Survival and Complication Rates of Combined Tooth–Implant–Supported Fixed and Removable Partial Dentures

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Purpose: The aim of this study was to assess and compare clinical outcome results of tooth-implant–supported fixed and removable partial dentures in a selected population group of partially edentulous patients. Biological and technical complications were recorded and reviewed. ***Materials and Methods:*** A retrospective analysis of the dental charts of 224 patients (174 men, 50 women) with a mean age of 51.3 years was carried out. The evaluation included details regarding the survival and technical complications of the prescribed prostheses, as well as the biological and technical complications associated with both types of abutments used, ie, teeth and implants. ***Results:*** A total of 229 prostheses were supported by 459 implants and 449 teeth. They were monitored for a period of 2 to 10 years (median follow-up time: 6.7 years). At the end of the different observation periods, 14% of the tooth-implant–supported prostheses had undergone technical modifications, with no statistical difference in the occurrence of technical complications between the 2 types of prosthesis. Three of the functionally loaded implants were removed, while 23 abutment teeth were lost (15 had undergone endodontic treatment). Abutment teeth with a reduced attachment level after prosthesis insertion were significantly affected by biological complications ($P = .04$). ***Conclusions:*** The survival data for both types of prosthesis were comparable to prostheses supported solely by implants. There was no difference in the complication rate between primary splinting (fixed) and secondary splinting with telescopic systems (removable). A greater risk of biological complications was recorded for endodontically treated abutments or teeth with a reduced attachment level. *Int J Prosthodont 2008;21:131–137.*

Published studies endorse the clinical merits of prostheses supported by teeth and implants or by implants alone.[1–6] Furthermore, the biomechanical behavior of teeth and implants under functional loading appears to be similar.[7] The use of a rigid connection between teeth and implants is preferred to a nonrigid connection[4,5,8–11] since the numerous biological and functional interactions of a mixed abutment design are imperfectly understood. The numerous reports on intrusion of the abutment teeth in cases of nonrigid connections[9,11] and greater bone loss in the vicinity of the implant in cases of rigid connections[12] underscore this concern. Peri-implant bone levels also appear to depend on tooth-implant distance; it has been observed that an increase in tooth-implant distance can result in an increasing area of residual ridge reduction, which then gradually diminishes.[13] It also appears that the concept of combined tooth-implant support can be integrated into routine treatment planning, particularly in overdenture designs for patients with significantly compromised dentitions.[14]

The purpose of this study was to assess the clinical performance of 2 prosthesis designs supported by both teeth and implants. The prostheses were either fixed partial denture (FPDs) or removable partial dentures (RPDs), with the latter employing the telescopic system. The incidence of biological and technical complications was reviewed on the basis of overall survival data.

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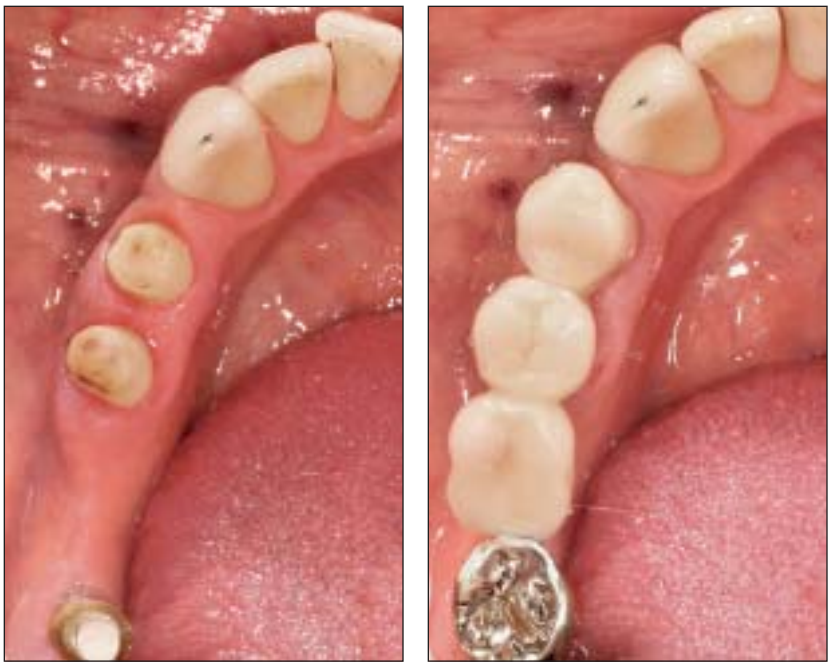

