ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 12, pp.43630-43632, December, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

VALIDITY OF CARIES DISCLOSING DYES IN IDENTIFYING CARIES IN PRIMARY TEETH: AN INVITRO COMPARATIVE STUDY

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ARTICLE INFO

Article History:
Received 23rd September, 2016
Received in revised form
15th October, 2016
Accepted 20th November, 2016
Published online 30th December, 2016

Key words:

Caries,
Infected dentin,
Caries detecting dye,
Restorative dentistry.

ABSTRACT

Introduction: Conservation of dental hard tissues has become the milestone for any recent caries excavation technique. Furthermore, leaving the caries-infected dentine in some critical regions of the cavity is now regarded as acceptable by many, nowadays, provided that creation of a proper marginal seal can be achieved and maintained. Thus we need highly specific and sensitive tools for identification of carious lesion

Aim: to investigate the accuracy of caries detecting dyes in identification of carious lesion in primary teeth.

Materials and Methods: Twenty extracted human primary posterior teeth without pulpal exposure were sectioned mesiodistally through the center of the lesions using a water-cooled disk. The dye was applied using a small brush and removed after 10 seconds by a 5-second water spray. The specimens were then examined under a Light microscope to find bacterial penetration into dentinal tubules. Sensitivity and specificity of dye was calculated.

Results: The specificity and sensitivity of the caries detecting dye was found to be 100% and 74% respectively.

Conclusion: Caries detecting dyes can be used as a screening test for identification of caries. However its applicability as the sole diagnostic tool is still doubtful.

Citation: Rishav Singh, Mukesh Kumar and Sankalp Verma, 2016. "Validity of caries disclosing dyes in identifying caries in primary teeth: An invitro comparative study", *International Journal of Current Research,* 8, (12), 43630-43632.

INTRODUCTION

Caries is from the Latin word that means *"rottenness"*. Dental caries is defined as, *"an infectious microbiological disease of the teeth that results in localized dissolution and destruction of the calcified tissue"* (Heymann *et al*., 2013). In the early nineteenth century, many theories were developed to explain the aetiology of dental caries; the psychic condition theory (Ancient Greeks), dental gangrene theory (Bell, 1825), fungi theory (Leber and Rottenstein, 1867), and chemical theory (Magitot, 1878). However, most of them were rejected (Black, 1936). In 1932, Williams (Black, 1936) isolated the bacterial films which covered the carious enamel and he referred to it as "bacterial plaque". However, the presence of dental plaque alone does not cause dental caries. This has led to a new modification of the dental plaque theory, which is now known as the "Specific dental plaque hypothesis" (Loesche, 1979). This theory considers dental plaque as an etiological factor for dental caries when pathogenic bacteria are also present. The term "cariogenic bacteria" refers to certain pathogenic microorganisms, which have the ability to ferment the carbohydrates and produce acids as a by-product (Heymann *et al*., 2013). Those acids can dissolve dental hard tissues; while the accumulated plaque layers act as an insulator protecting the pathogenic organisms from the buffering, antibacterial and washing actions of saliva (Heymann *et al*., 2013). Much evidence supports the specific dental plaque hypothesis; for example the absence of dental caries in un-erupted and germ-free animal's teeth (Heymann *et al*., 2013). Furthermore, many studies reported the presence of cariogenic bacteria within oral biofilms, which covered active carious lesions.

Caries detecting dyes

The clinical differentiation between "caries-affected" and "cariesinfected" dentine is one of the most difficult challenges

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encountered clinically (Fusayama, 1993; Ogawa *et al*., 1983). Conventional means of detection are based on visual and the tactile sensation; (Heymann *et al*., 2013) however, these methods are subjective and variable amongst practitioners. In 1983, an attempt was made to differentiate between the two layers of dentine caries using a chemical dye named as "caries-disclosing dye" or "caries detector". This was theoretically based on the histological features of dentine caries observed by Fusayama (Fusayama, 1993; Kuboki *et al*., 1983). Caries-disclosing dyes were introduced to overcome the drawbacks of visual and tactile methods. Kuboki *et al*. (1983) reported that caries-disclosing dyes could only stain the denaturated collagen fibres; however, the dyes could not stain either sound dentine powder or demineralized intact collagen. The first caries-disclosing dye consisted of 0.5% basic fuchsin in a propylene glycol base (Fusayama and Terachima, 1972; de Almeida Neves *et al*., 2011). Radiographic examination and laboratory study outcomes showed that this formula was not efficient in differentiating both dentine-caries layers.

