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INTERACTION BETWEEN SODIUM HYPOCHLORITE AND ETIDRONIC ACID AS ROOT CANAL IRRIGANTS

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Abstract:

An endodontic treatment consists of removing all contents of the root canal system before and during shaping. Irrigation is presently the best method for the removal of tissue remnants and dentin debris during instrumentation. The adjunctive use of chelating agents such as EDTA, Etidronic acid helps to remove and prevent the formation of the smear layer associated with root canal instrumentation. Meanwhile Sodium Hypochlorite solution is amongst the strongest disinfectants known, with antibacterial, sporicidal, antifungal and antiviral properties. The aim of this study is to determine the interaction between Sodium Hypochlorite and Etidronic acid as root canal irrigants.

Keywords: *Root canal system, irrigants, Sodium Hypochlorite, etidronic acid, interaction.*

I. Introduction:

Root canal treatment is one of the most common procedures performed in endodontics. The main purpose of performing root canal treatment is to completely debride the root canal of pathogens and to create a 3-dimensional seal of the canals to prevent re-infection. Root canal treatment involves the use of root canal irrigants, root canal medicaments and root canal sealers in conjunction with endodontic instrumentation. The use of endodontic instruments is for the biomechanical cleaning and shaping of root canal which greatly reduces the number of bacteria. However, due to the anatomical complexity of the root canal system, organic and inorganic residues and bacteria still persist. Root canal irrigants are used to overcome such difficulties during root canal treatment. Irrigation removes debris, tissue remnants, microbes and smear layer. The commonly used irrigants include chlorhexidine gluconate, sodium hypochlorite, EDTA, MTAD, etc,. Theses irrigants have different actions on the root canal system. Moreover the interaction of these irrigants results in precipitate formation which again differ in their mode of action on the root canals.

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One of the most common and most reported irrigant interactions in Endodontics is that between NaOCl and Chlorhexidine leading to the formation of a new precipitate called para- chloraniline. The main purpose of using an additional irrigant in combination with NaOCl is for effective smear layer removal. This is particularly carried out by chelators. With the advent of a number of new chelators in the field, such as, EDTA(1), Maleic acid, Etidronic acid, etc,. it becomes highly important to have a knowledge about their efficacy and interaction with other irrigants. NaOCl on the other hand is an effective tissue solvent and anti microbial agent. But it lacks one main property i.e., the property of smear layer removal. Hence, it is used along with chelating agents. Etidronic acid or HEBP (1-Hexaethylidene-1, 1-Bisphosphonate) as it is commonly known, is a biocompatible calcium chelator. Till date there are plenty of studies on the interaction between Sodium Hypochlorite and Chlorhexidine, and also between Sodium Hypochlorite and EDTA (1,2). But there are only sparse number of studies for the interaction between Sodium Hypochlorite and newer chelating agents such as Etidronic acid.

Hence, the main aim of this study is to determine the effectiveness of NaOCl and Etidronic acid on interaction, when used as root canal irrigants.

II. Materials and methods:

The concentration of NaOCl used in endodontics varies from 0.5%-5.25% . In our study we used 5ml of 4% NaOCl. Along with this, 5ml of 9% solution of etidronic acid was mixed. There was not any visible characteristic precipitate formation, such as the orange precipitate- parachloraniline in case of interaction between NaOCl and chlorhexidine. The sample containing NaOCl and etidronic acid was subjected to titration to find the individual concentrations of NaOCl and etidronic acid after mixing(after interaction).

The titration of Sodium Hypochlorite was done according to the U. S. Pharmacopeia protocol. The procedure was done as follows:

- Weigh accurately in a glass stoppered flask, about 3ml of sample solution and dilute it with 50ml of water.
- Add 2g of Potassium iodide and 10ml of 6N acetic acid, and titrate the liberated iodine with 0.1M sodium thiosulfate VS, adding 3ml of starch TS as the endpoint is approached.
- Perform a blank determination and make any necessary correction.
- Each ml of 0.1N sodium thiosulfate is equivalent to 3.722mg of NaOCl.

The titration of etidronic acid was carried out according to the Indian Pharmacopeia, according to which, the sample was titrated using Phenolphthalein as the end point was approached.

Following this, the sample was subjected to GCMS (Gas Chromatography and Mass Spectroscopy) Analysis, in order to find out the composition of a third component formed as a result of the interaction between NaOCl and etidronic acid.

III. Results:

The initial concentration of sodium hypochlorite was 4% and that of etidronic acid was 9%.