Fig 1 Tooth-implant–supported fixed partial denture (n = 178).

Materials and Methods

Data were compiled from the dental treatment records of 224 consecutive patients from the German Central Medical Corps dental clinics (n = 143 patients) and the Prosthodontic Department of the University of Aachen, Germany (n = 81 patients). Inclusion and exclusion criteria were focused on the abutment teeth. At the time of treatment, the abutment teeth needed to be periodontally healthy (absence of the following: loosening, loss of attachment > 1/3 of the root length, gingivitis, probing pocket depth > 3 mm), with an absence of periapical changes and proper position of the abutment teeth. Patients undergoing orthodontic treatment, patients with teeth in a radiation field, patients receiving chemotherapy, and patients showing xerostomia were excluded from the study. The charts were analyzed by 2 examiners using a standardized protocol. The clinicians who inserted the prostheses from 1990 to 2001 also performed aftercare for the patients until the end of 2006. Only 43 of the 229 tooth-implant–supported prostheses were of nonrigid construction, ie, equipped with attachments or similar (nonrigid) devices. The tooth-implant–supported prostheses were FPDs (n = 178; Fig 1) or RPDs with a telescopic system (n = 51; Fig 2). The hygiene and control recall was scheduled in a half-year period and conducted by the appropriate clinician. The choice of a screw- or cement-retained design for FPDs was based on the construction and esthetic aspects of the abutment type used (location of possible screw channels). In cases of a cemented construction, a zinc phosphate cement (Harvard Cement, Richter & Hoffmann Harvard Dental) was used.

Only patients who could be observed for at least 2 years were included in this retrospective study. All data were entered into a database and evaluated using SPSS software (SPSS) for Windows. All patients and the involved institutions gave their consent post hoc for participation in this study. The patients` charts and radiographs, provided by the involved institutions, were analyzed anonymously. Each case was assigned a registration number before evaluation, which allowed for the explicit and anonymous attribution of necessary information. Kaplan-Meier prosthesis survival curves were applied in addition to frequency counts. The time interval until modification of the prosthesis, abutment teeth, or implant abutments was defined as the time difference between the date of superstructure insertion and the date of occurrence or the end of the observation period (censored data). Dates concerning the abutment teeth, implants, and restorations were evaluated as follows: survival and technical complications of

