Case Report

Diode Laser Surgery for the Disinclusion of Palatally Impacted Canines: A Case Report

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AIM: Mandibular third molars are the most frequently impacted teeth, followed by maxillary canines. Between one and three percent of the general population is affected by permanent maxillary canine impaction; in males, this condition is less common than in females. This case report evaluates the spontaneous eruption of palatally impacted canines following diode laser exposure.
CASE PRESENTATION: A 15-year-old female referred to our observation to improve her smile. At the first visit, the absence of upper left permanent canines and the persistence of upper right primary canines were detected. Meticulous surgical exposure with a diode laser was planned based on the cone beam computed tomography (CBCT). The wound was covered with a periodontal pack, and the traction of the teeth in the dental arch was achieved without the need for orthodontic devices. The canines' eruption was tracked at 1, 8 and 16 weeks following surgery, using an intraoral scanner (Medit i700, Medit Corp., Seoul, South Korea) and photos.
RESULTS: Both canines completely erupted 16 weeks after surgery, so brackets were placed on them, and self-ligating multibrackets were used to bandage the upper arch.
CONCLUSIONS: Laser surgery for impacted canines is an excellent conservative option for their exposure; compared to standard surgery, it offers several advantages, including faster eruption, no need for sutures, and no bleeding during or after the operation.

Keywords: diode laser; laser; impacted tooth; cone beam computed tomography; orthodontics; oral surgical procedures; case report

Introduction

The maxillary permanent canines play an essentially functional and esthetical role, sometimes failing to erupt into an arch at the proper moment. The impaction rate of upper canines in the population varies between 1% and 3% [1]; they are the most susceptible teeth to the impaction, followed only by third molars. An unerupted canine is sometimes positioned outside or buccal to the dental arch. Most unerupted canines are displaced palatally; palatal impaction is eight times more frequent than buccal impaction [2,3].
The etiology of maxillary canine impaction is thought to be multifactorial: mal-shaped or missing lateral incisors, crowded or delayed eruptive pathways (guidance theory), and genetic factors (genetic theory). An early diagnosis of ectopic eruption is essential for implementing preventive measures (extraction of primary canines, creating space by widening the upper dental arch) [4].
Canine ectopically erupted cases can be diagnosed clinically using the digital palpation screening method or radiographically using a panoramic radiograph to evaluate the eruption angle and position [5,6]. Panoramic is the first-line radiographic examination; for this reason, for planning the treatment, it is essential to analyze Computed Tomography (CT). It is possible to measure the height of the maxillary canine inclusion and the distance and the relationship between the canines and incisors [7].

Treating impacted permanent maxillary canines can be challenging and laborious, involving surgery to uncover the tooth and prolonged orthodontic treatment to straighten it. Kokich and Mathews [8] proposed an alternative approach to exposing palatally impacted canines. Their approach involves uncovering the canine with a scalpel blade and waiting for autonomous eruption without orthodontic traction.

In modern dentistry, laser technology has become more prevalent, and over the previous 20 years, much research has been done on a wide range of laser applications. compared to traditional procedures, the use of a laser presents numerous advantages, such as minor intraoperative bleeding, sterilization of the surgical site, minor post-operative discomfort and edema, and a minor scar after the wound heals [9].

In this case report, the canine is exposed using a diode laser surgery, which allows the spontaneous eruption of the canine without postoperative pain and discomfort.

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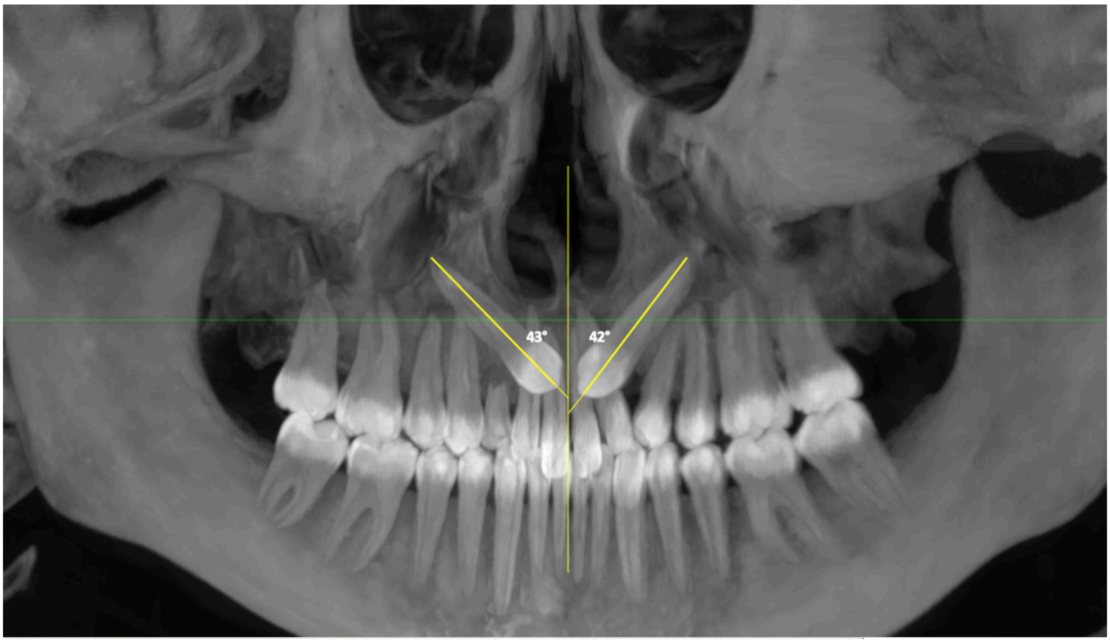

