Short Communication

Effect of Different Mucosal and Acrylic Resin Surface Treatments in a Denture Retention Model for Patients with Radiotherapy-Induced Xerostomia

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The purpose of this study was to determine the effect of oral moisturizing agents, denture adhesives, and surface treatments on the retention of an acrylic resin test base dislodged from the maxillary alveolar ridges of xerostomic radiotherapy patients. Acrylic resin test bases prepared for 10 edentulous xerostomia patients were subjected to 8 surface treatment methods: method 1 = untreated dry surface; method 2 = use of Biotène oral moisturizer; method 3 = use of Protefix denture adhesive; method 4 = combination of Biotène and Protefix; method 5 = sandblasting of test bases; method 6 = use of Biotène on sandblasted surface; method 7 = use of Protefix on sandblasted surface; method 8 = combination of Protefix and Biotène on sandblasted surface. After each treatment, a tensile testing apparatus was used to dislodge the inserted test bases, and force values (N) were recorded. A significant difference in retentive force was observed between the 4 Protefix groups and those that did not use denture adhesive ($P < .001$). There were no differences among the 4 combinations of denture adhesive treatments ($P > .05$). Sandblasting the denture surfaces did not increase retentive forces alone or in combination with any other treatments. Biotène oral moisturizing agent was used in 4 treatment methods, but only had a significant effect on increasing retentive force when used with a nonsandblasted surface ($P < .05$). Biotène had no effect on retentive force compared to a nonsandblasted surface without moisturizer or when it was used in combination with any other methods. Protefix denture adhesive offered the greatest improvement in retentive force. Sandblasting the intaglio surface did not improve retentive force. Biotène was reported to improve patient comfort but had minimal effect on retentive force; however, Biotène can be assumed to be a more advantageous method of increasing retention compared to sandblasting ($P < .05$). *Int J Prosthodont 2007;20:405–408.*

Xerostomia is a major side effect of radical radiation therapy for head and neck malignancies. It may be related to the disease or the irradiation volume to salivary glands. As radiation treatment progresses, parenchymal destruction of salivary glands and their vascular supply produces xerostomia.[1] The main complaint of edentulous patients undergoing radiotherapy is xerostomia and consequent disturbed denture retention. Xerostomia causes denture wearing to be very uncomfortable and exacerbates chewing difficulties. Oral moisturizers,[1] denture adhesives,[2] denture reservoirs,[3] various denture bases,[4] and various surface treatments[5] are used to enhance complete denture retention and eliminate or alleviate the effects of xerostomia.

However, limited data are available on the effects of different treatment methods on complete denture retention in xerostomia patients. The purpose of this clinical study was to compare the effects of oral moisturizing agents, denture adhesives, and denture surface treatments on the retention of maxillary complete dentures in radiotherapy-induced xerostomia patients.

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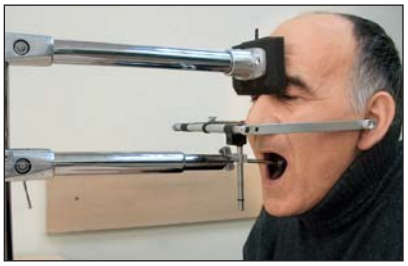
Fig 1 *(left)* Acrylic resin test bases with metal hooks placed at the center of the polished surfaces.

Fig 2 *(right)* Specially designed and fabricated denture-pulling apparatus with an electric motor and dynamometer.



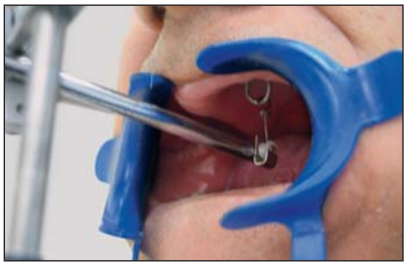


Fig 3 *(left)* The patient's forehead was pressed against the frontal cushion of the apparatus. Camper's lines were set parallel to the horizontal plane.

Fig 4 *(right)* Hook of the pulling apparatus attached to the hook of the acrylic resin base. A constant-speed vertical pulling force is exerted.

Materials and Methods

Ten edentulous cancer patients wearing complete dentures were selected. The patients were all undergoing radiotherapy, and their common complaints were oral discomfort, disturbed denture retention, and malnutrition.