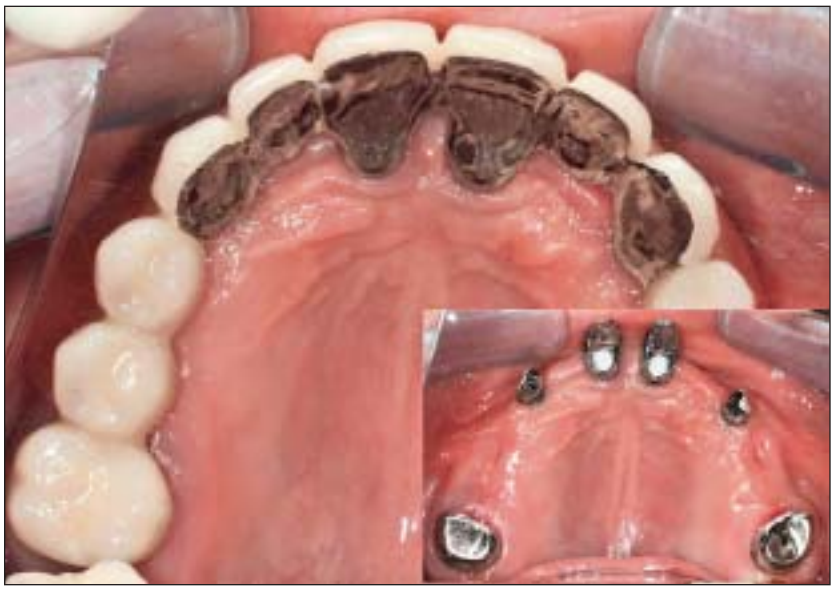

Fig 2 Tooth-implant–supported removable partial denture with a telescopic system (n = 51).

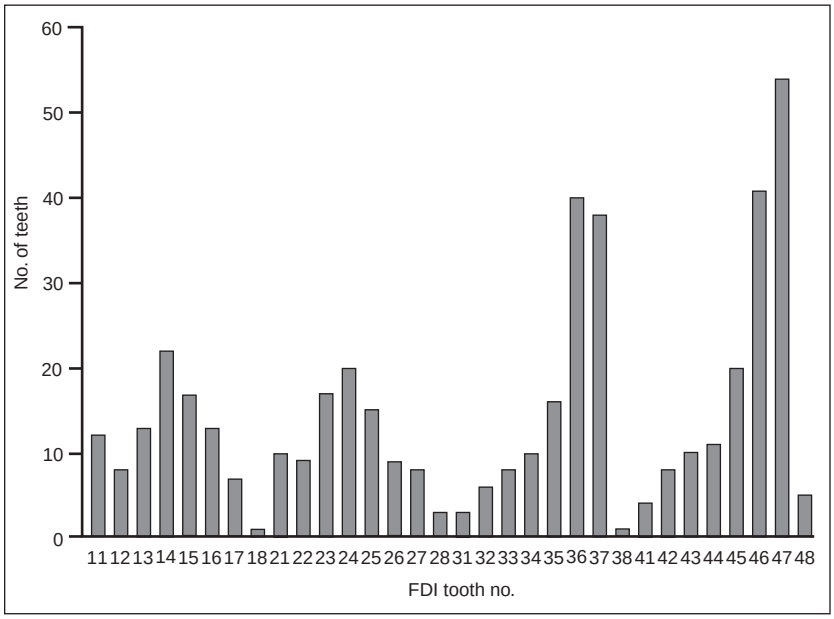

Fig 3 Frequency and distribution of abutment teeth (n = 449).

tooth-implant–supported prostheses (inclusion criteria: need for a new prosthesis or repair of prosthesis, repair of veneer fracture or fracture of frame, incidence of intrusion); survival of teeth and implants; biological complications of abutment teeth (inclusion criteria: periodontal treatment, filling therapy, or endodontic treatment); biological and technical complications of implant abutments (inclusion criteria: abutment or occlusal screw loosening, abutment fracture or abutment screw fracture, loss of cementation, or gingival inflammation with partial loss of localized osseointegration). Descriptive statistics and the chi-square test were used to test for independence of variables.

Results

Patient and Restoration Characteristics

A total of 229 tooth-implant–supported prostheses were inserted in 224 patients (50 women and 174 men). The median follow-up time was 6.7 years (range: 2.1 to 15.8). At the time of treatment, the average patient age was 51.3 years (range: 21.7 to 78.0). One hundred fifty-five of the 449 abutment teeth were mandibular premolars (Fig 3). One hundred seventy-five of the 459 implants were inserted in the posterior mandible (Fig 4). Approximately

