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Maxillary Canine Impaction - Orthodontic Challenges

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Abstract: ***With the exception of the third molars, impaction of the maxillary permanent canines is the most common form of tooth impaction.***

Keywords: Maxillary canine, impaction, diagnosis

1. Introduction

Maxillary canines have the longest and deepest area of development and the most difficult path of eruption in all teeth. Permanent maxillary canines are the second most commonly impacted teeth; their prevalence of impaction is 1-2 % in the general population (Thilander and Jacobson, 1968).they are more commonly impacted in females (1.17%) than in males (0.51%). The prevalence of maxillary canine impactions is higher than that of mandibular canines. Their normal age of eruption between 11 to 12 yrs. They are the teeth that frequently require surgical exposure and orthodontic guidance during the eruption. The frequency of palatally impacted canines is higher than that of labially impacted canines. Orthodontic management of impacted maxillary canines can be very complex and requires a carefully planned interdisciplinary approach[1].

The surgical orthodontic treatment of impacted canines is aimed at bringing the tooth into its correct position in the dental arch without causing periodontal damage[1]. The teeth are surgically exposed and moved towards the archwire after the maxillary arch is stabilized by progressing to a rigid archwire. To achieve thisgoal, a variety of surgical and orthodontic techniques have proposed both in relation to the position of the impacted tooth and to the ligation technique used. Getting the canine tooth into occlusion helps to establish a proper canine guided occlusion (Beggs Kesling1971)[1].

1.1 Development

To describe the normal path of eruption of the maxillary canine orthodontists rely heavily on the original work of Broadbent (1941) published more than 50 years ago. According to his classical narrative, the permanent maxillary canine begins to calcify at approximately 12 months of age between the roots of the first deciduous molar. It is then left behind as the deciduous molar erupts, allowing development of the first premolar between the deciduous molar roots. At this stage, the permanent canine is located immediately above both the first premolar and the first deciduous molar. As the deciduous teeth erupt towards the occlusal plane, the permanent incisor and canine crypts migrate forward in the jaws at a greater rate than the forward movement of the deciduous teeth themselves. At the age of 7 years, the canine crown is medial to the root of its deciduous predecessor, and there is a vertical overlap of approximately 3mm (Noyes,1930). The positional changes between 8 and 10 years of age need careful observation for the detection of potential impaction (Williams, 1981). During this stage of development the canine normally migrates buccally from a position lingual to the root apex of the deciduous precursor; however, some canines do not make the transition from the palatal to the buccal side of the dental arch and remain palatally unerupted. With sufficient increase in the size of the subnasal area, the maxillary canine normally moves downward, forward and laterally away from the root end of the lateral incisor. Between 8 and 12 years of age, the 'ugly duckling' stage, there is insufficient space at the apical base to permit the axis of the lateral incisor to shift into the more erect alignment of young adulthood until the canine approaches its place in the dental arch. In the final phase of the eruption, canines drive their way between the lateral incisors and first premolars, forcing these teeth to become more upright.

1.2 Etiology

Notwithstanding the opinions of some respected researchers in favor of an exclusively genetic etiology for its occurrence, there are many and varied reasons for impaction of the maxillary canines. The causes can be classified into 4 distinct groupings: local hard tissue obstruction, local pathology, departure from or disturbance of the normal development of the incisors, and hereditary or genetic factors[2].

- Localised
- Systemic
- Genetic

1.3 Local Pathology

- Tooth size-arch length discrepancies
- Failure of the primary canine root to resorb
- Prolonged retention or early loss of primary canine
- Ankylosis of permanent canine
- Cyst or neoplasm
- The absence of maxillary lateral incisor
- Variation in timing of lateral incisor root formation
- Iatrogenic factors Idiopathic factors

1.4 Systemic

- Endocrine deficiencies

- Febrile diseases
- Irradiation

1.5 Genetics

- Heredity
- Malposed tooth germ
- Presence of alveolar cleft

1.6 Sequelae of Canine Impaction

Shafer et al suggested the following sequelae for canineimpaction[3]

Labial or lingual malpositioning of impacted teeth
↓
Migration of neighboring teeth and loss of arch length
↓
Internal resorption or external root resorption of impacted or neighboring tooth
↓
Dentigerous cyst formation
↓
Infection particularly with partial eruption
↓
Referred pain

1.7 Diagnosis of Canine Impaction

The diagnosis of canine impaction is based on both clinical and radiographic examinations[4].