However, the titration of the sample after interaction of Sodium Hypochlorite and Etidronic acid has revealed a significant drop in the concentration of both Sodium Hypochlorite and etidronic acid.

The concentration of sodium hypochlorite was reduced to 0.025% and that of etidronic acid was reduced to 2.69% respectively, upon interaction.

This can be tabulated as follows:

Table 1:

Irrigant	Concentration before interaction	Concentration after interaction
Sodium hypochlorite	4%	0.025%
Etidronic acid	9%	2.69%

Also, since the concentration of both irrigants has been reduced to more than less than half their original concentration, the titration revealed that a 3rd new component has been formed as a result of the interaction for the remaining concentration. The constituents of this new component remain unknown at the end of titration. Hence, we have decided to proceed further with GCMS analysis, in future, to determine what the new component actually holds in place.

IV. Discussion:

The root canal system is complex due to the presence of many accessory canals and accessory foramina, which at many times are inaccessible for instrumentation. This poses a critical challenge during endodontic therapy, as incomplete debridement due to this complexity may lead to persistence of bacteria and other microbes, and thus infections too (3). Irrigants are used in such cases, as they are able to percolate the root canal system aiding in the microbial debridement and also facilitating the removal of smear layer at times. There are many root canal irrigants like Sodium Hypochlorite, Chlorhexidine gluconate, EDTA, Etidronic acid, Peracetic acid, MTAD, etc., and also Triphala, green tea and Morinda citrifolia.

Sodium hypochlorite as mentioned previously is an effective tissue solvent and anti microbial. Sodium hypochlorite is available in concentrations ranging from 1% - 5.25% for use in endodontics. According to researchers, there does not exist any significant difference in the antimicrobial activity of Sodium Hypochlorite at concentrations of 1%, 2.5% and 5.25% (4). But it's found that sodium hypochlorite when used at a concentration of 4% has a very significant antimicrobial activity against Enterococcus fecalis. Hence, we chose to test the interaction between Sodium Hypochlorite and Etidronic acid, at a concentration of 4% Sodium

Hypochlorite. According to Rossi-Fedele et al., there is no irrigant that has properties of both smear layer removal and organic tissue dissolution. Hence, irrigants such as Sodium Hypochlorite are commonly used along with chelators to aid in the removal of smear layer. The most common chelator used along with NaOCl is EDTA. This is because of the effective smear layer removal exhibited by EDTA. A final irrigation with EDTA can prove beneficial , as the removal of smear layer opens up the dentinal tubules. This further permits more number of lateral canals to be filled up by the sealer during the treatment (5).

While speaking about interactions, there are two very important combinations of irrigants used commonly along with Sodium Hypochlorite and also discussed by researchers over and over again. They are EDTA and Chlorhexidine (5, 6). In this combination EDTA facilitates smear layer removal and Chlorhexidine shows substantial antibacterial activity. It is also believed that the antimicrobial action of these three namely, Sodium Hypochlorite, EDTA and Chlorhexidine, when all three are used together as root canal irrigants is of value, any potential interactions that can be harmful must also be considered (7-13). The interaction of NaOCl with Chlorhexidine gives a characteristic precipitate called Parachloraniline. This cannot always be considered as beneficial as there is a chance for this precipitate to attach to the root surface and later leach into Periapical tissues, which can be harmful. Moreover such a presence of the precipitate on the root surface, prevents the coating of hybrid sealers too. Hence, all interactions are not always completely beneficial and possess a certain degree of harm always(14). But the efficacy of NaOCl when used separately is very poor compared to its combined usage with chelating agents. On the other hand, conventional chelating agents such as EDTA are more acidic, and reduce sodium hypochlorite to chloride, rendering it non reactive.

Hence, with the advent of newer chelating agents such as Maleic acid, Etidronic acid, etc,. it becomes essential to know their interaction with Sodium Hypochlorite and their effectiveness upon interaction. So, of the newer chelating agents, we chose Etidronic acid, to test its interaction with Sodium Hypochlorite .

