

# Palatally impacted canine: diagnosis and treatment options

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## Abstract

Canines contribute significantly to the esthetic and chewing functions. Orthodontists should diagnose canine ectopic eruption early, trying to prevent retention of these teeth. Its multifactorial etiology involves general and local factors and the correct diagnosis depends on clinic, radiographic and/or tomographic exams. Several therapeutic procedures depend on factors such as relationship between canine and adjacent structures, possibility of orthodontic movement and patient age. Orthodontic and surgical treatment with canine traction is very much effective, with time of treatment being shorter than in patients under the age of 25.

**Keywords:** impacted canine, diagnosis, treatment.

## Introduction

Dental impaction is a condition in which tooth cannot erupt because it may be retained by either adjacent bone or tooth. Following the third molars, upper canines are among the most frequently impacted teeth, with prevalence ranging from 1% to 3%. Therefore, impacted canines are defined as being those teeth not erupted within 6 months of their complete root formation or when they are not present in the arch during the eruption phase<sup>1</sup>.

Impacted upper canines are found in approximately 2.0% of the general population, occurring more than twice as frequently in women (1.17%) as in men (0.51)<sup>2-4</sup> and moving more palatally (60-80%) than unilaterally (75-95%)<sup>2</sup>.

Impacted teeth are particularly more difficult to treat in adults. Success rate among patients older than 30 years was 41%, whereas patients aged 20-30 years old achieved 100% success<sup>4</sup>. Prognosis depends on the canine position in relation to adjacent teeth and its alveolar height. However, it should be considered the possibility that they cannot be orthodontically moved, thus requiring extraction, rehabilitation with prosthesis or implant, or space closing with orthodontic appliance<sup>5</sup>.

Previous planning based on reliable risk estimates, length of orthodontic treatment, and success probability can be useful in the decision-making process for patients. An adequate diagnosis should be supported by clinical and complementary examinations for evaluating the sites of impacted canines and their relationship with adjacent teeth and anatomical structures (nasal fossae and maxillary sinus)<sup>4</sup>.

Few studies have focused on traction period and related factors. It is supposed that such a period is shorter in younger than in older patients. This literature review aimed at addressing diagnostic means and therapeutic procedures with emphasis on traction duration of palatally impacted canine.

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This study was approved by the local Research Ethics Committee under the protocol (CAAE number: 0028.0.045.000-10). Studies selected for literature review were retrieved from Medline database (National Library of Medicine, USA, Entrez Pub Med, [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov)), Ovid, Cochrane ([www.cochrane.org](http://www.cochrane.org)), Lilacs, Web of Science, Google Scholar Beta, Embase, Extenza, Evidence-Based Medicine, and BBO (Brazilian Dentistry Library), within the 1992-2009 period. Only clinical case reports and controlled human clinical studies were addressed, including a book chapter on topics discussed in the present literature review.

## Etiology

Upper canine has the longest period of development at the top portion of the canine fossae, being the most difficult eruption trajectory among all teeth. They usually emerge in the dental arch between the ages of 11 and 12 years old<sup>4</sup>, and due to their complex eruption trajectory they become more susceptible to factors that can interfere with such a process<sup>1</sup>.

Its impaction can be the result of sequelae from endocrine anomalies, fever, vitamin deficiency, and irradiation<sup>5</sup>. However, local etiologic factors may also be involved, such as, discrepancy between dental arch length and tooth size, prolonged retention or early loss of primary canine, abnormal position of the tooth germ, ankylosis, cystic, neoplastic formation, root dilaceration, presence of alveolar fissure and traumatic factors<sup>1</sup>.

Studies have shown that there is no significant relationship between lack of arch space and palatally impacted canine<sup>6</sup>. In general, palatal displacement occurs regardless of dental arch space. Other factors may be involved such as excessive growth in the base of maxillary bone, agenesis or cone-shaped lateral incisors, thus making root orientation difficult or even impossible during the initial eruption phases<sup>7</sup>.

Becker and Chaushu<sup>8</sup> have found that delayed dental development was present in at least half of the patients with palatally impacted canines, but with no impairment of eruption orientation. They also suggested that palatal impaction may be preponderantly related to genetic factors or familial inheritance pattern<sup>1,6-8</sup>.