1.8 Clinical Evaluation

It has been suggested that the following clinical signs might beindicative of canine impaction

1) Delayed eruption of the permanent canine or prolongedretention of the deciduous canine beyond 14–15 years of age,
2) An absence of a normal labial canine bulge,
3) Presence of a palatal bulge, and
4) The delayed eruption, distal tipping, or migration (splaying) ofthe lateral incisor.

According to Ericson and Kurol[5], the absence of the "canine bulge" at earlier ages should not be considered as indicative of canine impaction. In their evaluation of 505 schoolchildren between 10 and 12 years of age, they found that 29% of the children had nonpalpable canines at 10 years, but only 5% had it at 11 years, whereas at later ages only 3% had nonpalpable canines. Therefore, for an accurate diagnosis, the clinical examination should be supplemented with a radiographic evaluation.

1.9 Radiographic Evaluation

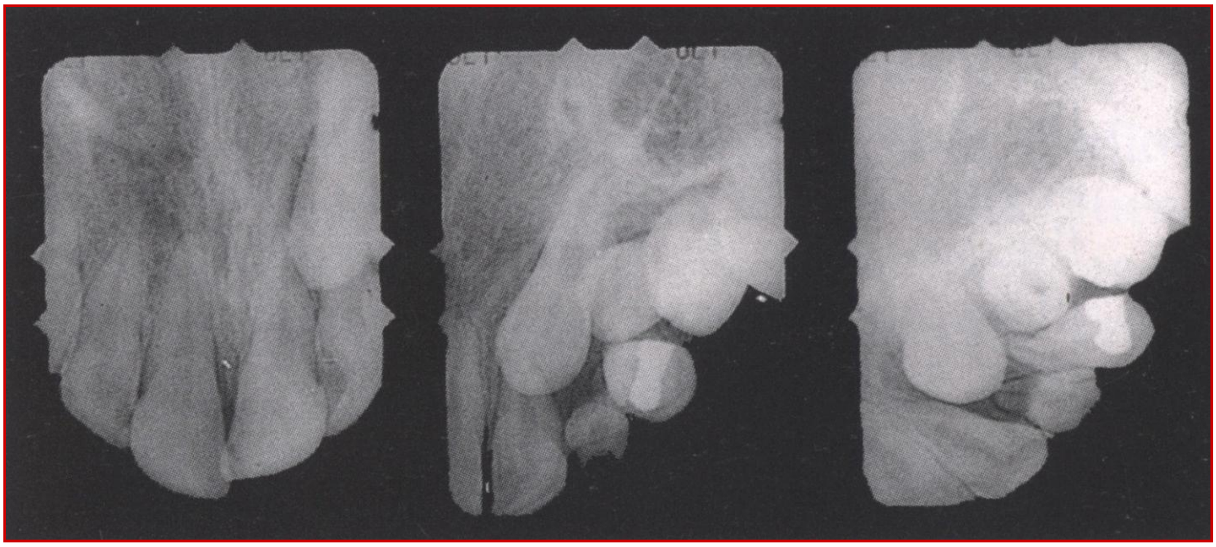
Although various radiographic exposures including occlusal films, panoramic views, and lateral cephalograms can help in evaluating the position of the canines, in most cases, periapical films are uniquely reliable for that purpose. Computerized medical tomography (CT) was an improvement over previously used techniques in that it eliminates overlapping structures and allows for visualization of the specific tissue volume. However, the higher radiation exposure with CT scans limits their clinical utility. The advent of three-dimensional (3-D) cone beam computerized tomography (CBCT) has resulted in lower radiation doses than those of CT, making it an advantageous imaging tool in dentistry[4,6].

