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Periodontal and Orthodontic Outcomes of Laser-Assisted Versus Conventional Surgical Exposure of Impacted Canines: A Retrospective Institutional Comparative Study

Running Title : Laser-Assisted Versus Conventional Exposure of Impacted Canines

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Abstract

Background

Impacted canines are among the most common eruption disturbances requiring interdisciplinary management involving surgical exposure and orthodontic alignment. Preservation of periodontal health and reduction in treatment duration remain important considerations during impacted canine management. Laser-assisted surgical exposure techniques have recently gained attention because of their minimally invasive nature and favorable soft tissue response.

Aim

To compare the periodontal and orthodontic outcomes following laser-assisted and conventional surgical exposure of impacted canines in an institutional retrospective study.

Materials and Methods

The present retrospective institutional comparative study analyzed 939 patient records of impacted canine exposure procedures performed between June 2019 and May 2026. Among these, 430 patients underwent conventional surgical exposure, while 509 patients received laser-assisted exposure. Periodontal parameters including gingival recession and width of keratinized gingiva, along with orthodontic alignment duration, were evaluated from clinical and orthodontic records. Statistical analysis was performed using SPSS software version 26.0, and $p < 0.05$ was considered statistically significant.

Results

Female patients constituted 54.5% of the study population. Gingival recession was observed in 13.5% of patients treated with conventional surgical exposure, whereas only 5.7% of patients in the laser-assisted group demonstrated gingival recession. The mean width of keratinized gingiva was higher in the laser-assisted group (4.3 ± 0.8 mm) compared with the conventional group (3.1 ± 0.7 mm). The mean duration required for orthodontic alignment was shorter in the laser-assisted group (7.2 ± 1.4 months) than in the conventional group (9.1 ± 1.8 months). The differences were statistically significant ($p < 0.05$).

Conclusion

Laser-assisted surgical exposure of impacted canines demonstrated superior periodontal outcomes and reduced orthodontic alignment duration when compared with conventional surgical exposure techniques.

Keywords: Impacted canines; Laser-assisted surgical exposure; health; quality of life;

Introduction

Impacted canines are among the most frequently encountered developmental eruption disturbances in dentistry and orthodontics, second only to impacted third molars in prevalence (1). The incidence of impacted canines has been reported to range between 1% and 3% in the general population, with maxillary canines exhibiting a significantly higher frequency of impaction compared to mandibular canines. Among maxillary impactions, palatal impaction is more commonly observed than buccal impaction (2). The etiology of canine impaction is multifactorial and includes genetic predisposition, arch length deficiency, prolonged retention or premature loss of deciduous teeth, abnormal eruption pathway, trauma, ankylosis, cystic changes, and craniofacial developmental disturbances. Female individuals have also been reported to exhibit a greater prevalence of impacted canines than males (3).

Canines play a vital role in maintaining facial esthetics, phonetics, arch continuity, and functional occlusion. Owing to their strategic position within the dental arch and their contribution to canine-guided occlusion, preservation and successful alignment of impacted canines are considered important objectives in comprehensive orthodontic treatment (4). Failure to manage impacted canines appropriately may result in several complications including root resorption of adjacent teeth, malocclusion, periodontal defects, cyst formation, midline discrepancies, and compromised esthetics. Therefore, early diagnosis and timely intervention are essential to minimize associated complications and improve treatment prognosis (5).

Management of impacted canines typically requires a multidisciplinary approach involving orthodontists, oral surgeons, and periodontists. Surgical exposure followed by orthodontic traction remains the most commonly adopted treatment modality for aligning impacted canines into the dental arch (6). Conventional surgical exposure techniques using scalpel-based soft tissue excision have been widely practiced for several decades and are generally considered effective. However, these procedures are often associated with intraoperative bleeding, postoperative pain, edema, delayed wound healing, need for suturing, and patient discomfort. In addition, excessive soft tissue manipulation during conventional surgery may adversely affect the periodontal health of the exposed canine (7).

Preservation of periodontal tissues around surgically exposed canines is an important determinant of long-term treatment success. Healthy periodontal architecture contributes not only to functional stability but also to esthetic outcomes following orthodontic alignment. Parameters such as gingival recession and width of keratinized gingiva are clinically significant indicators of periodontal health after surgical exposure (8). Gingival recession may result in root exposure, hypersensitivity, plaque accumulation, and esthetic compromise, whereas inadequate keratinized tissue may predispose the region to inflammation and reduced periodontal stability during orthodontic tooth movement. Consequently, evaluation of periodontal outcomes following canine exposure procedures has become increasingly relevant in contemporary interdisciplinary dental practice (9).

