Radiološke značilnosti neizraslih zob
Radiographic characteristics of impacted teeth

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Izvleček

Namen: *Namen retrospektivne študije je ugotoviti pogostnost posameznih neizraslih zob in položaj le-teh v kosti ter izid zdravljenja neizraslih zob pri preiskovancih, obravnavanih v specialistični ambulanti za zobno in čeljustno ortopedijo v 11- letnem obdobju.*

Metode: *V retrospektivno študijo je bilo vključenih 1909 ortodontskih pacientov, pri katerih smo ugotavljali prisotnost neizraslega zoba. Podatke smo pridobili iz ortodontske dokumentacije, ki vključuje ortopantomogram, anamnestične in klinične podatke. Ugotavljali smo pogostnost neizraslih zob ter število, vrsto in položaj teh zob pri preiskovancih. Prav tako nas je zanimala dolžina trajanja ortodontskega vleka zoba iz čeljustne kosti v zobno vrsto.*

Rezultati: *Pri 63 (3,3 %) ortodontsko obravnavanih pacientih smo odkrili vsaj en neizrasli zob. Zgornji podočnik (2,4 %) je bil najpogosteje impaktiran zob, sledijo zgornji in spodnji drugi ličniki (0,4 %). Pri večini*

Abstract

Purpose: *This study was performed to determine the prevalence, infraosseous position and treatment outcome of impacted teeth in patients treated at our Orthodontic Department over an 11-year period.*

Methods: *This retrospective study of orthodontic records was performed on 1,909 patients, who were examined for impacted teeth. It comprised panoramic radiographs, anamnestic and clinical data. We determined the number of subjects with impacted teeth and the number, type and location of the impacted teeth in these subjects. We were also interested in the duration of orthodontic traction with the purpose of bringing the impacted teeth into the dental arch.*

Results: *Sixty-three (3.3%) out of 1,909 treated orthodontic patients were found to have at least one impacted tooth. A maxillary canine (2.4%) was the most frequently impacted tooth, followed by maxillary and mandibular premolars (0.4%). The major-*

pacientov je neizrasel en (73 %) ali dva (25,4 %) zoba. Ortodontski vlek neizraslega zoba v zobno vrsto je bil najdaljši pri zgornjih podočnikih.

Zaključek: *Kadar je načrtovano ortodontsko zdravljenje neizraslih zob, je potrebno poleg števila in vrste neizraslih zob upoštevati tudi položaj neizraslih zob v kosti in odnos do sosednjih struktur.*

ity of patients had one (73%) or two (25.4%) impacted teeth. Maxillary impacted canines required the longest duration of orthodontic traction.

Conclusion: *When orthodontic treatment is performed on patients with impacted teeth, not only the number and the type of the teeth but also the infraosseous position of impacted teeth and their relationship to adjacent structures should be taken into consideration.*

INTRODUCTION

Tooth impaction can be defined as an infraosseous position of the tooth after the expected time of eruption (1). The most commonly impacted teeth are the third molars (2), followed by the maxillary canines (0.8–5.4%) (2–6). Despite the differences reported, an overall evaluation shows that canine impaction is encountered more frequently in females than in males (6). These are also the teeth that most often need orthodontic–surgical treatment (7, 8).

Tooth impaction can be caused by a variety of factors, which may be localized, genetic, or systemic. Primary etiological factors for tooth impaction are lack of space for eruption, ankylosis of the permanent tooth, dilaceration of the root, supernumerary teeth, or a local pathological lesion (cystic and neoplastic formation) (1, 9–11). Two major theories associated with palatal displaced maxillary canines are the guidance theory and the genetic theory (11,

Figure 1. *Panoramic radiograph showing the impacted maxillary canines before treatment.*

12). Other factors that can cause tooth impaction are endocrine diseases, irradiation of the orofacial area, and alveolar and/or palatal cleft (11).

