Resin-Bonded Fixed Partial Dentures and Splints in Periodontally Compromised Patients: A 10-Year Follow-up

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In the present study, 139 periodontally compromised patients received a complete periodontal treatment; in 104 cases this was followed by orthodontic treatment. At the end of the entire therapy, a total of 150 Maryland restorations (69 resin-bonded fixed partial dentures and 81 resin-bonded splints) was placed and then followed for a period of up to 10 years (mean 6.7 y). Thirteen fixed partial dentures and 16 splints failed during the observation period; the 10-year cumulative survival rate from lifetable analysis was 76.2% (70.6% for fixed partial dentures and 80.7% for splints). (Int J Periodontics Restorative Dent 2000;20:629–636.)

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After the introduction of the Maryland technique,[1,2] resin-bonded fixed partial dentures (RBFPD) were evaluated in several clinical follow-up studies,[3–8] in some cases with favorable results.[9–14] Creugers and Van't Hof,[15] however, examining the data collected from multiple clinical studies using a meta-analysis, claimed negative results. The aim of the present study was to evaluate long-term clinical outcomes of RBFPDs and resin-bonded splints (RBS) in periodontally compromised patients.

Method and materials

One hundred thirty-nine periodontally compromised patients (102 women and 37 men) between 32 and 58 years old (mean 42.1 ± 3.1 y) received periodontal treatment (surgical in 78 cases, nonsurgical in 61); 104 of them also underwent orthodontic treatment to realign migrated teeth. After orthodontic correction, 32 patients showed edentulous spaces and received 32 RBFPDs to retain and splint
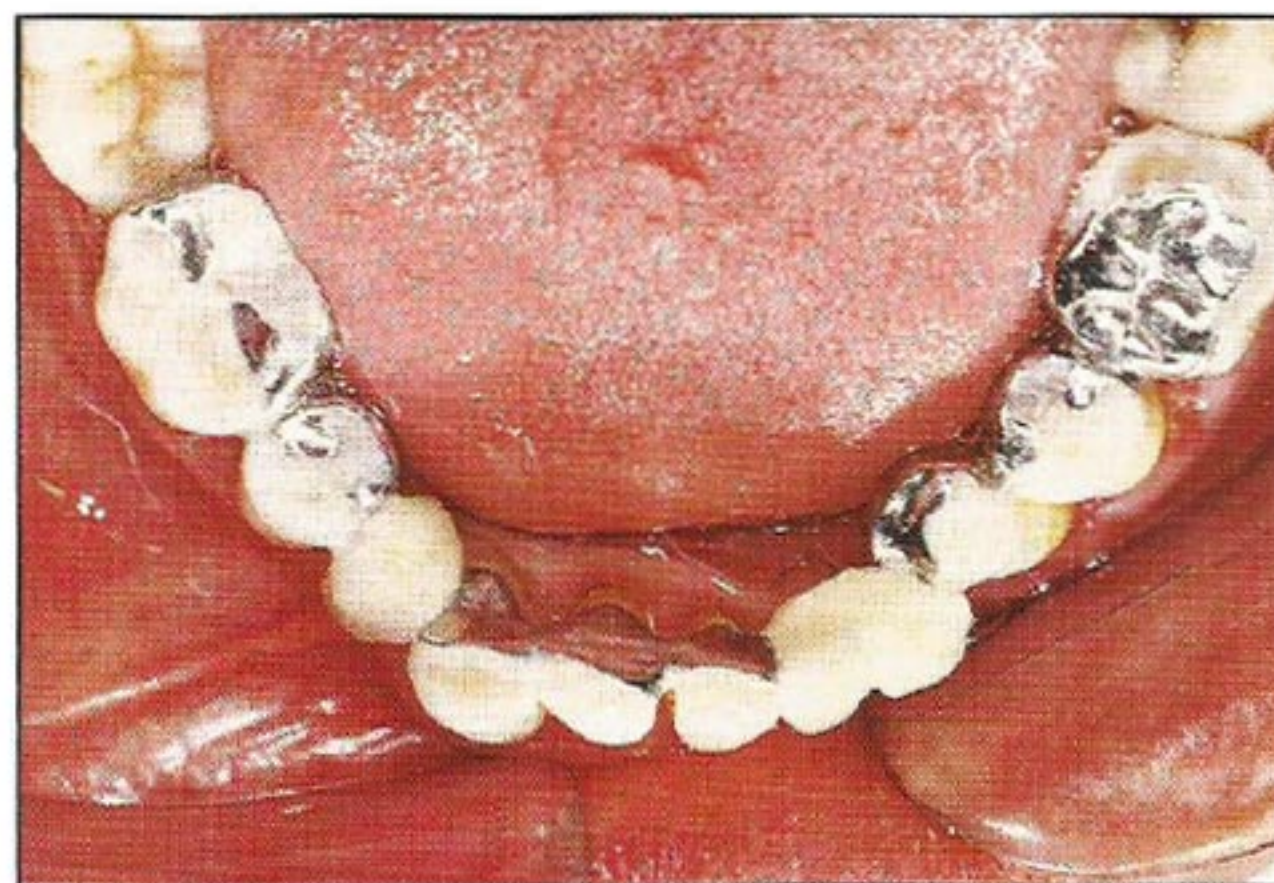
Fig 1 Maryland splint.

Fig 2 Maryland FPD splinting abutment teeth.

realigned teeth and to replace missing ones. In the 72 remaining periodontally-orthodontically treated patients, 82 RBSs were put in place to retain and splint realigned teeth. The 35 patients who did not have to undergo orthodontic therapy received 7 RBSs (Fig 1) to improve chewing comfort by stabilizing mobile teeth and 29 RBFPDs (Fig 2) to improve chewing comfort and replace missing teeth.

