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Comparison of Monopolar Cervical Loop Electrocautery and Conventional Scalpel Biopsy for Oral Mucosal Lesions in Patients With Reduced Mouth Opening

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Abstract

Introduction: Biopsy of oral mucosal lesions can be technically challenging in patients with reduced mouth opening because restricted access may affect tissue manipulation, visualization, and bleeding control. This study compared the postoperative and procedural outcomes following monopolar cervical loop electrocautery and conventional scalpel biopsy in this patient population.

Materials and methods: This prospective comparative observational study included 42 patients with reduced mouth opening who underwent oral mucosal biopsy in the Department of Oral and Maxillofacial Surgery, Karpaga Vinayaga Institute of Dental Sciences, India, between March 15, 2026, and August 16, 2026. The participants were classified into a monopolar cervical loop electrocautery group (n = 21) or a conventional scalpel biopsy group (n = 21). Postoperative pain was assessed on days 1 and 3, swelling on day 3, and bleeding severity, medication requirement within 24 hours, incision difficulty, and wound healing on day 3 were recorded. Between-group differences were analyzed using appropriate parametric and non-parametric tests, with statistical significance set at $p < 0.05$.

Results: Postoperative pain was significantly lower with monopolar electrocautery on days 1 (median, 4.0 vs. 6.5; $p < 0.001$) and 3 (median, 2.0, 4.0; $p < 0.001$). Mild bleeding occurred in 15 (71.4%) patients in the monopolar cervical loop electrocautery group compared to six (28.6%) in the conventional scalpel group, whereas severe bleeding occurred in one (4.8%) and five (23.8%) patients, respectively ($p < 0.001$). Post-biopsy analgesics were required in 11 (52.4%) patients in the monopolar cervical loop electrocautery group compared to 17 (81.0%) patients ($p = 0.048$) in the conventional scalpel group, and incision difficulty was reported in five (23.8%) and 16 (76.2%) patients ($p = 0.048$), respectively. Swelling was greater with monopolar cervical loop electrocautery (5.2 ± 2.1 vs. 3.1 ± 1.5 mm; $p < 0.001$). Day 3 healing also differed significantly ($p = 0.008$), with complete healing in three (14.3%) patients in the monopolar cervical loop electrocautery group compared to seven (33.3%) patients in the conventional scalpel group.

Conclusion: Monopolar cervical loop electrocautery was associated with favorable pain, bleeding, medication, and incision-related outcomes, whereas conventional scalpel biopsy was associated with less swelling and more favorable early healing.

Categories: Dentistry

Keywords: biopsy, electrosurgery, healing, mouth opening, oral mucosal diseases

Introduction

Obtaining an adequate and representative biopsy specimen is essential for the definitive diagnosis of oral mucosal lesions, particularly when malignancy or a potentially malignant disease is suspected. Despite advances in imaging and molecular techniques, conventional scalpel biopsy is widely used because it provides precise tissue sampling with minimal thermal alterations [1,2]. However, intraoral biopsy can be technically challenging in anatomically restricted regions because of limited access, restricted mouth opening, salivary contamination, and rich vascularity of oral tissues [3]. These challenges may be particularly pronounced in lesions involving the retromolar trigone, where limited access can compromise visualization, tissue handling, and hemostatic control.

Electrosurgical techniques offer potential advantages in such situations by allowing simultaneous tissue incision and coagulation. Monopolar cervical loop electrocautery, adapted from loop electrosurgical excision procedures used extensively in gynecological practice, may facilitate tissue removal while providing effective hemostasis and maintaining operative-field visibility [4,5]. Electrosurgical approaches have also

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been evaluated in oral soft-tissue procedures, with evidence suggesting improved intraoperative bleeding control compared to conventional scalpel techniques [6,7]. However, the generation of thermal energy raises concerns regarding thermal artifacts at the specimen margins and their potential effect on histopathological interpretation [7,8]. Although loop electrosurgical techniques have demonstrated acceptable tissue preservation in other surgical settings, evidence regarding their application in intraoral diagnostic biopsy remains limited.

