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**Case Report**

# Decision-making for Canine Exposure: Literature Review and Suggestion of a Clinical Algorithm

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## Abstract

The maxillary canines rank second after the third molars in terms of the frequency of impaction. The permanent canine teeth play a fundamental role in a functional occlusion and a balanced smile. This study aimed to review the literature and introduce clinical guidelines for surgical canine exposure techniques. The choice of treatment is influenced by several factors such as canine location, severity of impaction, patient's age, and other considerations. There are three treatment options, namely observation, exposure and extraction. Based on the location of the impacted canine, the amount of keratinized gingiva and distance from the gingival margin, a flow diagram is introduced for decision-making to choose an appropriate surgical technique.

***Key words:*** **Canine, guideline, impaction, surgical exposure.**

## Introduction

An impacted tooth is defined as a tooth that fails to erupt into its functional position.[1] The canine tooth is one of the most commonly impacted teeth. The maxillary canines rank second after the third molars in terms of the frequency of impaction. The permanent canine teeth play a fundamental role in a functional occlusion and a balanced smile.[2] Canines also provide a major support for the cheeks. A flattened upper lip results from the absence of canines. Canine impaction is associated with increased risk of infection and cyst formation. Also, the long-term prognosis of adjacent lateral incisors may be compromised.

Maxillary canine impaction may be prevented if tooth displacement is recognized early. Maxillary canines erupt at around 13 years of age in boys and 12.3 years of age in girls.[3] Thus, detection of canine displacement early in the mixed dentition stage (average age of 8 years) is extremely useful for prevention of impaction. In other words, the early mixed dentition period is the most appropriate time for evaluation of potential impaction.[4,5]

The prevalence of maxillary canine impaction ranges from 0.8 to 2.8%.[6-8] In the Western population, canine impaction occurs in the palatal aspect in 85% and in the buccal aspect in 15% of the cases.[9] Bilateral canine impaction has an incidence of 8%.[10] Impaction of all four permanent canines occurs very rarely.[11] Buccally impacted canines are more common in the Asian populations.[12] Also, females have a higher prevalence of maxillary canine impaction with a female/male ratio of 2.3:1 to 3:1.[1,6,13] Most

impactions are asymptomatic. However, some present pathological complications in the form of root resorption of the adjacent teeth, cyst formation, loss of arch length or referred pain.[2]

## Search Strategy

The literature search was performed via Pubmed/Medline and Science Direct back to 1950 using the following key words: (impacted tooth) OR (canine exposure) OR (space management) OR (crowding) OR (forced eruption). Relevant titles were selected by two researches (MK, RA) and all the abstracts were reviewed. A third researcher (ME) screened all the full texts and extracted data.

## Etiology

Several local factors have been hypothesized for maxillary canine impaction, such as a narrow maxillary arch or a Class II div 2 malocclusion.[14,15] A possible genetic origin for palatally displaced canines has also been indicated.[2,16] Two main theories explaining the occurrence of palatally displaced maxillary canines have been discussed, namely the guidance theory[17-19] and the genetic theory.[4,20] Palatally impacted canines are usually associated with other dental anomalies such as congenital absence of the lateral incisors or the second premolars and peg-shaped lateral incisors. Although the etiology of canine impaction is obscure,[21] at least 16 factors have been reported as potential causes[1,21-30] such as genetics, insufficient space, ankylosis, trauma, cysts and supernumerary teeth.

Retarded eruption of teeth may have general or local causes.[2,25,31] Important etiologic factors associated with canine impaction include absence of maxillary lateral incisors, variability in root sizes and variable timing of root formation.[2,16,32] It is believed that presence of a formed lateral incisor root with adequate length is an important factor guiding a mesially erupting canine to a more favorable direction distally and incisally. Becker et al reported that canines adjacent to missing lateral incisors had 2.4 times higher incidence of palatal impaction compared to the general population.[32]

## Classification

In order to classify impacted canines these variables are considered:

1. Crown position in the alveolar arch: Palatal, buccal or in the arch line[33]
2. Type of impaction: Partial vertical, complete vertical and complete horizontal impaction[33]
3. Root development: Incomplete or complete root development[33]
4. Tooth inclination: mesiovestibular, distovestibular, mesiopalatal or distopalatal[34]

Canine impaction classification is important in decision-making and treatment planning.

However, an efficient classification of canine impaction for selection of the most suitable surgical procedure for canine exposure is lacking.

## Localization

Localization of the impacted canine is important in choosing the appropriate surgical technique.