## Diagnosis

The diagnosis of palatally impacted canine consists in evaluating its relationship with the adjacent teeth. It is necessary an association between clinical (i.e. inspection and palpation) and radiographic examinations. It is important to correlate the patient's age to a chronological sequence of tooth eruptions and also investigate about the family history of agenesis or prolonged retention of primary teeth<sup>3</sup>.

Some events may indicate the presence of impaction during the clinical examination, such as delayed eruption of one or more canines following the age of 14 years, insufficient

amount of arch space for permanent canine, and prolonged retention of primary teeth associated with palatal elevation of soft tissue (Figure 1)<sup>6-7</sup>.

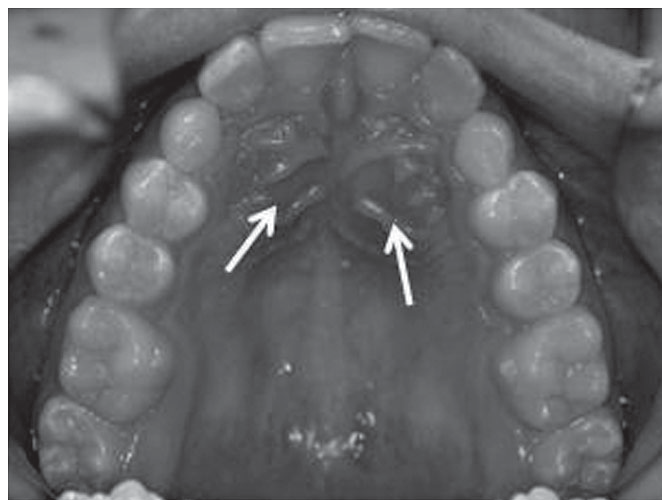


Fig. 1: Occlusal photograph with impacted canines.

In general, the palatally impacted permanent canine exerts a buccal pressure on the lateral incisor root, displacing the crown palatally. There is also a horizontal orientation in close relationship to nasal fossa and their crowns, thus increasing the contact with central or lateral incisors. Palatal depth and curvature provide a false radiographic image of these teeth, showing them closer to the bone surface<sup>9</sup>.

Mobility of the primary canine can indicate normal root resorption by the permanent successor. However, mobility of the permanent lateral incisor can be the result of root resorption caused by the pressure exerted by the impacted canine<sup>10</sup>.

Annual clinical examination of the alveolar process by palpating the alveolar process where the permanent canine will erupt is necessary starting from the age of 8 years old<sup>10</sup>. Palpation is possible in 70% of the cases<sup>3</sup>.

Absence of elevation of gingival mucosa at early age should not be indicative of impaction. In case of deviation of the normal eruption patterns at the ages from 10 to 12 years old, clinical evaluation should be associated with radiographic examinations<sup>10</sup>.

In most cases, periapical radiographs are sufficient to evaluate the canine position, based on the Clark's rule (mesial or distal displacement of the x-ray cone) (Figure 2)<sup>11-12</sup>. Occlusal films also help to determine whether canine is



Fig. 2: Clark's rule to evaluate canine position.

buccally or palatally located as well as to identify the transverse position of its long axis (Figure 3)<sup>11</sup>.

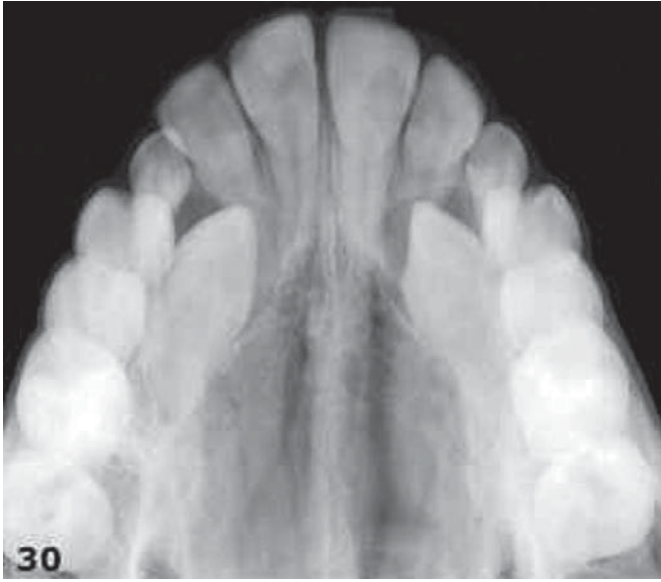


Fig. 3: Occlusal film to identify canine position.

