Republic of Iraq
Ministry of Higher Education
and Scientific Research
University of Baghdad
College of Dentistry

Open Versus Closed Surgical Exposure of Palatally Impacted Canine

A Project Submitted to
The College of Dentistry, University of Baghdad,
Department of Orthodontics in Partial Fulfillment for the
Bachelor of Dental Surgery

By

Teeba Manhal Abdul-rahman Majeed

Supervised By

Prof. Dr. Mushriq Fawzi

B.D.S, MSc, PhD (UK)

2023

Certification of supervisor

I certify this project entitled – Open Versus Closed Surgical Exposure of Palatally Impacted Canines – was prepared by (Teeba Manhal Abdul-Rahman) under my supervision at the College of Dentistry / University of Baghdad in partial fulfilment of the graduation requirements for B.D.S degree.

Signature

Prof. Dr. Mushriq Fawzi

College of Dentistry, University of Baghdad

Supervisor

Dedication

All thanks to Allah for giving me the strength to do the best I can, and to be in this place. I dedicate this project to my family and my friends who have been the family I chose, for being with me in every moment, encouraging me, whom without I would give up.

Acknowledgement

I would like to express my gratitude to Prof. Dr. Raghad Al-hashimi, Dean of College of Dentistry, University of Baghdad and Prof. Dr. Dheaa Hussein Chairman of Orthodontic Department for his continuous care.

I would like to express my deepest gratitude and thanks to my supervisor Prof. Dr. Mushriq Fawzi for his excellent scientific guidance, support, patience and providing me with comfortable circumstances for doing this research.

Table of contents

List of figures

Introduction

Impacted tooth is a tooth that cannot erupt into its normal functioning positions **(Becker, 2007).** Most of the impactions are asymptomatic and usually present no obvious abnormal appearance except from maxillary incisors. However, some impacted tooth presents pathological complications in the form of resorption of root of adjacent teeth, cyst formation, loss of arch length and referred pain **(Bishara, 1992).**

Impacted canines generally present a challenge to the clinician attempting to align the dentition naturally. Surgical intervention is often required to expose the impacted canine; a procedure that must be planned carefully to optimize esthetic and functional outcomes. Complications may include uneven gingival height or contour, asymmetrical clinical crown length, relapse of surgical exposure or damage to adjacent teeth **(Vermette et al., 1995).**

Canines are important teeth in the development of the maxillary and mandibular dentition **(Zasciurinskiene et al., 2008).** The canine tooth germ begins development at 4-5 months and is located very high in the anterior wall of the maxillary sinus, under the floor of the orbit. Canine crown calcification occurs at the age of one, and it moves below the orbit by the age of three. At age 5-6 years, the crown tip is at the level of the floor of the nose, and calcification is complete. Eruption occurs around 11 years of age and it takes approximately 2-3 years for completion of root development. Thus, the root is completely formed at approximately 13.5 years **(Proffit et al., 2019).**

After the third molar, the maxillary canine is the most frequently impacted tooth **(Walker et al., 2005)**, with a higher rate of occurrence in female patients

(Dağsuyu et al., 2018). Of all patients with impacted maxillary canines, it is estimated that 8% have bilateral impactions. Several authors reported that the palatal to buccal maxillary impaction ratio is 3:1 **(Alqerban et al., 2016).** Maxillary canine impaction is more often located palatally (85%) than labially (15%) **(Almuhtaseb et al., 2014).** With regard to the position of canine impaction within the arch, the maxillary canine is found in a palatal impaction 85% of the time, versus being in a buccal impaction position **(Shapira and Kuftinec., 1998).**

To expose a palatally impacted canine to the oral environment, there are mainly two exposure techniques: An 'Open' exposure, which involves raising a palatal flap, removal of bone and mucosa overlying the tooth and placement of a surgical pack. The cuspid is subsequently orthodontically aligned above the mucosa, on the other hand, closed exposure involves raising a palatal flap, limited removal of bone and instead of excision of the overlying palatal mucosa, an attachment is bonded to the crown of the exposed cuspid, allowing alignment of the tooth from below the mucosa **(Parkin et al., 2012).**

There are several advantages and disadvantages of each technique (open and closed), and a debate about which one is preferred over the other. Therefore, this review was set out to discuss these two surgical techniques depending on some important points to both, the patient's and dentist's point of view.

Aim of the review

The aim of the present review was to compare the effectiveness of two different canine exposure techniques (open and closed) regarding the following:

1. Periodontal outcomes
2. Duration of surgical treatment
3. Duration of canine eruption
4. Pain (patient's inconvenience)
5. Aesthetics
6. Complications

Chapter one: Review of literature

1.1 Overview of canine impaction

After mandibular third molars, maxillary canines are the most commonly impacted teeth among patients referred for orthodontic treatment **(Walker et al., 2005).** Previous studies have shown that while about two-thirds of maxillary canines are impacted palatally and one-third are impacted labially **(Al-Nimri and Bsoul., 2011)**. It is estimated that palatal canine impaction affects between 1.0% and 2.5% of the general population **(Almuhtaseb et al., 2014).**

1.2 Etiology of palatal canine impaction (Krishnamurthy et al., 2021)

Although the exact cause of impacted maxillary canines remains unknown, multiple factors may play a role. Primary causes that have been linked to impacted maxillary canines include the rate at which roots resorb in the deciduous teeth, any trauma to the deciduous tooth bud, disruption of the normal eruption sequence, lack of space, rotation of tooth buds, premature root closure and canine eruption into a cleft. Secondary reasons include febrile diseases, endocrine disturbances and Vitamin D deficiency. Impacted canine can be concomitant with other conditions. Except the third molars, maxillary canines are among the last teeth to erupt. They usually develop high in the maxilla and need to travel a considerable distance before they erupt.

Local factors may also play a role in canine impaction, and these include:

1. A longer eruption path that the tooth has to traverse from its point of development to normal occlusion.

2. Thick palatal bone and mucoperiosteum, which can obstruct eruption of palatally oriented canines.

3. More developed root at the time of eruption, which may minimize the eruptive force.

4. Disorder of the primary canine can affect the position of the permanent one. This is because the crown of the developing permanent canine lies just palatal to the apex of the primary canine root.

