An Up to 3-Year Randomized Clinical Study Comparing Indirect and Direct Resin Composites Used to Restore Worn Posterior Teeth

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Purpose: To compare a developmental indirect resin composite with an established, microfilled directly placed resin composite used to restore severely worn teeth. The cause of the tooth wear was a combination of erosion and attrition. ***Materials and Methods:*** Over a 3-year period, a total of 32 paired direct or indirect microfilled resin composite restorations were placed on premolars and molars in 16 patients (mean age: 43 years, range: 25 to 62) with severe tooth wear. A further 26 pairs of resin composite were placed in 13 controls (mean age: 39 years, range 28 to 65) without evidence of tooth wear. The material was randomly selected for placement in the left or right sides of the mouth. ***Results:*** Sixteen restorations were retained in the tooth wear group (7 indirect and 9 direct), 7 (22%) fractured (4 indirect and 3 direct), and 9 (28%) were completely lost (5 indirect and 4 direct). There was no statistically significant difference in failure rates between the materials in this group. The control group had 21 restorations (80%) that were retained (10 indirect and 12 direct), a significantly lower rate of failure than in the tooth wear patients ($P = .027$). ***Conclusion:*** The results of this short-term study suggest that the use of direct and indirect resin composites for restoring worn posterior teeth is contraindicated. *Int J Prosthodont 2006;19:613–617.*

Significant loss of tooth structure caused by attrition can result in flattened occlusal surfaces with little original form remaining and a significant proportion of exposed dentin.[1–3] Such morphologic changes complicate treatment with conventional dental restoratives in spite of the ability of adhesive materials to bond to dentin.[2,4,5]

A number of clinical trials comparing indirect and direct resin composites on teeth without tooth wear have been reported, with failure rates varying from 7.5% to 21%.[6–9] One 5-year study reported no statistically significant differences between direct and indirect resin composites, and the authors observed that the results compared favorably to those observed using other restorative materials.[6] A commonly used direct assessment for these resin composites is derived from the United States Public Health Service Evaluation System (USPHS),[10,11] which has gained considerable acceptability in clinical trials involving dental materials.

The use of resin composites to restore worn teeth is advocated as a conservative technique. However, most of the literature on the restoration of worn teeth consists of case reports or clinical articles, and only a few of these compare different materials or report the long-term results of restorative materials.[12–14] Most of the studies of direct or indirect resin composites used specifically to restore worn anterior teeth have reported failure rates of around 10%.[12,14] The aim of this particular study was to assess the success of restoring severely worn posterior teeth with a direct or indirect resin composite.

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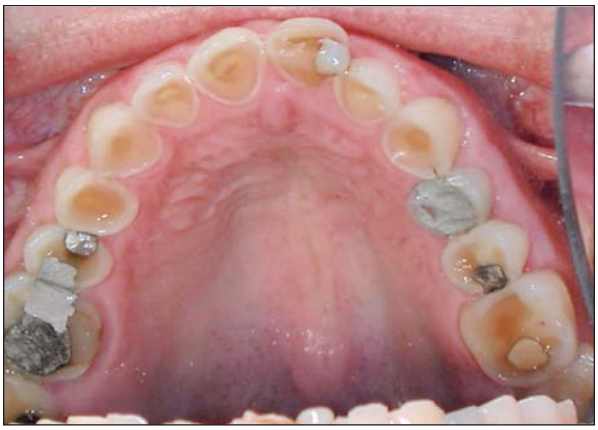

Fig 1 An example of a patient in the tooth wear group. All teeth shown were restored, but in this case, the paired restorations were selected for the second premolars.

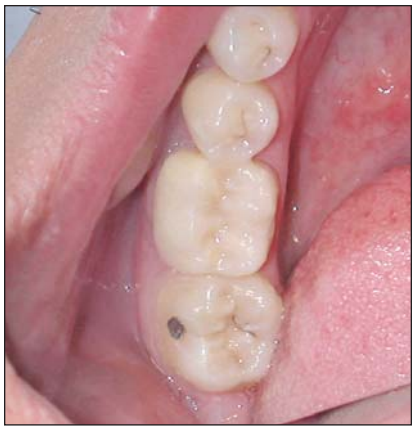

Fig 2 A restoration on the first molar of a control subject. The crown was bonded onto the tooth, which had fractured horizontally at the gingival margin.

Materials and Methods

Materials

A developmental, indirect, light/heat-cured, radiopaque, microfilled resin composite material was compared to a commercially available, direct, light-cured, radiopaque, microfilled resin composite material (Heliomolar HB, Ivoclar-Vivadent). Over a 3-year period, a total of 32 paired restorations using direct or indirect resin composite on premolars and molars were placed in 16 patients (mean age: 43 years, range: 25 to 62) with severe tooth wear, and 26 pairs were placed in 13 control patients (mean age: 39 years, range: 28 to 65) without evidence of tooth wear. The choice of material was randomly allocated to the left or right sides of the mouth. Ethical approval was obtained from the local hospital committee and conformed to the consort criteria.