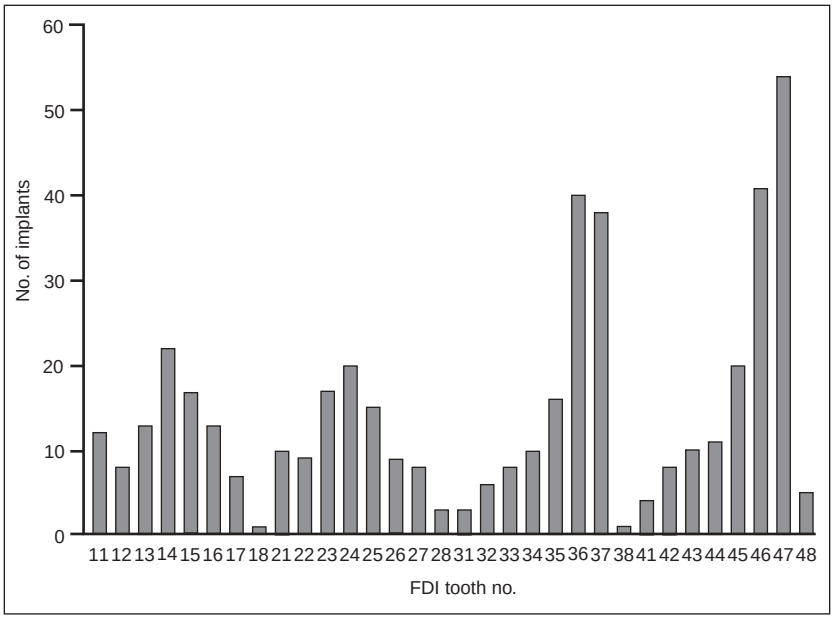

Fig 4 Frequency and distribution of implants (n = 459).

90% of the implants were either Brånemark implants (Nobel Biocare) (68.0%) or Straumann implants (Straumann) (22.8%). The reconstructions were secured using screws (61.3%), cement (14.9%), or a telescopic system (23.1%). There were more than 3 abutments supporting 49.3% of the tooth-implant–supported prostheses, whereas the other half of the constructions consisted of 3 or 4 units with 2 or 3 abutments (Fig 5).

Only 43 of the 229 tooth-implant–supported prostheses were of nonrigid construction, ie, equipped with attachments or similar (nonrigid) devices. The tooth-implant–supported prostheses comprised 178 FPDs and 51 RPDs with a telescopic system.

Prosthesis Survival and Technical Complications

The inclusion criteria for the analysis of technical problems were need for a new prosthesis (renewal), reintegration of a prosthesis, or repair of a prosthesis. There were no statistical differences between technical complications for FPDs (n = 178) or RPDs (n = 51). A renewal of the FPD was required within 10 years in 19 cases (8.3%). In 10 cases, this was due to the removal of an abutment tooth; in the other 9 cases, the reason was a permanent loosening of the superstructure. Reintegration was necessary in 7.1% (n = 16) of the dentures, and repair was required in 11.8% (n = 13; n = 5 for veneer fracture, n = 8 for FPD fracture). A graph of technical modifications versus time reveals that after 10 years, 14% (± 2.3; 95% confidence interval) of the tooth-implant–supported prostheses had been subjected to a technical modification (Fig 6).

In contrast to nonrigid connection of teeth and implants, technical modifications were rarely required for tooth-implant–supported FPDs with a rigid connection. Pearson chi-squared tests showed that the frequency of tooth-implant–supported FPD modifications was significantly associated with prosthesis splitting, and thus with nonrigid connections ($P < .05$). Technical modifications were needed for 20 of 43 prostheses with nonrigid connections. There was no statistical difference in terms of technical complications between FPDs and RPDs ($P = .19$). The incidence of intrusion of teeth for tooth-implant–supported prostheses was 6.9% (n = 16) and exclusively a complication of nonrigid connections.

Tooth and Implant Survival

During the observation period, only 3 of the 459 implants were removed because of loss of osseointegration. Twenty-three of the 449 abutment teeth were lost, in most cases because root canal–filled abutment teeth had to be removed (15 of 94 root canal–filled abutment teeth).