5. Canines are more susceptible to environmental infuences as they are among the last teeth to erupt (except the third molars).

6. Limited space for eruption as the canines erupt between teeth which are already in occlusion. The second molar may further reduce the space.

7. The permanent canine has a greater mesiodistal width than the primary canine.

1.3 Localization of palatally impacted canine

The term localization means “determination of the site”**,** basically based on both clinical and radiographic examination, the proper localization of the unerupted maxillary canine plays a crucial role **(Nagpal et al., 2009; Goyal et al., 2018)**. It can help to recognize the tooth displacement in mixed dentition to prevent subsequent impaction. It also aids in determining the feasibility as well as the proper access for the surgical approach and the proper direction for the application of orthodontic force **(Kumar et al., 2015).**

1.3.1 Clinical evaluation

It has been suggested by **Kumar et al. (2015)** that the following clinical signs might be indicative of canine impaction:

1. Delayed eruption of the permanent canine or prolonged retention of the deciduous canine beyond 14 to 15 years of age.
2. Absence of a normal labial canine bulge, in other words, either inability to locate canine position through intraoral palpation of the alveolar process or the presence of an asymmetry in the canine bulge noted during alveolar palpation.
3. Presence of a palatal bulge.
4. Delayed eruption, distal tipping, or migration of the lateral incisor.

The most critical point in the prevention of possible maxillary canine impaction is the ability to recognize the tooth displacement early and to predict the subsequent failure of eruption. The best time to begin assessing potential impaction is during the early mixed dentition period, because the early diagnosis of one dental anomaly may indicate an increased risk for later appearance of others. Recognition of tooth disturbances in early mixed dentition such as peg shape or missing lateral incisors, enamel hypoplasia, aplasia of second premolars, and infra-occlusion of primary molars could be predictors of possible canine impaction **(Litsas and Acar, 2011).**

1.3.2 Radiographic evaluation

Although various radiographic exposures, including occlusal films, panoramic views, and lateral cephalograms, can help in evaluating the position

of the canines, in some cases periapieal films are reliable for that purpose **(Wedl et al., 2004).**

1) **Periapical films (Wedl et al., 2004)**

Two-dimensional representation of the dentition, from the crown to the root tip. This type of X-ray is used to detect decay, gum disease, bone loss and any other abnormalities of the teeth or surrounding bone (Fig. 1).

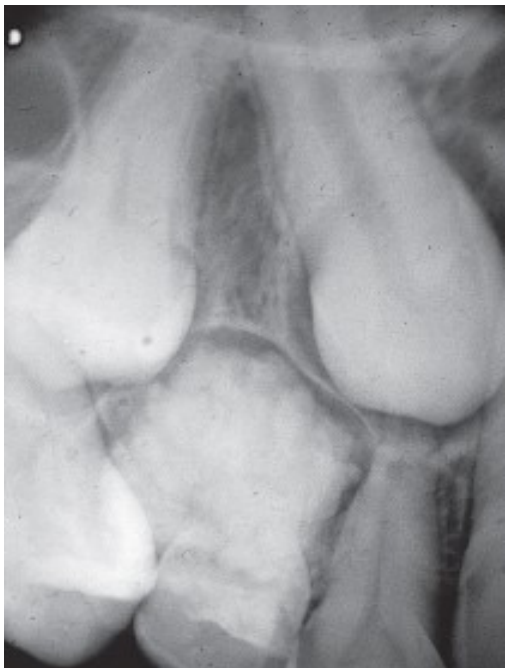

Figure (1): Periapical view of impacted canine and first premolar associated with an odontome and over-retained deciduous first molar (**Becker, 2012)**

2) Occlusal films (Wedl et al., 2004)

Help in the determination of the bucco-lingual 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 (Fig. 2).

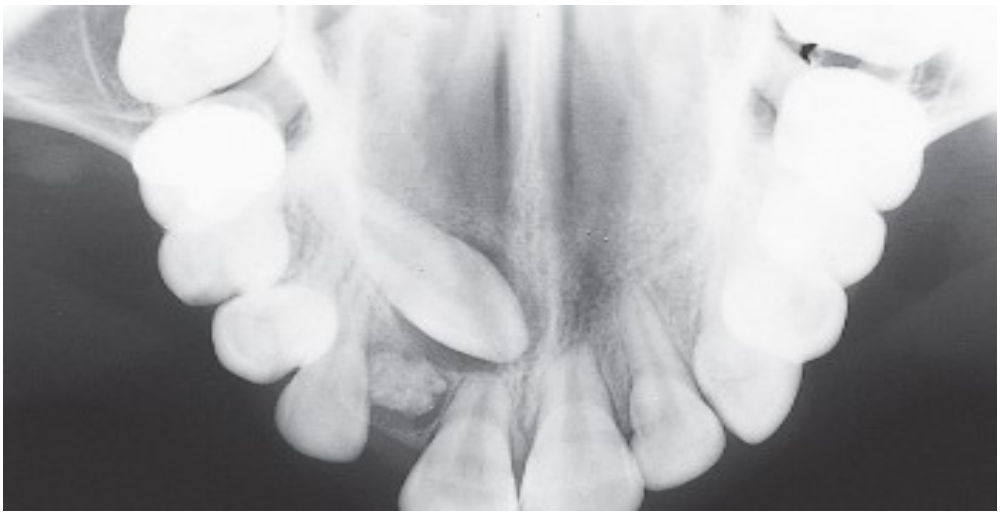

Figure (2): Occlusal film showing the palatally impacted canine **(Becker, 2012)**

(3) 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) (Fig. 3).

