Influence of arch bar splinting on periodontium and mobility of fixed teeth

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Altogether 17 patients treated with arch bar splints fixed onto teeth were tested at the time of splint removal and approximately 5 months later. Patients were treated with intermaxillary fixation (IMF) because of either orthognathic surgery (7 patients) or mandibular fractures (10). The CPITN index was used for estimating the periodontal status, and tooth mobility was measured with Periotest. Seven patients in the orthognathic surgery group could also be examined before splinting. Periodontal status, as shown with relative proportions of various CPITN indexes, worsened due to splinting but regained its original level at control examination a minimum of 5 months after splint removal. Since the mean Periotest values did not differ between the first and control examinations in the seven patients undergoing orthognathic surgery, the analysis of the effect of splinting on tooth mobility was performed from the values obtained immediately after splint removal and at control visit. Splinting was shown to increase Periotest values more in female patients, in younger ones, and in those who were splinted for a shorter period. Teeth with the smallest roots showed greater differences in Periotest values than those with large roots, and the greatest differences in mobility were observed in incisors.
□ *Periodontal status; Periotest; splinting*

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Intermaxillary fixation (IMF) achieved with arch bars ligated to teeth is used as a conservative treatment of facial bone fractures (1, 2) and to maintain immobilization in patients undergoing orthognathic surgery (3). Modern techniques to fix the fractures or osteotomies by means of AO plates (3, 4), miniplates (5), or screws (6) have led to a shorter duration or even avoidance of IMF, and in several cases no jaw-to-jaw fixation is needed during the healing period (3). However, short-term IMF is still necessary in cases like osteosynthesis performed with semi-rigid miniplates (7) or with lag screws (6).

Techniques for splinting tooth luxations have gone through changes in the past two decades as rigid arch bar splints have given way to more flexible fixation methods, most of which are based on acid-etching (8).

Arch bars are fixed on teeth either with or without acrylic. The arch bar introduced by Schuchardt et al. (9) has an acrylic coverage and is bent on the labial side and fixed on the teeth with ligament wires.

There are some experimental (10, 11) and clinical studies (12, 13) on the effect of dental splints on marginal gingiva. These clinical trials include two studies on the changes in tooth mobility (12, 13), both of which were based on subjective evaluation.

As no objective testing of tooth mobility after dental splinting and no study using CPITN as an index to illustrate the periodontal status and treatment need have been performed earlier, we examined patients needing intermaxillary fixation either because of mandibular fracture or because of orthognathic surgery. Patients were examined before splinting (patients undergoing orthognathic surgery), at splint removal, and a minimum of 5 months later (all patients). The aim was to estimate the changes in the periodontal CPITN index and in the mobility of teeth and to achieve some guidelines as to which teeth could be

Table 1. Number of teeth in the study on the basis of various factors

Total	316
Men	95
Women	221
Incisors	114
Canines	58
Premolars	92
Molars	52
Fixation less than 30 days	157
Fixation 30 days or more	159
Age less than 30 years	115
Age 30 years or more	201

ligated in arch bar splints and which should be left unligated.

Materials and methods

The study involved 17 patients (6 men and 11 women) with a mean age of 31.1 years (range, 17–47 years). The patients were treated with Schuchardt arch bar splints (9) owing to mandibular fracture in 10 cases and orthognathic surgery in 7.

Seven patients undergoing orthognathic surgery could be examined before splinting, at the time of splint removal, and at the control visit (a minimum of 5 months after splint removal). Mandibular fracture patients were examined at the time of splint removal and at the control visit (also a minimum of 5 months afterwards) but not before construction of splint owing to discomfort for the patient.

The duration of splinting varied between 19 and 48 days (mean, 30.5 days), and the duration of intermaxillary fixation between 4 and 41 days (mean, 18.8 days).