The tooth preparation protocol followed was according to that proposed by Simonsen et al.[16] Impressions were taken with a polyether paste (Permadyne, ESPE) using custom-made impression spoons previously prepared on the study cast.

The frameworks were made of nonprecious Ni-Cr alloys with pontics of ceramic or acrylic resin or composite resin; the internal surface of the appliance was electrolytically etched.[17]

The bonding protocol used was as follows. After isolation of the working area with a rubber dam, the prepared surface of the abutment teeth was cleaned with prophylaxis rubber cups and prophylaxis paste, washed with water, cleaned with Tubulicid (Dental Therapeutics) on a cotton pellet, air dried, and etched with a 37% orthophosphoric acid gel. All FPDs and splints were bonded by applying a chemically active luting cement (Panavia Ex, Kuraray)[18] on the etched surface of the frameworks and pressing the

Maryland devices onto the teeth for 6 minutes, then isolating the metal-to-teeth margin with Oxyguard (Kuraray) to let the cement harden free of oxygen influence for 5 minutes. The excess bonding agent was then removed with curettes, flame-like multiblade burs, or fine-grained diamond burs, silicone polishers, and paper abrasive disks. In the cases in which a fixed orthodontic treatment had been performed, orthodontic appliances were removed at least 2 days after bonding procedures.

All patients were followed up in a recall program every 3, 4, or 6 months. Apart from those FPDs and splints that failed between placement and 5 years, all Maryland

Table 1	Resin-bonded FPDs (RBFPD) and splints (RBS)	
	Abutments	Pontics
RBFPDs		
Maxillary (n = 31)	170	40
Mandibular (n = 30)	157	51
Total (n = 61)	327	91
RBSs		
Maxillary (n = 70)	433	
Mandibular (n = 19)	115	
Total (n = 89)	548	

Table 2	Debonding in orthodontic and nonorthodontic patients	
	Orthodontic patients	Nonorthodontic patients
RBFPDs		
Maxillary	5/17 (29.4%)	3/14 (21.4%)
Mandibular	2/15 (13.3%)	2/15 (13.3%)
Total	7/32 (21.9%)	5/29 (17.2%)
RBSs		
Maxillary	12/67 (17.9%)	0/3
Mandibular	3/15 (20%)	0/4
Total	15/82 (18.3%)	0/7

devices placed in a 5-year period were observed for 5 to 10 years (mean 6.7 y). Failures were scored during the observation period; the results were then evaluated according to a lifetable analysis of survival.[19]

Results

Sixty-one RBFPDs and 89 RBSs were evaluated in the study (Table 1). During the 10-year observation period none of the abutment teeth was lost because of periodontal problems, none developed caries, and none showed pulp pathology.

Twelve of 61 RBFPDs (19.7%) and 15 of 89 RBSs (16.9%) debonded. Eight of 31 maxillary (25.8%) and 4 of 30 mandibular RBFPDs (13.3%) debonded, and 12 of 70 maxillary (17.1%) and 3 of 19 mandibular RBSs (15.8%) debonded. Distribution of debonding in orthodontic and nonorthodontic patients is shown in Table 2. A fracture in the framework was observed in one RBFPD and one RBS, in both cases in the maxilla in postorthodontic patients 18 months after insertion.

Globally, 131 of 150 Maryland appliances showed evidence of success at the end of the follow-up period (56 of 61 and 65 of 89, respectively, for RBFPDs and RBSs; Figs 3 and 4). Based on the lifetable analysis,[20] the 10-year cumulative survival rate was 76.2% (70.6% and 80.7% for RBFPDs and RBSs, respectively; Tables 3 to 5). It was possible to rebond all of the debonded Maryland devices except for one splint.

Fig 3a (left)   Case 1. Periodontally compromised patient with the mandibular right central and lateral incisors missing and degree II mobility on the left ones.

