

Long-Term Results of Permanent Bonded Retention

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Relapse or age-related deterioration in arch alignment, or both, occurs in more than 90% of orthodontic patients after their appliances are removed.^{1,2} Permanent retention has been found to be the most reliable way to maintain alignment.^{3,4}

Fixed retention has evolved considerably since the introduction of early devices,⁵⁻⁸ which were highly visible, unattractive, and labor-intensive.⁷ The development of reliable, esthetic bonded retainers^{3,9} and additional refinements have led some orthodontists to place these wires permanently—that is, as permanent bonded retainers (PBRs).^{10,11} Surveys have found that both dentists and patients prefer PBRs over removable retainers (RRs),¹²⁻¹⁴ and studies have also shown PBRs to be more effective and reliable for long-term retention.^{10,12,15-17}

Although unfavorable reports about PBRs have been rare,^{18,19} the evidence regarding their long-term reliability and iatrogenic effects on the

dentition has been inconclusive. We evaluated the effectiveness, durability, and dental-health impact of PBRs in both arches more than 15 years after treatment.

Methodology

This study involved patients participating in the Newcastle Effects of Orthodontic Treatment Study (NEOTS), for which the methodology has been previously published.¹⁴ Each patient had worn a PBR or RR, or both, over the past 15 years. Forty-six patients had worn PBRs for more than 15 years, and 43 patients had worn RRs for as long as two years. (Most RR patients stopped wearing their retainers before two years had elapsed.) The survey instruments for each patient included a panoramic radiograph, a questionnaire about the patient's orthodontic treatment, and a clinical examination in three stages:

1. Four extraoral and seven intraoral digital imag-



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TABLE 1
RELAPSE BY RETAINER TYPE

LII* Relapse Category	Maxilla		Mandible		Totals	
	PBR** (N = 41)	RR*** (N = 18)	PBR (N = 14)	RR (N = 37)	PBR (N = 55)	RR (N = 55)
None (0-1mm)	92.7%	11.0%	78.6%	5.0%	89.0%	7.0%
	$p < 0.001$		$p < 0.001$		$p < 0.001$	
Mild (1-3mm)	7.3%	45.0%	21.4%	38.0%	11.0%	40.0%
	$p = 0.002$		$p = 0.334$		$p < 0.001$	
Moderate (3-6mm)	0.0%	33.0%	0.0%	46.0%	0.0%	42.0%
	$p < 0.001$		$p = 0.002$		$p < 0.001$	
Severe (>6mm)	0.0%	11.0%	0.0%	11.0%	0.0%	11.0%
	$p = 0.089$		$p = 0.565$		$p = 0.057$	
Mean	0.21mm	3.13mm	0.40mm	3.49mm	0.26mm	3.37mm

*Little's Irregularity Index.

**Permanent bonded retainer.

***Removable retainer.

es were taken, the widths of the maxillary and mandibular right central incisors were measured to within .01mm with digital calipers, and relevant pathologies involving the enamel or periodontium and PBR fractures were recorded.

2. Plaque-disclosing tablets (Disclotab*) were used to indicate the presence of any dental plaque, and five intraoral digital images were taken.

3. Prophylactic scaling and cleaning of the anterior teeth and any PBRs preceded a thorough final examination and recording of any previously missed dental or periodontal pathology.

The effectiveness of the retainers was assessed according to Little's Irregularity Index (LII),²⁰ which categorizes the amount of misalignment (relapse) in the anterior teeth as none (0-1mm), mild (1-3mm), moderate (3-6mm), or severe (>6mm). LII measurements were made from paper copies of the occlusal digital images of the anterior teeth and compared with the actual widths of the right central incisors for reliability.²¹

The durability of the retainers was evaluated by the number of times the PBRs had broken (bond or wire fractures), as determined both in clinical examinations and from patient reports.

The impact on dental health was measured by the following Dental Health Indices (DHI), each of which was rated very good, good, fair,

poor, or very poor:

- Decay index
- Plaque index²²
- Calculus index²²
- Gingival recession index²³
- Modified gingival index²⁴
- Alveolar bone index²⁵

The reliability and validity of measurements made by the chief researcher (Dr. Cerny) were assessed by comparing them with measurements made by two pairs of blinded, independent examiners (two orthodontists and two periodontists). Records for two random sets of 10 patients each (six from the PBR group, four from the RR group), selected by stratified random sampling, were used for comparison—the first set for the LII measurements and the second for the DHI rankings. The chief researcher repeated his measurements on two occasions, six months apart, to establish their reproducibility. The two random sets were compared for agreement (validity) with those of the four independent examiners using Bland-Altman plots²⁶ and Spearman's rank correlation coefficient analysis.²⁷ The measurements were verified as reliable and valid in consultation with an independent university statistician.

The statistical significance of differences between the PBR and RR groups was assessed by means of the chi-square Fisher's exact test, with a two-tailed p value of $\leq .05$ considered significant.

