

Management of palatal impacted canines: A narrative review

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Abstract

Palatal impaction of the maxillary canine continues to present a significant clinical challenge in orthodontics because of its multifactorial origin, variable clinical presentation, and close anatomical relationship with adjacent teeth. If left undetected, the condition may lead to complications such as external root resorption, periodontal tissue breakdown, prolonged orthodontic treatment, and compromised esthetic and functional outcomes. This narrative review provides a comprehensive overview of the current understanding of palatally impacted maxillary canines, focusing on their etiology, diagnosis, classification, and available treatment options. The importance of early clinical recognition and appropriate radiographic assessment is highlighted, as timely intervention can simplify treatment and improve prognosis. Contemporary management strategies, including interceptive procedures, surgical exposure with orthodontic traction, autotransplantation, and extraction in selected cases, are discussed together with the indications, benefits, and limitations of open and closed surgical techniques. Recent developments in cone-beam computed tomography, skeletal anchorage, and orthodontic biomechanics have enhanced diagnostic accuracy and improved treatment predictability. Successful management requires careful treatment planning based on patient age, stage of root development, position of the impacted canine, and associated pathology. An interdisciplinary approach involving orthodontists, oral surgeons, and restorative clinicians remains essential for achieving stable functional outcomes while preserving periodontal health and facial esthetics.

Keywords: Maxillary canine impaction, palatally impacted canine, orthodontic traction, surgical exposure, cone-beam computed tomography, interceptive orthodontics

Introduction

Maxillary canines are second only to third molars in terms of the frequency of impaction. Although the reported prevalence ranges from approximately 0.8% to 2.8%, the majority of impacted maxillary canines are displaced palatally. Their importance extends beyond esthetics, as these teeth contribute significantly to arch stability, functional occlusion, and canine-guided mandibular movements. Consequently, failure of eruption may have long-term consequences for both oral function and facial appearance if appropriate treatment is not initiated at the right time.^[1]

The mechanisms responsible for palatal canine impaction remain complex and are influenced by multiple interacting factors. Local factors such as prolonged retention of the primary canine, abnormalities of the maxillary lateral incisor, ectopic positioning of the developing tooth germ, and arch length discrepancies have all been implicated. In addition, hereditary influences are believed to contribute to abnormal eruption patterns. Among the proposed explanations, the guidance theory and the genetic theory continue to be the most widely accepted concepts for understanding palatal displacement of the maxillary canine.^[1]

Identifying an ectopically erupting canine during the mixed dentition stage offers the greatest opportunity to reduce treatment complexity. Careful clinical examination, supported by appropriate radiographic investigations, allows accurate localization of the impacted tooth and facilitates timely intervention before irreversible complications develop. Delayed diagnosis has been associated with root resorption of adjacent incisors, periodontal defects, cyst formation, and longer, more complex orthodontic treatment.

When indicated, interceptive extraction of the retained primary canine may encourage spontaneous eruption and decrease the need for surgical management in appropriately selected patients.^[2, 4]

Management of palatally impacted canines should always be individualized. Treatment decisions are influenced by factors such as the patient's age, stage of root development, three-dimensional position of the impacted tooth, periodontal condition, associated pathology, and overall orthodontic objectives. Depending on the clinical situation, management may range from observation and interceptive procedures to surgical exposure with orthodontic traction, autotransplantation, or extraction when preservation of the tooth is not feasible. Advances in three-dimensional imaging, skeletal anchorage systems, and contemporary orthodontic biomechanics have substantially improved treatment planning and clinical outcomes, enabling clinicians to achieve more predictable results while minimizing adverse effects on the surrounding tissues.^[3, 4]

Etiology

Canine impaction is a multifactorial condition that must be differentiated from a blocked-out tooth, which may erupt spontaneously once space is created.

True impaction persists despite adequate space, often due to ectopic positioning, with spontaneous eruption becoming less likely with age.

Etiologic factors are broadly classified into systemic and local causes.

Palatal impactions are more common than labial, occur more frequently in females, and show ethnic variation, while trauma and arch length discrepancies mainly influence labial impactions.

