Bonding porcelain laminate veneer provisional restorations: An experimental study

Herbert Dumfahrt, Dr med univ,[a] and Georg Göbel, Mag rer nat[b]
School of Medicine, University of Innsbruck, Innsbruck, Austria

Statement of problem. Minimal tooth preparation is required for porcelain laminate veneers, but an interim restoration is anticipated by patients to protect their teeth against thermal insult, chemical irritation, and to provide esthetics. Cement remaining after the removal of the provisional restoration can impair the etching quality of the tooth surface and the fit and final bonding of the porcelain laminate veneer.
Purpose. This in vitro study inspected the tooth surface for remaining debris from cement after removal of a provisional restoration.
Material and methods. Seventy-two extracted natural anterior teeth were prepared for porcelain laminate veneers. For half of the teeth, the smear layer was removed before luting provisional restorations. Veneer provisional restorations were fabricated and luted to teeth with 3 bonding methods: temporary eugenol–free cement, spot etching combined with dual-curing luting cement, and polyurethane adhesive combined with dual-curing luting cement. After removal of provisional restorations 1 week later, the tooth surface was examined for residual luting material with an SEM.
Results. Traces of cement debris were found on provisionally prepared teeth for all 3 material methods.
Conclusion. The use of polyurethane adhesive combined with the dual-curing cement revealed significantly less teeth with debris than the other methods. This difference was less distinct when the smear layer was removed. (J Prosthet Dent 1999;82:281-5.)

CLINICAL IMPLICATIONS

Bonding veneer provisional restorations with the described adhesive and dual-curing luting composite resulted in a clean tooth preparation surface after removing the provisional restoration. Therefore, this procedure is recommended as a viable option.

In the 1940s, Dr Charles Pincus[1] described the technical production and clinical use of porcelain laminate veneers (PLVs), but restorations were regarded as a temporary esthetic modification of anterior teeth. PLVs were adapted to the unprepared teeth with a denture adhesive. Development of technologies, such as composite,[2] enamel etching,[3] and surface conditioning of porcelain,[4] were responsible for PLVs becoming a standard treatment in restorative dentistry. Most researchers agreed that tooth preparation was critical for long-term success.[5-9] However, the prepared tooth surface required provisional restoration, despite minimal reduction of tooth structure. Treatment restorations were necessary to protect the pulp from thermal insult, chemical irritation, and exposed dentin from bacterial invasion. Provisional restorations are also considered a requirement to preserve the health of gingival tissue, ensure occlusal stability, and provide esthetics and comfort the patient.

Direct and indirect methods of fabricating provisional restorations with materials, such as autocuring acrylic resin or composites have been suggested for PLVs. As the tooth preparation for PLVs do not produce a retentive abutment, the cementation method for the provisional restoration is of particular importance. Various techniques have been reported to retain provisional restorations. Elledge et al[10] described a modified tooth preparation with 2 small dimples to increase the retention for PLV provisional restorations, and stated that it could be luted with the cement of choice. Sheets et al[11] recommended use of tooth-colored dental adhesive for highly esthetic provisional restorations, whereas Studer and Pietrobon[12] recommended eugenol-free interim cement. Partial etching of a small zone in the incisal one third of the prepared tooth surface[13] or spot etching[14-16] has been the most popular method.

Cement remaining after the removal of the provisional restoration can impair the etching quality of the tooth surface and the fit and final bonding of the PLV. Therefore, the purpose of this in vitro study was to evaluate the prepared tooth surface for cement debris.

[a]Assistant Professor, Clinical Department of Prosthetic Dentistry.
[b]Assistant, Institute of Biostatistics and Documentation.

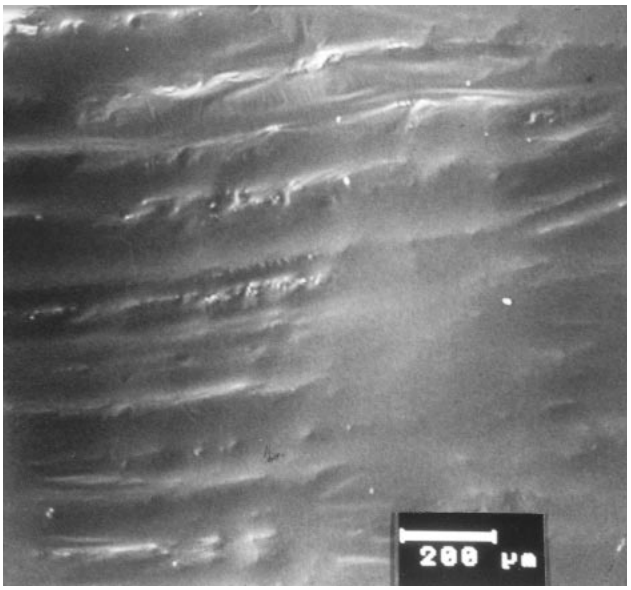

Fig. 1. Prepared tooth surface covered with thin layer of polyurethane adhesive.