Advancements in laser technology have introduced minimally invasive alternatives for soft tissue management in dentistry. Dental lasers, particularly diode and erbium lasers, have gained popularity in oral surgical and orthodontic procedures because of their precision and favorable biologic effects. Laser-assisted surgical exposure of impacted canines offers several potential advantages including superior hemostasis, reduced tissue trauma, minimal postoperative swelling, decreased bacterial contamination, reduced need for suturing, and improved patient comfort. Furthermore, laser procedures may facilitate enhanced soft tissue healing and preservation of gingival architecture around the exposed tooth (10).From an orthodontic perspective, treatment efficiency and patient acceptance are important determinants of successful impacted canine management. Parameters such as duration required for orthodontic alignment and postoperative pain and discomfort significantly influence patient compliance and overall treatment experience (11). Laser-assisted procedures have been suggested to reduce postoperative morbidity and improve healing, thereby potentially facilitating smoother orthodontic traction and shorter treatment duration when compared with conventional surgical approaches.Although several studies have investigated the clinical applications of lasers in oral surgery and orthodontics, literature comparing the periodontal and orthodontic outcomes of laser-assisted and conventional surgical exposure techniques remains limited. Most available studies

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predominantly focus on surgical efficiency and postoperative pain, while comprehensive evaluation of both periodontal and orthodontic parameters has received comparatively less attention. In addition, retrospective institutional studies evaluating real-world clinical outcomes across larger patient populations are scarce. Therefore, the present retrospective institutional comparative study was undertaken to evaluate and compare the periodontal and orthodontic outcomes following laser-assisted and conventional surgical exposure of impacted canines. The study specifically assessed periodontal parameters including gingival recession and width of keratinized gingiva, along with orthodontic parameters such as duration required for orthodontic alignment and postoperative pain and discomfort. The findings of this study may provide valuable evidence regarding the effectiveness of laser-assisted approaches and contribute to improved interdisciplinary management of impacted canines.

Materials and Methodology

Study Design and Study Setting: The present study was designed as a retrospective institutional comparative study conducted in a university-based dental teaching hospital. Patient records were retrieved and analyzed from the institutional digital case record management system following approval from the Institutional Ethical Committee. The study evaluated the periodontal and orthodontic outcomes following laser-assisted and conventional surgical exposure of impacted canines performed between June 2019 and May 2026.

Study Population: A total of 939 patient records involving surgical exposure of impacted canines followed by orthodontic alignment were screened and included in the final analysis after applying the inclusion and exclusion criteria. Among these, 430 patients underwent conventional surgical exposure, while 509 patients received laser-assisted surgical exposure procedures.

The patient records were reviewed independently by calibrated investigators to ensure accuracy and completeness of the collected data.

Inclusion Criteria

The following records were included in the study:

1. Patients diagnosed with impacted maxillary or mandibular canines requiring surgical exposure and orthodontic traction.
2. Patients treated using either laser-assisted or conventional surgical exposure techniques.
3. Patients with complete clinical documentation and orthodontic records.
4. Patients with available postoperative follow-up records documenting periodontal and orthodontic outcomes.
5. Patients aged above 15 years.

Exclusion Criteria

The following records were excluded from the study:

1. Patients with systemic diseases or conditions affecting periodontal healing.
2. Patients with syndromic conditions or craniofacial anomalies.
3. Records with incomplete clinical documentation or missing follow-up data.
4. Patients with previous periodontal surgery in the canine region.
5. Cases with failed orthodontic follow-up or discontinued treatment.

Group Allocation

Eligible patients were categorized into two groups based on the surgical exposure technique employed:

- Group I – Conventional surgical exposure group (n = 430)
- Group II – Laser-assisted surgical exposure group (n = 509)

Laser-assisted procedures were performed using soft tissue dental lasers according to institutional clinical protocols, while conventional exposure procedures were carried out using routine scalpel-based surgical techniques.

Data Collection

The following demographic and clinical variables were retrieved from patient records:

Demographic Parameters

- Age
- Gender

Periodontal Parameters

- Gingival recession around the exposed canine
- Width of keratinized gingiva

Orthodontic Parameters

- Duration required for orthodontic alignment of impacted canine

Clinical photographs, periodontal charting records, orthodontic progress notes, and postoperative reviews were analyzed to assess the outcome variables.

Assessment of Periodontal Parameters

Gingival Recession

Gingival recession was evaluated clinically based on the apical migration of the gingival margin relative to the cemento-enamel junction of the aligned canine during follow-up visits.

