

Surgical management of impacted upper canines – a review of the literature

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ABSTRACT

Introduction: Impacted teeth are characterized by fully developed roots and a location within the bone that persists beyond the expected time of eruption. They can be identified through clinical, extraoral, intraoral, and radiographic examinations. Teeth can be impacted unilaterally or bilaterally within the dental arch. Upper canines are the second most commonly impacted teeth (1–4%), following lower third molars. Impacted canines are more common in women, who usually develop palatal impaction (PIC). This article aims to summarize the current understanding of the surgical management of impacted upper canines.

Materials and methods: The literature review was conducted using the Scopus and Wiley databases. All open-access English-language articles on impacted canines, published between 2017–2021, were included in the analysis. The search terms used were: impacted canine, impacted canine teeth, impacted canine surgical, and orthodontic treatment. The search yielded a total of 216 records. Studies focused on the impact of upper canines, as well as surgical and orthodontic treatment, were included, while book chapters were excluded. The evaluation of the articles was

performed, and duplicate records were disregarded. A total of 25 articles were included in the literature review.

Etiology: The main factors causing the retention of upper canines are divided into systemic, genetic, and local categories, with local factors being the most common cause of these abnormalities.

Clinical and radiological diagnostics: Diagnosis of impacted upper canines includes anamnesis, clinical examination, and radiological evaluation. The initial screening typically involves a panoramic radiograph. Cone-beam computed tomography (CBCT) provides the most accurate localization of the impacted canine. A comprehensive clinical and radiological diagnosis enables proper planning of surgical procedures and orthodontic treatment.

Treatment: Treatment of impacted upper canines can be surgical, orthodontic, or a combination of both in a team-based approach. The management strategies vary, and therapeutic success depends on well-planned and carefully executed surgical and orthodontic procedures.

Keywords: impacted canines; surgical approach; therapeutic methods; orthodontic treatment.

INTRODUCTION

Tooth impaction is defined as a situation where a tooth cannot erupt into its normal position [1]. Impacted teeth are characterized by fully developed roots and a location inside the bone that persists beyond the expected time of eruption [2]. Disturbances in the normal period of tooth eruption may result from an impediment in the eruption path or the ectopic position of the tooth germ [3]. Impacted teeth can be observed through clinical and radiographic examination [1]. They may be impacted bilaterally or unilaterally in the dental arch, or they may be ectopic [3, 4]. Canines are the second most commonly impacted teeth, after mandibular third molars [1]. The incidence ranges 1–4%, with maxillary canines affected in about 2%. Among patients with this abnormality, only 8% have bilateral retention of maxillary canines [5].

Impaction of upper canines shows a gender predilection, being more common in women, with a ratio of 3 : 1. Palatal upper canine impaction (PIC) is more frequent than buccal upper canine impaction (BIC), with a ratio of 6 : 1 [6]. Additionally, impacted

teeth are usually covered only by soft tissues in as many as 90% of cases [7].

Early diagnosis and prompt treatment are crucial in clinical management, saving time and preventing the need for more complicated treatments later on [2]. Various methods exist for treating impacted upper canines, such as surgical exposure of the tooth followed by orthodontic insertion into the dental arch, extraction of the impacted canine and closure of the space with braces, autotransplantation, or observation [1]. Observation is important for monitoring the development and eruption stage of canines in growing children, which helps prevent potential complications.

In the present study, we focused on surgical approaches to the treatment of impacted upper canines. The aim of this paper is to present current perspectives, summarize available data on the incidence of canine impaction and transmigration, provide an overview of the etiology, and evaluate treatment methods, including surgical, orthodontic, or team-based surgical and orthodontic approaches, based on the available literature.

MATERIALS AND METHODS

The literature review was conducted using the Scopus and Wiley databases. All open-access English-language articles on impacted canines, published between 2017–2021, were included in the analysis. Articles were manually screened and selected based on their titles, keywords, study methodology, and reference lists. The search terms used included: impacted canine, impacted canine teeth, and impacted canine surgical and orthodontic treatment. An additional search for relevant articles was also performed in the Scopus and Wiley databases. Literature reviews, abstracts, author debates, summary articles, and animal studies were excluded.

The search yielded a total of 216 records. Studies in dentistry focusing on impacted canines, as well as surgical and orthodontic treatments, were included, while book chapters were excluded. Articles were evaluated, and duplicate records were removed. The reference lists of the selected articles were reviewed for related studies, which were also searched and considered.

The studies were independently selected for analysis by 3 authors. In cases of disagreement, the study was excluded following a discussion and consensus among the three. Data relevant to the aim of the review were independently extracted from the selected articles. A total of 25 articles met the eligibility criteria and were included in the literature review [1].