MATERIAL AND METHODS

Silicone impressions (Imprint II, 3M Dental Production Division, St Paul, Minn.) were made of the buccal tooth surface of 72 extracted anterior teeth before tooth preparation. Horizontal grooves, 0.3 mm in depth, were made with a self-limiting depth cutter (Komet, Gebr. Brasseler, Lemgo, Germany). Tooth preparation was performed with a tapered round-ended diamond bur with coarse grit. Smooth margins of the tooth preparation were accomplished with a fine grit diamond of identical shape. Provisional restorations were fabricated from autopolymerizing bis-acryl-composite (Protemp Garant, Espe, Seefeld, Germany) with the silicone impression as matrix. After the cementation procedure the teeth were stored in saline at a temperature of 37°C. One week later, the provisional restorations were removed with an excavator. Teeth were gold-coated for SEM examination and evaluated with use of ×15, ×50, and ×100 levels of magnification.

The total number of specimens was 72. Provisional restorations were divided into 3 groups, based on luting method. There were 20 specimens for method A, 20 for method B, and 32 for method C. For method A (n = 20), provisional restorations were cemented with a eugenol-free temporary cement (Nogenol, GC America Inc, Chicago, Ill.). After the provisional restorations were removed, parts of temporary cement were visible on the tooth preparation surface of all teeth. However, these particles were partly removed with the excavator. According to clinical procedure, specimens were polished with pumice until no cement particles were visible macroscopically.

For method B specimens (n = 20), on the incisal one third of the tooth, a spot with an average diameter of 2.5 mm was etched for 30 seconds with a 37% phosphoric acid gel, then rinsed and carefully air-dried. A dimple was created opposite to the etched spot in the veneer provisional restoration.[16] Dual-curing luting composite (Dual Zement, Vivadent, Schaan, Liechtenstein), not unfilled resin, was applied for cementation that was completed without excess of luting material. The material was light-cured for 1 minute. All provisional restorations fractured on removal. A bulk of luting composite that could not be removed by hand instruments and adhered to the area were spot etched, after which there were no further macroscopic remains.

For method C (n = 32), the prepared tooth surface was coated with a thin film of polyurethane isocyonate adhesive (Dentin protector, Vivadent), which was originally recommended by the manufacturer as a dentinal sealant or desensitizing agent. The material was applied with a disposable brush and air blown to a thin layer (Fig. 1), then finally air-dried for 30 seconds. The dual-curing luting composite was mixed and a layer was applied to the provisional restorations, which was set in place. Excess of luting cement was thoroughly removal by a fine brush moistened with bonding agent. The cement was light-cured for 60 seconds. The removal of the provisional restorations revealed there were no macroscopic remains evident on the specimens of this method.

To evaluate whether the smear layer may have an influence on the remaining cement debris on the tooth surface, 2 subgroups were formed for each method. In subgroup α "alpha," the smear layer was not removed, in subgroup β "beta," the smear layer was removed before luting the provisional restoration. Thus, the prepared tooth surface was treated with cotton pellets soaked with EDTA solution (Tublicid, Dental Therapeutics, Nacka, Sweden) for 60 seconds.

Statistical analysis

The hypothesis, whether there is an association between the methods A, B, C, and the remaining cement particles, was tested with the generalization of the chi-square test (r × c test). In addition, to determine whether the distribution of samples within the subgroups Aα and Aβ, Bα and Bβ, Cα and Cβ was independent of cement-debris, Fisher's exact test was applied.