Width of Keratinized Gingiva

The width of keratinized gingiva surrounding the exposed canine was assessed from clinical periodontal records and measured in millimeters from the free gingival margin to the mucogingival junction.

Assessment of Orthodontic Parameters

Duration of Orthodontic Alignment: The duration required for orthodontic alignment was calculated from the initiation of orthodontic traction following surgical exposure until satisfactory positioning of the canine within the dental arch.

Statistical Analysis: The collected data were tabulated and analyzed using Statistical Package for Social Sciences (SPSS) software version 26.0. Descriptive statistics were used to summarize demographic distribution and outcome variables. Continuous variables were expressed as mean ± standard deviation, while categorical variables were represented as frequencies and percentages. Comparison between laser-assisted and conventional groups was performed using independent t-test for continuous variables and Chi-square test for categorical variables. Statistical significance was considered at a p-value of less than 0.05.

Results

A total of 939 patient records involving impacted canine exposure procedures were included in the present retrospective institutional comparative study. Among these, 430 patients underwent conventional surgical exposure, while 509 patients received laser-assisted surgical exposure procedures. The periodontal and orthodontic outcomes were analyzed and compared between the two treatment groups. Table 1 represents the comparison of periodontal and orthodontic outcomes following laser-assisted and conventional surgical exposure of impacted canines.

The demographic distribution of the study population demonstrated a slight female predominance. Out of the total study population, 512 patients (54.5%) were female, whereas 427 patients (45.5%) were male as shown in graph 1. The majority of patients belonged to the 18–25 years age group, accounting for 402 cases (42.8%), followed by the 26–35 years age group with 331 cases (35.2%). Patients above 35 years constituted comparatively fewer cases.

Evaluation of periodontal outcomes revealed that the laser-assisted exposure group demonstrated more favorable soft tissue characteristics when compared with the conventional surgical exposure group. Gingival recession was observed in 58 patients (13.5%) in the conventional surgical group, whereas only 29 patients (5.7%) in the laser-assisted group exhibited gingival recession during follow-up evaluation as depicted in graph 2. Similarly, the mean width of keratinized gingiva was found to be higher in the laser-assisted group (4.3 ± 0.8 mm) compared to the conventional surgical group (3.1 ± 0.7 mm).

Assessment of orthodontic outcomes demonstrated a shorter duration required for alignment of impacted canines in the laser-assisted group. The mean duration required for orthodontic alignment was 7.2 ± 1.4 months in the laser-assisted group, whereas the conventional surgical group demonstrated a mean alignment duration of 9.1 ± 1.8 months as shown in graph 3.

The comparison between laser-assisted and conventional surgical exposure techniques showed statistically significant differences in periodontal and orthodontic outcomes ($p < 0.05$), indicating improved clinical performance associated with laser-assisted procedures.

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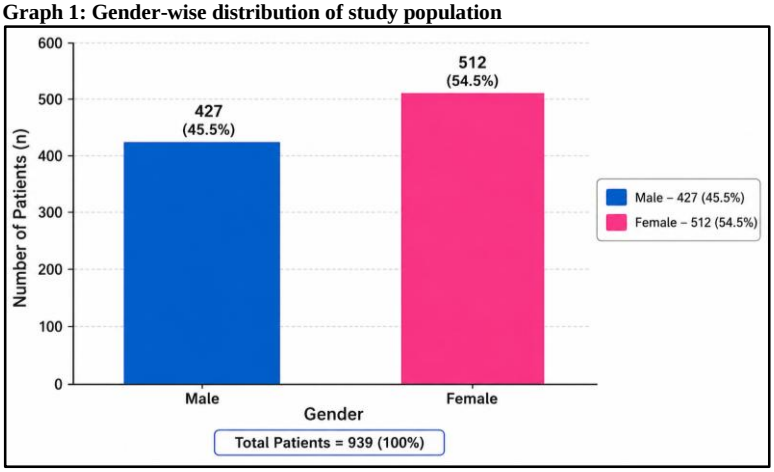
Table 1: Comparison of periodontal and orthodontic outcomes following laser-assisted and conventional surgical exposure of impacted canines

Parameter	Conventional Surgical Exposure (n = 430)	Laser-Assisted Exposure (n = 509)	p-value
Male patients	196 (45.6%)	231 (45.4%)	0.921
Female patients	234 (54.4%)	278 (54.6%)	0.921
Mean age (years)	24.8 ± 5.7	25.1 ± 5.4	0.684
Gingival recession present	58 (13.5%)	29 (5.7%)	0.001*
Width of keratinized gingiva (mm)	3.1 ± 0.7	4.3 ± 0.8	0.001*
Duration for orthodontic alignment (months)	9.1 ± 1.8	7.2 ± 1.4	0.001*

