

# Comparison between Polyacid-Modified Composite Resin and Conventional Composite Resin used for Primary Molars Restoration

Al Nowaiser A\*

Associate Professor and Pediatric Dentistry Consultant and Chairman of Internship Training Program, Faculty of Dentistry, King Abdulaziz University, Saudi Arabia

\*Corresponding author: Al Nowaiser A, Associate Professor and Pediatric Dentistry Consultant and Chairman of Internship Training Program, Faculty of Dentistry, King Abdulaziz University, P.O. Box: 80209, Jeddah 21589, Kingdom of Saudi Arabia, Tel: 0126400000, Fax: 0126403316, E-mail: aalnowaiser@hotmail.com

**Citation:** Al Nowaiser A (2017) Comparison between Polyacid-Modified Composite Resin and Conventional Composite Resin used for Primary Molars Restoration. *J Dent Oral Care Med* 3(2): 204. doi: 10.15744/2454-3276.3.204

**Received Date:** June 01, 2017 **Accepted Date:** September 20, 2017 **Published Date:** September 22, 2017

## Abstract

**Objective:** To evaluate and compare the laboratory behavior of polyacid-modified composite resin with conventional composite resin.

**Methods:** Ten recently extracted primary molars, were used in this study for the measurement of the shear bond strength. Occlusal enamel was ground, leaving a flat dentin surface, on which a cylindrical specimen of each of the two tested materials was applied and light-cured according to the manufacturer's instructions. Specimens were then mounted in self-cure acrylic resin. Ten specimens were used for the measurement of the compressive strength. The specimens were prepared in a special-cylindrical mold, then light-cured according to the manufacturer's instructions. The compressive and shear bond strength of each specimen was measured using a Universal Testing Machine. Ten specimens of each of the two resin materials were used to measure the abrasion resistance. The test was performed by means of a toothbrushing machine and abrasive dentifrice slurry. The specimens were weighed before and after the test. Weight loss of the specimens were calculated after the test and reported as percent weight loss. Regarding microleakage test, Class V cavities were prepared in the buccal surface of 36 exfoliated or extracted human primary molars. The teeth were divided into two equal groups. Each group was divided into three equal subgroups; according to the storage time (1 week, 6 and 12 months). At the end of each period, each tooth was covered by nail varnish except a 1 mm wide window surrounding the restoration. The teeth were then thermocycled in water between 4 °C and 60 °C for 200 cycles with a dwell time of 60 seconds. The degree of microleakage was evaluated according to a standard scoring system.

**Results:** Dyract had significantly higher shear bond strength than Degufill H in Kg/cm<sup>2</sup> (P=0.0073), and MPa (P=0.0073). Dyract and Degufill H did not have significantly different compressive strengths in Kg/cm<sup>2</sup> (P=0.64), or MPa (P=0.64). Dyract had significantly higher percentage of wear than Degufill H (P=0.0162). Dyract had significantly less gingival microleakage than Degufill H after one week (P=0.002). No other significant differences were found between Dyract and Degufill H (P=0.08 for gingival microleakage at 6 months, P=0.36 for gingival microleakage at 12 months, P=0.32 for occlusal microleakage at one week, P=0.16 for occlusal microleakage at 6 months, and P=1.00 for occlusal microleakage at 12 months).

**Conclusions:** No statistically significant difference was found in compressive strength and microleakage between the 2 resin materials. Polyacid-modified composite resin had significantly higher shear bond strength and higher percentage of wear than conventional composite resin.

**Keywords:** Composite Resin; Children; Bond Strength; Primary Molars

## Introduction

Despite the wide-spread use of amalgam, few studies have reported several problems associated with such restorations in the primary dentition [1]. An older study of 313 Class II amalgam failures in primary molars concluded that failure of amalgam, itself, was responsible for significantly more marginal defects than enamel breakdown. Those workers did not cite operator variables and manipulative factors as causes of failure, but suggested the need for a better restorative material or alternative methods for restoring primary teeth [2]. In a more recent study, the frequent failure of silver amalgam restorations has been widely discussed, it was reported that 88.7% of silver amalgam restorations in primary molars required replacement [3].

Research has detected elevated levels of elemental mercury vapor (a heavy metal whose toxicity at high exposure levels is well-

established) in the mouths of individuals with dental amalgam fillings [2]. Additional animal research suggested that mercury from dental fillings could be deposited in tissues distant from the site of amalgam placement [3].

