Assessment of periodontal status following the alignment of impacted permanent maxillary canine teeth

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Abstract

Purpose: The aim of the study was to assess the effect of orthodontic movement of the impacted canines after surgical exposure and alignment on the periodontal status of the transpositioned and adjacent teeth as well as to compare certain parameters with those of spontaneously erupted teeth.

Material and methods: Twenty-four patients (mean age 18.4±3.66) with unilaterally impacted 24 canines were enrolled in the study. The following parameters were assessed: pocket depth (PD), clinical attachment level (CAL), platelet index (PI) of Silness and Löe, and modified sulcus bleeding index (SBI). Optic density of the alveolar bone along the root surface of the aligned canine was analysed based on digital radiological images made with the right angle technique. Control group consisted of spontaneously erupted teeth.**

Results: In comparison to the control group, in the orthodonticaly treated group PD was found to increase on the mesial buccal and palatal surfaces of the first premolar ($p<0.003$, $p<0.04$), on the treated side; on the distal buccal ($p<0.01$), mesial buccal ($p<0.0005$), mesial palatal ($p<0.02$) and distal palatal surfaces of the canine ($p<0.02$); and on the distal buccal ($p<0.04$) and distal palatal surfaces of the lateral incisor ($p<0.048$). CAL was statistically significant on the mesio-buccal and mesio-palatal surfaces of the aligned canine ($p<0.02$). PI was statistically insignificant, while SBI values at the aligned tooth were statistically significant ($p<0.0004$). Positive correlation was found between treatment duration and distance to the occlusal plane (d) expressed by the correlation coefficient $r=0.49$ ($p<0.02$).

No relationship was observed between bone density within the canine alignment zone and the control, and there was no link between the method of treatment and periodontal status, either.

Conclusions: The alignment of the impacted permanent maxillary canines poses a risk of periodontal deterioration. Patients subjected to surgical-orthodontic treatment require periodic periodontal follow-ups.

Key words: impacted permanent maxillary canines, periodontal status, therapeutic methods.

Introduction

The impacted teeth located in the frontal segment of the maxilla frequently need to be surgically exposed and due to the application of extrusive forces erupt towards the occlusal plane [1,2]. The impaction of permanent maxillary canines is the most common, with a rate that varies between 1% and 3% [3-5]. Bishara et al. [3], summing up Moyers' theory, have stated that canine impaction may have primary causes (deciduous root resorption rate, injury to deciduous tooth bud, eruption disorders, arch space deficiency, bud rotation, preterm closure of the root apex, eruption of the canine close to a fissure that adjoins cleft palate) as well as secondary causes (abnormal muscle tone, pyretic diseases, hormonal disturbances, vitamin D deficiency). According to some researchers, genetic disorders can be responsible for malalignment of the canine, while others provide evidence confirming the guidance canine eruption theory based on the leading role of the lateral incisor root [3,6].

Orthodontic management in the case of impacted maxillary canines requires carefully planned interdisciplinary co-operation [2]. The canines are exposed surgically and fixed orthodontic appliances bonded to the exposed teeth are used

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Table 1. **Impaction zones with regard to patients' age, treatment duration and distance to the occlusal plane of the impacted canines (d)**

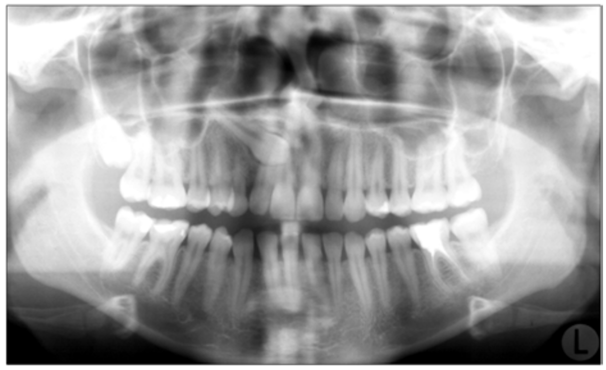
Impaction zones		Patients age	Treatment duration	d
	n	2	2	2
I	Mean	18.50	20.50	13.50
	SD	3.68	3.54	0.71
	n	5	5	5
II	Mean	19.56	21.20	17.20
	SD	5.27	3.11	7.33
	n	5	5	5
III	Mean	17.94	19.60	12.20
	SD	3.80	4.28	1.79
	n	7	7	7
IV	Mean	16.67	24.29	15.57
	SD	1.84	1.60	3.69
	n	5	5	5
V	Mean	20.06	23.40	17.20
	SD	3.95	8.88	3.96
	n	24	24	24
Total	Mean	18.40	22.17	15.38
	SD	3.66	4.83	4.49

