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Spiral computed tomograpy in the evaluation of relations of the impacted maxillary canines and the adjacent incisor roots

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Summary

Background: The relations of the crowns of impacted maxillary canines and the roots of adjacent incisors are difficult to evaluate on conventional radiographs due to superimposition of shadows of these structures. The aim of this study was to analyse the relations between the crowns of impacted canines and the roots of adjacent incisors with the use of computed tomography.

Material/Methods: The study involved a group of 65 patients suspicious for an impacted maxillary permanent canine. All the patients underwent pantomography. In 44 individuals in the age of 13–31 years (mean age 17.1±4.5) the examination revealed shadows of the impacted crowns superimposed on the roots of incisors. These patients were subjected to CT. On the basis of those CT examinations (including multiplanar and three-dimensional reconstructions) we defined the location of the impacted canines as buccal, palatal and horizontal. Likewise, the relations between the crowns of impacted canines and the roots of lateral or/and central incisors were studied.

Results: From among 54 impacted maxillary canines, 41 (75.9%) were located palatally, 10 (18.5%) buccally, and 3 (5.6%) horizontally. In 14 cases (29.5%), the impacted canine remained in various kind of contact with both adjacent incisors. In addition to those aforementioned 14 cases, the impacted maxillary canine remained in contact with adjacent root of the lateral incisor in 34 cases (in total: 48 cases of contact). We found 17 cases (35.4%) of adherence without features of root resorption and 31 cases (64.4%) of resorption. Among the cases of resorption, there were 18 instances of deep resorption (58.1%) and 13 instances of light resorption (41.9%). There were also 18 cases (33.3%) of contact between the impacted canine and the root of the central incisor, including 10 instances (55.6%) of adjacency without root resorption and 8 cases (44.4%) of resorption.

Conclusions: Computed tomography allows for a precise localisation of the impacted teeth and evaluation of their influence on the adjacent anatomical structures.

Key words: impacted canines • incisors • dental radiology • computed tomography

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Background

An impacted tooth is a tooth with a fully developed root which, despite that fact, did not reach its correct position in the dental arch and is still located in the alveolar process. If surrounded with osseous tissue, it is a fully impacted tooth. Partially impacted teeth are the ones with their crown remaining in soft tissues after penetrating the bone. Impacted may be every tooth but permanent maxillary canines are the second most common ones, right after the third premolar mandibular teeth [1–4]. This frequency, according to different authors, amounts to 0.9–5.2% [3–8].

Because the impacted teeth are, by definition, invisible in the clinical examination, this examination should be supplemented with x-ray results. X-ray diagnostics has long been used by orthodontists in examining and planning treatment of that developmental disorder.

Literature on impacted teeth, their diagnostics and treatment mentions different imaging techniques: intraoral x-rays of teeth performed with the use of Cieszyński's rule of isometry, as well as occlusal and extraoral x-rays: pantomographic, panoramic, cephalometric lateral, A-P, and P-A [9–20]. Dental x-ray diagnostics may involve standard and digital procedures. Due to mutual superimposition of the shadows of visualised anatomical structures and hardships in evaluation of the dental roots in buccolingual dimension, the state of the dental roots adjacent to the impacted teeth is hard to assess in the course of conventional radiological methods. Differences in the quality and amount of information following from x-rays make it hard to evaluate the range of the problem, which influences the choice of the treatment method and the course of the therapy.

Computed tomography (CT) used for dental diagnostics has been gaining on popularity in the recent years [2,6,14–30]. There have appeared many articles presenting the application of CT in morphological and structural examinations of the impacted canines [22], as well as in the detection of injured roots of adjacent teeth and the extension of complications [6,23–30].

Introduction of computed tomography resulted in a significant improvement of the quality of diagnostic data obtained in the course of x-ray imaging of the impacted teeth.

The aim of the work was to evaluate the relations of the crowns of impacted canines and the roots of adjacent incisors with the use of computed tomography.

Material and Methods

The study involved 65 individuals clinically suspected for impaction of the maxillary permanent canine. Every patient was subjected to pantomography with the use of Planmeca ProScan scanner. In 44 individuals in the age of 13–31 years (mean age 17.1±4.5), the examination revealed shadows of the impacted crowns superimposed on the roots of incisors (Figure 1). These patients were subjected to CT.