In addition, amalgam needs to be placed in bulk as it was prone to fracture in thin sections. This together with the need to incorporate mechanical retention into the cavity design often necessitates the removal of sound tooth tissue during cavity preparation [1].

The research for the ideal esthetic restorative material has followed two main paths of development; the resin-based composites and the glass-ionomers. Both materials have individual advantages and limitations which distinguish their mode of application and the clinical situations in which they are used [4].

Composite restorations are durable, esthetic and are relatively easy to handle, but in general, they lack fluoride release [4]. In the posterior region, however, the composite has not yet surpassed the amalgam, generally used up to the present. The reason for this is that the material requires precise handling and has unfavorable physical/chemical properties (polymerisation shrinkage, bacterial adhesion and side effects due to monomer release). The most significant disadvantages of this material are shrinkage that occurs during polymerization and its lower wear resistance in comparison with amalgam [5].

On the other hand, glass-ionomer cements are also durable, esthetic and release fluoride ions, which may contribute to a reduced incidence of recurrent decay. They also have the ability to physiochemically bond to both enamel and dentin, but are more difficult to handle [6,7]. The surface micro-profile does not allow a smooth glossy surface to be obtained. Also, these cements are prone to fracture and show a low resistance to abrasion [8].

Manufacturers of dental restorative materials are now concentrating on creating a bonded material that has the favorable properties of both glass-ionomer and composite resin, combined with the wear resistance and fracture toughness of metallic restorations [9]. The results have been the creation of a new composite material, now referred to as a "compomer". The compomer is a pioneer material in this new family. It combines the fluoride-releasing chemistry of a glass ionomer with the esthetics and structural properties of a resin-bonded composite into a mono-component restorative material. Accompanying the development of the compomer is a new bonding system which only requires one liquid both to prime and bond the restoration to the tooth [4]. This polyacid-modified composite resin is indicated for Class I, II, III, and V in primary and permanent dentition [10,11].

Compomers have been received with great popularity, and particularly in dentistry for children. Their composite-like esthetics, minimal steps in placement, no mixing, light polymerization (command-cure), and other features combine for highly rated ease-of-use. In addition, the actual handling characteristics of compomers are reported to be among the best of any available materials. Their physical properties approach those of resin composites, the strongest material described heretofore [12,13].

As a single-component material, compomers are available in a variety of delivery forms including syringe (screw) tubes, Compules, and most recently in Aplitips. It is likely that the success of compomers will continue for the foreseeable future, mainly because of their ease-of-use. Further development of these materials should result in an even easier-to-handle product and will likely offer other enhanced features [14].

If indeed this new system does prove successful in primary teeth restorations, problems of frequent failure associated with current restorative materials may be greatly reduced.

The null hypothesis tested was that there would be no difference in the laboratory behavior of polyacid-modified composite resin and conventional composite resin as regards to shear bond strength, compressive strength, abrasion resistance and microleakage.

## Aim of the Work

The aim of this study was to evaluate laboratory behavior of the polyacid-modified composite resin as regards to shear bond strength, compressive strength, abrasion resistance and microleakage.

## Materials and Methods

In this study, a polyacid-modified composite resin (DeTrey Dentsply), a single-component compomer and a conventional composite resin (Degussa), a light-cured hybrid composite were the materials used for evaluation of shear bond strength, compressive strength, abrasion resistance and microleakage.

### Shear Bond Strength

The shear bond strength between the two materials under investigation (Dyract and Degufill H) and dentin was tested using the Universal Testing Machine (Dayton Electric Co., Chicago, 60648, USA).

**Specimen Preparation:** Twenty freshly shed sound primary molars, stored in normal saline were used in this study. The teeth were mounted in self-cure acrylic resin using a split cylindrical copper mold. The teeth were mounted in such a way that their occlusal surfaces were facing upwards and protruding outside the acrylic resin for about 2mm. After setting of the acrylic resin, the occlusal surface of the tooth was ground on a dental trimmer (UY, Yoshida Dental, MFG, Co., Ltd.) so that the occlusal enamel

and all remnants of the occlusal groove pattern were removed, creating a flat surface of perpendicular to the long axis of the tooth. The dentin was polished with wet silicon carbide abrasive papers of 600 grit. The dentinal surface of each specimen was pretreated according to the manufacturer's instructions. A Teflon mold (3 × 3 mm) was centralized over the prepared tooth surface by screws. This mold does not adhere to the resin materials tested and therefore no lubrication is used which might influence strength [15]. The materials were then injected into the Teflon mold, then light-cured for 40 seconds. The Teflon mold was then removed and the materials were light-cured for another 40 seconds. The specimens were then stored in distilled water at 37 °C for 48 hours prior to testing, in an incubator.