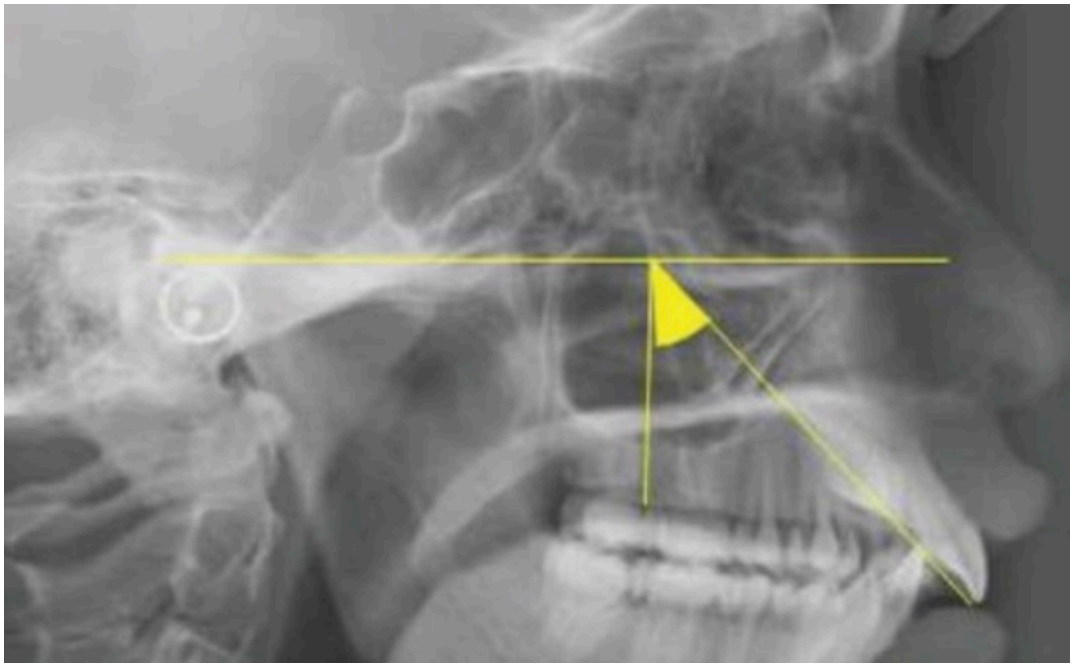

Figure (3): Canine position on Lateral Cephalogram (c) **(Kumar et al., 2015).**

(4) Panoramic Radiographs

These are also used to localize impacted teeth in all three planes of space, 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 position (Fig. 4).

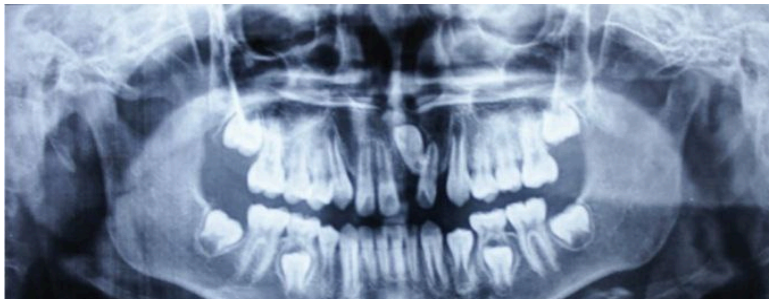

Figure 4: Panoramic radiograph showing palatally impacted canine

5) CBCT

With reduced radiation doses compared with those of medical CT, whilst offering three-dimensional (3D) imaging capability for displaying head and neck

structures in detail has been introduced. The rapid development of CBCT scanning combined with 3D rendering techniques produces high-resolution images that have been proven to be useful for the diagnosis of impacted canines, treatment planning, and the identification of associated complications, such as root resorption, in adjacent incisors **(Alqerban et al., 2011).** CBCT overcomes the limitations of conventional two-dimensional (2D) imaging **(Liu et al., 2008)** (Fig. 5).

Figure (5): A three-dimensional CBCT view showing the apical third of the root of a normally sited first premolar to be turned 90° to the mesial, directly in the path of the unerupted canine, which is being deflected further mesially and prevented from erupting **(Becker, 2012)**

1.4 Treatment methods (Krishnamurthy et al., 2021)

The impacted maxillary canine may be managed by several different techniques. The chosen method would depend on the degree of impaction, age of the patient, stage of root formation, presence of any associated pathology, dental condition of the adjacent teeth, position of the tooth, patient's willingness to undergo orthodontic treatment, available facilities for specialized treatment and patient's general physical condition.

1. **Extraction of primary canine:** This method is as an interceptive form of management. Extraction of the deciduous tooth may be considered when the maxillary permanent canine is not palpable in its normal position and the

radiographic examination confirms the presence of an impacted canine. However, this treatment will not necessarily correct the problem. Surgical intervention may be required if the permanent canine fails to erupt within one year of the deciduous extraction.

2. **No treatment (Leave the tooth in situ):** In some asymptomatic cases, no treatment may be required apart from regular clinical and radiographic follow-up. There is a small risk of follicular cystic degeneration, although the incidence of this is unknown. Rarely, odontogenic tumors may develop in relation to the impacted tooth.

3. **Surgical exposure of the tooth:** This technique may be used in cases where there is enough space for the canine to erupt, and where the root formation is incomplete. Surgically exposing the crown of the canine may allow it to come into position by normal eruptive forces.

4. **Surgical exposure and orthodontically assisted eruption.** This is the most appropriate approach for an impacted canine. For attempting this technique, the case must fulfil the following criteria:

(a) The impacted canine must be favorably positioned.

(b) The patient must be compliant with both surgery and long term orthodontics.

(c) The patient must not have associated medical problems.

5. **Surgical removal of the impacted tooth:** This technique is preferred for teeth that are in an unfavorable position, and which are likely to cause problems in the future. It may also be considered when a patient is not willing for orthodontic treatment or cannot afford it, even if the impacted tooth is in a favorable position.

6. **Surgical repositioning/Autotransplantation:** Impacted canines that are malpositioned, but have a favorable root pattern (without hooks or sharp curves) may be considered for autotransplantation into the dental arch. This may be done by utilizing the socket of deciduous canine or first premolar, depending on the amount of space needed and available.

1.5 Types of surgical exposure of the canine

1.5.1 Closed Surgical Exposure Technique

In the closed exposure technique, the canine is exposed by an excision made of covering mucoperiosteum and removal of bone. An attachment with a ligature passing through the flap is placed on the exposed canine and the palatal flap is repositioned. Soon after surgery the canine is gently brought into its correct position using an orthodontic appliance. Thus, the canine moves into position beneath the mucosa (Fig. 6).