ETIOLOGY

The main factors causing the occurrence of impacted canines are divided into systemic, genetic, and local categories. The most common systemic causes include primary failure of eruption (PFE), a syndrome in which parathormone receptor 1 (PTH1R) [8] is implicated in familial eruption failures, radiation, and endocrine disorders such as: hypopituitarism, hypothyroidism, hypoparathyroidism, hormone deficiencies [6], and vitamin A, C, or D deficiencies [7].

Local causes of tooth impaction include a small discrepancy between the length of the dental arch and the size of the teeth, prolonged retention of the deciduous canine [1] – present in the mouth beyond 13.9 years of age in females or 14.6 years of age in males [9] – premature loss of deciduous teeth, abnormal positioning of permanent tooth buds, bending of the tooth root, ankylosis, and cysts around the permanent tooth. Idiopathic origins may also contribute [1]. Most often, the abnormality is caused by local factors such as the presence of an alveolar cleft, root displacement, cysts, or iatrogenic factors [2].

Jacoby divided the causes of canine impaction into 2 primary groups: first, those related to low root resorption of the deciduous tooth, premature resorption of deciduous teeth, injury to the deciduous dentition, eruption disorders, and conditions associated with cleft palate; and second, those related to defective muscle function, systemic diseases, hormonal disorders, and vitamin deficiencies [10].

There are 2 theories related to PIC of the upper canine. The first is the eruption guide theory, which suggests that under

normal conditions, the erupting canine moves along the root of the upper lateral incisor, forming an eruption canal [6]. The close contact between the canine and the root of the upper lateral incisor allows the canine to straighten during eruption, approach the occlusal surface, and establish correct proximal contact with the upper incisors [8]. However, if the root of the upper lateral incisor is absent or distorted, this can prevent the eruption of the permanent upper canine and result in a 2.4 times higher incidence of PIC [2].

The second theory is the genetic theory, which suggests that genetic factors are the predominant cause of palatal displacement of the permanent maxillary canine [5]. This theory proposes a familial predisposition to the abnormality, with studies showing that the familial occurrence of impacted upper canines is observed 2.5 times more often than in the general population. This is often the case in patients with Gardner syndrome, clavicular dysostosis, Down syndrome, or Crouzon syndrome [7].

The most common factors contributing to labial impaction of the upper canine include a long eruption path and insufficient space in the dental arch [5].

CLINICAL AND RADIOLOGICAL DIAGNOSTICS

Patients, often unaware of the presence of impacted canines, typically visit the office seeking to improve the aesthetics of their smile or address functional disorders. After standard clinical and radiological examinations, it is often revealed that the disorder of upper canine eruption is the underlying cause of the patient's complaints [7]. Diagnosis of an impacted maxillary canine typically begins with a clinical examination of the oral cavity, where delayed eruption of the permanent upper canine and prolonged retention of the deciduous canine, persisting in the oral cavity beyond the age of 14–15 years, is noted [5]. Physiologically, upper canines should erupt by 13.9 years in girls and by 14.6 years in boys [9].

Additional signs may include a protrusion on the palatal surface of the maxillary alveolar process in the expected site of canine eruption and the absence of a protrusion on the vestibular side. A distal slope or abnormal displacement of the upper lateral incisor may also be present [5], suggesting a palatally impacted upper canine. Conversely, crowding in the upper dental arch and large tooth size may indicate a buccally impacted maxillary canine. Following clinical examination, radiographic imaging such as a panoramic radiograph [6], intraoral dental radiographs, or cone-beam computed tomography (CBCT) is performed to precisely localize the impacted canine [9].

The literature indicates that resorption of the lateral incisor root caused by an impacted upper canine occurs in 38–66.7% of cases, and CBCT allows for an accurate assessment of this pathology, as well as its impact on premolars adjacent to the canine. This is why CBCT is considered the gold standard for diagnosing impacted teeth [5]. Cone-beam computed tomography helps determine the exact location and position of the impacted tooth within the bone, any root damage to adjacent teeth, and the amount of bone surrounding each tooth. This

information is essential for planning proper surgical access and applying the correct orthodontic forces, which is crucial for successful treatment outcomes [5, 6].

The greatest risk of root resorption of adjacent teeth occurs when the root development of the impacted canine is incomplete. Root development is closely tied to the eruption process and tooth movement. When the impacted canine's root is fully developed and the apex is closed, these processes slow significantly, or the canine may have already reached a fixed position.