The diagnosis of impacted teeth is based on clinical and radiographic examinations (Figure 1). Various clinical signs of tooth impaction are documented in the dental literature. It is important to know the normal eruption time of teeth in the examined population (13). The traditional radiographs taken to locate the position of impacted teeth are the panoramic, occlusal and two periapicals. The value of these radiographs is primarily a clear display of teeth but the images show tooth position with less accuracy. The most accurate method is to use an advanced three-dimensional imaging technique. Cone beam computed tomography (CBCT) can identify and locate the position of an impacted tooth accurately (11, 14). Using this imaging technique, dentists can also assess any damage to the roots of adjacent teeth and the amount of bone surrounding each tooth. However, radiation exposure from CBCT is greater and the radiation risk should be weighed against the benefits of a precise preoperative diagnosis of an impacted tooth (11, 15).

Impacted teeth are a frequently-encountered clinical problem, the treatment of which usually requires an interdisciplinary approach. The treatment of this clinical entity usually involves surgical exposure of the impacted tooth, followed by orthodontic traction to guide and align it into the dental arch (7, 8) (Figure 2). Two basic surgical techniques are used to expose an impacted tooth: the open exposure technique and the closed exposure technique (16). The success of the therapy depends on the position of the impacted tooth and its relationship to adjacent teeth and other structures. Bone loss, root resorption, and gingival recession around impacted teeth are the most common complications. Early diagnosis and intervention could avoid these unfavorable effects (14).

In this study, we attempted to determine the relative diagnostic importance of radiographic factors, such as tooth angulation to the midline, vertical height of the impacted tooth crown, and canine crown overlap of the adjacent lateral incisor. Another aim of the present study was to evaluate the duration of active orthodontic traction required to bring the impacted tooth into the dental arch.

Figure 2. *Panoramic radiograph after treatment (with the maxillary canines aligned into the dental arch).*

MATERIALS AND METHODS

This study was reviewed and approved by the Medical Ethics Committee of Maribor University Clinical Centre (169/13).

In this retrospective study, the orthodontic records of 1,909 patients (1,081 females and 828 males) were reviewed. Patient age ranged from 12 to 42 years with a mean age of 15 years and 8 months. All patients were treated at the Orthodontic Department between September 2002 and September 2013. Orthodontic records comprised patients' data with clinical findings, study models and panoramic radiographs. Patients with syndromes and developmental anomalies (alveolar cleft and/or palate) were excluded. The minimum age range of patients was in accordance with the normal eruption time of teeth in the examined population (13). Third molars were not included in the study. All patients were examined by the same orthodontist (AF). A tooth was accepted as impacted if the tooth was not exposed to the oral cavity by the end of the normal eruption period and had an infraosseous position on a panoramic radiograph.

The type of impacted tooth was indicated by the international two-digit notation (according to the Federation Dentaire International system). Tracings of the radiographs showing impacted teeth were made on acetate paper using a 0.5 mm lead pencil, in a room with subdued lighting on a standard viewing box. The impacted tooth and the adjacent teeth were traced.

From the panoramic radiographs, the following variables were analyzed:

Tooth angulation to the midline

The angle between the two lines (midline of the jaws and long axis of the impacted tooth, Figure 3) gave the angle of the impacted tooth to the midline, and teeth were grouped as:

Grade 1: 0°–15°
Grade 2: 16°–30°
Grade 3: 31°–45°
Grade 4: 46°–60°
Grade 5: 61°–75°
Grade 6: ≥ 76°

Vertical height of the impacted tooth crown

The crown height was graded in relation to the adjacent tooth (Figure 3):

Grade 1: Above the cement-enamel junction (CEJ), but less than half the length of the adjacent tooth root.
Grade 2: Between one half of the adjacent root length and its full length.

