Predictability of Resin-bonded Splints in the Treatment of Patients with Periodontitis: a Retrospective Study

Yves Samama, Laïla Lboukili, Rosita Purer

A long-term retrospective analysis of clinical and radiographic data was carried out to determine the interest and value of splint therapy for stabilizing clinical conditions after periodontal treatment. The study population was composed of 51 patients enrolled in periodontal maintenance. Patients were selected for splint therapy (splints or combined splint-fixed partial dentures) because of residual tooth mobility in the anterior area following completion of periodontal treatment. The follow-up period comprised between 2 to15 years.
During the observation period, 2 out of the 308 abutment teeth were lost and a small number of complications (3 pulpal incidents, 9 debondings) occurred. The mean percentage of bone loss calculated on periapical radiographs was 0.27% in the group 5–10 years after splinting and 0.40% in the group 10–15 years after splinting.
The results of this study demonstrate that when modern adhesive techniques are applied, resin-bonded splints and fixed partial denture splints can be viable alternatives to conventional complete coverage prostheses in the treatment and maintenance of patients with periodontal diseases.

Key words: periodontitis, resin-bonded splints, periodontal maintenance

INTRODUCTION

Advances in research over the last 30 years have greatly enhanced our knowledge of periodontal diseases. A better understanding of the relationship between the bacterial etiology of periodontal diseases and the host response has led to more sophisticated diagnostic procedures and treatment concepts. However, prosthodontic procedures which involve some degree of hard and soft tissue invasion are still required to replace missing teeth, to improve comfort and aesthetics, and to stabilize some clinical situations in periodontal patients.
In addition to the considerable loss of tooth structure, the construction of conventional fixed partial dentures is often associated with problems such as pulp necrosis or periodontal complications due to subgingival preparations in the anterior region (Randow et al, 1986). Therefore, alternative methods of fixed tooth replacements have been proposed. One of them is the adhesive prosthesis, which was also introduced as a less aggressive method of splinting teeth with reduced periodontal support (Rochette, 1973). However, this technique has suffered a series of failures related to a poor understanding of the indications for its use and to the mediocre performance of the first bonding agents under occlusal and salivary stresses (Marinello, 1987, 1988).
The problems indicated by these initial failure rates have been addressed by improving not only the preparation protocol of the retaining teeth but also the quality of the bonding agents (Samama, 1995; Romberg et al, 1995; Wood et al, 1996)
It has been demonstrated that resin-bonded splints and fixed partial denture splints provide long term

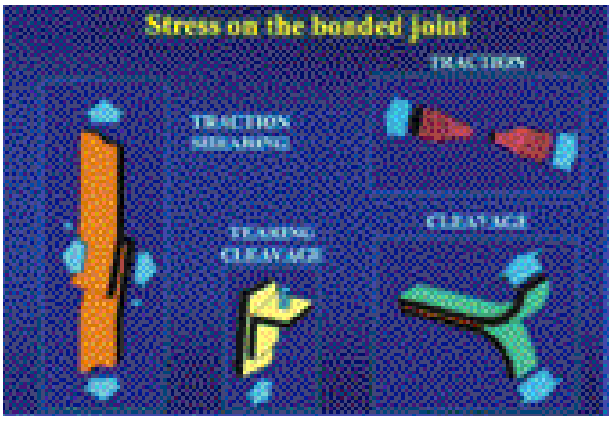

Fig. 1 Effects of the 4 types of stress on the bonded joint.

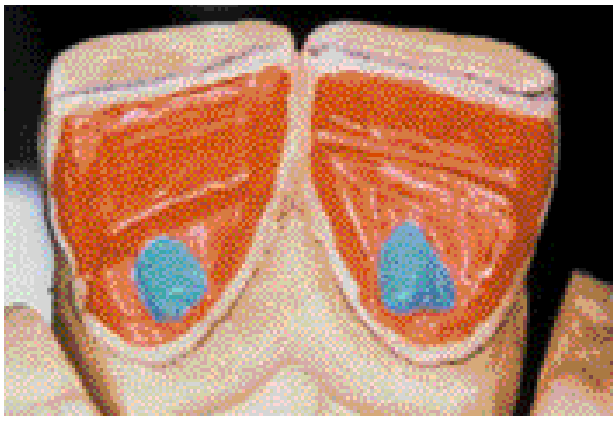

Fig. 2 Enamel microshoulders are designed to counter peeling stress.