Patients with reduced mouth opening represent a particularly relevant population, in which improved hemostasis and surgical access may provide meaningful procedural advantages [9]. Therefore, the present study aimed to compare monopolar cervical loop electrocautery with conventional scalpel incisional biopsy in patients with reduced mouth opening requiring retromolar trigone lesion biopsy. The primary objective was to compare procedural difficulty and intraoperative bleeding severity between monopolar cervical loop electrocautery and conventional scalpel biopsy in patients with reduced mouth opening. The secondary objectives were to compare postoperative pain, medication requirement, swelling, and early wound healing between the two biopsy techniques and to examine the association between baseline mouth opening and postoperative outcomes.

Materials And Methods

Study design and setting

This prospective comparative observational study was conducted in the Department of Oral and Maxillofacial Surgery, Karpaga Vinayaga Institute of Dental Sciences, India, between March 15, 2026, and August 16, 2026. The study was conducted in accordance with the principles of the Declaration of Helsinki and applicable institutional ethical requirements. The Institutional Ethics Committee of the college (reference number: KIDS/IEC/2026/1/008, dated March 5, 2026) reviewed and approved the study protocol before the commencement of participant recruitment. Written informed consent was obtained from all participants before the clinical examination and biopsy. Participants were informed about the purpose of the study, biopsy procedures, potential benefits and risks, postoperative assessment, and the use of their clinical information for research purposes.

Both biopsy techniques are routinely available and used for intraoral soft tissue biopsy in the department. The biopsy technique was selected by the treating surgeon according to routine clinical judgment and procedural feasibility for individual patients. No formal eligibility criterion or predefined allocation algorithm was used to determine biopsy technique. The patients were subsequently classified according to the technique received, and the outcomes were prospectively recorded and compared.

Participants and eligibility

Patients presenting to the Department of Oral and Maxillofacial Surgery for evaluation of retromolar trigone lesions requiring incisional biopsy were assessed for eligibility. Patients were included if they had a clinically identified retromolar trigone lesion for which an incisional biopsy was indicated, a maximum interincisal opening (MIO) of ≤ 35 mm, and were able to undergo the planned biopsy and postoperative assessment after providing written informed consent. MIO was assessed clinically as the maximum distance between the incisal edges of the maxillary and mandibular central incisors and was recorded in millimeters before the biopsy procedure. The use of a 35 mm threshold is consistent with commonly used objective criteria for defining trismus [10].

Patients were excluded if they had an MIO > 35 mm, did not provide informed consent, were unable to undergo the biopsy procedure or planned postoperative assessment, or had incomplete clinical or procedural information required for analysis. Patients without a clinically indicated retromolar trigone lesion requiring incisional biopsy were also excluded. Baseline demographic and clinical variables included age, sex, maximum interincisal mouth opening, lesion size, clinical lesion type, comorbidities, and smoking status. The final dataset comprised 42 participants, including 21 who underwent monopolar cervical loop electrocautery biopsy and 21 who underwent conventional scalpel biopsy. All analyzed lesions were located in the retromolar trigone and were clinically categorized as hyperplastic, benign, or malignant.

Biopsy procedures

The participants underwent intraoral incisional biopsy, according to the clinical biopsy procedure selected for the individual patient. The study did not use a random allocation of participants to biopsy techniques. The participants were subsequently classified according to the biopsy technique used for the comparative analysis. All biopsy procedures were performed by a single experienced oral and maxillofacial surgeon to minimize inter-operator variability in patient positioning, lesion exposure, incision, tissue handling, hemostasis, and specimen retrieval. The same surgeon performed both biopsy techniques using a standardized protocol.

For participants undergoing monopolar cervical loop electrocautery biopsy, local anesthesia was achieved using 2% lignocaine with adrenaline (1:200,000). A Bonart ART-E1 Electron electrosurgery unit (Bonart Co., Ltd., Keelung City, Taiwan) equipped with a cervical loop electrode (Bonart Co., Ltd., Keelung City, Taiwan)

was operated in the monopolar pure-cut mode at 14 W. The loop electrode was introduced through a selected portion of the lesion in a controlled manner to obtain a representative specimen of adequate depth. The electrosurgical current permitted simultaneous tissue incision and coagulation, providing effective hemostatic control during specimen retrieval. The unit incorporates a grounding/indifference plate and a handpiece, and its electrode system includes small- and large-loop electrodes. No additional suturing or adjunctive electrocautery was required.