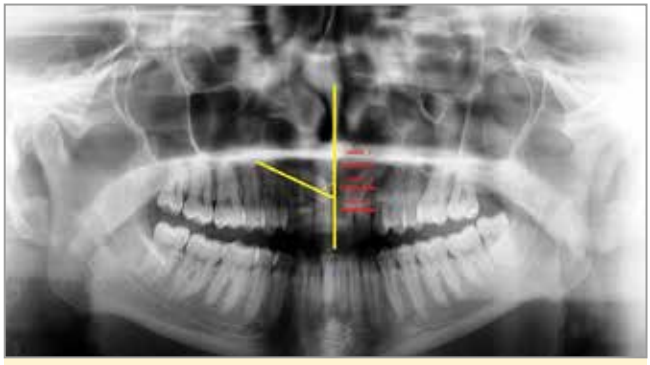

Figure 3. *Tooth angulation to the midline (yellow color) and vertical height (red color) of the impacted tooth crown before treatment (the impacted maxillary canines).*

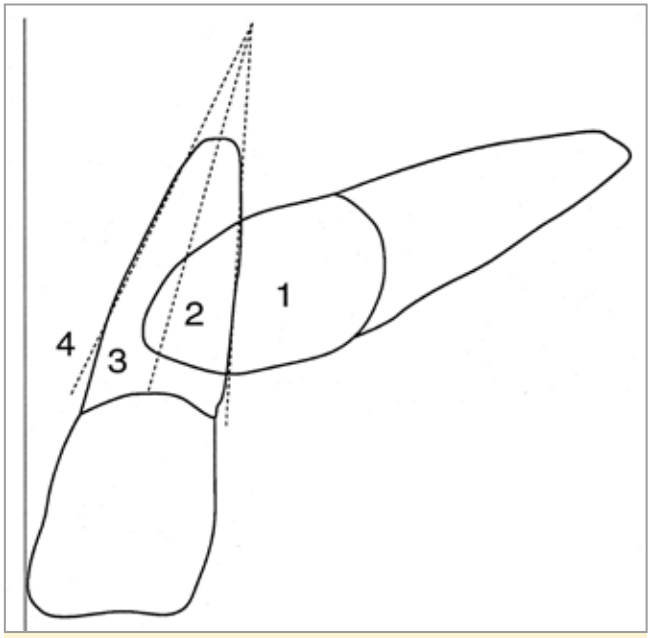

Figure 4. *Canine crown overlap of the lateral incisor.*

Grade 3: Above the full length of the adjacent tooth root.

Canine crown overlap of the lateral incisor (Figure 4)

The contact relationships between the cusp of impacted maxillary canines and the root of adjacent lateral incisors:

Grade 1: Horizontal overlap not seen.
Grade 2: Less than half of the root width of the lateral incisor.
Grade 3: More than half, but less than the whole root width of the lateral incisor.
Grade 4: Complete overlap of the lateral incisor root width or more.

Treatment time

We also evaluated the duration of active orthodontic traction to bring the impacted tooth into the dental arch. Treatment time was measured in months. The start of orthodontic traction of the impacted tooth was defined as the time elapsed between open surgical exposure technique (after arch levelling and creating space for the impacted tooth) and the end of treatment, defined as the time when the tooth was in its proper place in the dental arch. From this perspective, additional abnormalities in the dental arch did not affect the duration of orthodontic traction, as well as the establishment of maximum intercuspation.

Intra-examiner Reliability

All radiographic variables were measured again 2 weeks later by the same examiner. The recorded data were entered into the spreadsheet program Microsoft Office Excel 2007. For statistical analysis, we used the computer program SPSS 10.0 (SPSS, Chicago, IL, USA). Distribution of numerical variables (age of the subjects, duration of treatment) were presented with the appropriate values: the mean, and minimum and maximum data values. Descriptive variables (type of impacted tooth, position of impacted teeth) were presented with absolute and relative frequencies.

RESULTS

In the present study, the incidence of tooth impaction was found to be 3.3%. The distribution of impacted teeth is given in Table 1.

