

Management of the Impacted Canine and Second Molar

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Impacted canine and impacted second molars are problems frequently encountered by oral and maxillofacial surgeons. Success in management along with the development of a satisfactory treatment plan requires a team effort with input from the orthodontist, general dentist, and surgeon. Although the overall prevalence in the population is low, the impacted maxillary canine is second only to the impacted mandibular third molar in its frequency. We find that the population incidence is only between 1.7% and 2.2% [1]. Second molar impaction incidence is even less, at approximately 0.4%. The condition is twice as common in girls (1%–2%) as in boys (0.5%) [2]. Impacted canines are found palatally in 85% of cases, with labial position in 15% of cases. Having both conditions is rare, as seen in Fig. 1. For the purpose of this article, we discuss the management of the impacted canine and second molar.

Impacted maxillary cuspid

Etiology

Calcification of the maxillary canine starts at age 1 and is completed in 5 to 6 years. It remains high in the maxilla above the root of the lateral incisor until the crown is calcified. The maxillary cuspid erupts along the distal aspect of the lateral incisor, which closes the physiologic diastema present between the maxillary central incisors. The maxillary canine travels almost 22 mm during the time of eruption. It first moves in a palatal

direction then buccally. The maxillary canine should erupt before 13.9 years for girls and before 14.6 years for boys [3]. The origin of impaction is unclear but most likely is multifactorial. Because the maxillary canine has the longest path of eruption in the permanent dentition, alteration in position of the central and lateral incisor may be a factor. Arch length discrepancy and space deficiency may result in the canine becoming labially impacted. Studies have shown a higher incidence of palatally impacted canines in cases with missing lateral or peg-shaped incisors. Failure of the primary canine to resorb may cause palatal movement of the permanent canine, although Thilendar and Jakobsson [3] considered failure of resorption of the primary canine to be a consequence rather than a cause of impaction. A genetic predisposition has been shown in some studies. Pirinen and colleagues [4] found that palatally impacted canines are genetic and related to incisor-premolar hypodontia and preshaped lateral incisors.

Other possible causes are trauma to the anterior maxilla at an early age, pathologic lesions, odontomas, supernumerary teeth, and ankylosis. There is also a higher incidence of impacted maxillary canine after alveolar bone grafting in patients who have a cleft [5].

Localization

Localization of the maxillary canine is a key factor in the comprehensive assessment of the impacted canine. The position of the impacted canine is important when deciding management options for patients. Localization requires inspection, palpation, and radiographic evaluation. The

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Fig. 1. Impacted maxillary and mandibular canines with an impacted mandibular second molar.

position of the lateral incisor can give a clue to the canine position. The crown of the lateral root may be proclined if the canine is lying labial to the lateral incisor. Occasionally the impacted canine can be palpated on the labial or palatal aspect. The surgeon can take a series of periapical radiographs along with a panoramic radiograph to locate its position. When taking the series of periapical radiographs, the cone head is shifted horizontally so Clark's Rule can be used to discern the buccal or lingual position of the canine. I find that 45° to 60° anterior occlusal views provide the shifting necessary to localize the position of the canine. Cephalometric radiographs and CT scans are also useful in determining location of the impacted canine, but they are more costly. If you need to extract the over-retained primary canine, the resorption pattern on the root provides a clue to localization of the crown of the impacted cuspid. Sometimes you can feel the crown when giving your infiltration anesthesia on the buccal and palatal mucosa.

Treatment options

After the patient undergoes a clinical and radiographic evaluation, a comprehensive treatment plan can be developed. An informed consent with discussion of treatment options and alternatives is important to avoid misunderstanding or legal problems. Treatment options include (1) no treatment except monitoring, (2) interceptive removal of primary canine, (3) surgical removal of the impacted canine, (4) surgical exposure with orthodontic alignment, and (5) autotransplantation of the canine.

