Original Article

Comparison Between Nanocomposites and Conventional Pit and Fissure Sealants- an in Vitro Study

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ABSTRACT

Introduction: Dental caries is one of the most common infectious oral diseases. It affects populations of all ages across the globe. By using sealants, pit and fissure caries can be prevented. **Aim:** This study aimed to compare the microleakage and interfacial morphology of flowable nanocomposites and conventional pit and fissure sealants. **Materials and Methods:** We included 60 extracted intact and caries-free permanent mandibular third molars. According to the material used for pit and fissure sealants, the teeth were randomly divided into 3 groups. Each group comprised of 20 teeth. Group I: Unfilled resin-based pits and fissure sealants, Group II: Unfilled resin-based pit and fissure sealants with bond, and Group III: Nano flowable composite resin with bond. **Results:** The results showed that nano flowable composite was significantly better than the conventional sealant groups ($p = 0.000$). With sealants in group I and II, there were gaps between the sealants and the tooth surfaces, while with the nano flowable composite in group III, there was close contact. **Conclusion:** Nano flowable composites performed significantly better and offered promising results than conventional sealants with better microleakage and interfacial morphology than conventional pits and fissure sealants.

Key words: *Nanocomposites, pit and fissure sealants, microleakage, interfacial morphology.*

Dental caries is one of the most common infectious intraoral diseases affecting mankind. Children are considered to be at the highest risk group, although primary prevention can reduce this risk [1]. About 66% of patients have been observed to have occlusal carious lesions [2]. Pit and fissure sealants are recommended to prevent occlusal dental caries in permanent teeth by physical blockage of tooth pits and fissures, which prevent accumulation of bacteria and fermentable carbohydrates into the pits and fissures [3].

Different materials can be used as sealants, and they are divided into two groups; glass ionomer sealants, which come in conventional and resin-modified forms, and resin-based sealants, which are classified according to their polymerization mechanisms. Accordingly, they can be divided into three groups: auto-polymerizing, light-curable, and fluoride-releasing types. They can also be classified as opaque or transparent, and filled or unfilled [4].

Dental sealants are recommended once the permanent teeth fully erupt. They should be applied by six years of age, followed by another application at twelve years of age. Sealants were shown to reduce caries formation compared with controls without sealants, particularly if resin-based sealants were used rather than glass ionomer sealants [5]. A variety of pit and fissure sealants are available with new advancements and different characteristics. One of the latest innovations in the field of

composite resins is the use of nanotechnology by adding nanoparticles to composite resins to allow better mechanical properties and flowability than previous sealants [6]. Newer nanofilled composites have filler contents of more than 70%, yet despite these high filler contents, they exhibit excellent flow properties [7]. The aim of this in vitro study was to compare microleakage and interfacial morphology of flowable nanocomposites and conventional pit and fissure sealants.

MATERIALS AND METHODS:

Sample selection:

A total of 60 intact and caries-free permanent mandibular third molars extracted for impaction or orthodontic reasons were included in this study. The selected teeth had no change in enamel translucency after prolonged air drying (5 seconds) that scores 0 according to International Caries Detection and Assessment System (ICDAS-II). We also used DIAGNOdent (DIAGNOdent KaVo CO, Biberach/Riss, GmbH, D-88400 Germany) that showed a reading less than 10 indicating sound enamel [8]. Using hand scalers, periodontal tissues and extrinsic deposits were removed from the teeth. With low speed brush and fluoride free pumice, the teeth were cleaned and kept in a saline solution [8].

Grouping:

The teeth were randomly divided into 3 groups (n = 20) according to the material used for pit and fissure sealants as follows:

i. Group I: Unfilled resin-based pit and fissure sealants (Admira Seal- Voco GmbH)
ii. Group II: Unfilled resin-based pit and fissure sealants (Admira Seal- Voco GmbH) with bond (Futurabond- Voco GmbH)
iii. Group III: Nano flowable composite resin (Grandio Seal-Voco GmbH) with bond (Futurabond- Voco GmbH).

Treatment

The occlusal surfaces of each tooth were dried with cotton pellets and etched with 35% phosphoric acid gel (Vococid- Voco GmbH) for 20 seconds. After application, the tooth was rinsed thoroughly for 15-30 seconds, followed by air-drying with an oil-free compressed air. It was then evaluated for enamel chalky white appearance.

A layer of bonding agent was applied to the occlusal surfaces of the teeth used in group II and III, and light-cured for 10 seconds at 650 mW/cm2 with a LED light curing unit (Woodpecker, Beijing, China). All sealants were in the form of syringe. The sealants were applied in accordance to the manufacturer's instructions. To prevent void formation, the sealant material was applied from one side of the occlusal surface, and gently guided by a dental explorer into all occlusal grooves. Each specimen was light-cured for 20 seconds.

Evaluation:

i. Microleakage

The teeth were thermo-cycled in water (500 cycles). In each cycle, the teeth were immersed in a water bath for 30 sec. The teeth were prepared for dye penetration test in order to prevent dye penetration into dentinal tubules or lateral canals and to ensure that any leakage if occurred would be through the sealant-tooth interface. Root apices were sealed by wax and the teeth were coated with two layers of colored nail varnish leaving 1.5 mm window around the sealant margins. After 24 hours of immersion in Methylene blue dye, the roots of the teeth were removed and the teeth were sectioned longitudinally in a bucco-lingal direction using water-cooled diamond disc. The varnish was removed by acetone. Using a stereomicroscope, the dye penetration was examined at a magnification of 50x (Dinolite, New Taipei City, Taiwan) and ranked as follows [9]

0: No dye penetration
1: Dye penetration up to 1/3 of the depth of the fissure.
2: Dye penetration more than 1/3 and less than 2/3 of the depth of the fissure.
3: Dye penetration more than 2/3 of the depth of the fissure

ii. Interfacial micromorphology

Sections of the other half of the tooth were examined under scanning electron microscope (SEM) (FEL,Philips Elctron Optics and Micrion, USA).

