A histologic evaluation of tissue response to three currently used temporary acrylic resin crowns

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Controversy still exists concerning the optimal method of protecting a prepared tooth and the surrounding soft tissues during the fabrication of a cast restoration. The effects of various temporary crowns on the adjacent gingiva and epithelial attachment is not clear. It is thought that an accurately fitting crown margin is less damaging to the gingiva, particularly in those preparations that extend subgingivally.[1-12]

The cause of successive gingival inflammation, collagen fiber breakdown, epithelial detachment, alveolar bone loss, and subsequent gingival recession is not fully understood. The mechanical irritation of a crown margin in the gingival sulcus causing an inflammatory response has been investigated.[13-15] It also appears that bacterial plaque is necessary to produce inflammation.[16] A subgingival margin on a restoration, whether permanent or temporary, does alter the gingival environment and probably contributes to the inflammatory process.[17, 18]

Inflammation and gingival recession are frequently observed around teeth with temporary crown restorations, and gingival damage has been attributed to the use of temporary crowns.[19, 20] However, no study has been made in the past of differential gingival response to the placement of various commonly used temporary restorations. This study was aimed at examining that problem.

METHOD AND MATERIALS

Three commonly used acrylic resin crowns were fabricated for seven apparently healthy adults aged 25 to 65. They showed no gross oral pathology and had moderate to good oral hygiene. Each had received a dental prophylaxis and oral hygiene instruction 3 weeks before the study began. Three randomly distributed posterior teeth were chosen on each subject (Table I). All teeth required full-crown cast restorations with subgingival margins. An unprepared posterior tooth was also chosen as the control on each subject. Preoperative recordings of the plaque index[21] and the gingival index[22] were made, and the sulcus depth was recorded from each tooth mesially, distally, buccally, and lingually. A tattoo dot was placed on the attached gingiva on the buccal aspect of the four teeth, and a series of measurements were recorded from the dot to the adjacent gingival crest (Fig. 1). Reductions of the teeth were performed with various long-tapered diamond burs; chamfered or beveled margins were carried subgingivally for at least 1 mm on all prepared teeth.

After tooth reduction, which involved locating the margins subgingivally, three types of acrylic resin temporary crowns were placed on the prepared teeth. All of the temporary crowns were cemented with the same brand of zinc oxide/eugenol cement.* Care was taken to minimize gingival damage, but in all patients the gingiva was visibly traumatized by the extension of the margins subgingivally and by the removal of excess cement.

The patients were instructed to continue with their normal oral hygiene habits. No further attempts were made to influence their routine.

After 21 days the same indices and measurements were recorded. Following this examination biopsies of buccal sulcular gingivae of all four teeth were made. The tissues were microscopically examined for inflammation. Typical microscopic pictures were used to judge the severity of the gingival inflammation. The presence of a few scattered chronic inflammatory cells in a biopsy specimen was considered

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Table I. Gingival index (G.I.) and sulcus depth (S.D.) means by time, crown type, and location

	Location	Gingival index*	Sulcus depth†
Initial measurement			
G.I. = 0.86607			
S.D. = 2.20536			
Control	M	1.71428	2.42857
1.07143 (G.I.)	D	1.85714	2.71428
2.07143 (S.D.)	B	0.14286	1.28571
	L	0.57143	1.85714
Type III	M	0.85714	2.28571
0.67857 (G.I.)	D	1.42857	2.85714
2.25000 (S.D.)	B	0.14286	1.85714
	L	0.28571	2.00000
Type I	M	1.57143	2.57143
0.9285.7 (G.I.)	D	1.42857	3.00000
2.42857 (S.D)	B	0.28571	1.71428
	L	0.42857	2.42857
Type II	M	1.0000	2.28571
0.78571 (G.I.)	D	1.71428	2.57143
2.07143 (S.D.)	B	0.00000	1.42857
	L	0.42857	2.00000
Measurement at 21 days			
G.I. = 0.66946			
S.D. = 2.16071			
Control	M	1.42857	2.57143
0.78571 (G.I.)	D	1.14286	2.85714
2.32143 (S.D.)	B	0.00000	1.57143
	L	0.57143	2.28571
Type III	M	0.85714	2.57143
0.50000 (G.I.)	D	0.71429	2.42857
2.17857 (S.D.)	B	0.14286	1.71428
	L	0.28571	2.00000
Type I	M	1.00000	2.42857
0.7500 (G.I.)	D	0.71429	2.85714
2.2500 (S.D.)	B	0.42857	1.71428
	L	0.85714	2.00000
Type II	M	0.71429	1.85714
0.64286 (G.I.)	D	0.71429	2.28571
1.89286 (S.D.)	B	0.42857	1.57143
	L	1.85714	0.71429