Etidronic acid, commonly known as 1-hydroxyethylidene-1, 1-bisphosphonate (HEBP) is called as a “soft” chelator, due to its less aggressive action on the root dentin when compared to other chelators. It has the potential to condition the root canal dentin to facilitate resin adhesion. Being an aqueous irrigant, etidronic acid also reduces the mechanical stress on the rotary instruments. In a recent research carried out by Paque et al., the hard tissue accumulation in root canals following irrigation with sodium hypochlorite and etidronic acid combination was assessed (15). They selected sixty extracted Mandibular molars with isthmuses in their mesial root canal system for their study. The test irrigants included 2.5% NaOCl separately and a combination of 2.5%NaOCl in 9% etidronic acid. The hard tissue accumulation was evaluated using Computed Tomography, as % of the volume of the root canal system. It was found that the hard tissue accumulation is significantly lower when sodium hypochlorite and etidronic acid are used in combination than when sodium hypochlorite is used separately (15). Researchers have also reported that etidronic acid has only a short term interference with the action of NaOCl on root canal system, unlike the reduction of sodium hypochlorite to chloride caused by EDTA making the former inactive (16-18). But the efficacy of Sodium Hypochlorite must not be reduced as it is effective anti microbial, anti fungal and can also remove the intracanal as well as periapical biofilm which constitutes bacteria like Enterococcus fecalis, Streptococcus sanguinis and Fusobacterium nucleatum (19,20).

Present study revealed that when Sodium Hypochlorite and Etidronic acid interact, the following changes take place:

- The concentration of Sodium Hypochlorite is reduced from initial 4% to 0.025%
- The concentration of Etidronic acid is also reduced from initial 9% to 2.69%
- Further, for the remaining concentration a 3rd component has been formed, whose constituents are to be analyzed further by subjecting the post interaction sample to GCMS Analysis.

In a recent study, Mariyam Niyas et al., studied the efficacy of the combination of sodium hypochlorite and etidronic acid on root canal preparations of varying apical sizes. They used 12 freshly extracted Mandibular premolars teeth, divided into two groups of six each. The first group was prepared to an apical size of twenty and the second group to a size of 40. Their study revealed that the action of sodium hypochlorite and etidronic acid combination was better on smaller apical preparations than on the larger ones. In the same study, it was also inferred that their efficacy on larger apical preparations can be improved when used with other mechanical irrigating systems (21). This reveals that the action of irrigants is also technique sensitive.

Thus, from the above discussion, the following can be listed out as the ideal properties of root canal irrigants:

- Tissue solvent
- Broad Antimicrobial spectrum, particularly against anaerobic and facultative microorganisms organised as biofilms.
- Removal of smear layer
- Prevent formation of smear layer during instrumentation
- Low toxicity
- Acts as lubricant
- Low surface tension
- Inactivate endotoxins
- Non toxic systemically when it comes in contact with tissues, particularly when extruded into Periapical region

All root canal irrigants must possess these ideal properties for their use in Endodontics. It must also be assured that neither of these ideal properties are compromised when two irrigants interact. Only under such conditions can an interaction be termed as highly effective and highly beneficial on the root canal system. Most important is that the result of such interactions must possess less toxicity than that caused when the irrigants are used individually. Sodium Hypochlorite has a potential to extrude into periapical region, leaching the tissues. But on interaction with etidronic acid, since the concentration of sodium hypochlorite is reduced, it can be assumed that its potential to leach Periapical tissues is also reduced. To confirm such an assumption more number of animal studies followed by clinical trials need to be initiated on the effects of the interaction of sodium hypochlorite and etidronic acid on the root canal system.

V. Conclusion:

Root canal irrigants play a pivotal role in an effective root canal treatment because of their ability to percolate the complex root canal system which includes accessory and lateral canals in large numbers. Based on

their mode of action, root canal irrigants have been described under different categories as they possess varying capabilities of antimicrobial action, tissue dissolving and smear layer removal properties. Sodium hypochlorite is primarily known for its antimicrobial activity and tissue dissolving capacity. Till date, it is one of the excellent irrigant that can act against Enterococcus fecalis. However, it does not facilitate smear layer removal, without which the debridement of root canal system remains incomplete. To compensate for this, NaOCl was used along with a chelator called EDTA. Though the combination is effective so far, NaOCl is reduced to chloride and rendered inactive. So, now newer chelating agents are into the market, one of which is Etidronic acid. Our study reveals that Etidronic acid and sodium hypochlorite interaction does not form a characteristic precipitate unlike one formed between Sodium Hypochlorite and Chlorhexidine,I.e. parachloraniline. Instead, the concentration of both etidronic acid and sodium hypochlorite is reduced upon interaction and for the remaining concentration a third new component is formed whose composition remains unknown. In order to determine its composition, further GCMS analysis must be carried out, so that the actual efficacy of the new component can be arrived at. Based on this, the extent of usage of etidronic acid along with sodium hypochlorite as a root canal irrigant can be determined. Hence, more number of invitro studies and clinical trials need to be initiated in the upcoming years in this context.

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