ORIGINAL ARTICLE

Twenty-year follow-up of patients with permanently bonded mandibular canine-to-canine retainers

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Introduction: Many orthodontists believe permanent retention is the only way to maintain ideal tooth alignment after treatment. Fixed bonded retainers are now routinely left in place for many years, even decades. The purpose of this study was to examine the health effects and effectiveness of very long-term retention. **Methods:** Sixty patients who had had bonded canine-to-canine retainers placed a minimum of 20 years previously were recalled. **Results:** Forty-five still had the retainers still in place, and, of these, only 1 had an irregularity index score >2 mm. In this group, the retainers of 28 patients had never broken, and the retainers were repaired once for 8 patients and more than once for 9. The other 15 patients had had their retainers removed outside the orthodontic practice 5 to 25 years previously. In 13 of these patients, the irregularity index score was >3 mm, and 5 of them had scores >4 mm. Gingival index scores for all teeth from first molar to first molar in both arches demonstrated no detrimental effects to the mandibular anterior gingiva from leaving these retainers in place, and the mean score for the maxillary incisor area was better in the patients with a retained mandibular retainer, suggesting better hygiene in the group with retainers. **Conclusion:** Long-term retention of mandibular incisor alignment is acceptable to most patients and quite compatible with periodontal health. (Am J Orthod Dentofacial Orthop 2008;133:70-6)

Throughout the history of our specialty, orthodontists have sought methods to ensure the stability of corrections achieved during treatment. Mandibular incisor alignment after correction of crowding in that area has been a particular problem.

Edward Angle was confident that occlusal forces against teeth in what he described as normal occlusion would maintain them in that position. This view was replaced soon after his death by Tweed's demonstration of better stability after premolar-extraction retreatment of patients with relapse. In spite of considerable criticism from his contemporaries, Tweed theorized that avoiding arch expansion would prevent relapse. Echoes of both views are found in the more recent statement by Andrews[1] that "lower teeth need not be retained after maturity and extraction of the third molars, except in cases where it was not possible to honor the muscula-

ture during the treatment and those cases in which abnormal environmental or hereditary factors exist."

Reitan[2] demonstrated that gingival elastic fibers contribute to relapse after correction of rotations, and Edwards[3] described the surgical technique to prevent rotational relapse that has become known as circumferential supracrestal fiberotomy. Boese[4] combined this technique with reproximation of the mandibular anterior teeth during and after treatment. He demonstrated good stability in 40 patients 4 to 9 years after treatment who were never retained, but major reductions in incisor width were required.

Other notable concerns related to long-term stability have been the interincisal angle,[5] intercanine width,[5,6] overcorrection of rotations,[7] posttreatment growth,[8,9] and arch form,[10] but, as a result of personal experience and the classic studies at the University of Washington by Little et al,[10,11] most orthodontists believe that stable treatment is a myth. Studies of untreated normal occlusions have shown that arch length decreases and mandibular incisor crowding increases throughout life.[12,13] The changes that often are accepted as relapse also occur in untreated persons.

This has led many orthodontists to conclude that the only way to maintain ideal alignment after treatment is some form of permanent retention,[10,14-16] and fixed bonded retainers now are being left in the mouth for

Table I. Gingival index, anterior region (canine-to-canine)

| Jaw | Surface | Bonding status at follow-up | N | Gingival index score | | | | | |
				25th%	Median	75th%	Mean	SD	P value
Mandible	Facial/buccal	Bonded	45	0.00	0.00	0.50	0.28	0.42	.42
		Not bonded	15	0.00	0.33	0.67	0.37	0.42	
	Lingual	Bonded	45	0.00	0.40	1.00	0.58	0.63	.86
		Not bonded	15	0.00	0.33	1.17	0.66	0.85	
Maxilla	Facial/buccal	Bonded	45	0.00	0.00	0.50	0.28	0.39	.29
		Not bonded	15	0.00	0.17	1.00	0.40	0.45	
	Lingual	Bonded	45	0.00	0.33	0.83	0.50	0.61	.004
		Not bonded	15	0.67	1.00	1.17	0.93	0.48	

P, Probability that bonded = not bonded, Wilcoxon rank sum test.