Biological Complications

Inclusion criteria for the analysis of biological problems of abutment teeth were periodontal treatment (probing pocket depth > 5 mm; n = 13), the need for a restoration (n = 11), or endodontic therapy (n = 11). Figure 7 shows that after 10 years, as much as 11% (± 1.5; 95% confidence interval) of the abutment teeth required corresponding therapeutic treatment. Root canal–filled teeth or abutment teeth exhibiting a reduced attachment level after the insertion of the superstructure were significantly more likely to be affected by biological complications than "healthy" teeth ($P = .04$).

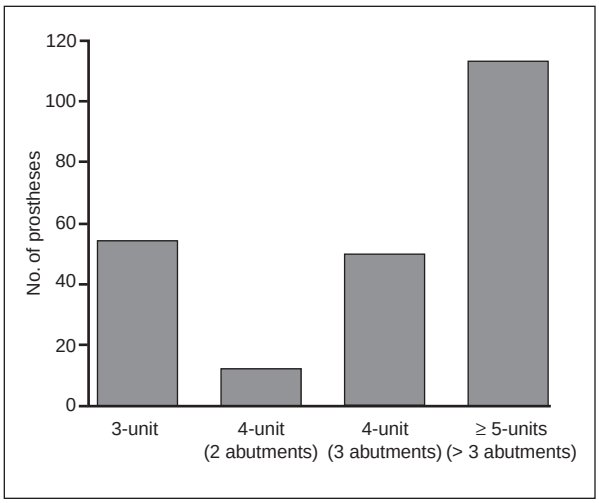

Fig 5 Frequency and extension of tooth-implant–supported prostheses.

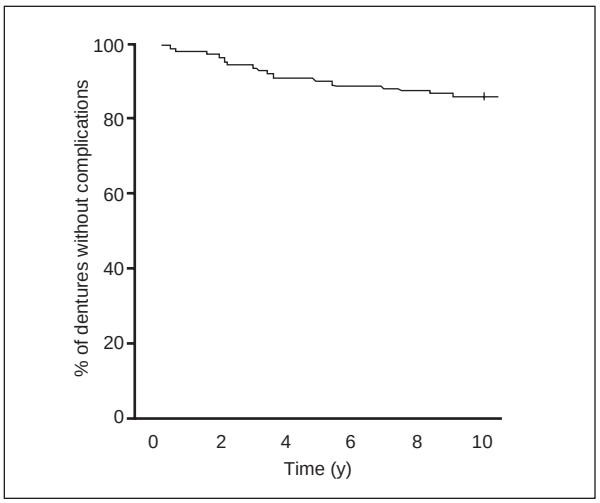

Fig 6 Kaplan-Meier survival curve: First technical modification of the tooth-implant–supported prostheses (n = 229).

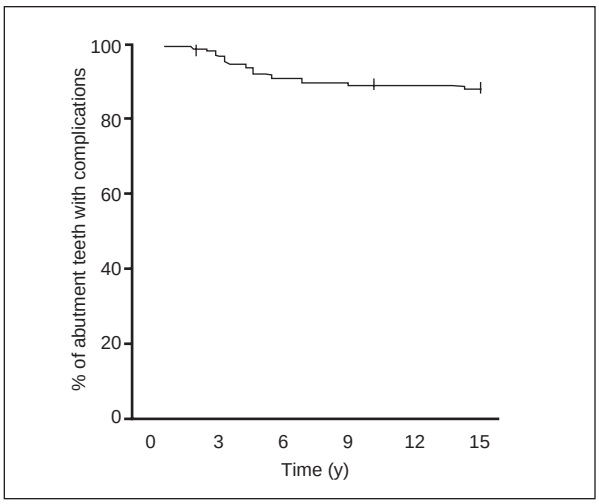

Fig 7 Kaplan-Meier survival curve: First follow-up treatment measure for the abutment teeth (n = 449).