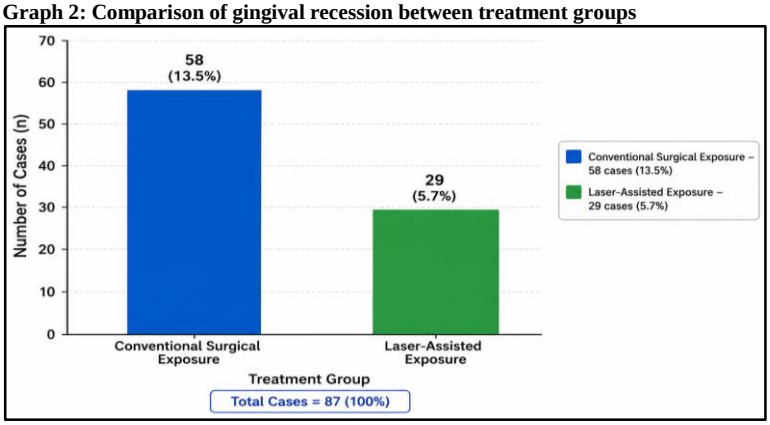
*Statistically significant ($p < 0.05$)

The findings presented in Table 1 demonstrated significantly reduced gingival recession and improved width of keratinized gingiva in the laser-assisted group when compared with the conventional surgical exposure group. In addition, impacted canines exposed using laser-assisted procedures exhibited shorter orthodontic alignment duration.

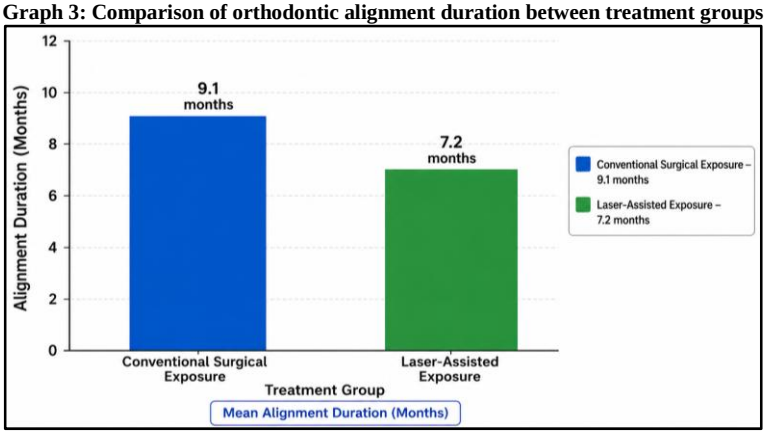
Graph 1: Gender-wise distribution of study population



Graph 2: Comparison of gingival recession between treatment groups



Graph 3: Comparison of orthodontic alignment duration between treatment groups



Graph 1 demonstrated a slight female predominance among patients undergoing impacted canine exposure procedures. Graph 2 illustrated reduced incidence of gingival recession in the laser-assisted exposure group compared with the conventional surgical group. Graph 3 demonstrated shorter orthodontic alignment duration associated with laser-assisted procedures.

Discussion

Management of impacted canines remains a significant interdisciplinary challenge involving orthodontic, periodontal, and surgical considerations. Surgical exposure followed by orthodontic traction is widely accepted as the treatment of choice for preserving impacted canines within the dental arch. However, the surgical technique employed may substantially influence both periodontal health and orthodontic treatment efficiency (12). The present retrospective institutional comparative study evaluated and compared the periodontal and orthodontic outcomes following laser-assisted and conventional surgical exposure of impacted canines. The findings of the present study demonstrated that laser-assisted exposure procedures were associated with superior periodontal outcomes and reduced orthodontic alignment duration when compared with conventional surgical exposure techniques.

In the present study, a total of 939 patient records were analyzed, including 430 patients treated using conventional surgical exposure and 509 patients treated using laser-assisted exposure procedures. A slight female predominance was observed in the study population, accounting for 54.5% of cases. This observation

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is consistent with previous literature reporting a greater prevalence of impacted canines among female individuals (13). The increased occurrence in females has been attributed to differences in craniofacial growth patterns, arch dimensions, and genetic influences associated with eruption disturbances.

