Periodontal Status of Orthodontically Treated Impacted Maxillary Canines

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Patients with fixed orthodontic appliances generally show gingivitis,[1,22,45] most likely as a result of an increase in the number of retention areas causing an accumulation of bacterial plaque along the free gingival margin,[6] but probably also as a reaction to the metal inserted in the gingival pockets.[44,45] According to Rateitschak, Herzog-Specht and Hotz[30] this will not result in an apical migration of the gingival pocket epithelium and will, therefore, not cause permanent damage. Recent studies[36,46,47] indicate, however, that corrections of Angle Class II, Div. 1 malocclusions are accompanied by loss of attachment during the treatment period, and especially so on the pressure side in closed extraction sites.

Orthodontic correction of impacted canines necessitates tooth movement in the vertical and buccal direction, which is rare in orthodontic correction of sagittal malocclusions, and also entails surgical treatment which may affect the periodontal condition of the treated teeth.

The purpose of the present study was to investigate the periodontal status of orthodontically-treated palatally-impacted maxillary canines by clinical and radiographic methods.

Material and Methods

The material comprised 34 patients with unilateral palatal impaction of a maxillary canine, 19 females and 15 males. Fourteen teeth were impacted on the left side and 20 on the right side. The contralateral tooth, which had erupted unaided, served as a control during the study. The participants had Angle Class I occlusions without space problems. In some cases a persisting temporary canine had to be removed.

After roentgenographic localization, the crown of the cuspid was exposed directly without raising a mucoperiosteal palatal flap. Thereby the gingival area of all teeth was left untouched. A pin was attached to the tip of the cusp. The crown was covered by a surgical pack for a week, thereafter it was left exposed in the mouth. In some patients the tooth was initially brought down by a spring soldered to a palatal archwire, but generally the whole upper dentition was banded immediately, and the tooth was moved in a vertical and buccal direction by a spring attached to the buccal aspect of the first molar band. The rest of the teeth were stabilized by edgewise wires. The force used was approximately 30 grams. The experimental teeth were banded as soon as the buccal surface was sufficiently exposed.

The average treatment period was 18 months, and all patients were examined one to two years after removal of the fixed appliances. The mean age at the time of examination was 17 years, 3 months. Fiberectomy was not carried out in any of the patients.

The oral hygiene for the experimental and control teeth was assessed according to the criteria of the Plaque

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Index (Pl I),[35] and the gingival condition was evaluated according to the Gingival Index (GI).[25] The scoring for plaque was always done first. Double recordings showed a coincidence of 87 percent for the plaque scores and 93 for the gingival scores; the error was never more than one score unit.

The depth of the gingival pocket was measured as the distance from the free gingival margin to the bottom of the clinical pocket to the nearest millimeter with the aid of calibrated periodontal probes.[14] The measurement error was 0.26 mm (S.D. 0.12) which corresponds well with that reported by other workers.[14,45] Loss of fiber attachment (LA) was defined as the distance from the cemento-enamel junction (CEJ) to the bottom of the clinical pocket. When the CEJ was located apically to the gingival margin, the loss of attachment would be the difference between the previously recorded depth of the pocket and the distance from the gingival margin to the CEJ. When the marginal gingiva was situated apically to the CEJ, the loss of attachment equalled the sum of the pocket depth and the distance from the gingival margin to CEJ.[14] When the CEJ could not be located, it was assumed to lie at the bottom of the clinical pockets.

Using Eggen's device for standardization of film position,[2,3,11] two roentgenograms each were taken of the treated and the control teeth, one with the central ray parallel to the distal surface of the canine, and one with the central ray parallel to the mesial surface.

The radiographs were placed on an illuminator, and the CEJ and the crest of the interdental bone (BM) where the periodontal space had a normal width was marked with a needle.[17] The distance between the two points was measured parallel to the long axis of the tooth to the nearest 0.1 mm with a calibrated magnifying glass. The mesial distance was measured on the mesiocentered roentgenograms, and the distal distance on the distocentered ones. The measurement error, including new marking of the reference points, was 0.19 mm (S.D. 0.11).

The statistical evaluation of the material included testing of the means (Students' two-sample t-test), and testing of the variability of the results (Variance ratio test F.).

Results

A comparison of the hygienic condition and the Gingival Index did not reveal any considerable differences between the experimental and the control teeth at the time of examination.