1.10 Periapical Films

A single periapical film provides the clinician with a two dimensional, Representation of the dentition. In other words, it would relate the canine to the neighboring teeth both mesiodistally and superoinferiorly. To evaluate the position of the canine buccolingually, a second periapical film should be obtained by one of the following methods.

1.11 Tube-shift technique or Clark's rule or (SLOB) rule

Two periapical films are taken of the same area, with the horizontal angulation of the cone changed when the second film is taken. If the object in question moves in the same direction as the cone, it is lingually positioned. If the object moves in the opposite direction, it is situated close to the source of radiation and is therefore buccally located.

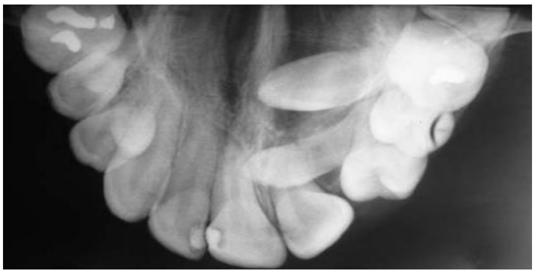


1.12 Buccal-object rule

If the vertical angulation of the cone is changed by approximately 20° in two successive periapical films, the buccal object will move in the direction opposite to the source of radiation. On the other hand, the lingual object will move in the same direction as the source of radiation.

1.13 Occlusal Films

Also help to determine the buccolingual position of the impacted canine in conjunction with the periapical films, provided that the image of the impacted canine is not superimposed on the other teeth.



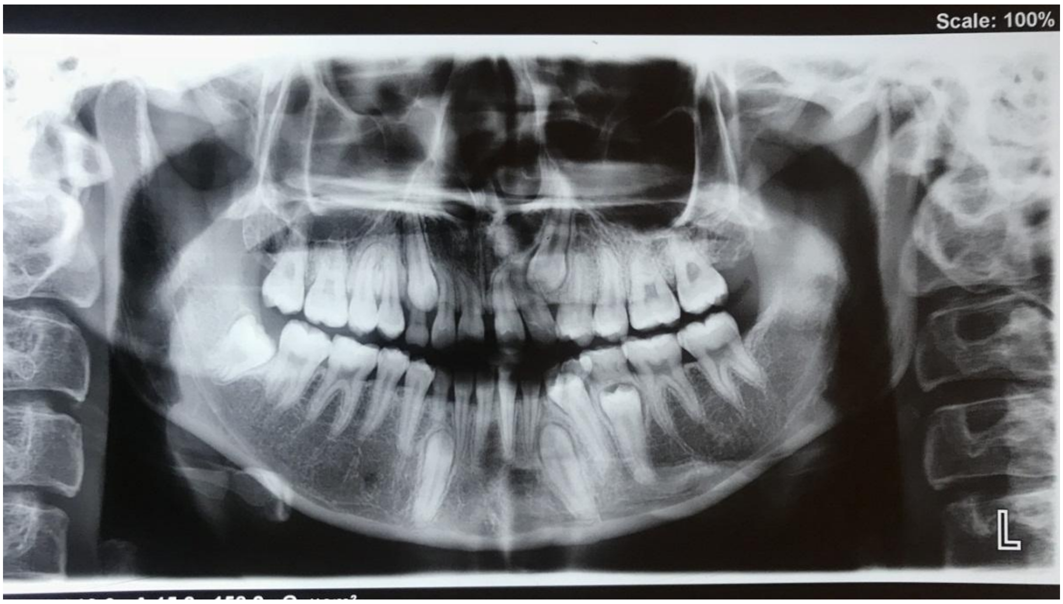
1.14 Extra Oral Films

1.14.1 Frontal and lateral cephalograms

These can sometimes aid in the determination of the position of the impacted canine, particularly its relationship to other facial structures (e.g., the maxillary sinus and the floor of the nose).