No treatment with periodic radiographic evaluation

No treatment is recommended if the canine is in good position and without contact with the

lateral incisor and first premolar. If there is no evidence of pathology or root resorption of the adjacent teeth or the patient refuses treatment, the patient can be monitored periodically. If the impacted canine is severely displaced and remote from the anterior teeth and is difficult to remove or expose, a decision can be made to monitor the patient radiographically. Ferguson and Pitt [6] surveyed all the UK consultant orthodontists to assess their opinion on management of the impacted maxillary canine in patients for whom no orthodontic treatment is planned. They found that most orthodontists were in favor of removal of the impacted canine, with a significant minority suggesting the conservative approach of radiographic monitoring.

Interceptive removal of primary canine

Extraction of the primary canine is recommended if the patient is between 10 and 13 years, the maxillary canine is not palpable, and localization confirms a palatal position (Fig. 2). If the canine position does not improve over a 12-month period, alternative treatment is indicated. Radiographic evaluation should be at 6-month intervals. Figs. 3 and 4 shows a case in which the primary canine was removed and it erupted within 6 months.

Surgical removal and prosthetic replacement

Surgical extraction of the impacted canine is indicated when there is poor position for orthodontic alignment, there is early evidence of resorption of adjacent teeth, the patient is too old for exposure, and the degree of displacement does



Fig. 2. Extraction of primary canine to facilitate eruption of impacted canine.



Fig. 3. Extraction of primary canine.

not allow for surgical reposition or transplantation. The treatment of choice for replacement of the canine is a dental implant. Sometimes orthodontic treatment is needed to provide enough space for implant placement.

Flap design. Flap design is dictated by the location of the impacted canine. If the impacted canine is located buccally, a gingival crest incision can be made in the gingival sulcus. If the impacted canine is high, the incision can be made horizontally above the papillae. Vestibular incisions made at the level of the mucogingival junction should be made only when the impacted canine is above the root apices. If the impacted canine is palatal, a palatal incision placed in the gingival sulcus can be performed. Palatal incisions placed between the gingival crest and palatal vault should be avoided, because trauma to the greater palatine artery could occur. Occasionally, the impacted canine can be positioned transversely in the alveolus,



Fig. 4. Normal eruption of canine after primary canine extraction.

which would require mucoperiosteal flaps on the palatal and labial sides.

Surgical removal. Bone generally is removed using a #8 round bur with copious amounts of irrigation. A 301 straight elevator is used to achieve movement of the tooth. Usually sectioning of the crown from the root is required for removal. Then the remaining portion of the root can be removed. If an implant is planned, a bone graft in the extraction site for ridge preservation is recommended.

Surgical exposure

Surgical exposure is the conventional treatment for impacted canines. There are three methods used for surgical exposure and orthodontic alignment [7]: (1) open surgical exposure, (2) surgical exposure with packing and delayed bonding of the orthodontic bracket, and (3) surgical exposure and bonding of orthodontic bracket intraoperatively. If the canine has correct inclination, the open surgical exposure is the treatment of choice. Excision of the gingiva over the canine with bone removal is sufficient to allow eruption of the canine [8].

If surgical exposure with orthodontic alignment has been chosen as the method of treatment, three surgical approaches can be used. The replacement flap technique replaces the mucoperiosteal flap over the exposed canine after the bracket and chain are applied. A disadvantage of this technique is that bonding can fail and re-exposure is necessary. The excisional exposure removes the mucosa overlying the crown of the impacted canine. The apically repositioned flap is used to preserve the attached gingiva (Fig. 5). Vermette and colleagues [9] found that apically repositioned flaps resulted in more aesthetic



Fig. 5. Apically repositioned flap.

problems than the replacement flap technique. The goal is to choose a technique that exposes the canine within a zone of keratinized mucosa without involvement of the cemento-enamel junction. This approach minimizes potential periodontal complications after orthodontic alignment.

If the inclination of the canine to the midline is more than 45° then the prognosis for alignment worsens. The closer the impacted canine is to the midline the worse the prognosis.

Application of orthodontic traction devices. Many different devices can be applied to the crown of an impacted canine, including a wire, pins, crown formers, and orthodontic brackets. Wires placed around the crowns of an impacted canine can injure the root of the tooth. Screwing pins into the enamel of the canine can damage the crown of the tooth. Crown formers placed or cemented over the crown of the impacted tooth were popular for many years; however, they acted as a foreign body and caused inflammation and eruption. The device of choice is an orthodontic bracket or gold mesh disk with a gold chain bonded onto the canine crown surface (Fig. 6).