A comparison between pocket depth, loss of attachment, and distance from the CEJ to the BM (Table I) showed that the pocket on the distal surface was significantly deeper in the experimental group ($p < 0.05$). Both the buccal and the palatal surfaces of the experimental teeth displayed significantly greater LA than did the control teeth ($p < 0.05$ and $p < 0.01$, respectively). The roentgenographic distance from the CEJ to the BM was significantly greater on the mesial surface in the experimental teeth ($p < 0.01$).

The depth of the mesial and palatal pockets showed considerably greater variability ($p < 0.01$ and $p < 0.05$) on the experimental teeth, as did the LA on the buccal and palatal surfaces. The distance from CEJ to BM for the proximal surfaces also varied considerably more for the experimental teeth ($p < 0.05$).

The material was divided in two groups according to the age of the patients at the start of treatment, and compared with respect to LA and distance from CEJ to BM (Table II). Group A consisted of patients younger than 15 years at the start of treatment

TABLE I

Comparison of the periodontal condition of the experimental and control teeth. $\bar{x}$—mean, s_x —standard deviation, t—values from Students two sample t-test, F—values from variance ratio test.

		Experimental teeth (n = 34)		Control teeth (n = 34)			
	Surface	$\bar{x}$	s_x	$\bar{x}$	s_x	t	F
Pocket depth	Mesial	2.59	0.82	2.29	0.52	1.76	2.49xx
	Buccal	1.85	0.66	1.62	0.55	1.60	1.44
	Distal	2.68	0.77	2.24	0.61	2.63x	1.59
	Palatal	2.06	0.34	2.03	0.46	0.30	1.83x
Loss of attachment	Mesial	0.91	0.67	0.62	0.60	1.78	1.09
	Buccal	0.82	0.80	0.47	0.56	2.11x	2.04x
	Distal	1.12	0.84	0.76	0.70	1.88	1.44
	Palatal	1.85	1.58	0.79	0.73	3.55xx	4.68xx
Distance from CEJ to BM	Mesial	2.06	0.79	1.51	0.53	3.40xx	2.22x
	Distal	2.05	0.90	1.71	0.62	1.85	2.11x

x $p < 0.05$
xx $p < 0.01$

TABLE II

Comparison of the periodontal condition of the experimental and control teeth in two age groups. Group A, patients below 15 years of age at the start of treatment, Group B, patients over 15 years of age.

		Experimental teeth		Control teeth			
	Surface	$\bar{x}$	s_x	$\bar{x}$	s_x	t	F
Loss of attachment in group A (n = 22)	Mesial	0.73	0.55	0.36	0.49	2.31x	1.26
	Buccal	0.77	0.67	0.36	0.58	2.37x	2.25x
	Distal	0.91	0.61	0.72	0.57	0.87	1.59
	Palatal	1.59	1.47	0.77	0.75	2.33x	3.84xx
Loss of attachment in group B (n = 12)	Mesial	1.25	0.75	1.08	0.79	0.52	1.11
	Buccal	0.91	0.87	0.67	0.49	1.04	1.87x
	Distal	1.50	1.09	0.83	0.77	1.88	3.53xx
	Palatal	2.33	1.72	0.83	0.72	2.78x	5.71xx
Distance CEJ to BM in group A	Mesial	1.95	0.68	1.47	0.48	2.70x	2.01x
	Distal	2.11	0.79	1.49	0.46	3.13xx	2.32xx
Distance CEJ to BM in group B	Mesial	2.26	0.96	1.96	0.63	2.09x	2.32xx
	Distal	2.96	1.10	2.01	0.68	0.38	2.62xx

x $p < 0.05$
xx $p < 0.01$

TABLE III

Comparison of the periodontal condition of the experimental teeth of the two age groups and comparison of the control teeth of the same groups.