1.14.2 Panoramic films

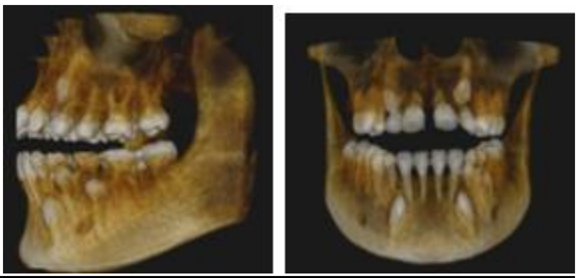
These are also used to localize impacted teeth in all three planes of space, as much the same as with two periapical films in the tube-shift method, with the understanding that the source of radiation comes from behind the patient; thus, the movements are reversed for a position.



Panoramic film of a 21-year-old female with impacted maxillary and mandibular canine

1.14.3 CT/CBCT

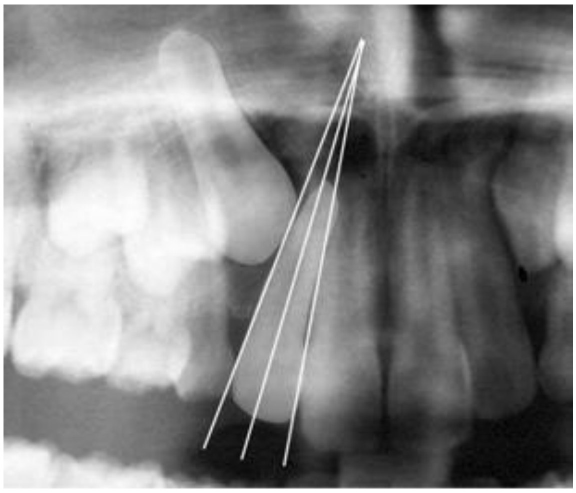
Clinicians can localize canines by using advanced three-dimensional imaging techniques. Cone beam computed tomography (CBCT) can identify and locate the position of impacted canines accurately. By using this imaging technique, dentists also can assess any damage to the roots of adjacent teeth and the amount of bone surrounding each tooth. However, increased cost, time, radiation exposure, and medicolegal issues associated with using CBCT limit its routine use. The proper localization of the impacted tooth plays a crucial role in determining the feasibility of as well as the proper access for the surgical approach and the proper direction for the application of orthodontic forces.



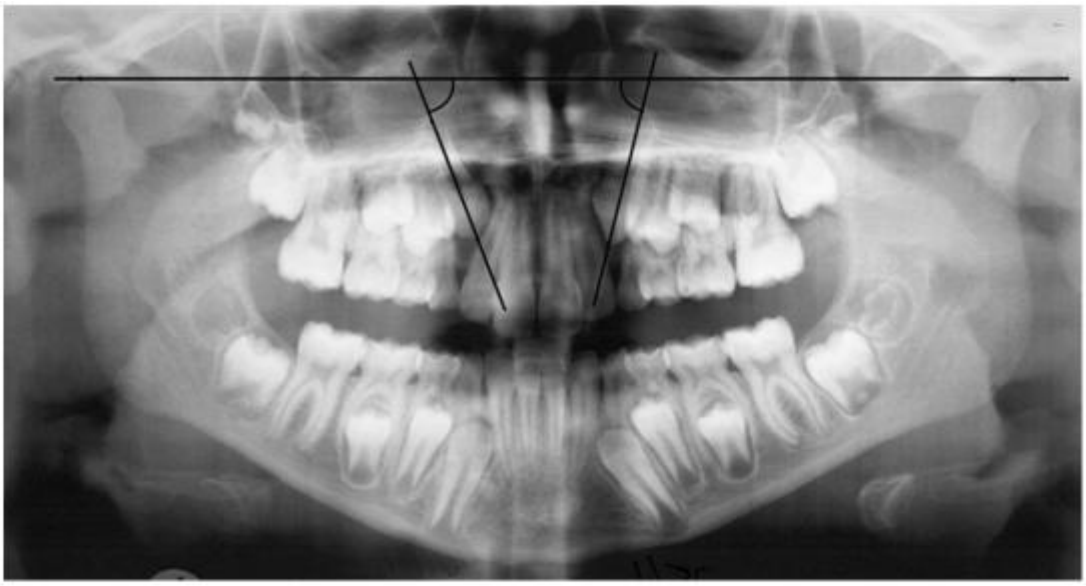
Prediction of Maxillary Canine Impaction

