Periodontal conditions following surgical and orthodontic treatment of palatally impacted maxillary canines—a follow-up study

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Combined surgical-orthodontic treatment of impacted maxillary canines may lead to varying amounts of injury to the marginal periodontal tissues.[1-5] According to Boyd,[4] cervical wire ligation as a means of attachment to palatally impacted canines causes loss of attachment on the mesial, distal, and lingual aspects 3 months after treatment; with direct bonding techniques, attachment loss can be prevented.

Kohavi et al.[5] reported an obvious connection between the extent of the surgical bone removal and marginal bone level following orthodontic traction on palatally impacted canines.

An increased level of plaque during orthodontic treatment has been discussed as a factor affecting periodontal status. Lundström et al.[6,7] observed increased retention of dental plaque following orthodontic treatment with fixed appliances. In spite of a good oral hygiene, gingivitis appeared during such treatment.[8-10] After removal of the appliance, gingival health was reestablished to the same level as in the controls.[9,11,12]

On the other hand, Zachrisson and Alnaes[13,14] found that the periodontal attachment level in a group of 16-year-old orthodontic patients was the same as in a group of 20- to 30-year-old untreated individuals, thus indicating somewhat faster reduction of marginal bone level in orthodontic patients. However, Polson and Reed[15] evaluated crestal alveolar bone levels in adults at least 10 years after orthodontic treatment and found no overall detrimental long-term effects in comparison with an untreated control group.

Abstract

This follow-up study reports on the periodontal status 1 to 18 years after the completion of orthodontic treatment of unilateral palatally impacted maxillary canines and their adjacent incisors and premolars. Registrations were performed on 42 patients, 19 to 59 years old (mean 35 years) at investigation. An orthodontic pin with eyelet had been placed after exploration of the canine and, in some cases, bone removal. A flap had been raised and resutured after bone removal in 11 cases. The results showed greater mesial probing depth of the canines on the treated side, on the adjacent lateral incisors distolingually, and on the first premolars mesiolingually. Marginal bone level was found to be lower on the distal aspect of the treated canines and adjacent laterals. In general, the results showed a good gingival and periodontal status with slight differences between treated and untreated sides.

Key Words

Impacted teeth • Periodontal conditions • Surgical exposure

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Table 1
Sex, treated canine, age distribution at start of treatment and at investigation

N	Sex		Treated canine		Age at start		Age at investigation	
	Female	Male	Right	Left	Mean	Range	Mean	Range
42	27	15	25	17	21.6	14-42	35.0	19-59

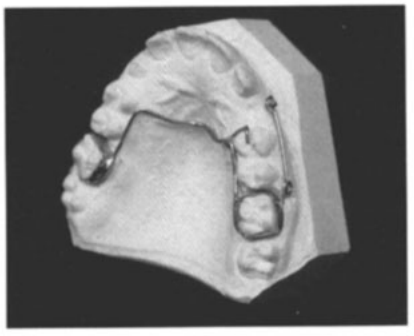

Figure 1A

Figure 1A-B
A: Fixed appliance used for orthodontic traction of impacted maxillary canines.
B: Radiograph showing pin with eyelet ligature to the spring on the appliance.

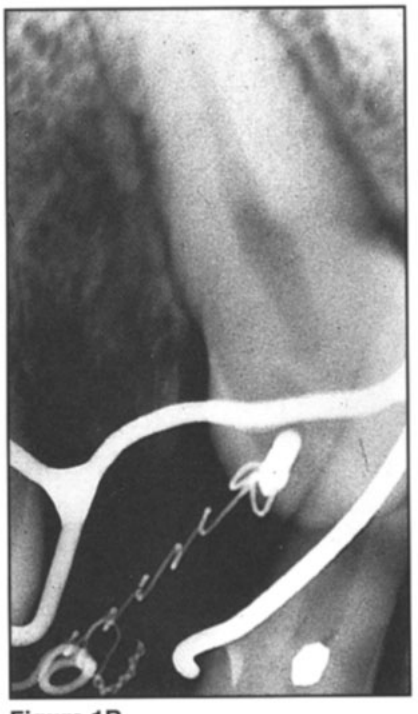

Figure 1B

Another aspect of treatment of impacted canines that has received very little attention concerns the periodontal status of the surrounding teeth. Shapira and Kuftinec[16] mentioned that most impacted canines and their often enlarged developmental follicles lay very close to the roots of the lateral incisors and that this could place the periodontal attachment of those teeth at great risk.