n – number of the canines; * – t Student test

for their alignment [3,7]. Then traction is applied in order to move the impacted tooth in the desired direction. With the optimum force applied, ranging from 10 to 100 g [6], the teeth move in the alveolar process. They are hold by the surrounding collagen structure, i.e. periodontal ligaments (PDL), containing non-differentiated mesenchymal and daughter cells: fibroblasts and osteoblasts, blood vessels, nerve endings and periodontal fluid. The orthodontic shift of the teeth is a response of biological reactions inside PDL and alveolar bone to the external force released by orthodontic appliances. Since surgical exposure of the palatally impacted canine reveals its lingual surface, it is there where orthodontic elements can be fixed. When canines are vestibularly impacted, brackets are placed directly on the labial surface. In order to apply orthodontic force to the tooth by means of orthodontic brackets, the following procedures should be instituted: firstly – after surgical exposure, vertically directed orthodontic force should be applied to allow movement of the tooth and shift from the roots of the adjacent teeth; secondly – exposure of the canine should take place after initial nivelization of the arch, with the possibility of stretching the traction to the rigid marginal arch. Such management delimits the occurrence of force which has undesirable effect on the periodontal tissues and minimizes the risk of root resorption. However, it should be remembered that after the application of orthodontic force the impacted teeth exhibit relatively slow movement in the bone and prolonged treatment duration may have an unfavourable effect on periodontal status.

Treatment involves canine exposure and alignment, with proper occlusion, healthy gums, right length of the crown and ideal height of the alveolar process maintained [8,9]. This, however, requires co-operation between oral surgeon, orthodontist and periodontist.

Figure 1. **Panoramic radiogram of a 16-year-old female patient with impacted tooth 13 in zone V**



The aim of the study was to assess the effect of orthodontic movement of the impacted canines after surgical exposure and alignment on the periodontal status of the transpositioned and adjacent teeth as well as to compare certain parameters with those of the homonymous spontaneously erupted teeth.

Material and methods

Twenty-four patients (19 girls and 5 boys) with 24 unilaterally impacted canines were enrolled in the study. The mean age of patients was 18.4±3.66. The impacted teeth were localized on the basis of clinical examination and panoramic radiogram using the method modified from Ericson and Kurol [10], (of zone I-V, distance to occlusal plane – d). When the impacted canine was recognized, fixed appliance (slot .018) was attached in order to align the teeth before surgical procedure. Following the nivelization phase, a rectangular steel arch 17x25 was inserted in the brackets with an additional passively ligatured spring and accessory steel arch (.016) with a "ballista" loop according to the Jacoby method [11]. Next, in local anesthesia, the tooth was surgically exposed (the choice of the method depended on the impaction zone and distance to the occlusal plane d – *Tab. 1*, *Fig. 1*); its range was consulted with the orthodontist. After haemostasis, an orthodontic bracket was attached, a flap was sewn or the tooth was left uncovered with an inserted golden chain, and it was activated by connecting it to the "ballista" loop with elastic thread (*Fig. 2*).

The clinical examination was performed after tooth alignment (*Fig. 3*, *4A-B*). A periodontal probe was used for examinations. The following parameters were assessed: pocket depth (PD in mm), plaque index (PI) according to Silness and Löe scale 0-3, modified sulcus bleeding index (SBI) and clinical attachment level (CAL in mm).