The same local anesthetic protocol was used for the conventional scalpel biopsy group. The lesion was stabilized with tissue-holding forceps, and an incisional biopsy was performed using a No. 15 Bard-Parker blade (Becton, Dickinson and Company [BD], Franklin Lakes, NJ, USA) with an elliptical incision to obtain a representative specimen. When required, hemostasis was achieved using conventional measures, including suturing and local hemostatic agents.

All biopsy specimens were immediately placed in 4% neutral-buffered formalin and processed using routine histopathological procedures. The specimens were dehydrated through graded concentrations of alcohol, cleared in xylene, embedded in paraffin wax, sectioned, and stained with hematoxylin and eosin (H&E). The stained sections were examined under light microscopy by a single experienced oral and maxillofacial pathologist who was blinded to the biopsy technique. Tissue architecture, preservation of diagnostic features, identification of tumor islands and keratin pearl formation, and the presence and extent of peripheral thermal artifact were assessed qualitatively. Representative photomicrographs were obtained at $\times 40$ and $\times 100$ magnifications for documentation and comparison between the biopsy techniques (Figure 1).

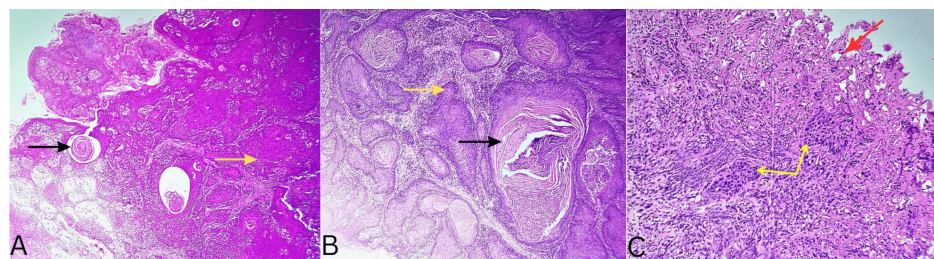


FIGURE 1: Histopathological comparison of biopsy specimens obtained using conventional scalpel and monopolar cervical loop electrocautery.

(A) Hematoxylin and eosin photomicrograph of a biopsy specimen obtained using a conventional scalpel, demonstrating preserved tissue architecture with identifiable tumor islands (yellow arrow) and keratin pearl formation (black arrow) ($\times 40$). (B) Hematoxylin and eosin photomicrograph of a biopsy specimen obtained using monopolar cervical loop electrocautery, demonstrating well-preserved tissue architecture with clearly identifiable tumor islands (yellow arrow) and keratin pearl formation (black arrow) ($\times 40$). (C) Hematoxylin and eosin photomicrograph of a specimen obtained using monopolar cervical loop electrocautery, demonstrating a peripheral thermal artifact confined to the specimen margin (red arrow), with preservation of identifiable tumor islands (yellow arrows) ($\times 100$).

Original histopathological images of the study samples.

Postoperative outcome assessment

Clinical and procedural outcomes were assessed using predefined parameters. Pain intensity was assessed on postoperative days 1 and 3 using a 10 cm visual analog scale (VAS), anchored at 0 (no pain) and 10 (worst pain imaginable), with higher scores indicating greater pain intensity [11]. The requirement for medication within 24 hours after the procedure was recorded as a dichotomous variable (yes/no). Difficulty during incision was recorded as yes/no according to the clinical assessment of the procedure.

Postoperative swelling was assessed clinically on postoperative day 3 using a standardized linear facial measurement technique. Preoperative facial measurements were obtained before biopsy to establish an individual baseline, and the same measurements were repeated on postoperative day 3. A flexible, non-stretchable measuring tape graduated in millimeters was gently placed against the skin without compressing the swollen tissue. Standardized anatomical landmarks were identified and marked before measurement to ensure reproducibility. Measurements included the distances from the tragus to the oral commissure, tragus to the soft-tissue pogonion, and lateral canthus to the gonion [12]. The change between preoperative and postoperative measurements was calculated for each facial dimension and used as an objective estimate of postoperative swelling.