The age distribution of patients in the present study predominantly involved young adults, with the majority of cases occurring between 18 and 35 years of age. This finding can be explained by the fact that impacted canines are commonly diagnosed during late adolescence and early adulthood, when orthodontic intervention is typically initiated for esthetic and functional correction. Early diagnosis and treatment during this age period are important because prolonged impaction may increase the risk of root resorption, periodontal compromise, and complexity of orthodontic movement (14).

One of the most significant findings of the present study was the reduced incidence of gingival recession observed in the laser-assisted exposure group. Gingival recession was identified in 13.5% of patients treated with conventional surgical exposure, whereas only 5.7% of patients in the laser-assisted group demonstrated recession during follow-up evaluation. The findings presented in Table 1 and Graph 2 indicate superior soft tissue preservation associated with laser-assisted procedures. This favorable periodontal outcome may be attributed to the minimally invasive nature of laser surgery, reduced tissue trauma, and enhanced precision during soft tissue removal. Laser-assisted procedures also provide superior hemostasis and reduced inflammatory response, thereby facilitating improved wound healing and preservation of gingival architecture surrounding the exposed canine.

Another important periodontal parameter evaluated in the present study was the width of keratinized gingiva. The laser-assisted exposure group demonstrated a greater mean width of keratinized gingiva (4.3 ± 0.8 mm) compared with the conventional surgical group (3.1 ± 0.7 mm). Adequate keratinized gingiva is essential for maintaining long-term periodontal stability around orthodontically aligned teeth. The improved gingival outcomes observed in the laser-assisted group may be related to minimal collateral tissue damage and enhanced biologic healing response associated with laser application. Preservation of keratinized tissue is particularly important in esthetic regions because it contributes to improved gingival contour, plaque control, and patient satisfaction.

The present study also demonstrated significantly reduced orthodontic alignment duration in patients treated using laser-assisted exposure techniques. The mean duration required for orthodontic alignment was 7.2 ± 1.4 months in the laser-assisted group compared with 9.1 ± 1.8 months in the conventional surgical group. As illustrated in Graph 3, laser-assisted procedures appeared to facilitate more efficient orthodontic traction and alignment of impacted canines. Reduced postoperative tissue inflammation and improved healing following laser exposure may contribute to decreased resistance during orthodontic movement and improved patient compliance during treatment. In addition, laser procedures may create a more favorable soft tissue environment for orthodontic mechanics, thereby reducing overall treatment duration.

The statistically significant differences observed between the two treatment modalities support the growing clinical application of lasers in interdisciplinary orthodontic and periodontal procedures. Lasers have gained increasing popularity because of their ability to provide bloodless surgical fields, reduced operative time, minimal postoperative discomfort, and accelerated healing (14). These advantages not only improve clinical efficiency but also enhance patient acceptance and cooperation during prolonged orthodontic treatment.

The findings of the present study are in agreement with previous studies that have reported improved periodontal healing and favorable soft tissue response following laser-assisted oral surgical procedures. Earlier investigations have also suggested that laser application may reduce postoperative complications and facilitate improved orthodontic outcomes when compared with conventional scalpel techniques. However, available literature specifically comparing periodontal and orthodontic parameters following impacted canine exposure remains limited, highlighting the relevance of the present institutional study.

Despite the favorable findings, the present study has certain limitations. As a retrospective study, the analysis was dependent on the accuracy and completeness of institutional records. Variations in operator experience, laser parameters, orthodontic mechanics, and follow-up duration may also have influenced the outcomes. Furthermore, patient-reported outcomes and long-term periodontal stability beyond the active orthodontic phase were not extensively evaluated. Future prospective randomized clinical trials with long-term follow-up are recommended to further validate the clinical benefits of laser-assisted exposure techniques.

Overall, the present study demonstrated that laser-assisted surgical exposure of impacted canines resulted in superior periodontal tissue preservation and reduced orthodontic alignment duration when compared with conventional surgical exposure procedures. These findings support the integration of laser-assisted approaches in contemporary interdisciplinary management of impacted canines.

Conclusion

Within the limitations of the present retrospective institutional comparative study, laser-assisted surgical exposure of impacted canines demonstrated superior periodontal and orthodontic outcomes when compared with conventional surgical exposure techniques. Laser-assisted procedures were associated with reduced gingival recession, greater width of keratinized gingiva, and shorter duration required for orthodontic alignment. The findings suggest that laser-assisted exposure may provide a minimally invasive and clinically effective alternative for the interdisciplinary management of impacted canines, contributing to improved periodontal tissue preservation and enhanced orthodontic treatment efficiency.

Conflict of interest : nil

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