*Journal of Oral Pathology* 1977: **6**: 63–81

# The Histological Effects of Composite Resin Materials on the Pulps of Monkey Teeth

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*Abstract.* Pulpal response of three bis glycol methacrylate composite resins, Smile®, Simulate® and Experimental Composite #2 were tested on primary and permanent monkey teeth using zinc oxide eugenol (ZOE) and silicate as controls. All materials were placed in Class V cavity preparations in Rhesus monkey teeth and evaluated at 3 days and 5 and 8 weeks. The materials were randomly placed in anterior and posterior teeth utilizing 75 primary and 75 permanent teeth. Following perfusion the teeth were prepared by routine histological procedures. The 3 day response of the composite resins was moderate, characterized by disruption of the odontoblasts, vacuolization and a mild inflammatory response underlying the cavity. At 5 weeks the formation of reparative dentin and a decrease in the inflammatory response was similar for all resins observed. At 8 weeks a slight increase in reparative dentin and a continued decrease in inflammation was noted when compared to the 5 week responses. At all time intervals ZOE produced the least pulpal response while silicate produced the most severe response.

*Received 2 February, revised, accepted for publication 17 August 1976*

Composite resins have become an integral part of restorative dentistry. Their uses range from anterior esthetic restorations to pin retained cores, and in some areas to posterior filling materials. One of the most important considerations in using composite resins is their pulpal compatibility.

Some of the early research by Schroff (1946), Leader (1948) and Zander (1951, 1959) indicated that autopolymerizing acrylics were irritating to the pulp. They found these materials produced hyperemia, inflammation and disruption of the odontoblastic layer and recommended that these materials be accompanied by a cavity liner to protect the pulp.

Langeland (1966), Langeland et al. (1966, 1970) evaluated Addent® in both monkeys and humans and initially found disruption of the odontoblastic layer and some inflammation. However with time, the severity of this reaction diminished and was accompanied by increased reparative dentin formation and a significant decrease in inflammation. Stanley et al. (1967, 1969) observed in testing Addent® in humans that by increasing post-operative time (up to 127 days), the histologic response of the superficial and deep cavity preparations increased and exceeded the values of silicate. Rao (1971) concurred with the Stanley finding that Addent® produced a prolonged reaction in

This work was supported in part by Kerr Manufacturing Company, Romulus, Michigan.

the pulp of monkeys but he found the reaction was mild.

Heldridge & Jensen (1966) observed pulpal reactions to Addent®, Bonfil® and silicate. Bonfil® elicited a mild inflammatory response with a slight amount of reparative dentin while silicate and Addent® produced a more severe inflammatory response involving disruption of the odontoblastic layer and a large amount of reparative dentin. Suarez et al. (1970) found Bonfil® produced a toxic necrosis similar to that caused by silicate.

Sayegh & Reed (1969a, b) evaluated Blendant®, Addent® and Dakor® at 1 week post-operatively and observed that all three produced a similar acute pulpal response, while by 8 weeks reparative dentin had formed with a reduced chronic inflammatory reaction. Blendant® showed a milder reaction than either Addent® or Dakor®. Guidi (1970) also studied Blendant® and found a similar response.

Goto & Jordan (1972) and Langeland et al. (1971) evaluated Adaptic®, Blendant® and Concise® and found that initially they produced a relatively severe response with disruption of the odontoblastic layer and a severe inflammatory response. Longer post-operative intervals (8 weeks for Goto & Jordan and 84 days for Langeland et al.) showed decreased responses including the reappearance of a normal pulp and large amounts of reparative dentin.

Adams & Lord (1971) reported on the histopathological effect of Adaptic® in monkey teeth. Their results showed that with increasing post-operative time the percentage of teeth exhibiting a pulpal response decreased. Tobias et al. (1973) tested Adaptic® with and without a liner and found that Adaptic® with a liner produced a less intense inflammatory response and less reparative dentin. They recommended the use of a liner in all cavities utilizing Adaptic®.

Seelig & Doyle (1974) reported on Adaptic®, Concise® and Epoxylite®. Using monkey teeth, they found Adaptic® elicited the least pulpal irritation followed with increasing severity by Epoxylite® and Concise®. They also concluded that although various composite resin materials may differ in their potential for causing pulpal damage, the least irritating composite still causes at least as many severe responses as do the silicates.

In light of some of the differing pulpal responses reported for composite resins, it was the purpose of our study to evaluate the pulpal compatibility of Smile®, Simulate® and an experimental composite, using ZOE (zinc oxide and eugenol) and silicate as controls.

Our objective was to test these materials in both primary and permanent teeth to determine any difference in pulpal response. All materials were evaluated utilizing the guidelines specified by the American National Standards Committee MD–156 for Dental Materials and Devices (1974). This specifies the use of intact, noncarious, non-significantly abraded teeth with Class V cavity preparations prepared with a high speed #35 carbide bur with efficient water spray coolant. The materials tested must be used as recommended by the manufacturer with zinc oxide-eugenol and silicate in unlined cavities as controls. There must be a minimum of 15 test cavities and 10 controls which are all balanced as to tooth size and remaining dentin. One third of the teeth were evaluated after 24–72 h, one third after 25–35 days and one third after 50–60 days. Following these guidelines it was our intention to determine if these resins were more compatible with pulpal tissue than some of the composites and silicates previously available.

## Materials and Methods

The study considered the histopathological observation of five compounds, Smile®[1], Si-

mulate®[2], Experimental #2 (bis glycol methacrylate resin)[3], ZOE[4] and Silicate[5] in Rhesus monkeys.

Before any cavity preparations were performed, each animal received a thorough prophylaxis. Following this, Class V cavity preparations were made on the buccal surfaces of all the monkey teeth using a #33–1/2 inverted cone bur with high speed water spray in primary teeth and a #35 inverted cone bur in permanent teeth. The size and depth of the cavities were standardized as follows: the occlusal-cervical dimension of the cavities was 1.5 times the diameter of the bur and the mesio-distal dimension was 3 times the diameter of the bur used. The depth of the cavities was 1.5 times the height of the cutting edge of the bur which provided approximately 0.5 mm remaining dentin.

The materials were evaluated according to the specifications of the American National Standards Committee MD–156 for Dental Materials and Devices. Five test cavities were used for each compound at each of three time intervals: 3 days, and 5 and 8 weeks, with silicate and zinc oxide eugenol used as controls. The materials were placed in both anterior and posterior, maxillary and mandibular of the 75 permanent and 75 primary teeth. This resulted in approximately 30 posterior and 20 anterior teeth being evaluated at each of the three time intervals. This means that three posterior and two anterior teeth were tested for each compound at the 3 days, 5 and 8 weeks and in both primary and permanent teeth.

After the appropriate time intervals the animals were sacrificed by ventricular vascular perfusion with 10 % phosphate buf-

[1] Smile (Batch #043311.32) Kerr Manufacturing Company, Romulus, Michigan.

[2] Simulate (Batch #38-251-2 Catalyst – #38-25-1 Base) Kerr Manufacturing Company, Romulus, Michigan.

[3] Experimental Composite #2 (Batch #38-250-1 Base – #38-241-2 Catalyst) Kerr Manufacturing Company, Romulus, Michigan.

[4] Cavitec (Batch #04321105) a zinc oxide eugenol liner, Kerr Manufacturing Company, Romulus, Michigan.