**Testing Procedure:** Shear bond strength was measured by the application of a shear force [16]. The force was applied at a cross-head speed of 5 mm/min. The shear load required to induce separation of the material was recorded in Kg. The shear bond strength was calculated and analyzed statistically:

$$\text{Shear Bond Strength} = \frac{\text{Load}}{\text{Surface Area}} \text{ (kg / cm}^2\text{) and (MPa)}$$

### Compressive Strength

Compressive strength was determined by testing specimens (4 × 8 mm) of the two resin materials used (Dyract and Degufill H), using the Universal Testing Machine.

**Specimen Preparation:** Ten specimens of each of the two tested materials were prepared in a special cylindrical Teflon mold (4 × 8 mm) [17]. The used materials were injected into the mold, then light-cured from both sides of the mold for 40 seconds to ensure complete setting, as the extent of light penetration is not more than 3mm. The mold was then split open and light-cured for another 40 seconds. Immediately after curing, the specimens were removed from the mold and were immersed in distilled water at 37 °C for 48 hours prior to testing [18,19].

**Testing Procedure:** Measurements were performed at a constant rate of loading of 5 mm/min. The specimen was compressed along its long axis until fracture. The compressive strength was calculated and analyzed statistically:

$$\text{Compressive Strength} = \frac{\text{Load}}{\text{Surface Area}} \text{ (kg / cm}^2\text{) and (MPa)}$$

### Abrasion Resistance Test

The abrasion resistance of the two resin materials under investigation was measured using the "Three Body Abrasion Resistance Test", performed by means of a Tooth-brushing Machine and abrasive dentifrice slurry [20].

**Specimen Preparation:** A total of 20 specimens were prepared as follows: the upper part of the specimen holder was lubricated with cocoa butter. It was then tightly screwed over the lower basal plate, thus the cylindrical cavities of the upper part were facing each other at the lower part, creating cylindrical cavities of 8 mm in diameter and 6 mm height. Each material was mixed according to the manufacturer's recommendations. Each of the two materials was injected inside its cavity by means of a special syringe. The mold cavities were slightly overfilled and a mylar strip was placed along the specimen holder over the resins. A glass slab was then pressed over the strip and underlying materials. Thus, producing specimens whose surfaces were continuous with that of the holder. The specimens were light-cured for 60 seconds. Then turned upside down and light-cured for another 60 seconds to ensure setting throughout the whole specimen. The glass slab and mylar strip were then removed and the flashes of the materials were removed by a sharp chisel. The specimens were then transferred to a humidity oven at 37 °C and 100% relative humidity for 24 hours. Thereafter, the upper part of the specimen holder was unscrewed and pulled away from the lower part, leaving a 3 mm high cylinder of each material protruding from the lower part of the specimen holder. Then, specimens were stored in artificial saliva for 7 days [21].

**Toothbrushes:** Hard nylon (Hygienic, Egypt) multituft toothbrushes were used. They were also stored in artificial saliva for 7 days to ensure their saturation [22]. At the time of the test, the toothbrushes' heads were screwed to the brush holders of the abrasive machine. The specimen holder was held in its place in the slurry bath which in turn, was tightened to the base of the machine. A slurry of 1 part dentifrice (Signal: Parfico, Egypt for Unilever Export, Ltd., Bristol, England) in one part artificial saliva solution was prepared and applied to the tufts of the toothbrushes and to the surface of the specimens. The slurry bath was also filled to ensure continuous wetting of the specimens during test. The toothbrushes were lowered till they came in contact with the surface of the tested material ensuring direct contact of the brush tufts to the surface of the specimens. Constant pressure of 500 grams was applied to the top of each brush to ensure continuous contact between the brushes and the specimens [23]. The abrasion test consisted of a total of 60,000 strokes, which were equivalent to two years wear in the mouth [20]. To evaluate the rate of abrasion with increasing strokes number, the test was done on three stages; each was 20,000 strokes, after which, weighing of the specimens was done. New brushes were used after each 20,000 strokes, the specimens were removed to adjacent position for each test in order to overcome any possible effect of location of specimens during brushing.

