The management of palatally displaced maxillary canines: Considerations and challenges

Elliott M. Moskowitz, DDS, MSd, and Ronniette C. Garcia, DDS

This article opens with a recognition that ectopic maxillary canines may lead to frank impactions requiring a coordinated and multidisciplinary approach to their surgical/orthodontic management and the potential benefit of managing canine ectopia, particularly palatally displaced canines, more conservatively in their pre-eruptive ectopic positions in an effort to avoid impaction. The prevalence of palatally displaced canines (PDC) in various populations and corroborating as well as competing or conflicting opinions of etiology are briefly reviewed. Some of the traditional as well as relatively newer strategies and associated investigations of managing pre-eruptive palatally displaced maxillary canines are discussed, and the imaging techniques utilized to identify and locate ectopic maxillary canines are also discussed. Early detection of ectopic canines must include at the very least panoramic and/or periapical radiographs as part of any mixed dentition orthodontic examination and assessment. The sometimes unpredictable continued path of the ectopic maxillary canine poses clinical and ethical issues to the clinician when developing treatment strategies as part of any overall orthodontic treatment plan for young patients presenting with maxillary canine ectopia. The need for more thoughtful and carefully designed randomized clinical trials with a greater emphasis on subject sample scrutiny is strongly recommended to add much needed clarity to the clinical management of ectopic maxillary canines. (Semin Orthod 2014; 20:46–58.) © 2014 Elsevier Inc. All rights reserved.

Introduction

The impacted maxillary canine presents a unique challenge to both the orthodontist and pediatric dentist. Most impacted maxillary permanent canines are symptomless and patients and parents of young patients are often unaware of such impactions until informed of this clinical finding by a dentist. Frequently, the maxillary primary canine will still be present and will pose far less of an esthetic concern than if the maxillary primary canine had exfoliated. When a frank impacted permanent maxillary canine is detected, the situation will frequently require a coordinated multidisciplinary orthodontic and oral surgical/periodontal procedure in order to bring the impacted tooth into the dental arch. Such routine procedures are not without occasional morbidity. Damage to adjacent teeth during the orthodontic traction process; compromised periodontal support; most notably decreased alveolar bone and soft tissue architecture; and, although rare, potential ankylosis or inability to successfully move the impacted canine tooth itself are potential adverse occurrences associated with managing impacted maxillary canines.

It has been stated and taught for many years that the maxillary permanent canine by virtue of its long path from initial development to its final position at the occlusal level is subject to displacements or degrees of ectopia that might
result in impaction.\textsuperscript{1} This anatomical circumstance alone does not adequately explain the precise etiology of maxillary canine impactions or reasons for pre-eruptive maxillary canine ectopia, which may be a strong predisposing factor resulting in future impaction. Pre-eruptive maxillary canine ectopia has also been associated with adverse effects upon the adjacent maxillary lateral incisors (and occasionally the central incisors as well), causing varying degrees of root resorption.\textsuperscript{2,4} Fig. 1 is a pre-treatment panoramic radiograph of a patient (age 11 years) with multiple impactions. The maxillary left lateral incisor root has already been partially resorbed by the advancing ectopic maxillary left permanent canine.

This article will explore some of the currently recommended treatment strategies intended to conservatively redirect ectopically developing palatally displaced maxillary canines (PDC) into more favorable eruptive positions with the overall intent of possibly avoiding or minimizing damage to adjacent structures as well as minimizing more invasive and costly surgical procedures associated with frank palatally impacted maxillary canines.