*Significant difference in means during experimental period ($p < .05$). Coefficient of variation for gingival index = 24.5%.
†Coefficient of variation for sulcus depth = 9.89%.

physiologically normal (Fig. 2). Focal accumulation of lymphocytes and plasma cells with no associated epithelial cell change indicated the presence of a minimal inflammation (Fig. 3). However, a generalized accumulation of chronic inflammatory cells, with early signs of epithelial cell layer changes such as acanthosis and parakeratosis, indicated the presence of moderate inflammation (Fig. 4). Statistical analyses of the preoperative and postoperative index recordings and measurements were performed to detect any significant effect of crown type upon the gingiva.

Fig. 1. Type I temporary crown on 16. Type II temporary crown on 17. Tattoo dot on attached gingiva above 16 and 17.

The Type I crown was a preformed autopolymerizing acrylic resin crown.* It was constructed on an artificial stone cast of the tooth that had been reduced to simulate the anticipated mouth preparation. The acrylic resin was polymerized in a pressure cooker at 20 psi pressure for 30 minutes and finished to approximate optimal natural tooth contour and occlusion. The crown was relined in the mouth to produce close marginal adaptation to the prepared tooth and then luted with cement.

The Type II crown was constructed like the Type I crown, but it was not relined with acrylic resin in the mouth. The luting cement also filled large marginal voids present in all crowns.

The Type III crown was constructed as described by Talkov,[9] directly on the prepared tooth in the mouth, using an irreversible hydrocolloid impression as a matrix with the same kind of autopolymerizing acrylic resin used for Type I and II crowns. It was relined to ensure good marginal adaptation of the resin.

The control tooth was a posterior tooth having minimal crown destruction and no restorations associated with the gingival sulcus. The health of the gingiva around the control tooth was clinically similar to the health of the preoperative gingivae of the prepared teeth being studied.

The tattoo, inserted with a 28 gauge hypodermic needle, was made with india ink. The height of the gingival crest from the tattoo dot was recorded at least five times preoperatively and postoperatively. A geometric compass and a machinist's micrometer†

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†Craftsman, Sears, Roebuck and Co., Chicago, Ill.

