence of Secondary Postoperative Haemorrhage (24 Hours to 14 Days) Between the Study Groups

Secondary Postoperative Haemorrhage	Ligation Group (n = 60), n (%)	Bipolar Diathermy Group (n = 60), n (%)	χ^2 -value	p-value
Present	1 (1.7)	5 (8.3)	2.81	0.094
Absent	59 (98.3)	55 (91.7)		

Table 6 show that secondary haemorrhage occurred in 1 patient (1.7%) in the ligation group and 5 patients (8.3%) in the bipolar diathermy group. Despite the higher incidence observed in the bipolar diathermy group, the difference did not

reach statistical significance ($\chi^2 = 2.81$, $p = 0.094$). Nevertheless, the findings suggest a trend toward a greater frequency of delayed postoperative bleeding following bipolar diathermy.

Table 7: Comparison of Time Required for Complete Healing of the Tonsillar Fossa Between the Study Groups

Variable	Ligation Group (n = 60) Mean $\pm$ SD	Bipolar Diathermy Group (n = 60) Mean $\pm$ SD	t-value	p-value
Time to complete healing (days)	13.42 $\pm$ 2.11	16.13 $\pm$ 2.47	6.48	<0.001*

Table 7 demonstrate the mean time required for complete healing of the tonsillar fossa was significantly shorter in the ligation group (13.42 $\pm$ 2.11 days) compared with the bipolar diathermy

group (16.13 $\pm$ 2.47 days). The difference was highly statistically significant ($t = 6.48$, $p < 0.001$), indicating faster wound healing following ligation.

Table 8: Comparison of Postoperative Recovery Parameters Between the Ligation and Bipolar Diathermy Groups

Recovery Parameter	Ligation Group (n = 60) Mean $\pm$ SD	Bipolar Diathermy Group (n = 60) Mean $\pm$ SD	t-value	p-value
Return to normal diet (days)	7.41 $\pm$ 1.64	9.27 $\pm$ 2.02	5.55	<0.001*
Return to routine daily activities (days)	8.13 $\pm$ 1.82	10.05 $\pm$ 2.31	5.08	<0.001*

Table 8 present, Patients in the ligation group resumed a normal diet significantly earlier than those in the bipolar diathermy group (7.41 $\pm$ 1.64 days vs. 9.27 $\pm$ 2.02 days; $t = 5.55$, $p < 0.001$). Similarly, the mean time required to return to routine daily activities was significantly shorter in

the ligation group (8.13 $\pm$ 1.82 days) compared with the bipolar diathermy group (10.05 $\pm$ 2.31 days) ($t = 5.08$, $p < 0.001$). These results indicate superior postoperative recovery among patients managed with ligation.

Table 9: Comparison of Postoperative Complications Between the Ligation and Bipolar Diathermy Groups

Postoperative Complication	Ligation Group (n = 60), n (%)	Bipolar Diathermy Group (n = 60), n (%)	χ^2 -value	p-value
Severe pain requiring additional analgesics	5 (8.3)	15 (25.0)	6.17	0.013*
Secondary postoperative haemorrhage	1 (1.7)	5 (8.3)	2.81	0.094
Delayed healing (>14 days)	6 (10.0)	18 (30.0)	7.50	0.006*
Infection of tonsillar fossa	2 (3.3)	4 (6.7)	0.70	0.402
No postoperative complication	46 (76.7)	27 (45.0)	12.71	<0.001*

Table 9 show that severe postoperative pain requiring additional analgesics was significantly more common in the bipolar diathermy group (25.0%) than in the ligation group (8.3%) ($\chi^2 = 6.17$, $p = 0.013$). Delayed healing beyond 14 days was also significantly more frequent among patients undergoing bipolar diathermy (30.0%) compared with those managed by ligation (10.0%)

($\chi^2 = 7.50$, $p = 0.006$). Although infection of the tonsillar fossa was observed more frequently in the bipolar diathermy group (6.7%) than in the ligation group (3.3%), the difference was not statistically significant ($\chi^2 = 0.70$, $p = 0.402$). Similarly, the incidence of secondary postoperative haemorrhage did not differ significantly between the groups ($\chi^2 = 2.81$, $p = 0.094$). Notably, a significantly greater

proportion of patients in the ligation group experienced no postoperative complications (76.7%) compared with the bipolar diathermy group (45.0%) ($\chi^2 = 12.71$, $p < 0.001$).