Panoramic radiography is used to determine the position of non-erupted canines in two spatial planes, besides offering a satisfactory indication of canine height, its relationship with median sagittal plane, and information on its inclination. However, no diagnostic indication of buccal-palatal position is given (Figure 4)<sup>3</sup>.



Fig. 4: Panoramic radiograph with bilateral impacted canines.

When the cusp tip of the canines is mesially positioned, along the axis of the erupted lateral incisor, palatal retention of these teeth occurs. If the cusp tip overlaps in the mid-distal root of the lateral incisor, palatal retention can occur as well. However, when the cusp tip is distally positioned in relation to lateral incisor (i.e., with no overlap), the great majority of canines will erupt normally in the dental arch<sup>1</sup>.

Lateral and frontal cephalometric teleradiographs (Figure 5) help to identify the long canine axis in relation to the palatal plane as well as incisors in the antero-posterior sense and the vertical inclination of its crown. In addition, facial structures surrounding the canine, such as maxillary sinus and floor of the nasal cavity, are also related<sup>11</sup>.

Computed tomography (CT) not only accurately determines the position of impacted canine and its relationship with adjacent structures in the three planes, but also defines the real extension of possible resorption,

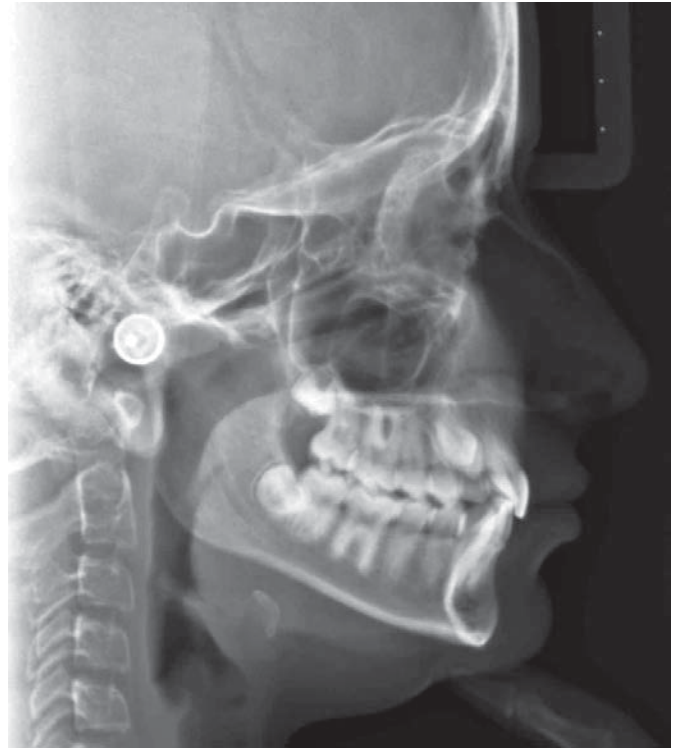


Fig. 5: Lateral cephalometric teleradiograph with impacted canines.

occurrence of ankylosis, and dilacerations<sup>12</sup>. This is possible because CT eliminates any superposition of other structures obscuring the image visualized in traditional radiography (Figures 6, 7)<sup>13</sup>. This method is widely used to identify its exact position, mainly when root resorption of lateral canine is suspected<sup>14</sup>.

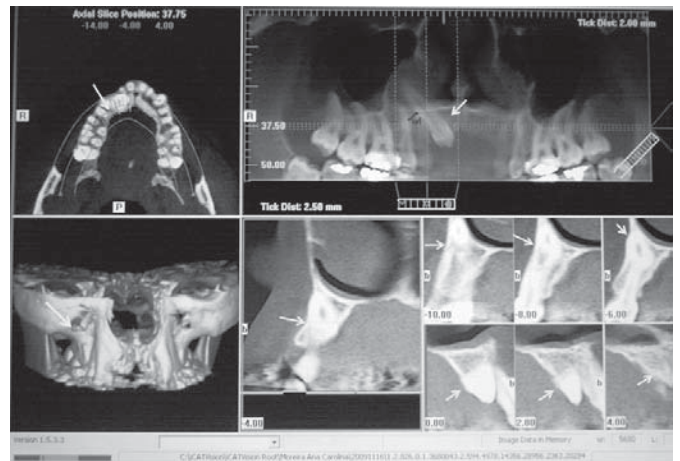


Fig. 6: Maxillary computed tomography image.