Fig. 1. Orthopanoramic radiography pre-treatment.

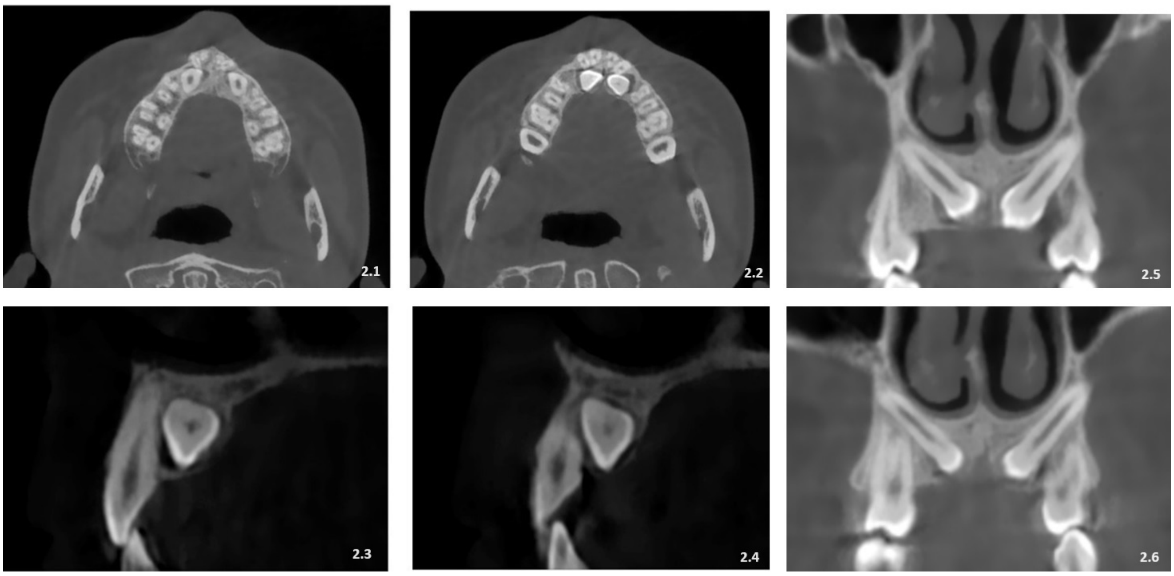

Fig. 2. Specific cone beam computed tomography (CBCT) projection of the patient, including the maxillary canines on both sides (2.1–2.2: axial sections; 2.3–2.4: sagittal sections; 2.5–2.6: coronal sections).

Case Presentation

The following study presents the clinical case of a 15-year-old female patient referred to the Department of Oral and Maxillo-Facial Science at Sapienza University of Rome's Orthodontics Unit.

The study was conducted in accordance with the Declaration of Helsinki, informed patient consent was obtained from the patient and her parents, and Ethics Committee approval of Policlinico Umberto I in Rome was obtained with the number (#4389).

The patient's visit was to improve her smile and close the antero-superior spaces. She has no occlusal symptoms or temporomandibular disorders (TMD) signs or symptoms. No relevant medical history was reported; the patient had not previously undergone orthodontic treatment, and there was no reference to genetic alterations in the patient or her family group. No individuals in her family have dental anomalies such as agenesis, ectopias, inclusions, or dental malformations. The presence of an upper primary canine in the first quadrant, the absence of a maxillary primary in the second one, and permanent canines were observed during the visit.