Two types of bonding agents can be used. One is a two-part, self-cure bonding agent and the other is a light cure bonding agent. The advantage of the light cure materials is that most can work in a partially wet field (Fig. 7). The gold mesh disks also work better than the orthodontic brackets or buttons with the light cure bonding agent because the curing light can get at all the bonding agent through the mesh. It cannot cure the bonding agent under the bracket.

The tooth surface must be acid etched for 30 seconds and then irrigated. Success improves with hemostasis. Once hemostasis is achieved, the



Fig. 6. Gold mesh disk with gold chain.



Fig. 7. Light cure bonding material used in partially wet field.

primer can be placed on the tooth. The bonding agent is placed on the bracket and pressed firmly against the enamel surface of the tooth. If it is a light cure material, it should be light cured for 20 to 40 seconds (Fig. 8). The chain that is attached to the bracket is then ligated to the patient's arch wire (Fig. 9). The orthodontist should activate the appliance within a week. The vector of force used to move the canine can be changed to move the canine away from the incisor roots and then move it vertically and buccally.

Autotransplantation of the canine

Selected maxillary impacted canines can be autotransplanted. This technique may be recommended when the degree of malposition is too great to make successful orthodontic alignment or interceptive measures have failed. This procedure surgically is more difficult than orthodontic repositioning. Moss [10] found that in adults the success of autotransplantation of the impacted canine is poor. Canine transplantation should be

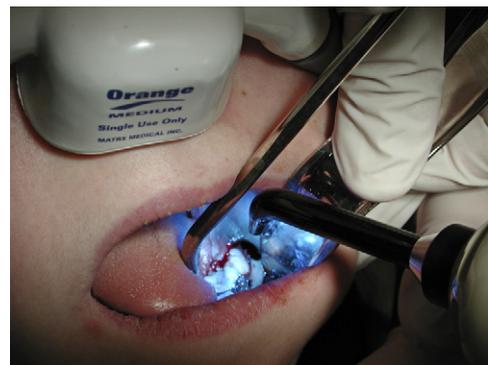


Fig. 8. Light cure for 20 to 30 seconds.



Fig. 9. Brackets ligated to arch wire.

planned as early as possible when the root is 50% to 75% formed. The transplanted tooth must be held in place for 2 to 3 months with an orthodontic appliance. If endodontic treatment is necessary, it should be performed when the immobilization device is removed.

Impacted mandibular canines

The mandibular canine is ten times less frequently impacted than the maxillary canine (Figs.10 and 11). The mandibular cuspid has the largest root of all the teeth. The mandibular canine follicle forms at the level of the inferior border of the mandible. Because the body of the mandible is labial to the alveolus, it may explain the fact that most impacted mandibular canines are labially impacted. Similar to maxillary canines, mandibular canines are three times more common in female patients than male patients.

A treatment plan can be developed once the impacted mandibular canine is localized and assessment of potential damage to adjacent teeth and involvement of the mental nerve is made. Localization is achieved in the same manner as impacted maxillary canines.

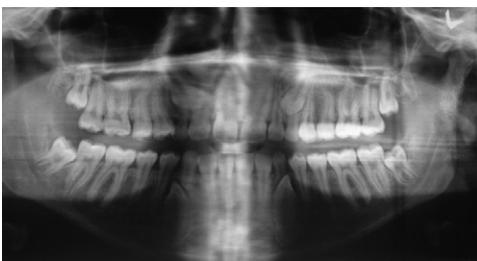


Fig. 10. Impacted mandibular canines (pretreatment).



Fig. 11. Mandibular canines in occlusion after 6 months of treatment.

Impacted mandibular canines are usually vertically impacted close to the labial surface. Occasionally, they can be located beneath the apices of the mandibular incisor. They are rarely found in a horizontal position.

Management of impacted mandibular canines includes the following treatment options:

- No treatment with clinical and radiographic observation
- Surgical extraction
- Surgical exposure to aid eruption
- Surgical exposure with orthodontic guidance
- Transplantation

No treatment, only observation

If the impacted mandibular canine is below the apices of the teeth and without pathology, it can be observed periodically.