Two main theories explain palatally displaced maxillary canines: the guidance theory and the genetic theory. The guidance theory suggests that the canine follows the root of the lateral incisor during eruption, and absence or malformation of this root can prevent eruption. The genetic theory attributes palatal displacement to hereditary factors and is often linked with other dental

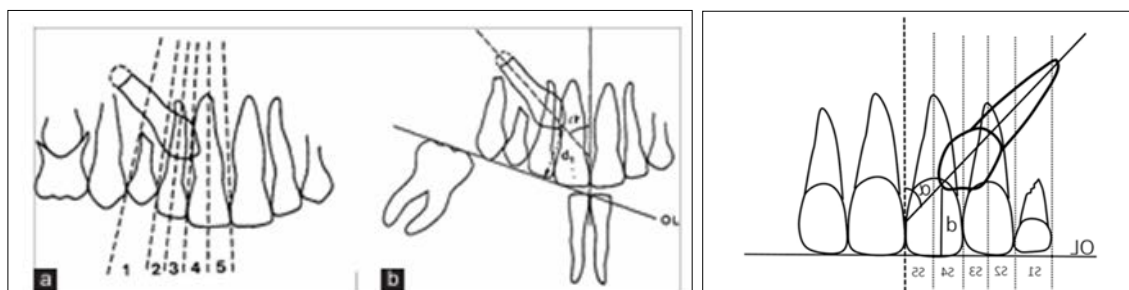
anomalies, including missing or small lateral incisors. Baccetti reported associations with enamel hypoplasia, infraoccluded primary molars, second premolar aplasia, and small maxillary lateral incisors. ^[1]

Etiologic Factors Associated with Impacted Canines ^[1]

Category	Predisposing Factors	Clinical Relevance
Local factors	Arch length deficiency, prolonged retention or premature loss of the primary canine, failure of physiological root resorption, ectopic tooth germ position, ankylosis, root dilaceration, odontogenic cysts or tumors, anomalies of the maxillary lateral incisor, iatrogenic causes	These factors interfere with the normal eruption pathway and are the most frequent causes of canine impaction.
Systemic factors	Endocrine disorders, febrile illnesses during tooth development, previous irradiation	May alter normal eruption timing and tooth development.
Genetic factors	Familial predisposition, abnormal tooth germ position, alveolar clefts and other developmental anomalies	Frequently associated with palatal displacement and other dental anomalies.

Classification of Palatal Impacted Canines ^[7,9]

Classification Parameter	Assessment	Clinical Implication
Mesiodistal position	Determined using Ericson and Kurol sector analysis (Sectors 1–5). Increasing mesial displacement indicates greater treatment difficulty.	More mesially displaced canines have a poorer prognosis and an increased risk of adjacent root resorption.
Long-axis angulation	Evaluated by measuring the alpha angle on panoramic radiographs. Greater angulation reflects increasing deviation from the normal eruption path.	Higher angulation reduces the likelihood of successful interceptive treatment and often necessitates surgical intervention.
Vertical position	Classified according to the depth of impaction relative to the occlusal plane.	Deeper impactions are generally associated with longer treatment duration and greater surgical complexity.
Relationship with adjacent teeth	Presence or absence of contact and root resorption affecting neighboring incisors.	Determines urgency of treatment and influences the surgical approach.
Eruption potential	Estimated using age, root development, angulation, and tooth position.	Helps determine whether interceptive measures are likely to succeed or whether surgical management is indicated.