On the left side of the upper arch, the medialization of molars and premolars and the absence of space for element 2.3

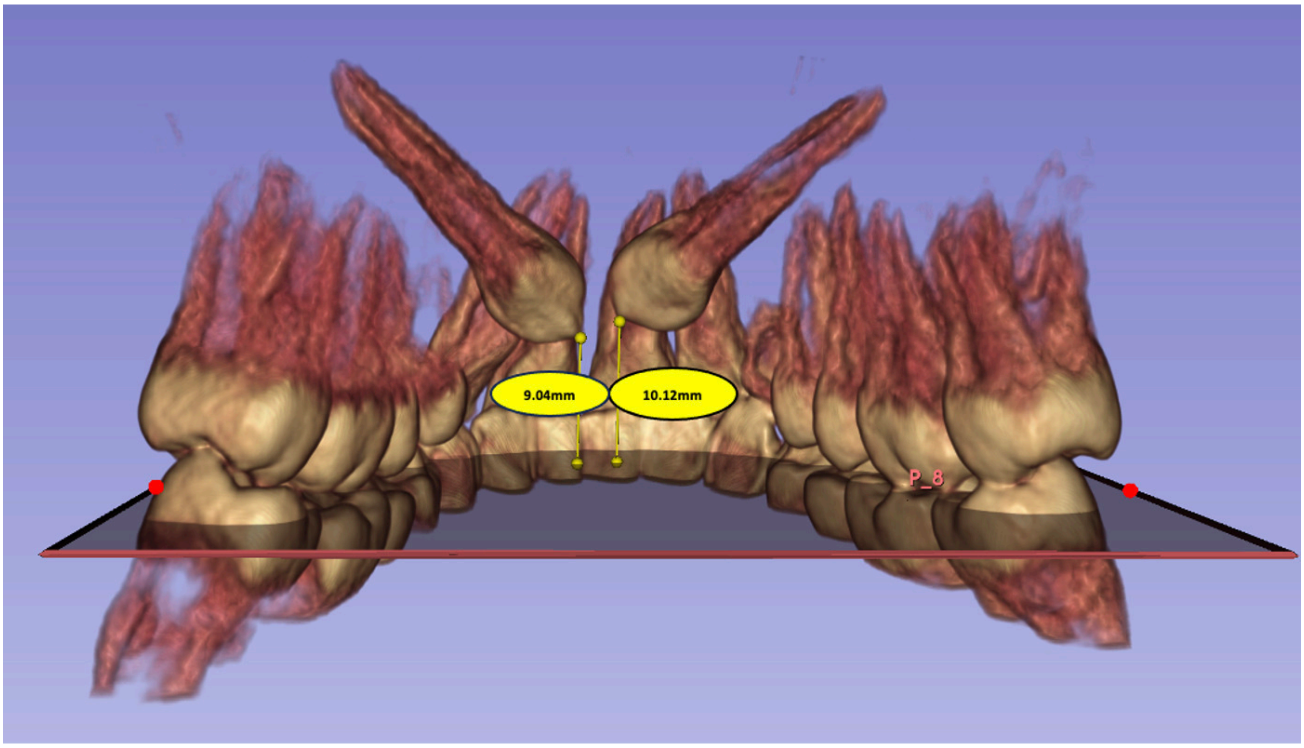

Fig. 3. Inclusion height of elements 1.3 and 2.3.

were detected. The patient provided ortho-panoramic radiography (Fig. 1), which revealed the inclusion of right and left upper canines. Cone beam computed tomography (CBCT) (Fig. 2(2.1–2.6)) was prescribed to identify the canines' position and plan the surgery.

By analyzing the orthopanoramic radiography (OPT) and CBCT images, it was possible to confirm the osteo-mucosal inclusion of both upper canines on the palatal side and with mesial inclination close to the lateral and central incisors, which indicates an adverse prognosis. The prognosis analysis was conducted using radiographic examinations, particularly on the OPT. The degree of inclination of the canine's axis concerning the interincisive midline was evaluated. Three-dimensional morphology, location, inclination, and depth of the impacted tooth have been analyzed on CBCT. This three-dimensional examination was also helpful in assessing the relationship between the canines and surrounding dental elements.

After an accurate study of the radiographic examinations, the patient was informed about the potential complications and benefits of surgical treatment.

Based on the three-dimensional analysis method of the position of the elements included in CBCT, a new measurement has been introduced, which is easy to perform and likely a good prognostic factor. The software "3D slicer" (an open-source platform for viewing and analyzing three-dimensional medical images, including Digital Imaging and Communication in Medicine (DICOM) CBCT files) has been used to evaluate the height of the inclusion of maxillary canines in the occlusal plane. This measurement was performed by tracing the occlusal plane using three reference points: mesial-palatal cusps of the upper first molars and the incisal edge of the upper incisors in correspondence with the inter-incisive midline. A line was then drawn perpendicular from the cusps of the impacted maxillary canines to the occlusal plane, obtaining the millimetric value of canine inclusion height. In this case, element 1.3 had an inclusion height of 10.12 mm, while element 2.3 had a height of 9.04 mm (Fig. 3).