## Prevention of dental impaction

Selective extractions of primary canines have been suggested for normalization of its eruption trajectory<sup>13</sup>. Ericsson and Kuroi *apud* Bishara<sup>14</sup> have suggested that removal of primary canine before the age of 11 years old can normalize the position of ectopic permanent canines in 91% of the cases if the crown is located distally to midline of lateral incisor. However, the success rate will be



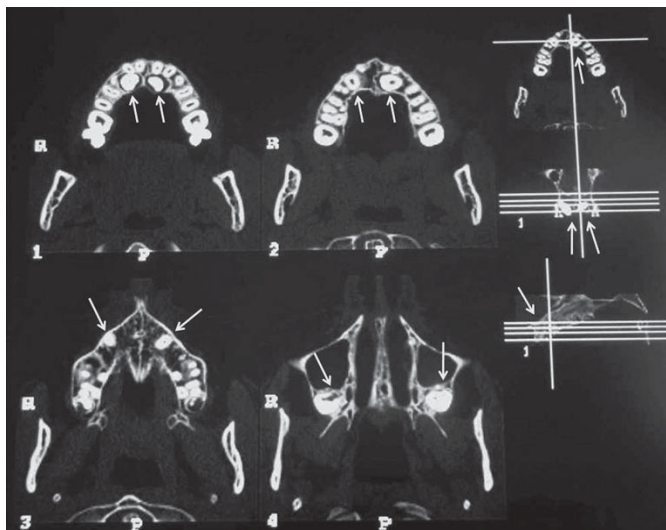


Fig. 7: Maxillary computed tomography image on transversal slice.

significantly reduced if canine's crown is mesial to midline of the lateral incisor, and angulation of the long canine axis exceeds  $31^\circ$  in relation to the mid-sagittal plane<sup>12</sup>.

This type of preventive intervention, however, is contraindicated in cases of very horizontal eruption trajectory, apical movement of permanent canine or evidence of root resorption of permanent incisor<sup>3</sup>.

## Risks of dental traction

The possibility of palatal traction depends on the position of the retained tooth in relation to adjacent teeth, angulation of its long axis, height of alveolar ridge, presence of ankylosis or dilaceration, presence of enough space arch, and correlation between chronological age and dental eruption sequence<sup>13</sup>.

Orthodontic traction involves risks such as ankylosis, discoloration, loss of vitality, and root resorption of retained tooth and adjacent teeth, gingival regression, and loss of keratinized mucosa<sup>2</sup>.

## Therapeutic procedures for palatally impacted canines

Several treatment options can be considered such as: radiographic follow-up of the impacted tooth should be performed as any pathological change may result; canine auto-transplantation; extraction of impacted canine and movement of premolar towards the space left; extraction of canine and osteotomy for moving posterior segment in order to close the residual space; reestablishment of occlusion with prosthesis, and finally, the most recommended option, surgical exposure with orthodontic treatment for moving the tooth to occlusal line<sup>14-15</sup>.

Before surgical exposure, orthodontic treatment should be performed to obtain enough space in the dental arch for accommodation of permanent tooth. Also, teeth should be leveled and aligned until a rectangular stainless steel wire can be placed in order to avoid the adverse effects of traction,

such as intrusion of adjacent teeth, constriction of dental arch, or change on occlusal plane, all impairing the movement control<sup>4</sup>.

There are various surgical methods, but the most recommended ones are the traditional surgical exposure allowing natural eruption and the surgical exposure with attachment of an orthodontic accessory on to the impacted canine's crown for traction<sup>1,16</sup>.

In those cases of surgical exposure with spontaneous eruption, incision in the tissue covering the impacted tooth should be made in such a way that part of the crown remains exposed.

Canine will erupt spontaneously towards where enough space exists, a phenomenon attributed to the force of periodontal tissues which will guide the exposed crown towards the area where the tissues were sectioned<sup>3</sup>.