RESULTS

SEM examination revealed that for method A (temporary cement), 19 of 20 specimens exhibited minute parts of temporary cement that extended over the prepared surface (Fig. 2). The remains appeared flattened (Fig. 3) as a result of polishing with pumice and water, but were not completely removed. The composite bulk on all teeth (20) subjected to method B (spot etching and dual-curing luting composite) covered most of the

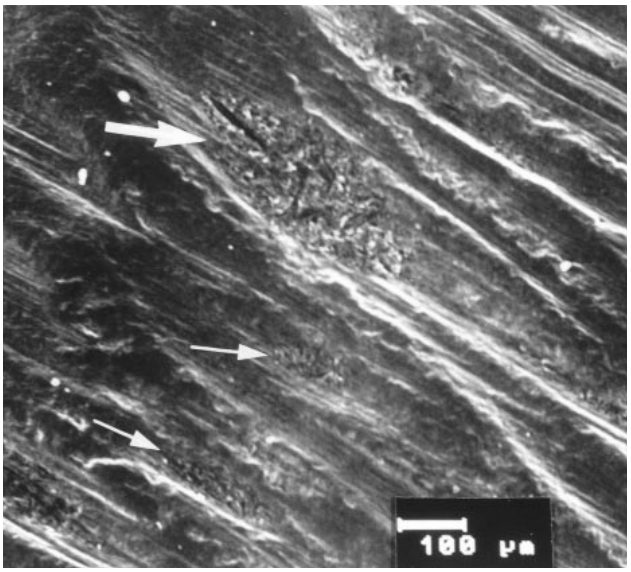

Fig. 2. After removal of provisional restoration bonded with temporary cement tooth surface was polished with pumice. Small parts of cement (*arrows*) remained in grooves of prepared surface of method A.

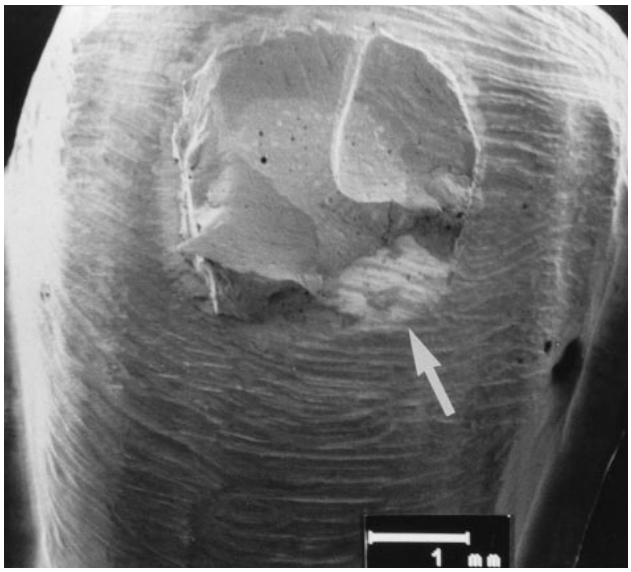

Fig. 4. Composite bulk adhered to spot etched area in method B. Only small part has been removed by excavator (*arrow*).

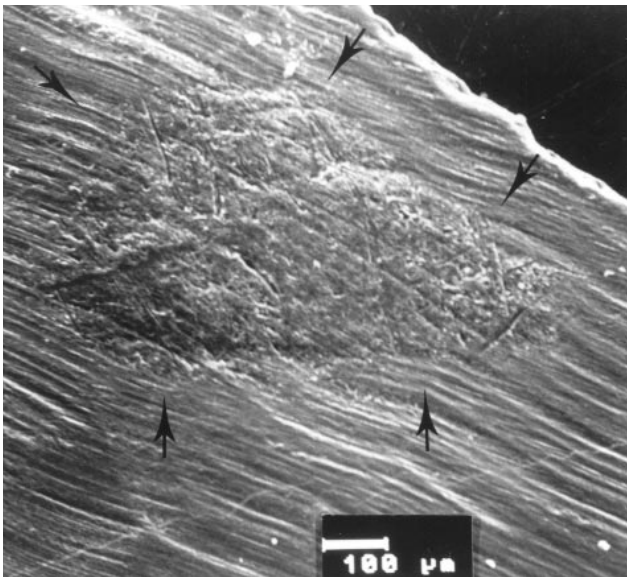

Fig. 3. Debris of temporary cement (*arrows*) was flattened by polishing with pumice but remains detectable in method A.

