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RESEARCH ARTICLE
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Nano spatial elemental characterization of deep pits in molar teeth

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ABSTRACT

Background: The caries of the pits and fissure follow the direction of the enamel rod, characteristically forming a triangular or conical lesion, the apex of which is on the outer surface and its base towards the DEJ. The caries of the pits and fissure follow the direction of the enamel rod, characteristically forming a triangular or conical lesion, the apex of which is on the outer surface and its base towards the DEJ. Pits and fissures cause more cavitation than cavitation on smooth surfaces.

Aim: Nano spatial assessment of deep pits in molars and premolars.

Objective: Characterization of pit and fissure for better treatment planning of treatment of pit and fissure sealants.

Materials and Methods: Field Emission Scanning electron microscope (FE-SEM – Jeol JSM – IT800, Tokyo, Japan) was used to visualize the tooth sections on the glass cover slip at a magnification of 5 µm. Sections will be dehydrated with 70% ethyl alcohol for 10 sec and nitrogen gas was applied for drying. After critical point drying, the sections were sputter-coated with platinum to induce conductivity. Finally, images were captured and projected. Further energy dispersive x-ray spectroscopy was used for elemental analyses and chemical characterization.

Conclusion: Base of the pit revealed more mineralization than the upper and middle third. Interestingly the zones adjacent to the pits were more mineralized

Keywords: *molar, Pathology, chemical, microscope*

INTRODUCTION

Due to their morphological complexity, pits and fissures on the occlusal surface of the posterior teeth tend to develop caries rather than a smooth surface, which makes dental hygiene more difficult and leads to increased plaque accumulation.(Carvalho, 2014) Enamels in pits and fissures cannot be as protected from fluoride as enamel on smooth surfaces. (Bekes, 2018)

Pit sealants and fissure sealants provide a physical barrier that prevents the buildup of microorganisms and food particles, prevents caries, and slows down the progression of caries.

(Peres, Antunes and Watt, 2020). Permanent first molars, followed by second molars, have the highest prevalence of caries. Treatment of occlusal caries on permanent molars is very difficult because it begins shortly after the caries erupts in the oral cavity(Miller, 1890). The effectiveness of pit and fissure sealants depends on their long-term retention.(Bekes, 2018)

Pit and Fissure Sealant is a material that is placed in the occlusal pits and fissure of perishable teeth, creating a micromechanical binding protective layer that blocks spoilage-causing bacteria from accessing nutrient sources.(Priscilla, Prathima and Suganya, no date)

Aim

Nano spatial assessment of deep pits in molars and premolars

Objective

characterisation of pit and fissure for better treatment planning for treatment of pit and fissure sealants

MATERIALS AND METHODS

The field emission scanning electron microscope (FESEM) provides topographic and elemental information at a magnification of 10x to 300,000x with virtually unlimited depth of focus. Compared to traditional scanning electron microscopes (SEMs), field emission SEMs (FESEMs)(Brodusch, Demers and Gauvin, 2017)produce clearer, less electrostatically distorted images with spatial resolution of up to 1 1/2 nano meters. This is 3 to 6 times better. With an electron-accelerated voltage compatible with Energy Dispersive Spectroscopy (EDS), you can study contamination points in smaller areas. Reduced penetration of low kinetic energy electrons near the surface in the immediate vicinity. Field Emission Scanning electron microscope (FE-SEM - Jeol JSM-IT800, Tokyo, Japan) was used to visualize the tooth sections on the glass cover slip at a magnification of 5 µm. Sections will be dehydrated with 70% ethyl alcohol for 10 sec and nitrogen gas was applied for drying. After critical point drying, the sections were sputter-coated with platinum for 30 sec (30 mA) to induce conductivity for FESEM analysis. Finally, images were captured at the acceleration voltage of 3.00kV and projected. Further energy dispersive x-ray spectroscopy was used for elemental analyses and chemical characterization.

RESULT

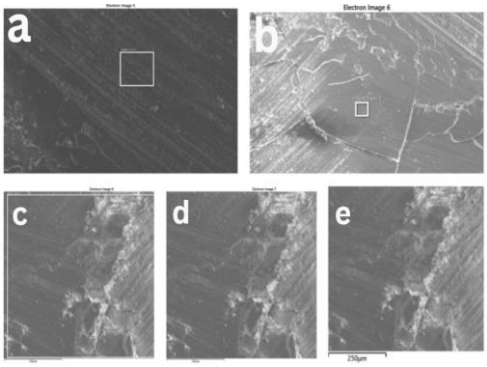

FIG 1: FESEM images (a-e)