In this clinical case, a 4-watt diode laser operating in continuous mode (fluency: da 0.1 J/cm^2 a 10 J/cm^2) was utilized (K-laser, Eltech, Blue Derma 445-660-970 nm). After a 2% mepivacaine with 1:100,000 adrenaline solution was used to administer local anesthesia, a diode laser was used to perform the operculectomy. This technique exposes the crown of the impacted tooth by rotating the laser tip in contact with the tissue surface (Fig. 4). The palatal mucosa is raised using a periosteal elevator, and the osteotomy is performed slowly using a handpiece and an ISO 018 diameter rosette bur (Ballaigues, Switzerland). An abundant saline solution irrigated the spot to prevent the tissues from overheating. The drill was employed obliquely. The coronal surface of the canines was gradually exposed by using the drill tangential to the bone tissue. Finally, the palate's treated area was covered for about a week using a periodontal compress (Coe-Pak, GC Dental, Tokyo, Japan) (Fig. 5).

Following surgery, the patient was advised not to eat anything hot, spicy, or complex and to refrain from brushing the surgical site for a full day. No orthodontic anchoring or relative traction was placed on the canine's exposed surfaces,

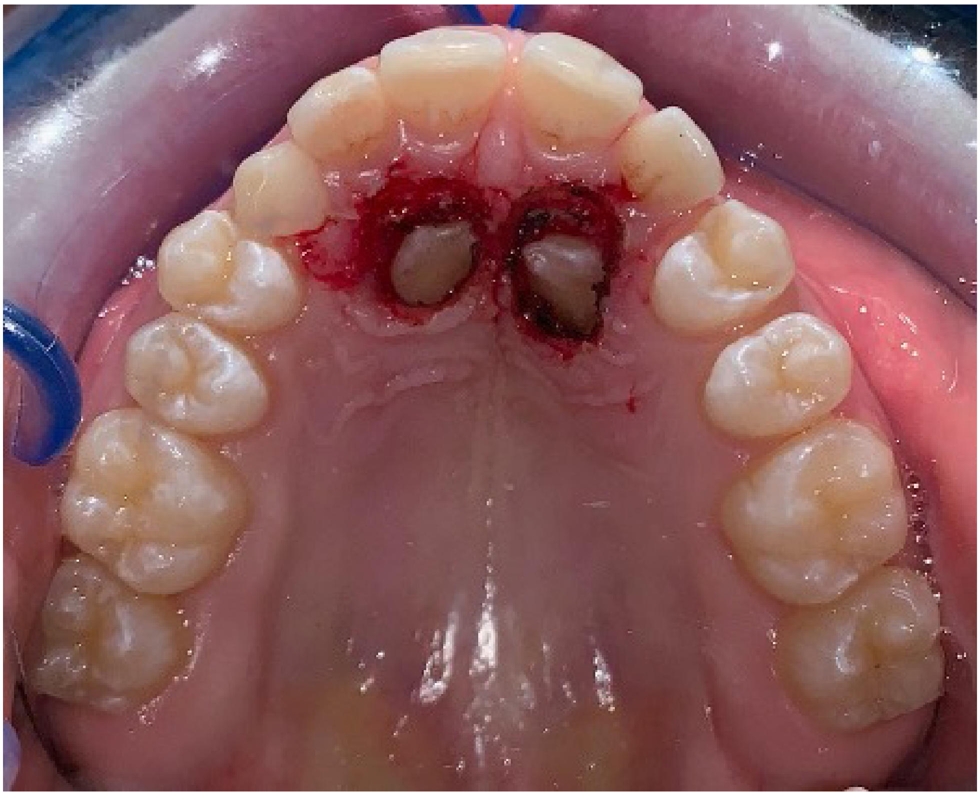

Fig. 4. Post-operative intraoral photo.