Intraoperative bleeding was categorized as mild, moderate, or severe. Mild bleeding represented readily controlled bleeding, moderate bleeding represented bleeding requiring greater control during the procedure, and severe bleeding represented substantial bleeding requiring additional measures. Early wound healing was assessed on postoperative day 3 using a predefined investigator-developed ordinal scale based on the

estimated proportion of wound closure. The wound was categorized as 25%, 50%, 75%, or 100% healed, corresponding to progressively greater clinical evidence of wound closure. This percentage-based scale was developed a priori for the present study because no established validated scale specifically applicable to the early healing of intraoral biopsy wounds in patients with reduced mouth opening was identified. As the scale has not been independently validated, it was considered an exploratory outcome measure. Postoperative analgesia was prescribed when clinically indicated rather than routinely administered to all participants. Paracetamol was used for pain relief according to the treating clinician's judgment and the patient's clinical requirements. Medication requirement within the first 24 hours was recorded as a dichotomous outcome (yes/no).

Sample size

Sample size calculation was performed using G*Power software (Heinrich Heine University, Düsseldorf, Germany). A priori power analysis was based on a two-independent group comparison framework, with a Cohen's d of 0.70, a two-sided significance level of 0.05, and 80% statistical power [13]. The calculation indicated a minimum requirement of 21 participants in each group. Accordingly, the final analysis included 42 participants, with 21 participants in each biopsy group.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics, version 28 (IBM Corp., Armonk, NY, USA). The distribution of the variables was assessed using the Shapiro-Wilk test. Normally distributed continuous variables were summarized as mean $\pm$ standard deviation (SD), whereas non-normally distributed continuous variables and ordinal variables were summarized as median and interquartile range (IQR). Categorical variables were expressed as frequencies and percentages. For comparisons between the monopolar cervical loop electrocautery and conventional scalpel biopsy groups, the independent-samples t -test was used for normally distributed continuous variables, whereas the Mann-Whitney U test was used for non-normally distributed continuous variables and ordinal variables. Categorical variables were compared using the chi-square test. Effect sizes were reported as Cohen's d for continuous variables analyzed using the independent-samples t -test, effect-size r for Mann-Whitney U comparisons, and Cramer's V for categorical comparisons. The relationship between baseline mouth opening and postoperative outcomes was additionally examined. Pearson's correlation coefficient (r) was used for continuous variables, Spearman's rank correlation coefficient (ρ) for ordinal variables, and the point-biserial correlation coefficient (r_{pb}) for dichotomous outcomes. All tests were two-sided, and $p < 0.05$ was considered statistically significant.

Results

A total of 42 participants were included in the final analysis, with 21 participants in each group: the monopolar electrocautery and conventional scalpel biopsy groups. The baseline demographic and clinical characteristics were comparable between the groups, with no statistically significant differences in age, sex, lesion size, mouth opening, lesion type, comorbidity, or smoking status (Table 1). This indicated broadly similar baseline characteristics between the two groups.

Parameter	Monopolar cervical loop electrocautery group (n = 21)	Conventional scalpel group (n = 21)	Test value	p-value	Effect size
Age (years), mean (SD)	52.4 ± 11.8	49.7 ± 12.5	t = 0.71	0.482	Cohen's d = 0.22
Sex (Male), n (%)	12 (57.1%)	11 (52.4%)	$\chi^2 = 0.09$	0.759	Cramer's V = 0.05
Size of lesion (mm), mean (SD)	15.4 ± 4.2	16.1 ± 5.0	t = -0.49	0.627	Cohen's d = 0.15
Mouth opening (mm), mean (SD)	21.3 ± 1.4	20.5 ± 1.8	1.69	0.115	Cohen's d = 0.50
Type of lesion, n (%)					
Hyperplastic	7 (33.3%)	6 (28.6%)			
Benign	10 (47.6%)	11 (52.4%)	$\chi^2 = 0.14$	0.932	Cramer's V = 0.06
Malignant	4 (19.0%)	4 (19.0%)			
Comorbidity present, n (%)	7 (33.3%)	8 (38.1%)	$\chi^2 = 0.10$	0.749	Cramer's V = 0.05
Smoking (Yes), n (%)	10 (47.6%)	9 (42.9%)	$\chi^2 = 0.09$	0.759	Cramer's V = 0.05

TABLE 1: Baseline characteristics of the study participants according to biopsy technique.