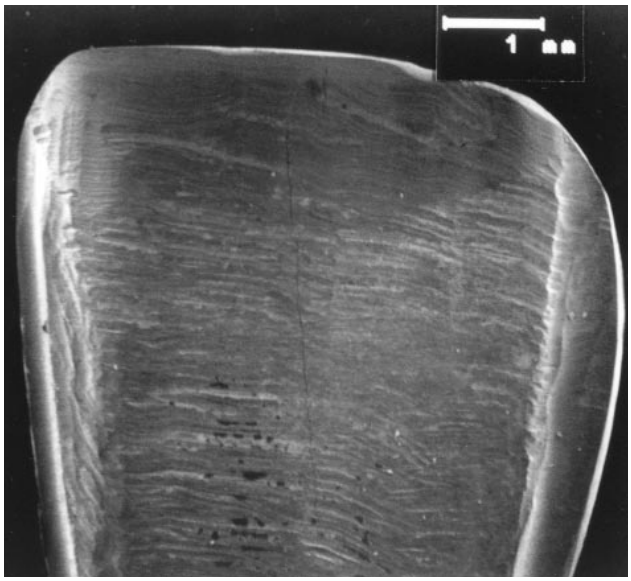

Fig. 5. Small remaining areas of adhesive in method C were visible as black spots on rough area of prepared surface.

etched area (Fig. 4), but the remains of luting composite were not detected. Of 32 specimens of method C (adhesive and dual-curing luting composite), 7 showed minute remains of adhesive that adhered only to the roughened part of the tooth preparation (Figs. 5 and 6, *A*). However, these areas could not be detected on the smoothened margins of the tooth preparations. These remains were also visible as small defects on the inner surface of the provisional restorations (Fig. 6, *B*). On the other teeth of method C (n = 32), there was no detectable adhesive or luting composite on the prepared tooth surface (Fig. 7), and no defects were found on the inner surface of the provisional restorations (Fig. 8). In the subgroup α, where the smear layer was not removed, only 1 specimen of 16 for method C showed remains of adhesive.

Table I presents the results of the study. A total of 46 specimens (64%) exhibited residual luting material, whereas 26 specimens (36%) showed no trace of luting

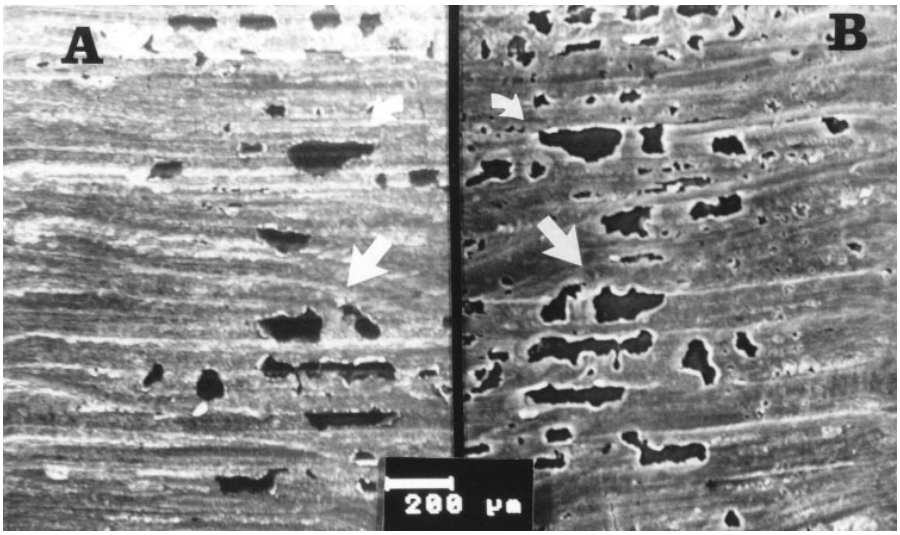

Fig. 6. Some spots (*arrows*) on tooth surface (**A**) are equal in form and dimension of defects on inner surface of provisional restorations (**B**).