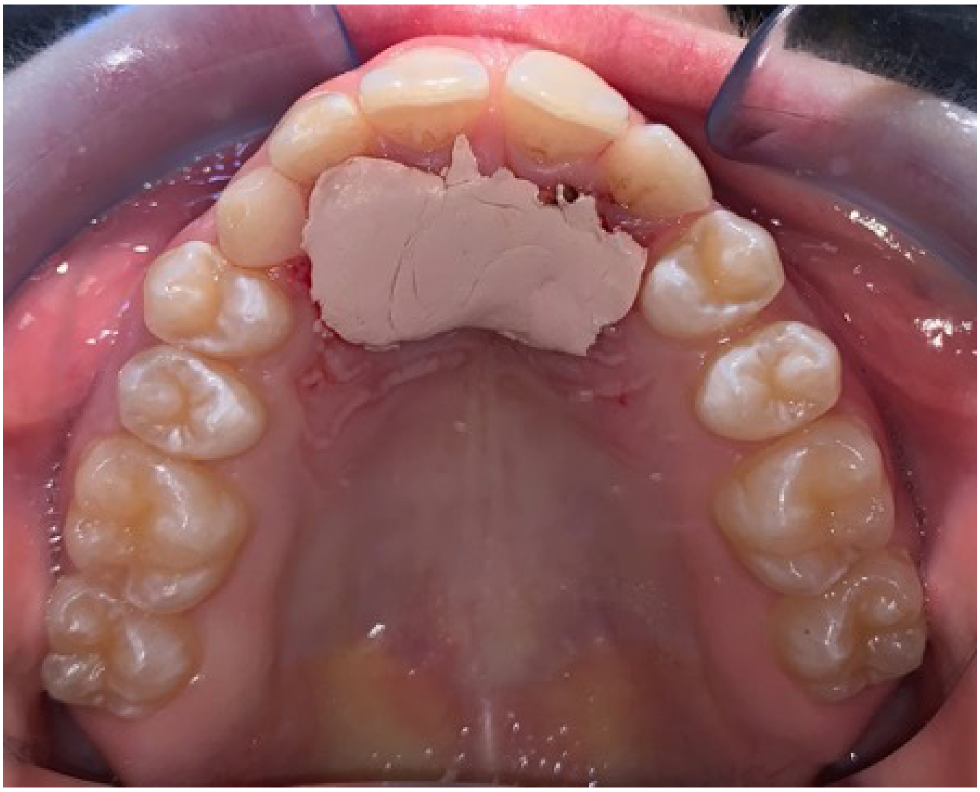

Fig. 5. Application of periodontal pack.

so it was possible to assess their spontaneous eruption. After surgery, three follow-up appointments were scheduled: one week (Fig. 6) and eight weeks (Fig. 7) after laser exposure. During this check-up, the canine's eruption was

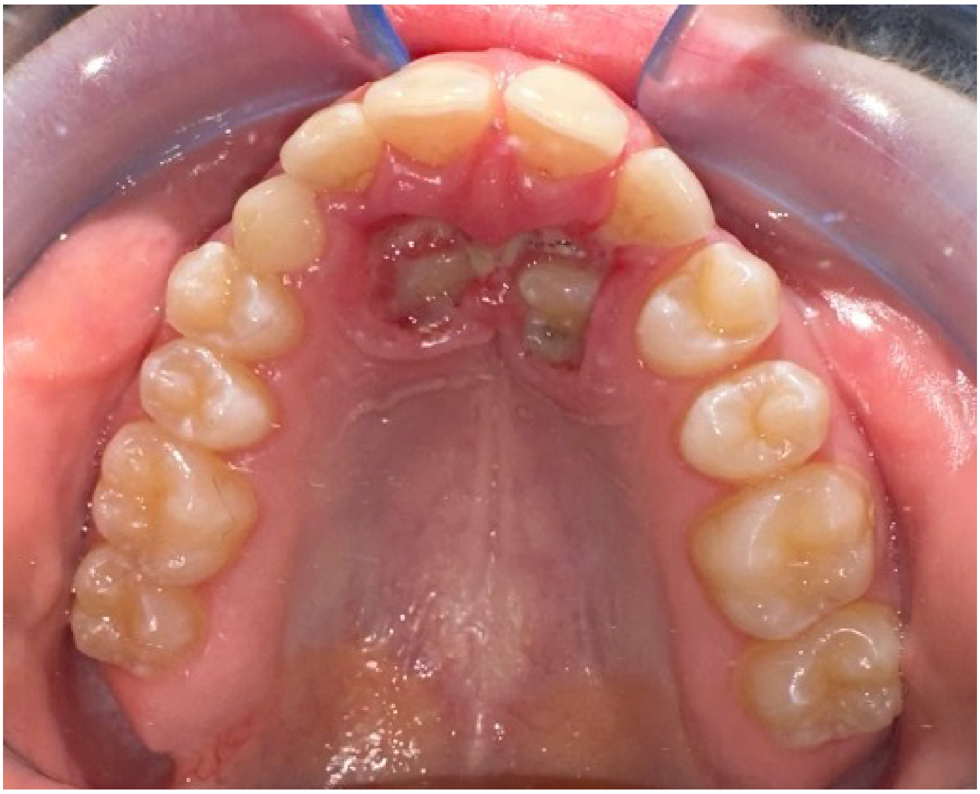

Fig. 6. Intra-oral photo one week after surgery.

Fig. 7. Intraoral photo 8 weeks after surgery.

monitored through photographic records and color digital scans obtained with an intraoral scanner (Medit i700, Medit Corp., Seoul, South Korea).

A clinical examination was performed one week after surgery. At every follow-up appointment, the patient was questioned about pain, swelling, bleeding, and the need for medication if any of these issues were present.

