IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 14, Issue 10 Ver. V (Oct. 2015), PP 97-104
www.iosrjournals.org

Surgical-Orthodontic Treatment of Impacted Canines

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***Abstract**: The main purpose of our study is to present the corrective movement of impacted canines using various surgical-orthodontic techniques*
***Materials and method**: Eighty-two impacted maxillary canines in 2200patients were included in the study and were observed for 2006 to 2013 ,in **Center for Dentistry research and Aesthetics, Jatt/Israel** after exposure. Following exposure by means of a palatal flap or an apically repositioned buccal flap, an orthodontic traction hook, with a **Titanium Button with chain by Watted (Dentaurum**) attached, was bonded to each impacted tooth using a light cured orthodontic resin cement. For this study we used only the batch of patients who presented upper impacted canine.*
Depending on the clinical status, we used the following surgical techniques: repositioned flap, gingival translation flap, window flap method and local mesh application. After surgery for 39 patients we considered that canine traction with an orthodontic device was necessary in order to obtain a vertical position of the teeth.
*The orthodontic systems used were: fixed orthodontics, with a **Titanium Button with chain by Watted (Dentaurum**).*
***Results and discussion**: We used the repositioned flap for 39patients with deep impacted canines in order to uncover the teeth and to bond an auxiliary orthodontic device, the gingival translation flap for 27 patients with superficial impacted canines: 10cases with apical translation and 2 with lateral and apical translation. The window flap was used for 22 patients with palatal impaction. After surgery all patients continued orthodontic treatment in order to correct every dental malposition and to obtain a neutral occlusion with esthetical, functional and stabile results.*
***Key words:** impacted canines, repositioned flap, gingival translation flap, window flap, surgical-orthodontic treatment*

I. Introduction

The maxillary canine is second only to the mandibular third molar in its frequency of impaction with a reported incidence of 0.8% to 2.8%(1,2) and a female predilection, with most impacted canines palatal to the arch(3).

According to Puricelli et al. (4), the presence of a canine provides a smooth transition between the anterior and posterior arch segments, playing a specifi c role in mastication. According to Dewel (5), canine teeth determine the shape of the dental arch, defi ning the contour of the mouth, maintain the harmony and symmetry of the occlusal relationship, and support lateral movements and masticatory load. Rodrigues & Tavano (6) described the canine as the largest tooth in the arch, with the longest root, being supported by bone tissue that is structured specially to distribute forces among the craniofacial elements.

The etiology of canine impaction may be related to general factors, such as inheritance, endocrine defi ciencies, febrile diseases, and irradiation. Regarding local factors, the causes include tooth size-arch length discrepancy, prolonged retention, premature loss of primary canines, abnormal position of the tooth germ, presence of alveolar cleft, agenesis, ankylosis, supernumerary teeth, deleterious oral habits, trauma, disruption of the root structure, iatrogenic and idiopathic causes (7,8), and ectopic path of eruption (8). The incidence of canine impaction ranges from 0.92 to 2.2% (3), and may reach 2.56% of cases (9), occurring more frequently in the palatal than in the labial region (2:1). The condition affects females more than males (3:1), exhibiting left sided predominance of unilateral occurrence (10).

The location of the impacted tooth determines the type of surgical approach. In general, there are three steps to clinical localization.[6] Visual inspection and digital palpation are the first two steps, while radiographic examination is the third and most critical step. Periapical, occlusal, cephalometric, posterior-anterior and panoramic radiographs, as well as polytomography have all been used to localize impacted. (7,8) Several factors should be taken into account when surgical-orthodontic traction of an unerupted tooth is chosen, including meticulous surgical technique with complete flap closure, minimal removal of bone and dental follicle, avoiding

manipulation of the root until the application of orthodontic mechanics, and application of light forces, with a reliable anchorage unit that is resistant to the applied load. Adverse effects on periodontal tissues and unfavorable aesthetic and functional results have been associated with inadequate diagnosis and treatment planning(7).