The purpose of the present investigation was to make a follow-up study of palatally impacted canines and surrounding teeth when the eruption of canines had been promoted by orthodontic means and to establish possible differences between the treated and untreated sides from a periodontal aspect.

Material and methods

The material consisted of 42 patients, 15 men and 27 women, 14 to 42 years old at the beginning of treatment. A posttreatment examination was made after 1 to 18 years (mean 12.3 years) (Table 1). The majority of the patients had been treated by one of the authors in his private office for unilateral impacted canine; others were seen by one of several orthodontists at the orthodontic clinic of the Public Dental Health Service at Örebro.

A small amount of covering bone of the impacted canines, all palatally situated, had been removed and in all cases a parapulpal pin had been cemented onto the palatal surface of the canine. In 11 cases a flap had been raised and resutured. In the other 31 cases soft tissue covering the canine had been removed. A lingual arch with occlusal stay on the adjacent premolar had been used for anchorage and the canine had been brought into place with a light force from a spring attached either to the first molar band or to the lingual arch (Figure 1A-B).

During treatment the patients' oral hygiene had been supervised.

After active treatment (duration 1 year 10 months, range 7 months to 5 years) the canine had been retained with an arm soldered to the lingual arch for 1 year.

At the posttreatment examination every canine was in good alignment with proximal contact points to the adjacent teeth and in good occlusion. No mesial or distal fillings were present and no other periodontal surgery had been performed.

The periodontal status of first premolars, canines, and lateral incisors was examined. The untreated contralateral side served as control. The occurrence of plaque was recorded according to Silness-Löe[17] and the gingival condition was registered with the aid of an index described by Löe-Silness.[18] Both were recorded for the labial/buccal, lingual, and mesial aspects. The probing depth of gingival pockets was measured with a graduated probe with an accuracy of 1 mm, according to Williams. Each of the measurements was made by the same investigator. The height of marginal bone was studied from intraoral bitewing radiographs (2x3 cm) taken with a modified parallel technique with the central ray directed toward the cementoenamel junction. The film-focus distance was 30 cm. On an enlarged (10x) image, the cementoenamel junction and the peak of the interdental alveolar crest, where the width of the periodontal space was normal, were marked with a needle. The distance between the two points was measured with a digital sliding caliper with an accuracy of 0.5 mm (CE Johansson AB, Eskilstuna, Sweden) parallel to

the axis of the tooth. Radiographs that could not be interpreted were excluded (Table 5). The error of the method was calculated by measuring the radiographs from 10 patients twice, with a 1 month interval. The measurements were made by both investigators mutually. The error was calculated according to Dahlberg's formula: $SE^2 = \frac{\sum D^2}{2N}$; the largest error was 9.85% of the total variance. During both the clinical and radiographic evaluations the examiners were not aware which side was the treated side.

Statistical analysis

The scores for gingival index were dichotomized into 0+1 and 2+3. Both plaque and gingival index scores were analyzed with the nonparametric Wilcoxon matched-pairs signed ranks test.

Multiple regression analysis was used to assess the possible influence of sex, initial age, duration of treatment, and long-term observation.

The Student's *t*-test for paired variables was used to establish possible differences in probing depth and height of marginal bone between the treated and untreated sides for each surface.

Results

The mean plaque-index value varied from 0.12 to 0.57 (Table 2) with a significant difference between treated and untreated canines on the mesial and lingual aspects.

The dichotomized gingival index did not show any difference between treated and untreated teeth (Table 3).