To prepare individual experimental acrylic resin bases for each patient, anatomic impressions were taken with irreversible hydrocolloid impression material (Hydrogum Soft, Zhermack), preliminary casts were obtained (type II dental stone, Moldano, Bayer), individual acrylic resin trays were prepared (Meliodent, Bayer), functional impressions were taken with zinc oxide eugenol paste (SS White), and definitive casts were obtained (type IV dental stone, Begostone, Bego). The experimental acrylic resin bases were planned to extend posteriorly to the hamular notch area. However, the bases did not include buccal or labial flanges that could enter into anatomic undercuts to avoid the effect of mechanical retention. To mark the equatorial contour lines of alveolar crests, the casts were transferred to a parallelometer unit (D-7970, KaVo). The marked equatorial lines and clinically determined hamular notch areas were scraped onto the casts to a depth of 0.5 to 1 mm. Two superimposed sheets of modeling wax (Cavex) were placed onto the cast surfaces within the marked boundaries, and the casts were then flasked. Following the wax elimination process, 2 coats of separator were applied to the cast surfaces, and a heat-polymerized acrylic resin denture base material (QC-20, Dentsply) was prepared according to the manufacturer's instructions. The acrylic resin dough was pressed into the mold, and 2 trial closures were made to remove excess resin before heating. The flasks were then pressed and heated for 30 minutes at 75°C, followed by an additional 30 minutes at 100°C. After polymerization, excessive tips were removed and the acrylic resin bases were immersed in distilled water at 24°C for 24 hours to provide residual monomer release. To determine the approximate center of gravity of the acrylic resin bases, a straight line was drawn on the outer polished surfaces of the bases along the palatal median suture. The length of each line was measured for each individual acrylic resin base, and a metal hook was secured with autopolymerizing acrylic resin at the center of the lines (Fig 1).

An electric motor-driven pulling apparatus (Fig 2) was fabricated for the dislodgement of test bases from the mouth. A dynamometer (Trionic, SN-20, Sundoo Instruments) with a capacity of 20 N was secured at the vertical bar of the apparatus. A frontal cushion and facebow (Hanau Wide-Vue II) were secured at the upper and lower horizontal bars of the system to determine and provide parallel positioning of Camper's lines of the patients to the horizontal plane (Fig 3). The apparatus was designed to apply vertical tensile force at a 90-degree angle to the horizontal plane at a constant tensile force of 5 mm/sec, with a hook attached to a thread pulled by the electric motor. The dynamometer indicated the maximum force recorded at the time of base dislodgement. The foreheads of the patients were pressed against the frontal cushion of the upper horizontal bar. The Camper's lines were set parallel to the horizontal plane. Test bases were placed in the mouth, the hook of the apparatus was attached to the hook of the test base, and vertical tensile force was applied until dislodgement occurred (Fig 4). One acrylic resin test base was used for each patient. Eight measurements were made for each of the 8 methods.

In method 1 (dry), the test bases and patients were not subjected to any treatment. In method 2 (bio), a mouth moisturizing gel and mouthwash solution

Table 1 Nonparametric 1-Sample Kolmogorov-Smirnov Test

Method	Sb	Sb + bio	Dry	Bio	Sb + pro	Sb + bio + pro	Pro	Bio + pro
Normal parameters*								
n	10	10	10	10	10	10	10	10
Mean	2.80	3.02	3.16	3.64	5.94	6.15	6.42	6.55
SD	0.96	1.00	1.00	1.31	1.71	1.79	1.84	1.87
Most extreme differences								
Absolute	0.17	0.13	0.15	0.12	0.24	0.26	0.23	0.25
Positive	0.14	0.13	0.11	0.12	0.24	0.26	0.23	0.25
Negative	−0.17	−0.12	−0.15	−0.08	−0.13	−0.13	−0.13	−0.14
Kolmogorov-Smirnov	0.55	0.43	0.47	0.39	0.77	0.82	0.74	0.81
Asymptotic significance (2-tailed)	0.92	0.99	0.99	0.99	0.59	0.51	0.63	0.52

*Test distribution is normal.

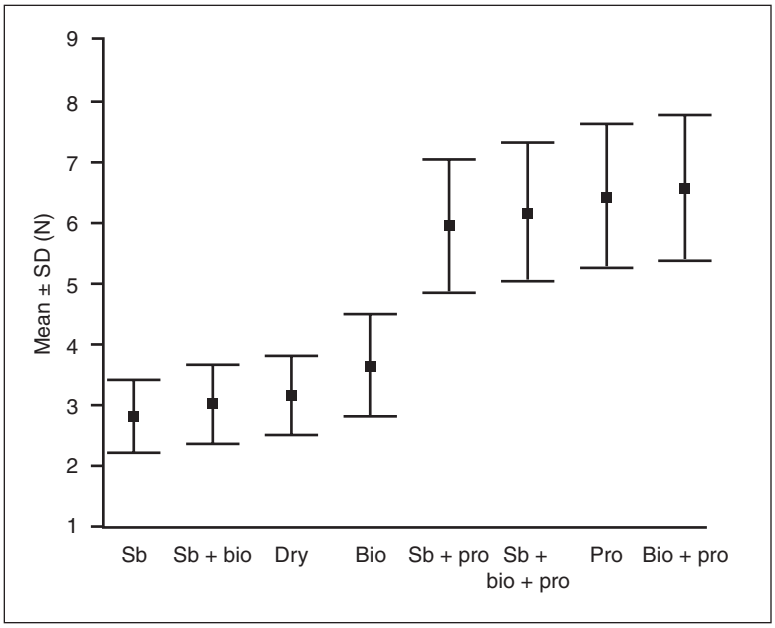


Fig 5 Mean retention force values (N) and SDs of the 8 experimental methods.