Fig 3b (right)   Mandibular right incisors are replaced by means of a Maryland FPD bonded to the canines and the mobile left incisors, which are splinted by the FPD.
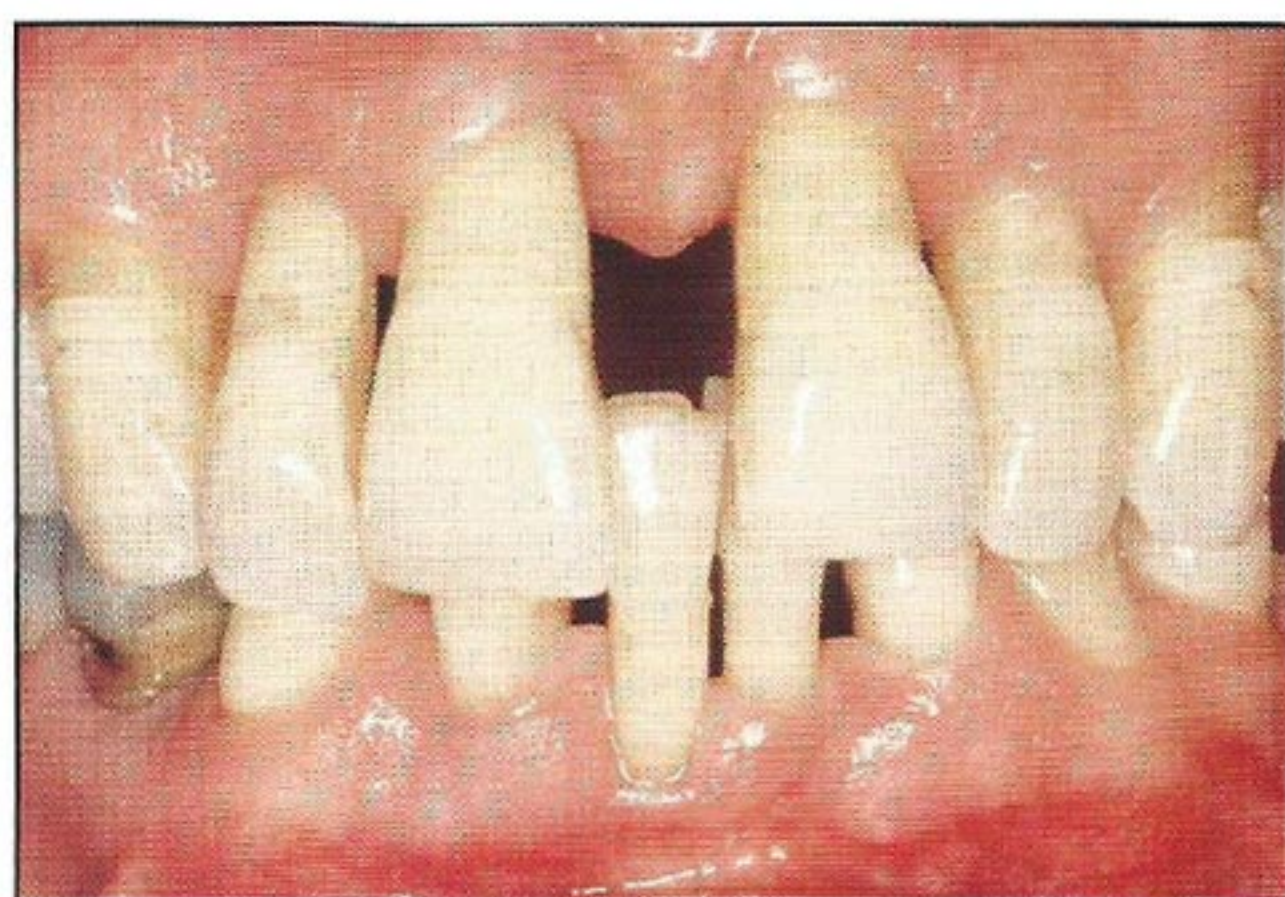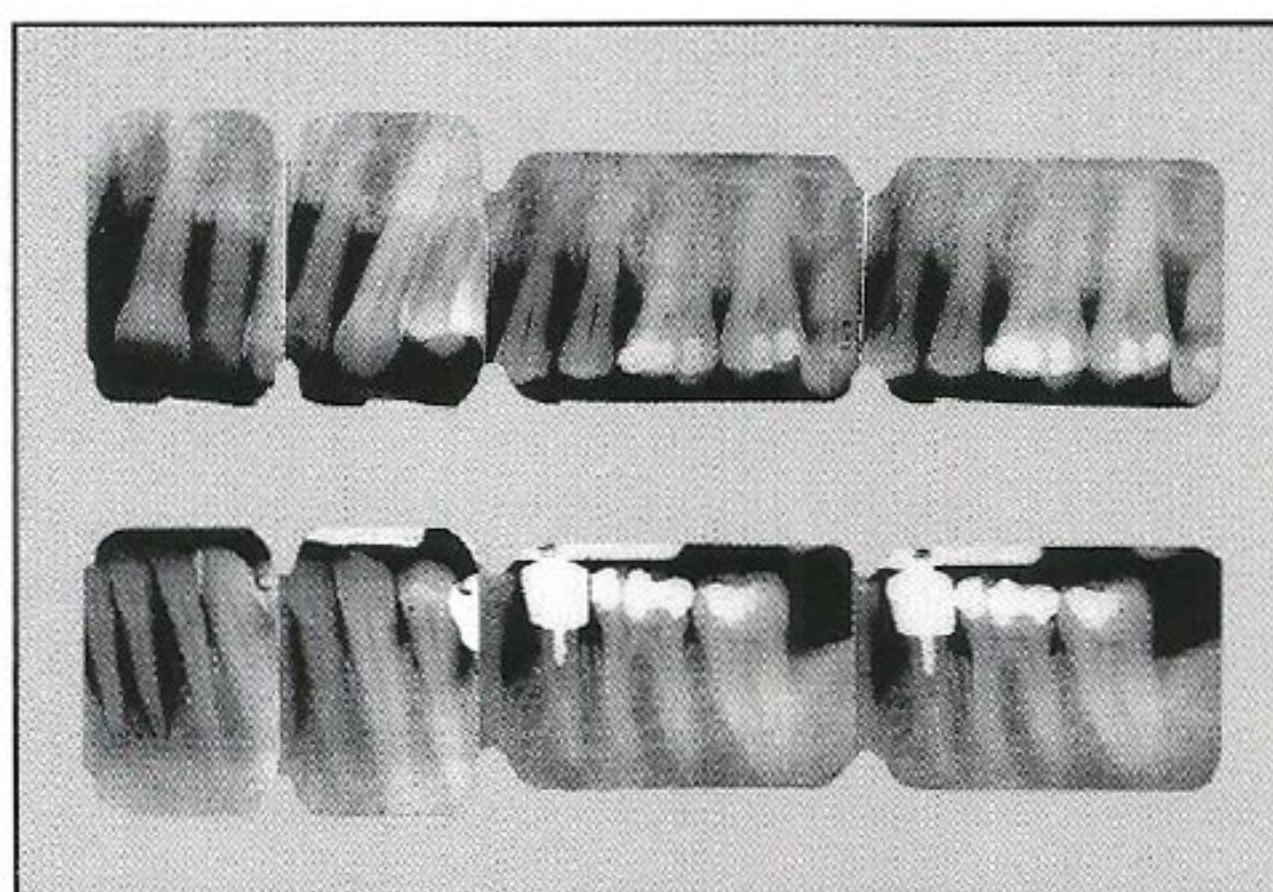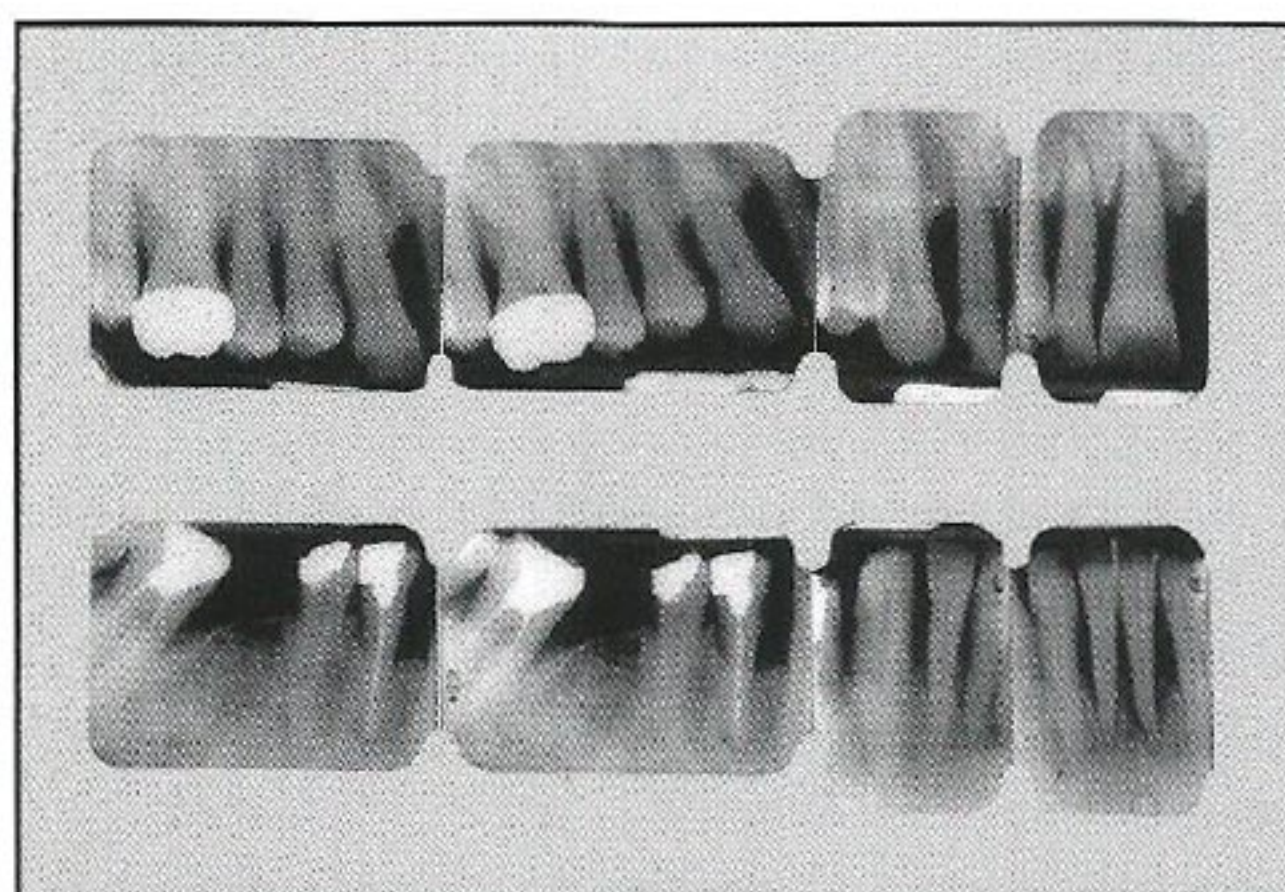