Surgical extraction

If the impacted mandibular canine is not in an upright position, extraction should be considered. Surgical extraction is accomplished by using a labial or lingual mucoperiosteal flap with possible releasing incisions. The removal of bone over the crown is achieved with a round bur. The tooth can be luxated and removed with an elevator. If this approach is unsuccessful, the crown is sectioned and the crown and root are removed. If the mandibular canine is lingual, the extraction is more difficult because of poor access.

Surgical exposure to aid eruption

If the mandibular canine impaction is caused by an overlying impediment, the impediment can be removed surgically. Then a bony pathway for eruption can be created.

Surgical exposure with orthodontic guidance

Four types of incisions can be used for exposing the impacted mandibular canine [11]: (1) the labial gingival crevice incision, (2) alternative labial gingival crevice incision, (3) free mucosal incision, and (4) lingual gingival crevice incision. The labial gingival crevice incision is an incision in the gingival sulcus from the right first premolar to the left first premolar that preserves the interdental papilla. A vertical releasing incision can be used if additional access is required. The alternative labial gingival crevice incision is a horizontal incision made at the base of the interdental papilla. Closure of the incision is more difficult. A vertical releasing incision also can be used if more access is required. The free mucosal incision is used when the impacted mandibular canine is located at the level of the apices of the incisors or lingual to them. The incision is placed a few millimeters away from the mucogingival junction in the nonkeratinized mucosa horizontally. The incision should remain anterior to the mental foramen to avoid the mental neurovascular bundle.

If the impacted maxillary canine is lingual to the incisors, the lingual gingival crevice incision should be used. The incision is made in the lingual gingival sulcus from the mandibular right first premolar to the mandibular left first premolar. The incision should be extended to provide adequate access. Releasing incisions should not be used. If the linguallly impacted mandibular canine is below the level of the apices of the incisors, an extraoral approach may be necessary.

Transplantation

Transplantation of the mandibular canine can be successful if the apex of its root has not closed. The canine can be transplanted to its correct position in the dental arch or even to a different site. The difficulty is in removing the tooth without damaging the root surface or apical end. The canine must be firmly immobilized for at least 2 months. The endodontic procedure can be performed on this tooth after immobilization.

Complications and side effects

Complications and side effects with the treatment of the impacted maxillary and mandibular canine are as follows:

Ecchymosis of the upper lip or lower lip and chin

Infection
Paresthesia
Damage to adjacent structures
Noneruption
Loss of soft tissue flap/dehiscence
Lack of attached gingiva
Devitalization of the pulp
Pain

Ecchymosis of the upper or lower lip and chin

An ecchymotic area can occur in the soft tissue if proper hemostasis is not achieved before closure. It also can occur if the patient is on aspirin or herbal medications that increase bleeding time.

Infection

Any surgical wound can develop an infection even with the best aseptic technique. With maxillary impacted canines, infections can develop in the lip, canine space, or palate. With the mandibular impacted canine, infections can develop in the lip, submental space, and sublingual space. Treatment consists of antibiotics and incision and drainage.

Paresthesia

When the mandibular impacted canine's location is near the neurovascular bundle, paresthesia may be a sequela of surgery. If the maxillary canine is impacted palatally, the nasopalatine nerve may be affected, although it rarely presents a problem for the patient. If the mandibular canine is located near the mental foramen, the patient may have a paresthesia of the lower lip and chin. Surgery performed midsymphysis may produce altered sensation in the incisors and gingiva.

Damage to adjacent structures

If the impacted canines are near the roots of neighboring teeth, the surgery could damage the impacted tooth or adjacent teeth. Displacement of a root into the maxillary sinus or nasal cavity can occur during surgical removal. Rarely, an oral antral or oral nasal fistula can follow surgical removal in the maxilla.

Noneruption

When eruption does not occur, the treatment plan should be reviewed. The most common causes of noneruption are ankylosis, inadequate interdental space, and gingival scarring.

Loss of soft tissue flap

Loss of the soft tissue flap is the result of interruption of its blood supply or infection. Flaps that are thin may have compromised blood supply. Allowing the acid etch material to come into contact with the tissues can compromise the vitality of the flap.