In the 63 patients, a total of 81 impacted teeth – 67 (82.7%) in the upper jaw and 14 (17.3%) in the lower jaw – were found. Forty-seven (58.1%) teeth were impacted on the right side and 34 (41.9%) on the left side. Most commonly, in 46 (73%) patients one permanent tooth was impacted, in 16 (25.4%) patients two teeth were affected, and in one (1.6%) patient three teeth were impacted.

The distribution of the impacted teeth according to the tooth angulation to the midline is presented in Table 2. In 88.9% of the impacted teeth we found the tooth angulation to the midline was less than 46° (Grade 1 to Grade 3). One incisor, three canines and one premolar were almost horizontally positioned (Grade 6).

The distribution of the impacted teeth according to the vertical height of the tooth crown at the start of treatment is presented in Table 3. Generally, the vertical height of the tooth crown was above the CEJ in the main teeth (75.3%), but less than half the length of the adjacent tooth root (Grade 1).

Table 1. *Distribution of impacted teeth in 1909 subjects according to tooth type*

Tooth type	Subjects with impacted tooth	
	N	%
Incisor impaction	2	0.1
Canine impaction	51	2.7
Premolar impaction	8	0.4
Molar impaction	2	0.1
Total impaction	63	3.3

Legend:
N = number of subjects with impacted tooth

Table 2. *Distribution of the impacted teeth according to the tooth angulation to the midline*

Tooth angulation to the midline	Incisor N (%)	Canine N (%)	Premolar N (%)	Molar N (%)	Total N (%)
Grade 1: 0–15°	1 (50)	4 (6.3)	5 (41.7)	0 (0)	10 (12.3)
Grade 2: 16°-30°	0 (0)	31 (48.4)	6 (50)	0 (0)	37 (45.7)
Grade 3: 31°-45°	0 (0)	24 (37.5)	0 (0)	1 (33.3)	25 (30.9)
Grade 4: 46°-60°	0 (0)	2 (3.1)	0 (0)	2 (66.7)	4 (4.9)
Grade 5: 61°-75°	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Grade 6: 76°≤	1 (50)	3 (4.7)	1 (8.3)	0 (0)	5 (6.2)
Total	2 (100)	64 (100)	12 (100)	3 (100)	81 (100)

Table 3. *Distribution of the impacted teeth according to vertical height of the tooth crown*

Vertical height of the tooth crown	Incisor N (%)	Canine N (%)	Premolar N (%)	Molar N (%)	Total N (%)
Grade 1	1 (50%)	49 (76.6%)	9 (75%)	2 (66.7%)	61 (75.3)
Grade 2	1 (50%)	12 (18.7%)	2 (16.7%)	1 (33.3%)	16 (19.8)
Grade 3	0 (0%)	3 (4.7%)	1 (8.3%)	0 (0%)	4 (4.9)
Total	2 (100)	64 (100)	12 (100)	3 (100)	81 (100)

Table 4. *Distribution of impacted canines according to the medial position of the canine crown*

Canine crown overlap of the adjacent incisor	N (%)
Grade 1	6 (9.4)
Grade 2	11 (17.2)
Grade 3	13 (20.3)
Grade 4	(53.1)
Total	64 (100)

Fifty-eight (90.6%) impacted canines were in contact with the adjacent lateral incisor and 26 (40.6%) impacted canines also contacted the central incisor (Table 4).

In the treatment protocol, five impacted teeth were extracted due to their unfavorable position and the remaining seventy-six impacted teeth were surgically exposed for orthodontic treatment. In the five teeth which were almost horizontally positioned above roots of adjacent teeth the risk of damage was too high.

We found that the duration of therapy depended on the tooth type and the position of the impacted tooth. The longest treatment time was found in the maxillary canines with a greater angulation to the midline and greater overlap with the lateral or even central incisor. Orthodontic traction of an impacted upper central incisor lasted 11 months, orthodontic traction of canines lasted from 8 to 17 months (mean ± SD; 12.1 months ± 2.6), premolars from 6 to 11 months (mean ± SD; 8.2 months ± 1.7) and molars 8 to 11 months (mean ± SD; 9.7 months ± 1.5).