Fig 4a   Case 2. Initial clinical view of a severely periodontally compromised patient: note the maxillary interincisor diastema caused by tooth migration (the right central incisor is nonvital).

Figs 4b and 4c   Initial radiographic situation.

Fig 4d *Final clinical view after endodontic therapy on maxillary right central incisor, periodontal treatment, and orthodontic realignment and bonding of a Maryland splint from the right to left first premolar.*
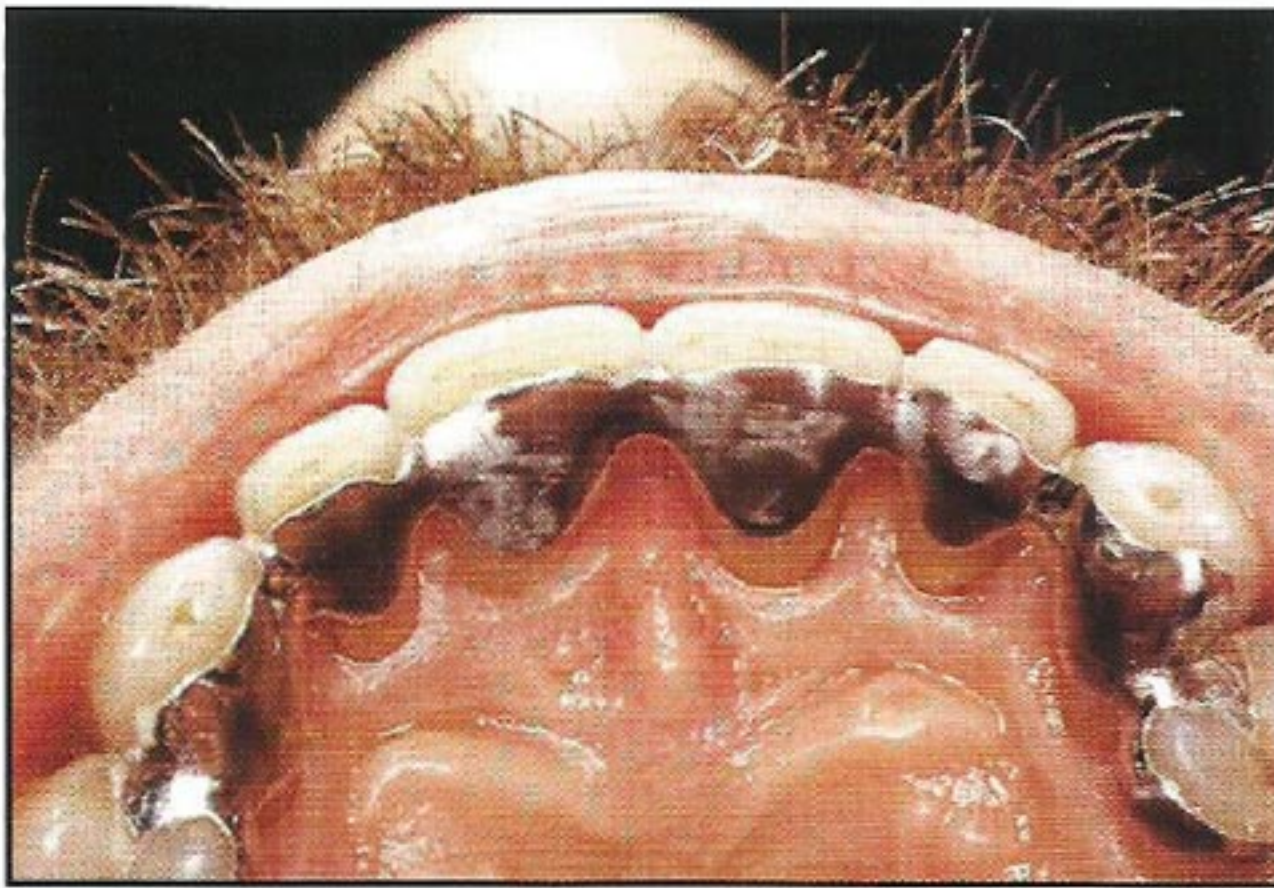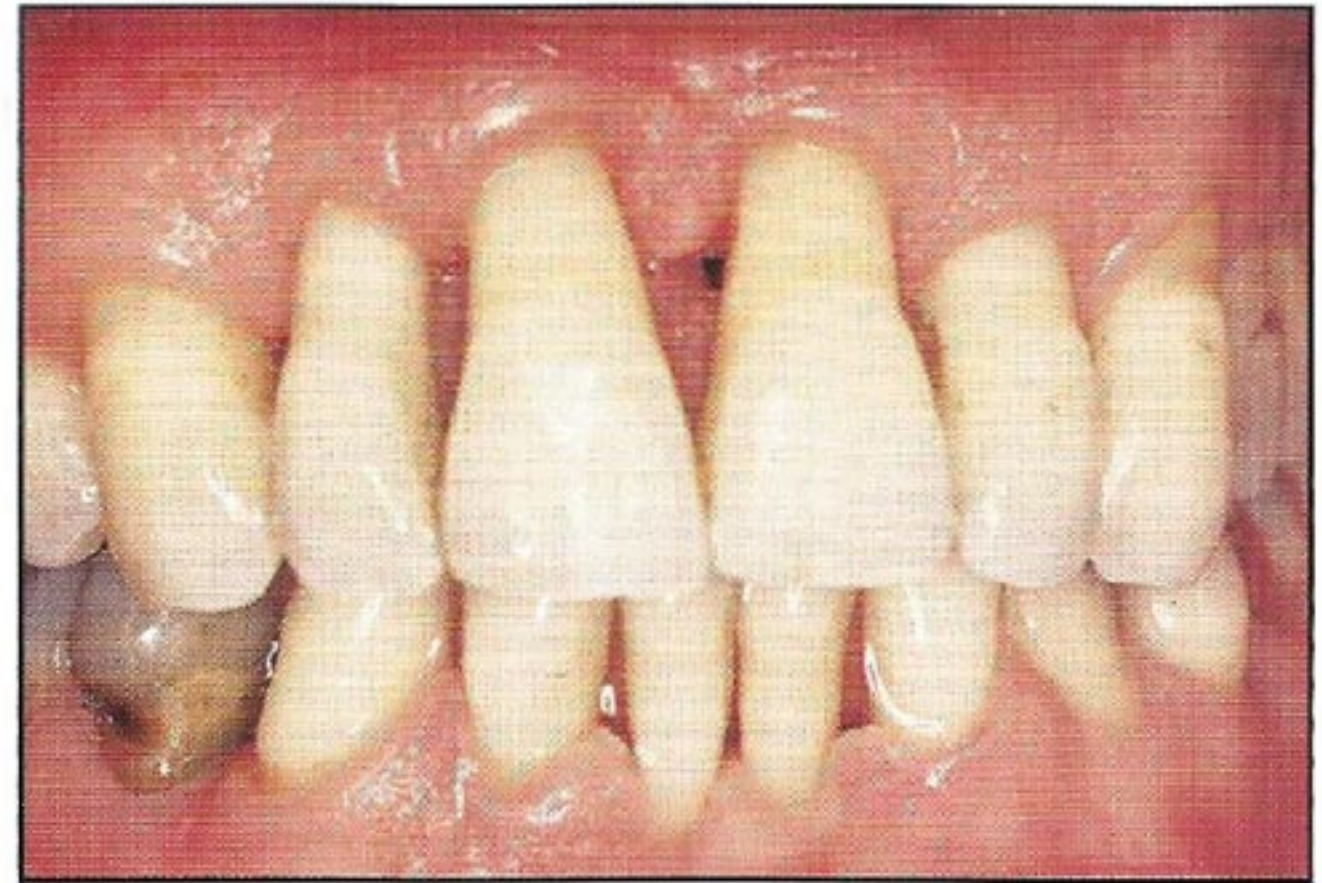