Data are presented as mean ± standard deviation (SD) for continuous variables and frequency (percentage) for categorical variables, continuous variables were compared using the independent-samples t-test, and categorical variables were compared using the chi-square test, a two-sided p < 0.05 was considered statistically significant.

mm: millimeter

Pain intensity was significantly lower in the monopolar cervical loop electrocautery group than in the conventional scalpel biopsy group on postoperative days 1 and 3 (both p < 0.001), with moderate to large effect sizes. Bleeding severity also differed significantly between the groups (p < 0.001), with 15 (71.4%) participants in the monopolar cervical loop electrocautery group experiencing mild bleeding compared to six (28.6%) in the conventional scalpel group. Severe bleeding occurred in only one (4.8%) participant in the monopolar electrocautery group compared to five (23.8%) in the conventional scalpel group. The requirement for medication within 24 hours was significantly lower in the monopolar cervical loop electrocautery group, occurring in 11 (52.4%) participants, compared with 17 (81.0%) in the conventional scalpel group (p = 0.048). However, postoperative swelling on day 3 was significantly greater in the monopolar cervical loop electrocautery group than in the conventional scalpel group (p < 0.001). Difficulty during incision was also less frequent with monopolar cervical loop electrocautery, occurring in five (23.8%) participants compared with 16 (76.2%) in the conventional scalpel group (p = 0.048). Early wound healing also differed significantly between the groups (p = 0.008). Complete healing at day 3 was observed in three (14.3%) participants in the monopolar cervical loop electrocautery group compared with seven (33.3%) in the conventional scalpel group, whereas partial healing at 50% and 75% was more frequently observed in the monopolar cervical loop electrocautery group (Table 2).

Parameter		Monopolar cervical loop electrocautery group (n = 21)	Conventional scalpel group (n = 21)	Test value	p-value	Effect size
Pain, (VAS 0–10), median (IQR)	Day 1	4.0 (3.0 – 5.0)	6.5 (5.0 – 7.5)	U = 80.0	< 0.001*	r = 0.64
	Day 3	2.0 (1.0 – 3.0)	4.0 (3.0 – 5.0)	U = 110.0	< 0.001*	r = 0.54
Size of swelling (mm), mean (SD)	Day 3	5.2 ± 2.1	3.1 ± (1.5)	t = 3.72	< 0.001*	Cohen's d = 1.16
Difficulty in incision, n (%)	Yes	5 (23.8%)	16 (76.2%)	χ ² = 3.93	0.048*	Cramer's V = 0.31
Bleeding severity, n (%)	Mild	15 (71.4%)	6 (28.6%)	U = 95.0	< 0.001*	r = 0.63
	Moderate	5 (23.8%)	10 (47.6%)			
	Severe	1 (4.8%)	5 (23.8%)			
Medication requirement, n (%)	Yes	11 (52.4%)	17 (81.0%)	χ ² = 3.93	0.048*	Cramer's V = 0.31
Healing at day 3, n (%)	25%	0 (0.0%)	0 (0.0%)	U = 140.0	0.008*	r = 0.41
	50%	8 (38.1%)	2 (9.5%)			
	75%	10 (47.6%)	12 (57.1%)			
	100%	3 (14.3%)	7 (33.3%)			

TABLE 2: Comparison of postoperative and procedural outcomes between monopolar cervical loop electrocautery and conventional scalpel biopsy.

Data are presented as median (interquartile range [IQR]) for pain scores, mean ± standard deviation (SD) for swelling, and frequency (percentage) for categorical and ordinal outcomes. Pain scores, bleeding severity, and healing were compared using the Mann–Whitney U test; swelling was compared using the independent-samples t-test; and binary categorical variables were compared using the chi-square test, a two-sided *p < 0.05 was considered statistically significant.