[5] MQ (Batch #36607 Liquid-#1666602 Powder) Silicate Cement. S.S. White, Philadelphia, Pennsylvania.

*Fig. 1.* Control, zinc oxide eugenol, Cavitec®. A 3 day pulpal response of a permanent tooth characterized by slight disruption of the odontoblastic layer and presence of a few inflammatory cells. Mag. × 40.

*Fig. 2.* Control, silicate (MQ) – S.S. White. A permanent tooth with a moderate pulpal response after 3 days characterized by vacuolization and disruption of the odontoblastic layer and infiltration of inflammatory cells in the subjacent pulpal tissue. Mag. × 40.

*Fig. 3.* Composite Resin – Simulate®. A 3 day pulpal response in a permanent tooth. A slight to moderate response characterized by the loss of continuity of the odontoblastic zone and a slight infiltration of inflammatory cells. Mag. × 40.

*Fig. 4.* Composite Resin – Smile®. A slight to moderate 3 day response in a primary pulp. The odontoblastic layer is characterized by vacuolization, disruption and loss of continuity with the infiltration of inflammatory cells in the adjacent pulp tissue. Mag. × 42.

*Fig. 5.* Control, zinc oxide eugenol, Cavitec®. A 5 week pulpal response in a permanent tooth illustrating a minimal response with very little reparative dentin underlying the cavity preparation and a slight increase in cellularity adjacent to the dentin. Mag. × 125.

*Fig. 6.* Control, silicate (MQ) – S.S. White. A moderately severe response in a permanent tooth at 5 weeks characterized by the presence of reparative dentin, the complete loss of the odontoblastic layer, some areas of focal necrosis, vacuolization and inflammation involving a large portion of the coronal pulp. Mag. × 39.