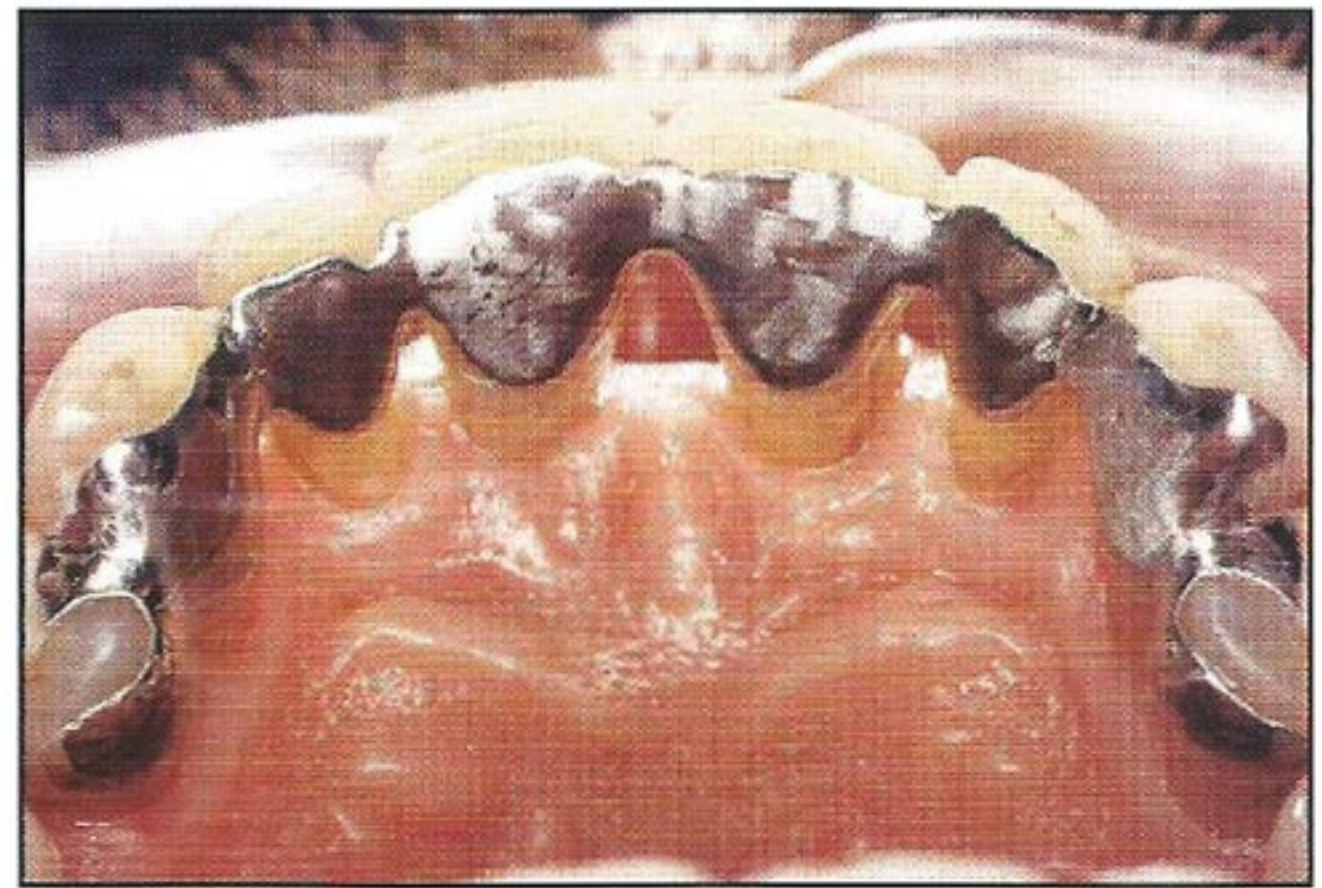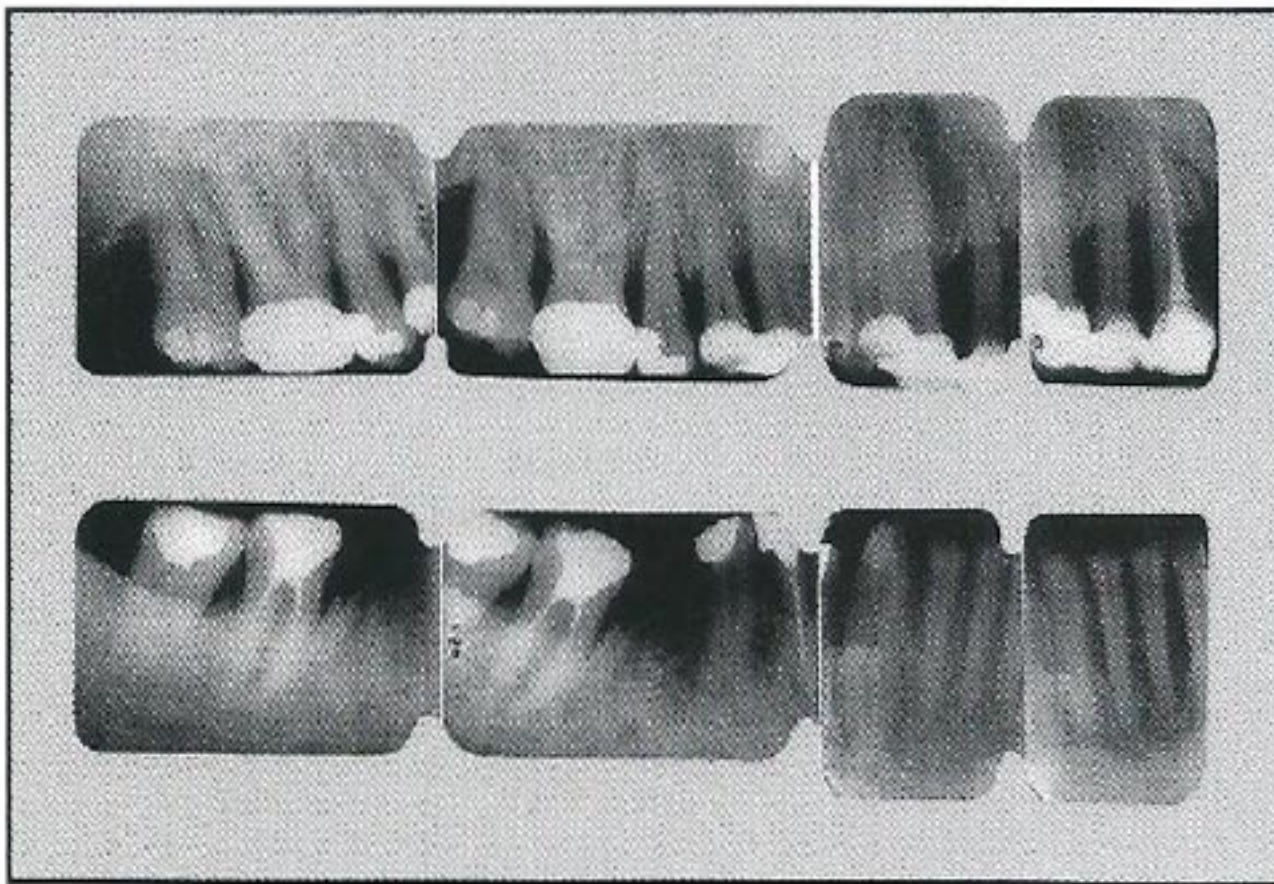**Fig 4e** *Clinical view of the Maryland splint after bonding.*