The open-source program MeshLab (version 2023.12, Visual Computing Lab, Pisa, Italy) was used to import the 3D impressions. Using MeshLab and the "measuring tool" fol-

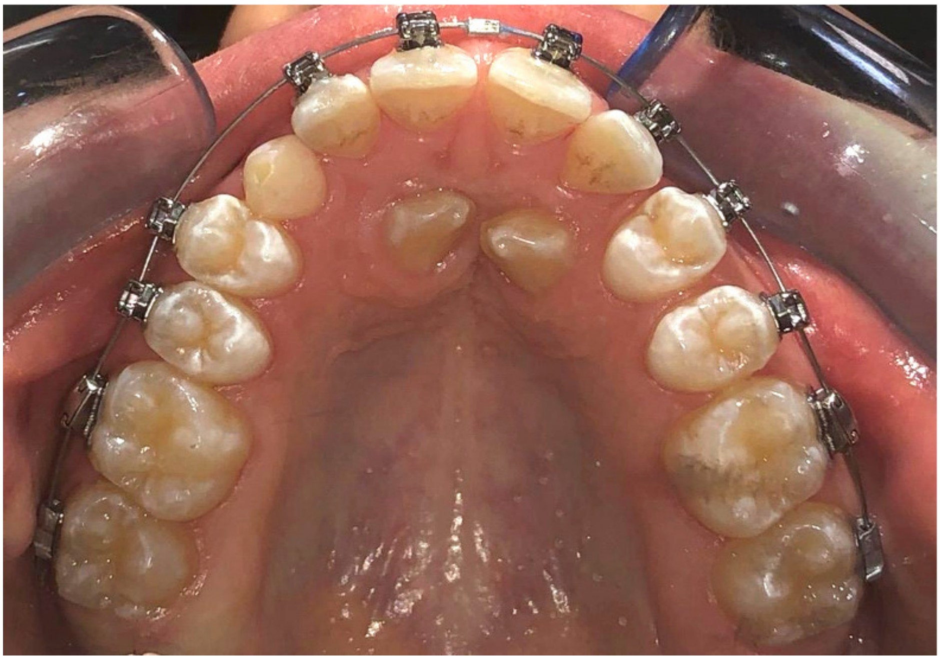

Fig. 8. Intra-oral photo 16 weeks after surgery.

Fig. 9. Intraoral photo 0.019″ × 0.025″ SS arch.

lowing the three scan files, it was possible to measure the distance between the canine's visible cusp one week after exposure and its cusp that erupted on the palate at eight and sixteen weeks after laser surgery.

Four months (16 weeks) after surgery, adequate coronal canine surfaces emerged into the palate, and an orthodontic therapy was planned to create proper spaces for elements 1.3 and 2.3. The elements of the upper arch were bandaged using the Damon System technique (Fig. 8). A first alignment phase was carried out with a 0.014″ CuNiTi arch; after two months, it was replaced with a rectangular arch (0.014″ × 0.025″ CuNiTi), and an open coil spring was inserted between the elements 1.2 and 1.4 and between 2.2 and 2.4. The alignment and leveling of the upper arch continued, following the sequence of arches up to the 0.019″ × 0.025″ SS arch (Fig. 9). The buttons were positioned on elements

Fig. 10. Intraoral photo. Metal ligature for traction of the canines to the dental arch.

1.3 and 2.3 only when adequate space between elements 2.2 and 2.4 was obtained. Using metal ligature, the canines were tractioned to the dental arch (Fig. 10). To preserve the space in the dental arch and the smile's aesthetics, the primary canines were removed only after the permanent ones were sufficiently near to it.

Consequently, a notable tooth movement was observed after the 16-week study period. The canine eruption measured 5.05 mm on the left and 4.29 mm on the right. The right canine erupted at 0.035 mm/day, while the left erupted at 0.042 mm/day.

Discussion

The surgery technique used for the presented case is based on Kokich's technique [10]. This technique allows the autonomous eruption of a palatally impacted canine. The canine crown will naturally erupt into the palate in six to eight months without needing fixed or removable orthodontic appliances. The canine crown typically emerges away from the roots of the central and lateral incisors and toward the middle of the palate. Study has also reported that the mechanical traction of impacted palatal canines may require longer orthodontic treatment and increase the risk of root resorption in teeth adjacent to the affected tooth [11].

The numerous advantages described in the literature led us to choose laser diode surgery to uncover both canines [12]. A high-intensity laser has many applications in oral surgery, for instance, operculectomy or other procedures for removing the soft tissue covering an impact dental element [13,14].

The K-Laser used in this case operates based on the absorption of melanin and hemoglobin. This feature allows us to obtain numerous advantages in the surgical field. With its higher energy coefficient than the infrared laser, it exhibits enhanced anti-inflammatory and biostimulatory properties. The 445 nm wavelength is combined with the 660 nm and 970 nm wavelengths as they support the biostimulation of superficial and deep tissues, which was sought to stimulate the spontaneous eruption of the canines. Furthermore, 4 watts of power allowed for a good cutting action on the mucosa without causing damage to the bone, which was removed using a micromotor and bone cutter [15,16].

When compared to traditional surgery, the laser surgical method has shown the following benefits that have already been noted in the literature: reduction of bleeding during surgery with consequent reduction of operating time and excellent visualization of the operating field; accuracy when making a tissue incision, reduction in the quantity of local anesthetic required, elimination of the use of sutures; the increase of postoperative comfort, due to the absence of the unpleasant taste of blood [17].