### Testing Procedure:

**Tooth-Brushing Machine:** The machine was constructed to accomplish brushing action on test specimens resembling as close, as possible that, occurring in the oral cavity. It consisted of a drive motor (A), with attached revolution counter, which was connected to a connecting rod (B). This imparted a reciprocating motion to a horizontal sliding cross-head (C). This in turn, carried four free sliding horizontal bars (D). The bottom of each bar was served as a brush holder (E), each capable of performing an abrasion test on a single specimen. A weight (F) could be placed on top of each bar. A stainless steel slurry bath (G) was tightly screwed to the base of the machine facing the free ends of the four bars. A sample holder (H) could be placed in the base of the bath and held in place by means of two screws. The stroke rate was 60 per minute, and the stroke length was 20 mm. Every back and forth movement of the bar was considered as one stroke.

**Sample Holder:** Metallic holder was specially constructed to fit the slurry bath. It was mainly used to hold the specimens during condensation and conduction of abrasion test. It consisted of two parts; a basal plate and a longitudinally split upper plate. The basal plate was a block of 12 cm length, 4 cm width and 6 cm in height. It had four gutters to hold the sliding two halves of the upper basal plate. The upper as well as the lower basal plates, i.e. the holder had four cylindrical cavities each of 8 mm diameter and 6 mm height to hold the material during condensation. The fit of the upper and lower plates was strengthened by means of six screws along the lateral side of the block (three on each side). The lower basal plate was fixed to the slurry bath at the bottom of the abrasion machine by means of two screws. The materials to be tested were injected in the central cavities and light-cured. Then, the upper half of the block was removed to leave 3 mm of material protruding from the lower basal plate.

**Measurement of Abrasion:** The amount of abrasion that occurred in the two tested materials was measured in terms of weight loss. Specimens were weighed before test and after every 20,000 revolutions, the percentage of wear was calculated using the following equation:

$$\text{Percentage of Wear} = \frac{W_1 - W_2}{W_1} \times 100$$

Where:  $W_1$  is the initial weight of the specimen in grams before each test.  $W_2$  is the weight of specimen after each test.  $W_1 - W_2$  is the abrasion loss of the specimen in grams. The results were calculated, tabulated and analyzed statistically.

### Microleakage Evaluation

**Specimen Preparation:** Thirty-six exfoliated or extracted human primary molars were used in this study. The teeth were cleaned, polished and stored in distilled water at room temperature to prevent dehydration. Standardized Class V cavities were prepared on the cervical third of the buccal surfaces of the primary molars using wheel diamond burs 2mm in diameter and 1mm in thickness. This was done by a turbine and constant water spray to a depth of 1mm which was the same thickness of the burs and widths of 2.6mm mesiodistally measured by dental vernier with double tips (specific for inner and outer measurements) and 2 mm occluso-cervical corresponding to the diameter of the bur. The burs were replaced for every four cavities. Following preparations, the teeth were cleaned and washed thoroughly with water for 30 seconds, then blown dry with oil-free compressed air. No liner was used in any of the cavities. The teeth were divided into two groups:

- Group I : 18 cavities were filled with polyacid-modified composite resin
- Group II : 18 cavities were filled with conventional composite resin

The manufacturer's instructions concerning the manipulation of the two resin materials were strictly followed.

**Testing Procedure:** Each group was subdivided into three subgroups, according to the storage time (1 week, 6 and 12 months). Each subgroup contained six teeth. The teeth were stored in artificial saliva at room temperature before being thermocycled [24]. At the end of each period, the teeth were thermocycled in a water bath between 4 °C and 60 °C for 200 cycles with a dwell time of 60 seconds. The clinical apex of each tooth was sealed with sticky wax and the tooth was coated with nail varnish except a 1mm wide window surrounding the restoration. The teeth were immersed in a 0.5% basic fuchsin solution for 24 hours, and rinsed until all the dye was removed from the surface. Each tooth was sectioned buccolingually through the center of the restoration, with a slow-speed diamond disc. The extent of the dye penetration at the cavity margins was detected using a stereomicroscope. The degree of microleakage was evaluated according to the following scoring system [25]:

- 0 = No microleakage.
- 1 = Microleakage along the enamel
- 2 = Microleakage extending beyond the enamel-dentin junction
- 3 = Microleakage along the floor of the cavity
- 4 = Microleakage reaching the pulp

The results were calculated, tabulated and analyzed statistically. Chi-square test was used to statistically analyze for significant differences in shear bond strength, compressive strength, abrasion resistance and microleakage between the two tested materials.