*Fig. 1*

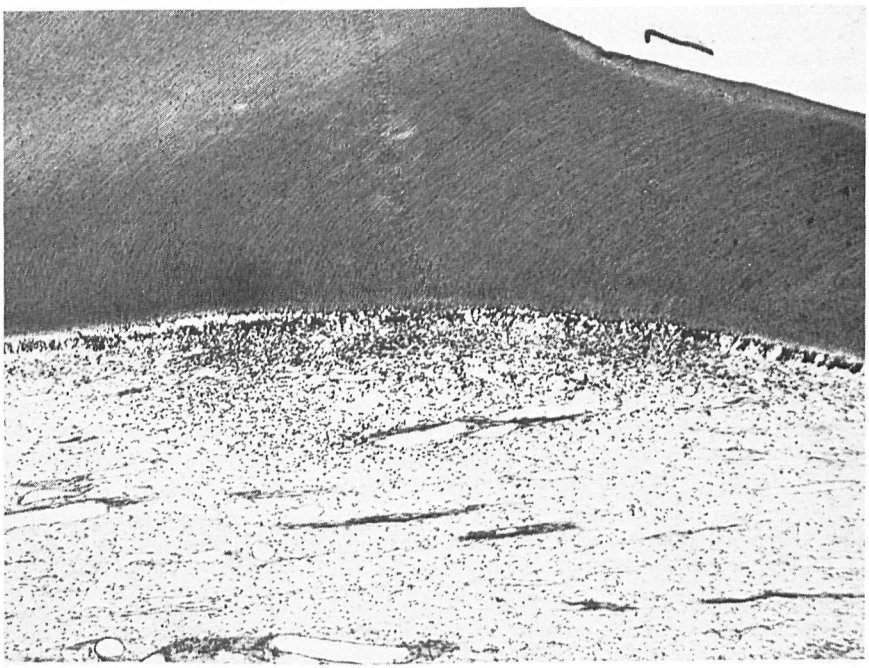

*Fig. 2*

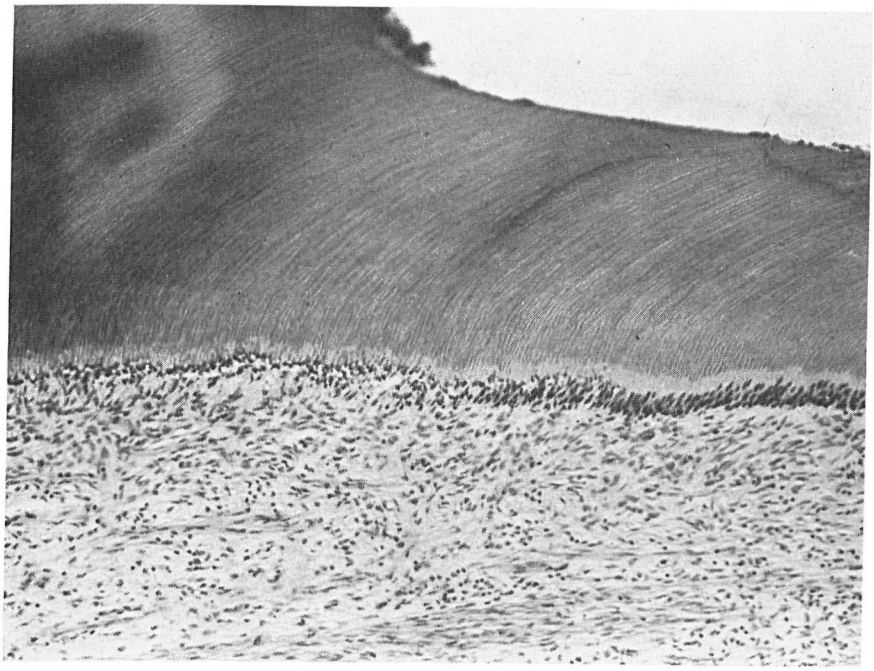

*Fig. 3*

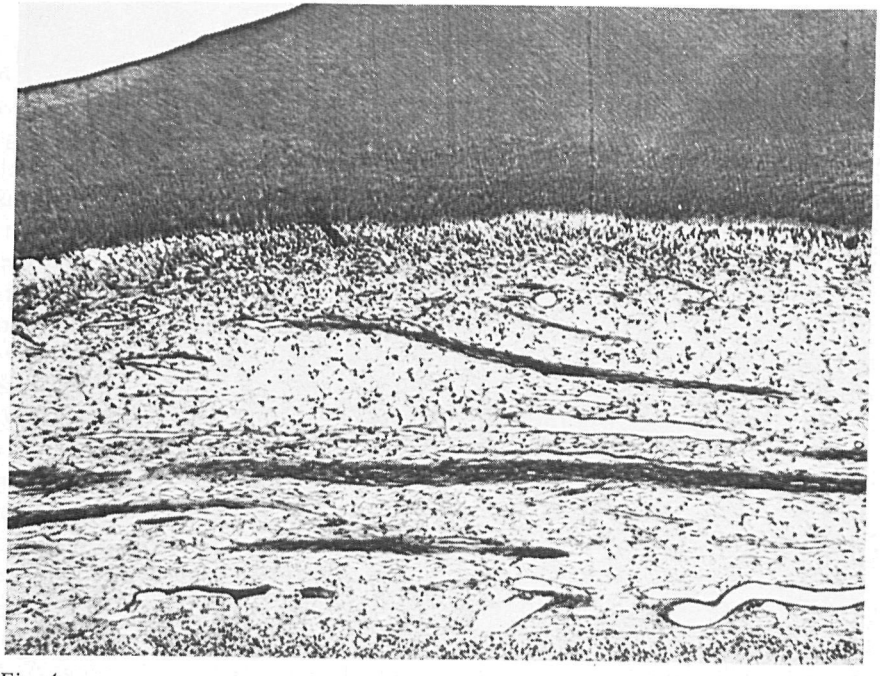

*Fig. 4*

*Fig. 5*

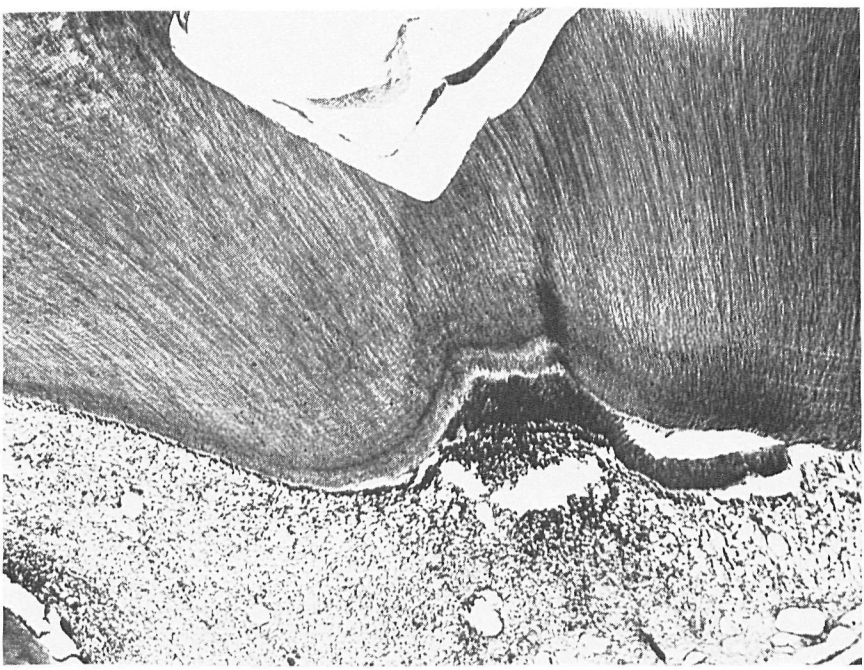

*Fig. 6*

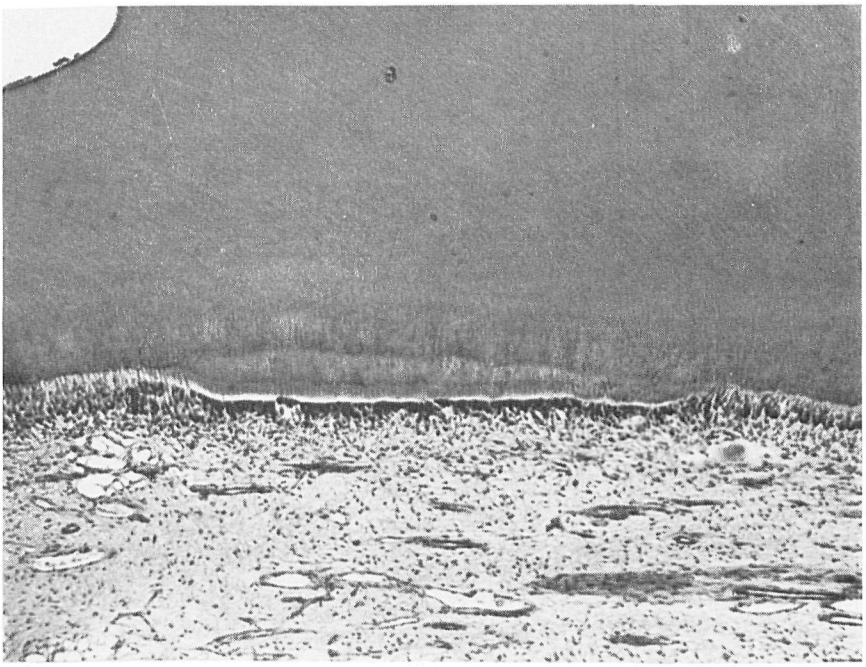

*Fig. 7.* Experimental Composite #2. A permanent tooth at 5 weeks showing a slight to moderate response characterized by the formation of reparative dentin, an intact odontoblastic layer and very few inflammatory cells. Mag. × 59.

fered formalin. The teeth were removed by relieving the adjacent buccal bone. The apical 1/3 of the tooth was removed with a surgical bone bur and then placed in phosphate buffered formalin for further fixation. The teeth were then decalcified, dehydrated, embedded in paraffin, serially sectioned and stained with hematoxylin and eosin.

The histological findings were evaluated according to Safer's (1971) modification of the Stanley et al. (1967) criteria which adds the flexibility of pluses and minuses to Stanley's 0–4 range, but essentially retains the general classification of slight, moderate, and severe.

A *slight reaction* is characterized by slight increased cellularity in, and adjacent to, the cell-free zone underlying the cavity preparation. These cells are mainly granulocytes. A mild hyperemia is found in the pulp tissue adjoining the cavity tubules, and small hemorrhages may have occurred in the odontoblastic region. Furthermore, small irregularities in the odontoblastic layer are found, often associated with a displacement of odontoblast nuclei into the dentinal tubules.

A *moderate reaction* is characterized by a distinctly increased cellularity containing granulocytes. A localized hyperemia with occasional hemorrhages in the odontoblastic and subodontoblastic region is observed. Furthermore, the odontoblast layer is discontinuous, and many odontoblastic nuclei may be displaced into the dentinal tubules.

A *severe reaction* is characterized by marked cellular infiltration, mainly granulocytes which may progress to abscess formation, in the pulp tissue subjacent to the cavity tubules. Signs of hyperemia may be found

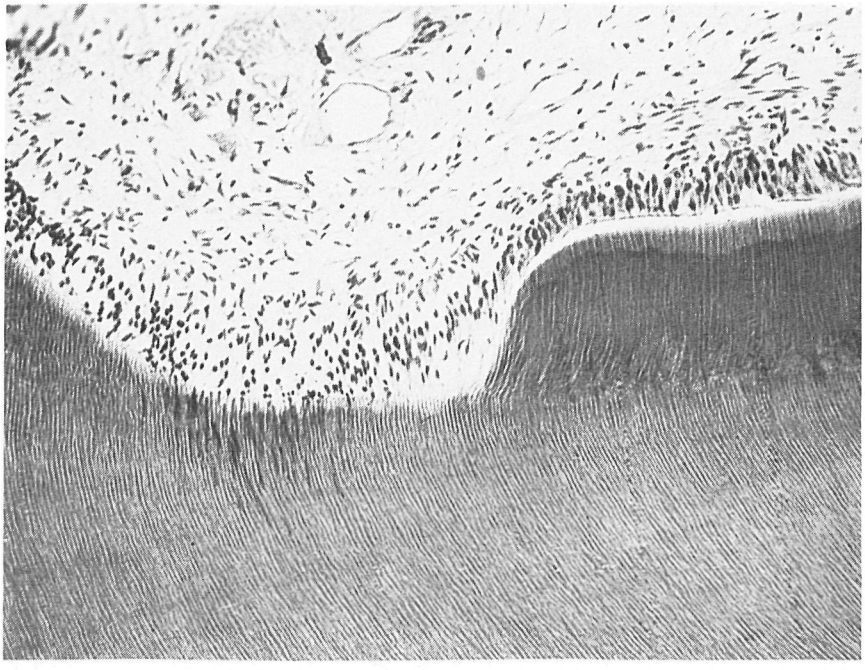

*Fig. 8.* Experimental Composite #2. A 5 week permanent tooth illustrating a large amount of reparative dentin with an intact odontoblastic layer but with continued aspiration and disruption of the odontoblastic layer adjacent to the reparative dentin. Mag. × 148.

surrounding the cellular infiltration, and areas of hemorrhage may be seen. The odontoblastic layer is also disrupted or destroyed and sometimes the odontoblastic nuclei have been displaced into the dentinal tubules.