The mean values for probing depth (Table 4) showed that mesiolingual probing depth on the treated canine and distolingual depth on the adjacent incisor were deeper than on the controls, the difference being statistically significant ($p < 0.01$). A similar difference was found for the mesiolabial probing depth on the treated canine and the mesiolingual probing depth on the adjacent premolar ($p < 0.05$). Increased probing depths of 2 mm or more were found in 20 of 256 measurements, six of these in one single patient, the others in different patients.

Marginal bone level (Table 5) was significantly lower on the distal aspect both on the treated canine and on the adjacent lateral ($p < 0.01$ and $p < 0.05$, respectively). One patient showed alveolar bone loss of 6 mm on the canine.

Table 2
Plaque index according to Silness-Löe (N=42). Comparison between treated and untreated sides

Tooth surface	Treated Mean	Treated SD	Untreated Mean	Untreated SD	z	Significance (Wilcoxan matched-pairs signed ranks test)
Lateral incisor						
lingual	0.38	0.54	0.45	0.59	-0.64	n.s.
labial	0.21	0.42	0.17	0.44	-0.56	n.s.
mesial	0.38	0.54	0.29	0.51	-0.91	n.s.
Canine						
lingual	0.52	0.63	0.21	0.42	-2.55	*
labial	0.29	0.51	0.14	0.35	-1.68	n.s.
mesial	0.40	0.54	0.12	0.33	-2.64	**
First premolar						
lingual	0.57	0.59	0.43	0.55	-1.15	n.s.
buccal	0.29	0.51	0.19	0.40	-0.73	n.s.
mesial	0.36	0.58	0.21	0.42	-1.26	n.s.

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 3
Gingival index according to Löe-Silness dichotomized into 0+1 and 2+3 (N=42)

Tooth surface	Treated Mean	Treated SD	Untreated Mean	Untreated SD	z	Significance
Lateral incisor						
lingual	0.33	0.75	0.33	0.75	0.00	n.s.
labial	0.00	0.00	0.10	0.43	-1.34	n.s.
mesial	0.24	0.66	0.14	0.52	-0.91	n.s.
Canine						
lingual	0.33	0.75	0.19	0.59	-1.01	n.s.
labial	0.05	0.31	0.10	0.43	-0.53	n.s.
mesial	0.19	0.59	0.33	0.75	-1.21	n.s.
First premolar						
lingual	0.05	0.31	0.24	0.66	-1.83	n.s.
buccal	0.19	0.59	0.10	0.43	-0.73	n.s.
mesial	0.33	0.75	0.14	0.52	-1.26	n.s.

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Double-checking by excluding these two patients from the sample changed the statistical analysis of probing depth and resulted in a significant ($p<0.05$) difference even labially on the treated canine. On the other hand, the difference mesiolingually on the premolar was eliminated. The marginal bone level was not influenced by excluding these two patients.

The regression analysis did not indicate any connection between sex, initial age, duration of

Table 4
Probing depths in mm (N = 42)

Tooth surface	Treated Mean	Treated S.D.	Untreated Mean	Untreated S.D.	Difference	Sig.
Lateral incisor						
mesiolingual	1.43	0.55	1.55	0.59	-0.12	n.s.
lingual	1.38	0.62	1.38	0.58	0.00	n.s.
distolingual	1.95	0.88	1.62	0.73	0.33	**
distolabial	1.93	0.97	1.83	0.66	0.10	n.s.
labial	1.00	0.00	1.10	0.30	-0.10	n.s
mesiolabial	1.67	0.61	1.79	0.65	-0.12	n.s.
Canine						
mesiolingual	1.98	0.87	1.57	0.67	0.41	**
lingual	1.38	0.54	1.31	0.47	0.07	n.s.
distolingual	1.79	0.84	1.79	0.72	0.00	n.s.
distolabial	2.19	1.13	1.95	0.76	0.24	n.s.
labial	1.14	0.35	1.05	0.22	0.09	n.s.
mesiolabial	1.98	0.87	1.74	0.63	0.24	*
First premolar						
distolingual	1.78	0.94	1.76	0.77	0.02	n.s.
lingual	1.39	0.63	1.37	0.49	0.02	n.s.
mesiolingual	2.00	0.95	1.76	0.80	0.24	*
mesiobuccal	2.07	0.79	2.02	0.69	0.05	n.s.
buccal	1.07	0.26	1.02	0.16	0.05	n.s.
distobuccal	2.04	0.76	1.93	0.69	0.11	n.s.