STATISTICAL ANALYSIS

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) software for Windows version 21. Data of microleakage scores were collected and expressed as mean ± SD. An ANOVA test followed by a post-hoc analysis was conducted, and the significance level was set at 5%.

RESULTS

Microleakage results:

Table (1) showed that nano flowable composite (0.3±0.57) was significantly better than the two other conventional sealant groups (0.8±0.89, 0.6±0.86 respectively) (p = 0.000).

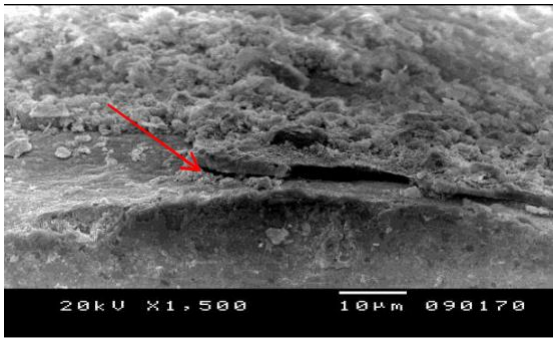
Table 1: Comparison between the three groups according to microleakage scores

Group	Mean ±SD	P value
Group I[1] (Sealant)	0.8±0.89	0.0000*
Group II[2] (Sealant + bond)	0.6±0.86	
Group III[12] (Nano flowable composite +bond)	0.3±0.57	

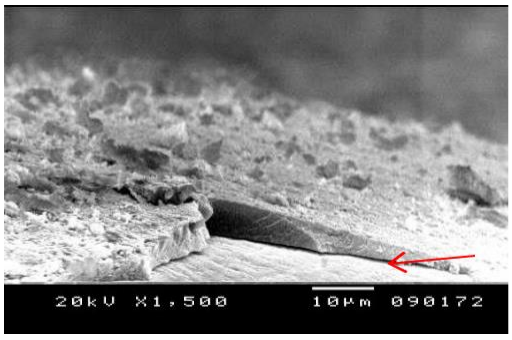
*Significance difference (p <0.05), [1] indicate significance difference between G I & III, (p <0.05), [2] indicate significance difference between G I & III (p <0.05).

Interfacial micromorphology results:

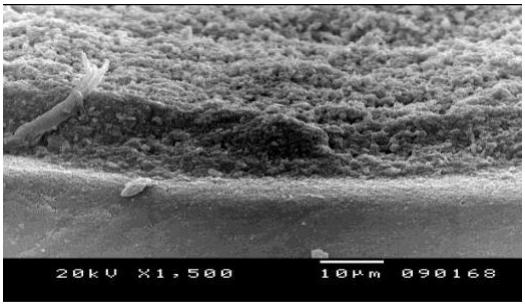
Based on SEM examinations, sealants were not in close contact with the teeth in groups I and II, but were in close contact with the teeth in group III. (fig.A, B, & C).



A: Contact between sealant and enamel - there was a gap between sealant and enamel



B: Contact between sealant with bond and enamel - there was a gap between sealant and enamel



C: Contact between nanocomposite and enamel- no gap was found between nano composite and enamel

DISCUSSION

Conventional composites were not considered to be good pit and fissure sealants in the past due to their high viscosity. In recent years, flowable composites and nanocomposite materials have demonstrated better viscosity. It has been shown that nanocomposites have better penetration into the pits and fissures thus affecting the retention rates significantly and enhancing clinical performance. It is therefore not surprising that clinical studies on flowable composites encourage the use of flowable composite as a pit and fissure sealant material [10].

In the current study, nano flowable composites showed better results than the other 2 sealant groups in terms of microleakage. These results were consisted with the results found in an in-vitro study that compared flowable nanocomposite, flowable composite, filled sealants, nano-filled sealants, and unfilled sealants. The results showed that flowable composite and nanofilled flowable composite had almost no microleakage (P<0.001) [11]. Another study aimed to evaluate the microleakage and penetration depth of three different types of dental materials;

conventional pit and fissure sealant, flowable composite and flowable nanocomposite on extracted human posterior teeth. According to the results, the nano flowable composite was found to be an excellent dental material for penetration in deep pits and fissures, and can be recommended for use in pediatric patients, as a pit and fissure sealing agent [12]. By adding nanoparticles to composites, superior mechanical properties and flowability can be achieved [13].

In this study, interfacial micromorphology using SEM revealed that there were gaps between sealants and the tooth surface in group I and II but for group III there was close contact between the nano flowable composite and tooth surface. Another in vitro study evaluated the interfacial morphology of different fissure-sealant materials: nano flowable composite, resin-based unfilled fissure sealant and resin-based filled fissure sealant. It was found that nano flowable composite when applied with bonding agents showed better results than other tested fissure sealant materials [14]. Another study evaluated shear bond strength and sealing to enamel of the flowable composite in comparison to conventional sealant. The results showed that flowable composite had significantly higher shear bond strength and lower microleakage score than conventional sealant material [15].

CONCLUSION

Nano flowable composites performed significantly better and offered promising results than conventional sealants with better microleakage and interfacial morphology than conventional pits and fissure sealants.

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