

THE EFFECT OF DIFFERENT FORMULATIONS OF CALCIUM HYDROXIDE ON THE FRACTURE RESISTANCE OF ENDODONTICALLY TREATED TEETH

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ABSTRACT

This study aimed to evaluate the effect of nano calcium hydroxide application on the fracture resistance of endodontically treated teeth as compared to conventional calcium hydroxide and calcium hydroxide paste with iodoform. Seventy freshly human extracted single rooted teeth were selected. The samples were biomechanically prepared and classified according to the type of the calcium hydroxide dressing into four groups as follows; Group 1; (21 samples) dressed with nano calcium hydroxide (Nano streams company, Cairo, Egypt), Group 2; (21 samples) dressed with conventional calcium hydroxide with saline (GAMA dental lab, Cairo, Egypt). Group 3; (21 samples) dressed with calcium hydroxide paste with Iodoform (Metapex) (META, Chungcheongbuk-do, Korea) and Group 4; Control group (undressed). The samples were further classified according to the observation time into: Subgroup A; (7 samples) after one month. Subgroup B; (7 samples) after two months and Subgroup C; (7 samples) after three month. Samples were loaded vertically after the observation periods using Universal Testing Machine until fracture. The results showed that nano calcium hydroxide weakened the endodontically treated teeth more than conventional calcium hydroxide followed by Metapex paste and this weakness increased by time for all tested groups. It was concluded that all formulations of calcium hydroxide weaken the endodontically treated teeth.

INTRODUCTION

The chemical formulation of the used intra-canal medication is a determining factor that affect its biological activity. It is some times mandatory to use intra-canal medicament through out the root canal treatment procedures specially in refractory cases with resistant bacterial strains. Calcium hydroxide is still the most public and regular material used as an intracanal medication^(1,2). Its mode of action

is dependant on the release of hydroxyle ions⁽³⁾. This mode of action is dependant on many factors such as the vehicles used⁽⁴⁾ and the particle size⁽⁵⁾. These hydroxyle ions have the advantage of the anti-bacterial effect and anti-inflammatory effect but still have a weakening effect on the tooth structure. Many researches proved that the use of calcium hydroxide intra canal medicament for long period can render the mechanical properties of root canal dentine^(6,7).

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MATERIALS AND METHODS

1) Samples Preparation :

Seventy freshly human extracted single rooted teeth were selected free from any cracks or fracture line and inspected under light microscope (10X). Before canal instrumentation, decoronation of the teeth was performed by using a high-speed carbide bur and water spray to obtain standardized 15-mm long roots.

2) Root canal instrumentation:

Cleaning and shaping of the samples was performed till file 50 as master apical file then stepped back till size 70. The patency of the samples was ensured using file number 10.. Irrigation of samples was done using 2.5% sodium hypochlorite followed by saline. After dressing of the root canals the coronal portion of the samples was sealed using zinc phosphate cement. The control Group was tested without biomechanical preparation.

3) Samples Classification:

The samples were classified according to the type of the calcium hydroxide dressing into four groups as follows; Group 1; (21 samples) dressed with nano calcium hydroxide (Nano streams company, Cairo, Egypt), Group 2; (21 samples) dressed with conventional calcium hydroxide mixed with saline (GAMA dental lab, Cairo, Egypt). Group 3; (21 samples) dressed with calcium hydroxide paste with Iodoform (Metapex) (META, Chungcheongbuk-do, Korea) and Group 4; Control group (undressed). The samples were further classified according to the observation period into: Subgroup A; (7 samples) after one month. Subgroup B; (7 samples) after two months and Subgroup C; (7 samples) after three month.

5-Mounting of samples;

A copper mold formed of a block former and a perpendicular arm was used to form the specimens.

The specimen was formed of the obturated samples embedded in self cured acrylic resin.

6- Method of evaluation:

The acrylic blocks including the samples were mounted on the lower fixed compartment of a Universal Testing Machine (Model LRX-Plus, Lloyd Instruments, Fareham, UK) with a loadcell of 5 kN –then secured by tightening screws. Samples were subjected to a slowly increasing vertical load (1mm/min) until the fracture occurred. Data were recorded using computer software (Nexygen-MT-4.6; Lloyd Instruments).

