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The Purpose of Calcium Hydroxide in Root Canal Treatment

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Abstract: ***The use of different chemical compounds in endodontics has proven to be effective in dental procedures, treatments, and the preservation of teeth. Calcium hydroxide ($Ca(OH)_2$) is a common chemical compound used as an intracanal medicament during root canal treatment. It can also be used as a root canal sealant, a root dressing, and many more procedures such as root perforations and apical closures. This article aims to explore how $Ca(OH)_2$ uses its antibacterial properties to contribute to the success of root canal treatment. It will go over the mechanism of action, the effects it has, and how it is used in the field of endodontics. By inhibiting enzymes, damaging the cytoplasmic membrane, and causing protein denaturation, $Ca(OH)_2$ is used for disinfection. It is still unclear which function is the main cause of bacterial destruction. Nonetheless, $Ca(OH)_2$ is an effective medicament that has many antibacterial properties.***

Keywords: Endodontics, Root Canal Treatment, Calcium Hydroxide, Dentistry, Intracanal Medicament, Root Canal Sealant, Root Canal Dressing, Hydroxyl Ions

I. INTRODUCTION

Calcium Hydroxide ($Ca(OH)_2$) is a common compound used in many aspects of endodontics. Specifically for the disinfection of the root canal, intracanal medicaments such as $Ca(OH)_2$ are used after shaping and cleaning the canals. It can be used in the form of powder, or a paste if mixed with a proper saline, inserted into the canals up to the apex. If it goes beyond the apex, patients may feel much discomfort. With a pH of 12.5, $Ca(OH)_2$ is highly alkaline and is recognized for its high clinical success. Amela Lačević et al. investigated the clinical application of $Ca(OH)_2$, and determined that it keeps its antibacterial properties for about two months before turning into calcium oxide and other salts, making it much less effective [1]. This is important for intracanal medicaments as they need to keep their properties in order to work properly and disinfect the root canal of unwanted bacteria, leading to the success of overall treatment.

II. ROOT CANAL TREATMENT AND CALCIUM HYDROXIDE PLACEMENT

Root Canal Treatment is the process in which the tooth is restored from detrimental tooth decay which reaches the pulp. After anesthesia is placed, the pulp is accessed and is commonly poured with sodium hypochlorite for cleaning and shaping. After shaping and cleaning, this is usually when intracanal medicaments are placed to finish the disinfection of the root canal. When placing $Ca(OH)_2$ into the canal, the endodontist must make sure that the tip of injection is freely moving. If not and the needle is binding, the patient may feel much discomfort. After filling the tooth with a bit of $Ca(OH)_2$, the endodontist makes sure it goes deep into the canal and fills up to the coronal third of the tooth. It must be placed right up to the apex of the tooth as well. Gutta-percha is commonly used to seal the tooth, before a crown, amalgam, or other type of restoration is needed to finish root canal treatment.

III. CALCIUM HYDROXIDE MECHANISM OF ACTION

The antibacterial properties of $Ca(OH)_2$ are effective if placed in an aqueous environment. Raidan Ba-Hattab et al. believes that the effect of $Ca(OH)_2$ is through damage of the cytoplasmic membrane of bacteria, protein denaturation, and DNA damage [2]. However, it is still unclear which mechanism of action is the sole cause of bacterial destruction. Estrela et al. investigated the effects of $Ca(OH)_2$ on the cytoplasmic membrane and the enzymes that surround it [3]. The enzymes are essential to the bacteria for cellular growth, division, formation of a cell wall, electron transport, and oxidative phosphorylation. $Ca(OH)_2$ releases hydroxyl ions which inhibit the functions of these enzymes, therefore it is believed to kill bacteria. $Ca(OH)_2$ can also activate tissue repair through mineralization, which is another benefit of using it during root canal treatment. Zahed Mohammadi et al. also investigated the mechanism of action of $Ca(OH)_2$, and determined that the pH gradient of the cytoplasmic membrane is changed due to the levels of hydroxyl ions present [4].

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This would occur because of the interaction between $Ca(OH)_2$ and the proteins of the membrane. Additionally, the pH is an important factor in antibacterial properties. The pH of $Ca(OH)_2$, shown through its alkalinity, is seen to have a large effect on the cytoplasmic membrane, disrupting the transport of nutrients and the destruction of phospholipids and fatty acids.

IV. DISCUSSION

$Ca(OH)_2$ seems to have an overall positive effect when used during root canal treatment. Liying Jia et al. compared the success of $Ca(OH)_2$, Formocresol (FC), and Camphor Phenol (CP), which are all intracanal disinfectants [5]. Evaluating 16 randomized controlled trials, $Ca(OH)_2$ had better clinical effectiveness over FC and CP. FC and CP had weaker anti-inflammatory and antibacterial properties. However, an endodontist should always select an intracanal medicament based on the compatibility with the patient's situation. Choosing the same one in every operation may be dangerous as situations can be different, prompting another intracanal medicament to be more effective. Furthermore, the requirements of an intracanal medicament include being stable, antimicrobial, and non irritating. They should also not irritate the patient, and uphold their oral health. $Ca(OH)_2$ has the effect of stimulating healthy, hard tissue, which is important for repairment. These are the functions for an intracanal medicament, and $Ca(OH)_2$ upholds its duty well.