The total number of teeth tested at splint removal and at control visit was 316 (95 teeth in male and 221 in female patients). More than one-third of the teeth were incisors (114), 31% were premolars, 18% were canines, and 16% molars (Table 1). Fixation lasted less than 30 days in 157 teeth and 30 days or more in 159. In patients less than 30 years old a total of 115 teeth were tested, and in patients 30 years or older 201 were tested (Table 1).

Periodontal status before fixation, at splint removal, and at the control visit was examined by using the CPITN index (14), and the mobility of teeth was measured by Periotest (Siemens, Germany). Periotest is an objective method for analyzing tooth mobility and is based on tapping the tested tooth 14 times with a small head during one measurement. The instrument measures the time the tapping head touches the enamel and converts this time from milliseconds into Periotest values (PTV) (15).

During intermaxillary fixation, patients were advised to brush the labial sides of their teeth and to rinse their mouths with tap water. No antiseptic mouthwashes were used during IMF. Teeth were cleaned with a prophylactic paste, and toopical sodium fluoride gel was applied on the enamel at the time of splint removal.

The size of roots was measured from orthopantomographs with computer-linked planimetry. On the basis of this test teeth were divided into three categories, the first being teeth with small roots, the second teeth with medium-sized roots, and the third group teeth with large roots. Categorizations were made interindividually regardless of the number of teeth the patients had. All patients had virtually complete dentitions.

Statistical analyses were performed with paired *t* test and analysis of variance.

Results

Relative CPITN values before splinting (7 patients) and at the time of splint removal (17 patients) and at the visit at least 5 months after splint removal (17 patients) showed a tendency for more CPITN values 2 and 3 (supra- or sub-gingival calculus and pathologic pockets of 4 or 5 mm) to be obtained at the time of splint removal, whereas the relative proportions of CPITN values did not differ much between the examinations before splinting and at a visit several months after splint removal (Fig. 1).

Seven patients undergoing orthognathic

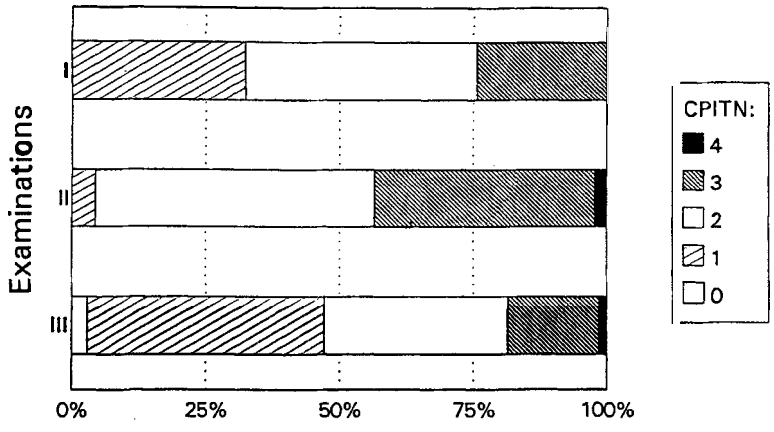

Fig. 1. Relative proportions of CPITN indexes at examinations before splinting (I; 7 patients), at the time of splint removal (II; 17 patients), and approximately 5 months later (III; 17 patients).

surgery had altogether 116 teeth inside the splint. These could be tested three times, and the mean PTV before splinting was 4.1 (SD, 4.9), at splint removal 5.8 (SD, 3.9), and at control visit 4.1 (SD, 4.5). There was no difference between the measurements before splinting and at control; registrations received at the visit approximately 5 months after splint removal were therefore considered to be the control value, and the calculations in this article were made from the differences between the values obtained immediately after splint removal (second examination) and at the control visit (third examination).

The mean change in PTV between the second and third measurement was 1.9 (SD, 2.7) in men's teeth and 2.3 (SD, 3.8) in women's teeth, and the differences were in both cases statistically significant ($p < 0.001$) (Table 2). Greater differences were observed in the canines and premolars of women than in those of male patients, but the differences in mobility values of incisors and molars were similarly significant in both sexes (Table 2).