- Reference lines used to define the sectors of the canine crown on panoramic radiographs.
- Measurement of the distance from the canine crown to the occlusal plane and assessment of canine inclination

to the midline (alpha angle), as determined on panoramic radiography (Ericson and Kurol, 1988) ^[7]

Clinical Consequences of Maxillary Canine Impaction ^[1]

Affected Area	Possible Consequences
Tooth position	Labial or palatal displacement of the canine
Adjacent dentition	Loss of arch length, migration of neighboring teeth, root resorption
Supporting tissues	Periodontal defects and alveolar bone loss
Pathology	Dentigerous cyst formation and localized infection
Symptoms	Pain, discomfort, or completely asymptomatic presentation
Clinical significance	Requires regular clinical and radiographic monitoring to prevent irreversible damage

Clinical and Radiographic Evaluation of Impacted Canines ^[1]

Assessment Stage	Key Findings
Clinical examination	Delayed eruption, retained primary canine, absence of a labial canine bulge, palatal swelling, displacement of the lateral incisor.
Conventional radiography	Periapical, occlusal, panoramic, and cephalometric radiographs provide information regarding tooth position and surrounding structures.

Localization techniques	Clark's tube-shift (SLOB) rule and the buccal object rule help determine buccopalatal position.
Advanced imaging	CBCT offers three-dimensional localization, assessment of root resorption, and evaluation of surrounding bone.
Clinical application	Accurate localization guides surgical access, orthodontic mechanics, and overall treatment planning.

Diagnostic Features Suggestive of Ectopic or Impacted Maxillary Canines ^[4]

Feature	Clinical Importance
Routine screening between 9 and 11 years	Facilitates early detection during mixed dentition.
Missing or asymmetric canine bulge	Raises suspicion of ectopic eruption.
Delayed eruption or retained primary canine	Indicates the need for further investigation.
Lateral incisor displacement	May suggest abnormal canine eruption.
Radiographic abnormalities	Enlarged follicular space or abnormal canine position confirms the need for detailed evaluation.
High-risk patients	Children with dental anomalies or ectopic eruption of first permanent molars require closer follow-up.

Management of Impacted Canines ^[4]

Category	Key Details
Interceptive Strategies	- Extract primary canine at age 8–9 in Class I uncrowded cases (per Williams) to guide eruption - The position of the permanent canine crown relative to the lateral incisor's midline has been identified as an important prognostic factor. Ericson and Kurol reported a success rate of approximately 91% when the canine crown was located distal to the lateral incisor's midline, whereas this rate decreased to about 64% when the crown was positioned mesially.
Comprehensive Evaluation	Assess full malocclusion before selecting from these options:
Treatment Options	1. Observation only (monitor for pathology; note: primary canine often lost to resorption) 2. Autotransplantation of impacted canine 3. Remove impacted canine; slide premolar into space 4. Extract canine + posterior osteotomy to close gap 5. Prosthetic replacement 6. Preferred: Surgical exposure + orthodontic traction into arch
When to Extract Permanent Canine	Avoid extracting labially positioned/crowded canines (harms esthetics/occlusion). Consider only if: - Ankylosed (non-transplantable) - Root resorption (internal/external) - Severe root dilaceration - Extreme impaction risking adjacent roots - Acceptable occlusion with premolar in canine position - Pathology present (cyst/infection) - Patient refuses orthodontic treatment
Interceptive Strategies	- Extract primary canine at age 8–9 in Class I uncrowded cases (per Williams) to guide eruption - The position of the permanent canine crown relative to the lateral incisor's midline has been identified as an important prognostic factor. Ericson and Kurol reported a success rate of approximately 91% when the canine crown was located distal to the lateral incisor's midline, whereas this rate decreased to about 64% when the crown was positioned mesially.

Early Management

Early identification of an ectopically erupting maxillary canine is essential because intervention during the mixed dentition stage can reduce treatment complexity and improve the chances of preserving the permanent tooth. The first step in management is a thorough clinical and radiographic assessment to determine the position of the impacted canine and to evaluate the presence and severity of root resorption affecting the adjacent incisors. This assessment forms the basis for selecting the most appropriate treatment strategy. ^[4]

When radiographic examination shows no evidence of root resorption, or only minimal involvement of adjacent teeth, extraction of the retained primary canine is generally considered the preferred interceptive procedure. Removal of the deciduous canine eliminates a potential obstacle to eruption and may encourage spontaneous correction of the eruption path of the permanent canine. Depending on the

clinical situation, this approach may be supplemented with adjunctive measures such as rapid maxillary expansion, transpalatal arch therapy, or extraoral traction to improve the eruption environment. ^[4]