Many orthodontists simply pull the tooth laterally toward the edentulous ridge instead of erupting the impacted canine distally and palatally away from the adjacent central and lateral incisors. This often causes the canine crown to compress against adjacent palatal bone. The enamel of the crown cannot resorb the adjacent bone physiologically, so this crown-to-bone contact leads to pressure necrosis, which will result in bone resorption as the impacted canine moves laterally. In addition, bone remodeling occurs behind the canine crown as the advancing crown erupts. This type of forced movement has been shown to result in bone levels and attachment levels on the distal of the lateral incisor and mesial of the previously impacted canine that are more apical than the contralateral lateral incisor and nonimpacted canine **(Crescini et al., 1994).** Therefore, the esthetics are negatively impacted. However, the closed eruption technique does not have to result in bone resorption or poor

attachment levels around the previously impacted canine. Therefore, the direction of eruption pathway of the canine crown beneath the palatal tissue is critical. For the most predictable outcomes with the closed eruption technique, the impacted tooth should first be erupted lingually and then moved laterally so as not to compromise the bone levels or cause root resorption of the lateral incisor.

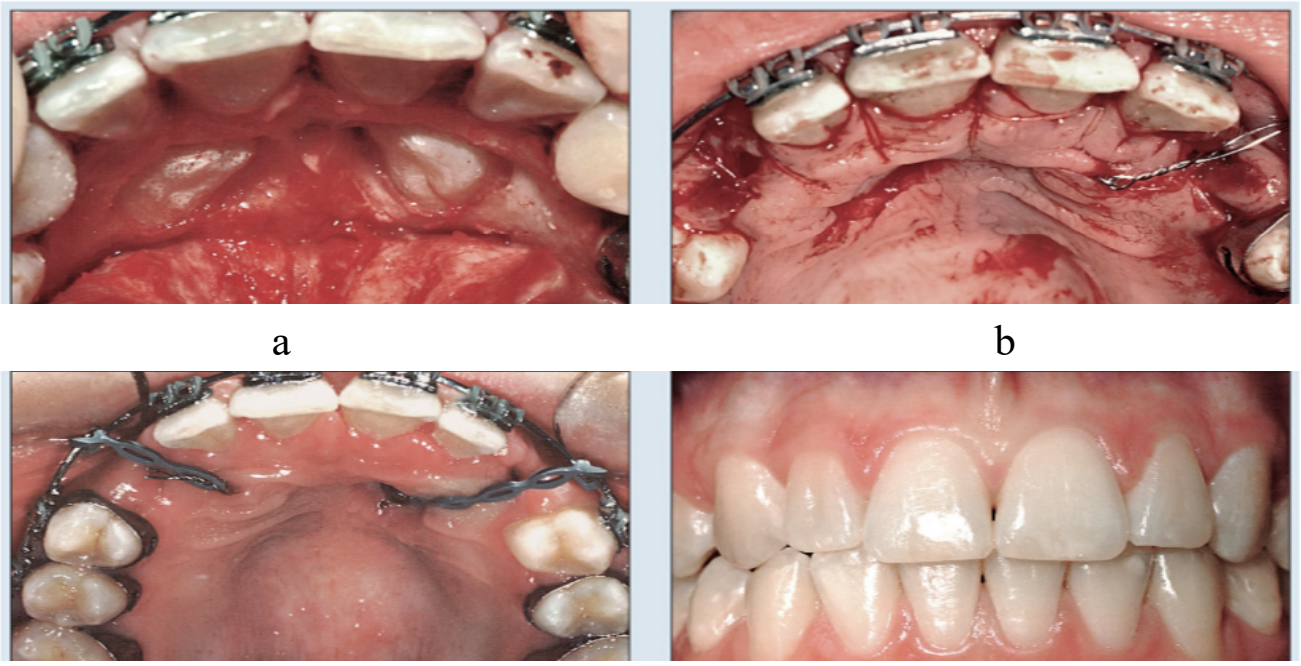

Figure 6: Closed exposure (a) Bone was carefully removed from over the crowns of both canines, and attachments were bonded to the teeth. (b) Ligating wires were attached to the brackets, and the flap was fenestrated and repositioned with resorbable sutures. The ligating wire passed through the fenestration and was attached to the archwire. (c) Six weeks postoperatively, elastomeric chains were attached from the canines to the archwires to move the teeth laterally. (d) After the completion of orthodontic treatment, the canines have been moved into their proper position within the maxillary arch **(Vincent et al., 2014)**

1.5.1.1 Tunnel approach

An interesting variant of the closed technique was introduced by **(Crescini et al. 1994).** The impacted canine is drawn downwards through the evacuated socket of the simultaneously extracted deciduous canine. This modification is aimed at ensuring the preservation of the buccal plate of the alveolar bone and the principal indication of this technique is for impacted canines that are located high in the maxilla and in close proximity to the line of the arch. The choice of surgical procedure is decided in relation to 3D location of impacted tooth **(Vincent et al., 2014).**

1.5.2 Open exposure technique

This technique involves surgically uncovering the canine tooth, as before, but instead of bonding an attachment on the exposed tooth at the time of the surgery, a window of tissue is removed from around the tooth leaving it exposed. A dressing or 'pack' is placed to cover the exposed area. The dressing is removed approximately 10 days later. The tooth is then either left to erupt naturally, or an orthodontic attachment is placed to enable the tooth to be moved, above the gum, into its correct position in line with the rest of the teeth **(Crescini et al., 1994).** (Fig. 7[H1]).