In radiological examination, digital radiography method with the right angle technique was employed to take pictures on the side of the aligned tooth and on the side of the spontaneously erupted canine. Then, alveolar bone density along the root surface of the translocated canine was analysed, by measuring point by point from the distal side of the lateral incisor, using

Figure 2. **Radiogram presents initial activation of a ballista loop in the extrusion phase in tooth 13**

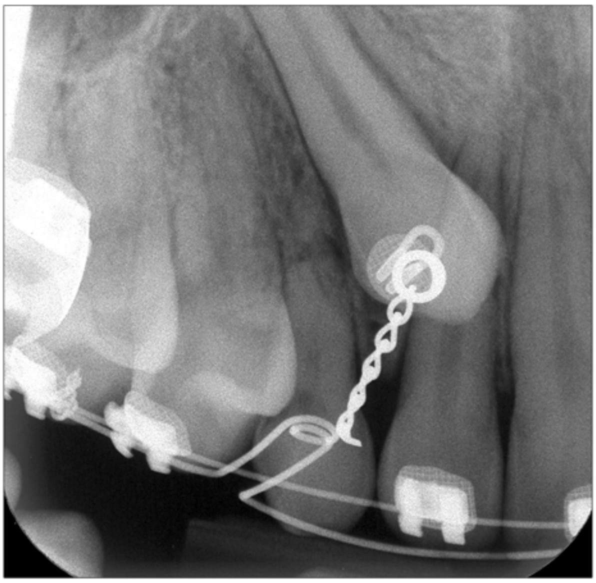


Figure 3. **Tooth 13 after two-month ballista loop activation**

a computer programme for measurement of optical density of bones. The control group consisted of spontaneously erupted teeth in the enrolled patients.

Statistical analysis

Results were subjected to statistical analysis, using t-Student test, non-parametric Wilcoxon test and Pearson correlation coefficient for paired variables.

Ethics

The Ethics Committee of Medical University of Białystok accepted the study.

Results

Tab. 1 presents distribution of the impacted canines with reference to the impaction zones, age, treatment duration and distance to the occlusal surface. Most canines were impacted in zone IV (7/24), then in II, III and IV (5 in each), with 2 canines in zone I. The impacted canines in zone IV were found in the youngest patients (mean age 16.67 years), in zone V in the oldest (mean age 20.06 years). The longest distance to the occlusal surface was in zones II and IV (17.20 mm in each), which was connected with the longest time of treatment. The canines impacted in zone V were being aligned for the mean period of 23.4 months, in zone III for 19.6 months. *Tab. 2* presents the surgical methods of the exposure of 24 impacted canines, of which 20 required the closed technique.

PD measurements assessed with the Wilcoxon non-parametric test for paired variables showed an increase on the mesial buccal and mesial palatal surfaces of the first premolar ($p<0.003$, $p<0.04$), on the side of the aligned tooth. Canine PD values were statistically significant for the distal buccal surface

Figure 4 A-B. **Successive stages of left canine alignment in an 18-year-old female patient**

a)

b)

Table 2. **Distribution of surgical methods with reference to canine impaction zones**

Impaction zones	Surgical methods		Total
	open	close	
I	1	1	2
II	0	5	5
III	1	4	5
IV	1	6	7
V	1	4	5
Total	4	20	24

n – number of the canines; * – t Student test

***Table 3*. Clinical assessment of probing depth (PD) and attachment level (CAL)**

Tooth surface	PD		CAL	
	Mean/SD	p value	Mean/SD	p value
First premolar				
mesio-buccal surface of the treated tooth	2.23±0.93	0.003*	1.53±1.14	0.07
mesio-buccal surface of the controlled tooth	1.63±0.89		1.13±0.84	
mesio-palatal surface of the treated tooth	1.19±0.89	0.04*	1.15±0.93	0.14
mesio-palatal surface of the controlled tooth	1.00±0.71		1.00±0.71	
Canine				
distal buccal surface of the treated tooth	2.48±1.20	0.01*	1.35±1.08	0.48
distal buccal surface of the controlled tooth	1.77±0.86		1.15±0.94	
mesio-buccal surface of the treated tooth	2.63±0.96	0.0005*	1.58±0.96	0.02*
mesio-buccal surface of the controlled tooth	1.56±0.84		1.15±0.99	
mesio-palatal surface of the treated tooth	1.46±1.02	0.02*	1.58±0.96	0.02*
mesio-palatal surface of the controlled tooth	1.08±0.87		1.15±0.99	
distal palatal surface of the treated tooth	1.52±0.90	0.02*	1.27±0.92	0.13
distal palatal surface of the controlled tooth	1.13±0.98		1.08±0.96	
Lateral incisor				
distal buccal surface of the treated tooth	1.96±0.76	0.04*	1.23±0.90	0.19
distal buccal surface of the controlled tooth	1.85±2.06		0.98±0.91	
distal palatal surface of the treated tooth	1.17±0.80	0.048*	0.92±0.82	0.60
distal palatal surface of the controlled tooth	0.90±0.66		0.88±0.73	