*Colgate Oral Care Company, 195-203 Forest Road, Mount Waverly, Victoria 3149, Australia; www.colgate.com.au.

Results

Among the 61 NEOTS patients who participated in the study, 46 had worn 55 PBRs (41 maxillary, 14 mandibular), and 43 had worn 55 RRs (18 maxillary, 37 mandibular). The 28 patients who had worn both PBRs and RRs were included in both groups as appropriate.

The average LII after 15 years of retention was .26mm for patients who wore PBRs and 3.37mm for those who wore RRs (Table 1). When the PBR had remained intact, 100% of the patients showed mild or no misalignment. Mild relapse in this group was associated with composite or wire fractures or with failure to bond the lower incisors to the retainer wires (Fig. 1). In contrast, more than half the RR group had experienced moderate or severe relapse. The differences between the groups were significant in all categories except severe relapse.

Three bond failures and five broken wires were detected in six patients in the PBR group upon clinical examination. Most of the patients were unaware of the breakages and had not noticed any tooth movement. Another 15 patients in the PBR group reported having broken their PBRs over the 15-year period, with three having done so on two occasions. Overall, 21 of the 242 composite bonds and five of the 55 retainer wires had fractured over the 15 years, for a total PBR fracture rate of 3.15% per year and a unit bond/wire fracture rate of .58% per year. Composite fractures accounted for 81% of the failures and wire fractures for 19%. Of the bond fractures, 43% were attributed by the patients to biting down on something hard, while the causes of the remaining 57% were unknown.

None of the DHI rankings differed significantly between the two groups. No incidents of decay or subsurface decalcification were seen in any of the patients.

The plaque index on the maxillary lingual tooth surfaces was consistently rated very good or good, except among the 10% of patients who wore PBRs in both the maxilla and the mandible, for whom the plaque index rating was fair ($p = .408$ compared with the RR group). On the mandibular

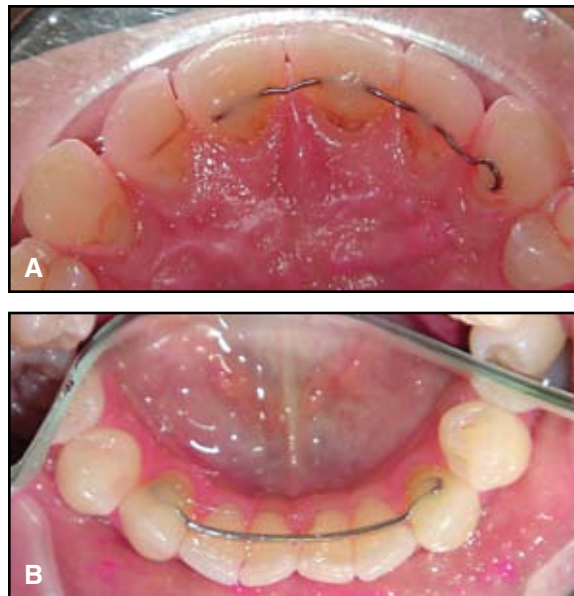


Fig. 1 Mild relapse seen in two patients, resulting from fracture of PBR wire (A) and failure to bond lower incisors to wire (B).

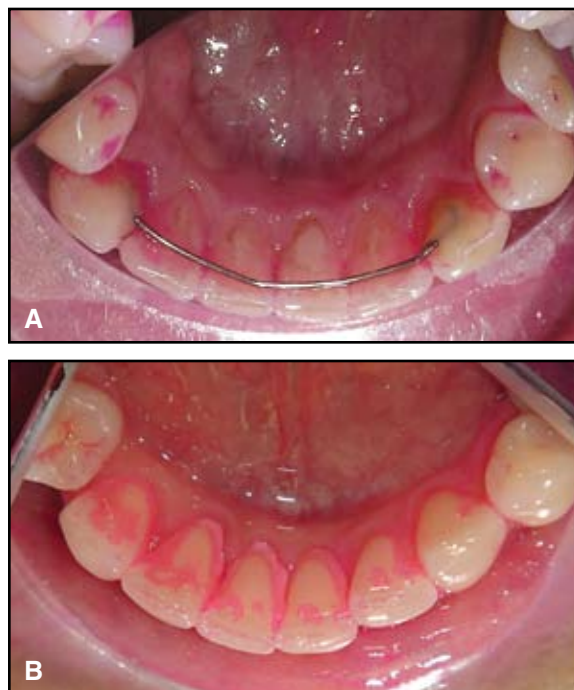


Fig. 2 Typical examples of lower-arch plaque seen in PBR (A) and control (B) patients.

lingual surfaces (Fig. 2), the plaque index was very good or good for 40% of the PBR group and 80% of the RR group ($p = .060$).