Table II. Gingival index, posterior regions

| Jaw | Surface | Bonding status at follow-up | n | Posterior left | | | Posterior right | | |
				Mean	SD	P value	Mean	SD	P value
Mandible	Facial/buccal	Bonded	45	0.39	0.58	.89	0.29	0.48	.66
		Not bonded	15	0.33	0.42		0.37	0.60	
	Lingual	Bonded	45	0.41	0.53	.52	0.49	0.63	.66
		Not bonded	15	0.33	0.59		0.58	0.70	
Maxilla	Facial/buccal	Bonded	45	0.33	0.49	.16	0.33	0.56	.06
		Not bonded	15	0.50	0.40		0.62	0.60	
	Lingual	Bonded	45	0.70	0.80	.02	0.67	0.82	.03
		Not bonded	15	1.27	0.62		1.24	0.93	

P, Probability that bonded = not bonded, Wilcoxon rank sum test.

long periods of time. Despite the concern by general dentists and dental hygienists about the difficulty of cleaning around these appliances and the risk of developing periodontal problems, there have been relatively few studies of their effects on the health of the periodontium. In periods of up to 3 years, several investigators reported no evidence of hard- or soft-tissue lesions related to a bonded retainer.[17-21] Dahl and Zachrisson,[21] after examining 72 patients with bonded mandibular retainers with retention times of 3 and 6 years, found no signs of dental caries or white spots, but wrote that "we must express caution regarding the indiscriminate use of extended retention in routine orthodontics. Little is currently known about how long retainers can or should be used."

The purpose of this study was to evaluate the health effects and the effectiveness of bonded retainers on follow-up at 20 years or longer.

MATERIAL AND METHODS

From the records of the practice of the senior author (F.A.B.), patients treated with full orthodontic appliances and bonded retainers placed between 1977 and 1985 were identified. For almost all of that time, the bonded retainer was fabricated from .025-in steel wire

and retained with bonding to loops on the canines only. A few patients toward the end of that period had .032-in twisted wire retainers as recommended then by Zachrisson.[6] None had the retainer bonded to both the incisors and the canines. Only patients whose pretreatment records were available were considered.

An attempt was made to contact patients on this list who were known to be in the area or could be located through Internet searching, or whose parents could still be contacted at their original address. There was no attempt to select patients who still had retainers in place or to use any criterion other than those mentioned above. It was expected that some patients had lost the retainer or had it removed, and this would allow comparison of those with and without long-term retention. Our goal was to recall at least 60 patients, and efforts were continued until this number was reached: 102 contact attempts were made, 72 patients were successfully contacted, and 60 returned for recall examination. For those who were examined, the median time since placement of the retainers was 25 years, with a range of 20 to 29 years.

At the recall appointment, a gingival index score for all areas of the mouth (first molar to first molar) was obtained by using the scoring system of Loe and
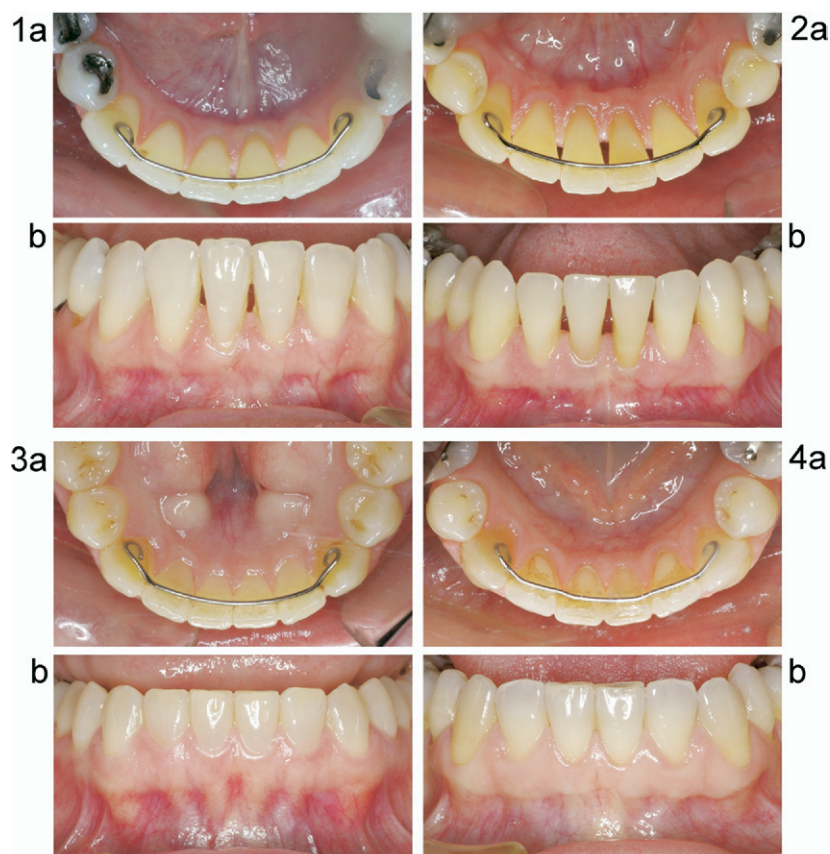
Fig 1. The 4 patients with long-term retainers with the best gingival index scores (zero, facial and lingual). Patient 1, 26 years posttreatment; patient 2, 22 years; patient 3, 26 years; patient 4, 23 years.