Subjects

All subjects had a minimum of 20 teeth and were medically fit. The allocation to the control or study groups was made through an assessment of each subject's tooth wear. The tooth wear group had multiple worn and flattened posterior tooth surfaces with little coronal structure remaining (Fig 1). They were recruited from patients referred to a dental hospital for treatment of tooth wear. The cause of the tooth wear was considered to be a combination of bruxism and erosion and was bilateral in the maxilla or mandible. Insufficient vertical space was available for restorations using conventional principles of occlusal reduction. The control group without tooth wear comprised patients undergoing routine dental treatment at the same hospital. These subjects were recruited if they had bilateral paired extensive caries lesions involving occlusal and proximal replacements with at least 1 cusp missing (Fig 2).

Placement of Materials

One operator placed all the restorations, but the randomization and clinical assessments were conducted by an independent observer. The flattened and worn tooth surfaces were cleaned with pumice and water, and an abrasive paste was applied with a rubber cup. No further preparation was undertaken on the worn tooth surfaces. The extensive caries lesions in the control group required cavity preparation for the indirect restorations, particularly to remove undercuts or previous restorations, but cavity shaping was kept to a minimum. Temporization between appointments was unnecessary in the tooth wear group, while in the control group, non-eugenol cement protected the sensitive dentin. Pulpal protection was not used in either group.

The indirect restorations were made by the same laboratory technician on the die cast from the elastomeric impression material (Impregum, 3M ESPE). Restorations were made on models mounted on semiadjustable articulators using facebow transfers. The tooth wear patients had the occlusal vertical dimension increased by 2 to 3 mm to provide sufficient vertical space to place the restorations. A diagnostic waxup of the proposed vertical dimension was made, and a silicone matrix was made to guide placement of the resin composite on the anterior teeth when necessary. For these patients, more than 1 resin composite restoration was placed at a time, but only 1 pair was randomly selected to be included in the data analysis.

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Table 1 No. of Molars and Premolars Restored with the Indirect or Direct Resin Composite

	Indirect	Direct	Total
Tooth wear			
Molars	5	5	10
Premolars	11	11	22
Control			
Molars	7	7	14
Premolars	6	6	12
Total	29	29	58

Table 2 Size of the Restorations

	Indirect		Direct		
	Tooth wear	Control	Tooth wear	Control	Total
MO/DO/MOD	2	3	2	3	6
Three-fourths crown	4	4	4	4	8
Full coverage	10	6	10	6	44
Total	16	13	16	13	58

Table 3 No. of Indirect and Direct Restorations Retained, Lost, or Fractured in the Tooth Wear Group

	Indirect		Direct		
	Premolar	Molar	Premolar	Molar	Total
Lost	5 (16%)	0 (0%)	3 (9%)	1 (3%)	9 (28%)
Fractured	3 (9%)	1 (3%)	2 (6%)	1 (3%)	7 (22%)
Retained	3 (9%)	4 (13)	6 (19%)	3 (9%)	16 (50%)
Total	11 (34%)	5 (16%)	11 (34%)	5 (16%)	32 (100%)

Cementation of the indirect resin composite was conducted in a moisture-free environment, and rubber dam was used when possible. The tooth surfaces were treated with Syntac dentin adhesive, and, when appropriate, Variolink dentin luting cement (Ivoclar-Vivadent) following the manufacturer's instructions. The direct resin composite was applied at 1- to 2-mm increments at the same visit as the cementation of the indirect resin composite. Light polymerization of both the luting cement and the direct resin composite was conducted for both materials for 20 seconds on the lingual surface and 30 seconds on the occlusal surface. All restorations for the controls were polished and adjusted to the intercuspal position. For the tooth wear patients, all restorations were restored to the retruded contact position.

Evaluation

Baseline evaluations were made during the same visit in which the indirect resin composite was finished. An investigator other than the operator was calibrated to the USPHS criteria prior to the investigation, and assessments of anatomic form, marginal adaptation, color match, marginal discoloration, secondary caries, fractures of restoration and tooth, and overall patient satisfaction were made for each restoration. The vitality of the tooth was assessed by cold and electrical stimulation. Photographic records of the restorations were taken and stored digitally. Review appointments were made at 3, 6, 12, and 24 months, at which the USPHS assessments and impressions of the restorations were undertaken. Fractures were graded at 2 levels: minor or major. Minor fractures, which were assessed to not affect the longevity of the restorations, were repaired.

Statistical Analysis

Data were investigated regarding success or failure using an exact chi-square test for comparing the study and control groups and using a McNemar test for comparing the restorative materials within subjects. Power tests were conducted before the study, assuming that a control group would experience a 10% failure rate. Thirty patients in each group would be sufficient to reveal a failure rate of 50% and above in the tooth wear group as a statistically significant difference.

Results

The total number of restorations placed in the tooth wear group was 32 indirect and 31 direct restorations in 16 patients. From these, 16 restorations were randomly selected for paired comparison, while 13 were selected from the control patients (Table 1). The review period for the tooth wear group was a mean of 12 months (range: 3 to 28) and for the controls it was a mean of 16 months (range: 6 to 30). The indirect and direct restorations were placed on 11 premolars and 5 molars in the tooth wear group. In the control group, indirect and direct resin composites restored 6 premolars and 7 molars. The size and extent of the restorations were similar in both groups (Table 2).