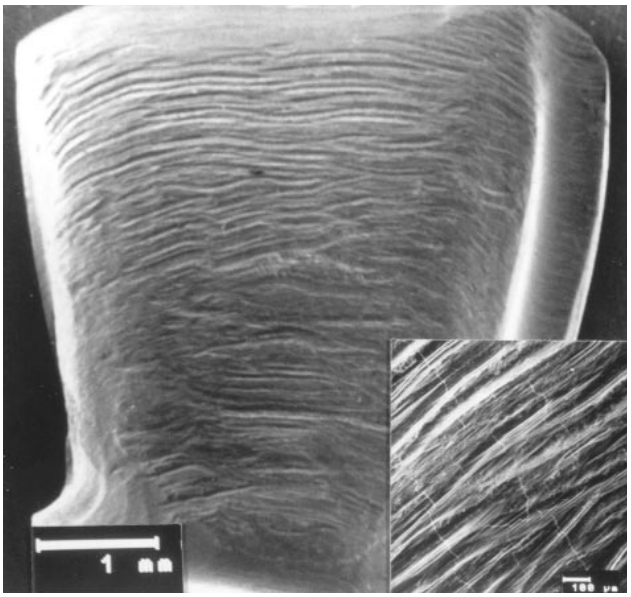

Fig. 7. Clean tooth surface of method C.

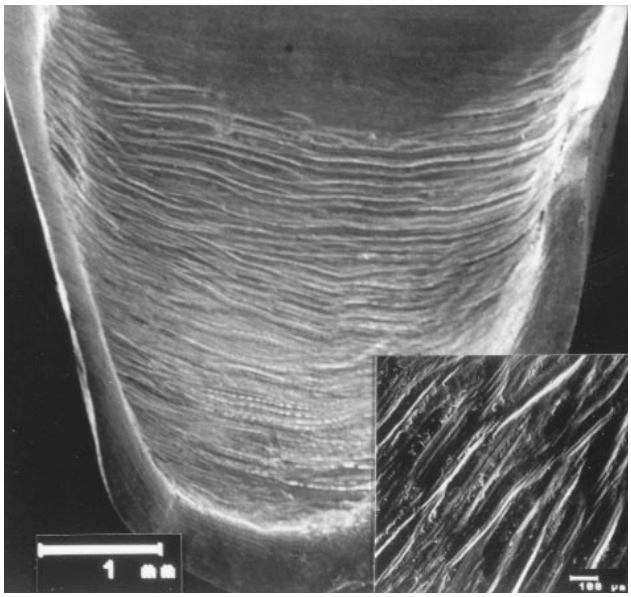

Fig. 8. No defects on inner surface of provisional restoration of method C.

material. One specimen from method A (5%) and 25 (78%) from method C were free of residual luting cement.

The chi-square test demonstrated a significant difference in the amount of cement residue among the different methods at a 1% level of significance ($P<.01$). The Fisher's exact test revealed a significant association at a 10% level ($P<.1$), found only for the subgroups in method C.

DISCUSSION

Many patients treated with PLVs expect to receive interim restorations that provide acceptable esthetics, comfort, and protection. This demand can only be met by provisional restorations that adhere to prepared teeth by cement, because no primary retentive form is achieved during tooth preparation. Sufficient adhesion of provisional restorations can be accomplished initially with eugenol-free cement as used in method A,[12] but the minute cement debris that persisted after polishing, documented by SEM, can impair etching and final bonding of the PLV. Clinical experience has shown that provisional restorations may debond because of solubility and the opacity of cement and compromise esthetics. In our study, there was no effect found when using

Table I. Results of SEM evaluation

Method		Remaining of cement		Total
		No	Yes	
A[1]	α[4]	1	9	10
	β[5]	0	10	10
B[2]	α	0	10	10
	β	0	10	10
C[3]	α	15	1	16
	β	10	6	16
Total		26 (36%)	46 (64%)	72 (100%)

[1]Temporary eugenol-free cement.
[2]Spot etching combined with dual-curing luting cement.
[3]Polyurethane adhesive combined with dual-curing luting cement.
[4]Smear layer not removed.
[5]Smear layer removal.

this method, whether or not the smear layer was removed.

Acid etch techniques, combined with either directly fabricated composite provisional restorations[14,17] or composite luted indirect provisional restorations[13,15,16] resulted in composite bulk adhering to etched enamel. This bulk can be removed only by instrument with great force,[17] or the use of a bur. Kurtz[17] described PLV provisional restorations fabricated directly on prepared and etched enamel that were fractured from teeth during removal. This approach risked enamel or tooth fracture and should be avoided. For this method, the removal of the smear layer did not change the result in our study.