Surgical exposure and orthodontic traction is the preferred approach for management of palatally impacted canines in compliant, motivated patients, with good dental health, where interceptive measures are inappropriate. (11) The position of the impacted canine gauged radiographically is instrumental to the orthodontist's decision to both expose and orthodontically align, or to remove the impacted maxillary canine. (12) A grading system to determine the severity of palatal impaction of canines based on radiographic location has been proposed, with high canines having severely transposed roots considered most unfavorable. Four main radiographic predictors believed to correlate with prognosis for exposure and alignment of ectopic canines have been described. These considerations include angulation of the canine long axis to the midline, vertical position of the canine crown from the occlusal plane, anteroposterior position of the canine root apex relative to the midline, and the degree of overlap of the adjacent incisor by the canine crown tip(13).

Treated (Orth.)	N=2200	%
Female	**1354**	**61.6%**
Male	**846**	**38.4%**
Impacted	**82**	**3.7%**
Non Impacted	**2118**	**96.3%**

Table 1. The distribution of the canine impaction

However, there is little evidence linking the duration of orthodontic mechanical eruption of the impacted palatal canine to these influential radiographic predictors. Stewart et al, (14)in a retrospective study, suggested alignment of canines positioned 14 mm or more above the occlusal plane to take longer than those in a more favorable vertical position. Furthermore, Zucatti et al reported a strong association between the number of visits and increasing age, vertical height, and mesial displacement of the cusp tip. However, that study involved a heterogeneous sample treated by multiple operators(15).

Impacted	N=82	%	%Treated (2200)	%Investigated Patients (4250)
Female	**46**	**56.1%**	**2.1%**	**1.1%**
Male	**36**	**43.9%**	**1.6%**	**0.8%**

Table 2. Prevalance of impacted maxillary canine

T**he main purpose of our study is to present the corrective movement of impacted canines using various surgical-orthodontic techniques.**

II. Material And Method

This study comprises data from patients who attended the out-patient department 2200 patients between June 2006 and December 2013. Patients were examined in order to detect the impacted maxillary canines by intraoral examination, palpation, dental records and followed by radiographs(7). Aged 10,2 to 39,5 years, which were examined and treated in **Center for Dentistry research and Aesthetics, Jatt/Israel** .

Age, Impacted	Min	Max	Avg
	10.2	39.5	16.2

Table 3. Means age impacted

Impacted Canine: N=82	
Male Palatally	25
Male Buccally	11
Female Palatally	40
Female Buccally	6
Total	82

Table 4.. Anatomomics localization of canine impactionaccording to the gender

The distribution of the cases was as follows: 82 patients with upper impacted canine (12 patients with differences between mezio-distal distances of the canines and the existent space, 2 patients with complex odontoma, 3 patients with cystic formations and 1patient with dento-alveolar ankylosis) and 5 patients with lower impacted canine(7). For this study we used only the batch o patients who presented upper impacted canine, with the following distribution: 12 patients with palatal impaction and 10 patients with buccal impaction. Surgical-orthodontic recovery of impacted canines involves three steps:

The first is the pre-surgical orthodontic step which has the purpose of creating the necessary space for the canine alignment.

On the patients from our study batch we used the Edgewise technique. The second is the surgical step and the third is the post-surgical orthodontic treatment which accomplishes the alignment of the canine within the dental arch. Depending on the clinical status, we used the following surgical techniques: repositioned flap, gingival translation flap and window flap method.

Impacted Canine: N=82	
Male Unilateral Left	16
Male Unilateral Right	6
Male Bilateral	14
Female Unilateral Left	20
Female Unilateral Right	16
Female Bilateral	10
Total	82

Table 5: Site localization of canine impactionaccording to the gender

On the 3 patients with deep buccal impaction we used the repositioned flap because the gingival tissue cannot be positioned in the vestibule in order to uncover the tooth and to bond the auxiliary orthodontic device We used the gingival translation flap for the 7 patients with superficial buccal impacted canine: apical translation for 5patients and lateral and apical translation for 2 patients respectively .

For the 12 patients with palatal impaction we applied the window flap method.