Proper localization of unerupted maxillary canines enhances the detection of tooth displacement in the mixed dentition period and subsequent impaction can be prevented as such. It can also help determine the feasibility, proper surgical access and direction of orthodontic load application. Localization of canine is based on both clinical and radiographic examination.

**Clinical evaluation:** The following clinical signs may indicate canine impaction: (1) delayed eruption of the permanent canine tooth or prolonged retention of the primary canine tooth beyond 14 to 15 years of age; (2) absence of a normal labial canine bulge, either the inability to locate canine position through intraoral palpation of the alveolar process or the presence of an asymmetry in the canine bulge detected during alveolar palpation; (3) presence of a palatal bulge; and (4) delayed eruption, distal tipping or migration of the lateral incisor.[2]

However, Ericson and Kurol believe that absence of canine bulge at an earlier age does not indicate canine impaction.[3] The authors evaluated 505 children between 10 and 12 years of age and demonstrated that 29% of children had non-palpable canines at 10 years of age. This rate was 5% at 11 years of age and 3% at older ages. In order to make an accurate diagnosis, clinical examination must be accompanied by radiographic evaluation.[3]

**Radiographic assessment:** Various radiographic techniques, including panoramic, peri-apical, occlusal and panoramic radiographs can help evaluate the position of canines. However, all these techniques visualize the tooth in two dimensions. Thus, 3-dimensional radiographic techniques, including cone-beam computed tomography (CBCT) have been introduced.[35]

Compared with conventional 2D images, CBCT images provide applicable diagnostic information for dental structures in the sagittal, axial and coronal

planes without superimposition or overlap, providing valuable information related to impacted canines.[36,37]

## Decision-making process

The treatment of impacted canines needs a multidisciplinary approach and is associated with increased treatment time and cost.[38] The choice of treatment is influenced by several factors such as the canine location, severity of impaction, patient's age and other patient considerations (Figure 1).

For patients requiring surgical exposure of a labially or intra-alveolarly impacted canine, the surgeon must assess four criteria in order to choose the correct surgical technique for uncovering the tooth.

First, the labiolingual position of the impacted canine crown must be evaluated. Generally, there are three different techniques for uncovering an impacted canine: excisional uncovering (open exposure), apically positioned flap and closed exposure. Any of the afore-mentioned three techniques may be used for labially impacted teeth, because there is little or no bone over the crown of the impacted canine. However, for teeth impacted in the center of the alveolus, an excisional approach (open exposure) and an apically positioned flap are generally more difficult to perform. In such cases, extensive bone might need to be removed from the labial surface of the crown. Also, apically positioned flaps expose bone and result in healing via secondary intention.

The vertical position of the tooth relative to the mucogingival junction is the second criterion to be considered. Any of the above-mentioned three techniques may be used for uncovering a canine tooth with a coronally positioned crown relative to the mucogingival junction. However, an excisional technique (open exposure) is inappropriate for an impacted canine with an apically positioned crown relative to the mucogingival junction because it will remove all the gingiva over the labial surface of the tooth after it erupts. For very apically positioned crowns relative to the mucogingival junction, an apically positioned flap may also be inappropriate because it will result in instability of the crown and possible reintrusion of the tooth after orthodontic treatment. In the latter situation, a closed exposure technique will provide adequate gingiva over the crown and reintrusion of the tooth will not occur in the long term.

The amount of gingiva in the area of the impacted canine is the third criterion to be considered. An apically positioned flap is often performed when there is insufficient gingiva in the area of the impacted canine because it is the only technique that can predictably produce more gingiva. However, any of the afore-mentioned three techniques may be used for cases where there is sufficient gingiva to provide a minimum of 2–3 mm of attached gingiva over the canine crown after it erupts.

The mesiodistal position of the impacted canine crown is the fourth and final criterion to be considered. Canine crowns positioned mesially over the lateral incisor root are difficult to move through the alveolar ridge unless they are fully exposed via an apically positioned flap. In this situation, closed exposure or excisional uncovering (open exposure) is often not recommended.

There are two basic surgical methods for exposure of a palatally impacted canine, namely the open and