Additionally, it has been shown that the laser has antibacterial and disinfecting properties, which enhance postoperative healing and reduce the need for antibiotics. Rapid

healing is due to the laser's biostimulation and photobiostimulation properties. The photobiostimulatory effect of low-intensity lasers on the stimulation of tooth movement in orthodontics has now been widely demonstrated [18].
Photobiostimulation therapy, known as low-level laser therapy, has been discovered that exposure to laser light stimulates osteoclast, osteoblast, and fibroblast growth, which influences bone remodeling and quickens tooth movement [19].
In the literature, few studies assess the biostimulatory effect of high-intensity lasers on tooth movement. The activation of regenerative and healing processes, known as biostimulation, depends on subcellular photoreceptors' capacity to react to visible red and near-infrared wavelengths. The respiratory chain, the electron transport chain, and oxidation are all impacted by the stimulation of these receptors, manifesting as an increase in cellular metabolic processes [20–24].
The advantages mentioned above were found in the postoperative experience described by the patient after one week of surgery. It was reported as a good experience: no pain, bleeding, or swelling occurred in the postoperative period. Spontaneous eruption of both canines (4.29 mm for the canine in the first quadrant and 5.05 mm for the canine in the second one) occurred without orthodontic traction; in fact, brackets could be bonded to the tooth surfaces 16 weeks after surgery. The limitations of the case are that the response to the surgery can vary based on the individual susceptibility of the patient and the surgical ability of the operator. Future work will focus on introducing lower laser therapy sessions after laser surgery exposure to evaluate the effects on the canine eruption, particularly on the speed of the movement. Additionally, digital technology like software and CBCT allows for the exact and accurate monitoring of tooth movement and, thus, the eruptive response of the canines following surgery [25–29].

Conclusions

Spontaneous eruption of both canines (4.29 and 5.05 mm) was achieved, avoiding the need for orthodontic traction. The bracket could be bonded to the vestibular surface of the canine 16 weeks after surgery. Therefore, we can conclude that the high-intensity laser is effective in exposing palatally impacted canine, allowing them to erupt more quickly than reported in the literature for conventional cold blade surgery.
It is a valuable tool for surgical exposure of impacted canines. It offers numerous advantages compared to the traditional method in terms of visibility of the operating field and post-operative discomfort, and it also simplifies and speeds up orthodontic therapy.

Availability of Data and Materials

All the data and materials included in this study can be obtained by contacting the first author if needed.

Author Contributions

MH, AAD and GG designed the research study. MH, AAD and UR performed the research. AI and FC analyzed the data. FC and MH drafted this manuscript. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki, informed patient consent was obtained from the patient and her parents, and Ethics Committee approval of Policlinico Umberto I in Rome was obtained with the number (#4389).

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Not applicable.

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Conflict of Interest

The authors declare no conflict of interest.

References

[1] Ericson S, Kurol J. Radiographic examination of ectopically erupting maxillary canines. American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, its Constituent Societies, and the American Board of Orthodontics. 1987; 91: 483–492.

[2] Johnston WD. Treatment of palatally impacted canine teeth. American Journal of Orthodontics. 1969; 56: 589–596.

[3] Al-Nimri KS, Bsoul E. Maxillary palatal canine impaction displacement in subjects with congenitally missing maxillary lateral incisors. American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, its Constituent Societies, and the American Board of Orthodontics. 2011; 140: 81–86.

[4] Ericson S, Kurol J. Early treatment of palatally erupting maxillary canines by extraction of the primary canines. European Journal of Orthodontics. 1988; 10: 283–295.

[5] Warford JH, Jr, Grandhi RK, Tira DE. Prediction of maxillary canine impaction using sectors and angular measurement. American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, its Constituent Societies, and the American Board of Orthodontics. 2003; 124: 651–655.

[6] Sambataro S, Baccetti T, Franchi L, Antonini F. Early predictive variables for upper canine impaction as derived from posteroanterior cephalograms. The Angle Orthodontist. 2005; 75: 28–34.

[7] Walker L, Enciso R, Mah J. Three-dimensional localization of maxillary canines with cone-beam computed tomography. American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, its Constituent

Societies, and the American Board of Orthodontics. 2005; 128: 418–423.

[8] Kokich VG, Mathews DP. Orthodontic and Surgical Management of Impacted Teeth. Quintessence Publishing Co, Inc.: USA. 2014.

[9] Impellizzeri A, Horodynski M, De Stefano A, Guercio Monaco E, Palaia G, Serritella E, *et al*. Disinclusion of Palatally Impacted Canines with Surgical and Photobiomodulating Action of a Diode Laser: Case Series. Applied Sciences. 2021; 11: 4869.