Following extraction of the primary canine, patients should be monitored both clinically and radiographically. Improvement in the eruption path of the permanent canine is generally expected within approximately 12 months. If little or no change is observed during this period, further interceptive measures are unlikely to be successful, and comprehensive surgical-orthodontic treatment should be considered. ^[4]

The outcome of interceptive treatment depends on several prognostic factors. Greater success has been reported in younger patients, particularly when the impacted canine demonstrates a favorable mesiodistal position, moderate angulation, and limited displacement from its normal eruption path. As the severity of displacement increases and

patient age advances, the probability of spontaneous eruption decreases, making surgical exposure and orthodontic traction more likely. ^[4]

Canine-First Technique

The Canine-First Technique is a contemporary treatment approach that prioritizes alignment of the impacted canine before comprehensive orthodontic alignment of the remaining dentition. Unlike conventional treatment protocols, where the impacted canine is usually addressed after leveling and alignment of the dental arches, this method focuses on early eruption guidance of the canine immediately after accurate localization and surgical exposure. ^[10]

Successful application of this technique depends on careful diagnosis, adequate space creation, and establishment of stable anchorage before traction is initiated. Controlled orthodontic forces are then used to guide the impacted canine into its correct position while minimizing undesirable movement of adjacent teeth. Addressing the canine at an early stage provides better control over the direction of tooth movement and helps preserve periodontal tissues during treatment. ^[10]

Several clinical advantages have been reported with the Canine-First Technique. Early traction of the impacted tooth may improve anchorage control, reduce unnecessary orthodontic mechanics, facilitate more favorable root positioning, and potentially shorten overall treatment duration in carefully selected patients. Functional occlusion, periodontal health, and esthetic outcomes are also enhanced when the canine is guided into the arch using appropriate biomechanics. Nevertheless, careful case selection remains essential, as the technique is most effective when combined with accurate diagnosis, sound biomechanical planning, and close coordination between the orthodontist and oral surgeon. ^[10]

Surgical methods of canine exposure

When interceptive measures fail or the position of the impacted canine makes spontaneous eruption unlikely, surgical exposure followed by orthodontic traction becomes the treatment of choice. The primary objective of surgery is to expose the impacted tooth while preserving the surrounding periodontal tissues, thereby facilitating controlled orthodontic movement into the dental arch. The

choice of surgical technique should be based on the location of the impacted canine, its vertical depth, the amount of keratinized tissue available, and the overall treatment objectives. ^[3]

Two principal surgical approaches are commonly employed for palatally impacted canines: closed surgical exposure and open surgical exposure. Although both techniques have demonstrated favorable clinical outcomes, each has specific indications, advantages, and limitations.

Closed Surgical Exposure

In the closed eruption technique, a full-thickness palatal mucoperiosteal flap is carefully reflected to expose the impacted canine. After adequate bone removal, an orthodontic attachment, usually connected to a gold chain or ligature, is bonded to the most accessible surface of the crown. The flap is then repositioned and sutured back to its original position, allowing only the attachment to emerge through the surgical site. Orthodontic traction is initiated after satisfactory healing, guiding the tooth along its natural eruption pathway while maintaining soft-tissue coverage. ^[3] This technique is particularly advantageous for deeply positioned palatal impactions because it preserves keratinized tissue, promotes favorable periodontal healing, and provides excellent esthetic outcomes after eruption.

Open Surgical Exposure

The open exposure technique involves creating direct access to the impacted canine by removing the soft tissue covering the crown. Depending on the position of the tooth, either a small window of tissue is excised or a mucoperiosteal flap is reflected and repositioned after bone removal. Once the crown is exposed, the tooth may be allowed to erupt spontaneously or an orthodontic attachment may be bonded immediately to facilitate traction. ^[3]

Open exposure provides excellent visibility during surgery and simplifies bracket placement. However, because a portion of the crown remains exposed within the oral cavity, meticulous oral hygiene and periodic clinical review are essential throughout treatment.