After each investigator had studied the criteria, a series of random slides were selected and each member independently evaluated the histologic sections and placed them in a specific category. When all the selected slides had been examined, all observations were compiled and occasional variations were discussed until a consensus was reached.

## Results

At the 3 day time interval in permanent teeth, zinc oxide eugenol produced a minimal response; namely, slight vacuolization of the sub-odontoblastic layer and minimal cellular disruption of the odontoblastic zone (Fig. 1). Silicate, on the other hand, produced a much more severe response including vacuolization and loss of continuity of the odontoblastic layer, loss of the cell-free zone of Weil and a moderate infiltration of inflammatory cells (Fig. 2). Smile® and the two experimental composites produced similar pulpal responses; although they were less intense than silicate, they were more severe than ZOE. They were characterized by aspiration of the odontoblastic nuclei into the dentinal tubules, some disruption of the odontoblastic layer, loss of the cell-free zone, and a slight infiltration of inflammatory cells (Fig. 3). The remaining pulpal tissue beyond the cut dentinal tubules appeared normal.

Silicate produced the most intense re-

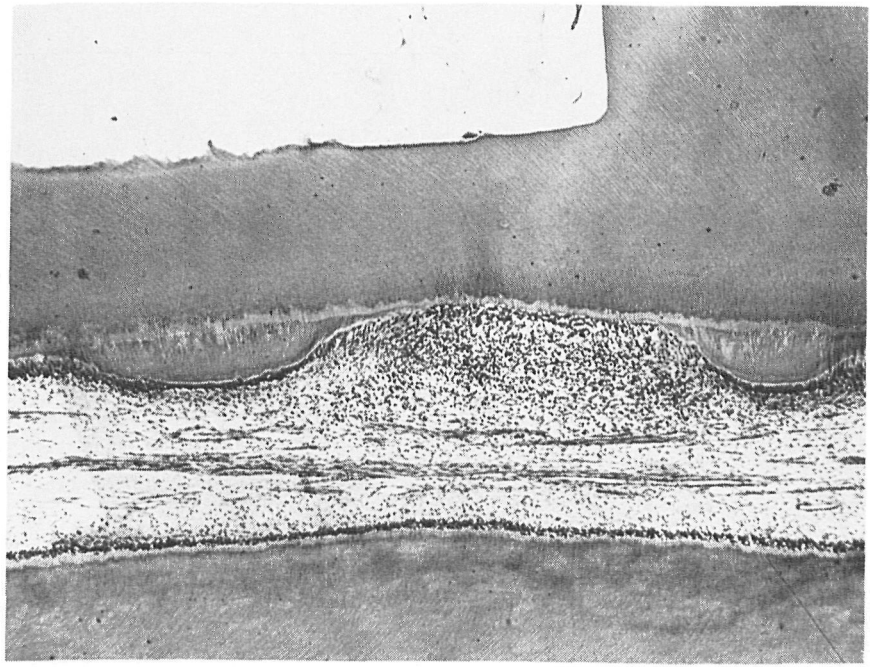

*Fig. 9.* Composite Resin – Simulate®. A moderate pulpal response (in a permanent tooth at 5 weeks) illustrating two areas of reparative dentin underlying the cavity with loss of the odontoblastic layer and infiltration of inflammatory cells between the two buttons of reparative dentin. Mag. × 48.

sponse, followed by the composite resins. The degree of odontoblastic disruption, the number of inflammatory cells and the percentage of the pulp involved was slightly more intense in the primary teeth than in the posterior teeth at this interval (Fig. 4).

As the post operative time increased to 5 weeks, zinc oxide eugenol elicited a slight to moderate response. At this time some reparative dentin was noted underlying the cavity preparation with the reorganization of the odontoblasts and presence of some scattered inflammatory cells (Fig. 5). Silicate at 5 weeks initiated a moderate to severe response. However, the initially formed reparative dentin appeared irregular, containing cellular inclusions, while the more recently formed dentin was uniform and regular. The odontoblastic layer varied in appearance from only slight disruption in some areas to complete loss in others. The subjacent connective tissue exhibited some areas of focal necrosis, abscess formation and complete loss of pulpal architecture (Fig. 6). In contrast, Smile®, Simulate® and the Experimental Composite #2 produced a slight to moderate pulpal response (Fig. 7). All materials produced a relatively large amount of reparative dentin characterized initially as being irregular, containing cellular inclusions; while later deposition was more regular and generally resembled the tubular arrangement of normal dentin. Teeth containing the three composites at this time interval showed aspiration of odontoblastic nuclei into the dentinal tubules either just apical or coronal to the button of reparative dentin (Fig. 8). The odon-

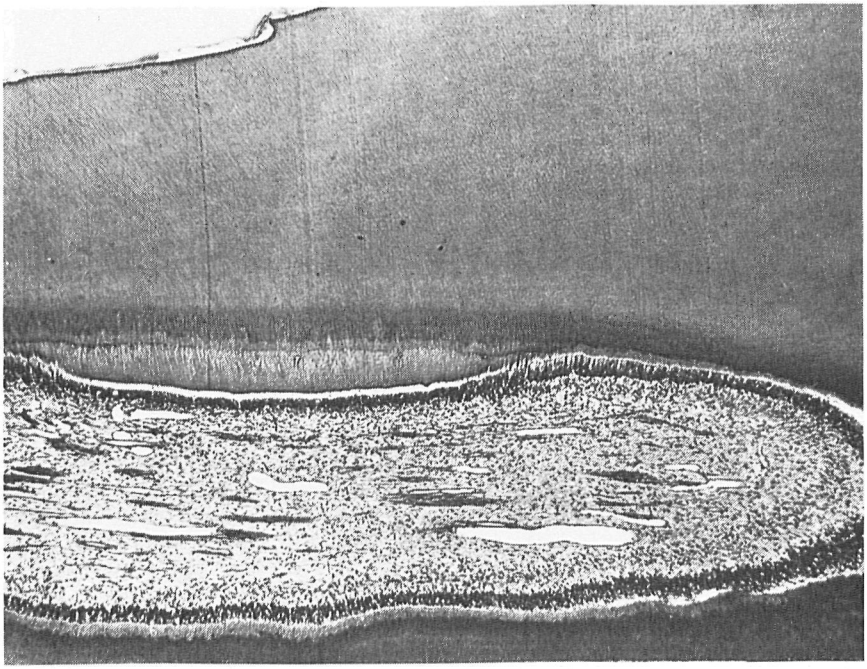

*Fig. 10.* Composite Resin – Smile®. A 5 week response in a primary tooth characterized by a slight pulpal response illustrating an area of reparative dentin with an intact odontoblastic layer and little inflammatory cell infiltration. Mag. × 36.

toblastic layer was generally continuous to the reparative dentin except in the areas of continued aspiration. The subjacent connective tissue appeared relatively normal with only a slight inflammatory infiltrate containing macrophages and lymphocytes. One observation in a tooth with Simulate® was an area of reparative dentin consisting of two separate buttons of dentin (Fig. 9). The odontoblastic layer adjacent to these two nodules of dentin appeared continuous and relatively normal, as did the subjacent connective tissue. But the pulpal tissue between these areas showed aspiration of odontoblastic nuclei into the dentinal tubules, disruption and vacuolization of the odontoblastic layer and a chronic inflammatory response in the adjacent tissue. Serial sections of this same tooth showed a coalescence of these two nodules into one button of reparative dentin with an adjacent intact and continuous odontoblastic layer and minimal surrounding inflammatory response. The remaining pulp appeared normal and intact.