After evaluating the position of the adjacent teeth, it is critical to determine the optimal time to initiate surgical-orthodontic treatment to minimize the risk of adverse effects [6]. When diagnosing and preparing a treatment plan, the condition of the dentition and periodontium, oral hygiene, patient motivation [11], and patient age should be considered, particularly when utilizing an orthodontic extractor. In cases where the impacted canine's root development is complete, the success rate of orthodontic treatment is lower. Therefore, in addition to surgically exposing the impacted tooth, a corticotomy procedure is often performed to accelerate orthodontic tooth movement [1].

TREATMENT

The choice of appropriate treatment for impacted canines is based on clinical and radiographic examinations. The main goals of treatment are to improve facial aesthetics, enhance the smile, and optimize the function of the stomatognathic system [6]. Particular attention should be paid to the relationship between the tooth and the alveolar process in the labiolingual dimension, the axial inclination, and the height of the tooth's impaction in the bone [11].

The most physiological form of surgical treatment for impacted upper canines is spontaneous eruption, which is often preceded by the extraction of the retained deciduous tooth. Therefore, when a dentist identifies early signs of impacted canines, early intervention is essential to prevent complications. Timely extraction of the deciduous canine in patients aged 10–13 years can be effective in 80% of cases, particularly for palatally impacted upper permanent canines [5]. However, this method is effective only if the crown of the impacted permanent canine is above the root of the maxillary lateral incisor [11]. If the apex of the upper canine crosses the long axis of the lateral incisor, extraction of the deciduous tooth may not lead to spontaneous eruption, and the success rate drops to 64% [5].

Common surgical treatments for impacted upper canines include closed and open approaches [12], which involve surgically exposing the teeth and attaching orthodontic appliances to guide them into the correct position within the arch. The choice of technique depends on the depth of the tooth's impaction, the anatomy of the affected area, and the type of orthodontic force applied [5]. Achieving correct occlusion, healthy attached gingiva, and proper alveolar bone height is crucial during treatment [2].

The closed method is recommended when the tooth is impacted at mid-alveolar height or higher, near the anterior nasal spine [5].

This technique involves making an incision in the alveolar mucosa between the maxillary lateral incisor and the first premolar. At the ends of the incision, further release incisions must be made to free the mucoperiosteal flap up to behind the mucogingival junction (MGJ). This flap is then peeled back over the impacted upper canine. The ligaments above the tooth are removed, allowing the flap to be freed and fully exposing the impacted tooth [2]. After the bone covering the crown of the tooth is removed [5], an orthodontic bracket is attached to the surface of the impacted tooth. A steel ligature or chain is passed through the flap, allowing traction and extrusion [4]. The site of the exposed canine, at the end of the procedure is covered by a full thickness mucoperiosteal flap. The mucoperiosteal flap is then repositioned and stabilized with sutures [13]. After a week, the sutures are removed, and patients are advised to take pain medication. This technique ensures a stable zone of attached gingiva and good long-term stability [14].

Piezoelectric surgery instruments can be used for the closed technique. These instruments use ultrasound to create microvibrations in the blades, allowing a safe and effective osteotomy. When piezoelectric surgery is used, there is a more rapid formation of new bone than when bone chisel or a round burs are used. It also allows selective cutting of hard tissues in an effort to spare soft tissues. Piezoelectric surgery allows to minimize the trauma [15]. This method also minimizes heating, reducing the risk of osteonecrosis by preserving the vitality of osteocytes [16]. The closed technique involves lifting the mucoperiosteal flap; the bone covering the canine is removed using ultrasonic tools whose tips are shaped like a sphere, with a diamond coating on its surface [17].

The open technique involves creating a mucosal and bony window to expose the crown of the impacted tooth, followed by orthodontic treatment [18]. Common open methods include gingivectomy, the double pedicle graft technique, and the apically positioned flap (APF) [2].

Gingivectomy, the first method, involves removing the gingiva above the impacted canine to expose part of the crown. It is suitable when there is abundant keratinized gingiva, and the crown of the canine is in an intracoronal position relative to the MGJ [7]. In addition, this method is recommended when the impacted tooth is labial to the alveolar process and is located between a lateral incisor and a premolar [19]. The advantage of gingivectomy is the technical ease of performing the procedure, while the disadvantage is the increased risk of postoperative bleeding, which can be eliminated using laser or electrosurgery [20]. Laser surgery improves precision, sterilizes the surgical area, and promotes scar-free wound healing with reduced pain and swelling [21]. The use of low-energy lasers a biostimulatory effect on tissues, or photobiomodulation (FMD), at certain laser wavelengths [22]. Activation of regenerative and healing processes is observed through effects on the electron transport chain, respiratory chain, and oxidation. Reports can be found in the literature that high-intensity laser therapies (HILT), surgical lasers that have a cutting effect on soft tissues, can be successfully used in the removal of soft tissues covering an impacted tooth, as in a gingivectomy procedure. However, the stimulating

