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Title-An Overview on Staining Potential of Root Canal Irrigants and Medicaments in Endodontics

Dr. Nitish Mathur, Dr. Kartik S Nath, Dr. Yusuf Md Nasir Khan,
Dr. Anupam Singh, Dr. Tarun Nagpal and Dr. Prashant Kothari

Abstract--- *Success of endodontic treatment depends upon eliminating microorganisms from the root canal. Thus, disinfection in endodontics is a critical step which relies on root canal irrigants and intracanal medicaments. This review aims to discuss the intrinsic and internalized staining potential of routinely used root canal irrigants and intracanal medicaments in endodontic practice. Keeping in mind the antimicrobial effect of irrigants and intracanal medicaments, the dentist should also consider their staining potential and measures to prevent the same. Thus, endodontic treatment should not focus only on biological and functional aspects, but also consider aesthetic consequences as well.*

Keywords--- *Disinfection, Intracanal Medicaments, Root Canal Irigants, Staining Potential.*

I. INTRODUCTION

Tooth colour known to be a critical principle of smile aesthetics[1] has a major impact on person's psychosocial well-being and dental self-confidence.[2] It takes substantial amount of time and money to improve the appearance of a discoloured tooth.[3.]Since discolouration of tooth can be attributed to a variety of reasons, hence they are mainly categorized as extrinsic and intrinsic.[4,5]

Extrinsic discolouration can occur either when staining compounds are absorbed in the pellicle layer or as a result of the interaction between them and tooth surface. Intrinsic discolouration can occur due to the structural changes within the bulk of tooth that could either be systemic or pulpal in origin.[6]

When the extrinsic stains are taken up by the tooth due to developmental defects, dental caries and restorations, it is termed as internalized tooth discoloration.[7]

The primary aim of endodontic treatment is to achieve maximum disinfection and to prevent reinfection of the root canal. Root canal irrigants and intracanal medicaments are the endodontic materials which serve this purpose by eliminating microbial load in the root canal.[8,9] However, past studies indicate that endodontic materials can compromise aesthetics of tooth by inducing coronal discolouration[10,11,12]

Dr. Nitish Mathur, Department of Conservative Dentistry and Endodontics, Peoples Dental Academy, Bhopal, India. E-mail: nitishomr@gmail.com
Dr. Kartik S Nath, Assistant Professor, Department of Conservative Dentistry and Endodontics, Melaka Manipal Medical College, Manipal, affiliated to Manipal Academy of Higher Education, Karnataka, India. E-mail: kartik.nath@manipal.edu
Dr. Yusuf Md Nasir Khan, Consultant Orthodontist, Department of Orthodontics and Dentofacial Orthopaedics, Clove Dental, Bangalore, India. E-mail: yusufmnk@gmail.com
Dr. Anupam Singh, Lecturer, Department of Oral and Maxillofacial Surgery, Manipal College of Dental Sciences, Manipal, affiliated to Manipal Academy of Higher Education, Karnataka, India. E-mail: anupam.singh@manipal.edu
Dr. Tarun Nagpal, Consultant Oral and Maxillofacial Surgeon, Department of Oral and Maxillofacial Surgery, Link Hospital, Gwalior, India. E-mail: drtarunomfs@gmail.com
Dr. Prashant Kothari, Senior Lecturer, Department of Prosthodontics and Crown & Bridge, Chhattisgarh Dental College and Research Institute, Rajnandgaon, Chhattisgarh, India. Email: drprashantjainkothari@gmail.com

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Besides having a proper knowledge of the antimicrobial effects of various root canal irrigants and intracanal medicaments, dentists should also be aware of their staining potential during usage in root canal therapy.

Thus, this review aims to describe the staining potential of routine root canal irrigants and intracanal medicaments used in endodontics

II. ROOT CANAL IRRIGANTS

Sodium Hypochlorite (NaOCl)

Sodium hypochlorite (NaOCl) is the most commonly recommended endodontic irrigant as it possess high tissue dissolving property and wide-spectrum antimicrobial activity.[13,14] Saponification reaction, amino acid neutralization and chloramination reactions are responsible for its pulp dissolution.[15] Moreover, sodium hypochlorite is a bleaching agent too and will not be causing discoloration on its own. However, on its contact with the red blood corpuscles and its high tendency to crystallize on the dentinal walls may produce discoloration which will be difficult to remove it from the canal.[16]

NaOCl and Chlorhexidine (CHX) Solution

An irrigation regimen combining NaOCl with CHX solution is used to enhance the antimicrobial properties.[17] This combination however forms a dark brown precipitate which can compromise the aesthetics by staining dentin.[18] The precipitate acts a residual film and may get adhered on the dentinal walls, floor of the pulp chamber and apart from staining, it may also affect the diffusion of root canal irrigants and medicaments into the dentin. Moreover, it will also interfere with the root canal obturation leading to a failure.[19,20]

Examination of the dark brown precipitate using X-ray photoelectron spectroscopy (XPS) and time-of-flight secondary ion mass spectrometry (TOF-SIMS) reveals that it contains a significant amount of parachloroaniline (PCA) which is carcinogenic in nature.[21]

The precipitate formation can be prevented by including a thorough intermediate flush in the irrigation protocol with the solutions such as saline or sterile distilled water, followed by drying of the canal before the next solution is used.[22]