Primary teeth at 5 weeks appear to respond similarly to the permanent teeth (Fig. 10). Silicate produced the most intense response including reparative dentin formation, continued loss of the odontoblastic layer in some areas, moderate to severe inflammatory response and in some cases necrosis and abscess formation. The response to experimental resins at 5 weeks, including formation of reparative dentin, a minimal inflammatory reaction, with similar responses, was less than that noted in permanent teeth. Reparative dentin measurements at 5 weeks for both permanent and primary teeth were variable, but deeper cavity pre-

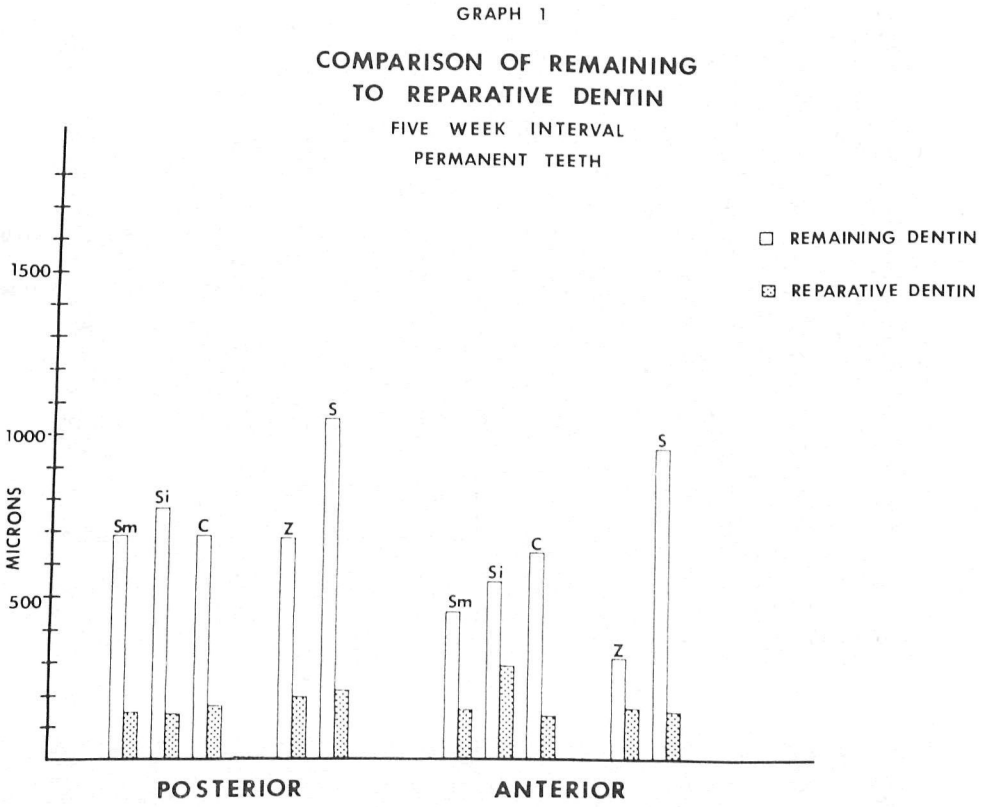


*Fig. 11*

Sm = Smile®
Si = Simulate®
C = Experimental Composite #2
Z = Zinc Oxide Eugenol
S = Silicate

parations tended to have more (Figs. 11 and 12). Both permanent and primary teeth with all the composites tested showed similar amounts of reparative dentin. ZOE produced slightly less reparative dentin and silicate slightly more than Smile® and the two experimental materials.

Zinc oxide-eugenol after 8 weeks post operative interval elicited a very slight response (Fig. 13). Reparative dentin deposition initially contained some cellular inclusions, but gradually became more tubular with the re-establishment of a uniform predentin border. The surrounding odontoblastic layer was intact and continuous with only occasional scattered macrophages and leukocytes present; no chronic inflammatory cell infiltrates were present. The remaining pulpal tissue appeared normal and continuous. Silicate at this time interval caused a greater variation in response than was noted at the earlier time periods (Fig. 14). The responses ranged from a moderately severe reaction with some disruption of the odontoblastic layer and inflammatory infiltration, to a severe reaction with total necrosis of

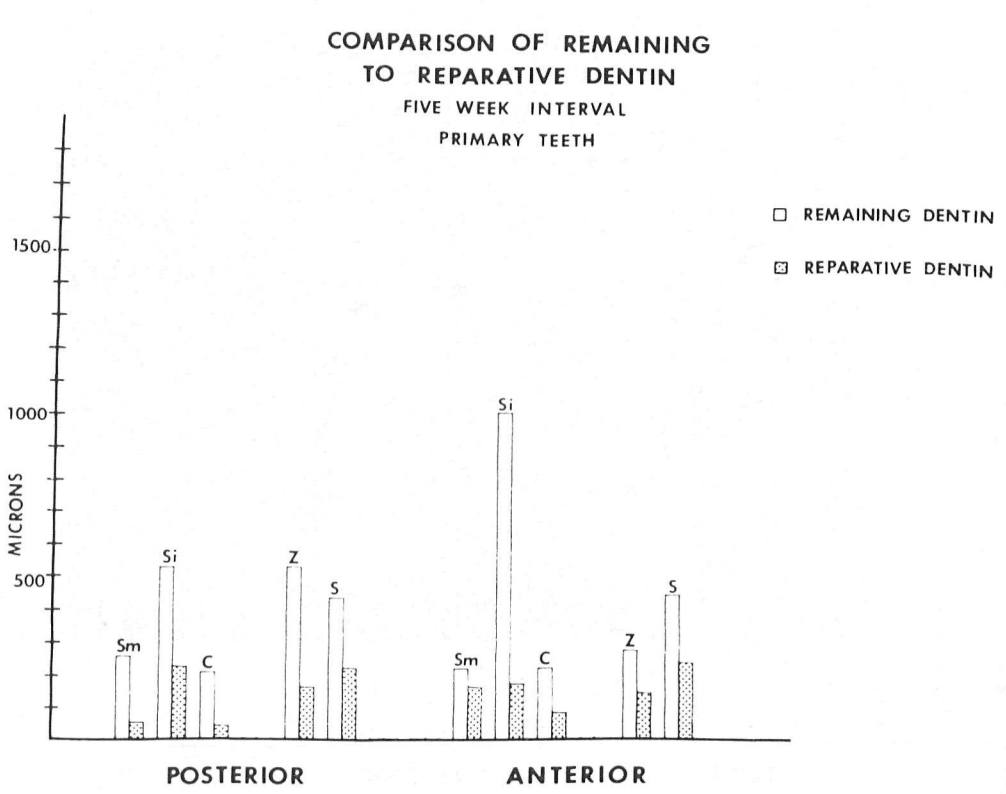


*Fig. 12*

Sm = Smile®
Si = Simulate®
C = Experimental Composite #2
Z = Zinc Oxide Eugenol
S = Silicate

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*Fig. 13.* Control, zinc oxide eugenol, Cavitec®. A permanent tooth at 8 weeks showing a very mild response with an area of reparative dentin underlying the cavity. The odontoblastic layer is intact with a uniform zone of predentin and the odontoblastic layer is uniform with no indication of an inflammatory response. Mag. × 60.