**Prevalence and etiology**

The prevalence of maxillary canine impaction has a considerably wide range and largely depends upon the ethnic and racial populations studied. Becker has cited a number of studies\textsuperscript{5} that included the lowest frequency reported in the literature in Japan at 0.27%,\textsuperscript{6} the United States at 0.92%,\textsuperscript{7} and the Icelandic population survey at 1.8%.\textsuperscript{8} Some corroborating findings include 8% of all patients with maxillary canine impactions having bilateral impactions and the increased prevalence of impacted canines in females to males of approximately 2:1 in the above mentioned study of American patients\textsuperscript{7} and even 3:1 in a Welsh orthodontic group.\textsuperscript{9} There is a considerably higher incidence of palatally displaced canines (85%) than labially positioned impactions (15%).\textsuperscript{10,11}

The definition of “impaction” varies considerably among clinicians. Perhaps Abron et al.\textsuperscript{12} most succinctly described impaction as a retardation or halt in eruption. Kufinec and Shapira\textsuperscript{13,14} more broadly defined impaction as a “condition in which a tooth is embedded in the alveolus and its spontaneous eruption is prevented by a local mechanical obstruction or position of adjacent teeth.” Occasionally, the tooth loses its eruptive potential even though no physical obstacle can be detected. Several authors define the latter condition as the “primary,” and the former as the “secondary impaction.”

A number of theories have been proposed to explain the etiology of palatally displaced permanent maxillary canines. Genetic influences have been attributed to the prevalence of ectopic and impacted maxillary canines,\textsuperscript{15} while others have favored a “guidance” influence that might be associated with missing, displaced, or...
peg-shaped maxillary incisors, thereby depriving the developing maxillary canines of sufficient lateral incisor root surface to help guide them into proper position. The authors speculate that this complex issue may be due to some combination of both genetic (missing and small maxillary lateral incisors) and guidance factors (the maxillary canine lacks the appropriate guidance from these atypical variations of missing, misplaced, or undersized maxillary lateral incisors) at some point of critical canine eruptive development working synergistically to eventually cause palatal displacement of the pre-eruptive maxillary canine. Further complicating theories attempting to explain maxillary canine impaction as strictly genetic or environmental etiologies are numerous other circumstances, which might include the role that delayed dental maturation might play in contributing to palatally displaced maxillary canines. Other factors cited by Bishara include endocrine deficiencies, febrile diseases, irradiation, presence of an alveolar cleft, ankylosis, cystic or neoplastic formation, and idiopathic conditions with no apparent cause.

Although it might seem to be the most intuitively derived etiology, Jacoby found that dental arch length was not a causative factor in 85% of palatally displaced maxillary canines.

Crowding in the maxillary dental arch, similar to that in the patient in Fig. 2, will frequently result in buccal displacement of the maxillary permanent canine, many of which may eventually erupt in a notably buccal position or on rarer occasions become impacted. The latter observed clinical circumstance appears to justify not grouping buccally and palatally displaced maxillary canines together in investigations “to form a homogeneous sample of impacted teeth” since their etiologies appear to be distinctly different.

Can palatally displaced developing maxillary canines be conservatively redirected to normal pre-eruptive positions?

Orthodontists and pediatric dentists are in the best position to detect ectopically developing maxillary permanent canines. The authors of this article advocate that in addition to the clinical examination of patients in the mixed dentition by the orthodontist or pediatric dentist, a panoramic radiograph is indispensable. Fig. 3 is an intraoral view of an 11-year-old male patient who had been examined by his dentist periodically but had never received a panoramic radiograph. The occlusion extant could very well represent...
what was once called “the ugly duckling stage” in which greater latitude in “awkwardness” of the occlusion and individual tooth position may be acceptable and expected to improve as the patient transitions from the mixed dentition stage to the adult permanent dentition. The lack of an expected “canine bulge” upon palpation and the panoramic radiograph obtained at this developmental stage, however, clearly suggests otherwise (Fig. 4). The maxillary permanent canines are obviously ectopic and appear to be well on their way to frank impactions in the near future. A relatively short period of a “Phase I” orthodontic treatment, which consisted solely of maxillary expansion as the only appliance utilized, and selective removal of primary teeth (maxillary primary canines) resulted in a more favorable path of the pre-eruptive position of the maxillary permanent canines (Fig. 5), which eventually led to the successful spontaneous eruption of the bilaterally ectopic maxillary permanent canines (Fig. 6). Is such earlier or timely intervention (orthodontic treatment in the mixed dentition) a predictable and reproducible solution to managing potentially impacted maxillary permanent canines? And if so, is there any evidence-based or evidence-bolstered information that justifies such intervention?