Levis *apud* Bishara<sup>14</sup> proposed other technique, which is performed in two steps. Firstly, the canine is surgically exposed and then protected with surgical cement. After healing and cement removal, the orthodontic accessory is bonded to the non-erupted tooth. The crown bone of the impacted tooth has to be minimally removed, allowing the tip of the crown to be exposed. Otherwise, the tooth will not be able to reabsorb the bone efficiently during crown movement, since crown enamel will be in contact with bone and therefore no cells will exist within the enamel to reabsorb it<sup>15</sup>.

Palatally ectopic canines which have been surgically exposed and aligned orthodontically exhibit clinically insignificant reduction in periodontal support compared to contra-lateral canine. The current literature shows no study proving that closed-eruption surgical technique has some advantage on the open-eruption technique at long-term regarding periodontal health. In fact, there is scientific evidence that the amount of bone removal and type of orthodontic movement needed to align the canines can be more important than the variables influencing the periodontal health<sup>17</sup>.

## Methods of attachment

For many years the "loop technique" was used, which consisted in placing a ligature wire around the neck of the impacted tooth during surgical exposure. This procedure required very extensive bone removal, which resulted in many cases of ankylosis and external tooth resorption caused by the mechanical trauma exerted on the periodontal cells<sup>2,18</sup>.

The method of transfixation was widely used despite using incisal perforations of the crowns of the teeth to be submitted to traction by ligature wires. Due to the possibility of pulp injuries and dental destruction during access procedures as well as to the difficulty in keeping the surgical site dry for bonding the orthodontic accessory, this method has no longer been recommended<sup>3,18</sup>.

With the emergence of acid attack and adhesive systems, the technique of directly bonding the orthodontic accessory (bracket, button, mesh) to the retained tooth's enamel is now being employed. Osteotomy is enough only for exposing portion of the enamel for bonding procedure, thus allowing

determined local to be chosen according to the movement and direction desired by the orthodontist. As the more horizontal the impacted canine is, the more incisal the accessory should be bonded in order to promote its verticalisation<sup>1</sup>. Ligature wire or elastomeric ligature may be attached around the orthodontic accessory before the flap is repositioned and sutured, thus exposing part of the wire or ligature for immediate traction<sup>3</sup>.

### Ideal system of forces

Palatally impacted canines need to follow a buccal trajectory to obtain adequate positioning in the dental arch. Application of traction force promotes, consequently, an intrusive force on and anterior inclination of the posterior segment, thus keeping the system in equilibrium. On the transverse plane, canine tends to erupt palatally, with posterior teeth shifting buccally. After eruption, the tooth should be orthodontically moved in the buccal direction so that it becomes aligned with other teeth in the arch. The force applied buccally to canine generates a lingual force to the molar, which in turn undergoes a mesio-palatal rotation. This explains, therefore, the use of a posterior rigid wire segment during traction in association with transpalatal bar (Figures 8, 9) in order to avoid undesirable movements in the posterior segment of the dental arch<sup>11</sup>. Bishara<sup>18</sup> recommends that traction force should not be greater than 60 gf.



Fig. 8: Lateral photograph of cantilever activation.

### Traction Systems

The "Ballista spring" is a system in which the impacted tooth undergoes continuous traction force released by a spring made of 0.14", 0.16" or 0.18" round stainless wires.

The tip of this spring being inserted into the molar tube should be attached to it by using a 0.25-mm ligature wire, thus avoiding rotation of the tube. The tip of the spring will be occlusally rigid and once placed next to the impacted canine, in association with the ligature wire, will exert a force linking the device to the tube. This traction system has some advantages such as application of continuous force as well as control of force magnitude and direction without requiring complete appliance assembly. In addition, this



Fig. 9: Occlusal photograph of cantilever activation.

method not only reduces the final time for alignment and leveling of the impacted tooth, but also provides less traumatic surgical intervention on a conservative basis<sup>16</sup>.

### Extraction of Impacted Canine

Extraction of canine should only be performed in the following situations: if impacted tooth is ankylosed and transplantation impossible; if internal or external root resorption exists; if root is severely dilacerated; if impaction is severe (e.g. canine situated between the roots of central and lateral incisors, which can affect the orthodontic movement of these teeth); if occlusion is acceptable, that is, first premolar in the canine position exhibits functional occlusion while other teeth are well aligned; if pathological changes occur (e.g. cystic formation, infection); or if the patient desires no orthodontic treatment<sup>14</sup>.