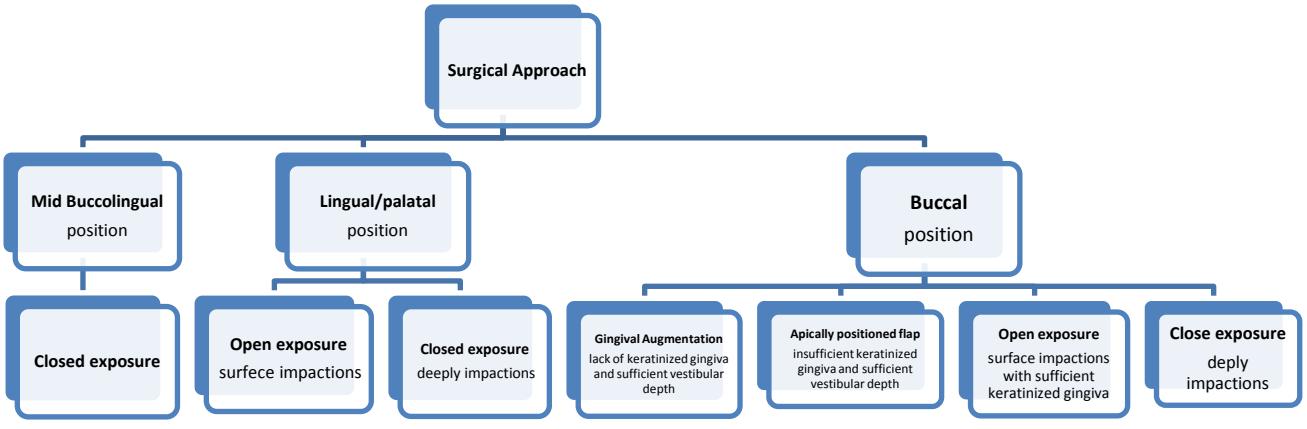


**Figure 1. Diagram for reatment options in impacted teeth.**

the closed method. There is considerable debate on the issue of the choice of surgical technique. The anatomical structure of the soft tissue that covers the impacted tooth is one major factor that determines the choice of a surgical exposure method. The surgical–orthodontic treatment should simulate the natural eruption pattern of the impacted tooth through the attached gingival tissue. All the palatal gingiva is attached; therefore, both closed and open surgical methods are appropriate. Also, some authors modify open exposure by using a modified window.[39] Other advantages of the surgical techniques have been discussed, comparing the operating time and the extent of the surgical procedure,[40] namely patient comfort after surgery,[41,42] need for repeated surgery,[40,43,44] time of the eruption/extrusion of the impacted tooth, overall treatment time,[40,45,46] success of treatment,[43] relapse and postoperative periodontal outcomes.[47-56]

An alternative technique has been introduced by Kokich and Mathews, which recommends earlier uncovering of palatally impacted canines. They recommend uncovering of palatally impacted canines before starting orthodontic treatment[57] or during the late mixed dentition stage in some patients. For this purpose, a full-thickness mucoperiosteal flap is elevated over the impacted canine. Bone covering the crown is completely removed to the level of the cementoenamel junction. The flap is then repositioned followed by creating a hole through the gingival flap. Occasionally, the tooth may be positioned deep in the palate. In these cases, the exposed area in the flap is covered by a dressing. Removal of the bone and gingival tissue triggers spontaneous eruption of the palatally displaced canines.

In addition, wherever attached gingiva is inadequate, soft tissue augmentation with free epithelial graft might be indicated.

### Clinical note: a flow diagram for surgical canine exposure

Decision-making for choosing the best method of surgery for canine exposure depends on impacted tooth position, condition of the overlying gingiva based on keratinized tissue width, and vestibular depth.[58-61] A diagram is suggested for decision-making in this situation (Figure 2):

After deciding on the surgical approach for canine exposure, we should evaluate accessibility of different sides (buccal, palatal/lingual). There are similarities in the buccal approach in the upper and lower jaws. In this step, the most important factors for selecting the surgical technique are the overlying keratinized tissue width and the position of impacted canine. When this width is less than 3 mm, selecting treatment is soft tissue augmentation and then reevaluation for final decision-making about the surgical approach for canine exposure. When the overlying keratinized tissue width is 3–5 mm, vestibular depth determines continuing selections. In this situation when vestibular depth is appropriate, apically positioned flap is the best approach to preserve and increase the overlying keratinized tissue width. However, closed exposure with flap replaced into the initial position is indicated in a shallow vestibule. Fi-