Fig. 3 Tooth mobility leads to significant traction stress on bonded joints, accounting for the debonding of mobile teeth in splints. The arrangement of cingulum pins helps to limit traction stress on mobile teeth with reduced periodontal conditions.

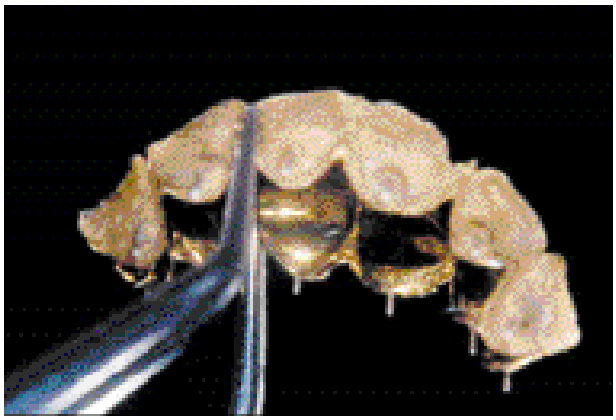

Fig. 4 The inner surface of a maxillary splint with cingulum pins (elaborated on the base of the preparation shown in Fig. 3), before bonding.

efficiency (Livatidis et al, 1982; MacLaughlin, 1981), the primary clinical criterion being the length of time that restorations remained bonded. However only few studies on the periodontal response to this type of reconstructions are available (Freilich et al, 1990; Marinello et al, 1990; Quirynen, 1999) They all show that, despite the possibly altered contour of the abutment teeth and the resulting higher frequency of plaque retention, this prosthodontic alternative did not seem to change the periodontal status in long-term evaluations.

The purpose of this study is to investigate the value of this minimally invasive prosthodontic approach for stabilizing clinical conditions after periodontal disease treatment, using both clinical and radiographic criteria.

STUDY DESIGN AND RESULTS

Resin-bonded splints were used according to the protocol described by Samama (1995). The success of this protocol depends on a good understanding of the interface mechanisms and stresses on the bonded joints. The necessity of tooth preparation has proven to be of great importance in countering the major stresses on the bonded joints related to tooth mobility. Four types of stress have been described: tearing and cleavage, peeling, traction, and traction-shearing (Samama, 1995) (Fig. 1).

Enamel micro-shoulders were designed to counter peeling stress, while an arrangement of cingulum pins was intended to reduce traction stresses

(Figs. 2–4). All the abutment teeth were prepared but the exact number of preparations for each tooth depended on tooth mobility, the extent of the edentulous zone and on the occlusal conditions observed in each patient. All restorations were designed to be supragingival and to respect pulpal conditions. A chemically activated resin (Superbond, Sun-Medical, Shiga, Japan) was used.

Characteristics of the Population Studied

The study was limited to the anterior sector of the arch, where function and aesthetics are equally important. Clinical data including prosthetic and endodontic complications and radiographic data from 51 patients (38 females and 13 males), ranging in age from 18 to 64 years, were used in this study. Each patient had periodontal disease requiring anterior teeth to be splinted or treated with combined splint fixed partial dentures.

At the first clinical examination by a periodontist, and according to periodontal and radiographic parameters, 6 patients were diagnosed with initial chronic periodontitis and 35 with moderate to severe chronic periodontal disease (Armitage, 1999). Only 10 patients were diagnosed with aggressive periodontitis. Following periodontal treatment, patients were referred for prosthodontic stabilization with resin-bonded splints or with combined splint-fixed partial dentures. All patients were maintained in parallel supportive periodontal care by their periodontists for a period of 2 to 15 years and followed regular maintenance visits, including periodontal screening, prophylaxis and oral hygiene instructions. Patients were recalled at 3 to 12 month intervals on average.

Clinical and Radiographic Analysis

The subjects were analyzed according to specific clinical and radiographic parameters.