For the three cases of impaction in which we diagnosed dentigerous cysts we performed cystectomy followed by meshing of the post-surgical cavity. The patient with dento-alveolar ankylosis underwent dental extraction.

After surgery the orthodontist performed canine traction with an orthodontic device was necessary in order to obtain a vertical position of the teeth. The orthodontic systems used were: fixed orthodontics, ballista spring system or simple metallic clasps fixed on molar rings (Fig.1,2,3).

Fig.1: a patient before the treatment The Orthopantomogram shows the retention of tooth 23 and displacement of tooth 15

Fig 2 Pre-operative view showing the edentulous site at maxillary left canine region and the prominence created by the palatelly impacted tooth 23.

Fig 3: buccal view of the same patient. small lack of space for the impacted canine

After surgery all patients continued orthodontic treatment in order to correct every dental malposition and to obtain a neutral occlusion with esthetical, functional and stabile results. (Fig.4 a-b)

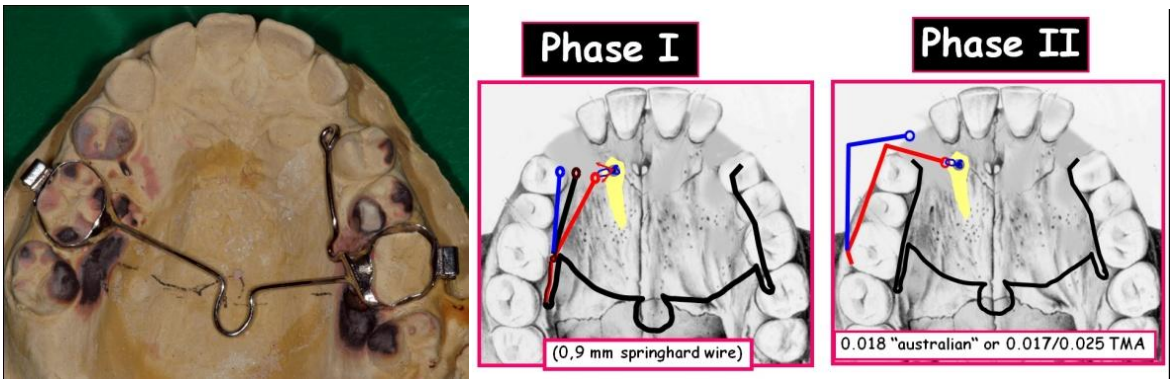

Fig 4a, b: Treatment concept by Watted for a controlled aligment of palatally impacted maxillary canines; Palatal bar with extension (0,9 mm springhard wire)

Patients were then evaluated 7-14 days after surgery, when the dressing and sutures were removed(Fig. 5).

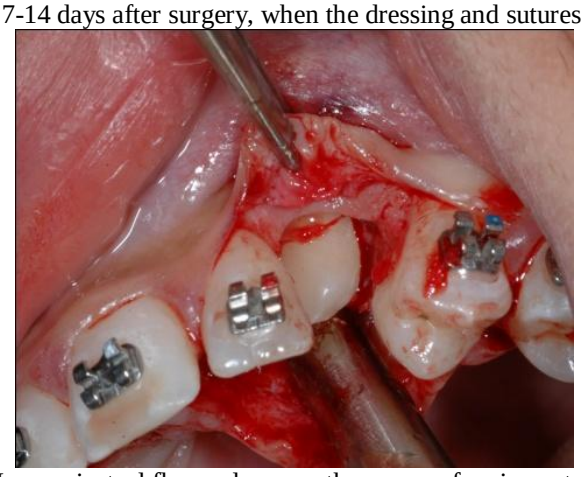

Fig. 5: Formation of a Mucoperiosteal flap and expose the crown of an impacted canine with substantial protection of the bone.

Clinical evaluation included assessment of bracket attachment, eruption status, gingival tissue response, recession, periodontal pocket depth and infection(Fig. 6a-b).