Lack of attached gingiva

Poor quality gingival mucosa may occur with exposure of labially impacted maxillary canine. The flap technique must preserve keratinized tissue. A connective tissue graft can be placed to correct this problem.

Devitalization of the pulp

If symptoms of pulpitis develop when the impacted canine is being orthodontically moved, the orthodontic therapy should be stopped and the canine should be evaluated for possible endodontic treatment. If adjacent teeth develop symptoms of pulpitis, endodontic therapy should be considered. This complication is rare in young individuals.

Pain

Patients experience some pain with any surgical procedure; however, there is slightly more postoperative pain from maxillary impacted canine surgery than surgery of other impacted teeth. Postoperative management during the first 24 hours should include nonsteroidal anti-inflammatory drugs and long-acting local anesthesia. Narcotic agents occasionally are necessary to relieve postoperative pain.

Impacted second molars

The impaction of the second molar is a rare complication in tooth eruption. The incidence is approximately 0.03% to as high as 3%, depending on the study. It usually occurs unilaterally more commonly than bilaterally and occurs slightly more often in men. It is more common in the mandible than maxilla. The management of impacted second molars has been a challenge for orthodontists and oral and maxillofacial surgeons. The impacted second molar is usually recognized when orthodontic treatment is complete and the roots are fully formed. Proper alignment of the second molar into the dental

arch in an angle Class I position is an integral part of completing orthodontic therapy.

Management of impacted second molars requires a team approach with the orthodontist, oral and maxillofacial surgeon, and general dentist.

Etiology

There are multiple causes for impacted second molars. When the deciduous second molar is lost, the first permanent molar must move forward to accommodate the eruption of the second molar. If this does not occur, the eruption of the second molar is compromised, which can lead to tipping. If the developing third molar infringes in the space required for the second molar to erupt, mesial tipping occurs. Ill-fitting first molar bands are an iatrogenic cause of the mesial impacted second molar.

Localization

A panoramic radiograph is optimal to evaluate the position of the impacted second molar. Periapical radiographs are also useful, especially using Clark's Rule, because it tells you if the clinical crown is tilted buccally or lingually.

Treatment options

The degree of impaction and location of the second molar determine if a surgical, orthodontic, or combined approach is used. Impacted second molars must be treated. Not treating this condition and simply observing is not an option. Lack of treatment causes periodontal disease with bone loss and decay of the first and second molars. The following treatment options can be used to treat the impacted second molar.

Surgical extraction of the impacted second molar

Surgical extraction of the impacted third molar and surgical uprighting of the second molar
Transplantation of the third molar into the impacted second molar site

Extraction of the impacted second and third molar and placement of a dental implant

Surgical extraction of the impacted second molar

One treatment option involves extracting the impacted second molar and allowing the third molar to migrate forward into the second molar position. The eruption of third molar is not

predictable. Often, the third molar only migrates anteriorly slightly and then tips into the second molar space, which predisposes the second molar to periodontal problems because of its malposition. Second molar extraction is contraindicated when the third molars are smaller or poorly formed, are in a horizontal position, are in the maxillary sinus, or have a severe space deficiency. It is important to make patients aware that the eruption of the third molar is not predictable and the third molar may need extraction.

Surgical uprighting of the second molar with extraction of third molar

Usually the decision to upright the impacted second molar is made by the orthodontist. The patient is referred to an oral and maxillofacial surgeon to discuss this combined orthodontic and surgical approach. This treatment plan may not be successful if the second molar root has two-thirds root formation.

After appropriate local anesthetic blocks, an incision is made along the cervical areas of the first molar along the external oblique ridge. A full-thickness mucoperiosteal flap is elevated. A round bur is used to expose the crown of the impacted second molar and third molar. It is important to avoid exposing the cemento-enamel junction and root surface, which increases the chance of periodontal defects and external resorption. The third molar is sectioned and elevated from its bone socket. Using a 301 elevator, the second molar is gently elevated. If the second molar can be elevated into proper position, then an orthodontic appliance is not required. Sometimes stabilizing the uprighted second molar can be a problem. If it is unable to self-stabilize in the surrounding bone, an orthodontic bonding material is used to bond the second molar to the first molar (Figs. 12 and 13). This procedure is not required with maxillary



Fig. 12. Impacted second molar.