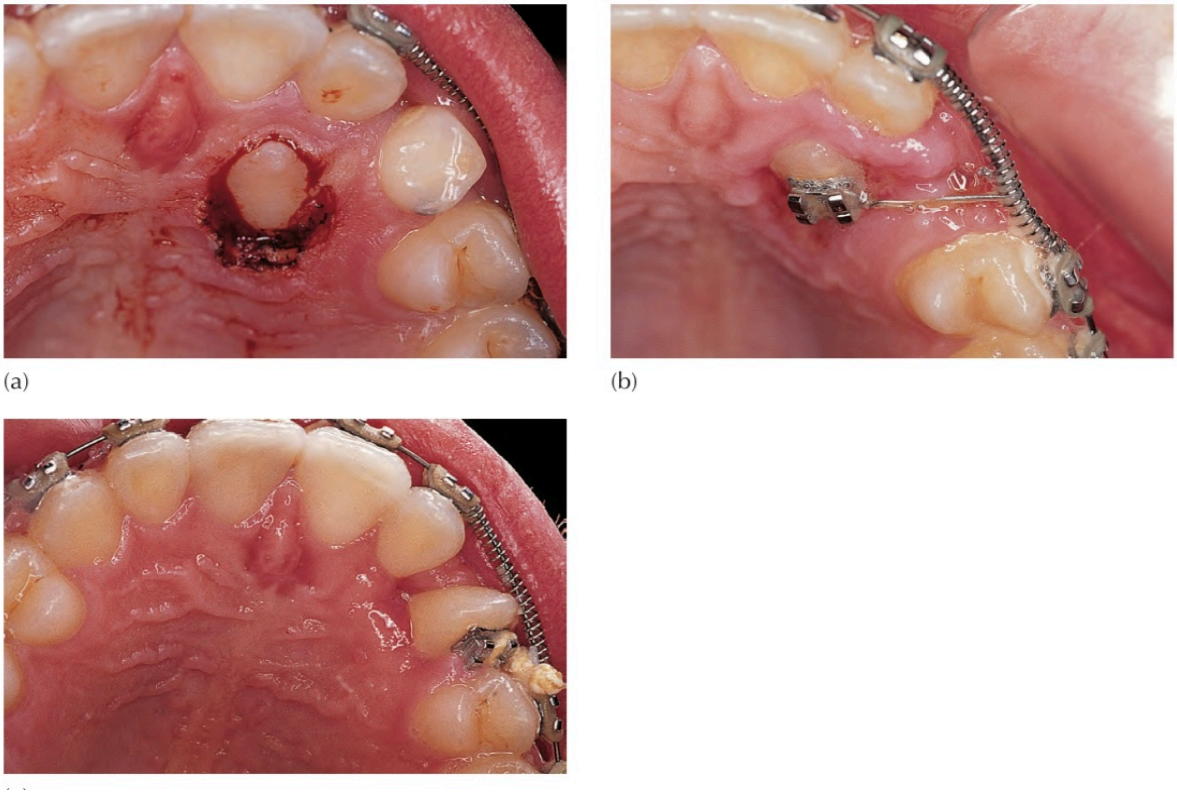

Figure (7): Open exposure (a) A group 3 canine has been exposed by an open procedure and healing is by secondary intention (b) An edgewise bracket has been sited on the palatal aspect of the canine. The tooth is being drawn from this palatal attachment directly to a flexible labial archwire (c) The tooth has reached the archwire, and is now rotated a further 30–40°. Note the swollen appearance of the gingiva and its poor contour **(Becker, 2012)**

1.5.2.1 Full flap open exposure

Reflecting a full palatal flap to reveal the crypt of the canine, exposure of the tooth to its maximum circumference and then re-suture the flap back to its former place, after having first excised a circular portion of the mucosa immediately overlying the tooth **(Parkin, 2015).**

1.6 Attachment bonding

With access to the tooth presented during surgery, an attachment needs to be placed in the most convenient location on the crown of the tooth, with a connector leading from the tooth to the exterior. Superficially, it would seem logical to assume that, with an open exposure technique, bonding of an attachment may be performed either at the time of the surgical exposure or at later date. However, experience has shown that the cut and raw mucosal tissues rapidly close within the first few days and access to the tooth may be lost, even when the exposure was very wide. Placement of a surgical pack for the first 2-3 weeks of the healing period will delay the tissue closure, but bonding an attachment deep into a surgically created cavern with an oozing periphery following pack removal, is far from reliable. If we accept that it is preferable to place an attachment at the time of surgery and that the attachment comes into intimate contact with the healing mucosa as the tooth is erupted into the mouth, then a low profile and rounded eyelet must be the attachment of choice. Placing a bulky and a sharply concerned standard bracket as a" back-pack" on the tooth will lead to impingement and consequent inflammation of the gingival tissues as it emerges. This will have a negative effect on the periodontal outcome, particularly in the closed procedure cases. No requirement was established regarding the type of attachment to be bonded in the various treatment centers, so the likelihood that a standard orthodontic bracket was used in fairly unlikely and the consequences could be quite significant **(Parkin, 2012).**

1.7 Methods of orthodontic attachment (Pritam et al., 2015)

1. Lasso wires

2. Elastic ties and modules.

3. Orthodontic attachment of bondable mesh, bracket or eyelet chain or lingual button with ligature chain or to the bonded attachment.

4. Magnets in attractive mode.

5. TADs (Temporary Anchorage Devices).

1.7.1 Lasso wires (Shpira and Kuftinec, 1998)

A lasso wire twisted tightly around the cementoenmel junction was used as an attachment.

Disadvantages:

- Causes irritation of the gingiva.
- Prevents reattachment of the healing tissue
- Causes external resorption and ankyloses at the cementoenamel junction area

1.7.2 Orthodontic brackets, Lingual buttons and eyelet chains (Becker et al., 1996)

Orthodontic brackets can be used as attachments, but the base of the bracket is wide and rigid, thus bonding elsewhere on the tooth apart from mid-buccal region results in bonding failure (Fig. 8,9).

Figure (8): lingual button **(Mathews and kokich, 2013)**

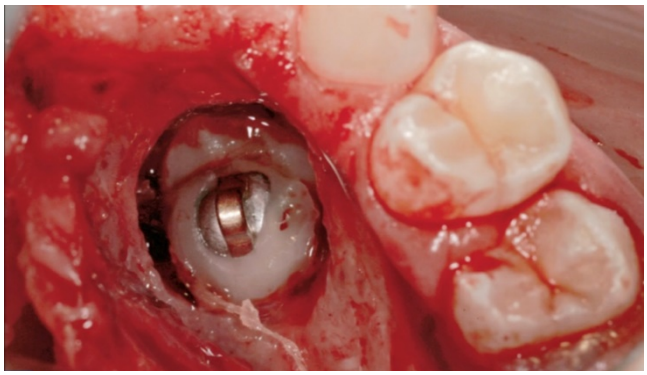

Figure (9): Eyelet chain **(Mathews and kokich, 2013)**

1.7.3 Elastic ties and modules (Pritam et al., 2015)

When tying the elastomeric thread, the knot tends to loosen and much of the original force of the tie is lost in this loosening. The force required for tooth movement decreases over a period of 1 to 3 weeks depending upon the amount of tension applied.