VAS: visual analog scale

Baseline mouth opening demonstrated a significant moderate negative correlation with postoperative pain in both groups. Greater mouth opening was associated with lower pain scores on postoperative day 1 and day 3 in both the monopolar cervical loop electrocautery and conventional scalpel groups. In contrast, swelling and difficulty during incision were not significantly correlated with baseline mouth opening. A significant moderate positive correlation was observed between baseline mouth opening and healing on postoperative day 3 in both groups, indicating that greater preoperative mouth opening is associated with better early wound healing. Correlation patterns were similar between the two biopsy techniques (Table 3).

Parameter	Monopolar cervical loop electrocautery group (n = 21)			Conventional scalpel group (n = 21)		
	Correlation coefficient	Test value	p-value	Correlation coefficient	Test value	p-value
Pain at day 1 (VAS)	r = -0.52	t = -2.64	0.016*	r = -0.55	t = -2.87	0.010*
Pain at day 3 (VAS)	r = -0.48	t = -2.38	0.028*	r = -0.51	t = -2.57	0.019*
Swelling at day 3 (mm)	r = -0.35	t = -1.64	0.117	r = -0.38	t = -1.81	0.086
Healing at day 3 (Ordinal)	ρ = 0.44	S = 480.5	0.045*	ρ = 0.46	S = 465.2	0.038*
Difficulty in incision (Yes/No)	r _{pb} = -0.39	t = -1.85	0.079	r _{pb} = -0.42	t = -2.02	0.058

TABLE 3: Correlations between baseline mouth opening and postoperative outcomes according to biopsy technique.

Data are presented as correlation coefficients with corresponding p-values. Pearson correlation (r) was used for continuous normally distributed variables, Spearman rank correlation (ρ) was used for ordinal variables, and point-biserial correlation (r_{pb}) was used for dichotomous variables; a two-sided *p < 0.05 was considered statistically significant.

t = Student's t-test statistic; S = test statistic for the non-parametric correlation analysis

Discussion

The present study compared monopolar cervical loop electrocautery with conventional scalpel biopsy for oral mucosal lesions in patients with reduced mouth opening and demonstrated a clinically relevant trade-off between perioperative hemostatic and pain-related advantages and early tissue-healing outcomes. The groups were comparable with respect to age, sex, lesion size, mouth opening, lesion type, comorbidity, and smoking status, thereby reducing the likelihood that the observed postoperative differences were primarily attributable to baseline imbalance. The principal finding was that monopolar cervical loop electrocautery was associated with less postoperative pain, less severe bleeding, lower medication requirements, and less difficulty during incision, whereas conventional scalpel biopsy was associated with less postoperative swelling and more favorable early wound healing.

The lower pain scores observed with electrocautery on postoperative days 1 and 3 are consistent with previous evidence comparing electrosurgical and scalpel incision. Electrocautery simultaneously cuts tissue and coagulates small blood vessels, potentially reducing tissue bleeding and the need for repeated manipulation of the surgical field [14]. The reduced requirement for postoperative medication in the electrocautery group in this study supports this clinical benefit. A previous clinical study comparing electrocautery and stainless-steel scalpel incisions in oral mucoperiosteal surgery similarly reported significantly lower postoperative pain and reduced intraoperative blood loss with electrocautery [15]. More broadly, a systematic review and meta-analysis of cutting electrocautery versus scalpel incisions found lower blood loss and postoperative pain with electrocautery, although the included studies were conducted across different surgical settings [16]. A recent network meta-analysis of pediatric oral soft-tissue surgery also ranked electrosurgery highly for postoperative pain reduction compared to scalpel surgery, providing further support for the pain-related findings of the present study [17].

The superior hemostatic performance of monopolar cervical loop electrocautery observed in the present study is consistent with evidence from head and neck surgery. In our study, patients treated with electrocautery had significantly less severe bleeding during incision, with mild bleeding being substantially more frequent than that in the conventional scalpel group, while severe bleeding was uncommon. This finding is biologically plausible because monopolar electrocautery simultaneously divides the tissue and coagulates small blood vessels, thereby reducing ongoing bleeding during tissue incision [16]. In a retrospective study of 200 patients undergoing neck dissection, Obermeier et al. [18] directly compared monopolar electrocautery with cold scalpel/scissors and reported significantly lower blood loss with electrocautery in both the reconstruction groups. They also observed a smaller postoperative decline in hemoglobin and shorter operative duration with electrocautery. Although their study involved extensive neck dissection rather than small oral mucosal biopsies, the consistent direction of the hemostatic effect supports the present finding, suggesting that the coagulative properties of monopolar electrocautery may be particularly useful when surgical access is restricted. This consideration is clinically relevant in patients with reduced mouth opening, in whom control of even modest bleeding may facilitate visualization, tissue manipulation, and biopsy completion.