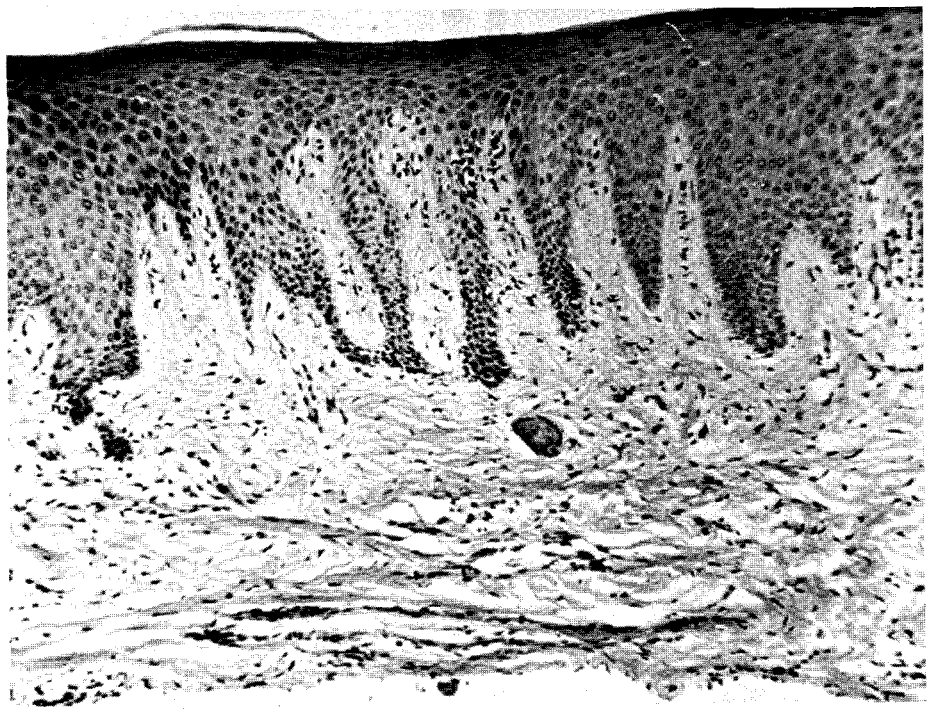

Fig. 2. Normal tissue magnified ×100.

Fig. 3. Minimal inflammation magnified ×100.

Fig. 4. Moderate inflammation magnified ×100.

Table II. Means of gingival height in relationship to crown type and duration of use

Time	Control crown	Type III crown	Type I crown	Type II crown	Mean*
Initial	5.74000	5.73666	5.58569	5.66677	5.68228
21 days later	5.64986	5.57733	5.79194	5.77305	5.69804
Mean*	5.69492	5.565699	5.68881	5.71991	

*No significant difference ($p > .05$); coefficient of variation = 3.7%.

Table III. Presence of chronic inflammation* as revealed by microscopic examination

Subject	Age (years)	Control	Tooth	Type I	Tooth	Type II	Tooth	Type III	Tooth
1	43	none	26	moderate	17	moderate	16	minimal	14
2	34	none	46	none	17	none	16	minimal	36
3	33	none	46	moderate	16	none	26	minimal	36
4	65	minimal	44	minimal	48	moderate	45	minimal	44
5	30	moderate	16	minimal	26	minimal	27	minimal	17
6	32	none	46	minimal	47	minimal	15	none	26
7	38	minimal	35	minimal	26	minimal	27	minimal	23

*Criteria used in determining presence and degree of inflammation explained in Methods section.

Table IV. Means of gingival index relating to location and duration of use

Time	M location	D location	B location	L location	Mean
Initial	1.28571a*	0.60714a	0.14286b	0.24857b	0.86607†
21 days later	1.00000a	0.82143a	0.25000b	0.60714ab	0.66964
Mean	1.14286a	1.21428a	0.19643b	0.51786ab	

*Any two location means within a time period (or averaged over time periods) followed by the same letter are not significantly different according to Duncan's New Multiple Range Test ($p > .05$).
†Significant difference in means during experimental period ($p < .05$).

with an automatic ratchet were used so that the error of measurement would be minimized.

The plaque index, as described by Podshadley,[21] was measured for each tooth following the application of an erythrosin solution (4 drops of 6% aqueous solution of erythrosin in 6 cc of water).

The biopsy specimens were necessarily of minimal size, approximately 2 × 1 × 5 mm. They were fixed in formalin and sectioned and stained with hemotoxin and eosin. The specimen size precluded an accurate orientation for sectioning. At least five sections of each specimen were studied to determine the degree of inflammation present.

STATISTICAL ANALYSIS

The statistical analysis of the responses corresponded to a split-plot experiment in time and space.[23] Duncan's New Multiple Range Test[24] was used when the *F*-test in the analysis of variance showed significance. The significance of the mean variation could thus be detected.

RESULTS

The coefficients of variation for sulcus depth and gingival height were 9.89% and 3.70% (Tables I and II). The degree of inflammation corresponding to each crown type is shown in Table III. No correlation ($p > .05$) was found between crown type used and inflammation in the adjacent gingival tissue. The measured gingival index did vary during the experimental period, but this could not be related to any of the three crown types (Tables I and IV). The plaque index did significantly vary with crown type.

DISCUSSION

Although the number of subjects was limited the data were sufficiently precise to detect significant

treatment effects on the gingiva. The crowns differed in the amount of free monomer contacting the gingiva during fabrication and in the accuracy of marginal fit during the study period. The sulcus depth and gingival height showed minimal variation. The moderate inflammation observed in some teeth may be attributed to normal physiologic variation that depends upon the location of the tooth. The gingival index variation, which was not related to crown type, could be a normal oral phenomenon present when oral hygiene is less than perfect over a 3 week period.