**Imaging and palatally displaced maxillary permanent canines**

Although panoramic and/or periapical radiographs can be helpful in identifying superoinferior and mesiodistal deviations of maxillary canine positions, neither of these radiographs gives the precise 3-dimensional position of such
impacted teeth and would need to be supplemented with additional periapical radiographs (Clark’s rule and/or Buccal-object rule) if more precise buccolingual positioning information is desired. Additional images that might include occlusal radiographs as well as extraoral images, such as frontal and lateral cephalometric radiographs, can be helpful in better determining the spatial relationship of an impacted maxillary canine. The patient in Fig. 1 who had presented with a notable impaction of the maxillary left canine provides a somewhat different perspective when the cephalometric radiograph (Fig. 7) is viewed, indicating that the incisal tip of the impacted canine is oriented towards the anterior portion of the maxilla.

Current cone beam technology (CBCT) indisputably offers the most comprehensive imaging in determining both detailed and accurate spatial relationships of an impacted tooth as well as detecting the extent of any damage to adjacent structures such as the maxillary lateral, and, at times, the maxillary central incisors. Fig. 8 is a panoramic radiographic view of an impacted maxillary right canine of a 16-year-old male. The CBCT imaging views (Fig. 9) illustrate the precise 3-dimensional relationship of the palatally impacted maxillary right canine at the surgical exposure and placement of the orthodontic attachment (Fig. 10).

Orthodontists have also attempted to judge the severity of maxillary canine ectopia by the degree of mesiodistal location of the crown and the angulation as measured on a panoramic radiograph. The intent of the latter was perhaps to predict the future success of interceptive strategies aimed at redirecting the eruptive path.
Figure 8. A panoramic radiograph of a 16-year-old male with an impacted maxillary right permanent canine.

Figure 9. Subtracted CBCT views of the patient shown in Fig. 8 more precisely locate the actual spatial relationship of the impacted maxillary right canine tooth.
of palatally displaced maxillary permanent canines. Fig. 11 shows ectopic canines and the degree of angulation to the midline as well as the sector scheme as presented by Lindauer et al. Sector I is the area distal to a line tangent to the distal heights of the contour of the lateral incisor crown and root. Sector II is mesial to sector I but distal to a line bisecting the mesiodistal dimension of the lateral incisor along the long axis. Sector III is mesial to sector II but distal to a line tangent to the mesial heights of the contour of the lateral incisor crown and root. Sector IV

Figure 10. An image obtained at the time of surgical exposure and orthodontic attachment placement (of the patient in Figs. 8 and 9) showing the precise location of the impacted maxillary right canine.

Figure 11. The angular relationship of the ectopic canine long axis to the midline and sector allocation used to determine the degree of severity of the ectopia.
includes all areas mesial to sector III. Lindauer, in the same study, concluded that up to 78% of the canines that had cusp tips located in sectors II through IV were destined to become impacted. Warford et al.24 found that sector location provided the greatest information on future impaction with angulation providing very little statistically predictive value.

**Strategies utilized to redirect pre-eruptive ectopic maxillary displaced canines**

Clinicians have advocated the removal of primary canines associated with palatally displaced maxillary permanent canines as an interceptive measure intended to redirect the ectopic canines into more favorable pre-eruptive positions.25–27 More recently, Bonetti et al.27,28 have advocated a “double extraction” procedure involving the removal of both the primary canines and primary first molars and reported a higher degree of positive effects in redirecting ectopic canines.