		Experimental teeth						*Control teeth*					
		Group A (n = 22)		*Group B (n = 12)*				*Group A (n = 22)*		*Group B (n = 12)*			
	Surface	$\bar{x}$	$s_{\bar{x}}$	$\bar{x}$	$s_{\bar{x}}$	t	F	$\bar{x}$	$s_{\bar{x}}$	$\bar{x}$	$s_{\bar{x}}$	t	F
Loss of attachment	Mesial	0.73	0.55	1.25	0.75	—2.32x	1.86x	0.36	0.49	1.08	0.79	—3.27xx	2.60xx
	Buccal	0.77	0.67	0.91	0.87	—0.50	1.69x	0.36	0.58	0.49	0.49	—1.53	1.40
	Distal	0.91	0.61	1.09	1.09	—2.04	3.19xx	0.72	0.57	0.77	0.77	—0.42	1.76x
	Palatal	1.59	1.47	2.33	1.72	—1.33	1.37	0.77	0.75	0.72	0.72	—0.73	1.09
Distance from CEJ to BM	Mesial	1.95	0.68	2.26	0.96	—1.07	1.99x	1.47	0.48	1.96	0.63	—7.31x	1.72x
	Distal	2.11	0.79	1.96	1.10	0.43	1.94x	149	0.46	2.10	0.68	—3.10xx	2.19x

x $p < 0.05$
xx $p < 0.01$

(mean age 14 years, 3 months), and group B of patients older than 15 years (mean age 18 years, 7 months). In both groups the LA was significantly greater on the palatal surface of the experimental than of the control teeth ($p < 0.05$), and in group A it was greater on the mesial and buccal surfaces as well.

The distance from CEJ to BM, on the experimental teeth in group A, was greater than in the control teeth both on the mesial and the distal surfaces ($p < 0.05$ and $p < 0.01$, respectively), whereas only the mesial distance was significantly greater on the experimental teeth in group B ($p < 0.05$).

In group A the LA varied more on the buccal and palatal surfaces on the experimental teeth compared with the control teeth ($p < 0.01$ and $p < 0.05$, respectively), whereas in group B the LA varied more for all the surfaces of the experimental teeth, except for the mesial surface. In both groups the CEJ to BM distance showed greater variability in the experimental than in the control teeth.

A comparison of the LA and CEJ to BM distance of the experimental teeth in the two age groups (Table III) showed that on these teeth only the LA on the mesial surface was significantly greater in group B ($p < 0.05$). The same comparison of the control teeth of the two age groups showed that the CEJ to BM distance for the mesial and distal surfaces was significantly greater ($p < 0.01$), as well as the LA on the mesial surface. The variability of the results was generally greater in group B for both the experimental and the control teeth.

Discussion

Recent studies indicate that orthodontic treatment may result in alveolar bone loss.[36,47] It is likely that this is partly a result of the difficult hygienic conditions during orthodontic treatment with the risk of plaque accumulation, gingivitis and the subsequent loss of fiber attachment. It seems, however, that even tooth movement itself contributes to the alveolar bone destruction, as the greatest loss of attachment has been observed on the pressure side of distalized canines.[47] It is also likely that extractions may cause a permanent destruction of the alveolar process[34] which may result in loss of attachment when a tooth is orthodontically moved into the extraction site.[10,13,21]

Impacted maxillary canines can be corrected either by surgical exposure of the crown and free eruption with subsequent transversal movement by orthodontic treatment, by exposure and combined vertical and transversal movement by orthodontic means, or by surgical treatment only. The last method was discarded due to its poor long-term prognosis. Surgical exposure generally gives a high frequency of spontaneous eruption, but does not bring the tooth into its correct position in the dental arch, therefore, in the present material both the vertical and transversal movements were controlled by orthodontic means.[8,16,23,24,39,42,43]

The comparison of the plaque and gingival scores of the experimental and control teeth showed that the condition on the two sides was similar with relatively low scores for the majority of the individuals, an observation which may probably be related to the hygiene instructions given during the orthodontic treatment. It is not unlikely, however, that the hygiene may have varied during the treatment period, particularly during the period while the experimental teeth were in a palatal position where accessibility for cleansing was poor. On the other hand, the control teeth were subjected to banding and increased plaque retention for a longer period of time than were the experimental teeth. Consequently, it is impossible to establish whether or to what extent hygienic conditions during treatment may have influenced the periodontal condition differently on the two sides.

The gingival pocket depths were generally similar in both groups (Table I) except for the distal pocket which was significantly deeper on the experimental teeth ($p < 0.05$). It should be noted, however, that the variability of the measurements was greater for both the mesial and palatal surfaces of the experimental group. This indicates a greater risk of pocket formation on the treated teeth. Hansson and Linder-Aronson[15] observed increased depth of the mesiolingual and mesiobuccal pockets of corrected canines, but did not report findings on the proximal surfaces.