## Results

### Shear Bond Strength

For Dyract, the mean shear bond strength was  $26.43 \pm 6.47$  kg/cm<sup>2</sup> ( $2.59 \pm 0.63$  MPa), and the mean used load was  $7.40 \pm 1.81$  kg. Degufill H showed lower readings ( $16.82 \pm 7.70$  kg/cm<sup>2</sup>) ( $1.65 \pm 0.75$  MPa) and  $4.71 \pm 2.15$  kg for shear bond strength and the used load, respectively. Comparing the mean values of shear bond strength, for both materials, it was found that Dyract had significantly higher shear bond strength than Degufill H in kg/cm<sup>2</sup> ( $P=0.0073$ ), and MPa ( $P=0.0073$ ).

### Compressive Strength

For Dyract, the mean compressive strength was  $1337.83 \pm 94.39$  kg/cm<sup>2</sup> ( $131.20 \pm 9.26$  MPa), and the mean used load was  $162.35 \pm 12.95$  kg. Degufill H showed higher readings for compressive strength ( $1494.19 \pm 1042.20$  kg/cm<sup>2</sup>) ( $146.53 \pm 102.21$  MPa). The mean used load was  $142.43 \pm 37.63$  kg. Comparing the mean values of compressive strength, for both materials, it was found that Dyract and Degufill H did not have significantly different compressive strength in kg/cm<sup>2</sup> ( $P=0.64$ ), and MPa ( $P=0.64$ ).

### Abrasion Resistance

Table 1 shows the mean value and standard deviation (SD) of percentage of wear for the tested materials (Dyract and Degufill H) after 20,000, 40,000 and 60,000 revolutions. The mean value of % of wear for Dyract was found to be  $1.554\% \pm 0.461$  after 20,000 revolutions,  $0.783\% \pm 0.430$  after 40,000 revolutions, and  $0.878\% \pm 0.578$  after 60,000 revolutions. The mean value of % of wear for Degufill H was found to be  $1.362\% \pm 0.386$  after 20,000 revolutions,  $0.728\% \pm 0.088$  after 40,000 revolutions, and  $0.377\% \pm 0.143$  after 60,000 revolutions. When both materials were compared, Dyract had significantly higher % of wear than Degufill H ( $P=0.0162$ ). After 20,000 revolutions, they had significantly higher % of wear than after 40,000 revolutions ( $P=0.0001$ ) and 60,000 revolutions ( $P=0.0001$ ), but % of wear after 40,000 revolutions and after 60,000 revolutions were not significantly different ( $P=0.71$ ).

	Revolutions	n	Mean	±SD	SE	Minimum	Maximum
Dyract	20000	10	1.554	0.461	0.146	1.052	2.564
	40000	10	0.783	0.430	0.136	0.433	1.754
	60000	10	0.878	0.578	0.183	0.447	2.449
Degufill H	20000	10	1.362	0.386	0.122	0.435	1.694
	40000	10	0.728	0.278	0.088	0.435	1.271
	60000	10	0.377	0.143	0.045	0.219	0.647

**Table 1:** Mean and standard deviation of percentage of wear for the tested materials (Dyract and Degufill H) after 20,000; 40,000 and 60,000 revolutions

Table 2 shows the mean value and standard deviation (SD) of weight loss of the tested materials (Dyract and Degufill H) after 20,000, 40,000 and 60,000 revolutions. The mean value of weight loss for Dyract was found to be  $0.461 \pm 0.013$  gms after 20,000 revolutions,  $0.457 \pm 0.014$  gms after 40,000 revolutions,  $0.453 \pm 0.014$  gms after 60,000 revolutions. The mean value of weight loss for Degufill H was found to be  $0.450 \pm 0.017$  gms after 20,000 revolutions,  $0.447 \pm 0.016$  gms after 40,000 revolutions,  $0.445 \pm 0.016$  gms after 60,000 revolutions. When both materials were compared, Dyract and Degufill H did not have significantly different weight loss in gms ( $P=0.19$ ). After 20,000 revolutions, they had significantly higher weight loss in gms than after 40,000 revolutions ( $P=0.0001$ ) and 60,000 revolutions ( $P=0.0001$ ), and after 40,000 revolutions they had significantly higher weight loss in gms than after 60,000 revolutions ( $P=0.0001$ ).