Leonardi et al.29 investigated 2 interceptive approaches to the treatment of palatally displaced maxillary canines. Their samples consisted of 3 distinct groups. Group 1 consisted of a sample that underwent the extraction of the maxillary deciduous canines as a sole treatment measure. Group 2 received in addition to the removal of the deciduous canines the use of a cervical pull headgear. Group 3 was an untreated control group. The removal of the deciduous canine as an isolated measure to intercept palatal displacement of the maxillary canines showed a prevalence rate of 50% success. It is interesting to note that the success rate of this group was not significantly greater than the untreated controls. The group that received extractions of the deciduous canines as well as the use of headgear had a successful eruption of the permanent canines in 80% of the cases. In a subsequent study, Baccetti et al.30 investigated the effectiveness of rapid maxillary expansion in a sample of palatally displaced maxillary canines in the early mixed dentition. A group that received no treatment served as a control. The group that received RME showed a successful eruption rate of 65.7%, while the group that received no treatment experienced a 13.6% successful eruption of the displaced maxillary canines.

**Current clinical problems**

Interpreting the clinical relevance of these studies poses numerous problems for the clinician. The design of many of these investigations is frequently very different and, understandably, conflicting conclusions could result. Schindel and Duffy31 reported an association between potentially impacted canines and transverse discrepancies, while Langberg and Peck32 refute this finding in their investigation. Few studies have included control samples composed of patients receiving no treatment due in many instances to either logistic or ethical issues.

![Figure 12](image_url). Ectopically developing maxillary and mandibular canines in a female patient aged 10.5 years.
associated with developing such potentially useful samples. The investigations by Baccetti et al.\textsuperscript{29,30} are particularly intriguing to the clinician because their study observations (no treatment control samples included) validate the clinician’s empirical observations that a certain percentage of patients who present with palatally displaced maxillary canines will self-correct without any treatment. This presents an ethical challenge to the orthodontist in developing a viable treatment philosophy of addressing ectopically erupting canines earlier (mixed dentition) rather than later and the benefit, at the very least of what might be called “active observation” for such patients who present early, but with mild ectopic positions of maxillary canines. Fig. 12 is a panoramic radiograph of a female patient 10.5 years of age, with pre-eruptive maxillary and mandibular permanent canines of some concern due to their ectopic positions. The parent rejected any interceptive treatment aimed at addressing the ectopic canines but returned to the office approximately 27 months later. The panoramic radiograph taken at that time (Fig. 13) shows a complete correction without any treatment. Conversely, the patient illustrated in Fig. 14 was a 10-year-old female with excessive spacing in the mixed dentition, relatively small maxillary incisors, long unresorbed primary maxillary canine roots, and no evidence of a labial canine bulge upon palpation. The degree of ectopia of the maxillary right and left canines and the unresorbed roots of the maxillary primary canine roots (Fig. 15) warranted consideration for intervention. The parent rejected treatment at this time but returned precisely one year later. The ectopia and root maturation of the maxillary canines advanced (Fig. 16) and the patient eventually received comprehensive orthodontic treatment, including bilateral canine exposures and subsequent orthodontic traction of these teeth becoming necessary. The unpredictability of maxillary canine development in spite of the previously mentioned studies, and the attempts at the prediction of both continued and advancing ectopia as well as success in response to orthodontic treatment, is illustrated in the treatment of a male patient 11 years of age, who presented with an occlusion that was not too

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure13}
\caption{A panoramic radiograph of the patient shown in Fig. 12, 27 months after the initial radiograph had been taken. The canines had erupted normally, the patient having received no treatment.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure14}
\caption{An intraoral view of a 10-year-old patient with excessive spacing in the mixed dentition.}
\end{figure}
disparate from a normally developing occlusion in the mixed dentition (Fig. 17). The panoramic radiograph (Fig. 18) revealed severe ectopia of the maxillary right canine with respect to increased angulation and crown location in sector IV, suggesting a poor prognosis for early interceptive guidance into more favorable pre-eruptive positions. The maxillary left canine was “mildly” ectopic by comparison. The patient was initially treated with a fixed palatal expander followed by fixed appliances. Fig. 19 is a panoramic view and images in Fig. 20 are intraoral views of the patient during an interim stage of comprehensive orthodontic treatment in which the maxillary canines successfully erupted into the oral cavity and dental arch. No extractions of primary teeth were employed.