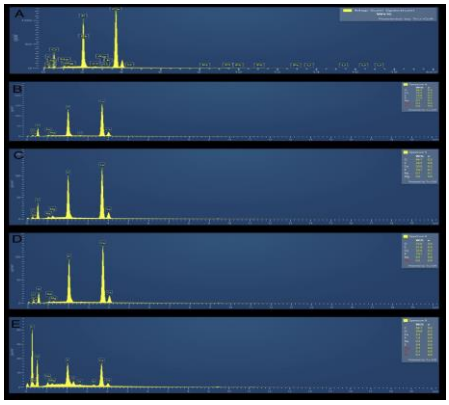

FIG 2: Electron dispersal spectroscopy images with peaks of ions predominantly present.(a-e)

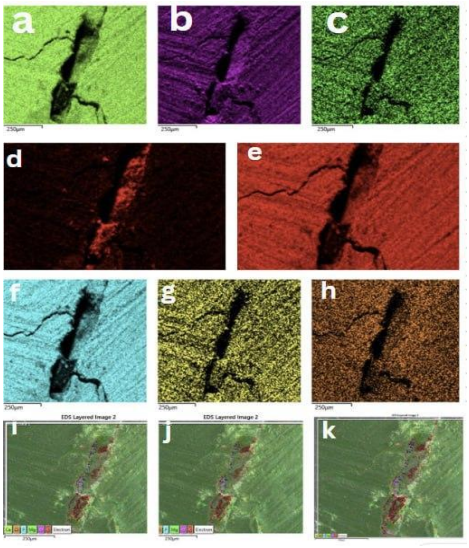

FIG 3: Elemental mapping of EDS and individual composition distributed in the deep dentinal caries.(a-k)

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DISCUSSION

Nano spatial characterization of pits and fissures have revealed the existence of variation in mineral content in various zones of the pits restricted to the enamel layer. Base of the pit revealed more mineralization than the upper and middle third. Interestingly the zones adjacent to the pits were more mineralized. The length of the pit identified was 2.135µm which was much deeper than expected. If this pit was examined by a probe the measurement would have been much lesser than it is actually. Since a scanning electron microscope was used it was able to find the actual depth of the pit (i.e) 2.135µm.(Priscilla, Prathima and Suganya)

The pits and fissures on the occlusal surface of the posterior teeth are areas that are prone to tooth decay. Spolsky VW postulated that approximately 50% of all caries lesions in the age group 6-14 years occur on the occlusal surface. Kelly J.E. and Harvey CR. Confirmed that the prevalence of dental caries has decreased dramatically in recent years. Nonetheless, studies show that occlusal caries account for about 50 percent of caries attacks, despite many advances in preventive dentistry.(Priscilla, Prathima and Suganya)

The inspection of the tooth pieces revealed that practically every tooth fissure had areas with deep invagination. These regions frequently extended almost to the junction of the dentin and enamel. However, the dentin surface didn't seem to be revealed in any of these instances. With the exception of one case, it was clear from examination of the reconstructed fissure section planes, along with their probe and ideal enamel thickness recordings, that any attempt to measure the enamel thickness present at the base of a pit or fissure by the use of a probe may mislead the clinician.Even when comparing teeth from the same place in the mouth, the location of the invaginated portions did not seem to follow any clear pattern in any of the molars, though they did occur to roughly the same extent in the upper molars, lower molars, and upper bicuspids. The mesial, middle, and distal pit regions frequently saw the deepest invasions.

Over half of the fissure area for the average molar in this investigation, true enamel thickness of less than 1.0 mm was present, whereas probe enamel thickness was more than 1.3 mm. The actual enamel thickness was less than 0.7 mm and less than half the probe enamel thickness for one-third of the fissure length. The desired enamel thickness typically exceeded the probe enamel thickness by about 0.3 mm.

Our team has extensive knowledge and research experience that has translated into high quality publications(Uthrakumar et al., 2010; Ramesh Kumar et al., 2011; Felicita, 2017; Vishnu Prasad et al., 2018; Chellapa et al., 2020; Mohanavel et al., 2020; Arumugam, George and Jayaseelan, 2021; Markov et al., 2021; Muthukrishnan, 2021; Ganapathy et al., 2022)

CONCLUSION

The present study revealed that the depth of the pit will be deeper than expected and variation of mineral content in various zones of pits in enamel. Pit and fissure sealants should be a better treatment plan for such types of carries. Nanocomposite was found to be a better dental material for penetration in deep pits and fissures. Therefore, it can be recommended for use in pediatric dental patients as a pit and fissure sealant, which is a core strategy for preventing tooth decay.

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