The mean loss of attachment on the buccal surface of the control teeth corresponds fairly well with that reported for the treated group by Zachrisson and Alnæs,[46] and indicates that orthodontic treatment may result in loss of attachment even for the teeth which have not been moved during the treatment. It seems likely to relate this to an increased possibility of accumulation of bacterial plaque, due to the orthodontic apparatus with subsequent gingivitis and periodontal breakdown. However, no decisive conclusion can be drawn, as the gingival condition before and during treatment was not recorded.

There was a significant difference between the loss of attachment on the buccal surface of the control and experimental teeth, which confirms the findings of Zachrisson and Alnæs[47] that the pressure side is particularly apt to show periodontal destruction, even when it is not related to an extraction site. This has also been shown by others.[7,26,38,41]

The results also disclosed a significantly greater loss of attachment on the palatal aspect of the treated canines. If this difference was caused by less favourable hygienic conditions on the experimental teeth, it should have been reflected also on the proximal surfaces. More than one surface would also be expected to be involved if the loss of attachment was caused by a rate of extrusion which did not allow a full reorganization of the alveolar periodontal fibers. Another possible explanation is the formation of a pressure zone at the palatal alveolar crest during the transversal uprighting of the tooth resulting in a reduction in bone height. Finally, the radical surgical exposure of the crown may have caused an injury to the palatal fibers in the cervical area. A comparison with results obtained when a more moderate surgical method is employed is now in progress.

At the proximal surfaces the clinical recordings of loss of attachment were supplemented by radiographic measurements of the bone level. Difficulties in measuring the bone height were overcome through the use of both a mesiocentered and a distocentered radiograph of each tooth.

The distance from the cementoenamel junction to the bone margin was approximately two millimeters on both the mesial and distal surfaces of the experimental teeth thus indicating a definite bone loss.[33] The measurement differed significantly from the control teeth only on the mesial surface, which may indicate that the bone loss was caused by the mesial pressure zone created when the canines are uprighted in mesiodistal direction. Hansson and Linder-Aronson, who used a different method for measuring bone destruction, also observed changes of the bone height on the mesial side in their material.

The variability of the different registrations was generally higher for the experimental teeth which indicates that the risk of considerable periodontal destruction is greater for a corrected impacted canine than for its contralateral tooth serving as part of the anchorage system.

According to clinical experience, it is often more difficult and time consuming to correct impactions in adults. In the older group (B) the loss of attachment of the palatal surface was significantly greater on the experimental teeth, and in the younger group the attachment loss on the mesial and buccal surfaces was more pronounced (Table II). Thus, the longer treatment time in the older group, 22 months compared with 15 months, apparently did not accentuate the differences between the experimental and the control teeth. On the other hand, the mean loss of attachment was higher in the older group. The distance from CEJ to BM was significantly greater on both the mesial and distal surfaces of the experimental teeth in the younger group, whereas only the mesial surface was affected to any extent in the older group. This may indicate that bone destruction occurred more easily in young individuals, or that more bone destruction had already taken place around the control teeth at the start of treatment of the older individuals, and consequently some of the differences might be concealed.

A comparison of the mean loss of attachment on the experimental teeth in two age groups (Table III) revealed that only on the mesial surface was this loss significantly greater in the older group. It should be noted, however, that the variability of the attachment loss was considerably higher in the older group, which means that the risk of relatively great periodontal destruction in an individual case is greater in adults. The control teeth also displayed greater attachment loss on the mesial surface in the older group, and the distance from CEJ to BM was considerably greater for both the mesial and distal surfaces. This sustains the hypothesis that a difference in loss of attachment between the experimental and control teeth during treatment may be concealed by loss of periodontal support on the control teeth prior to treatment in older individuals.

Summary

Thirty-four unilateral palatal impacted maxillary canines were brought down by orthodontic means after a radical surgical exposure. The contralateral canines which had erupted unaided served as controls during the study. Measurements of the gingival pocket depths showed that the distal pocket on the treated teeth was significantly deeper than on the control teeth. The treated canines displayed significantly more loss of periodontal support on the buccal and palatal surfaces than did the untreated teeth.

Radiographically, there was more alveolar bone loss on the mesial surfaces of the corrected than on the uncorrected canines, the mean distance being 2.06 and 1.51 millimeters, respectively.

The age of the patients at the start of treatment did not seem to have any profound influence on the loss of attachment, but the individual variation was considerably greater in adults.

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