Fig. 6a, b: the full flap is now re-sutured into its former place and the titanium chain by Watted (DENTAURUM).may be seen through the flap (a). clinical situation during active eruption of the impacted tooth (b)

A radiographic examination with one standard periapical film was performed to assess the status of adjacent structures, as well as the presence of root resorption, ankylosis or periodontal defects. (Fig. 7)

Fig. 7: Orthopantomogram at the end of treatment.

The patients then had orthodontic traction forces activated within seven to 21 days. At subsequent orthodontic appointments, the same clinical examination was performed with radiological evaluation occurring every three months. Progress was noted and complications were recorded. (Fig. 8a-c)

Fig. 8a-c: Clinical situation after the treatment; a sufficient attachede gingiva with healthy periodontal situation

III. Results And Discussion

The purpose of our study was to analyze the indications of surgical methods according to the clinical status of each case.

From a total of 4250 orthopantomographies were analyzed 2200 (51.8%) , 846 (38.4%) from male patients and 1354 (61.6%) from female [Table 1]. There were 82 (3.7%) cases of impacted canine [Table 2], being 36 (43.9%) from male and 46 (56.1%) from female ($P < 0.0001$) .

Ages were in the range of 10.2-39.5 years, with a mean age of 16.3 years [Table 3], in 58 patients (71%), we found unilateral impaction, whereas the remaining 24 (29%) were bilateral. This difference was also statistically significant ($P < 0.0001$). Among the 58 unilaterally impacted canines, were on the left side and were on the right side [Table4,5].

In deep impactions, because the gingival tissue cannot be positioned in the vestibule in order to uncover the tooth and to bond the auxiliary orthodontic device, it is recommended the use of muco-periostal repositioned flap with passive guidance of the impacted canine(13). The apical translation flap has the purpose of assuring the uncovering of the teeth and provides the amount of periodontal tissue for the repositioned canine. Due to the fact that the lower margin of the flap is positioned in direct contact with the tooth, this method contributes to periodontal restoration.

The window flap used in palatal impaction avoids extensive decollation of themucosa, allows the attachment of orthodontic devices and minimizes the trauma to the marginal periodontal tissue(8,9,13) Periodontal follow-up 6 month after surgery shows that in the cases in whichwe used the repositioned flap, apical translation flap and window flap there were no periodontal recessions or dental mobility which could compromise the treatment. Conversely, in the cases in which we used the lateral and apical translation method and meshing, the periodontal tissue was damaged and it needed surgical restoration.

Boyd demonstrated that in labially positioned canines, a 2–3 mm band of attached gingiva created by an apically repositioned flap is preferable to a window exposure with no attention to keratinized tissue. This technique results in a significant reduction of gingival recession, inflammation and loss of attachment(16).

Factors implicated in increasing the duration of orthodontic treatment include the number of failed appointments, the number of treatment phases, poor compliance in terms of maintenance of oral hygiene and headgear cooperation, Class II molar relationship, treatment involving extraction of teeth, pretreatment sagittal skeletal discrepancy, and age at the start of treatment. As this study was retrospective in design, all of these factors were difficult to control completely. However, the influence of factors likely to affect treatment duration was kept to a minimum; all subjects were treated without extraction, those with poor compliance and who failed multiple appointments were excluded from the analysis(17,18,19). Treatment proceeded in one phase and correction of a Class II molar relationship was not attempted in any subject. Therefore, it is considered that duration of treatment accurately reflected the time taken to align the maxillary canine. In the current study, treatment time for alignment of the impacted canine was 26.3 months; this treatment duration is similar to previous reports of 28.8 months10 and 25.8 months Orthodontic treatment duration to address impacted canines is correlated with increasing age(13). In particular, mechanical eruption of palatal canines in patients over 30 years of age has a less favorable prognosis ; consequently, a low upper age threshold of 18 years was used to eliminate this confounding factor in the current study. Increasing age was also found to have no influence on treatment duration in the stepwise regression analysis.(20)