*Fig. 14.* Control, silicate (MQ) – S.S. White. At 8 weeks a severe pulpal response in a permanent tooth illustrating an area of reparative dentin with generalized loss of the odontoblastic layer overlying this, abscess formation and the presence of chronic inflammatory cells in this area. Mag. × 37.

*Fig. 15.* Composite Resin – Smile®. At 8 weeks in a permanent tooth Smile® produces a slight pulpal response characterized by a relatively large area of reparative dentin, an intact odontoblastic layer and a minimal inflammatory response. Mag. × 41.

*Fig. 16.* Composite Resin – Smile®. In a primary tooth at 8 weeks a slight pulpal response is noted with an area of reparative dentin surrounded by an intact odontoblastic layer and little inflammatory cell infiltration. Mag. × 61.

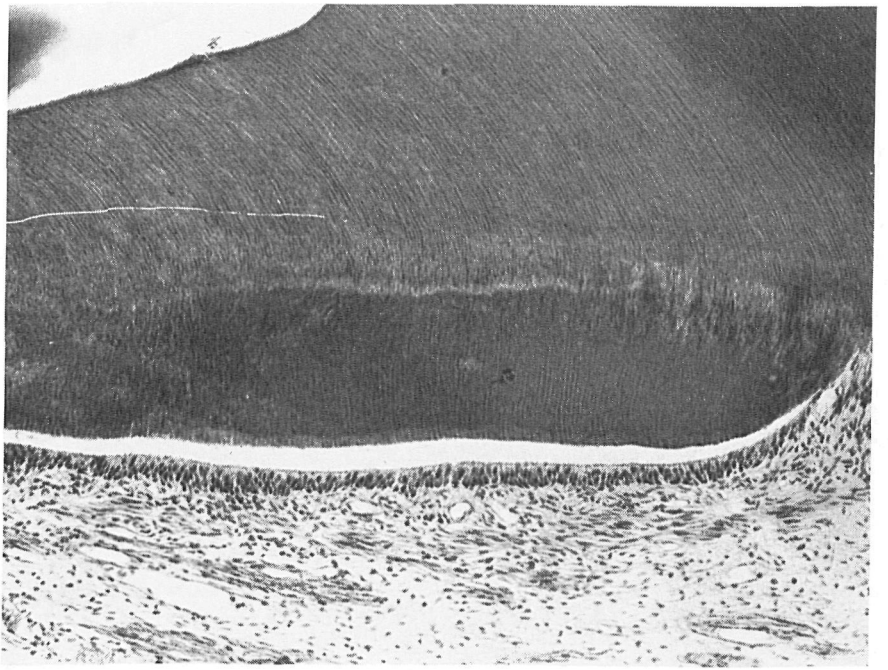

*Fig. 13*

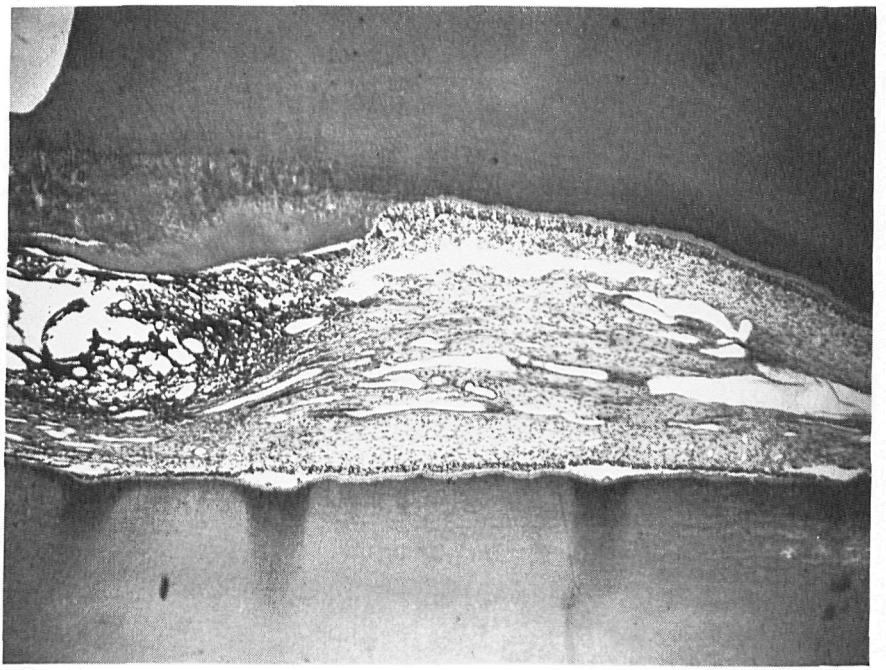

*Fig. 14*

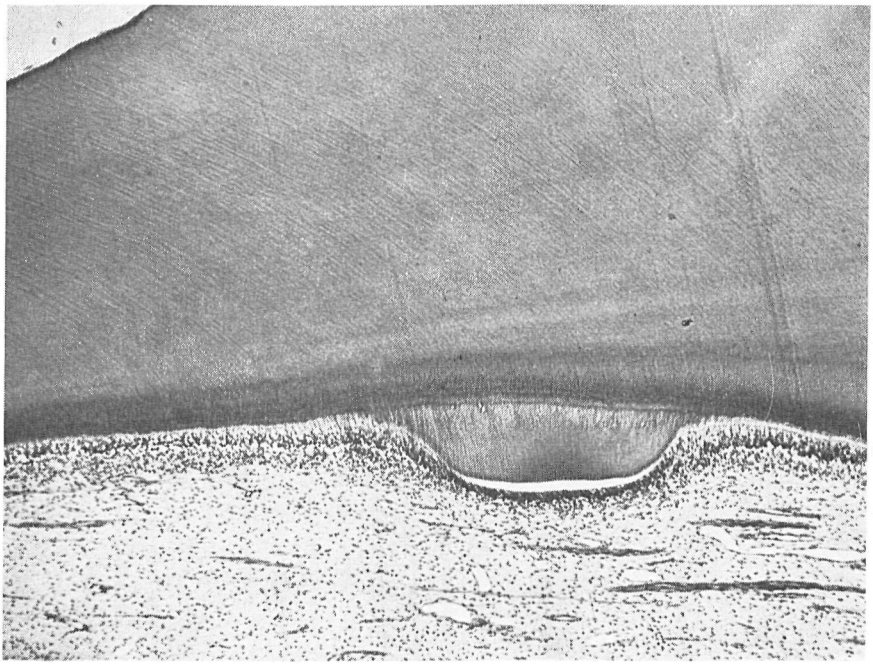

*Fig. 15*

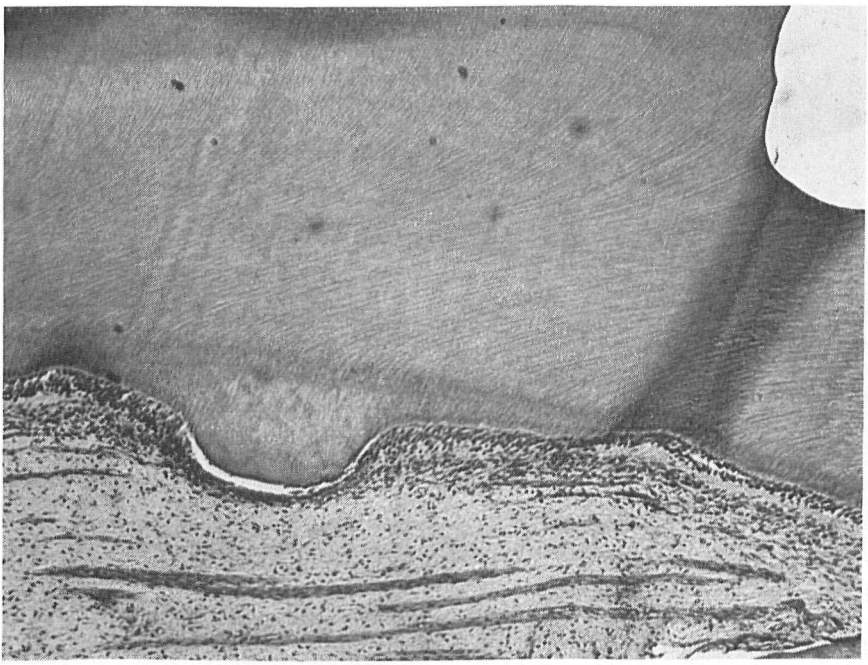

*Fig. 16*

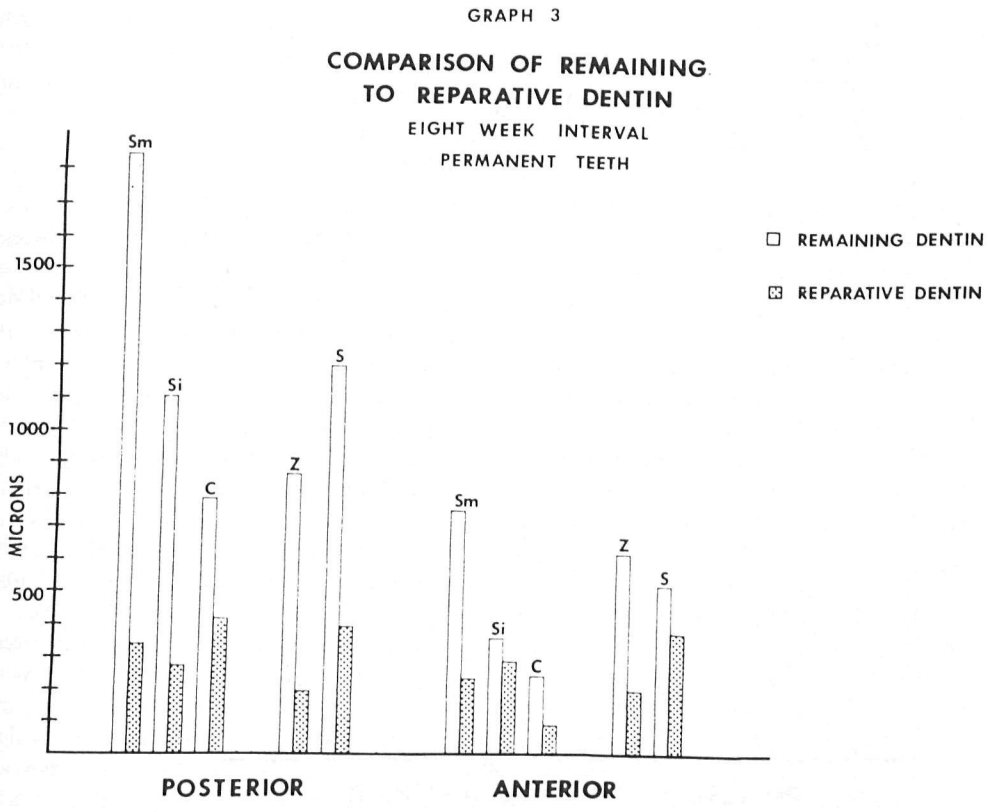


*Fig. 17*

Sm = Smile®
Si = Simulate®
C = Experimental Composite #2
Z = Zinc Oxide Eugenol
S = Silicate