	Revolutions	n	Mean	±SD	SE	Minimum	Maximum
Dyract	20000	10	0.461	0.013	0.004	0.447	0.494
	40000	10	0.457	0.014	0.004	0.443	0.491
	60000	10	0.453	0.014	0.005	0.438	0.488
Degufill H	20000	10	0.450	0.017	0.005	0.423	0.472
	40000	10	0.447	0.016	0.005	0.421	0.466
	60000	10	0.445	0.016	0.005	0.420	0.464

**Table 2:** Mean and standard deviation of weight loss (in grams) for the tested materials (Dyract and Degufill H) after 20,000; 40,000 and 60,000 revolutions

### Microleakage Evaluation

Table 3 show the microleakage scores at the gingival margin for 6 teeth with Dyract and 6 teeth with Degufill H at different evaluation periods. After one week, the number and percentage of Dyract restorations were as follows. Five teeth (83%) were with microleakage score 0, one tooth (17%) with score 1 and no teeth (0%) were found with scores 2,3 or 4. Results of Degufill H restorations showed no teeth (0%) were with score 0 or 1, two teeth (33%) with score 2, three teeth (50%) with score 3 and one

tooth (17%) with score 4. At 6 months, the number and percentage of Dyract restorations were as follows. Five teeth (83%) were with microleakage score 0, no teeth (0%) with scores 1,2 or 4 and one tooth (17%) showed score 3. Results of Degufill H showed one tooth (17%) was with microleakage score 0, two teeth (33%) with score 1 and one tooth (17%) with scores 2,3 and 4. At 12 months, the number and percentage of Dyract restorations were as follows. Three teeth (50%) were with microleakage score 0, one tooth (17%) with scores 1,2 and 4. No teeth (0%) were found with score 3. Results of Degufill H restorations showed one tooth (17%) was with microleakage score 0, two teeth (33%) with scores 1 and 3, no teeth (0%) with score 2 and one tooth (17%) showed score 4.

	Dyract										Degufill H									
	0		1		2		3		4		0		1		2		3		4	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>1 Week Scores</b>	5	83	1	17	-	-	-	-	-	-	-	-	-	-	2	33	3	50	1	17
<b>6 Month Scores</b>	5	83	-	-	-	-	1	17	-	-	1	17	2	33	1	17	1	17	1	17
<b>12 Month Scores</b>	3	50	1	17	1	17	-	-	1	17	1	17	2	23	-	-	2	33	1	17

**Table 3:** Microleakage score at the gingival margin for 6 teeth with Dyract and 6 teeth with Degufill H at different evaluation periods

Table 4 show the microleakage scores at the occlusal margin for 6 teeth with Dyract and 6 teeth with Degufill H at different evaluation periods. After one week, the number and percentage of Dyract restorations were as follows. Six teeth (100%) were with microleakage score 0 and no teeth were found with microleakage scores 1,2,3 or 4. Results of Degufill H showed five teeth (83%) were with microleakage score 0, no teeth (0%) with scores 1,2 or 4 and one tooth (17%) with score 3. At 6 months, the number and percentage of Dyract restorations were as follows. Six teeth (100%) were with microleakage score 0 and no teeth (0%) were found with scores 1,2,3 or 4. Results of Degufill H restorations showed four teeth (67%) were with microleakage score 0, one tooth (17%) with scores 1 and 2 and no teeth (0%) were found with scores 3 or 4. At 12 months, the number and percentage of Dyract restorations were as follows. Four teeth (67%) were with microleakage score 0, two teeth (33%) with score 1 and no teeth (0%) were found with scores 2,3 or 4. Results of Degufill H restorations showed four teeth (67%) were with microleakage score 0, two teeth (33%) with score 1 and no teeth (0%) were found with scores 2,3 or 4.

	Dyract										Degufill H									
	0		1		2		3		4		0		1		2		3		4	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>1 Week Scores</b>	6	100	-	-	-	-	-	-	-	-	5	83	-	-	-	-	1	17	-	-
<b>6 Month Scores</b>	6	100	-	-	-	-	-	-	-	-	4	67	1	17	1	17	-	-	-	-
<b>12 Month Scores</b>	4	67	2	33	-	-	-	-	-	-	4	67	2	33	-	-	-	-	-	-

**Table 4:** Microleakage score at the occlusal margin for 6 teeth with Dyract and 6 teeth with Degufill H at different evaluation periods

After one week, the mean leakage score gingivally for Dyract was (0.17±0.41). Degufill H showed higher readings (2.83±0.75). At 6 months, the mean leakage score gingivally for Dyract was (0.50±1.22). Degufill H showed higher readings (1.83±1.47). At 12 months, the mean leakage score at the gingival margin for Dyract was (1.17±1.60). Degufill H showed higher readings (2.00±1.55). Comparing the mean values of gingival microleakage, for both materials, it was found that Dyract has significantly lower gingival microleakage than Degufill H after one week (P=0.002). No other significant differences were found between the 2 materials at 6 months (P=0.08) and at 12 months (P=0.36).