The application of both a flexible arch wire and an elastic ligature is counterm productive, since the elasticity of the one that exerts the stronger force will be effectively neutralized and will offer no physical advantage over steel ligature (Fig. 10).

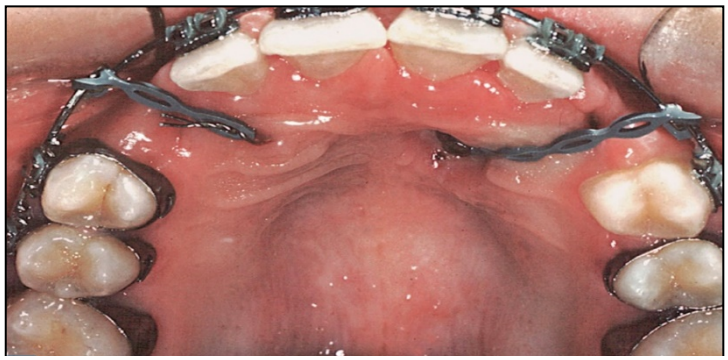

Figure (10): Elastic ties **(Mathews and kokich, 2013)**

1.8 Outcomes of surgical exposure of palatally impacted canine

Probing pocket depth was shown to be increased in cases of palatally mpacted maxillary canine. This increase was reported in the mesio-vestibular, mesio-palatal, disto-vestibular, and disto-palatal aspects of previously palatally impacted canines as well as greater loss of clinical attachment at the mesio-vestibular and mesio-palatal surfaces. This confirmed that the process of alignment of an impacted canine alters the structure of the periodontal tissue, probably due to the long forced eruption process and the tortuous and difficult course the tooth must travel in order to reach the occlusal plane **(Szarmach et al., 2006).**

Furthermore, poor oral hygiene during fixed appliance therapy can lead to a buildup of plaque, rising inflammatory processes detrimental to the health of the periodontium itself **(Frank and Long, 2002).** The probing depths at the mesial and distal aspects of the treated teeth were lower than those of the contralateral and control group teeth **(Woloshyn et al., 1994).** An increased probing depths at vestibular, disto-vestibular/disto-buccal, and disto-palatal/ disto-lingual sites at the end of active orthodontic treatment of impacted maxillary canines was found, whereas at follow-up 3 years later, only the vestibular values were increased. This pattern of improvement over the 3 years, without attachment loss, was due to the apical migration of gingival margin and reduction of the free gingiva **(Crescini et al., 1994).** Another study showed an increase mean probing depth at the mesio-vestibular/mesio-buccal site of the treated tooth was increased compared to the values recorded at all the other sites of the same tooth **(Parkin et al., 2012).**

There was a clinical trial involving young people with a unilateral PDC found no statistically significant differences in the length of time in the operating room or patient-reported outcomes following surgery, between those who were randomly allocated to receive either an Open or Closed surgical procedure. It appears therefore that either technique is acceptable to both the operator and the patient **(Parkin et al., 2012).**

A clinical trial involving 32 patients that are randomly allocated to either an open or closed surgical exposure showing almost identical mean operating time for both techniques which is nearly 30.9 minutes for the open technique and 37.7 minutes for the closed technique **(Gharaibeh and Al-Nimri, 2008).**

Another ectopic canines-focused prospective study involving 60 patients showed longer mean operative time for both exposure techniques (36.4 minutes for open technique and 44.6 minutes for closed techniques). The increased operating time in the Open group was probably because they did not raise a flap over the unerupted tooth, but used an electrosurgical instrument to remove any overlying thick fibrous mucosa, then sutured a periodontal pack in place **(Chaushu et al., 2005).**

Shorter operating time was reported by retrospective audit where patients were treated either with the Open or Closed surgical techniques at two different centers. One center used the open exposure technique and showed a shorter operating time (12 minutes) while the other center used the closed exposure technique (36 minutes). The shorter operating time of open techniques was certainly due to the use of acrylic cover plates that are manufactured before the operation to dress the surgical wound for 10 days following Open exposure, rather than a sutured surgical dressing sutured **(Person et al.,1997).**

The research of **(Iramaneerat et al., 1998)** revealed no significant difference between the two technique. On the other hand, the open technique is slightly quicker by means of canine eruption **(Smailiene et al., 2013).**

It was reported that there is no difference in the pain perception between the two exposure techniques **(Gharaibeh et al., 2008).** A study showed a higher pain perception following open procedure than the closed procedure **(Chaushu et al., 2005).**

A study of Parkin showed no difference in the esthetic outcome between the two techniques **(Parkin et al., 2015).** Meanwhile, it was reported that we can achieve a better esthetic result with the use of closed technique rather than the open technique **(Jonathan et al., 2020).**

As any other surgical procedure, there is an inevitable failure risk that was shown to be more in closed exposure technique as a result of orthodontic attachment debonding. In open procedure, failure risk is due to gingival overgrowth **(Pearson et al., 1997).** There is a much lower failure rate with closed exposure technique **(Caminiti et al., 1998).**

Chapter two: Discussion

Impacted canines generally present a challenge to the clinician attempting to align the dentition naturally. Surgical intervention is often required to expose the impacted canine; a procedure that must be planned carefully to optimize esthetic and functional outcomes. Complications may include uneven gingival height or contour, asymmetrical clinical crown length, relapse of surgical exposure or damage to adjacent teeth **(Vermette et al., 1995).**

To expose a palatally impacted canine to the oral environment, there are mainly two exposure techniques: An 'Open' exposure, which involves raising a palatal flap, removal of bone and mucosa overlying the tooth and placement of a surgical pack. The cuspid is subsequently orthodontically aligned above the mucosa, on the other hand, closed exposure involves raising a palatal flap, limited removal of bone and instead of excision of the overlying palatal mucosa, an attachment is bonded to the crown of the exposed cuspid, allowing alignment of the tooth from below the mucosa **(Parkin et al., 2012).**

There are several advantages and disadvantages of each technique (open and closed), and a debate about which one is preferred over the other.

