Tooth impaction is a common dental condition ranging from 0.8–3.6% of the general population [3, 4]. A tooth normally erupts when half to three-quarters of its final root length has developed. Impaction is usually diagnosed well after this period and is generally asymptomatic. It is principally for this reason that patients seek treatment later than optimal. Tooth impaction is a common problem in daily orthodontic practice and, in most cases, it is recognized by chance in a routine dental examination. Therefore, it is very important that dental practitioners are aware of this condition, since early detection and intervention may help to prevent many harmful complications. The treatment of impacted teeth requires multidisciplinary cooperation between orthodontists, oral surgeons and sometimes periodontists. Orthodontic treatment and surgical exposure of impacted teeth are performed in order to bring the impacted tooth into the line of the arch. The treatment is long, more complicated and challenging. This article presents an overview of the prevalence, etiology, diagnosis, treatment and complications associated with the management of impacted teeth (Adv Clin Exp Med 2016, 25, 3, 575–585).

Key words: etiology, impacted teeth, surgical techniques, orthodontic treatment, multidisciplinary treatment.
6:6:1 [15]. According to Ericson and Kurol, the incidence of palatally impacted canines in relation to buccally impacted canines is 85% to 15%, respectively [16]. Also, various but significant differences in the occurrence of impaction between females and males have been reported, such as 2.3 to 1 (American population [6]), 2.5 to 1 (Israeli population [17]) and 3 to 1 (Welsh population [18]).

In the population of patients who are referred to regional hospitals, the prevalence of unerupted maxillary central incisors (Fig. 3–4) has been estimated as 2.6% [19]. Some studies indicate that 0.42–2.1% of patients suffer from central incisor impaction due to the presence of supernumerary teeth [20].
Etiology

The etiology of tooth impaction is multifactorial. In the literature, the most commonly reported etiological factors related to tooth impaction can be divided into three different groups: systemic, local and genetic [1, 3, 21–22]:

1. **Systemic factors:**
   1) endocrine deficiencies (e.g. hypothyroidism),
   2) radiation therapy,
   3) cleidocranial dysostosis,
   4) *amelogenesis imperfecta*.
II. Local factors:
1) failure of deciduous tooth resorption,
2) premature loss of a deciduous tooth,
3) prolonged retention of a deciduous tooth,
4) abnormal eruptive path,
5) presence of a supernumerary tooth/teeth,
Impacted Teeth

6) dental crowding and space loss,
7) early extraction of a deciduous tooth,
8) enlarged dental follicle/dentigerous cyst or other forms of soft tissue pathology (neoplasm),
9) thickened post-extraction or post-trauma repair of the mucosa,
10) dental trauma,
11) odontoma,
12) anomaly in the position of a tooth (e.g. tilting, displacement, transmigration),
13) ankylosis of deciduous molars,
14) root dilacerations,
15) alveolar cleft.

III. Genetic factors:
1) hereditary factors such as a malposed tooth germ and presence of an alveolar cleft.

Third Molars

The most common cause of impaction of the third molars (Fig. 1) is the discrepancy between jaw and tooth size, e.g. lack of space in the lower arch [23].

Maxillary Canines

There are two main theories related to the etiology of palatally impacted maxillary canines (Fig. 2), the genetic theory [24, 25] and the guidance theory [17, 26, 27]. The genetic theory declares that maxillary palatal impaction has familial and hereditary component and includes other associated dental anomalies, such as missing or small lateral incisors [24]. Additionally, impaction of upper canines is correlated with enamel hypoplasia, infraocclusion of primary molars, aplasia of second premolars and small size of maxillary upper lateral incisors [28]. According to the guidance theory, the canine erupts along the distal surface of the root of the lateral incisor, which serves as a guide. If the root of the lateral incisor is absent or malformed (peg-shaped), the canine may not erupt [1, 29]. Palatal displacement of canines can occur when the cuspids have sufficient or even excessive space in the maxilla. In the case of buccally impacted canines, the most probable reason is dental crowding [15].
Maxillary Central Incisors

The most common cause of impaction of the maxillary central incisor (Fig. 3–4) is the presence of a supernumerary tooth including a mesiodens [1, 30].

Diagnosis, Timing and Prevention

During the clinical examination, we should always suspect the impaction of a permanent tooth, when: 1) its normal time of eruption is exceeded, 2) there is insufficient space for tooth eruption,
3) in case of the malposition or malformation of the adjacent teeth such as rotations, or 4) in case of over-retention of deciduous teeth [31]. Moreover, the upper permanent canines should be palpated buccally after the age of 10 years [12, 15]. The presence of congenitally missing, small or peg-shaped upper lateral incisors may also indicate palatal canine impaction [1, 17, 29].

The most common radiographic methods in the diagnosis of tooth impaction are periapical or panoramic radiographs (OPG). However, in many cases, a diagnosis based on 2D radiography is not sufficient, because it is very difficult to assess the buccolingual aspects of the relation between the canine crown and the roots of the incisors [32, 33]. Nowadays, three-dimensional diagnosis of tooth position, such as computerized tomography (CT) or cone beam computerized tomography (CBCT), is considered to be the best diagnostic tool to assess tooth impaction [33, 34].

However, special measurements performed on panoramic radiographs can help us to predict the risk of canine impaction, which include: angula-

Fig. 4. 13-year old boy with impacted maxillary left central incisor; A – panoramic view

Fig. 4B. Periapical view

Fig. 4C. Axial and transaxial CBCT views
tion of the long axis of the canine to the midline more than 30°, the position of the canine root apex antero-posteriorly above the upper first premolar region, vertical canine crown height above the cementoenamel junction but less than half way up relative to the adjacent upper incisor root or complete or even more horizontal canine overlap of the adjacent incisor root width [21, 35, 36]. When the canine cusp tip is located mesial to the long axis of the lateral incisor root, the canine can be palatally impacted. When the canine cusp tip overlays the distal half of the lateral incisor root, the risk of impaction is much lower [12].