No calculus was noted on the maxillary anterior lingual surfaces in any of the patients in either group. On the mandibular lingual surfaces, the calculus index was rated very good or good for 80% of the PBR group and 100% of the RR group ($p = .259$). Only a few patients in either group were rated as poor or very poor (Fig. 3).

Gingival recession ratings were very good or good for all patients in both groups. Isolated instances of gingival recession were not considered to be related to the retainers (Fig. 4).

The modified gingival index was rated very good or good in the maxillary arch for all patients. In the mandibular arch, it was rated very good or good for 80% of the PBR group and 95% of the RR group ($p = .129$). There were no ratings of poor



Fig. 3 Extreme example of calculus seen in PBR patient.



Fig. 4 Gingival recession seen on labial surfaces of anterior teeth, attributed to overzealous oral hygiene.



Fig. 5 Worst examples of chronic marginal gingivitis, in PBR patient (A), and chronic periodontal inflammation, in middle-aged control patient (B), affecting alveolar bone only minimally in each patient.

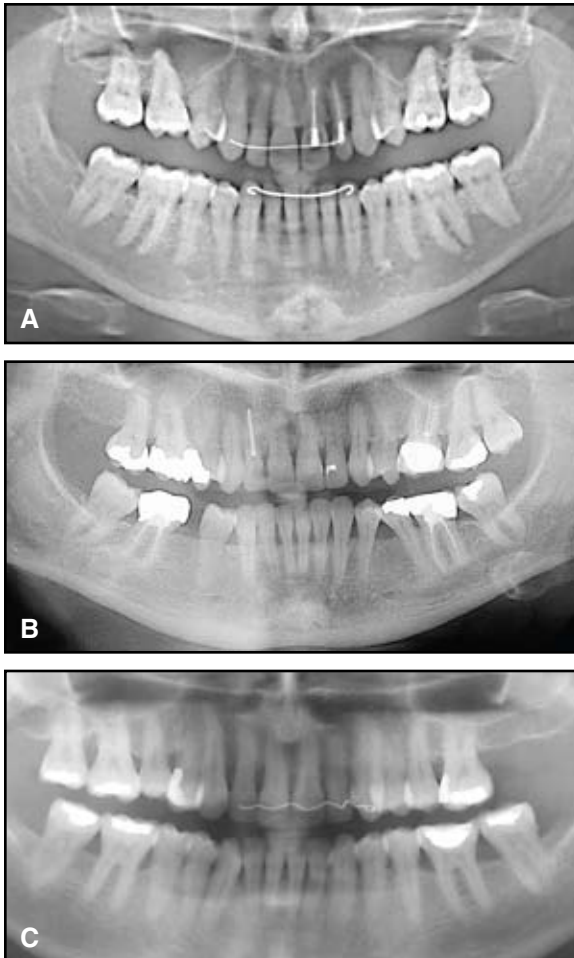


Fig. 6 Female PBR patient, age 45 (A), and female control patient, age 44 (B), showing typical alveolar bone levels seen in most study patients. C. 52-year-old female PBR patient showing most extreme case of alveolar bone loss, likely due to smoking.



Fig. 7 Patient with 20-year-old PBR, originally placed in 1990 and repaired once (arrow) in 2004.

or very poor in either group (Fig. 5).

The maxillary alveolar bone index was very good or good for 85% of the PBR group and 90% of the RR group ($p = .845$). The mandibular index was very good or good for 100% of the PBR group and 90% of the RR group ($p = .520$). Overall, the alveolar bone levels in both groups were rated very good or good for more than 85% of the patients, excluding those who were older than 50 and those who smoked (Fig. 6). There were no indications that PBRs were responsible for alveolar bone loss.

Discussion

In this retrospective case-control study, PBRs effectively maintained the alignment achieved by treatment for as long as 15 years, with an LII of less than 1mm in 89% of the cases and less than 3mm in the other 11%. In contrast, only 7% of the patients who wore RRs showed less than 1mm of relapse, and 40% had less than 3mm. The degree of gingival recession, periodontal disease, and alveolar bone loss did not differ significantly between the two groups.

The annual fracture rate for the PBRs was .58% per unit bond/wire, which compares with findings in other studies.^{10,28-30} The time required to repair fractured PBRs was usually less than 15 minutes per unit bond/wire.

Although accumulation of dental plaque and calculus tended to be greater in the PBR patients, neither group showed tooth decay or subsurface decalcification of the enamel. This may be explained by the placement of the PBRs in areas constantly bathed with saliva, which contains remineralizing ions and has acid-buffering and antibacterial properties.³¹ Furthermore, considering that most of the PBR patients had routinely visited their dentists once or twice a year,¹⁴ any calculus deposits were likely to be removed, thus reducing the risk of periodontal disease.

Conclusion

Fifteen years or more after their placement (Fig. 7), permanent bonded retainers were found to be very effective at maintaining the alignment

achieved by orthodontic treatment. We found no clinically significant differences in the dental health of patients who had worn permanent bonded retainers vs. those fitted with removable retainers.

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