After one week, the mean leakage score occlusally for Dyract was (0.00±0.00). Degufill H showed a higher reading (0.50±1.22). At 6 months, the mean leakage score at the occlusal margin for Dyract was (0.00±0.00). Degufill H showed a higher reading (0.50±0.84). At 12 months, the mean leakage score occlusally for Dyract was (0.33±0.52). Degufill H showed the same reading (0.33±0.52). Comparing the mean values of occlusal microleakage, for both materials, it was found that they did not have significant differences after one week (P=0.32), 6 months (P=0.16) and 12 months (P=1.00).

## Discussion

The null hypothesis was rejected, since there was significant difference in the laboratory behavior of polyacid-modified composite resin and conventional composite resin as regards to shear bond strength and abrasion resistance.

As stated by Kilpatrick the demands for a restoration in the primary dentition are somewhat different from those for the permanent dentition [26]. This is due to the limited life span of the teeth themselves, the variations in levels of co-operation achieved by children and the different morphology of the teeth. The ideal restorative material for primary teeth should be easy to apply and have adhesive properties, which will limit the need for extensive preparation.

According to Moodley and Grobler the compomer material used in this study fulfils these criteria [12]. Adhesion is achieved by application of a special primer, which only has to be air dried and cured. All other conditioners like phosphoric or poly-acrylic acid require rinsing and drying which makes it necessary to replace cotton rolls. As for the primer, the cotton rolls can stay in place, resulting in a lower risk for contamination and a more comfortable procedure for the child. As the compomer is delivered in a compule, the material can be injected directly into the cavity preparation. Immediately after light curing is completed, the restoration can be finished.

### Shear Bond Strength

Shear bond strength is believed to be a good indicator of the ability of the material to adhere to both enamel and dentin. The difference in shear bond strength obtained in this study for Dyract ( $2.59 \pm 0.63$  MPa) and Degufill H ( $1.65 \pm 0.75$  MPa) were statistically significant. These results are quite different than the results obtained by Salama, *et al.*, who recorded  $26.1 \pm 3.2$  MPa for shear bond strength of conventional composite resin and  $9.25 \pm 1.26$  MPa for polyacid-modified composite resin [27]. Shear bond strengths of adhesive materials to dentin have been reported to be influenced by various factors. A study by Irie and Suzuki concluded significantly higher values for shear bond strength when dentin conditioner was used [28]. Dentin thickness and distance from the pulp were also reported to affect bond strength by Mitchem and Gronas [29]. Therefore, the thickness of dentin must be reported when conducting adhesion tests. Storage solution type and duration of storage have also been reported to affect shear bond strength by Goodis, *et al.* Also, an increase in shear bond strengths have been observed *in-vivo* by Mason and Ferrari [30,31]. The hypothesis could be put forward that the bond of resin materials gain strength from tubular fluid of vital dentin. Therefore, changes in dentin properties immediately after extraction, need to be determined and related to those changes in dentin structure due to storage, in order to develop *in-vitro* methods, which closely simulate *in-vivo* conditions.

### Compressive Strength

Compressive strength is considered to be an important property of restorative materials, particularly, in the process of mastication. In this study, Degufill H showed higher readings for compressive strength ( $146.53 \pm 102.21$  MPa) than Dyract ( $131.20 \pm 9.26$  MPa). Comparing the mean values of compressive strength for both materials showed no significantly different compressive strengths. These findings agree with Attin, *et al.* who found that the strength properties of resin-modified glass-ionomers (Fuji II LC, Ionosit-Fil, Vitremer, Photac-Fil) and polyacid-modified composite resins (Dyract and Variglass VLC) were inferior to those of the hybrid composite resin (Blend-a-lux) [32]. However, Meyer, *et al.* have reported that absolute values for compressive strength among different studies may not be comparable due to differences in test conditions [33]. Clinical durability and longevity of these resin materials will be the final judge.