Conversely, the present study demonstrated greater postoperative swelling and slower early wound healing after monopolar cervical loop electrocautery. Thermal energy may produce a zone of tissue coagulation

adjacent to the incision, increasing local tissue injury and the inflammatory response. Experimental oral mucosa research has demonstrated greater thermal injury associated with monopolar electrosurgery than with cold-steel scalpel techniques, while scalpel wounds demonstrated faster re-epithelialization [19]. Histological studies of oral lesions have likewise shown considerably greater tissue damage at the margins of specimens removed using electrosurgical instruments than with cold scalpel excision [20]. These findings provide a plausible biological explanation for the greater swelling and less favorable day-3 healing observed in the present study.

However, the present findings indicate that electrocautery is universally inferior for wound healing. Evidence is heterogeneous and depends on energy modality, power setting, tissue type, incision technique, and clinical application. A randomized trial comparing CO₂ laser, Er:YAG laser, and scalpel excisional biopsy found no significant differences in postoperative pain or analgesic intake, illustrating that postoperative outcomes may not consistently favor an energy-based technique [21]. Similarly, experimental work has shown differences in re-epithelialization and tissue strength depending on the surgical instrument used [19]. Therefore, the contrasting healing profile observed in this study is best interpreted as an outcome-specific disadvantage of monopolar electrocautery, rather than evidence against its overall clinical utility.

Clinically, these findings suggest that the choice of the biopsy technique may be individualized according to the patient's oral access and procedural requirements. Monopolar cervical loop electrocautery may be particularly useful in patients with reduced mouth opening when maintaining visualization and achieving hemostasis because its simultaneous cutting and coagulative effects may facilitate biopsy within a restricted working space. Conventional scalpel biopsy should be considered when minimizing local tissue effects and supporting early wound healing. Thus, the potential benefits of electrocautery should be balanced with the observed effects on postoperative swelling and early healing.

This study has several limitations beyond its relatively small sample size, single-center setting, and short follow-up. First, the observational design and clinician-directed selection of biopsy technique may have introduced selection bias and confounding, despite the broadly comparable baseline characteristics. Second, procedural differences between the groups, including the use of sutures and local hemostatic measures in the scalpel group and the absence of additional suturing or adjunctive electrocautery in the electrocautery group, may have influenced postoperative outcomes. Postoperative medication was not routinely administered to all participants, and the absence of clearly predefined prescribing criteria limits the interpretation of medication requirement as an outcome. Third, some methodological details, including the criteria for assessing incision difficulty, bleeding severity, and early wound healing, require further standardization to facilitate reproducibility. The sample-size calculation was based on Cohen's *d* and does not independently establish adequate statistical power for categorical and ordinal outcomes. Furthermore, the reported statistical comparisons require verification against the original dataset. Finally, the assessment of early wound healing and swelling was restricted to postoperative day 3, precluding conclusions about longer-term tissue healing, scarring, or histopathological thermal injury. These limitations should be considered when interpreting the findings, which represent associations rather than definitive evidence of causal superiority of either biopsy technique.

Conclusions

Compared with conventional scalpel biopsy, monopolar cervical loop electrocautery was associated with lower postoperative pain, less severe intraoperative bleeding, lower medication requirements, and less difficulty during incision. Conversely, conventional scalpel biopsy was associated with less postoperative swelling and more favorable early wound healing. These findings suggest potential differences in the clinical profiles of the two techniques; however, the observational design, potential procedural confounding, and limited sample size warrant cautious interpretation. The choice of technique should therefore be individualized according to clinical circumstances, procedural accessibility, hemostatic requirements, and anticipated tissue healing. Further prospective comparative studies with standardized outcome assessment and longer follow-up are needed to confirm these findings.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethical Committee of Karpaga Vinayaga Institute of Dental Sciences issued approval KIDS/IEC/2026/1/008, dated March 5, 2026. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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