Computed tomography was performed with the Somatom Sensation 10 scanner, and a program designed for dental diagnostics. This scanner allows for examination of objects in 1.0-milimiter-thick slices with an overlap of 0.1 mm, and with a simultaneous decrease of the radiation dose. We performed a reconstruction using a bone filter. During data processing, mutliplanar and three-dimensional reconstructions were carried out apart from the transverse CT scans. On the basis of CT examinations, the locations of impacted canines were defined as buccal, palatal and horizontal. The relations between the crowns of impacted canines and the roots of lateral and central incisors were analysed as well. They were divided into five groups on the basis of Ericsson's classification [30]:

1. No contact – the crown of the impacted canine and the root of the incisor are placed in a distance from each other;
2. No resorption – the root surface is intact – only the cement layer may be slightly damaged;

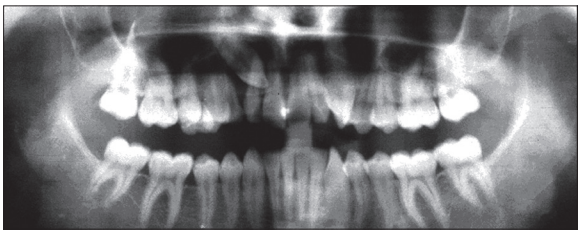

Figure 1. Pantomographs – an impacted right maxillary canine, whose crown overlaps with the roots of the adjacent incisors.

3. Light resorption – concerns less than a half of the dentin layer;
4. Medium resorption (of mild degree) – involves a half (or more) of the dentin layer but the dentin layer covering the pulp is intact;
5. Deep resorption – the process involves the pulp (the pulp of the tooth is exposed).

Results

1. The results of pantomographic x-ray analysis

From among 44 patients, 34 individuals (77.3%) were diagnosed with one-sided canine impaction, while the remaining 10 patients (22.7%) showed a bilateral condition.

Among the cases of one-sided impaction, 15 (44.1%) concerned the left side and 19 (55.9%) the right side.

Two patients were diagnosed with an innate absence of buds of the lateral maxillary incisors. However, characteristic for them was only one-sided impaction of the permanent canine, despite the diagnosed bilateral hypodontia.

There were also two cases of transposition of the permanent canine with the lateral incisor. Moreover, in one case, both impacted maxillary canines were accompanied by the impaction of one of the mandibular canines.

In 30 cases (55.5%), the authors found a persistent milk canine.

2. CT examination results

In 44 patients, 41 out of 54 (75.9%) impacted maxillary permanent canines were located palatally, 10 (18.5%) bucally, and 3 (5.6%) horizontally, in the middle of the tooth bud.

2.1. Relations of the impacted canines and the roots of incisors.

Only in 2 cases out of 54 (3.7%) there was no contact found with the roots of both incisors. There were four cases (7.4%) in which the impacted canines were in contact with the root of the central incisor only – two times due to hypodontia of the lateral incisors and two times with their presence.

In 5 cases (9.25%) the impacted canine adhered to the roots of both incisors at the same time, not causing their resorption. The next 5 cases (9.25%) revealed resorption (every time the light one) connected with adjacency: in 3 cases the

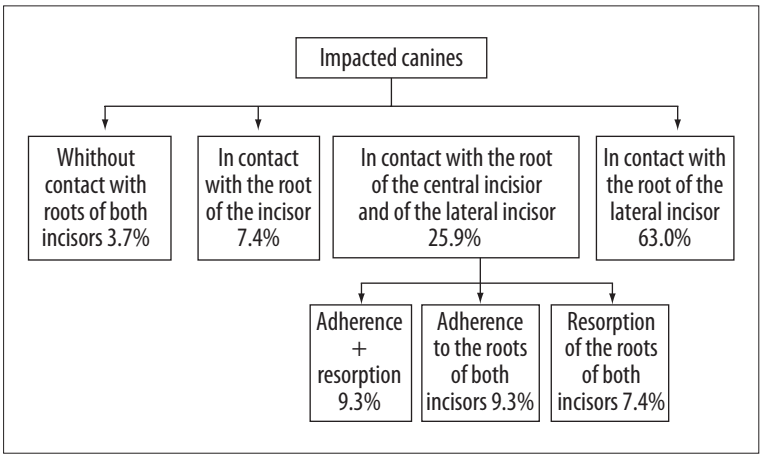

Figure 2. Relations of impacted canines with incisor roots.

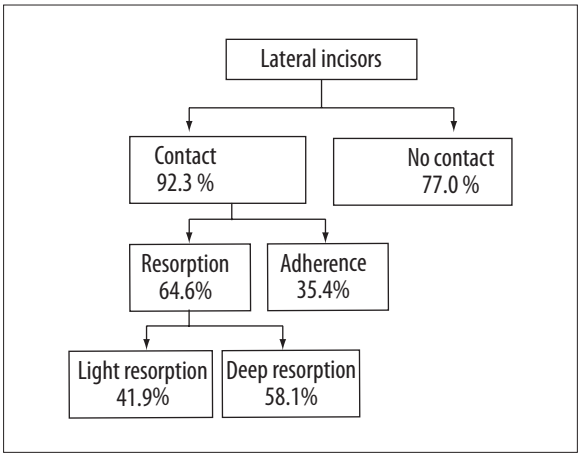

Figure 3. Types of relations of impacted canines with lateral incisor roots.