### Abrasion Resistance

Wear of restorative materials occurring *in vivo* is a complex process. The toothbrushing machine is designed to simulate as closely as possible normal tooth brushing, which is one type of wear that occurs. The percentage of wear, corresponding to two-years of *in-vivo* brushing was found to be  $0.878 \pm 0.578\%$  for Dyract and  $0.377 \pm 0.143\%$  for Degufill H, the difference was statistically significant. The wear resistance values of the two tested materials (Dyract and Degufill H) were higher than those obtained by Peutzfeldt, *et al.* in a resin-modified glass-ionomer (Vitremer) study [34]. This also agrees with the results obtained by Yap, *et al.*, in which composite resin (TPH) and compomer (DR) showed better resistance to abrasion than resin-modified glass-ionomer (VM) [35]. It was evident that the percentage of wear decreased with time but the rate of wear slowed dramatically after the first 20,000 revolutions. The percentages of wear for Dyract restorations were 1.554%, 0.783%, 0.878% after 20,000, 40,000, and 60,000 revolutions and 1.362%, 0.728%, 0.377% for Degufill H restorations after 20,000, 40,000, and 60,000 revolutions, respectively. This findings agrees with those of Harrington, *et al.*, who suggested that the relatively high value of wear could be attributed to loss of resin from the resin-rich matrix surface, and once this resin has been removed, the filler particles protect the bulk of the material and the rate of loss decreases [36]. Ideally, a restoration should have abrasion resistance similar to that of enamel. In a study done by Heath and Wilson, enamel wore at a rate of  $0.38 - 0.5 \times 10^{-3}$  mm<sup>2</sup> per test [20]. Gold was the most abrasion resistant, amalgam wore at a rate 50% higher than enamel, while composites and glass-ionomers wore at a rate 2-3 times greater than enamel.

### Microleakage

Comparing the mean values of gingival microleakage, for both materials, it was found that Dyract ( $0.17 \pm 0.41$ ) had significantly lower gingival microleakage than Degufill H ( $2.83 \pm 0.75$ ) after one week. No other significant differences were found between the two materials at 6 months and at 12 months. Comparing the mean values of occlusal microleakage, for both materials, it was found that they did not have significant differences after one week, 6 months and 12 months. In general neither resin restorative material in Class V cavities of the primary teeth in the present study completely resisted microleakage at the occlusal or gingival

margins. This is in accordance with the results of Hakimeh, *et al.* [37]. Microleakage was noticed in the present study one week after placement of the material. However, Hembree and Andrews used five acid-etch composite resin systems and reported that there was no marginal leakage at the experimental periods after one day, three months or six months [38]. At the end of the year, they found that half of the restorations revealed some evidence of leakage at the tooth/ restoration interface. They also noticed microleakage at the gingival and occlusal margins. In the present study, Degufill H restorations exhibited greater gingival microleakage than Dyract restorations, after one week, although no statistically significant difference was found between the two materials. This difference in the results obtained may be related to the amount of resin content and filler particles of the materials [39]. In addition, the difference could be contributed to the placement procedures, material manipulation or surface treatment. The leakage observed with the Dyract restorative material used in this study supports what was found by Yap, *et al.*, who showed that the margins of the polyacid-modified composite resin (Dyract) could be penetrated by the basic fuchsin dye *in-vitro* [40]. Contrary to this, Morabito and Defabianis claimed that Dyract provides an effective cavosurface marginal seal to eliminate salivary leakage, deep into the confines of the preparations [41]. This inconsistency in the results may be due to variations in manipulation of the material or possibly by other differences in the technique of application.

Although Dyract showed better sealing ability than Degufill H, the comparison was statistically not significant. Perhaps the seal was improved by the use of primer with Dyract prior to its placement. Presumably, the primer application leads to a more intimate resin tooth structure interface. Apparently the primer improves adhesion to the inorganic part of the dentin and facilitates penetration of resin into the dentinal tubules [42]. Hakimeh, *et al.* found microleakage in the occlusal and gingival walls with Dyract when used as a restorative material for Class V cavity preparation [37]. These findings support the results of the present study where microleakage was found in both the occlusal and gingival walls in Class V cavities. The two resin materials used in the present study were applied in the prepared Class V cavities without beveling the gingival margins. This was according to the recommendations of Owens, *et al.*, who showed that Class V restorations with gingival bevels displayed greater microleakage than non-beveled margins [43].

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