effect on eruption of impacted teeth has not been proven [21]. The double pedicle graft [2], also known as the repositioned vestibular flap method [7], uses a double pedicle flap and is indicated when not enough attached gingiva has been removed during gingivectomy, which places the cusp of the erupting canine within the MGJ. This makes it impossible to move the gingiva apically toward the erupting tooth using a double-succulent flap. This procedure requires careful positioning of the flap. If the tooth is erupting at a significant distance from the MGJ, apical positioning of the flap is not a favorable procedure [2].

Another technique, the APF, aims to preserve the gingiva covering the impacted canine, as it is used when there is insufficient keratinized gingiva. This method is also recommended in situations of labial or medial positioning of the tooth in relation to the maxillary alveolar process, as well as distal positioning of the impacted tooth in relation to the lateral upper incisor [19]. It involves the creation of a mucosal, mucogingival [7] or mucoperiosteal flap [13], which is displaced more apically and is immobilized with a suture at the level of the neck of the impacted tooth, thus exposing its crown [18]. When the tooth is still covered with bone during its exposure, the bony tissue must be removed to access the crown of the impacted tooth and fix an orthodontic bracket [7]. In addition, the area of periosteal bone can be protected from closure of this space with a surgical dressing [13].

Advantages of APF include preservation of the correct width of the attached gingiva, ease of attachment of the bracket to the crown of the tooth, and the ability to control tooth movement until exposure in the arch. Disadvantages of the technique include the potential for an uneven and unsightly gingival margin, an increased length of the clinical crown after treatment, and the possibility of loss of attachment and bone on the labial surface [18].

Another possible therapeutic option is the removal of impacted canines, followed by orthodontic or implant treatment to close the gap left by the missing tooth. Extractions of impacted canines are applicable in cases of unsuccessful exposure procedures and orthodontic treatment. Factors contributing to a poor prognosis include complete root formation, insufficient space in the arch, unfavorable positioning of the canine (e.g., between the roots of the lateral and medial upper incisors), and pathologies related to the crown of the impacted tooth, such as cysts or inflammation [5].

Yet another method is the autotransplantation of impacted teeth into their target position in the arch [23]. This procedure involves harvesting a graft that consists of a bone block along with a tooth whose root is covered with bone. The graft is then transplanted to the top of the alveolar ridge at a site prepared in advance by the orthodontist. The gap created at the site where the graft is taken is filled with allogeneic bone granules along with cell-rich fibrin. The graft, along with the tooth, is stabilized with a ligature for a period of 3 months. After this time, the ligature is removed and an orthodontic bracket is attached to the transplanted tooth for further stabilization [24]. This method is the treatment of choice when surgical exposure and orthodontic relocation are impossible or too difficult.

Another procedure, especially in adult patients, is corticotomy. This procedure aids and accelerates orthodontic treatment by cutting or perforating the outer compact bone. The procedure has several advantages: it speeds up tooth movement, provides safe expansion of the alveolar process, accelerates the integration of retained teeth into the arch [25], and reduces the time needed to move impacted teeth in adults by up to 33% [1]. The procedure involves creating a mucoperiosteal flap over the roots of the teeth, both buccally and palatally. Then, using a surgical drill, cuts are made within the lamina on both sides of the alveolar process. Vertical cuts are made between the roots of the teeth, from a few millimeters from the edges of the alveolar process up to above the root apices, and horizontal cuts connect the vertical incisions above the root apices. The next step is placing bone substitute material in the osteotomy area, which increases the bucco-lingual dimension of the alveolar process. Two weeks after the procedure, orthodontic forces are applied to the teeth [25].

CONCLUSION

The permanent upper canines are important teeth for dental arch esthetics and facial and smile appearance. They also play a crucial functional role in lateral articulation movements. Currently, many methods and various techniques are available for the treatment of impacted teeth, including canines. Close cooperation between the dental surgeon and orthodontist plays a very important role in achieving therapeutic success. Clinical examination and radiological diagnosis at the initial stage of treatment determine the correct choice of treatment plan. These assessments allow for the determination of the tooth's position in relation to the alveolar process, adjacent teeth, and the MGJ, as well as an evaluation of the amount of keratinized gingiva, helping to avoid incorrect diagnoses and inappropriate treatment choices.

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