the pulp and complete loss of normal architecture. In the less severe response a large amount of reparative dentin was deposited under the cavity preparation. The odontoblastic layer was generally continuous over the area of reparative dentin, however, disruption and disorganization were noted at the apical and coronal ends of the reparative dentin. The subjacent pulpal tissue showed chronic inflammatory cells consisting of macrophages, plasma cells and lymphocytes. In comparison the teeth with a more severe reaction involved the whole coronal pulpal architecture. However, an area of reparative dentin underlying the cavity preparation was present. The odontoblastic layer throughout the whole coronal pulp and central pulp tissue was disrupted by an area of necrosis including abscess formation.

Smile®, Simulate® and Experimental Composite #2 elicit a very slight response when compared to silicate (Fig. 15). Initially, irregular reparative dentin formed under the cavity preparation; however, later deposition appeared more regular and tubular when seen at 8 weeks. The odontoblastic

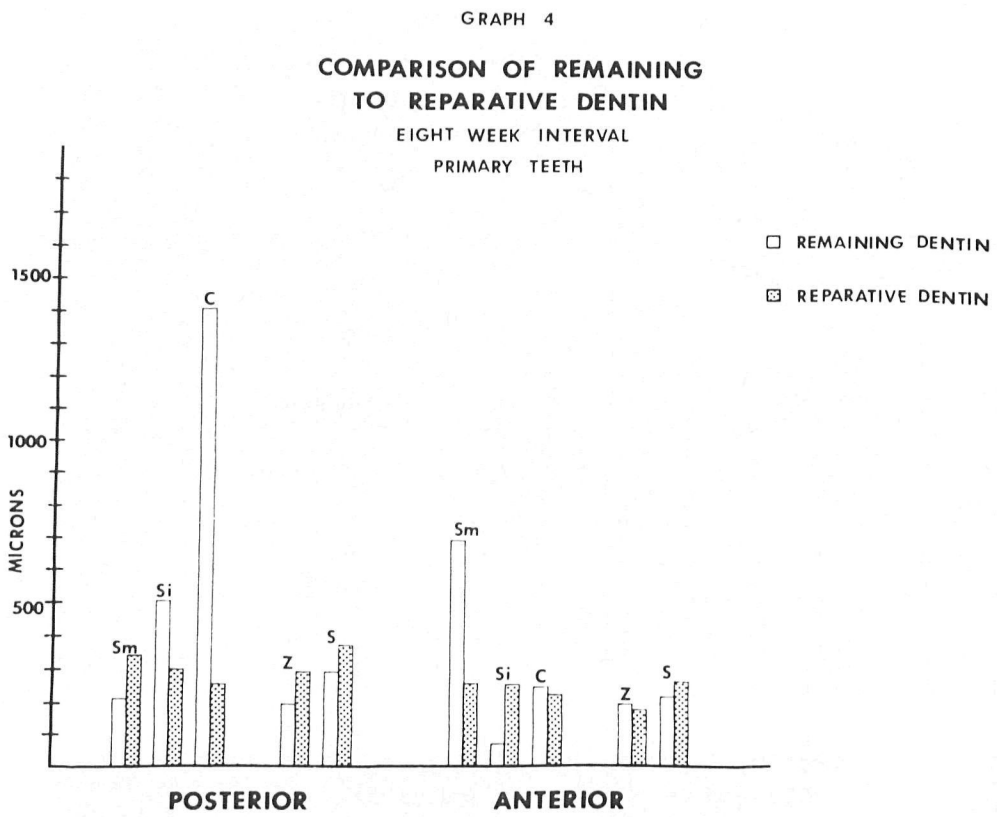


*Fig. 18*

Sm = Smile®
Si = Simulate®
C = Experimental Composite #2
Z = Zinc Oxide Eugenol
S = Silicate