Fig. 13. Impacted second molar surgically uprighted with removal of third molar.

impacted second molars. Luxation of the tooth stimulates eruption. In Fig. 14, the second molar was exposed and luxated. Within 6 months, the tooth erupted. After eruption, the third molar was removed (Fig. 15).

Often an orthodontic appliance must be placed to upright the second molar. Going and Rayes-Lois [12] reported on a technique in which the second molar is bracketed with a band that contains a buccal tube. A heavy gauge nickel titanium arch wire is threaded through the tube. The arch wire is ligated to the two premolars and canine and helps to upright the second molar. Other appliances can be used. For example, segmental springs and nickel titanium coil springs have been successful in uprighting second molars [13,14]. With the advent of endosteal implants, microimplants that can be placed in the alveolar bone have been developed. They are used as an anchorage device. A 2-week healing period is necessary before elastics are placed. This method is used especially when trying to upright lingually tipped lower second molars and buccally tipped upper second molars [15]. Brass wire also can be used as



Fig. 14. Impacted maxillary second molar.



Fig. 15. Impacted second molar erupts into position after luxation.

a separator when placed below and above the contact point between the first molar and impacted second molar. The wire can be tightened incrementally to upright the second molar. This technique is used infrequently because it causes pain, swelling, and future periodontal problems.

Transplantation of the third molar into the second molar position

This treatment plan can be performed if the third molar has two-thirds root development. The impacted second molar must be extracted, and then the third molar is extracted as atraumatically as possible. The third molar is wedged within the second molar socket. If the tooth is not stabilized between the buccal and lingual cortices, bonding material should be placed to keep it in its proper position without mobility. Transplantation is only possible in select cases. Once firm mobilization has occurred, endodontics must be performed.

Extraction of the impacted second and third molars with dental implants

If the age of the patient and the stage of root development are limiting factors, one should consider extracting the impacted second and third molars as an option. This treatment plan should be considered with older patients who have complete root formation (Fig. 16). With the excellent success rates of dental implants, replacing the second molar with dental implants is a predictable option.

Risk factors and complications

As with any surgical procedure, complications are possible, and they should be discussed with the patient before surgery [16]. Risk factors and



Fig. 16. Impacted maxillary second molar fully developed.

complications include (1) loss of teeth, (2) root injury, (3) external resorption, and (4) periodontal defects.

Loss of teeth

Loss of the first, second, and third molars is possible if treatment is not performed. These teeth are usually lost to decay and acute periodontal disease.

Root injury

Uprighting a second molar can cause root injury and loss of vitality. If the second molar roots are fully formed there is a greater chance of root fracture or injury. Treating the impacted second molar when the roots are two-thirds developed prevents this complication.

External resorption

If the cemento-enamel junction or root surface is exposed or damaged when surgically exposing the second molar, external resorption is possible. Care should be taken to stay above the cemento-enamel junction and not expose the root surface.

Periodontal defects

When the second molar is surgically uprighted, a bone defect remains distal to the first molar. If bone fill is absent in that area, a periodontal defect develops, which gives the second molar a poor prognosis. Treating the periodontal defect with guided tissue regeneration techniques—using a bone graft and barrier—is an option.

Summary

Management of impacted canine and second molars can be difficult but rewarding. Treatment planning in these cases should be multidisciplinary. The decision to correct these impacted teeth surgically usually is made by orthodontists. Patients then seek consultation with an oral and maxillofacial surgeon concerning the treatment plan.

Usually the risk-to-benefit ratio favors the preservation of the impacted canine and second molar. Generally the recommendation is surgical exposure of the impacted canine with orthodontic alignment into the arch. It is also recommended to upright the second molar and remove the impacted third molar. Close follow-up by the orthodontist and surgeon is important to the success of these procedures. Preserving these teeth is an important orthodontic standard of care. It is important that treatment be based on an appropriate diagnosis and consultation with the orthodontist.

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