### Auto-Transplantation of Impacted Canine

Auto-transplantation is only recommended when intervening measures are inappropriate or failed, or when impaction is severe enough to compromise the orthodontic alignment. A favorable prognosis is possible if the canine is atraumatically removed, ankylosis is absent, and dental arch space is enough<sup>17</sup>.

## Traction duration for palatally impacted canine

Duration of the traction for malocclusion involving impacted canine is greater than that involving erupted permanent teeth. This occurs as a result of the initial need for space to accommodate the impacted tooth in the dental arch. The other teeth in the same dental arch and sometimes the lower ones should be well anchored to resist the forces applied during traction<sup>10</sup>.

The treatment difficulty and probability of complications, which interfere with duration of the traction, are related to age, occlusal movement, apical movement, angulation and mesiodistal location of the impacted canine's crown, complex relationship between canine's crown and midline, close contact between canine's incisal facet and adjacent lateral incisor, and presence of transposed lateral incisor or first premolar<sup>2</sup>.

Zuccati et al.<sup>2</sup> have observed that if the impacted canine cusp tip is located mesially to the root of adjacent lateral incisor, the mean number of visits will be 10 times greater than that if the cusp tip is located distally to or on the root of lateral incisor. Patients aged 25 years or older need, on average, 30 visits or more compared to younger patients.

## Discussion

Although canines are one of the last teeth to erupt, the dentists are not accustomed to prevent ectopic eruption from occurring. On the other hand, early diagnosis and preventive intervention are possible, thus reducing the need for more complex treatment of permanent dentition. Removal of primary canines can influence positively the eruption of the succeeding permanent tooth that is palatally displaced<sup>12</sup>.

Early diagnosis can minimize the problems caused by impaction, such as root resorption of canines and lateral incisors, ankylosis or infections resulted from impaction<sup>3</sup>.

Orthodontic traction in permanent dentition is aimed at positioning the canines in the dental arch without causing periodontal damage, since they play an important aesthetic and functional roles in the development of a normal occlusion<sup>1</sup>. Traction of teeth used to be a great challenge for orthodontists, mainly in those cases involving palatally impacted permanent canines, because such a treatment was frequently unsuccessful due to the surgical techniques employed at the time. Today, with the advances in surgery, dental traction is performed with great odds of success<sup>17</sup>.

Surgical exposure for traction is the most commonly used treatment today, but some complications can occur such as loss of pulp sensibility, root resorptions, bone loss, and gingival recession<sup>10</sup>.

In periodontal aspects, the esthetics, the establishment of normal function and periodontal health at the end of treatment are fundamental, because the patients, mainly adults, have the expectation regarding the probability of successful of treatment<sup>13</sup>.

Bishara<sup>14</sup> has emphasized that two methods are largely used: surgical exposure for spontaneous eruption and surgical exposure for attachment of auxiliary accessory for application

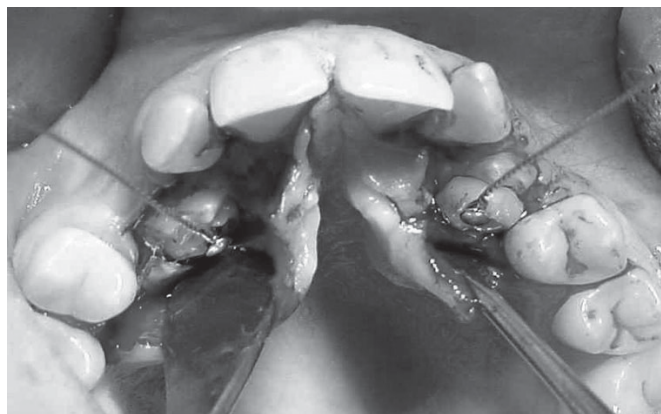


Fig. 10: Osteotomy and bonding the orthodontic accessory.

of orthodontic forces (Figure 10).

Impacted canines with chances for spontaneous eruption within 6 months can follow a more anterior and palatal trajectory, thus requiring further orthodontic movement. However, if orthodontic traction is applied soon after the surgical exposure, the canine will be directly brought into its correct position and time will be consequently saved. One can argue that the time elapsed between exposure and application of orthodontic traction is the most important factor<sup>16</sup>.