Open method approach minimizes tissue trauma while ensuring orthodontic control. The closed method preserves gingiva; open exposure provides better access for deep impactions.

Comparison of Surgical Exposure Techniques ^[3]

Feature	Closed Exposure	Open Exposure
Surgical principle	Flap is repositioned after bonding the attachment.	Crown remains partially exposed following surgery.
Soft tissue management	Preserves keratinized gingiva and natural eruption pathway.	Provides direct visualization of the crown during treatment.
Preferred indication	Deep palatal impactions and teeth positioned high within the alveolus.	Superficial impactions with easier surgical access.
Orthodontic traction	Usually initiated after initial healing.	May begin immediately or after spontaneous eruption, depending on the treatment plan.
Clinical advantages	Improved periodontal outcomes, favorable esthetics, reduced soft-tissue scarring.	Simpler surgical procedure, easier access for attachment placement and monitoring.
Potential limitations	Technique-sensitive and surgically more demanding.	Risk of soft-tissue overgrowth and greater need for plaque control during treatment.

Post-Exposure Monitoring

Regardless of the surgical technique employed, regular follow-up is essential to evaluate healing and monitor the progress of canine eruption. Clinical examination should be

supplemented by periodic radiographic assessment to verify the direction of tooth movement and identify any obstacles to eruption. If orthodontic movement becomes stagnant, the clinician should investigate possible causes such as fibrous

tissue interference, inadequate biomechanics, ankylosis, or loss of attachment integrity before modifying the treatment plan.³

Timing of Orthodontic Traction

Orthodontic traction may be initiated either immediately after surgical exposure or after a short healing period, depending on the clinical circumstances and the selected surgical technique. Immediate traction allows earlier tooth

movement and may shorten overall treatment duration, whereas delayed traction permits initial soft-tissue healing before orthodontic forces are applied. Current evidence indicates that both approaches can produce predictable results when appropriate biomechanics and force systems are used.^[3]

Differences between Open Exposure without and with Traction

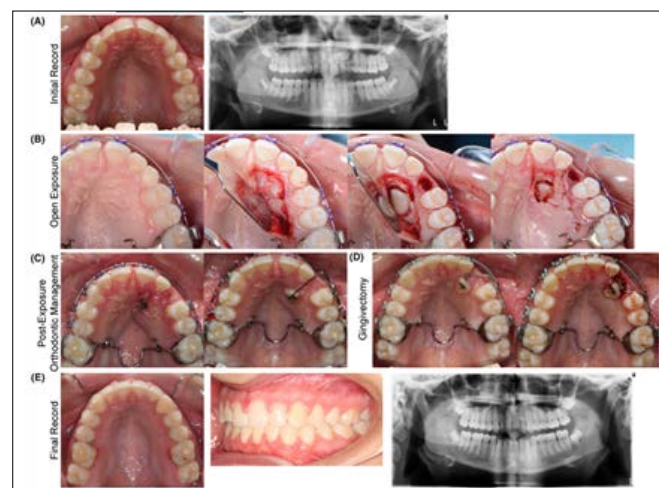
Technique	Patient Selection Criteria	Detailed Surgical Protocol	Attachment & Traction Details	Timeline & Monitoring	Success Rates & Evidence	Advantages	Disadvantages & Risks
Open Exposure WITHOUT Traction	- Late mixed dentition (age 9-11) - Favorable axial inclination on OPG (crown angled toward arch) - Complete root formation NOT required - Vertical position favorable for spontaneous movement	1. Full-thickness mucoperiosteal flap 2. Bone removal to expose 2-3mm crown 3. NO attachment placed 4. Primary closure with window over crown 5. Optional Coe-Pack dressing	- None - relies on spontaneous eruption - Monitor position monthly clinically	- Eruption: 3-9 months post-op - Radiographic check at 3, 6, 9 months - Re-expose if stalled >6 months	- 60-75% spontaneous eruption - Limited palatal canine data	- Simplest surgical approach - Reduces ortho treatment time - Preserves natural eruption path - Lower cost	- Slowest eruption - Gingival overgrowth (30-50%) - Unpredictable for palatal cases - May need re-exposure
Open Exposure WITH Traction	- Unfavorable angulation on OPG - Complete root formation - Horizontal/vertical impactions - Palatal/labial positions	One-Step (Preferred): 1. Full mucoperiosteal flap 2. Bone removal for crown access 3. Immediate Attachment Bonding 4. Flap closure with window 5. Traction starts Day 7-14 Two-Step: 1. Exposure only 2. Heal 6-8 weeks 3. Secondary bonding 4. Traction starts	- Eyelet: 94% success - Bracket: 75% success - Gold chain/elastic chain - Light force (25-50g initial) - Piggyback mechanics preferred	- Weekly traction adjustment - Monthly panoramic - Target alignment: 6-12 months - Full arch integration: 18-24 months	- Eyelet immediate: 94% - Bracket immediate: 75% - Two-step: 85% overall	- Most predictable - Controls path of eruption - Fastest alignment - Works all positions	- Most complex - Requires ortho compliance - Root resorption risk (5-10%) - Higher cost