V. CONCLUSION

In conclusion, $Ca(OH)_2$ has antibacterial properties but also stimulates tissue repair, which makes it useful during endodontic procedures. It is widely believed to kill bacteria through damage of the cytoplasmic membrane, protein denaturation, and DNA damage. Future research can be directed towards how $Ca(OH)_2$ poses negative threats towards oral health, and also what other oral procedures it can be useful in. Since its properties generally support the disinfection of unwanted bacteria, it could be a convenient tool during tooth extraction. Even so, with all its benefits, $Ca(OH)_2$ as an intracanal medicament is effective through its antibacterial properties during root canal treatment. By inhibiting enzymatic functions of bacteria, cell growth and division are blocked and bacteria is removed, resulting in success.

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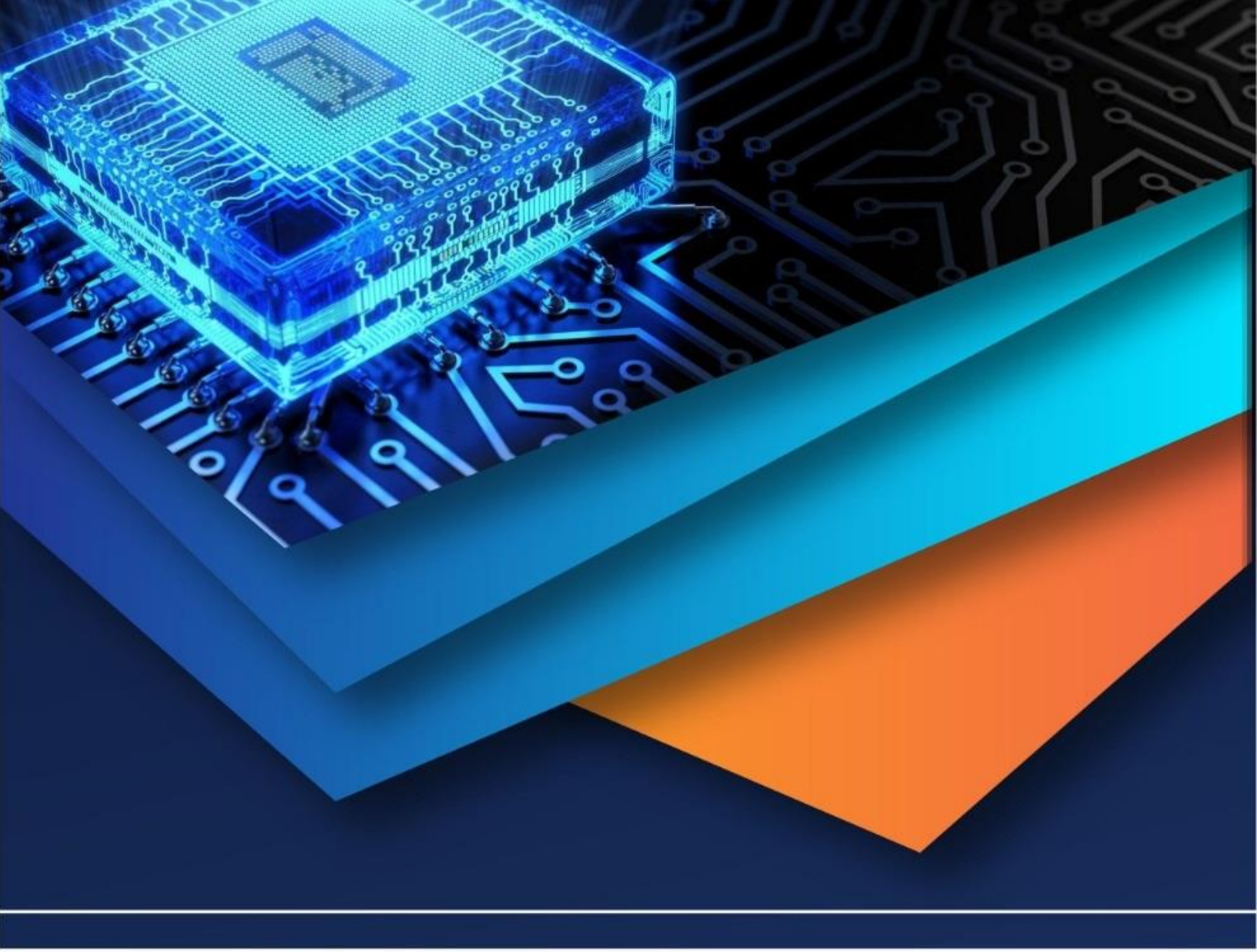
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