Lindauer et alused an aspect of the Ericson and Kurol model for predicting eruption after deciduous extraction as a means for predicting eventual impaction of the maxillary canine. Lindauer's method used the location of the cusp tip of the canine in question and its relationship to the adjacent lateral incisor. He determined the probability for impaction based on the canine cusp tip location in 1 of 4 sectors. Lindauer et al reported that this method identifies up to 78% of the canines that are destined to become impacted, all of which have cusp tips located in sectors II, III, and IV[6].

According to Warford[7] et al along with sector analysis, angular measurement also is a valuable aid for prediction of impacted maxillary canine impaction. The most superior point of the condyle was selected as a landmark, as alluded to in the secondary criteria. A bicondylar line was then drawn and used as a constructed horizontal reference line. The measurement was taken from the mesial angle formed by using the constructed horizontal and the long axis of the uneruptedtooth. The sector of the unerupted canine cusp tip also was located in accordance with the sector delineation used by Lindauer et al taken from Ericson and Kurol.



Sector analysis



Angular measurement of unerupted canines

2. Treatment Options

Surgical exposure Open or closed

In general, there are two basic approaches to surgically exposing impacted teeth[8].

He Open Eruption Technique

The first method used to disimpact impacted teeth left the tooth exposed to the oral environment, while surrounded by freshly trimmed soft tissue of the palate or labial mucosa, following the removal of the mucosa and bone actually covering the tooth. The is known as open eruption technique[8].

The Closed Eruption Technique

The alternative approach to surgical exposure, the closed eruption technique has an attachment placed at the time of exposure and tissues fully replaced and sutured to their former place, to recover the impacted tooth[8].

Table 1: Comparison between closed and open eruption technique

Variables	Open eruption	Closed eruption
Efficacy of treatment	The orthodontist doesn't need to present during exposure.	The orthodontist should be present at the time of exposure to bond the attachment
Reliability of bonding	Reliability of bonding is poor	Reliability of bonding improved
Duration of surgical exposure	Takes less time	Comparatively more time taken
Initiation of traction	Traction only starts after some post-surgical weeks.	It is propitious to apply eruptiveforce immediately taking full advantage of prevailing anesthesia
Speed of eruption	Teeth move slowly	Teeth move Rapidly
Final treatment outcome	Less treatment outcome in means of periodontium of impacted teeth.	Good periodontal outcome.

3. Techniques for Orthodontic Disimpaction

The teeth are surgically exposed and moved towards the archwire after the maxillary arch is stabilized by progressing to a rigid archwire. To achieve this goal, a variety of surgical and orthodontic techniques have proposed both in relation to the position of the impacted tooth and to the ligation technique used. The techniques are:

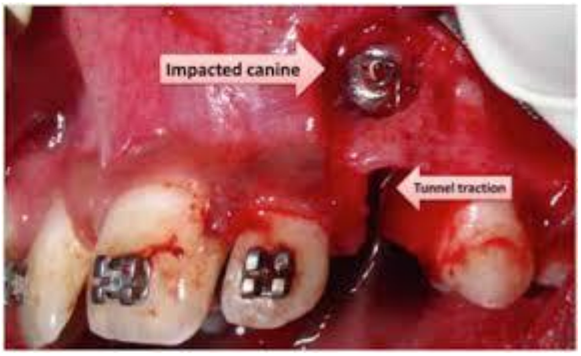
Ballista spring

Introduced by Harry Jacoby in 1979[9]. The term Ballista was given by one of his patient as it reminded him of Roman BallistaSpring is made up of 0.014, 0.016 and 0.018 inch round SS wire which stores its energy by being twisted on its long axis. Its anchorage extremity penetrates in both headgear and the edgewise vestibular tube of first and second maxillary molar thus preventing it to rotate in the tube giving dual stability. The horizontal portion of the wire accumulates the energy. This part of the wire is attached by a ligature on the first premolar, which allows it to rotate in the slot of the bracket as a hinge axis. The last part of the spring is bent down vertically and ends in a loop shape to which a ligature elastomeric thread can be attached.

Maxillary canine disimpactionusing Ballista springs

Tunnel traction

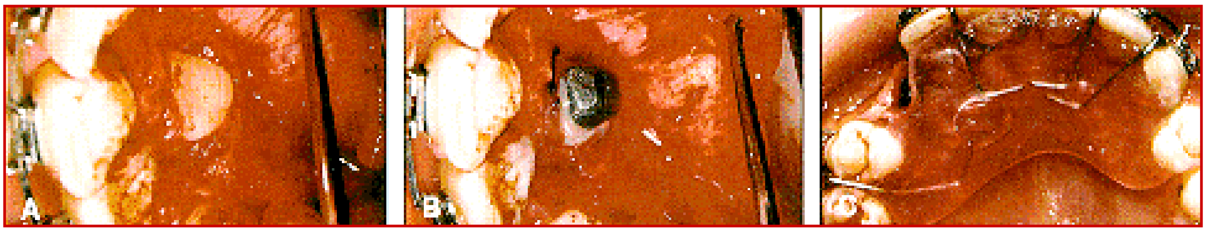
This technique was introduced by Crescini et al. (1994) describes a surgical approach for the orthodontic treatment of deep intraosseous impacted canines. This technique allows for orthodontic traction of the impacted tooth to the center of the alveolar ridge. Cortical bone is removed to provide access to the crown, and the follicular socket is eliminated. A low-speed drill is inserted into the seat of a deciduous tooth root to drill a perforation into the bone under careful cooling, to reach the crown of the impacted canine. The perforation and the deciduous socket forms a tunnel that is used for the traction[10].



Disimpaction of maxillary canine using Tunnel traction

Magnets

Magnetic forces have been used in dentistry for a very long time and Sandler and colleagues (Kawata and Takeda, 1977; Darendeliler and Joho, 1992) have reported the use of magnets in the eruption of an impacted tooth. Darendeliler *et al.* (1994) used magnets in conjugation with fixed appliance therapy for canine disimpaction. After the permanent canine has been exposed after surgery a small magnet is bonded to the palatal surface of the canine, and the mucosal flap is sutured so that it completely covers the impacted tooth and the magnet [11,12].

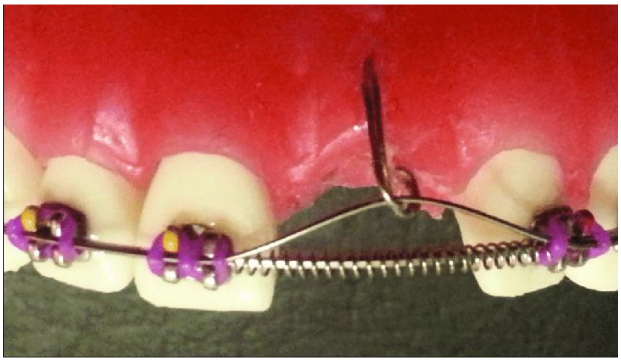


Stainless steel Archwire Auxiliaries (Becker 1995)

It is the most conveniently fashioned made up of 0.014 or 0.016 inch round stainless steel wire by forming a vertical loop in the area of the impacted canine. This loop has a small terminal helix. The auxiliary is tied into all the brackets of the arch in a piggyback fashion over a heavy main archwire, with the extremities slotted into a spare tube on the molars or left free distal to the second premolar bracket[13].