7-Statistical analysis:

Data were analyzed by SPSS software (version 16.0, SPSS, Chicago, IL, USA). Data in each group were compared by the ANOVA and Kruskal-Wallis tests. Also the Dunnett's test was performed to compare the results between two groups. The level of significance was set at 0.05.

RESULTS

Group I. Nano ($Ca(OH)_2$); the average fracture resistance of samples after one month observation period was 605 N. and decreased by time to reach 520 N. After two months and 364 N. after three months.

Group II. Conventional ($Ca(OH)_2$); the average fracture resistance of samples after one month observation period was 850 N. and decreased by time to reach 672 N. after two months and 460 N. after three months.

Group III. Metapex; The average value of the fracture resistance after one month observation period was 871 N. while it was 801 N. after two months and 442 N. after three months.

Group IV. Control; The uncleaned and undressed samples showed fracture resistance of 1041 N.

TABLE (1) Fracture resistance (average and standard deviation) of different groups. (N).

Group Subgroup	Nano(Ca(OH) ₂)	Conv.(Ca(OH) ₂)	Metapex	Control	P-value
1 month	605±16	850±14	871±14.5	1041±18	<0.0001
2 month	520±21	672±23	801±20.1		<0.0001
3 months	364±14	460±20	442±16		<0.0001

P ≤ 0.05 is considered significant.

The difference between the four groups was statistically significant with nano (Ca(OH)₂) showing the least values among the three observation periods. It was found that the value of the fracture resistance decreased significantly by time for all tested groups.

DISCUSSION

The main problem of endodontically treated teeth is their high risk of fracture. Many factors are contributing for this risk such as the previously existing carious lesion, Bacterial by-products, increased brittleness by loss of moisture, lack of reflux endodontic procedures and many endodontic materials such as sodium hypochlorite, EDTA and calcium hydroxide intra-canal medication. Estrela et al.⁽³⁾ stated the mechanism of action of calcium hydroxide through the release of hydroxyl ions through the process of ionic dissociation. This ionic dissociation has two main effects; an advantageous effect through the alkalinity of the produced hydroxyl ions that raises the PH of the surrounding media and so affect the integrity of the bacterial cytoplasmic membrane, inhibits bacterial enzymes and destroy the ionic bond of the tertiary structure of the bacterial protein⁽³⁾. In addition to the elimination of the carbon dioxide which is considered to be the main nutrient for the survival of bacteria by the formation of calcium carbonate. In addition to the strong anti-inflammatory action of calcium hydroxide^(8,9). On the other hand these elaborated hydroxyl ions weakens the mechanical

properties of the root canal dentin⁽⁷⁾. The fracture resistance testing was done to detect the structural integrity of the root canal dentin after dressing with calcium hydroxide. The results showed decrease in the fracture resistance of the root canal dentin with time till it reaches less than half of the control group after three months observation period. These results was in agree with Andreasen et al.⁽¹⁰⁾. and disagree with Grigoratos et al.⁽¹¹⁾ this can be attributed to the break down of the protein structure of the root canal dentin caused by the strong alkalinity of the dressing material used⁽¹²⁾. It can also be explained by the disruption of the link between the hydroxyl apatite crystals and the collagenous network in dentin by the calcium hydroxide. The disruption could take place due to neutralization, dissolution or denaturing of the acid proteins and proteoglycans that in dentin might serve as bonding agents between the collagen network and the hydroxyl apatite crystals⁽¹⁰⁾. The results also showed statistically significant decrease in the fracture resistance for samples dressed with nano calcium hydroxide. Which may be related to higher degree of ionic dissociation that is related to that Nano particles are microscopic particles with dimensions less than 100 nanometers with different properties such as active surface area, chemical and biological reactivity⁽¹³⁾. The higher surface to volume ratio and charge density of these materials results in their greater interaction with the environment and thus causes a higher ionic dissociation.^(14,15)

CONCLUSION

It was concluded that all formulations of calcium hydroxide weaken the endodontically treated teeth.

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