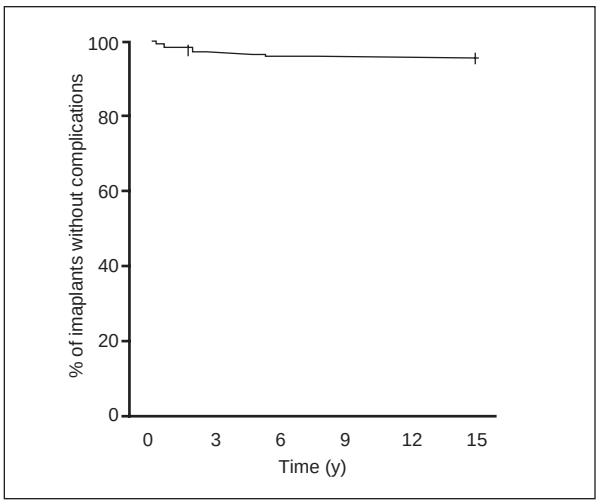

Fig 8 Kaplan-Meier survival curve: First follow-up treatment measure for the implants (n = 459).

Biological and Technical Complications of Implant Abutments

A biological complication was defined as the presence of a soft tissue complication with a probing pocket depth >5 mm. This was treated using site debridement and irrigation with 0.12% chlorhexidine digluconate. Technical complications of implant abutments were divided into either connection-related complications with abutment or occlusal screw loosening, or abutment fracture or abutment screw fracture. In cases of cemented FPDs, the loss of cementation was recorded. After 10 years, less than 5% of implant abutments had biological or technical complications ($\pm$ 0.9; 95% CI); thus, these complications were rare.

During the study period, only 3 screw or abutment fractures were detected. Screw loosening was documented in 9 of 276 screw-retained abutments. Loss of cementation was reported in 6 of 67 cemented connections between implant abutments and FPDs. Most connection-related complications (abutment or occlusal screw loosening or loss of cementation) appeared and were corrected in the first 5 years after prosthesis insertion. During the subsequent 5 years, few additional technical modifications were needed (Fig 8).

Discussion

This retrospective study is based on the analysis of the dental records of a specific cohort of 224 patients who were available for at least 2 years of recall. It is readily conceded that this approach is not a compelling clinical scientific research design. However, the authors hope that it still provides clinical colleagues with preliminary and valuable insights into the aftercare requirements of combined tooth-implant–supported prosthetic treatments.

It is also inappropriate to compare these results with those of other studies because of the differences in research design, patient populations, sites analyzed, evaluation criteria, and the rigor and length of the observation periods. Nevertheless, a number of studies have addressed similar topics. Naert et al[8,12] carried out clinical follow-up examinations of 339 implants and 313 teeth and concluded that prostheses supported solely by implants are preferred due to numerous complications with tooth-implant support. The complication rate for teeth and implants was 5% to 10%, with an average utilization period of approximately 6.5 years. In accordance with the results of the present study, it must be assumed that after 10 years, approximately 14% of the tooth-implant–supported prostheses would be subjected to at least 1 technical modification. When a nonrigid connection between tooth and implant is used, the complication rate of FPDs is significantly increased. There were no statistical differences between technical complications of tooth-implant–supported FPDs or RPDs.

The obvious limitation of the present study is that nearly two thirds of the patients were members of the German army. This fact has a positive and negative effect on the results. No dropouts as a result of missing or incomplete treatment records were registered during the investigation. Because most patients were soldiers, they were under steady and well-documented dental control by different clinicians. The records were analyzed by 2 independent clinicians using a standardized protocol; however, because of a lack of independent evaluation of aftercare needs, the statements relating to the complications are limited. Further, the preponderance of mandibular reconstructions limits the general significance of the study concerning tooth-implant–supported prostheses.