Many methods of attaching “hardware” to teeth have been described. Originally, wire ligatures were placed around the crown of the impacted tooth but, this had the potential to upset the periodontal attachment. Boyd compared wire ligation to bonding brackets on palatally impacted canines. In general, the wire ligated teeth had a greater incidence of non-eruption, ankylosis, external root resorption and loss of attached mucosa, due to the larger flaps required.(21)

In this study, all of the 82 impacted canines treated, erupted. This success rate may be partly due to early diagnosis and to the age of the patients. It is recommended to treat this condition before the age of 20, to maximize the potential for success.(22)

Stewart et al, in a retrospective study performed in three centers based on analysis of panoramic radiographs, detected a threshold height of 14 mm from the tip of the impacted canine to the occlusal plane; above this level, treatment duration increased from 24 to 31 months. In the current study, concerns relating to the validity of direct measurement of vertical canine position on the panoramic film ensured the height of the displaced canine tip was considered in terms of its position relative to the adjacent tooth. Canines impacted more than halfway above the adjacent tooth took almost 6 months longer to correct (30.7 vs 25.3 months). However, the study was of inadequate power to detect a statistically significant effect ($P = .065$).(14)

Complications in treating impacted canines include failure to erupt, periodontal defects, bond failure, and ankylosis. The effect of ankylosis is to prevent tooth eruption. This may cause the anchoring teeth, on the archwire, to tip into the space created for the canine. Ankylosis has also been implicated in some cases where the canine initially moved and then suddenly ceased to erupt. Luxation of the ankylosed tooth has been a recommended treatment in this case however, success is unpredictable.(23-26)

Wisth et al. compared “radical” surgical exposure of maxillary canines with a more moderate exposure technique that involved flap replacement. They found that there was a small difference between the post-treatment periodontal status of the two methods, but that the more radical exposure technique resulted in a greater loss of bone height and greater periodontal damage(27).

Surgically uncovering impacted teeth exposes deeper areas of the periodontium to the destructive effects of poor plaque control. The open approach creates an atypical soft tissue architecture that enhances plaque accumulation while challenging plaque control measures. Routine plaque control measures must be adapted to address the exposed tooth’s atypical position in the alveolar process and to the crater-like soft tissue

defect created by an open approach surgery. When a closed approach is used, the amount of plaque in the pericoronal area of an impacted tooth might be reduced but plaque removal becomes impossible.(28)
The important question for the clinician is whether one of the two commonly used surgical techniques is less harmful to long-term periodontal health. Unfortunately, a review of the relevant literature failed to produce a clear answer to this question. Most investigations have been limited to retrospective studies in which only one of the two surgical methods have been evaluated(29)

Parkin et al. (30) performed a review of the literature concerning the use of open versus closed surgical exposure of palatally impacted canines. This review revealed that currently, there is no evidence to support one surgical technique over the other in terms of dental health, aesthetics, economics and patient factors. Until high quality clinical trials with participants randomly allocated into the two treatment groups are conducted, methods of exposing canines will be left to the personal choice of the surgeon and orthodontist. Crescini et al. (31) evaluated the prognostic role of the pre-treatment radiographic features on the post-treatment periodontal status of intra-osseous impacted maxillary canines. They concluded that these parameters measured on the pre-treatment radiograph did not represent valid prognostic indicators of final periodontal status of impacted canines treated by the combined surgical-orthodontic approach.

IV. Conclusions

The management of impacted canines has a multidisciplinary approach as it plays a vital role in esthetics and function. Traction of impacted canines involves surgical exposure, acid etching, an orthodontic appliance bonded to the crown of the involved tooth, and fi nally the application of orthodontic forces. The closed eruption technique should be the choice of treatment, with conservative removal of bone tissue and complete flap replacement, producing better aesthetic and periodontal results, with preservation of the attached gingival. The canine should be moved using light forces, resulting from elastics, springs or stainless steel ligatures, not exceeding 100 g. Fixed orthodontic appliances should be used as a basis for traction, due to better resistance to reactive forces and distortions. Surgical exposure and orthodontic correction is the most preferable treatment unless contraindicated. Extraction of the impacted canine should be the last resort, as every impacted canine should be treated in a hostile way to prevent its complications.

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