NaOCl and MTAD

MTAD-Mixture of tetracycline isomer, citric acid and detergent has been shown to overcome the lack of antimicrobial substantivity and inability to remove smear layer of NaOCl in clinical settings.[23] For an optimum smear layer removal along with superior antimicrobial sensitivity, an irrigation protocol with 1.3% NaOCl for 20 minutes, followed by the irrigation of MTAD for 5 minutes has been proposed.[24] The high affinity of doxycycline to the dentin makes it a potential staining agent present in MTAD.[25,26]

But since MTAD is delivered for a very short duration in the root canal and there is no usual exposure of canals to light, therefore the adult onset tetracycline tooth staining is not seen.[27]

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However, a chemical reaction between NaOCl and MTAD leads to the production of brown solution in root canals.[28] this reaction might be caused by the dentinal absorption and release of doxycycline present in MTAD with the exposure to final rinse of NaOCl.[28]

A study also reports the formation of yellow precipitate on the walls of root canal when MTAD is used a final rise. In the same study, when MTAD is used a final rinse following the initial rinse of 1.3% NaOCl ,the light exposed root dentinal walls were red-purple stained due to photooxidation by NaOCl.[29] To prevent the oxidation effect of NaOCl and photo degradation of the doxycycline that is present in MTAD, an intermediate flush with sodium ascorbate is recommended which acts a reducing agent.[30]

CHX and EDTA

In routine endodontic therapy,17% EDTA is used as a chelating agent which serves the purpose of smear layer removal and making the dentin soft for better instrumentation.[31,32]

A white to pink precipitate has been reported to form on its interaction with CHX.[33,34] The precipitate is formed as result of electrostatic neutralization of the cationic chlorhexidine by the anionic EDTA.[34,]The resultant precipitate doesn't show any significant amounts of p-chloroaniline unlike the interaction between NaOCl and CHX.[34]

To prevent the outcome of above-mentioned combination of irrigants, Maleic acid can be substituted for EDTA, as it has been proven a better agent in smear layer removal which do not cause any precipitation and discolouration on its association with CHX.[35]

Silver Diamine Fluoride

3.8% Silver diamine fluoride has shown to be used as a potential antimicrobial root canal irrigant against E faecalis biofilm. In the same study silver salts were seen occluding the dentinal tubules.[36]The formation of silver phosphate layer and silver sulphide precipitation on dentin is attributed to the black staining potential of silver diamine fluoride.[37,38]

Herbal Irrigants

Green Tea Extract

Green tea polyphenols, prepared from the young shoots of the tea plant *Camellia sinensis* has showed statistically significant antibacterial activity against *E faecalis* biofilm formed on tooth substrate.[39] However it should be noted that the tannins present in the green tea can cause staining of teeth.[40]

Triphala Juice

Triphala comprises dried and powdered fruits derived from three medicinal plants *Terminalia bellerica, Terminalia chebula*, and *Emblica officinalis*.[41] This formulation is effective against Faecalis and the citric acid in trehala also removes the smear layer, making it a potential root canal irrigant.[39] The dentinal discoloration is observed following the use of commercially prepared triphala juice which can be attributed to its natural pigment or due to the presence of additives.[42]

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III. INTRACANAL MEDICAMENTS

Calcium Hydroxide based Medicaments

Calcium hydroxide has noteworthy properties such as antimicrobial activity, hard tissue barrier formation, arrest of resorption all of which makes it to be used widely as an effective intracanal medicament and as a material of choice in various clinical scenarios.[43,44] Some studies have reported tooth staining, although insignificant, following its application as an intracanal medicament.[43,45,.46,47] This staining can been attributed to the radiopacifies present in the calcium hydroxide based intracanal medicaments. [45,48]

Tetracycline based Medicaments

Triple antibiotic paste (containing ciprofloxacin, metronidazole, and minocycline) is the most common intra-canal medicament that can cause tooth staining if they are not completely removed from the access cavity at a level coronal to the gingival margin.[49] Tooth staining has been reported in tetracycline based endodontic materials in the effect of light through a photoinitiated reaction as stated before.[49]However a significant staining due to minocycline is also seen in the absence of light which is due to its bond with the calcium of dentin forming insoluble complex.[49]

Ledermix paste contains a combination of a tetracycline antibiotic agent, 3.2% demeclocycline hydrochloride and a steroid agent, 1% triamcinolone acetonide in a polyethylene glycol base.[50]Effect of light, oxidation reaction and presence of moisture are the key mechanisms which are attributed to the staining potential of demeclocycline present in the paste.[50]

To prevent the discoloration, doxycycline hylate must be substituted to demeclocycline hydrochloride, keeping the other component of paste the same.[51] Incorporation of ascorbic acid, an oxidising agent into the paste or rinsing with it before placement of the medicament can also be an approach to prevent discoloration.[52]Moreover,prevention of moisture and oxygen is the most important factor in preventing the tooth staining.

Iodoform based Medicaments

A study evaluated the clinical success of pulpally treated primary incisors revealed a yellowish discoloration which was clearly seen through the coronal composite restoration. The iodoform paste used as an intracanal medicament in the study was concluded to be the reason for this yellow staining.[53]

Formocresol based Medicaments

The small molecular composition of formocresol aids its penetration into wide dentinal tubules, seen especially in young patients which reports to cause coronal discoloration.[55,54]Gingival necrosis and crestal bone sequestration are also seen following the use of formocresol based medicaments.[55]

IV. CONCLUSION

Almost all the irrigants and intracanal medicaments used in modern endodontics have shown to cause tooth staining. Therefore, keeping in mind, the staining potential of these agents during endodontic therapy, the dentist must know the preventive measures and treatment options for the same. The endodontic therapy should not only focus on the biological and functional aspects, but should also consider the aesthetic outcome of procedure.

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