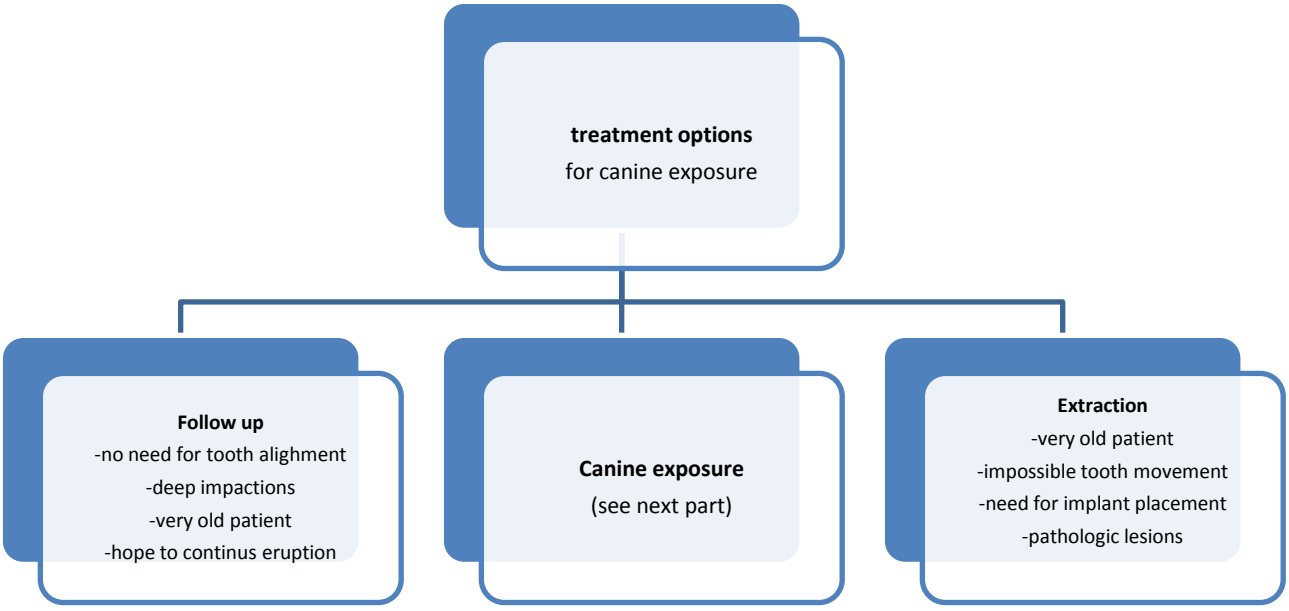


**Figure 2. Suggested protocol for decision-making in impacted canines.**

nally, our approach in more than 5 mm of keratinized tissue width depends on the distance between tooth and the alveolar bone crest. In this situation when the tooth is near the alveolar crest, the flap should be prepared by open exposure and elimination of gingiva overlying the impacted tooth (Figure 3). On the other hand, when the tooth is far from the alveolar crest, closed exposure should be used to avoid secondary intention after surgery and access to the impacted tooth (Figure 4).

In maxillary impacted teeth when the selected approach is palatal, usually sufficient keratinized tissue is available. Therefore, the most important factor is the depth of impaction in the bone. Therefore, it is suggested that for the tooth which is near the soft tissue, open exposure should be used (Figure 5), and for the tooth which is far from the soft tissue closed exposure should be applied to avoid extensive wound after surgery. When the lingual approach has been chosen due to difficulties in apical positioning of flaps and soft tissue augmentation in the mandible, the suggested method is closed exposure. Other explanations come on diagram in Figure 2.

## Postoperative complications

Smailiene et al evaluated postoperative status of palatally impacted maxillary canines treated by applying two different surgical orthodontic methods (open and closed exposure). They did not find any evidence supporting that the postoperative status of the palatally impacted canines and their adjacent teeth depended on the surgical methods.[62] While both techniques are acceptable for the treatment, the choice of the surgical technique and the orthodontic treatment tactics could depend on other features of individual cases, such as the probability of the re-

**Figure 3. Open exposure technique using gingivectomy incision has been indicated due to sufficient amount of keratinized gingiva and unnecessary osseous surgery in a buccally positioned impacted canine in the maxilla.**