(Biotène, Oral Balance) were used in combination for 2 days, 4 times in a day. Measurements were made at the third day, just after the administration of the second dose. In method 3 (pro), a denture adhesive (Protefix, Queisser Pharma) was applied to the internal surfaces of test bases before tensile measurements. In method 4 (bio + pro), Protefix was applied to the internal surfaces of test bases just after the application of the second dose of Biotène, and tensile measurements were performed. In method 5 (sb), internal surfaces of test bases were abraded with 50-μm alumina dust for 30 seconds to provide surface enlargement.[5] In method 6 (sb + bio), measurements were made with sandblasted test bases at the third day of Biotène use. In method 7 (sb + pro), Protefix was applied on sandblasted test bases before measurement. In method 8 (sb + bio + pro), Biotène and Protefix were combined on sandblasted test bases before measurement.

Statistical Analysis

The normal distribution of recorded Newton values of 8 treatment methods for each patient was determined with the 1-sample Kolmogorov-Smirnov test ($P > .05$). Normally distributed data ($P > .05$) were analyzed with 1-way analysis of variance followed by post hoc tests using least square difference (LSD) at a significance level of $P < .05$.

Results

Mean force values (N) and SDs are presented at Table 1 and Fig 5. Multiple comparisons between 8 treatment methods with LSD post hoc test are presented in Table 2. No significant difference was found between methods 1 (dry), 5 (sb), and 6 (sb + bio) ($P > .05$). Method 2 (bio) showed significantly higher retention values

Table 2 Multiple Comparisons Between 8 Treatment Methods with Least Square Difference Post Hoc Test (95% Confidence Interval)

Method	Dry	Sb	Bio	Sb + bio	Sb + pro	Sb + bio + pro	Pro	Bio + pro
Dry	–	.277	.394	.477	.000	.000	.000	.000
Sb	.277	–	.050	.704	.000	.000	.000	.000
Bio	.394	.050	–	.121	.000	.000	.000	.000
Sb + bio	.477	.704	.121	–	.000	.000	.000	.000
Sb + pro	.000	.000	.000	.000	–	.635	.238	.075
Sb + bio + pro	.000	.000	.000	.000	.635	–	.477	.187
Pro	.000	.000	.000	.000	.238	.477	–	.537
Bio + pro	.000	.000	.000	.000	.075	.187	.537	–

than method 5 (sb) ($P < .05$). Methods 3 (pro), 4 (bio + pro), 7 (sb + pro), and 8 (sb + pro + bio) displayed significantly higher retention values than methods 1 (dry), 2 (bio), 5 (sb), and 6 (sb + bio) ($P < .001$). No significant difference was found between methods 3 (pro), 4 (bio + pro), 7 (sb + pro), and 8 (sb + pro+ bio) ($P > .05$).

Discussion

The primary complaints of radiotherapy-induced xerostomia patients wearing complete dentures are oral discomfort and poor denture retention. A range of subjective and objective methods using measurement equipment can be used to quantify retention forces of a complete denture.[2] In the present study, an electric motor-driven pulling apparatus was built to measure the force required to dislodge acrylic resin bases of radiotherapy-induced xerostomia patients. A dynamometer indicated the maximum force at the time of base dislodgement. Measurements revealed that Protefix application (methods 3, 4, 7, and 8) increased the retentive force of acrylic resin test bases approximately 2-fold in each patient ($P < .001$). Patients treated with Biotène (methods 2, 4, 6, and 8) expressed greatly enhanced oral comfort. Biotène (method 2) provided a slight but significant increase in retention compared to sandblasted test bases (method 5). Biotène can be assumed to be a more advantageous method to increase retention than sandblasting. It may be that this slight retentive advantage does not reflect the retentive superiority of Biotène, but rather the retention-decreasing effect of sandblasting. Contrary to the findings of Kikuchi et al,[5] it was determined that despite the combined use of Biotène oral rinses, sandblasting of acrylic resin test base surfaces did not increase the retentive forces in xerostomic patients. This may be a result of the lack of interposed mucous salivary film acting as an effective media for physical retention.

Conclusions

Protefix denture adhesive (methods 3, 4, 7, and 8) offered the greatest improvement in retentive force compared to surface treatments or oral moisturizers. Sandblasting the intaglio surface did not improve retentive force. Biotène oral moisturizer was reported to improve patient comfort but had minimal effect on retentive force. However, the use of Biotène can be assumed to be a more advantageous method of increasing retention compared to sandblasting ($P < .05$).

References

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