Both soft and hard tissues, which form a barrier impeding the natural course of eruption, are removed during the surgical procedure. It is important to avoid excessive and unnecessary bone removal as well as to preserve the gingiva as much as possible<sup>4</sup>.

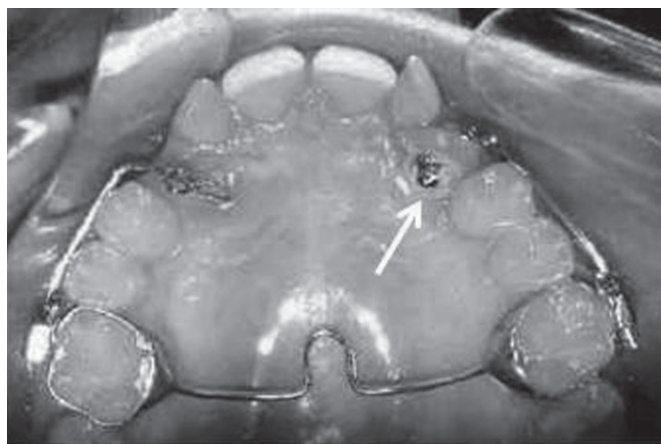


Fig. 11: Canine (left side) after open-eruption method

The closed eruption method preserves the periodontal tissues (Figure 11). In this way, eruption occurs more naturally despite the lack of scientific evidence confirming the advantage of this surgical technique over the open-eruption method in terms of periodontal health at long-term<sup>16</sup>. Although a retrospective comparative study have found no difference in treatment duration after surgical exposure using either open-eruption or closed-eruption method<sup>2</sup>.

Langlade *apud* Zuccali et al.<sup>2</sup> have reported that the maximum age for traction of an impacted tooth is 45 years old, provided that only small apical movements are to be



performed, being the treatment duration significantly longer in patients aged 25 years or older. It is thought that residual eruptive potential and good bone density in younger patients might have made traction of impacted canines easier.

Location of the impacted canine also plays an important role in determining both treatment duration and probability of failures and complications. If canine is impacted more than 14 mm from the occlusal plane, the mean duration of the treatment is 31.1 months<sup>18</sup>. The distance between canine tip and occlusal plane, long axis inclination of the lateral incisor, and mesiodistal location are the most strongly correlated variables with the treatment duration<sup>2</sup>.

There is a significant difference in the treatment duration between cases of unilateral and bilateral impaction. The mean treatment duration for those cases of bilateral palatally impacted canines is more than the mean value for unilateral cases because, in general, bilaterally impacted canines are in more unfavorable positions, with less space than the unilateral cases<sup>18</sup>.

The traction mechanics consist of verticalization, palatal positioning, and extrusion, with posterior teeth, premolars, and first molars serving as anchorage, whereas tooth leveling and space recovery are obtained by using the conventional orthodontic mechanics. This allows traction to be controlled without risk of root resorption of adjacent teeth or loss of rigidity in the support tissues.

A statistically determined system of forces enables the canine movement to be controlled with smaller anchorage loss and less side effects of adjacent teeth. By using the segmented arch technique, with insertion of a beta-titanium cantilever into the molar tube to the impacted canine (Figures 8, 9), the intrusive force occurring on lateral incisors would be null and the canine traction would be more effective. In addition, the spring could be further activated and orthodontic force slightly disseminated for a longer period of time<sup>16</sup>.

In conclusions: 1. Initial diagnosis is carried out by inspection, palpation, and radiographic examination. In the majority of cases, periapical radiography (with Clark's rule) is sufficient to determine whether canine is palatally impacted or not. Computed tomography is a more precise diagnostic method as the relationship between canine and adjacent structures is determined three-dimensionally; 2. Treatment of palatally impacted canine depends mainly on its location and patient's age. In the cases of early diagnosis, the best option is ortho-surgical treatment for later traction; 3. The traction mechanics consist on verticalization, palatal positioning, and extrusion, with posterior teeth, pre-molars, and first molars serving as anchorage, has been controlled without risk of root resorption of adjacent teeth or loss of rigidity in the support tissues.

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