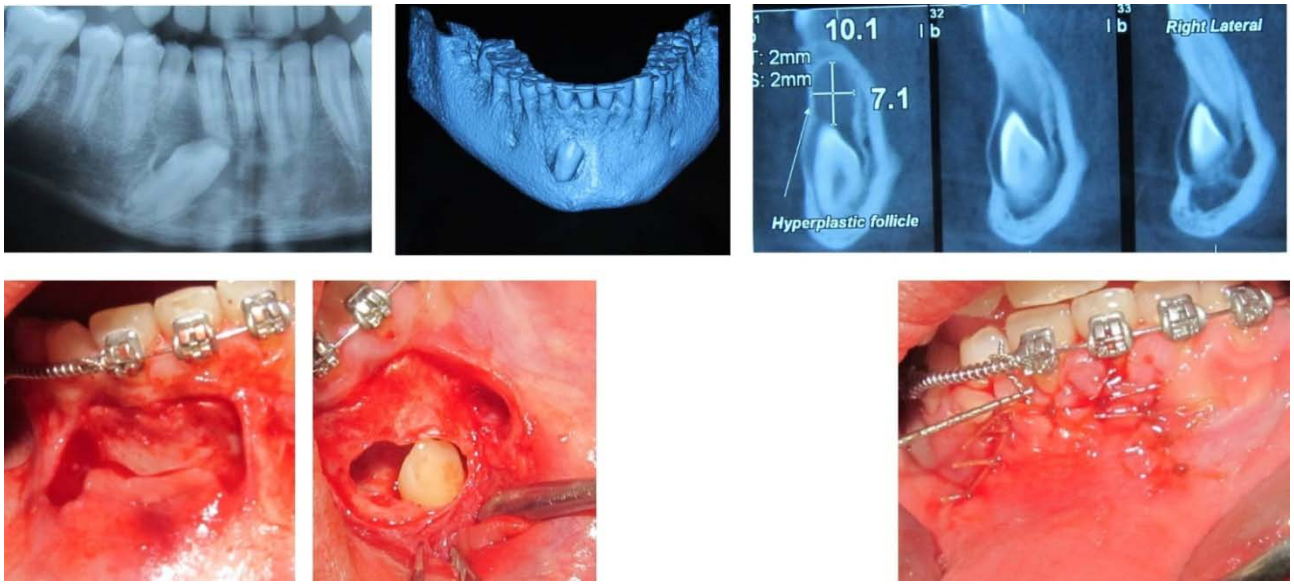


**Figure 4. A deep impacted canine in the mandible exposed through closed approach.**

**Figure 5. Considering the depth of impacted canine in the palate, excisional uncovering was performed with diode laser in order to prevent excessive bleeding during surgery and bracket attachment.**

sorption of adjacent dental roots, the depth of impaction, the proximity of an impacted tooth to the adjacent teeth and patient comfort.[62]

Sajnani et al performed a retrospective study on the complications associated with the occurrence and treatment of impacted maxillary canines.[63] The most commonly occurring postoperative sequela was swelling of the soft tissue, which was persistent even after 48 hours (18.8%).[64,65] In addition, 3% of patients treated with closed eruption technique had severe pain at 3-day postoperative interval. No pain was reported on subsequent days. However, patients treated with the open eruption technique reported severe pain up to seven days postoperatively.[41] Surgical procedures have secondary effects and complications. The intensity of these complications depends on several factors such as the extent of tissue damage.[66] Patients often experience some degrees of pain following surgical procedures. Also, pain after surgical exposure of impacted canines has been reported to be slightly more than pain after surgery of other impacted teeth.[67] However, a significantly lower incidence of pain (1.5%) was reported by patients in a study at 48-hour postoperative interval.[63] Interrupted blood supply to the soft tissue flap during the surgical procedure or postoperative infection might result in unsatisfactory healing.[67] Compromised blood supply is a common occurrence in thin flaps. In these situations, the flap must be carefully elevated and handled to prevent unsatisfactory healing. Complications following surgical exposure of impacted teeth are influenced by the position of impacted canines in the arch. Impacted canines too close to the roots of the adjacent teeth may damage them.[68] Furthermore, during surgical removal, a root may be displaced into the maxillary sinus or nasal cavity.[67] Also, an oroantral or nasoantral fistula can follow surgical removal of an ectopic maxillary canine.[68] However, it should be noted that the afore-mentioned postoperative complications are not common.[67] The nasopalatine nerve may be traumatized in surgical exposure of palatally impacted maxillary canines; however, it rarely becomes problematic for the patient. Failing in attachment bonding is another complication after treatment. The results of the study by Sajnani et al reported a predictable successful outcome with minimal complications following exposure of impacted canines, bonding of an attachment in the closed flap technique and subsequent orthodontic eruption. They reported low frequency of root resorption in teeth adjacent to impacted maxillary canines. Root resorption of adjacent teeth was twice more common in females than males. Postoperative complications were rare in their study and included bleeding from the surgical site, hematoma, postoperative pain, purulent discharge, transient paresthesia, unsatisfactory healing, iatrogenic damage to the adjacent soft tissue, maxillary sinus perforation, subconjuctival hemorrhage and discoloration of the adjacent teeth.[63] Considering all the above, surgical exposure and bonding of an attachment allow orthodontic traction and this method can be used as a reliable treatment with minimal complications.

## Conclusion

Selection of an appropriate surgical technique for canine exposure is important. The level and position of tooth impaction, bone thickness and available keratinized soft tissue are the most important factors in selecting the surgical approach. Higher surgical knowledge and skills and use of current technologies like surgical lasers should be considered in special cases.

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