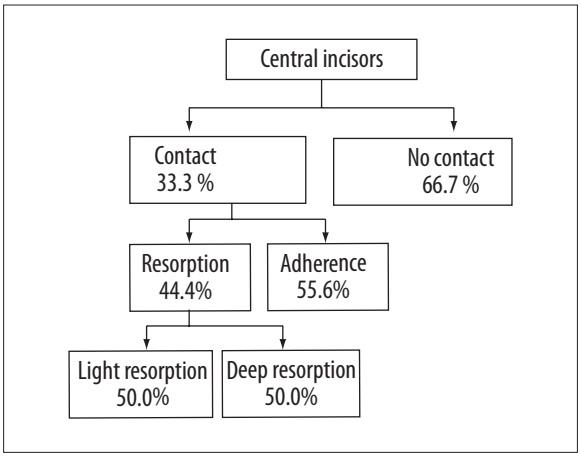

Figure 4. Types of relation of impacted canines with central incisor roots.

resorption was found within the root of the lateral incisor in combination with the canine crown adhering to the root of the central incisor, while in the other 2 cases the resorption involved the roots of the central incisors and the authors found adherence to the roots of the lateral incisors. Moreover, there were 4 cases (7.4%) in which the roots of both incisors revealed the features of resorption: deep one in both teeth in 2 cases and in another 2 cases: a deep resorption within the root of the lateral incisor and a light resorption within the root of the central incisor. In total, in 14 cases (25.9%) the impacted canine remained in various kind of contact with the roots of both incisors.

The authors revealed 18 cases (33.3%) of contact between the impacted canine and the root of the central incisor.

As far as the root of the lateral incisor is concerned, the contact was found in 34 more cases (apart from the 14 mentioned ones). There were 48 impacted canines (88.9%) that remained in contact with the roots of lateral incisors (Figure 2).

2.2. The evaluation of the roots of lateral incisors adjacent to impacted canines.

Among 52 lateral incisors adjacent to the examined canines, only four (7.7%) did not remain in contact with the impacted tooth, while in 48 cases (92.3%) there was some kind of contact found. The group of the aforementioned cases in which the canines remained in contact with the lateral incisor revealed what follows: there were 17 cases (35.4%) of adjacency without any features of root resorption and 31 cases (64.6%) of resorption. The cases of resorption involved 18 instances (58.1%) of deep resorption and 13 cases (41.9% out of the aforementioned 31 cases) of light resorption (Figure 3).

Characteristic is the absence of root injuries in moderate degree. And thus, 31 lateral incisors out of 52 (59.6%) were connected with root injuries of different degrees. Deep resorption, found 18 times, concerned 34.6% of all lateral incisors in the study material.

2.3. The evaluation of the roots of the central incisors adjacent with impacted canines

In the group of 54 central incisors, 36 (66.7%) had no contact with the impacted canine, while 18 (33.3%) contacted with it. Among those 18 cases of contact between the impacted canine with the root of the central incisor, there were 10 cases (55.6%) of adherence without features of root resorption and 8 cases (44.4%) of resorption (Figure 4). Those 8 instances revealing features of root injury constituted 14.8% of all central incisors in the study group.