For the clinical evaluation: the study population was divided into 3 groups based on the time span of the follow-up period after splinting: 2–5 years (n=7), 5–10 years (n=9), and 10–15 years (n=35). For each patient, the following clinical data were collected: type of periodontal treatment, orthodontic treatment needs, nature of retention (splint or fixed partial denture splint), number of teeth involved in bonding, number of teeth lost during observation period; number of debonding incidents during observation period, and frequency of pulp disease incidents during observation period.

For the radiographic evaluation: only 2 groups were established based on the availability of their radiographic status: 5–10 years after splinting (n=29) and 10–15 years after splinting (n=16).

The radiographic assessments did not correspond exactly in time with clinical evaluations. These two analyses were thus considered as parallel studies. Periapical radiographs, applying the long cone paralleling technique, taken before and after splinting were used to analyze the evolution of bone loss around the anterior splinted teeth. For each patient, the mean percentage of bone loss was calculated between the initial status and the follow-up status. Measurements were taken with a magnifying glass graded to one tenth of a millimeter and allowing a magnification of ten. All analyses were undertaken by the same examiner under standardized conditions, using an illuminated light box. Radiographs were separated so that the initial and final sets from each patient were not read at the same session. To ensure that bone loss was consistently measured, 10 randomly selected radiographs were re-measured. There was an exact correspondence between the original and the repeated measurements in 93% of cases, indicating that the reproducibility of this technique for assessing alveolar bone loss was good.

Interproximal alveolar bone heights were assessed using a modified version of the technique of She et al (1959) as described by Linden (1988). The cemento-enamel junction (CEJ) was chosen as the coronal reference point since it is more reliable than the most occlusal point (Selikowitz et al, 1981). When the CEJ was not visible due to the presence of a restoration, the most apical point of the restoration was used. The alveolar crest, which constituted the second reference point, was considered as the most coronal level when the periodontal membrane retained its normal width. When widening of the cervical part of the periodontal membrane space was present, it was scored as bone loss only if evidence of oblique resorption was also present (Albandar et al, 1987). The CEJ, the apex and the alveolar bone margins of each splinted tooth were identified and marked on the periapical radiographs. The latter were considered as acceptable only if the CEJ, restoration margin, interdental bone crest, and apex were clearly visible.

Observation period	2–5 years	5–10 years	10–15 years
Total No. of patients	7	9	35
No. of splints	6	9*	21**
No. of fixed partialdenture splints	1	1	16
No. of retainers	43	54	211

** One patient received a splint in the maxilla and in the mandible*

*** Two patients were treated each with a splint in the maxilla and in the mandible, and one patient received a fixed partial denture splint in the maxilla and a metal splint in the mandible*

Fig. 5 Distribution of splints, prostheses and retainers in the study population (clinical evaluation).

Fig. 6 Example of the repair work debonded elements: the debonded element is separated from the rest of the splint. The latter is preserved. New preparations are elaborated within the metallic elements of the splint adjacent to the tooth.

Fig. 7 A new small splinting device is elaborated, reuniting the debonded tooth with the rest of the initial splint.

Fig. 8 The newly elaborated splint is bonded onto the tooth surface and onto the adjacent metal surface, the former having been pre-treated with sandblasting and the application of a primer (Sun Medical).

The optimal bone level was taken as extending to 1mm below the CEJ. The mean percentage of bone loss was calculated for the mesial and distal sites of each splinted tooth as follows:
% of bone loss:
[(CEJ-MBL) – 1 / (CEJ-apex) – 1] x 100
where MBL is the marginal bone level.
To measure the difference in bone loss, the readable score for each post-splinting site was subtracted from the initial radiograph score for each site.

Clinical Observations

In our study population, 8 patients received surgical treatment after initial therapy and 35 patients received orthodontic treatment before splinting. From the 51 patients, 32 patients received resin-bonded metallic splints (26 in the maxilla, 3 in the mandible and 3 in both the maxilla and the mandible); 18 patients received splint fixed partial dentures (12 in the maxilla and 6 in the mandible); and 1 patient received a fixed partial denture splint in the maxilla to replace the upper right central incisor and a metal splint in the mandible. In total, the number of resin-bonded splinting devices was 55 constructed on 308