Silness[22] and an adaptation of their method. Scores were 0, normal gingiva, absence of inflammation; 1, mild inflammation, slight change of color, slight edema, no bleeding on probing; 2, moderate inflammation, bleeding on probing; and 3, severe inflammation, ulceration, tendency to spontaneous bleeding.

To generate a score, a probe was passed with minimal pressure from 1 interproximal contact through the gingival sulcus to the next interproximal contact, on both the lingual and the facial aspects of each tooth from first molar to first molar. A separate score was recorded for the facial and the lingual aspects of each tooth, and these scores were averaged to generate a score for the anterior (canine to canine) and right and left posterior regions of both arches for each patient.

Facial and intraoral photographs, including close-up photos of the mandibular anterior region from the lingual and facial aspects to visually record the clinical appearance of the tissues, were taken. The presence or absence of the mandibular bonded retainer was noted and, if present, whether it had been previously broken and the number of times repaired. Although the main purpose of this study was to evaluate gingival health as related to long-term retainer wear, the relative stability of the mandibular incisors with and without the long-term retainer was also of interest. Irregularity was calculated for patients who no longer had a retainer in place, and for those who still had a retainer but had measurable irregularity, with an adaptation of Little's method.[23] Occlusal photographs were printed for all patients, and the width of the teeth in the original pretreatment dental casts was used to determine the exact enlargement factor for each patient. This varied, but was approximately 2.5 times. With the known enlargement, the measurements were considered at least as accurate as direct measurement on dental casts, and certainly adequate to evaluate differences between the retainer and the no-retainer groups.

For evaluation of differences in gingival index scores between the retainer and the no-retainer groups, the Wilcoxon rank sum test was used. A 1-sample *t* test was used to determine whether the irregularity index

Fig 2. The 4 patients with retainers lost or removed with the best gingival index scores (zero, facial and lingual). Patient 1, 24 years posttreatment; patient 2, 29 years; patient 3, 21 years; patient 4, 29 years. Note the good alignment in patient 3, with varying amounts of relapse into crowding in the other 3 patients.

was different from zero for patients who had lost their retainers. For both tests, the level of significance was set at 0.05.

RESULTS

Gingival health was assessed with gingival index scores for the patients with and without retainers as shown in Tables I and II. There was no difference in the scores for the anterior part of the mandibular arch for either the facial or the lingual sides (Table I). Interestingly, there was a statistically significant difference in the scores for the lingual side of the maxillary arch, with better scores for the patients with a mandibular retainer in place. The same effect can be seen for the posterior areas (Table II).

Photos of patients with the best and worst gingival index scores in the mandibular anterior region are shown in Figures 1 through 4, which also illustrate the variation in long-term irregularity in the patients who had lost their retainer (see below). There were no enamel lesions on the lingual aspect of the mandibular incisors and canines (white spots, decalcification, caries), even in those with poor oral hygiene.

The success of the bonded retainers was also measured. For those who no longer had a retainer, an irregularity score >2 was considered evidence of relapse toward crowding. Only 1 of the 45 patients with a retainer still in place had >2 mm of irregularity. Figure 5 shows the patient with the worst relapse and a retainer in place. Of the 15 patients who no longer had retainers, 13 had irregularity scores >3 mm, and 5 had scores >4 mm. The scores were significantly different from zero (Table III).