Clinical Considerations in the Selection of Open versus Closed Surgical Exposure

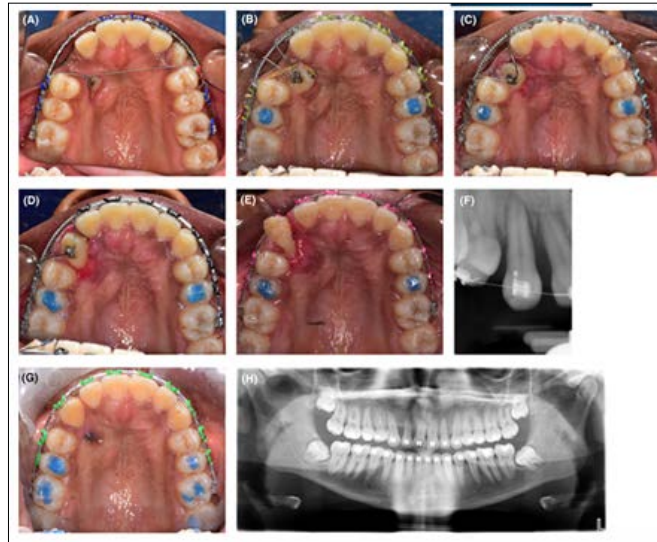
The selection of an appropriate surgical exposure technique for an impacted canine begins with an assessment of the surrounding soft tissues, particularly the gingival phenotype and the amount of keratinized tissue available. The palatal mucosa generally provides a favorable surgical environment because it is firmly attached and highly keratinized, allowing either the open or closed exposure technique to be used effectively.

The choice between these approaches should be guided by several important clinical factors, including:

- The presence of an associated dentigerous cyst,
- The patient's age at the time of treatment,
- The Vertical position or depth of the impacted canine within the alveolar bone, and
- Radiographic evidence of root resorption involving the adjacent incisors.



Open Exposure with traction^[3]



Ballista Loop and Power chain [3]

Clinical Decision for Surgical Exposure of Impacted Canines [2]

1. Assess associated pathology

- Absent → Proceed to evaluate root development.
- Present → Identify the type of pathology.

2. If pathology is present

- Supernumerary tooth, odontome, or small dentigerous cyst → Remove the pathology, then reassess canine position.
- Large dentigerous cyst → Manage the cyst first, followed by reassessment of the canine.

3. Evaluate stage of root development (when no pathology is present)

▪ Open apex

If the canine shows a favorable axial inclination and no significant resorption of adjacent roots → Open exposure without orthodontic traction to allow spontaneous eruption.

If axial inclination is unfavorable or resorption is present → Proceed to assess depth of impaction.

▪ Closed apex

Proceed directly to assessment of the vertical depth of impaction.

4. Assess vertical level of impaction

▪ Grade I or II impaction

Evaluate adjacent incisor root resorption:

- Severe resorption → Closed exposure recommended.
- None or mild resorption → Open exposure with orthodontic traction.