2.1 Outcomes of open versus closed surgical exposure

2.1.1 Periodontal outcome

A study found that there was no statistical difference for periodontal outcomes in terms of mean pocket depth, gingival recession, bone support, and width of keratinized gingiva between closed and open exposure technique **(Smailiene et al., 2013)**. Similarly, another randomaized clinical trial did not find different periodontal status after treatment for the previously impacted canines between two techniques.

More specifically, level of attachment, crown height, bone support and gingival recession were investigated in terms of comparisons of mean differences between previously impacted canines and their normal contra-laterals for closed and open eruption technique. Statistical tests proved that there is no statistical difference between mean differences in open and those in closed exposure technique for most of the investigated variables **(Parkin et al., 2013).**

2.1.2 Duration of surgical exposure procedure

Regarding the duration of surgical procedure, two studies found significantly less time in the operation room for the open technique **(Gharaibeh et al., 2008 and Pearson et al., 1997)**, while other study reported that there is not any statistically significant difference between the two treatment alternatives **(Parkin et al., 2008).**

2.1.3 Duration of canine eruption

The time needed for canine's eruption, more specifically the duration from the surgical exposure of the canine until it was well positioned in the line of the arch did not differ between the two exposure techniques **(Iramaneerat et al., 1998).** On the other hand, it was reported that the eruption of impacted canine was quicker for the patient group treated with open technique. These investigators assessed the duration from surgery until a bracket can be bonded on the middle of canine's labial surface **(Smailiene et al., 2013).**

2.1.4 Pain perception

Perception of pain after surgical exposure of canines is investigated in previous studies which reported that there is no difference in the amount of pain between closed and open technique. A moderate degree of discomfort was observed

after the procedure, which disappeared few days later **(Parkin et al., 2012 and Gharaibeh et al., 2008).**

2.1.5 Aesthetic outcomes

The assessment of the inclination, shape and color of the treated canines did not show any difference between the open and closed procedures **(Smailiene et al., 2013).** On the other hand, it was reported that the frequency of correct identification of the operated canine and the frequency that the previously impacted tooth was considered aesthetically better than its contralateral did not differ significantly between closed and open exposure technique groups **(Parkin et al., 2015).**

2.1.6 Complications of orthodontic treatment

The result of the different articles is inconsistent. Over two-fold failure rate was found for the group treated with closed exposure technique in comparison with the group that had undergone the open exposure technique **(Pearson et al., 1997).**

On the other hand, 9.6 per cent of the patients treated with open technique required re-exposure of the canine, while the corresponding rate for the closed technique was only 2.9 per cent. However, there was not any statistical test to prove any significant difference **(Parkin et al., 2012).**

Chapter three: Conclusion and suggestion

Most of the mentioned studies revealed no significant difference between both exposure techniques with regards to the discussed outcomes (Periodontal, duration of surgical procedure and canine eruption, patient's inconvenience, aesthetics results and other complications).

More comprehensive reviews should be done in the future to involve labially impacted canines.

References

(A)

Almuhtaseb, E., Mao, J., Mahony, D., Bader, R. and Zhang, Z.X. (2014). Three-dimensional localization of impacted canines and root resorption assessment using cone beam computed tomography. *Journal of Huazhong University of Science and Technology-Medical Sciences,* 34(3):425-430.

Al-Nimri, K.S. and Bsoul, E. (2011) Maxillary palatal canine impaction displacement in subjects with congenitally missing maxillary lateral incisors. *American Journal of Orthodontics and Dentofacial Orthopedics*, 140:81-86.

Alqerban, A., Jacobs, R., Fieuws, S. and Willems, G. (2011). Comparison of two cone beam computed tomographic systems versus panoramic imaging for localization of impacted maxillary canines and detection of root resorption. *European Journal of Orthodontics*, 33:39-102

Alqerban, A., Storms, A.S., Voet, M., Fieuws, S. and Willems, G. (2016). Early prediction of maxillary canine impaction. Dentomaxillofacial Radiology, 45(3):20150232.

(B)

Becker, A. 2nd ed. (2007) *The Orthodontic Treatment of Impacted Teeth.*

London: Informa Healthcare.

Bishara, S.E. Impacted maxillary canines: A review. *American Journal of Orthodontics and Dentofacial Orthopedics,* 1992;101:159–71.

Becker, A. (2012). The orthodontic treatment of impacted teeth. 3rd ed., *Oxford: Wiley Blackwell*

Becker, A., N.I.R, S. and A.R.Y.E, S. (1996). Attachment bonding to impacted teeth at the time of surgical exposure. *European Journal of Orthodontics,* 18:457-463

(C)

Caminiti, M.F., Sandor, G.K., Giambattistini, C. and Tompson, B. (1998) Outcomes of the surgical exposure, bonding and eruption of 82 impacted maxillary canines. *Journal of the Canadian Dental Association,* 64:572.

Chaushu, S., Becker A., Zeltser, R., Branski, S., Vasker, N. and Chaushu, G. (2005) Patients perception of recovery after exposure of impacted teeth: a comparison of closed- versus open-eruption techniques. *Journal of Oral and Maxillofacial Surgery,* 63, 323–329.

Crescini, A., Clauser, C., Giorgetti, R., Cortellini, P. and Pini Prato, G.P. (1994) Tunnel traction of infraosseous impacted canines. A three-year periodontal follow-up. *American Journal of Orthodontics and Dentofacial Orthopedics,* 105: 61 – 72.

(D)

Dağsuyu, İ.M., Kahraman, F. and Okşayan, R. (2018). Three-dimensional evaluation of angular, linear, and resorption features of maxillary impacted canines on cone-beam computed tomography. *Oral radiology,* 34(1):66-72.

(F)

Frank, C.A. and Long, M. (2002) Periodontal concerns associated with the orthodontic treatment of impacted teeth. *American Journal of Orthodontics and Dentofacial Orthopedics,* 121: 639 – 649.