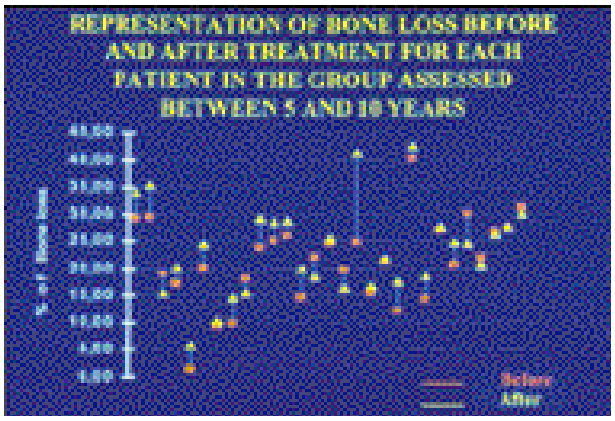

Fig. 9 Representation of bone loss for each patient before and after treatment in the 5–10 year observation group.

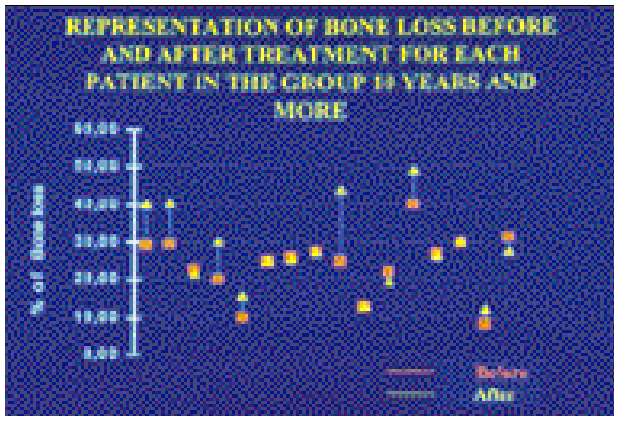

Fig. 10 Representation of bone loss for each patient before and after treatment in the 10–15 year observation group.

teeth. The number of splints, prostheses, and units of the splints/prostheses in each group is presented in Figure 5.

Due to periodontal complications, 2 out of the 308 teeth (1 lower lateral incisor and 1 upper central incisor) were lost during the 10–15 year observation group. No tooth loss was recorded in the 2–5 year group or the 5–10 year group.

Nine debonding incidents occurred in 7 patients in the 10–15 year group (211 total retainers in 35 patients), resulting in 7 repairs and 2 remakes. One single debonded unit was observed in 5 patients; 2 patients presented 2 debonded units each, thus resulting in 4 debonded units. No debonding was observed in the 2–5 year group or the 5–10 year group (97 retainers in 16 patients). Figures 6, 7 and 8 illustrate an example of splint repair.

Only 3 pulpal incidents on 3 different patients (1 lower lateral incisor, 1 upper lateral incisor and 1 canine) were observed among the 3 groups.

Radiographic Observations

The mean interval between radiographs was 6.54 years (range 5–8 years) for the 5–10 year observation group and 10.94 years (range 10–15 years) for the 10–15 year group. Due to interpretation difficulties, 6 out of a possible 308 surfaces were not included in the first group and 5 out of a possible 174 surfaces were not included in second group.

Bone loss scores were obtained for 302 sites in the 5–10 year group and 169 sites in the 10–15 year group. Figures 9 and 10 represent the average bone loss for each patient before and after splinting for both study groups. Figures 11 and 12 show the distribution in bone loss during the study period. In the 5–10 year observation group, it ranged from a mean bone gain of 5.48% and a mean bone loss of 6.10%; the median bone loss being around 2.27%. In the 10–15 year group, the change ranged was from a mean bone gain of 3.63% to a mean bone loss of 19.55%; the median bone loss being around 0.52%. The average percentage of interproximal bone resorption was 0.27% per year in the first group and 0.40% per year in the second group.

DISCUSSION

The results of this study support the use of resin-bonded splints and splinted fixed partial dentures for maintaining patients with moderate to advanced periodontal diseases. This prosthodontic technique has the advantage of limiting the functional problems caused by periodontal diseases and extending tooth longevity with reduced periodontal support using minimally invasive procedures. Furthermore, splinting is often necessary for post-orthodontic maintenance in periodontal patients.