The authors’ clinical guidelines include the following:

1. Clinical examination of young patients at 8 or 9 years of age.
2. Panoramic screening radiograph to observe underlying dental development.
3. Assessment of any possible ectopia.
4. Decision to intervene or continue to observe at 6–8-month intervals.
5. Discussion with the parents of young patients of the considerations of early orthodontic treatment, which is generally planned as a Phase I treatment often followed by a Phase II treatment, and numerous other cost/risk/benefit factors associated with any Phase I type of treatment, particularly, treatment

Figure 15. A panoramic view of a patient showing bilateral maxillary permanent left and right canine ectopia.

Figure 16. A panoramic view of the patient illustrated in Fig. 15 exactly 1 year after the initial examination. There is advancing ectopia and eventual frank impaction requiring surgical exposures and orthodontic traction.
Figure 17. A patient, 11 years of age, with a relatively unremarkable mixed dentition occlusion.

Figure 18. The panoramic radiograph of the patient illustrated in Fig. 17 reveals a severely ectopic maxillary right canine, suggesting a poor prognosis for conservative interceptive treatment.

Figure 19. A panoramic view of the patient (Figs. 17 and 18) at an interim stage of comprehensive orthodontic treatment showing spontaneous successful eruption of the maxillary canines.

Figure 20. Intraoral views of the patient at the same time point as Fig. 19, showing the maxillary canines erupted into the dental arch.
that may be initiated largely because of detected palatally displaced maxillary canines.

(6) Selection of a specific treatment protocol (extractions of primary teeth) and use of adjunctive appliances (expanders and headgear).

The selection of a specific protocol for individual patients with PDC remains, at this juncture, exceedingly challenging in light of the findings and interpretations of the various investigations published, as well as the opinions and clinical experience of the clinicians. In a survey of 100 consecutively observed and/or treated young patients at the authors’ office with maxillary canine ectopia of varying degrees, over 88% were able to be redirected to normal eruptive positions. This clinical group received observation, primary canine removal, and primary canine and primary first molar removal (double extraction technique) combined, at times, with palatal expanders in some instances in the absence of transverse discrepancies. There was no single predictable factor that could be identified or specific treatment modality that could be recommended as a reproducible strategy that could be applied to every patient. The limitations of such clinical and obviously filtered observations would be too numerous to mention, but the “success” of a more aggressive approach to the management of ectopic canines may in some respects parallel the dilemma associated with the selection of specific mechanotherapy and appliances in the Class II patient. Furthermore, it might be that some disruption in the homeostasis of the existing clinical condition (Class II relationship) during periods of active growth have resulted in the resolution of such malocclusions, accounting for the efficacy of so many seemingly different orthodontic appliances. Similarly, it appears that a disruption in the status quo of the developing young patient with maxillary canine ectopia with methods described in this article might result in a greater percentage of successfully redirected ectopic teeth than doing nothing at all. As always, the challenge for the clinician remains in developing predictable and reproducible strategies for individual patients presenting with palatally displaced maxillary canines that will result in a substantially high success rate for redirection of these ectopic teeth.

**Concluding remarks**

There is a profound need for greater clarity and understanding of the etiology of maxillary canine ectopia, particularly, the causative factors of palatally displaced canines. With such clarity, perhaps more predictable and reproducible strategies can be developed, which would benefit individual patients with earlier-detected rather than later-detected maxillary canine ectopia. Although admittedly, by way of meta-analysis of many past studies of varying quality and empirical observations, some insight has been gained of both etiology and efficacy of active intervention in cases of maxillary canine ectopia, there is a distinct need for more carefully designed prospective randomized clinical trials in this area to facilitate separating the “gold from the dross.” Until such investigations are concluded, we remain empirically bound in desperate need for more real science upon which to base our clinical decisions.

**References**