Two archwire technique

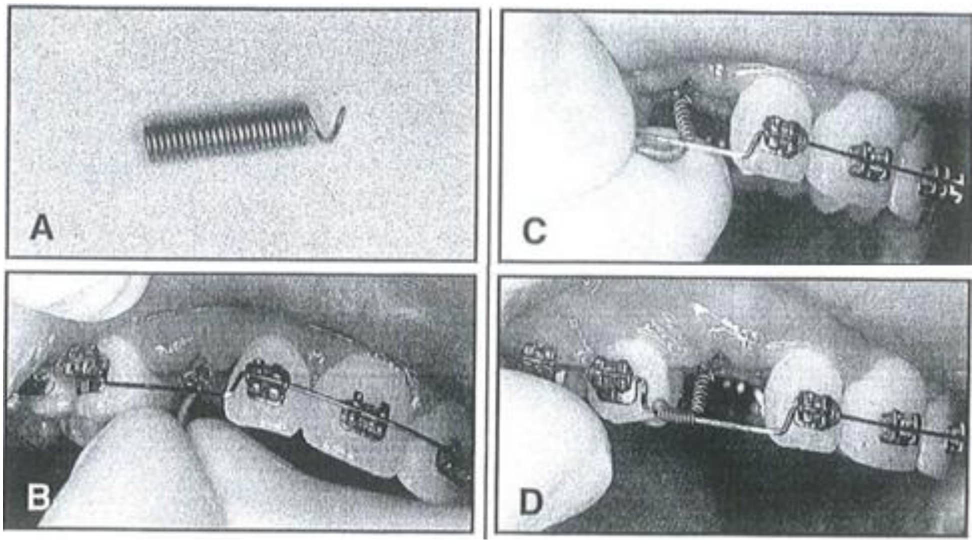
Samuels and Rudge (1997) introduced this technique of applying traction system to an impacted tooth using two nickel titanium archwires. 0.014 nickel titanium archwire is used for attachment to the gold chain which has been attached to the surgically exposed impacted tooth, and the main archwire is placed in the same bracket slot, over the traction archwire, for anchorage and control of the archform[14].



Orthodontic wire traction

Nickel titanium closed coil spring

Loring Ross (1999) introduced the concept of attaching nickel titanium closed coil spring without end loops to be effective in a patient with impacted canines. The eruptive force can be directly attached from the main archwire to a button or chain bonded to the impacted tooth. The end loops are eliminated because they reduce the effective amount of spring activation by 2-3 mm, and there is often only 3-4 mm between the stepped archwire and the canine attachment[15].



Nickel titanium closed coil spring for extrusion of impacted canine

<u>Cantilever and box loop</u>

Superelastic wires, elastic threads, and chain elastics have made pre-adjusted edgewise appliance technique more efficient, while TMA wire has facilitated segmented arch technique. (Burstone, 1962) TMA cantilever springs have been used to extrude impacted canines as described by Lindauer and Isaacson, (Samuels and Rudge, 1997) and the use of TMA box loops to produce first and second order correction while continuing vertical eruption. The segmented arch technique introduced by Burstone involves constructing a TMA cantilever spring made of 0.017×0.025" TMA wire which is inserted into the auxiliary tube of the first molar and connected by a one point contact to the active point[14,16].