In contrast to the results of Donaldson's studies,[19, 20] gingival recession was not detected. However, this study confined itself to posterior teeth, whereas Donaldson investigated anterior teeth. The reaction to trauma of the different types of attached and free gingival tissue described by Gartrell[25] may explain the apparent conflict in results between this and Donaldson's studies.

CONCLUSION

The subgingival placement of any one of the three types of temporary crowns placed on 28 posterior teeth of seven subjects caused no detectable change in the gingiva over a 3 week period. There is a need for further study of the influence of temporary crowns on the different types of gingival tissue.

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REFERENCES

1. Johnston, J. F., Phillips, R. W., and Dykema, R. W.: Modern Practice in Crown and Bridge Prosthodontics. Philadelphia, 1971, W. B. Saunders Company, p 465.
2. Lorencki, J.: Preventive crown and bridge dentistry, construction of tissue kind anterior temporary crowns. J Acad Gen Dent **20**:20, 1972.
3. Vega, E. A.: Temporary crowns—A practical technique. J Philip Dent Assoc **34**:31, 1972.
4. Josephson, B. A.: Efficient acrylic temporary coverage: Description of a technique. NY J Dent **36**:7, 1966.
5. Fritts, K. W., and Thayer, K. E.: Fabrication of temporary crowns and fixed partial dentures. J Prosthet Dent **30**:151, 1973.
6. Sotera, A. J.: A direct technique for fabricating acrylic resin temporary crowns using the Omnivac. J Prosthet Dent **29**:577, 1973.
7. Josephson, B. A.: A technique for temporary acrylic resin coverage in functional occlusal relationship. J Prosthet Dent **32**:339, 1974.
8. King, C. J., Young, F. A., and Cleveland, J. L.: Polycarbonate resin and its use in the matrix technique for temporary coverage. J Prosthet Dent **30**:789, 1973.
9. Talkov, L.: Temporary acrylic fixed bridgework and splints. J Prosthet Dent **2**:693, 1952.
10. Rosen, H., and Gitnick, P. J.: Integrating restorative procedures into the treatment of periodontal disease. J Prosthet Dent **14**:343, 1964.
11. Loe, H., Theilade, E., and Jensen, S. B.: Experimental gingivitis in man. J Periodont **36**:177, 1965.
12. Glickman, I: Periodontal structures and removable partial denture prosthesis. J Am Dent Assoc **37**:311, 1948.
13. Waerhaug, J.: Tissue reactions around artificial crowns. J Periodont **24**:172, 1953.
14. Waerhaug, J.: Histologic considerations which govern where the margins of restorations should be located in relation to the gingiva. Dent Clin North Am, March, 1960, pp 161-176.
15. Waerhaug, J.: Effect of rough surfaces upon gingival tissue. J Dent Res **35**:323, 1956.
16. Richter, W. A., and Ueno, H.: Relationship of crown margin placement to gingival inflammation. J Prosthet Dent **30**:156, 1973.
17. Bergman, B., Hugoson, A., and Olsson, C. O.: Periodontal and prosthetic conditions in patients treated with removable partial dentures and artificial crowns. Acta Odontol Scand **29**:621, 1971.
18. Karlsen, J.: Gingival reactions to dental restorations. Acta Odontol Scand **28**:895, 1970.
19. Donaldson, D.: Gingival recession associated with temporary coverage. J Periodont **44**:691, 1973.
20. Donaldson, D.: The etiology of gingival recession associated with temporary crowns. J Periodont **45**:468, 1974.
21. Podshadley, A. G., and Haley, J. V.: A method of evaluating oral hygiene performance. Public Health Records **83**:259, 1968.
22. Loe, H., and Silness, J.: Periodontal disease in pregnancy. I. Prevalence and severity. Acta Odontol Scand **21**:532, 1963.
23. Steel, R. G. D., and Torrie, J. H.: Principles and Procedures of Statistics. New York, 1960, McGraw-Hill Book Company, Inc., p 107.
24. Steel, R. G. D., and Torrie, J. H.: Principles and Procedures of Statistics. New York, 1960, McGraw-Hill Book Company, Inc., p 247.
25. Gartrell, J. R.: The Connective Tissue of the Marginal-Vestibular Complex of the Human Periodontium. Thesis, University of Washington, 1975.

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