Teeth fixed for 30 days or less showed a greater difference in mean Periotest values than those fixed for 30 days or longer (2.7 ± 3.4 and 1.7 ± 3.5, respectively) (Table 3). All teeth fixed for a shorter period had a statistically highly significant difference ($p < 0.001$) between the values at splint removal and at control, whereas canines, molars, and premolars fixed for a longer period showed less significant differences ($p < 0.01$, $p < 0.01$, and $p < 0.05$, respectively).

Table 2. Mean changes (and SD) in Periotest values of female and male patients between the measurements after splint removal and at control on the basis of the type of tooth

	Men			Women		
	Mean	SD	p^*	Mean	SD	p^*
All teeth	1.9	2.7	0.001	2.3	3.8	0.001
Incisors	2.1	2.8	0.001	2.5	4.3	0.001
Canines	0.8	1.9	0.087	2.3	3.9	0.0001
Premolars	1.8	3.2	0.0122	2.3	3.9	0.0001
Molars	2.8	2.0	0.0001	2.0	3.8	0.0039

* Paired *t* test between the means at splint removal and at control

Table 3. Analysis of variance of the changes in Periotest values immediately after splint removal and at the control visit, of various teeth on the basis of sex, duration of fixation, and age of the patient

	Incisors		Canines		Premolars		Molars		All teeth	
	F	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*
Sex	1.91	0.1694	6.84	0.0115	1.83	0.1793	0.21	0.6484	5.09	0.021
Fixation	9.99	0.002	3.57	0.064	14.01	0.0003	3.36	0.0073	30.13	0.0001
Age	15.00	0.0001	8.28	0.0057	14.25	0.0003	4.01	0.0508	42.46	0.0001

Table 4. Analysis of variance of the influence of various factors on the difference in Periotest values between measurements immediately after splint removal and at the control

	F	*p*
Type of tooth	0.44	0.7245
Sex of patient	5.09	0.0247
Duration of fixation	30.02	0.0001
Age of patient	42.07	0.0001

The mean change in the Periotest values in the teeth of patients younger than 30 years was 3.2 (SD, 2.6), and in those 30 years or older it was 1.6 (SD, 3.8)

Analysis of variance of the influence of sex, duration of fixation, and age of the patients showed that the mobility values of canines differed significantly between male and female patients. The duration of fixation had a statistically significant influence on the changes in Periotest values of all teeth but least so in canines and molars. The age of the patient also influenced the changes in all teeth, but less so in canines and molars (Table 3).

Analysis of variance of all four properties (type of tooth, sex, duration of fixation, and age of patient) showed that the changes in Periotest values due to the duration of fixation and the age of the patient were more significant than changes due to the type of tooth. Sex also influenced the difference, as shown with ANOVA (Table 4).

The mean change in the Periotest values at splint removal and at control was 1.7 (SD, 2.8) in teeth with large roots, 2.0 (SD, 3.9) in teeth with medium-sized roots, and 2.7 (SD, 3.5) in teeth with the smallest roots (Fig. 2). There was a statistically significant difference in the changes between teeth with large and small roots ($p = 0.0327$).

Discussion

The results of this study showed that fixation with arch bar splints causes changes in the periodontium and in tooth mobility. Tooth mobility as measured with Periotest also reflects periodontal conditions, since it measures both elastic and viscous characteristics of the periodontium and is strongly correlated to marginal bone loss (16).

Changes caused by dental splints were all reversible, as has been also shown by Lello & Lello (13), who estimated plaque index, papillary bleeding, and interproximal periodontal pocket depth and measured clinically tooth mobility in patients splinted with interdental continuous loop wire. The experimental studies of Ngassapa et al. (10, 11) have also shown that clinical and histologic changes in marginal gingiva are apparent as early as after 2 days' splinting. Clinical studies by Härle et al. (12) demonstrated that 6 weeks of dental splint increases tooth mobility, pocket depth, and sulcus bleeding, but these variables return to normal 6 weeks after splint removal.