The present results corroborate the few existing studies on the periodontal response to resin-bonded splints and fixed partial denture splints (Marinello, 1988; Freilich, 1990; Marinello et al, 1990; Quirynen et al, 1999), showing an overall favorable result. They also confirm the findings

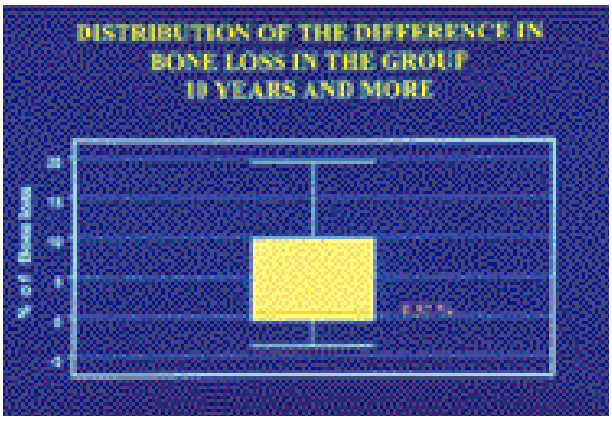

Fig. 11 Distribution of the difference in bone loss in the 5–10 year observation group.

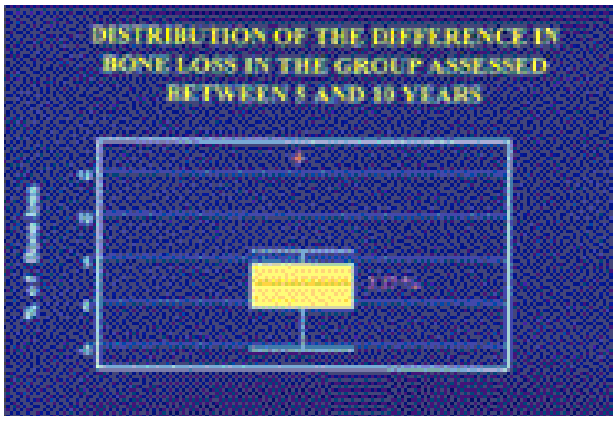

Fig. 12 Distribution of the difference in bone loss in the 10–15 year observation group.

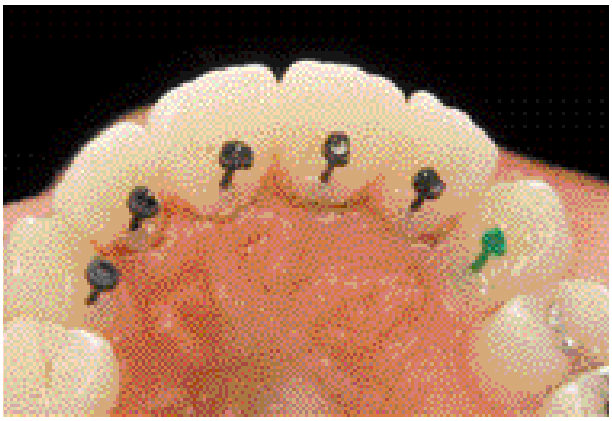

Fig. 13 View of palatal preparations with pins in place, ready for impression. This is a young patient with aggressive periodontitis, who had undergone multidisciplinary treatment (periodontal care followed by orthodontic and prosthodontic treatment).

Fig. 14 Lingual view of a splint cast made with a noble alloy. The inner surface of the splint was silica coated.

of Wood et al (1996) who concluded that caries was not associated with resin-bonded fixed partial dentures.

Aesthetic problems due to the dark metal giving a grayish appearance to the incisal third of the abutment teeth are also resolved by adding opaquers to the formerly translucent resins.

In general two means of evaluation are applied to assess the rate of periodontal disease progression and the effectiveness of possible therapeutic interventions: namely tooth loss and the amount of bone loss around the remaining teeth. Tooth loss can be defined as the number of teeth lost during a period of more than 10 years, resulting in a total tooth loss score of 0.65%. The score of tooth loss per patient and per year is 0.001 respectively. This result compares well with those generally obtained in the literature, varying from 0.02 to 0.24, with an average of 0.07 (Hirshfeld et al, 1978; McFall, 1982; Lindhe et al, 1987; Becker et al, 1984; Goldman et al, 1986; Wood et al, 1989; McGuire, 1991; Brägger et al, 1992). However, it is important to emphasize that these studies included mono- and pluri-radiculated teeth, whereas in the present investigation, only anterior teeth were examined.