For permanent retention to be a viable option, breakage must be at a level that does not unduly burden either the orthodontist or the patient. Table IV shows the findings in this regard. Of the 45 patients who still had a retainer in place 20 years later, 28 (62%) had had no breakage over that period; 18% required 1 repair; and 20% required more than 1 repair.
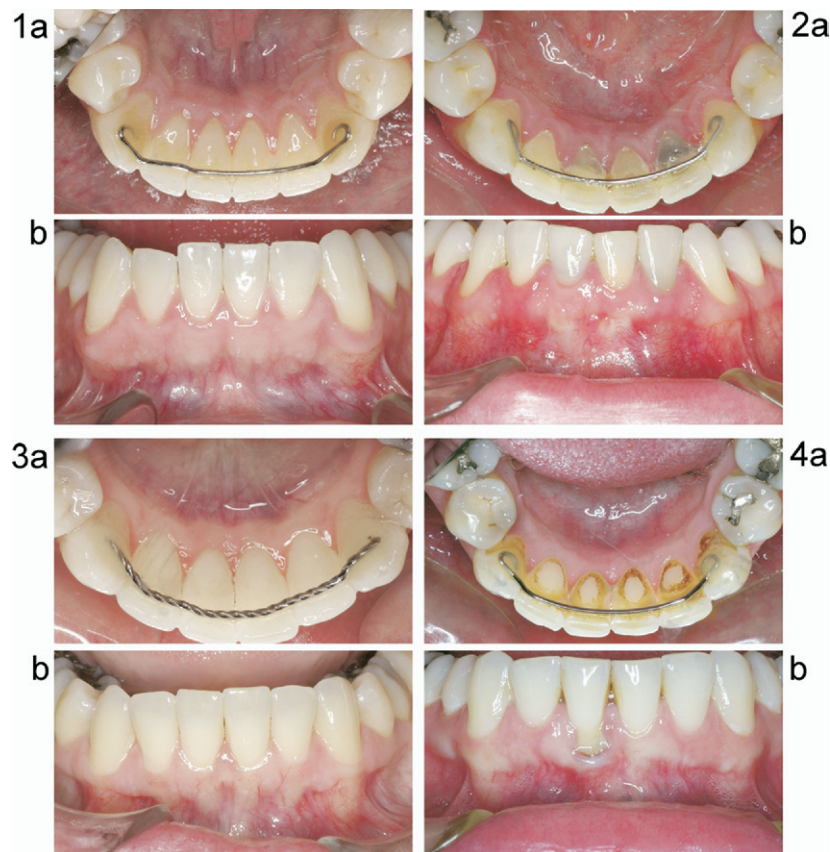
Fig 3. The 4 patients with long-term retainers with the worst gingival index scores. Patient 1, 26 years posttreatment, gingival index facial 2.0, lingual 1.83; patient 2, 23 years, facial 0.83, lingual 2.0; patient 3, 20 years, facial 0.33, lingual 2.0; patient 4, 25 years, facial 1.0, lingual 1.16. Note that patients 2 and 4 show some accumulation of stain and calculus, whereas patients 1 and 3 do not.

DISCUSSION

The gingival index data indicate no negative effect on periodontal health from long-term application of a bonded mandibular canine-to-canine retainer. There was no difference in the patients with and without a retainer in the mandibular anterior region, even though calculus was noted in some patients in both groups (Figs 3 and 4). There was a significant difference between the groups in scores for the maxillary arch, with better scores for gingival health in those with a mandibular retainer (no patient had a long-term maxillary retainer). This probably indicates better daily home care and more regular recalls for prophylaxis in the patients who had a retainer. Irregularity of the maxillary incisors did not contribute to the poorer gingival index scores in the patients who had lost their retainer. There was little maxillary irregularity in any patient, and no difference was noted between the mandibular retainer and the no-retainer groups. Årtun[17] also noted

that a retainer could have a positive effect on hygiene. He commented that "The presence of a retainer wire, with occasional accumulation of plaque and calculus, does not seem to prevent satisfactory hygiene along the gingival margin. In this regard, the patient's own attitude and motivation, possibly acquired under the influence of the orthodontist, is probably the main factor."

At present, 2 types of bonded 3-3 retainers are in use: a heavier wire bonded only on the canines and a lighter wire (usually multi-stranded) bonded to the incisors as well as the canines. Our results apply only to the first type of bonded retainer. No long-term data indicate whether bonding all the teeth makes a difference in periodontal health, but it seems likely that how well the patient maintains good hygiene is the major factor.