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

treatment, long-term observation, and differences between the experimental and control teeth. (The highest value was p=0,2., R^2 % 5,5 for connection between sex and distolingual probing depth on the lateral incisor).

Discussion

This follow-up study demonstrates the presence of some periodontal problems following surgical and orthodontic treatment of palatally impacted canines. Thus higher plaque values were found lingually and mesially on the treated canines than on the untreated teeth. A possible explanation could be the increased difficulty of cleaning due to a tendency of the lingual gingival margin of the canine to become concave after the treatment.

All patients used their right hand for tooth brushing, and an impaired ability for cleaning on this side[19] might contribute to increased plaque on the right side. But even if 60% of the treated canines were situated on the right side these teeth showed no overall higher values of gingivitis.

The probing depths of the treated canines were deeper mesiolingually and mesiolabially, which is in accordance with Hansson and Linder-Aronson[1] who found significantly increased probing depths in adolescents (mean age 17.6 years) both on the mesiolingual and mesiobuccal aspect of the treated canine, with a greater depth on the mesiolingual aspect. The reasons for these findings can only be speculated upon and might be explained by the fact that the palatally impacted canine had not been completely uprighted during orthodontic treatment and thus had reached occlusion with its attachment at a more apical level. On the other hand, Wisth et al.[2] noted deeper distal pockets on the treated canine ($p < 0.05$), perhaps as a result of orthodontic pressure forces. Although in our sample the mean probing depth on the distolabial aspect of the treated canines was large, with a large standard deviation, the difference was not significant and an almost statistically significant lower marginal bone level mesially. (Contrary to Wisth,[2] who noted loss of attachment even palatally of the canine, this study did not show any difference on this aspect.)

The radiographic measurements showed a lower marginal bone level only distally of the treated canines, while Wisth et al[2] reported a distance of 2 mm from the cementoenamel junction to the bone margin both on the mesial and distal surfaces of the experimental canine and 1.5 mm on the control teeth in a group of adolescents. In an older group, mean age 18 years

7 months, significant alveolar bone loss occurred only on the mesial surface of the corrected canines, but the distance from CEJ to bone margin was greater for both sides. Diverse results may be due to differences in surgical and orthodontic techniques.

A question will arise, does the force direction influence bone level?

In the present study the adjacent lateral incisor on the treated side had a greater probing depth and a lower bone level on the distal aspect. A possible reason might be the original lingual position of the canine with its crown and follicle very close to the root of the lateral. Also the size of the follicle and thus the bone regeneration of this cavity as well as the direction of movement of the canine might be of importance. Thus the apprehensions mentioned by Shapira and Kuftinec[16] seem to be supported. Another explanation might be the difficulty of maintaining proper oral hygiene with toothbrushing in this area during treatment.

On the first premolar, a significantly greater probing depth was found mesiolingually on the treated side. A possible explanation might be the shape of the appliance eventually causing mesial tipping and intrusion of these teeth.

The differences found in this study showed that orthodontic treatment might have an effect on the periodontal status of the canines, and also on the adjacent teeth. These results do not agree with Polson and Reed's follow-up study[15] on 29-year-old individuals with unchanged alveolar bone level at least 10 years after orthodontic treatment.

On the other hand, Zachrisson and Alnäs[13,14] found that orthodontic treatment did have an influence on periodontal status, and our findings seem to confirm their results. It should be added that preoperative recordings were not available in our study.

The slight overall differences for the patients indicate a good periodontal prognosis.