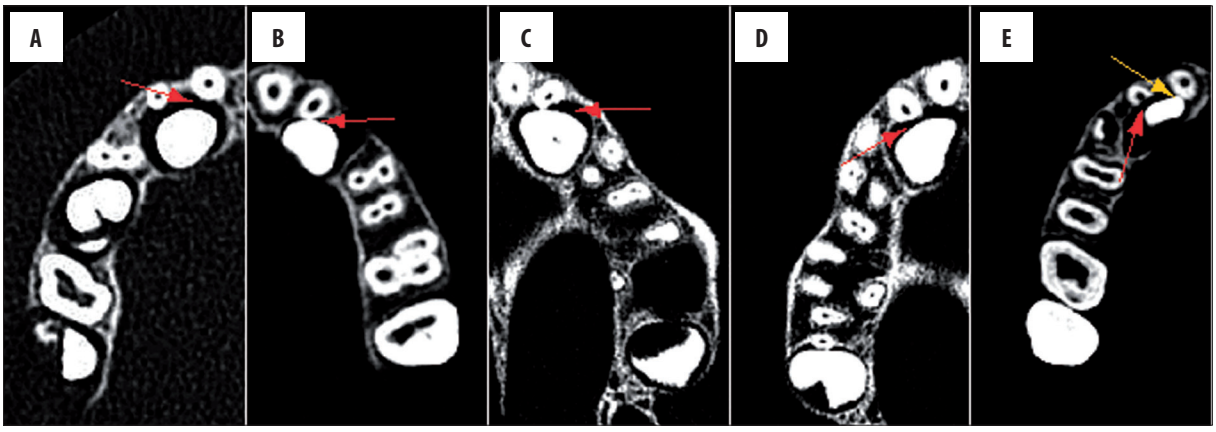

Figure 5. Types of relation of an impacted canine with incisors roots and assessment of resorption extent: (**A**) no contact with the roots of the lateral or central incisor; (**B**) adherence of the crown of the impacted canine to the lateral incisor root with no features of damage; (**C**) light resorption of lateral incisor root; (**D**) medium resorption of lateral incisor root; (**E**) deep resorption of lateral incisor root and adherence of the impacted canine crown to the root of the central incisor.

Figure 5 illustrating the relations of impacted canines and the roots of incisors

Overview of the Results and Discussion

The presented work revealed 92.3% of lateral incisors remaining in contact with the impacted canine. As the study group involved two cases of hypodontia of the maxillary lateral incisors, this percentage amounted to 88.9%. As far as the central incisors are concerned, 33.3% of those teeth remained in different kind of contact with the impacted canine. The results concerning lateral incisors are very similar to the results obtained by Ericsson and Kurol. Their study, conducted in the year 2000 [30], provided us with information on the largest ever described group of maxillary canines undergoing ectopic eruption and diagnosed with CT (107 patients, 156 canines). In their work, 93% of canines remained in contact with the roots of lateral incisors. The proportion of canines in contact with the roots of central incisors was lower and amounted to 19%. The analysis of results with respect to the frequency of different relations showed some differences between our group and the Swedish group. In our study, the resorption within the roots concerned 59.6% of the lateral incisors and 14.8% of the central incisors. In the study by Ericsson and Kurol, this percentage amounted to 38.0% for lateral incisors and 9.0% for central incisors. The Swedish study concerned patients between 9 and 15 years of age, while in our group the age range was as follows: 13–31years. That is the reason for possible differences in the results of both studies. The discrepancies follow also from the use of different CT protocols. In the study by Ericsson and Kurol, the slice thickness amounted to 2 mm and the planes were perpendicular to the long axis of the maxillary lateral incisor. In our group, the slice thickness was set at 1 mm, with an overlap of 0.1 mm, and the planes were parallel to the hard palate. The differences in slice positioning did not influence the number of revealed injuries because the evaluation considered output images in transverse projections, as well as multiplanar and three-dimensional reconstructions. Reduction of the slice thickness by half, as well as overlapping of the adjacent slices must have influenced the accuracy of the study. Better resolution allowed for qualifying as 'resorption' such instances that would be defined as 'adherence' in less precise examinations. This increased the number of revealed root injuries of the incisors at an early stage.

In the basic radiological examination – pantomography – special attention was paid to the image of crown shadow of the impacted canine overlapping the roots of adjacent incisors. The authors describing impacted canines – Richardson et al. [6], Traxler et al. [24[, Preda et al. [28], Freisfeld et al. [29] and, first of all, Ericsson and Kurol [8,21,23,30], agreed on the significance of the diagnostic value of standard x-rays in such cases as the above mentioned ones. Although it is possible then to define the canine location in the mesio-distal aspect, the buccal or palatal location may be difficult to determine, especially with no canine palpable on clinical examination. It is also totally impossible to assess the state of the adjacent teeth roots [8,21,24,25,28]. In our group, it was unfeasible to diagnose (solely on the basis of pantomographic x-rays) the resorption of the roots of incisors or to find out whether there is any contact between the crown of the impacted canine and the roots of the incisors. Such information was obtained in each case with the use of CT.

The disadvantage of CT in dentistry is its relatively high dose of ionising radiation. Introduction of the cone-beam computed tomography allowed for elimination of that drawback [31,32]. However, due to a limited availability of such scanners, the CBCT examinations are rarely performed.

That is why, since popularisation of CT, this method, due to the high quality of the recorded data, still remains the method of choice in cases suspected for incisor root injury, and in the need for an accurate localisation of the impacted canine.

Conclusions

1. Pantomography is a method of insufficient diagnostic value in the assessment of the influence of impacted teeth on the adjacent anatomical structures.

2. Computed tomography allows for a precise localisation of the impacted teeth.
3. Computed tomography remains currently the examination of choice in cases of crown shadow of the impacted canine overlapping the roots of adjacent incisors, found on pantomographs.

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