A radiographic assessment of alveolar bone loss in patients with periodontitis can be used to measure the progression of bone loss on a longitudinal basis. In this study, the average percentage of interproximal bone resorption was 0.27% per year and 0.40% per year in the 5–10 year and

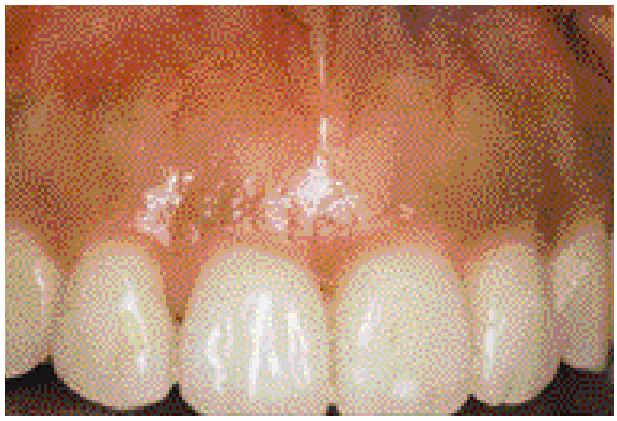

Fig. 15 The use of opaque powder eliminates the unaesthetic grayish aspect widely observed with metallic splinting.

Fig. 16 Initial radiographs of a patient with aggressive periodontal disease. Lateral incisors were extracted.

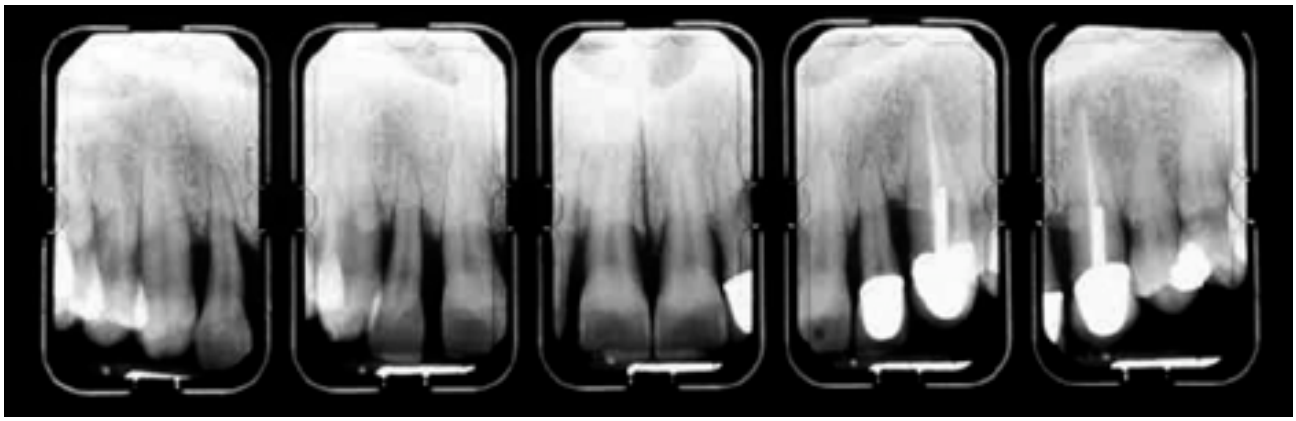

Fig. 17 Palatal view of the 6-unit resin-bonded fixed partial denture, replacing the lateral incisors after periodontal treatment.

Fig. 18 Radiographic view 10 years after placement of resin-bonded prosthesis. Dental and periodontal conditions were stable.