Fig 4f *Clinical view of the Maryland splint 10 years after bonding.*

Figs 4g and 4h *Radiographic situation 10 years posttreatment.*

| Table 3 | Lifetable analysis of survival for RBFPDs and RBSs considered together |

x to x-1	1x – dx	dx	wx	1x´	qx	px	p1xp2 ...px	1x´ – dx	qx/ 1x´ – dx	Survival rate (%)
0–1	150	10	0	150	0.067	0.933	0.933	140	$47.86 \cdot 10^{-5}$	93.3
1–2	140	6	0	140	0.043	0.957	0.890	134	$32.09 \cdot 10^{-5}$	89.0
2–3	134	2	0	134	0.015	0.985	0.875	132	$11.36 \cdot 10^{-5}$	87.5
3–4	132	2	0	132	0.015	0.985	0.860	130	$11.54 \cdot 10^{-5}$	86.0
4–5	130	4	0	130	0.031	0.969	0.829	126	$79.36 \cdot 10^{-5}$	82.9
5–6	126	2	20	116	0.017	0.983	0.812	114	$14.91 \cdot 10^{-5}$	81.2
6–7	104	1	22	93	0.011	0.989	0.801	92	$11.96 \cdot 10^{-5}$	80.1
7–8	81	1	26	68	0.015	0.985	0.786	67	$22.39 \cdot 10^{-5}$	78.6
8–9	54	1	26	41	0.024	0.976	0.762	40	$60 \cdot 10^{-5}$	76.2
9–10	27	0	16	19	0	1	0.762*	19	0	76.2
									$291.47 \cdot 10^{-5\dagger}$	

*10-year survival rate.
†Sum of 10 entries in qx/1x´ – dx; the square root of this number, when multiplied by the 10-year survival rate, yields the standard error of the 10-year survival rate. x to x-1 = years after placement; 1x = total RBFPDs/RBSs in place at the beginning of that year; dx = total RBFPD/RBS failures during that year; wx = RBFPDs/RBSs withdrawn alive during the year (survival); 1x´ = effective number of RBFPDs/RBSs exposed to failure during the year (projected); qx = proportion of RBFPDs/RBSs failing during the year (probability); px = proportion of RBFPDs/RBSs surviving the year in percent (survival rate); p1xp2...px = cumulative survival rate (%); 1x´ – dx = standard error expressed by the effective number of RBFPDs/RBSs exposed to failure during the year less the number of RBFPDs/RBSs failed during the year; qx/1x´ – dx = standard error expressed in percent/ratio.