▪ Grade III impaction

Closed exposure is generally preferred. [2]

Orthodontic Techniques for Palatal Impacted Canine Management by various authors [1]

Year	Authors	Orthodontic Technique	Key Features
1979	Harry Jacobay	Ballista Spring	Heavy-duty spring delivering continuous force for canine traction
1994	Criscini <i>et al.</i>	Tunnel Traction	Intra-arch tunnel system for guided canine movement
1994	Ali Darendeliler	Magnets	Magnetic attraction for precise, non-invasive traction
1995	Becker <i>et al.</i>	Stainless Steel Auxiliary	Simple SS wire auxiliary on main archwire
1995	Lindauer & Isaacson	Cantilever Spring	Single-point force from auxiliary arm
1995	Lindauer & Isaacson	TMA Box Loop	Titanium-molybdenum alloy loop for flexible force
1997	Samuels	Two Archwire Technique	Dual archwire system for independent canine control
1999	Loring L. Ross	Mandibular Anchorage	Enhanced lower arch stabilization for upper canine traction
1999	Pramod K. Sinha	K-9 Spring	Versatile spring design for multi-plane movement
2000	Varun Kalra	Australian Helical Archwire	Helical coil integration for continuous force
2000	Christine Hauser	Monkey Hook	Low-profile hook for elastic chain attachment
2002	Jay Bowman	Nickel-Titanium Closed-Coil Spring	Superelastic Niti springs for light, continuous force
2002	Dillingham	Temporary Anchorage Devices (TADs)	Skeletal anchorage eliminating patient compliance issues
2004	Park <i>et al.</i>	TAD-Supported Mechanics	Mini-implants enabling absolute anchorage control

Surgical Complications

Postoperative complications associated with surgical procedures may include bleeding, hematoma formation, pain, and suppuration, each occurring in a small proportion of cases. Soft-tissue edema is the most commonly

encountered finding and usually becomes evident within the first two days after surgery.

When an orthodontic attachment is bonded to a surgically exposed canine, etching should be restricted to a minimal area of the enamel surface, taking care to avoid contact with

the root. Inadvertent injury to the periodontal attachment apparatus can predispose the tooth to complications such as ankylosis or root resorption.

In situations where extraction of an adjacent premolar is planned to create space or correct crowding, special caution is required to prevent trauma to the periodontal ligament or root surface of the impacted canine. This is particularly important when the canine is located close to the premolar, as unrecognized iatrogenic damage may result in resorption or subsequent ankylosis.^[3]

Orthodontic Management Postsurgically

Orthodontic treatment of impacted canines is individualized and depends on sound clinical judgment. Establishing adequate anchorage is essential and is usually completed before surgical exposure to allow effective orthodontic traction. However, when significant resorption of adjacent roots is present, early surgical intervention may be required. Anchorage can be reinforced using methods such as auxiliary archwires, transpalatal or Nance appliances, double archwire systems, or temporary anchorage devices. Poorly planned mechanics may result in anchorage loss, inefficient tooth movement, prolonged treatment, or occlusal plane discrepancies.

Proper control of force direction and root torque is critical in both open and closed exposure techniques to achieve correct canine positioning and avoid mucogingival problems. Sufficient space must be created and maintained, and occlusal interferences should be eliminated during traction.

The impacted canine should be evaluated for ankylosis before removing the primary canine. If ankylosis is suspected, careful luxation with immediate orthodontic traction may be attempted, although this carries a risk of failure and possible need for extraction.^[3]

Conclusion

Effective management of impacted canines demands precise case selection, interdisciplinary collaboration among surgeons, orthodontists, and restorative specialists, and tailored strategies addressing each patient's unique anatomy. Compared with conventional panoramic radiography, three-dimensional imaging provides greater diagnostic precision, while panoramic images remain useful as a rapid, low-dose screening tool. Prognostic models that combine variables such as sector position, canine angulation, cusp height, and root apex location improve the prediction of successful alignment. These assessments support appropriate treatment timing, reduce mucogingival complications, and enhance both esthetic and functional outcomes.

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