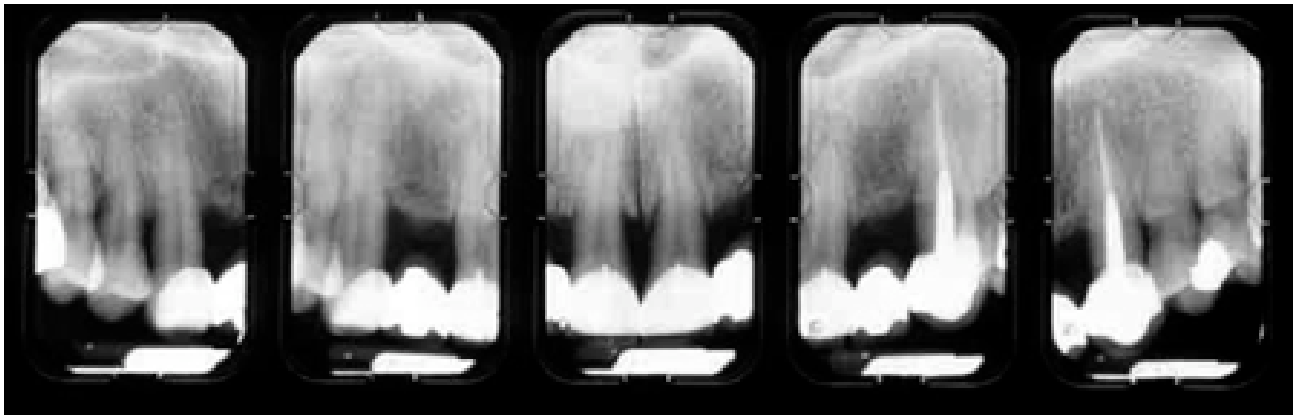

Fig. 19 Example of mandibular splint in fiber-reinforced composite.

10–15 year groups respectively. These values are slightly lower than those presented by Rohner et al (1983), who recorded a mean bone loss of 0.51% per year over a period of 4–14 years, in a population of patients under periodontal maintenance. In our two study groups, 10 patients presented a mean bone loss of about 0.46% per year during the 5–10 year period with a comparable figure of 0.5% per year during the 10–15 year period. However, this annual bone loss score should not be interpreted as a slow, continuous rate of destruction on a truly annual basis because of the great variability observed among the subjects and among different sites within the same patients: interproximal alveolar bone change ranged from an individual mean gain of 5.48% to a mean loss of 6.10% in the 5–10 year group and from a mean gain of 3.63% to a mean loss of 19.55% in the 10–15 year group. It should thus be kept in mind that the results of any clinical investigation indicate only the average occurrence and may not be applied to every individual subject.

The clinical and radiographic results of this study demonstrate the value of resin-bonded splints and splinted fixed partial dentures, which improve aesthetics and may extend tooth longevity. Figures 13–15 provide an example of a maxillary splint, illustrating the quality of the aesthetic result achievable with this technique. Figures 16–18 show the clinical and radiographic aspects of a maxillary splinted fixed partial denture 10 years after periodontal and prosthodontic treatment, and indicate the long term stability of this technique.

With most of its initial problems resolved (Marinello et al, 1987, 1988; Samama, 1995; Romberg et al, 1995; Wood et al, 1996), adhesive prostheses may now be considered as true alternatives for the conventional prosthodontic treatment of periodontal patients. The development of fiber-reinforced composite technology over the last decade has also opened avenues in the field of rapid, aesthetic and non-invasive direct tooth replacements and splints using this type of material (Rada, 1999; Meiers et al, 1998, 1999) (Fig. 19). These techniques would seem to represent good alternatives to metal adhesive prostheses if their long-term durability is proven. However, treatment planning must be undertaken with care given the current state of ignorance on the progression rates of periodontal diseases and the influence of host susceptibility and other risk factors such as stress, smoking habits, and general health status. With these factors in mind, final decisions must be made on a multivariate level for each patient. Depending on patient age, the type of periodontal disease, the extent of periodontal damage, and the occlusal profile, other treatment modalities such as implant placement may be appropriate.

CONCLUSIONS

Out of the total 55 resin-bonded splinting devices applied to 51 patients on 308 teeth, only nine debonding incidents were managed with minor repairs. Only 2 out of the 55 splinting devices had to be remade. During the 10–15 year observation period, 2 out of 308 teeth were lost due to periodontal complications. No tooth loss was recorded during the shorter observation periods. Only 3 pulpal incidents in 3 different patients were observed among the 3 groups.

The average percentage of annual bone loss around splinted teeth is comparable to that observed in the general population by other authors (Rohner et al, 1983). Some degree of variability was reported in alveolar bone resorption among individuals in the population studied.

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