* – Wilcoxon non-parametric test for paired variables; Table contains statistically significant results of the test (p*)

***Table 4*. Comparison of mean values of modified bleeding index SBI in the groups**

Modified bleeding index SBI	Mean/ SD	p value
SBI treated group	32.25±24.97	0.0004
SBI control group	19.42±20.79	

* – t Student test

***Table 5*. Analysis of correlation between age, treatment duration and distance to the occlusal plane**

	r	p
Age× treatment duration	0.25	0.24
Age × d	0.14	0.51
Treatment duration × d	0.49	0.02

r – Pearson correlation coefficient for paired variables; p – statistically significance of the correlation coefficient given statistically significant positive correlation between treatment duration and distance

(0.01), mesial buccal surface ($p<0.0005$), mesial palatal surface ($p<0.02$) and distal palatal surface ($p<0.02$). Compared to the control group, lateral incisor PD in the study group was statistically significant for the distal buccal ($p<0.04$) and distal palatal surface ($p<0.048$).

CAL was statistically significant on the mesio-buccal and mesio-palatal surfaces of the aligned canine as compared to the control ($p<0.02$) (*Tab. 3*). In the study group, PI values were not statistically significant, while SBI was statistically significant at the aligned tooth compared to the control group ($p<0.0004$) (*Tab. 4*).

Positive correlation was found between treatment duration and distance to the occlusal plane (d) expressed by the correlation coefficient $r=0.49$ ($p<0.02$) (*Tab. 5*). No relationship was observed between bone density in the alignment zone as compared to the control. No relationship was found between the method of treatment and periodontal status.

Discussion

Surgical exposure of impacted maxillary canines and their alignment by means of fixed orthodontic appliances is a common method of treatment. Periodontists believe that orthodontic treatment by means of fixed appliances may cause chronic inflammation of the periodontal margin [9,12], and that the changes induced may play a major role in aetiopathogenesis of periodontal diseases at a later age. Among the factors of pathogenic diseases dental abnormalities are mentioned [13].

The study results confirm that the process of impacted tooth alignment is accompanied by changes in the structure of the periodontal tissue. This is perhaps associated with a long-lasting process of forced orthodontic eruption of the impacted canines, especially when the regained tooth has a difficult tortuous distance to the occlusal plane. Lack of proper oral hygiene during fixed appliance therapy leads to dental plaque accumulation that may trigger the inflammatory process [12,14].