Table 3 shows that 16 (50%) restorations were retained in the tooth wear group (7 indirect and 9 direct),

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Table 4 No. of Indirect and Direct Restorations Retained, Lost, or Fractured in the Control Group

	Indirect		Direct		
	Premolar	Molar	Premolar	Molar	Total
Lost	2 (8%)	0 (0%)	0 (0%)	0 (0%)	2 (8%)
Fractured	0 (0%)	1 (4%)	0 (0%)	0 (0%)	1 (4%)
Retained	3 (11%)	6 (23%)	5 (19%)	7 (27%)	21 (80%)
DNR	1 (4%)		1 (4%)		2 (8%)
Total	6 (23%)	7 (27%)	6 (23%)	7 (27%)	26 (100%)

DNR = the patient did not return.

7 fractured (22%) (4 indirect and 3 direct), and 9 (28%) were completely lost (5 indirect and 4 direct). In the control group, 1 indirect restoration (4%) fractured and needed replacing. There was no statistically significant difference in the outcome of the 2 materials within groups, but the success rate of the control group was better than that of the tooth wear group ($P = .027$), with 21 (80%) restorations being retained (10 indirect and 12 direct) (Table 4). The results show an overall failure rate in the tooth wear group of 28% for the indirect restorations and 21% for the direct restorations. The control group lost 2 indirect restorations (8%) and no direct restorations. The remaining 2 patients failed to attend for review. There was no statistically significant difference between the materials in the control group.

Clinical Evaluation

Recalls were made at 3, 6, 12, and 24 months, and any restoration fracture within the review period resulted in the elimination of that subject from further evaluation. In the tooth wear group, 1 direct restoration developed secondary caries after 2 years. Marginal discoloration in the tooth wear and control groups was graded A or B, except for 1 indirect restoration in a premolar that was graded C. Marginal adaptation was graded A or B for all restorations in both groups, except for 2 indirect restorations, 1 each in the tooth wear and control groups, that were graded D. Anatomic form and color matching were graded A or B for both restorations, but in the tooth wear group, more direct restorations were graded B than indirect restorations. Contact points were present for both materials, except for 1 direct restoration in the tooth wear group. No tooth lost vitality or had any pulpal changes. Patients rarely showed any preference for either material, and their concerns reflected more the nature of the treatment than the choice of materials.

Discussion

This clinical trial investigated the outcome of resin composites used to restore severely worn posterior teeth. Given the high fracture rate observed in this study, the results suggest that these materials are contraindicated for restoring posterior teeth. The likely cause of this failure was the high loading forces on the restorations from bruxing actions and the impact of the increased vertical dimension. Another possibility was the brittle physical properties of the microfilled resin composites. It is not known what the outcome would be if this study were repeated with a hybrid resin composite. Unfortunately, the alternatives to restoring severely worn posterior teeth involve more extensive prosthodontic techniques, including crown lengthening and possibly elective endodontics. While results from previous studies using resin composites on anterior teeth seem to be more successful,[12,13] the use of extensive resin composites for restoring severe tooth wear on posterior teeth should be undertaken with caution.

Subjects with tooth wear were selected from patients referred to a dental hospital for treatment of wear. Controls were selected from patients already undergoing treatment at the same institution with restorations as comparable in size as possible to those of the tooth wear group. For this reason, the number of control subjects was small. Inevitably, the tooth wear group had slightly larger restorations than the control group, but every effort was made to make this difference as small as possible.

The indirect and direct restorations in the control group appeared to be clinically acceptable. The direct composite and luting system have both been extensively researched.[15–18] They appear to show acceptable fracture resistance[18] and simulated wear rates[17] and have shown acceptable long-term success in other studies.[15,16] The fact that the resin composites did not perform well under loading is an important clinical

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finding. What effect a Michigan or full-coverage heat-cured acrylic resin splint, worn at night, may have had on the outcome is not possible to predict. It is possible that these splints may reduce the number of fractures, but further work is needed to investigate this theory.

The results from the control group lend some support to the use of dentin-bonded restorations to restore severely worn teeth.[19,20] Ideally, the investigation would have been conducted over a longer period, but following the failure of the restorations, conventional restorative management had to be undertaken. Some continuance of the study was undertaken if the minor fractures of the resin composite were repaired. In a few cases, fractures and loss of retention occurred in the same individual, and so once the restoration fractured, the decision was made to eliminate it from further analysis. This prevented longer review periods to assess the success of restorations in the control group.

The data from the clinical assessment do not contribute significantly to the results, but they suggest that, despite the size of the restorations, caries was not observed, although some discoloration was present. However, the time period of the study was relatively short, and the lack of clinically observable caries is not entirely surprising. Overall, when the restorations remained in place, they performed satisfactorily.

Conclusion

This study showed a high fracture rate for direct and indirect resin composites used to restore worn posterior teeth.

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