| Table 4 | Lifetable analysis of survival for RBFPDs |

x to x-1	1x	dx	wx	1x´	qx	px	p1xp2 ...px	1x´ – dx	qx/ 1x´ – dx	Survival rate (%)
0–1	61	4	0	61	0.065	0.935	0.935	57	$114.03 \cdot 10^{-5}$	93.5
1–2	57	1	0	57	0.017	0.983	0.918	56	$30.36 \cdot 10^{-5}$	91.8
2–3	56	2	0	56	0.036	0.964	0.882	54	$66.67 \cdot 10^{-5}$	88.2
3–4	54	0	0	54	0	1	0.882	54	0	88.2
4–5	54	2	0	54	0.037	0.963	0.845	52	$71.15 \cdot 10^{-5}$	84.5
5–6	52	1	12	48	0.021	0.979	0.824	47	$44.68 \cdot 10^{-5}$	82.4
6–7	39	1	8	35	0.028	0.972	0.796	34	$82.35 \cdot 10^{-5}$	79.6
7–8	30	1	6	27	0.037	0.963	0.759	26	$142.31 \cdot 10^{-5}$	75.9
8–9	23	1	8	19	0.053	0.947	0.706	18	$294.44 \cdot 10^{-5}$	70.6
9–10	14	0	6	11	0	1	0.706*	11	0	70.6
									$845.99 \cdot 10^{-5\dagger}$	

*10-year survival rate.
†Sum of 10 entries in qx/1x´ – dx; the square root of this number, when multiplied by the 10-year survival rate, yields the standard error of the 10-year survival rate. x to x-1 = years after placement; 1x = total RBFPDs in place at the beginning of that year; dx = total RBFPD failures during that year; wx = RBFPDs withdrawn alive during the year (survival); 1x´ = effective number of RBFPDs exposed to failure during the year (projected); qx = proportion of RBFPDs failing during the year (probability); px = proportion of RBFPDs surviving the year in percent (survival rate); p1xp2...px = cumulative survival rate (%); 1x´ – dx = standard error expressed by the effective number of RBFPDs exposed to failure during the year less the number of RBFPDs failed during the year; qx/1x´ – dx = standard error expressed in percent/ratio.

Table 5	Lifetable analysis of survival for RBSs									
x to x-1	1x	dx	wx	1x′	qx	px	p1xp2 ...px	1x′ − dx	qx/ 1x′ − dx	Survival rate (%)
0–1	89	6	0	89	0.067	0.933	0.933	83	$80.72 \cdot 10^{-5}$	93.3
1–2	83	5	0	83	0.068	0.940	0.873	78	$76.92 \cdot 10^{-5}$	87.3
2–3	78	0	0	78	0	1	0.873	78	0	87.3
3–4	78	2	0	78	0.026	0.974	0.847	76	$34.21 \cdot 10^{-5}$	84.7
4–5	76	2	0	76	0.026	0.974	0.821	74	$35.13 \cdot 10^{-5}$	82.1
5–6	74	1	8	70	0.014	0.986	0.807	69	$20.29 \cdot 10^{-5}$	80.7
6–7	65	0	14	58	0	1	0.807	58	0	80.7
7–8	51	0	20	41	0	1	0.807	41	0	80.7
8–9	31	0	18	22	0	1	0.807	22	0	80.7
9–10	13	0	10	8	0	1	0.807*	18	0	80.7
									$247.27 \cdot 10^{-5}$†	

*10-year survival rate.
†Sum of 10 entries in qx/1x′ − dx; the square root of this number, when multiplied by the 10-year survival rate, yields the standard error of the 10-year survival rate.
x to x-1 = years after placement; 1x = total RBSs in place at the beginning of that year; dx = total RBS failures during that year; wx = RBSs withdrawn alive during the year (survival); 1x′ = effective number of RBSs exposed to failure during the year (projected); qx = proportion of RBSs failing during the year (probability); px = proportion of RBSs surviving the year in percent (survival rate); p1xp2...px = cumulative survival rate (%); 1x′ − dx = standard error expressed by the effective number of RBSs exposed to failure during the year less the number of RBSs failed during the year; qx/1x′ − dx = standard error expressed in percent/ratio.

Discussion

RBFPDs and RBSs provide a useful solution for final rehabilitation of periodontal patients: they are able to splint residual teeth, to replace lost ones and, if necessary, to act as a permanent retention for orthodontically realigned teeth.

In a 10-year observation period, the periodontal response to the presence of RBFPDs showed good clinical outcomes comparable to those of other types of restorations.[20] Previous clinical research has shown equivocal results during the follow-up period.[3,14] In particular, a meta-analysis by Creugers and Van't Hof[15] on 1,598 RBFPDs from 16 published investigations showed less than 75% cumulative survival at 4 years. Rijk et al[14] evaluated 164

RBFPDs on 146 patients: 117 of them (71%) showed evidence of success at the end of the observation, with a median time in service of 10.3 years. The authors estimated 21.3 years as the characteristic lifetime of the RBFPDs (ie, the time to failure of 63% of the specimens of the total sample). Samama[13] claimed a 71.6% 10-year cumulative survival for 98 Maryland splints and FPDs splinting abutment teeth when bonded to prepared teeth and 53.6% when bonded to nonprepared teeth.

The results from the present research show a 76.2% 10-year cumulative survival for 150 RBFPDs and RBSs considered together in periodontal patients. All Maryland devices were bonded to teeth that were prepared according to Simonsen et al.[16] Therefore, Maryland

FPDs and splints also seem to be an effective treatment for periodontal patients in the long term.

It is important to remark that:

1. Such clinical performance was obtained with tooth preparation with minimal mechanical retention and with a bonding agent that was effective on enamel but not on dentin; improved outcomes are likely to be reached by means of more up-to-date tooth preparation designs[21–24] and different bonding agents that are also adhesive to dentin.[25]

2. It was possible to rebond 16 of 17 debonded RBFPDs and RBSs, so that at the end of the 10-year observation period 147 of 150 (98%) Maryland appliances were still in clinical function.

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