<u>K-9 spring</u>

K-9 spring introduced by Varun Kalra (1995) is made up of 0.017 0.025 TMA wire, which can be activated twice as far as stainless steel before it undergoes permanent deformation while producing less than half the force. The horizontal arm of the spring is inserted into the first molar buccal tube and the premolar brackets. About 7 mm mesial to the first premolar bracket, the horizontal arm is bent 90^0 downward to form a vertical arm, which is about 11 mm long and ends in a helix. While the spring is held with a plier just distal to the vertical arm, the vertical arm is bent about 200 inwards, towards the plate[17].

<u>Australian helical archwire</u>

Australian archwires are made up of austenitic stainless steel that has been heat treated and cold drawn down to the desired diameter to gain exceptional resilience, toughness, and tensile strength. (Begg and Kesling, 1977) For moving impacted teeth, special plus 0.016" archwire with straight length is preferred over spooled wire because they are more formable and less brittle. The Australian wire is bent with helices that serve as stops against the brackets of the adjacent teeth to maintain space for the erupting canine[18,19].

<u>Monkey hook</u>

Given by Bowman *et al*. in 2002**,** is a simple auxiliary with an open loop on each end for the attachment of intraoral elastics or elastomeric chains, or for connecting to a bondable loop button. Its S-shaped design was inspired by the children's game, "barrel of monkeys" since more than one monkey hook can be linked together to form a chain. The hook can be closed with a plier to prevent disengagement[20].

<u>Kilroy spring</u>

Kilroy spring is a constant force module introduced by Bowman *et al*. (2003), which is slid onto a rectangular archwire over the site of an impacted tooth. The configuration of Kilroy reminded the designers of the popular "Kilroy was here" graffiti of 1940. In the passive state, the vertical loop of the Kilroy spring extends perpendicularly from the occlusal plane. To activate the spring, a stainless steel ligature wire isguided through the helix at the apex of the vertical loop, and the loop is directed towards the impacted tooth. The ligature is then tied to an attachment that has been direct-bonded to the surgically exposed tooth. A Kilroy spring can be tied to a loop button, monkey hook or a gold chain. Support for the activated Kilroy spring is derived from the continuous rectangular archwire and reciprocal forces from the incisal third of the adjacent teeth, which are contacted by the lateral extensions of the spring[21].

Orthodontic auxillaries used to Manage Impacted Canines

Harry Jacobay (1979)	Ballista spring
Criscini *et al* (1994)	Tunnel traction
Ali Darendeliler (1994)	Magnets
Becker *et al*. (1995)	Stainless steel archwire auxiliary
Lindauer and Isaacson (1995)	Cantilever spring TMA box loop
Samuels and Rudge (1997)	Two archwire technique
Loring L Ross (1999)	Nickel titanium closed-coil spring
Pramod K. Sinha (1999)	Mandibular anchorage
Varun Kalra (2000)	The K-9 spring
Christine Hauser C (2000)	Australian helical archwire
Jay Bowman (2002)	The monkey hook
Jay Bowman (2003)	Kilroy spring
Schubert M (2008)	Easy way coil system (EWC)
Arun and Shetty (2011)	Magnetic canine disimpactor
Vibhuti PKJ (2011)	Versatile auxiliary orthodontic spring
Rizvi and Nayak (2015)	Modified disimpaction spring

4. Conclusion

This review of the literature shows that, compared with those from 1968, techniques have improved. This is a matter of making our protocols more reliable, and they are constantly being improved. Today, it seems certain that the management of the impacted canine begins with the screening and interception phase. However, in cases requiring surgery, it should be noted that the treatment plan should be discussed by both the orthodontist and the surgeon. To repeat the conclusion of our authors: "The diversity of technique clearly indicates the difficulty of impacted canine removal. However, all the authors quoted happily illustrated their case techniques. Finally, in spite of the progress of dental implantology, extraction should be limited to cases of refusal of treatment on the part of the patient, in the absence of a sign of root resorption of the neighboring teeth, in cases of satisfactory contact between the lateral incisors and the premolars, and in cases of very severe ectopia without any pathological signs.

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