The Antibacterial Effect of Calcium Hydroxide Modified with Dragon Blood Tree Extract Compared to other Intercanal Medicaments and Their Effect on Crown Discoloration and Dentin Microhardness: An In Vitro Study

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Dedication

To **My father**, for all the encouragement and motivation to fight and face all the obstacles. You have been the best symbol of a great father. I Hope I always make you proud.

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Symbol	Meaning
E.faecalis	Enterococcus faecalis
TAP	Triple antibiotic paste
$Ca(OH)_2$	Calcium hydroxide
CHG	Chlorohexidine gluconate
NaOCl	Sodium hypochlorite
PCR	Polymerase chain reaction
P.gingivalis	Porphyromonas gingivalis
qRT-PCR	Quantitative real-time polymerase chain reaction
S. aureus	Staphylococcus aureus
C. albicans	Candida albicans
MTAD	Mixture of doxycycline, citric acid, and a detergent
EDTA	Ethylenediaminetetraacetic acid
CFU	Colony-forming unit
DAP	Double antibiotic paste
CLSM	Confocal laser scanning microscopic
CHX	Chlorhexidine
ZOE	Zinc oxide eugenol
OSCC	Oral squamous cell carcinoma
ΔE	Color differences

Introduction

The goal of endodontic treatment is to control pulpal and periradicular infections and to promote healing. The success of endodontic treatment is directly influenced by the elimination of microorganisms in infected root canals.(1)

Chemomechanical instrumentation removes the majority of bacteria, together with pulp debris. However, it should be supplemented by intracanal medicaments to eliminate the remaining bacteria, to prevent its regrowth, thereby making the environment conducive for periapical tissue repair.(2)

Enterococcus faecalis (E.faecalis) is the predominant microorganism and occasionally, the only species detected in root canals of teeth associated with persistent periradicular lesions. E. faecalis is able to invade dentinal tubules and remain viable within the tubules for prolonged period of time, adhere and form biofilm on dentin under different environmental conditions, resist intracanal disinfectants, and survive harsh conditions within root-filled teeth.(3)

Calcium hydroxide ($Ca(OH)_2$) is one of the most commonly used intra canal medicaments. Its antimicrobial efficacy is attributed to its high alkaline pH, antimicrobial effect and potentiality to stimulate healing of pulp and periapical tissues. Although it has antibacterial activity on a wide range of microflora present in the root canal, it was found less effective against E.faecalis.(1)

Because of the complexity of the root canal infection, it is unlikely that any single antimicrobial agent could result in effective sterilization of the canal. More likely, a combination would be needed to address the diverse flora encountered. The combination that appears to be most promising consists of Metronidazole, Ciprofloxacin, and Minocycline.[4]

However some antibiotics have serious undesirable side effects which limit their application.[5] Thus, there is a need to develop new antimicrobial agents that are effective with minimal side effects.

In last few decades, the use of alternative therapeutic agents has considerably increased and these agents which are derived from plants, insects, microorganisms, etc. are a part of a growing trend to seek natural remedies in dental treatment. The use of natural derivatives may have a greater level of tolerance by the body with exhibition of fewer side effects. According to world health organization (WHO), medicinal plants would be the best source to obtain a variety of drugs.[6] Many plants with biological and anti microbiological properties have been studied to eliminate antibiotic overuse.[7]

Dragoon blood tree extract (Dracaena Cinnabari extract) is a species plant in Agavaceae family. It is a tree endemic to the Island of Socotra, Yemen. It was used as a dye and medicine in Socotra and the Mediterranean basin.[8]

Up to our knowledge, there was no studies on the use of dragoon blood tree extract as intracanal medication in primary teeth. So owing to its reported antimicrobial activity, we decided to study and compare the antimicrobial efficacy of dragoon blood tree extract with the $Ca(OH)_2$ and TAP in primary root canals contaminated with E. faecalis then evaluate their effect on crown discoloration and dentin microhardness.

Review of literature

The maintenance of primary teeth in form and function until their normal exfoliation is one of the fundamental objectives of pediatric dentistry. Primary teeth act as guides for the eruption of permanent dentition and contribute to the development of jaws, chewing process, preparing food for digestion and nutrient assimilation. Primary teeth are also important for normal speech development, and self-esteem. They are the best way to preserve arch length and avoid secondary issues such as space loss and permanent tooth impaction.(9)

Dental traumas or extensive caries lesions affect the pulp of deciduous teeth, making the maintenance of these teeth is dependent on endodontic treatment. The dental pulp is located in a closed chamber, which makes it a unique tissue in providing strong mechanical support and protection from the microbes found in the oral cavity. If this protection is broken the microorganisms and their toxins will enter the pulp, and pulpal initially inflames in response to irritation and will become necrotic and infected if left untreated.(10)

Pulpectomy, which is the complete removal of both the coronal and radicular pulp tissue of deciduous teeth, is carried out when the criteria for classical pulpotomy can't be met. Pulpectomy has several obstacles, such as molar root curvature, root canal complexity and physiological resorption. In addition, patient cooperation, limited

working time and mouth opening, add to the problem of inability to achieve complete pulp extirpation and disinfection.[11]

The success of endodontic treatment depends mainly on elimination of infecting microorganisms. This is achieved through chemomechanical preparation of root canals and leaving antimicrobial dressings in the root canal between appointments. However, microorganisms might still survive these challenges.[12]

Evidence has shown that the mechanical instrumentation technique with files is limited because it tends to leave significant portions of the infected canal walls untouched. So number of viable pathogenic microorganisms persist, stuck together with dentine debris and necrotic pulp tissue remnants inside the dentinal tubules, canal ramifications, and resorption craters.[13]

Therefore, it is necessary to significantly reduce or eradicate, to the possible extent, the microorganisms and their by-products present in the root canals by employing clinically effective and biocompatible medicaments and irrigants, which also aid in dissolving organic debris. However, the problem for pediatric dentists is to choose the most appropriate medicament agent when performing pulp canal treatments, due to the risk of damage to the permanent germ.[14]

Intracanal medicaments are usually used to: (i) eliminate any remaining bacteria after canal instrumentation; (ii) render canal contents inert and neutralize tissue debris; (iii) reduce inflammation of