layer appeared normal and continuous both in and around the cavity preparation and throughout the rest of the pulp as well. The subjacent connective tissue also appeared normal and continuous with the exception of the re-establishment of the cell-free zone. The inflammatory response was very slight to zero with only the occasional presence of some lymphocytes and macrophages.

At 8 weeks the response observed in primary teeth was similar to that observed in the permanent teeth. Again, silicate elicited the most intense response with continued inflammation and a large area of reparative dentin. Simulate® and Experimental Compound #2 produced a zero to slight reaction with very minimal, if any, pulpal response (Fig. 16).

Reparative dentin measurements at this time period indicated the same trends that were noted at 5 weeks with the exception of more dentin formation noted at 8 weeks (Figs. 17 and 18). All the compounds stimulated similar amounts of reparative dentin in both permanent and primary teeth. Our controls showed similar results at 8

weeks with ZOE producing slightly less reparative dentin and silicate slightly more than did the composites.

### Discussion

It was the purpose of this study to compare the biological response of Smile®, Simulate® and Experimental Composite #2 resins in primary and permanent monkey teeth using ZOE and silicate as controls. To exclude variables we attempted to standardize the cavity depth, utilizing both maxillary and mandibular, anterior and posterior teeth and evaluating the responses at three time intervals as prescribed by the American Dental Association standards.

ZOE and silicate were used as controls to establish a range of response for comparison, with ZOE an indicator of minimal responses and silicate representing the severe response on the opposite end of the spectrum.

All three composite resins showed similar responses at all time intervals. When compared to ZOE at these time intervals the composites produce a more severe response. Although ZOE and the composites both produced reparative dentin at 5 and 8 weeks, ZOE tends to stimulate a smaller amount at both time periods. At 8 weeks, the response to the composite resins is slight, with little if any inflammatory response or disruption of the odontoblastic layer underlying the reparative dentin, indicating that the trauma from cavity preparation and placement of the material has dissipated and that the pulp and odontoblasts have recovered.

Comparing silicate response to the composites, it is evident at 3 days that the responses are very similar but at 5 and 8 weeks the response is less severe with the composites. Whereas the pulpal irritation seems to be less at 5 and 8 weeks with the composites, the pulpal irritation of silicate remains the same or becomes more severe. The similar response noted at 3 days for all compounds seems to indicate that the response is mainly due to the trauma of cutting and placing the materials. The more intense response of silicate at later time periods is probably due to the phosphoric acid.

Two interesting features were noted at the 5 week interval. Fig. 8 illustrated continued aspiration of odontoblastic nuclei into the dentinal tubules in teeth with the experimental composite resins. This continued aspiration would seem to indicate that either a toxic effect of the material placed in the cavity preparation has taken longer to reach the pulp tissue due to the greater length of the dentinal tubules or there is a continued release of toxic substances from the restorative material. The regularity of the odontoblastic cells overlying the reparative dentin in this area would suggest the protective quality of the reparative dentin. The other interesting feature seen in Composite #2, Fig. 9, illustrates two nodules of reparative dentin separated by inflammation. Further serial sectioning showed coalescence of the reparative dentin with the absence of the inflammatory response. This would seem to indicate that the formation of reparative dentin can be rather irregular and that serially sectioning the specimen and examining all sections is the only way to accurately assess the actual response. A second possible method would be to follow dentinal tubules from the center of a cavity preparation to an inflammatory area. Odontoblasts in this area may be most severely damaged and destroyed while those in adjacent areas may be less affected. Therefore, it would take this area longer to regenerate and form reparative dentin while peripheral areas are injured less and are more capable of regeneration at an earlier time.

One fact that becomes obvious in reviewing the histograms (Figs. 11 and 12) is that it is almost impossible to prepare cavity pre-

parations with exactly 0.5 mm remaining dentin. Even though specific attention was directed to achieving a standard cavity depth it is almost impossible to attain this, due to variation in animal size and the differences in dentin and enamel which is especially noted in comparing anterior and posterior teeth. In spite of this there are some general characteristics which may be noted. As the cavity depth increases, reducing the amount of remaining dentin, the amount of reparative dentin tends to increase with a given compound. It is also evident that ZOE seems to produce the least amount of reparative dentin, and silicate the most, with the composite resins falling in a range between the two extremes. The composite resins all produced similar amounts of reparative dentin. These findings indicate that different categories of compounds will elicit varying amounts of reparative dentin.

In comparing primary and permanent teeth it is generally noted that the cavity preparations in primary teeth left smaller amounts of remaining dentin. This is probably due to thinner layers of enamel and dentin resulting in proportionally deeper preparations because of our concern in providing for sufficient retention of the materials. As previously noted, this increased cavity depth resulted in greater amounts of reparative dentin in primary teeth due to the closer proximity to the pulp.

In this study we also tried to compare the response between anterior and posterior teeth (Figs. 11 and 12, 17 and 18). The data observed on the histograms indicate that the amount of reparative dentin found was generally similar regardless of the type of tooth at both 5 and 8 week intervals.

Statistical analysis was compiled to note any correlation between the different variables such as the relationship between the various compounds and the amount of reparative dentin formed. Results indicated no significant correlation between any of the variables tested. A possible explanation for this is the method of classifying pulpal response into three major categories, of which there were four divisions. In doing this it was felt that it is difficult to be specific enough in numerical evaluations, resulting in the placement of most of our results in the middle two divisions. We are of the opinion that pulpal response evaluation must be more specific to allow for a greater range of responses, making this type of investigation more applicable for statistical analysis.

In summary it is evident that as the postoperative interval increases from 3 days to 8 weeks the pulpal response to the composites decreases and the tooth returns to a relatively normal state. These findings would seem to indicate the clinical acceptability of these materials on the monkey pulp with little residual harm to the pulps. However, this may not always be the case. This study shows that intact non-carious monkey teeth restored with composite resins in unlined cavities are for all purposes normal at 8 weeks, but how often does the clinician restore non-carious teeth? How would a carious tooth with pulpal inflammation respond to cavity preparation and placement of these materials? Our study cannot answer this. It is possible that placement of a composite resin in an unlined cavity preparation overlying an inflamed pulp may produce pulp irritation. As a result it is felt by these investigators that the use of a liner is recommended under composite resins.

**Acknowledgement**

The authors wish to thank Miss Kathleen R. Engelhard for her technical assistance.

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