Table 5
Marginal bone level. Distance in mm from the cementoenamel junction to the peak of marginal bone measured on radiographs

		Treated		Untreated			
Tooth surface	N	Mean	SD	Mean	SD	Difference	Sig.
Lateral incisor distal	39	4.18	1.61	3.42	1.24	0.76	*
Canine mesial	40	3.03	1.58	2.74	1.22	0.29	n.s.
distal	37	3.42	1.62	2.85	1.04	0.57	**
First premolar mesial	30	3.68	2.14	2.97	1.56	0.70	n.s.

Conclusions

The surgical and orthodontic treatment of palatally impacted canines resulted in alveolar bone loss both on the canine and the adjacent lateral incisor in a few patients that was present 12 years after treatment. These findings call for careful periodontal supervision during and after orthodontic treatment.

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References

1. Hansson C, Linder-Aronson S. Gingival status after orthodontic treatment of impacted upper canines. Transactions of the European Orthodontic Society, 48th Congress, Oslo 1972;433-441.
2. Wisth PJ, Norderval K, Böe OE. Periodontal status of orthodontically treated impacted maxillary canines. Angle Orthod 1976;46:69-76.
3. Wisth PJ, Norderval K, Böe OE. Comparison of two surgical methods in combined surgical orthodontic correction of impacted maxillary canines. Acta Odontol Scand 1976;34:53-57.
4. Boyd RL. Clinical assessment of injuries in orthodontic movement of impacted teeth. I. Methods of attachment. Am J Orthod 1982;82:478-486.
5. Kohavi D, Becker A, Zilverman V. Surgical exposure, orthodontic movement, and final tooth position as factors in periodontal breakdown of treated palatally impacted canines. Am J Orthod 1984;85:72-77
6. Lundström F, Hamp SE. Effect of oral hygiene education on children with and without subsequent orthodontic treatment. Scand J Dent Res 1980;88:53-59.
7. Lundström F, Hamp SE, Nyman S. Systematic plaque control in children undergoing long-term orthodontic treatment. Eur J Orthod 1980;2:27-39.
8. Zachrisson BU. Gingival condition associated with orthodontic treatment. II. Histologic findings. Angle Orthod 1972;42:352-357.
9. Zachrisson S, Zachrisson BU. Gingival condition associated with orthodontic treatment. Angle Orthod 1972;42:26-34.
10. Tersin J. Studies of gingival conditions in relation to orthodontic treatment. IV. The effect of oral hygiene measures on gingival exudation during the course of orthodontic treatment. Swed Dent J 1978;2:131-136.
11. Tersin J. Studies of gingival conditions in relation to orthodontic treatment. II. Changes in amounts of gingival exudate in relation to orthodontic treatment. Swed Dent J 1975;68:201-210.
12. Lundström F. Promoting dental health in orthodontic patients (thesis). Huddinge, Sweden: Karolinska Institutet 1985.
13. Zachrisson BU, Alnaes L. Periodontal condition in orthodontically treated and untreated individuals. I. Loss of attachment, gingival pocket depth and clinical crown height. Angle Orthod 1973;43:402-411.
14. Zachrisson BU, Alnaes L. Periodontal condition in orthodontically treated and untreated individuals. II. Alveolar bone loss: Radiographic findings. Angle Orthod 1974;44:48-55.
15. Polson AM, Reed BE. Long-term effect of orthodontic treatment on crestal alveolar bone levels. J Periodontol 1984;55:28-34.
16. Shapira Y, Kuftinec MM. Treatment of impacted cuspids: The hazard lasso. Angle Orthod 1981;51:203-207.
17. Silness J, Löe H. Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. Acta Odontol Scand 1964;22:121-135.
18. Löe H, Silness J. Periodontal disease in pregnancy: Prevalence and severity. Acta Odontolo Scand 1963;21:533-551.
19. Ånerud Å. The effect of preventive measures upon oral hygiene and periodontal health (thesis). Oslo: Universitetsforlaget, 1970.