Discussion

The validity of comparative surgical studies largely depends upon the baseline comparability of study groups. In the present study, no statistically significant differences were observed between the ligation and bipolar diathermy groups regarding age, sex distribution, duration of symptoms, frequency of recurrent sore throat episodes, or presence of adenoid hypertrophy ($p > 0.05$). These findings indicate successful randomization and minimize the likelihood of confounding bias. Similar observations were reported by Yaman et al. (2021), who compared various haemostatic techniques during tonsillectomy and found no significant demographic or clinical differences between study groups at baseline, thereby ensuring comparability of postoperative outcomes.[8] Likewise, Nunez et al. (2022) reported comparable demographic characteristics among patients undergoing cold dissection and electrosurgical tonsillectomy, supporting the validity of outcome comparisons.[9]

One of the principal findings of the present study was the significantly lower intraoperative blood loss observed in the bipolar diathermy group compared with the ligation group (27.81 ± 8.47 mL vs. 48.24 ± 10.63 mL; $p < 0.001$). In addition, the mean time required to achieve haemostasis was significantly shorter with bipolar diathermy (4.82 ± 1.12 minutes) than with ligation (8.63 ± 1.54 minutes; $p < 0.001$).

These findings are consistent with those reported by Temiz et al. (2020), who demonstrated that bipolar coagulation significantly reduced operative blood loss and shortened operative duration because of its ability to achieve rapid vessel sealing and immediate coagulation of bleeding points.[10] Similarly, Korkmaz et al. (2021) observed that bipolar electrocautery reduced intraoperative bleeding by nearly 40% compared with conventional haemostatic techniques and improved operative field visualization.[11]

The superior haemostatic efficiency of bipolar diathermy may be attributed to localized thermal coagulation, which simultaneously seals small blood vessels during surgery. Reduced intraoperative blood loss improves surgical visibility and may decrease operative fatigue, particularly in pediatric patients and difficult tonsillectomy cases.

Postoperative pain remains one of the most important determinants of patient satisfaction and recovery following tonsillectomy. In the present

study, pain scores were significantly lower in the ligation group on postoperative days 1, 3, and 7 ($p < 0.001$ for all comparisons). These findings are in agreement with Akin et al. (2022), who reported significantly lower postoperative pain scores following cold dissection and ligation techniques compared with bipolar electrocautery.[12] Similarly, Lee et al. (2023) demonstrated that thermal injury associated with electrosurgical haemostasis resulted in increased inflammatory response, greater tissue edema, and higher postoperative pain intensity during the first postoperative week.[13] The increased pain associated with bipolar diathermy is likely related to thermal damage extending beyond the immediate site of coagulation. Tissue necrosis and inflammatory mediator release may contribute to prolonged nociceptive stimulation and delayed recovery.

Effective haemostasis on the first attempt was achieved significantly more frequently in the bipolar diathermy group (96.7%) than in the ligation group (83.3%) ($p = 0.015$). Furthermore, additional haemostatic interventions were required less frequently in patients managed with bipolar diathermy. Comparable findings were reported by Hultcrantz et al. (2021), who observed superior immediate haemostatic control with bipolar coagulation owing to rapid vessel sealing and reduced need for repeated interventions.[14] Likewise, Sarny et al. (2022) found that electrosurgical haemostasis provided more consistent control of bleeding points during tonsillectomy than conventional ligature-based methods.[15] Primary postoperative haemorrhage occurred in 3.3% of patients in the ligation group and 1.7% of patients in the bipolar diathermy group, with no statistically significant difference between groups ($p = 0.559$). This observation is consistent with findings reported by Graboyes et al. (2020), who found no significant differences in primary postoperative bleeding rates between cold and electrosurgical haemostatic techniques.[16] Similarly, Kandogan et al. (2021) reported that immediate postoperative bleeding was uncommon and largely dependent on surgical technique and meticulous intraoperative haemostasis rather than the specific haemostatic modality employed.[17] The low incidence of primary haemorrhage in both groups suggests that both ligation and bipolar diathermy can provide adequate immediate postoperative safety when performed by experienced surgeons.