DISCUSSION

Impaction of the permanent teeth is a common finding of oral pathology. The results of this study show that impacted teeth are present in 3.3% of patients receiving orthodontic treatment. The third molars were not included in this study.

Impacted maxillary central incisors were found only in two (0.1%) patients, which is comparable with the study of Grover and Lorton (17).

Moyers (18) established that "the upper cuspids move downward, forward and laterally away from the root ends of the laterals". If this has not happened in the last stage, a lack of canine guidance and eruptive anomalies are expected. Maxillary canines are the most commonly impacted teeth, second only to third molars. The incidence ranges from 0.8% to 5.4%, depending on the population examined (2–6). Mandibular canine impaction is regarded as a much less common phenomenon. In studies by Aydin *et al.* (6) and Saglam and Tuzum (19) the incidence of maxillary canine impaction was 3.3% and 2.9%, respectively, while the incidence of mandibular canine impaction was 0.4% and 0.3%, respectively. In this study, the incidence of maxillary canine impaction was 2.4% and that of mandibular canine impaction was 0.3%. Both maxillary canines were impacted in 12 subjects (18.6%), while Bishara (10), Kajan *et al.* (20) and Cotič and Ovsenik (21) reported incidence rates of 8%, 29.1%, and 14.3%, respectively, for bilateral impacted maxillary canines. In this study, the canine angulation to the midline was less than 16° in 6.3% of patients, which is a lower proportion than that reported by Cotič and Ovsenik (21), and in 45.3% of patients the canine angulation to the midline was more than 30°, which is similar to that reported by Cotič and Ovsenik (21). In the current investigation, most (76.6%) of the canines were located between the CEJ and half length of the lateral incisor root, which is a greater incidence than that reported by Cotič and Ovsenik (21) and Stivaros and Mandall (22). Lindauer *et al.* (23) reported that 78% of impacted canines contact the lateral incisor root, while Stivaros and Mandal (22) reported that the overlap of the adjacent lateral incisor root was complete in 55.6% of cases. In this study, 58 (90.6%) impacted canines were in contact with the adjacent lateral incisor root. There was complete overlap of the lateral incisor root in 53.1% of impacted canines, and 40.6% of them were also in contact with the central incisor.

In eight (0.4%) subjects impacted premolars were found, which is comparable with the results of Andreasen *et al.* (24). In this study, an impacted molar was noted in two (0.1%) subjects. Grover and Lorton (17) and Andreasen *et al.* (24) reported a similar prevalence of impacted molars. In the literature we did not find any data on angulation to the midline or vertical height of the impacted tooth crown for impacted central incisors, premolars or molars, therefore our results cannot be compared. Crescini *et al.* (25) reported that the active treatment time in patients with impacted canines was proportional to the overlap of the lateral incisor and was inversely proportional to the angulation to the midline. They indicated that every 5° of widening of the angle (tooth angulation to the midline) required approximately one additional week of traction, and complete crown overlap of a lateral incisor or of half or more of a central incisor required approximately 6 additional weeks of active orthodontic traction when compared to impaction of grade 2. In addition, they reported that the overall duration of orthodontic traction was on average 8.0 ± 2.3 months (range 4–13 months). Mavreas and Athanasiou (26) also found that the treatment time is related to the position of the impacted teeth. In this study, the duration of therapy was found to depend on the type and position of the impacted tooth. The longest treatment time was found for maxillary canines (8 to 17 months (mean ± SD; 12.1 months ± 2.6)) with a greater angulation to the midline and greater overlap with a lateral or even central incisor.

CONCLUSION

Teeth have a high functional, aesthetic, and especially in the case of the canines, gnathological value, so it is important to detect impacted teeth in a timely manner. It is also important to know the normal eruption time for teeth in the general population. The treatment of an impacted tooth is a complex procedure requiring a multidisciplinary approach. It is recommended to start treatment immediately and thus reduce the possibility of potential complications and injury to otherwise healthy teeth.

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