Differences in the depth of gingival crevices at the aligned canines were increased on the mesial and distal sides of the buccal and palatal surfaces. So were those at the adjacent teeth, i.e. in the first premolars – mesio-buccally and mesio-palatally, and in the lateral incisors – disto-buccally and palatally. However, the crevice depth oscillated from 1.17±0.80 to 2.65±0.96 mm. These results are consistent with the data reported by other authors [13,15]. A detailed analysis of the periodontal tissues after surgical exposure of maxillary canines has been conducted by Gaulis and Joho [16], who noted that tissue removal, particularly in the case of vestibular impaction, can have an unfavourable effect on mucosa and gingiva. In such cases, flap should be shifted to the crown. Vanarsdall and Corn [17] and Vermette and Kokich [18] described the technique that helps to avoid soft tissue recession and bone loss during treatment of vestibularly misaligned unerupted teeth. Radical surgical exposure of the orthodontically treated impacted maxillary canines results in greater pocket depth and bone loss [19,20]. Surgically exposed teeth erupt when force released by active orthodontic elements is applied [1,8,11]. At first, the force vector is vertically oriented for extrusion, and then the force works in the buccal direction. The canines moved from the impaction zone need derotation and additional torque, especially when the teeth show palatal displacement [13]. In the present study, the closed technique was the predominant one (20/24). Although surgical canine exposure with flap and its sewing were done with great care and precision, CAL was found to be lowered on the mesio-buccal and mesio-palatal surfaces of the impacted canine. The loss of attachment may be due to the orthodontic procedures or/and it may be caused by injury during toothbrushing [14]. In a group of patients with no hygienic regime instituted, Suomi et al. [21] demonstrated the loss of attachment of 0.10 mm per year in a 3-year observation. A similar view has been presented by Zachrisson [9], who tried to explain the effect of fixed appliances on the periodontal status in a group of 16-year-old teenagers in comparison to orthodontically untreated patients. His study revealed a 0.4 mm loss of attachment in canines in the treated group and 0.1 mm in the control group, with 2 mm PD found in both groups. Chaushu et al. [22], who examined 11 canines aligned in the open method procedure, described a considerable loss of CAL of the impacted teeth, which was associated with gingival recession without substantial deepening of the gum crevices labially but with their slight deepening and bone loss mesially. Recession, however, was not observed at the aligned canines, which can be explained by the proper supervision of the treatment, with the minimum palatal leaning of the root and crown shift towards the vestibule in the exposed canine.

The PI values of the teeth adjacent to the impacted and spontaneously erupted teeth were not statistically significant, which is consistent with the data reported by Kohavi et al. [13] and Zachrisson and Alnaes [23]. This is certainly associated with frequent visits (in the extrusion phase at least twice a month) and intensified hygienic procedures. Wisth et al. [20] also support this opinion. However, in the open technique, dental plaque may accumulate when the exposed canine is spared and thus not brushed properly [23]. In the study group of patients with impacted canines, SBI measurement at the aligned tooth was statistically significant in comparison to the control group. This may indicate an inflammatory process taking place in the gingival crevices.

From the biomechanical point of view, when there is not sufficient room for the canine, light vertical force should be applied locally. The use of elastic chains or threads to obtain single eruption force from the rigid basic arch should produce slight force due to a substantial bend resulting from loading and rapid loss of force provided by elastic elements.

Alignment of a larger number of teeth causes that side-effects can spread over the enlarged surface area of the roots and thus become attenuated. In all the cases of the aligned teeth, slight force of 60 g released by the activated “ballista” loop was applied. The length of the loop arm should equal the distance measured from the retained tooth to the occlusal plane, which produces enough force for mild shift of the canine in the bone tissue tunnel [11]. The use of the “ballista” loop lasts till the canine cusp appears in the gingiva zone. Then a bracket is properly attached and treatment is continued on the rectangular arches to even the tooth axis and achieve the appropriate torque. Determination of the exposed tooth gradient is an extremely important clue for the orthodontist, as it is its long axis that determines the direction of traction. In the current study, all the exposed teeth had orthodontic golden brackets stuck to them, with a chain which due to its plasticity is the least traumatizing and does not injure the soft tissues. Time of impacted tooth alignment positively correlated with the distance to the occlusal plane – more deeply retained canines required longer therapy. These data are in agreement with those reported by Stewart et al. [24]. Lack of changes in bone density after alignment of exposed and transpositioned canines may indicate that movements of the teeth induced by orthodontic force are comparable to the changes that accompany their physiological eruption.

The retained and aligned teeth subjected to surgical exposure require constant monitoring throughout the orthodontic treatment followed by periodontal care after termination of the active phase. Improvement in periodontal status is associated with regular hygiene, especially in the final stage of canine alignment.

Conclusions

1. Alignment of impacted maxillary canines is associated with the risk of periodontal status deterioration.
2. Patients treated with the surgical-orthodontic method require periodical periodontal follow-ups.