(G)

Gharaibeh, T.M. and Al-Nimri, K.S. (2008) Postoperative pain after surgical exposure of palatally impacted canines: closed-eruption versus open eruption, a prospective randomized study. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics,* 106, 339–342.

(I)

Iramaneerat, S., Cunningham, S.J. and Horrocks, E.N. (1998) The effect of two alternative methods of canine exposure upon subsequent duration of orthodontic treatment. *International Journal of Paediatric Dentistry,* 8, 123–129.

(J)

Jonathan Luyten, Koenraad Grisar, Reinhilde Jacobs and Constantinus Politis (2020) A retrospective long-term pulpal, periodontal, and esthetic, follow-up of palatally impacted canines treated with an open or closed surgical exposure technique using the Maxillary. *American Association of Orthodontists.*

(K)

Kumar, S., Mehrotra, P., Bhagchandani, J., Singh, A., Garg, A., Sharma, A. and Yadav, H. (2015). Localization of impacted canines. *Journal of Clinical and Diagnostic Research,* 9(1): ZE11-4.

Krishnamurthy Bonanthaya, Elavenil Panneerselvam, Suvy Manuel, Vinay, V., Kumar and Anshul Rai (2021). Oral and Maxillofacial Surgery for the Clinician, 978-981-15-1345-9.

(L)

Litsas, G. and Acar, A. (2011). A review of early displaced maxillary canines: Etiology, diagnosis and interceptive treatment. *Open Dentistry Journal,* 25:39-47.

Liu, D.G., Zhang, W.L., Zhang, Z.Y., Wu, Y.T. and Ma, X.C. (2008). Localization of impacted maxillary canines and observation of adjacent incisor resorption with cone-beam computed tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol Endodontic,* 105:91-8.

(N)

Nagpal, A., Pai, K.M., Setty, S. and Sharma, G. (2009). Localization of impacted maxillary canines using panoramic radiography. *Journal of Oral Science,* 51(1):37-45.

(P)

Parkin, N.A., Deery, C., Smith, A.M., Tinsley, D., Sandler, J. and Benson, P.E. (2012) No difference in surgical outcomes between open and closed exposure of palatally displaced maxillary canines. *Journal of Oral and Maxillofacial Surgery,* 70, 2026–34.

Parkin, N.A., Freeman, J.V., Deery, C. and Benson, P.E. (2015) Esthetic judgments of palatally displaced canines 3 months postdebond after surgical exposure with either a closed or an open technique. *American Journal of Orthodontics and Dentofacial Orthopedics*, 147, 173–181.

Parkin, N.A., Milner, R.S., Deery, C., Tinsley, D., Smith, A.M., Germain, P., Freeman, J.V., Bell, S.J. and Benson, P.E. (2013) Periodontal health of palatally displaced canines treated with open or closed surgical technique: a multicenter, randomized controlled trial. *American Journal of Orthodontics and Dentofacial Orthopedics,* 144, 176–184.

Parkin, N., Benson, P.E., Thind, B. and Shah, A. (2008) Open versus closed surgical exposure of canine teeth that are displaced in the roof of the mouth. *The Cochrane Database of Systematic Reviews,* 8, CD006966.

Pearson, M.H., Robinson, S.N., Reed, R., Birnie, D.J. and Zaki, G.A. (1997) Management of palatally impacted canines: the findings of a collaborative study. E*uropean Journal of Orthodontics,* 19, 511–515.

Pritam Mohanty, Swati Saraswata Acharya, Subha Soumya Dany, Debapreeti Mohanty (2015). Maxillary canine impaction and its management –A review. *International Journal of Contemporary Medical Research,* 2(4):949-955

Proffit William, R., Fields Henry, W. and Sarver David, M. (2019) *Contemporary orthodontics,* St. Louis, Mo.: Mosby Elsevier.

(S)

Shapira, Y. and Kuftinec, M.M. (1998) Early diagnosis and interception of potential maxillary canine impaction. *J Am Dent Association,* 129: 1450-1454.

Smailienė, D., Kavaliauskienė, A. and Pacauskienė, I. (2013) Post treatment status of palatally impacted maxillary canines treated applying 2 different surgical-orthodontic methods. *Medicina (Kaunas),* 49, 354–360.

Smailiene, D., Kavaliauskiene, A., Pacauskiene, I., Zasciurinskiene, E. and Bjerklin, K. (2013) Palatally impacted maxillary canines: choice of surgical-

orthodontic treatment method does not influence post-treatment periodontal status. A controlled prospective study. *European Journal of Orthodontics,* 35, 803–810.

Szarmach, I.J., Szarmach, J., Waszkiel, D. and Paniczko, A. (2006) Assessment of periodontal status following the alignment of impacted permanent maxillary canine teeth. *Advances in Medical Sciences,* 51: 204 – 209.

(V)

Vermette, M.E., Kokich, V.G. and Kennedy, D.B. (1995) Uncovering labially impacted teeth: apically positioned flap and closed-eruption techniques. *Angle Orthodontist,* 65: 23-32.

Vincent, G., Kokich, David, P. and Mathews. (2013). *Orthodontic and surgical management of impacted teeth*.

(W)

Walker, L., Enciso, R. and Mah, J. (2005). Three-dimensional localization of maxillary canines with cone-beam computed tomography. Americn Journal of Orthodontics and Dentofacial Orthopedics, 128(4):418-423.

Wedl, JS., Schoder, V., Blake, F.A., Schmelzle, R., Friedrich, R.E. 2004. Eruption times of permenant teeth in teenage boys and boys in Izmir (Turkey). *J Clin Forensic Med,* 11(6):299-302.

Woloshyn, H., Årtun, J., Kennedy, D.B. and Joondeph D.R. (1994) Pulpal and periodontal reactions to orthodontic alignment of palatally impacted canines. *Angle Orthodontist*, 64: 257 – 264.

(Z)

Zasciurinskiene, E., Bjerklin, K., Smailiene, D., Sidlauskas, A. and Puisys, A. (2008) Initial vertical and horizontal position of palatally impacted maxillary canine and effect on periodontal status following surgical-orthodontic treatment. *Angle Orthodontist,* 78: 275-280.