Due to the carcinogenicity of fuchsin (magenta), a new generation of caries detectors was introduced (Poole-Wilson, 1960; National Cancer Institute, 1954-1960). The replacement of fuchsin by 1% acid-red in a propylene glycol base was the most characteristic feature of these newer caries detector dyes (Yip *et al*., 1994). However, some authors showed disagreement with the efficiency of this type of caries-disclosing dye, and reported that it can give false positive results (de Almeida Neves *et al*., 2011; Boston and Liao, 2004; Kidd *et al*., 1989). This consequently led to over cutting of healthy dental tissues. This study is a preliminary effort to investigate the applications and limits of caries disclosing dyes in detecting caries in primary teeth.

MATERIALS AND METHODS

This was an experimental study performed on 20 primary decayed teeth, which were extracted within the previous ten days. For this study, carious lesions with roughly similar dimensions (assessed by inspection) were selected and none of them had hypoplasia, abnormal discoloration, or pulpal exposure. Following extraction, the teeth were immediately immersed in sterile distilled water and kept in the dark at 4°C according to previous studies. (Yip *et al*., 1994)

Application of dye

The dye was applied to the proximal or occlusal cavities using a small brush and removed after 10 seconds by a 5-second water spray.

Microscopic examination

The cavities were then examined under a Light microscope (×2 magnification, Olympus BX 50, Japan) for any dentin site stained by the dye. Both the sensitivity and specificity were recorded

Statistical analysis

The results were tabulated using Microsoft office and subjected to descriptive statistics. The final values were depicted in graphs for ease in understanding.

RESULTS

All areas stained by dye on the tooth samples contained tubules with bacterial penetration, thus the specificity of the dye was 100%. 68% of the areas on the specimens were devoid of bacteria, while 32% demonstrated infected tubules. Based on these findings, sensitivity of this dye were calculated as 74%.The results are illustrated in Table 1.

Table 1. Specificity and sensitivity of the caries disclosing dye

Specificity (100%)	Sensitivity (74%)	
Lesions detected 20	False positive (68%) 14	False negative (32%) 06

DISCUSSION

The main aim of a dentist is to remove the irreversibly demineralised superficial tissue and to remove the highly infected biomass of carious dentin during the carious process. Currently, physical criterion, used most commonly by dental practitioners to guide clinical excavation of this infected, demineralised that dentin is hardness/texture of the tissue, although some dentists may take into account its color and may use caries detector dyes. (van de Rijke, 1991; Kidd *et al*., 1996) Caries detecting dyes have been used to differentiate clinically "infected" from "affected" dentine during caries removal (Pitts, 1993). The use of these dyes, however, does not provide a completely objective method for assessment of caries removal. Pitts (Pitts, 1993) reported that the more superficial zone of infected dentine was an irreversibly damaged, bacterially infected layer that would never remineralize. The deepest affected dentine was shown to harden as a result of remineralization. Fusayama's group suggested the dye staining front coincided with the bacterial invasion of the dentine. However, several studies have reported that the dye does not discretely discriminate the bacterially infected from softened affected tissues (van de Rijke, 1991; Boston and Graver, 1989). Also, Banerjee *et al*. reported that the use of dyes is not routinely advocated in lesions extending into the middle third of dentin or deeper due to the increased risk of unnecessary and often avoidable pulpal involvement during cavity preparation (Banerjee *et al*., 2003).

Consequently, its injudicious use may lead to overpreparation of the tissues, encouraging excess removal at the enamel-dentine junction as well as unnecessary removal of dentine over the pulpal surface (Yip *et al*., 1994). Hosoya *et al*. (2007) studied the efficiency of CC dyes on both deciduous and permanent teeth. They stated that the lower molecular weight and surface tension of propylene glycol found in CD along with its high diffusional property may lead to deeper penetration of the dye into sound dentin. The present study showed that caries detector dye has specificity of 100%, but sensitivity insufficient for complete removal of carious dentin.

Conclusion

On the basis of the results of the study, the authors propose that Caries disclosing dyes could be used as a guide to diagnose dental caries. It can serve as a screening test for identification of caries. However its applicability as the sole diagnostic tool is still doubtful.

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