[10] Kokich VG. Preorthodontic uncovering and autonomous eruption of palatally impacted maxillary canines. In Seminars in Orthodontics (Vol. 16, No. 3, pp. 205–211). WB Saunders. 2010, September.

[11] Trelles MA, Mayayo E. Bone fracture consolidates faster with low-power laser. Lasers in Surgery and Medicine. 1987; 7: 36–45.

[12] Impellizzeri A, Horodynski M, Serritella E, Palaia G, De Stefano A, Polimeni A, *et al*. Uncovering and Autonomous Eruption of Palatally Impacted Canines-A Case Report. Dentistry Journal. 2021; 9: 66.

[13] Sulieman M. An overview of the use of lasers in general dental practice: 2. Laser wavelengths, soft and hard tissue clinical applications. Dental Update. 2005; 32: 286–288, 291–294, 296.

[14] Impellizzeri A, Horodynski M, Palaia G, La Monaca G, Pergolini D, Polimeni A, *et al*. CO_2 and Diode Lasers vs. Conventional Surgery in the Disinclusion of Palatally Impacted Canines: A Randomized Controlled Trial. Photonics. 2023; 10: 244.

[15] Walsh LJ. The current status of low level laser therapy in dentistry. Part 2. Hard tissue applications. Australian Dental Journal. 1997; 42: 302–306.

[16] Jnaneshwar PR, Venkatesan K, Prince T, Pethuraj V, Rajaram K, Bhat S. Assessment of the effect of frequency of low-level laser therapy exposure at different intervals on orthodontic tooth movement - A systematic review and meta-analysis. Journal of Orthodontic Science. 2023; 12: 14.

[17] Fornaini C, Rocca JP, Bertrand MF, Merigo E, Nammour S, Vescovi P. Nd:YAG and diode laser in the surgical management of soft tissues related to orthodontic treatment. Photomedicine and Laser Surgery. 2007; 25: 381–392.

[18] Grajales M, Ríos-Osorio N, Jimenez-Peña O, Mendez-Sanchez J, Sanchez-Fajardo K, García-Perdomo HA. Effectiveness of photobiomodulation with low-level lasers on the acceleration of orthodontic tooth movement: a systematic review and meta-analysis of split-mouth randomised clinical trials. Lasers in Medical Science. 2023; 38: 200.

[19] Nimeri G, Kau CH, Abou-Kheir NS, Corona R. Acceleration of tooth movement during orthodontic treatment–a frontier in orthodontics. Progress in Orthodontics. 2013; 14: 42.

[20] Bakdach WMM, Hadad R. Effectiveness of low-level laser therapy in accelerating the orthodontic tooth movement: A systematic review and meta-analysis. Dental and Medical Problems. 2020; 57: 73–94.

[21] Fujita S, Yamaguchi M, Utsunomiya T, Yamamoto H, Kasai K. Low-energy laser stimulates tooth movement velocity via expression of RANK and RANKL. Orthodontics & Craniofacial Research. 2008; 11: 143–155.

[22] Verma SK, Maheshwari S, Singh RK, Chaudhari PK. Laser in dentistry: An innovative tool in modern dental practice. National Journal of Maxillofacial Surgery. 2012; 3: 124–132.

[23] Wilcko MT, Wilcko WM, Bissada NF. An evidence-based analysis of periodontally accelerated orthodontic and osteogenic techniques: A synthesis of scientific perspectives. In Seminars in Orthodontics (Vol. 14, No. 4, pp. 305–316). WB Saunders. 2008, December.

[24] Sarver DM. Use of the 810 nm diode laser: soft tissue management and orthodontic applications of innovative technology. Practical Procedures & Aesthetic Dentistry: PPAD. 2006; 18: suppl 7–13.

[25] Melkos AB. Advances in digital technology and orthodontics: a reference to the Invisalign method. Medical Science Monitor: International Medical Journal of Experimental and Clinical Research. 2005; 11: PI39–PI42.

[26] Sukovic P. Cone beam computed tomography in craniofacial imaging. Orthodontics & Craniofacial Research. 2003; 6 Suppl 1: 31–36; discussion 179–182.

[27] Venkatesh E, Elluru SV. Cone beam computed tomography: basics and applications in dentistry. Journal of Istanbul University Faculty of Dentistry. 2017; 51: S102–S121.

[28] Kobayashi K, Shimoda S, Nakagawa Y, Yamamoto A. Accuracy in measurement of distance using limited cone-beam computerized tomography. The International Journal of Oral & Maxillofacial Implants. 2004; 19: 228–231.

[29] Galluccio G, De Stefano AA, Horodynski M, Impellizzeri A, Guarnieri R, Barbato E, *et al*. Efficacy and Accuracy of Maxillary Arch Expansion with Clear Aligner Treatment. International Journal of Environmental Research and Public Health. 2023; 20: 4634.