References

1. Becker A, Kohavi D, Ziberman Y. Periodontal status following the alignment of palatally impacted canine teeth. Am J Orthod, 1983; 84: 332-6.
2. Kokich VG. Surgical and orthodontic management of impacted maxillary canines. Am J Orthod Dentofacial Orthop, 2004; 126: 278-83.
3. Bishara SE. Impacted maxillary canines: a review. Am J Orthod Dentofacial Orthop, 1992; 101: 159-71.
4. Dachi SF, Howell FV. A study of impacted teeth. Oral Surgery, 1961; 14: 1165-69.
5. Dewell BF. The upper cuspid: its development and impaction. Angle Orthod, 1949; 19: 79-90.
6. Proffit WR. Contemporary orthodontics. St. Louis: Mosby; 2000.
7. Ferguson JW, Parvizi F. Eruption of palatal canines following surgical exposure: a review of outcomes in a series of consecutively treated cases. Br J Orthod, 1997; 24: 203-7.
8. Jacoby H. The etiology of maxillary canine impaction. Am J Orthod, 1983; 84: 125-32.
9. Zachrisson S, Zachrisson BU. Gingival condition associated with orthodontic treatment. Angle Orthod, 1972; 42: 26-34.
10. Ericson S, Kurol J. Resorption of maxillary lateral incisors caused by ectopic eruption of the canines: a clinical and radiographical

analysis of predisposing factors. Am J Orthod Dentofacial Orthop, 1988; 94: 503-13.

11. Jacoby H. The "ballista spring" system for impacted teeth. Am J Orthod, 1979; 75: 143-51.

12. Frank CA, Long M. Periodontal concerns associated with the orthodontic treatment of impacted teeth. Am J Orthod Dentofacial Orthop, 2002; 121: 639-49.

13. Kohavi D, Becker A, Ziberman Y. Surgical exposure, orthodontic movement and final tooth position as factors in periodontal breakdown of treated palatally impacted canines. Am J Orthod, 1984; 85: 72-7.

14. Zachrisson BU, Shultz-Haudt SD. A comparative histological study of clinically normal and chronically inflamed gingival from same individuals. Odont T, 1968; 76: 179-92.

15. Woloshyn H, Artun J, Kennedy DB, Joondepth DR. Pulpal and periodontal reaction to orthodontic alignment of palatally impacted canines. Angle Orthod, 1994; 64: 257-64.

16. Gualis R, Joho JP. Parodonte marginal de canines supérieures incluses: Evaluation suite á differentes méthods d'accés chirurgical et de systéme orthodontique. Rev Mens Suisse d'odonto-stomatol, 1978; 88: 1249-61.

17. Vanarsdall R, Corn H. Soft tissue management of labially positioned unerupted teeth. Am J Orthod, 1977; 72: 53-64.

18. Vermette ME, Kokich VG, Kennedy DB. Uncovering labially impacted teeth: apically positioned flap and closed – eruption technique. Angle Orthod, 1995; 65: 23-34.

19. Vardimon AD, Graber TM, Dresher D, Bouravel C. Rare earth magnets and impaction. Am J Orthod Dentofacial Orthop, 1991; 100: 494-12.

20. Wisth PJ, Norderval K, Boe OE. Periodontal status of orthodontically treated impacted canines. Angle Orthod, 1076; 46: 69-76.

21. Suomi JR, Greene JC, Vermillion JR, Doyle J, Chang JJ, Leatherwood EC. The effect controlled oral hygiene procedures on the progression of periodontal disease in adults: results after third and final year. J Periodontal, 1971; 42: 152-60.

22. Chaushu S, Brin I, Ben-Bassat Y, Zilberman Y, Becker A. Periodontal status following surgical – orthodontic alignment of impacted central incisors with an open – eruption technique. Eur J Orthod, 2003; 25: 579-84.

23. Zachrisson BU, Alnaes S. Periodontal condition in orthodontically treated individuals. II alveolar bone loss: radiographic findings. Angle Orthod, 1974; 44: 48-58.

24. Stewart JA, Heo G, Williamson PC, Lam EW, Major PW. Factors that relate to treatment duration for patients with palatally impacted maxillary canines. Am J Orthod Dentofacial Orthop, 2001; 119: 216-25.