Ten percent of the abutment teeth were subjected to follow-up treatment (ie, periodontal treatment, filling therapy, or endodontic treatment). Root canal–filled teeth or abutment teeth with a reduced attachment level after insertion of the superstructure were significantly affected by biological complications. In contrast to the results of this study, a systematic review of survival rates and complications of FPDs on severely reduced periodontal tissue support showed that survival rates compared favorably to those of FPDs incorporated in subjects without severely periodontally compromised dentitions.[15] Implant abutments rarely showed biological and technical complications (less than 5% after 10 years), and there were no differences resulting from the type of fixation or implant system.

When searching the literature for time-related studies of FPDs supported solely by implants, the authors found that such studies deal almost exclusively with the survival rate of implants.[16,17] In the present study, only 3 of 459 implant abutments were lost. In contrast, 23 of 449 abutment teeth were lost, in most cases because root canal–filled teeth failed (15 of 94 root canal–filled teeth). This is comparable to the results of a 20-year retrospective study of conventional FPDs,[18] in which a significant difference between the survival rates of the vital abutment teeth and the root canal–treated abutment teeth was found.[19,20] Bragger et al[21]observed that FPD loss over 4 to 5 years occurred at a similar rate among tooth-, implant-, and tooth-implant–supported prostheses.

Conclusion

The results of this report suggest that there was no difference between the complication rates of fixed or removable tooth-implant–supported prostheses. There was, however, a higher risk of biological complications when using root canal–filled abutment teeth or teeth with a reduced attachment level.

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Literature Abstract

Distribution of biofilm on internal and external surfaces of upper complete dentures: The effect of hygiene instruction

This study evaluated biofilm distribution over the internal and external surfaces of complete maxillary dentures as well as the efficacy of oral hygiene instructions using disclosing solution. The study was conducted in 2 stages using 29 complete denture wearers. Biofilm from the previous deposits was disclosed with a 1.0% neutral red solution and mechanically removed using a hand brush and denture brush with liquid soap. Following biofilm removal, the dentures were returned to the subjects. During the first stage, subjects were shown how to clean their dentures. The protocol consisted of using a specific brush and dentifrice. Biofilm distribution was recorded at 4 weekly examinations, disclosed with the solution, and the dentures were cleaned and returned to the participants. The second stage involved similar hygiene instructions in addition to the use of disclosing agent. The subjects were also examined 4 times to record biofilm accumulation. The internal surface was divided into 14 areas, and the external surface was divided into 8 areas. Each area was scored from 0 to 4, and a hygiene index was calculated (sum of individual score divided by the number of evaluated areas on surface). Statistical analysis involved the Friedman test, followed by the Dunn multiple comparison test to evaluate the hygiene index of the internal and external surfaces. As for the scores of biofilm for individual areas, a rank test was employed for assessment of the interaction between "areas" and "stages." The mean scores for each area were compared using analysis of variance for repeated measures. The Student-Newman-Keuls test was used for post hoc comparisons. The results indicated that internal and external surfaces had similar amount of biofilm, which was concentrated over the posterior teeth, rugae area, and internal vestibular incline of the distobuccal flange. The overall amounts were reduced following denture hygiene information, and the use of disclosing solution resulted in a further reduction. The author concludes that oral health instruction was effective in reducing biofilm, especially when associated with the use of disclosing agent. This study supports the importance of oral hygiene instructions for denture wearers and may assist policy makers in designing home care programs for their long-term residents wearing dentures.

Paranhos HFO, Da Silva CHL, Venezian GC, Macedo LD, De Souza RF. *Gerodontology* 2007;24:162–189. **References:** 23. **Reprints:** Dr Helena de Freitas Oliveira Paranhos, Department of Dental Materials and Prosthodontics, Riberiao Preto Denta School, University of Sao Paulo, Av. Do Café s/n, 14040-904 Riberirao Preto, São Paulo, Brazil. E-mail: helepar@forp.usp.br—*Beatrice Leung, Toronto, ON*