For method C, there were significantly less residual cement particles than for the other methods. This result was worse when the smear layer was removed (Cβ) before cementation procedure. Traces of adhesive discovered on 6 specimens (37.5%) of group Cβ indicated that this material can adhere to rough surfaces of prepared teeth if the smear layer is removed. In subgroup Cα, where the smear layer was not removed, bonding of adhesive to the prepared tooth surface was not as strong as to the dual-curing cement. The provisional restorations subjected to dual cement and polyurethane adhesive were removed in bulk, which left a clean preparation for 15 of 16 teeth. This method has been successful in the Department of Prosthetics at the University of Innsbruck for the last 10 years and is capable of retaining any form of PLV provisional restorations for weeks.

CONCLUSION

Within the limits of this study, the following conclusions were drawn:

1. The use of eugenol-free temporary cement used in method A resulted in minute residual particles of cement on most tooth specimens (95%).

2. Spot etching and use of composite cement in method B left a clean tooth preparation surface, except composite cement on the etched spot, which required removal with a bur.

3. Polyurethane adhesive and dual-curing composite cement used in method C resulted in significantly less ($P<.01$) cement particles than for the other methods.

4. Removal of the smear layer did not have significant influence on the cement debris in methods A and B.

5. When the smear layer was removed in method C, significantly ($P<.1$) more specimens with debris were found.

We thank D. Swarovsky & Co. KG and especially to Anton Pfeiffer for supporting the SEM analysis. In addition, we acknowledge the help of Carmen Korpitsch in preparing this manuscript.

REFERENCES

1. Pincus CL. Building mouth personality. J S Calif Dent Assoc J 1938; 14:125-9.
2. Bowen RL. Development of a silica-resin direct filling material. Report 6333. Washington, DC: National Bureau of Standards; 1958.
3. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res 1995; 34:849-53.
4. Simonsen RJ, Calamia JR. Tensile bond strength of etched porcelain. J Dent Res 1983;62:297 (abstract 1154).
5. Calamia JR. Etched porcelain veneers: the current state of the art. Quintessence Int 1985;16:5-12.
6. Sheets CG, Taniguchi T. Advantages and limitations in the use of porcelain veneer restorations. J Prosthet Dent 1990;64:406-11.
7. Nordbø H, Rygh-Thoresen N, Henauy T. Clinical performance of porcelain laminate veneers without incisal overlapping: 3-year results. J Dent 1994;22:342-5.
8. Shaini FJ, Shortall AC, Marquis PM. Clinical performance of porcelain laminate veneers. A retrospective evaluation over a period of 6.5 years. J Oral Rehabil 1997;24:553-9.
9. Peumans M, Van Meerbeek B, Lambrechts P, Vuylsteke-Wauters M, Vanherle G. Five-year clinical performance of porcelain veneers. Quintessence Int 1998;29:211-21.
10. Elledge DA, Hart JK, Schorr BL. A provisional restoration technique for laminate veneer preparations. J Prosthet Dent 1989;62:139-42.
11. Sheets CG, Ono Y, Taniguchi T. Esthetic provisional restorations for porcelain veneer preparations. J Esthet Dent 1993;5:215-20.
12. Studer S, Pietrobon N. Ceramic veneer shells. The use of ceramic veneer shells is presented via a clinical case. [in German] Schweiz Monatsschr Zahnmed 1992;102:201-8.
13. Nixon RL. Masking severely tetracycline-stained teeth with ceramic laminate veneers. Pract Periodontics Aesthet Dent 1996;8:227-35.
14. Burke FJ. Provisional restorations of veneer preparations. Dent Update 1993;20:433-4.
15. Meijering AC, Creugers NH, Mulder J, Roeters FJ. Treatment times for three different types of veneer restorations. J Dent 1995;23:21-6.
16. Zalkind M, Hochman N. Laminate veneer provisional restorations: a clinical report. J Prosthet Dent 1997;77:109-10.
17. Kurtz KS. Constructing direct porcelain laminate veneer provisionals. J Am Dent Assoc 1995;126:653-6.

Reprint requests to:
DR HERBERT DUMFAHRT
UNIVERSITATSKLINIK FUR ZAHN-, MUND- UND KIEFERHEILKUNDE
ANICHSTRAßE 35
A-6020 INNSBRUCK
AUSTRIA
FAX: 43-512-504-3790
E-MAIL: Herbert.Dumfahrt@uibk.ac.at

Copyright © 1999 by The Editorial Council of *The Journal of Prosthetic Dentistry*.
0022-3913/99/$8.00 + 0. **10/1/99830**