The facts that nearly 50% of the originally placed retainers were still in place and that two-thirds of those retainers had needed no repairs were most encouraging.
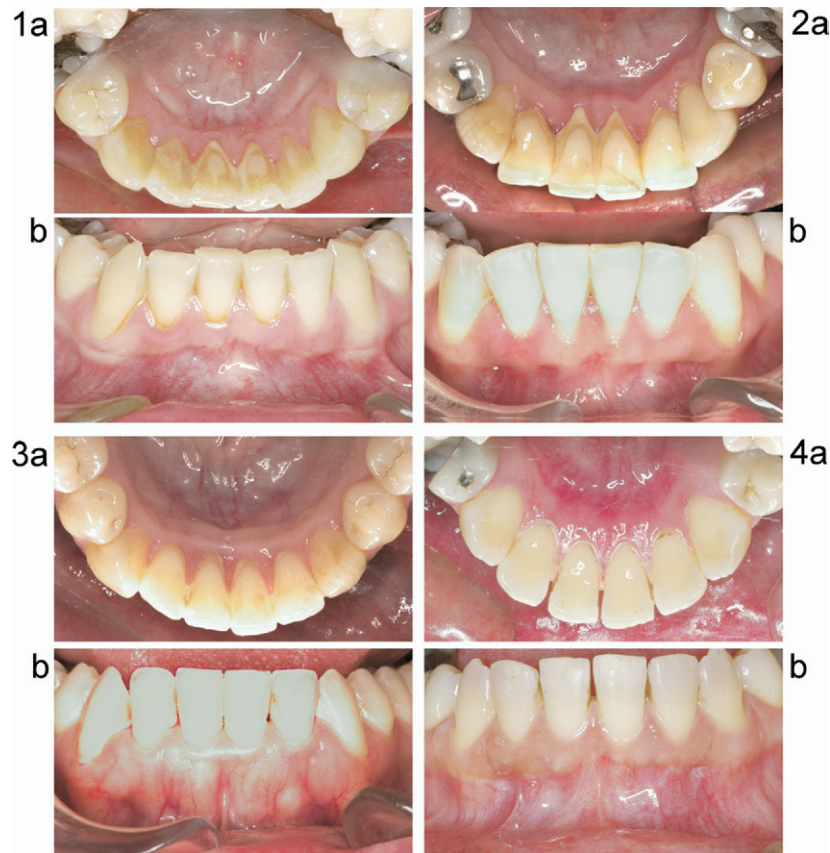
Fig 4. The 4 patients with retainers lost or removed with the worst gingival index scores. Patient 1, 27 years posttreatment, gingival index facial 0.33, lingual 3.0; patient 2, 22 years, facial 1.0, lingual 1.6; patient 3, 20 years, facial 1.0, lingual 1.16; patient 4, 28 years, facial 0.0, lingual 1.16. Three of these patients experienced some relapse toward crowding, and space opened slightly in patient 4.

Fig 5. The patient with a long-term retainer with the worse irregularity score (2.8). Irregularity was so low that it was almost unmeasurable in 43 of the 45 patients who still had a retainer.

All of these were originally bonded before our current composites were available; most received Orthomite (Rocky Mountain Orthodontics, Denver, Colo), an acrylic liquid/powder mix applied to the teeth with a brush. A recent report shows almost no breakage with a more modern bonding technique.[24]

These findings have caused the senior author (F.A.B.) to return to his original technique using .025-in wire with loops at the canines for the bonded retainer. This is after many years of using the innovations of Zachrisson[6] of the spiral .032-in wire and then an .032-in straight wire microetched at the attachments to the canines. It may be that the smaller diameter wire can flex slightly and accept some shock without breaking, and the smaller wire diameter might also reduce the occlusal load during mastication.

CONCLUSIONS

The data from this sample of 60 patients, 45 of whom had bonded 3-3 retainers in place for 20 to 29 years, indicate that orthodontists can be confident in recommending permanent retention to maintain the

Table III. Irregularity index, patients with lost retainers

n	Lower quartile	Median	Upper quartile	Mean	SD	t value	P value
15	2.06 mm	3.28 mm	4.22 mm	3.30 mm	1.55 mm	8.24	<.0001

P, Probability that irregularity index differs from zero, 1-sample *t* test.

Table IV. Breakage and repair with long-term lingual retainers

Total	Never broken	Repaired once	Repaired twice	Repaired 3 times	Repaired 4 times
45	28	8	2	6	1

alignment of the mandibular anterior teeth. It clearly is possible to maintain good hygiene and periodontal health with a bonded retainer in place. With good technique, breakage is not a major problem and should not be used as a reason not to place bonded retainers.

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