Patients in this study were all fixed with Schuchardt-type arch bar splints, which differ from loop wires in that the latter loosen easily during fixation and finally rest on marginal gingiva. In an animal study prominent plaque retention has been shown to occur in connection with arch bars or ligature wire splints, which both lie on marginal gingiva

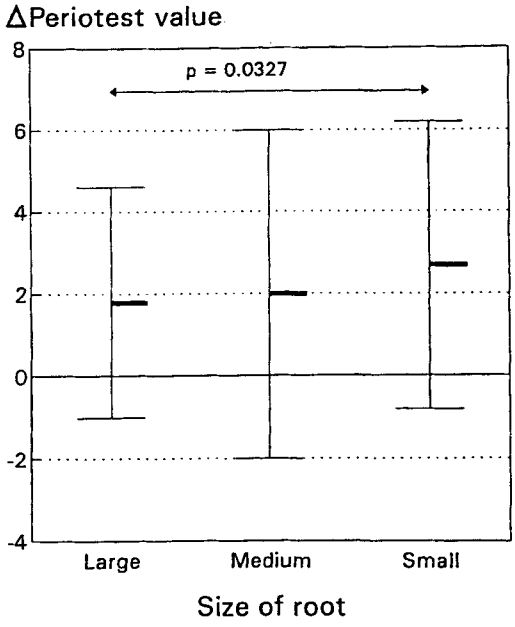

Fig. 2. Differences of Periotest values (means and SD) between second (splint removal) and third examinations (control) on the basis of the size of roots.

(10, 11). The Schuchardt splint is fixed with loops onto teeth, and the arch bar is covered with acrylic, making the splint absolutely rigid (17) so that it does not move downward (or upward) toward the marginal gingival.

Periotest values of teeth in females are higher (16), and the changes caused by splinting were also higher in this study in females than in males. No large difference was observed in the changes in Periotest values in various teeth in females, and therefore no recommendation can be given as to which of the teeth in females should not be used for ligation of arch bars. In contrast, in males the smallest changes were observed in canines and premolars but surprisingly not in molars, even though these are teeth with large roots. Canines and molars, however, are suitable for ligation in both sexes.

It was shown that the longer the duration of fixation, the smaller the change in Periotest value. This must be partly due to the fact that fixation always causes periodontal pressure, since the fixation of loops deflects the teeth. This increased mobility might not be improved during a short fixation, but during a longer one the periodontium has time to regenerate. Experimental and clinical studies have shown that rigid splinting increases the frequency of external replacement of root resorption (18, 19), which in turn results in less mobility (20). It has been shown experimentally that the incidence of external root resorption is most prominent 8 weeks after luxation (and subsequent fixation) (21, 22). These teeth were fixed for a maximum of 19 days, which is why decreased changes in the mobility caused by external root resorption should be regarded as a theoretical possibility.

The changes in mobility were greater in younger patients. This might be due to the fact that the mobility of teeth decreases with age (15) as well as to the fact that older subjects have more endodontically treated teeth (23), which in turn decreases the mobility of teeth.

The difference observed between the mean changes in Periotest values in small and large roots shows that care should be taken when considering the benefits and risks of using the smallest teeth in ligature fixation. Teeth with the smallest roots were incisors and premolars, which also have highest Periotest values and hence are more susceptible to changes in mobility than canines or molars, which are more rigid (16).

In conclusion, the results of this study show that changes in periodontium occur due to dental-fixed arch bar splints, but they are reversible. A more thorough analysis showed that teeth with small roots are especially prone to changes in mobility and should be left unligated if possible, or care should be taken to mold the arch bar close to the labial surface of these teeth so as not to cause pulling by the ligatures.

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