Secondary haemorrhage was more frequent in the bipolar diathermy group (8.3%) than in the ligation group (1.7%), although the difference did not reach statistical significance ($p = 0.094$). A similar trend was reported by Tomkinson et al. (2021), who identified higher rates of delayed postoperative

bleeding among patients undergoing electrosurgical tonsillectomy compared with cold dissection techniques.[18] Likewise, Schrock et al. (2022) observed that thermal tissue injury may predispose patients to slough formation and delayed wound separation, thereby increasing the likelihood of secondary haemorrhage.[19]

The mean time required for complete healing of the tonsillar fossa was significantly shorter in the ligation group (13.42 ± 2.11 days) than in the bipolar diathermy group (16.13 ± 2.47 days) ($p < 0.001$).

These findings are comparable with those reported by Yilmaz et al. (2022), who demonstrated earlier mucosal re-epithelialization following cold dissection techniques compared with electrosurgical procedures.[20] Similarly, Park et al. (2023) found delayed wound healing in patients treated with bipolar cautery owing to greater thermal tissue destruction and prolonged inflammatory response.[21]

Patients in the ligation group resumed a normal diet and routine daily activities significantly earlier than those in the bipolar diathermy group ($p < 0.001$). Comparable results were reported by Moualed et al. (2021), who found earlier dietary recovery among patients undergoing cold dissection tonsillectomy.[22] Similarly, Bitar et al. (2022) reported that reduced postoperative pain and faster wound healing translated into earlier functional recovery and return to normal activities in patients managed with non-thermal haemostatic techniques.[23]

The present study demonstrated significantly higher rates of severe postoperative pain and delayed healing among patients undergoing bipolar diathermy. Conversely, a significantly greater proportion of patients in the ligation group experienced no postoperative complications (76.7% vs. 45.0%; $p < 0.001$).

Similar findings were reported by Mowatt et al. (2021), who observed increased postoperative morbidity associated with electrosurgical tonsillectomy owing to thermal tissue injury.[24] Likewise, Erickson et al. (2023) reported that bipolar cautery was associated with higher rates of postoperative discomfort and delayed mucosal recovery despite improved intraoperative efficiency.[25]

Limitations of the Study

- The study was conducted at a single tertiary care centre, which may limit the generalizability of the findings.
- The sample size was relatively small and may not have been sufficient to detect significant

differences in infrequent complications such as postoperative haemorrhage.

- The follow-up period was limited to the early postoperative phase and did not assess long-term outcomes.
- Postoperative pain assessment was subjective and based on patient-reported Visual Analogue Scale scores.
- Surgeon-related factors and variations in tissue handling could not be completely eliminated despite standardized surgical techniques.

Conclusion

The present study demonstrated that bipolar diathermy was significantly more effective in achieving intraoperative haemostasis, resulting in reduced blood loss, shorter haemostasis time, and a higher rate of successful first-attempt haemostasis compared with ligation.

However, ligation was associated with significantly lower postoperative pain scores, faster tonsillar fossa healing, earlier return to normal diet and daily activities, and a lower overall rate of postoperative complications. Although the incidence of primary and secondary postoperative haemorrhage did not differ significantly between the groups, bipolar diathermy showed a trend toward increased delayed postoperative bleeding. Overall, bipolar diathermy offers superior intraoperative efficiency, whereas ligation provides more favourable postoperative recovery and patient comfort following tonsillectomy.

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