Regarding periapical radiographs, it is advisable to obtain two or even three views of the same object, taken from slightly different angles, which can help us to distinguish between buccal and palatal canine impaction. This technique is known as a “tubeshift” or a “rule of Clark” [1, 31, 37]. The first radiograph is taken at mesial eccentric projection, the second radiograph is taken with the central beam positioned perpendicular to the alveolar process and the third one in an eccentric distal projection. If the tooth moves in the same direction as the source of X-rays, then the tooth is positioned palatally. Conversely, if the tooth moves in the opposite direction, it is considered to be displaced buccally [1, 31, 37].

If the position of an unerupted permanent upper canine is unfavorable, we may consider extraction of the deciduous canine at the age of 10 to 13 years [1, 12, 16] or concomitant extraction of the deciduous canine and first molar [38]. According to Ericson and Kurol, 78% of ectopic canines showed normalization of the path of eruption and, later, clinically correct position at the final control after extraction of the primary canines [16], while Bonetti et al. reported favorable clinical outcomes in a group of patients having extraction of only the deciduous canine (78.6%) compared to a group with concomitant extraction of the deciduous canine and first molar (97.3%) [38]. Surgical exposure followed by orthodontic treatment, if needed, should be performed preferably before closure of the root apex.

**Interdisciplinary Treatment**

There are 3 main options in the management of impacted teeth: 1) extraction of an impacted tooth, 2) extraction of an adjacent tooth or 3) non-extraction treatment involving orthodontic space opening and surgical exposure [1].

When non-extraction treatment is performed, the orthodontic treatment is often initiated before the surgical exposure in order to align the teeth, to open the space for the impacted tooth and to enhance the natural eruption process [1]. At the surgery, any hard or soft tissue obstruction is removed and the unerupted tooth is exposed. Then, an attachment is placed on the impacted tooth, either at surgery or shortly thereafter [5]. The pres-
Impacted Teeth

Open Eruption Technique

The open eruption technique (Fig. 2E) involves the surgical removal of a circular section of the overlying mucosa and the alveolar bone, covering the impacted tooth [1, 40]. Afterwards, an attachment, such as an eyelet or button, can be bonded and orthodontic traction may be performed immediately [1]. The Ballista spring (Fig. 5), which is an auxiliary stainless steel archwire attached to the main archwire, may be used in order to bring the impacted tooth into the dental arch [1].

This method has both advantages and disadvantages as compared to the closed eruption technique [1]:

Advantages:
- simple and direct method,
- orthodontist’s presence during surgery is not needed,
- in case of bonding failure, there is no need for a second surgical exposure.

Disadvantages:
- can result in poorer periodontal outcome,
- increased risk of infection,
- greater discomfort to the patient,
- more extensive removal of alveolar bone,
- bad taste and breath in the mouth,
- risk of closure of the exposure,
- increased bonding failure,
- additional visits to change the surgical dressing.

Apically Repositioned Flap

The apically repositioned flap is a modification of the open exposure technique. It includes the raising of a labial flap, including the attached gingiva, which is taken from the crest of the alveolar ridge and relocated higher up, and then is followed by suturing it on the buccal side of the crown of the newly exposed tooth. The main advantage of this method is the improved periodontal outcome compared to the open eruption technique by ensuring that the attached gingiva covers the labial aspect of the erupted tooth [41]. This method is well-known and generally accepted in the periodontal management of buccally displaced teeth [41]. The apically repositioned flap is performed when the tooth is located mesio-distally fairly close to its final position and a bulging of the oral mucosa appears at its junction with the attached gingiva [1].

The main advantages and disadvantages of this method may include [1]:

Advantages:
- good access for attachment bonding,
- faster eruption,
- easy follow-up.

Disadvantages:
- unfavorable gingival contour.

Closed Eruption Technique (Primary Full Flap Closure)

The closed eruption technique (Fig. 2D, 3D, 4D) involves bonding an attachment at the time of the exposure. The tissues are fully replaced and sutured to their former places, to re-cover the impacted tooth [1]. In a case when a canine is very high up and following the raising of a palatal flap, the canine will be revealed together with the thin bone covering the palatal aspect of the roots of the adjacent teeth. Below and distally to the canine is the vertical wall of the alveolar process. Bonding of the eyelet attachment is performed in the usual manner on the palatal side of the tooth [1, 41].

The main advantages and disadvantages of this method include [1]:

Advantages:
- fast healing,
- less discomfort,
- good postoperative homeostasis,
- less intense functional disturbances,
- less extensive removal of alveolar bone,
- possibility of an immediate traction,
- applicable close to resorbing root.

Disadvantages:
- presence of an orthodontist may be needed during the surgery,
- in case of a bonding failure, re-exposure is needed.
Complications

The most frequent complications associated with untreated impacted teeth include [1]:

1) morbidity of the deciduous predecessor and migration of the adjacent teeth,
2) development of a dental cyst,
3) resorption of a crown of an impacted tooth,
4) resorption of the roots of adjacent teeth,
5) ankyloses,
6) infraocclusion,
7) pain and/or discharge (related to infected cysts, tumors),
8) displacement of the adjacent teeth and shortening of the dental arch.

Summary

The etiology of tooth impaction is multifactorial. Patients with impacted teeth are often referred for orthodontic help by general dentists. Their treatment is challenging and requires an interdisciplinary approach, however early detection of tooth impaction can prevent many unwanted complications by instituting preventive measures.

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References:

Impacted Teeth


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