ORIGINAL RESEARCH

Short Term Effects of Calcium Hydroxide at Various Time Intervals on the Fracture Resistance of Human Teeth: An In Vitro Study

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ABSTRACT

Aim: The aim of this study was to evaluate the effect of calcium hydroxide at various time intervals on the fracture resistance of permanent human teeth**. Materials and methods:** Fourty five freshly extracted single rooted human teeth divided into three groups of 15 teeth each. Number 4 round bur was used for Coronal access, endodontic instrumentation using stainless steel files were completed for each tooth. Root canal system of each tooth was filled with $Ca(OH)_2$ (group 1), Metapex (group 2) and saline solution (group 3). The apices and access openings were sealed with glass ionomer cement and the teeth were immersed in saline for 7,15 and 30 days. At the end of this selected time period fracture strength test were performed. The maximum load required to fracture the samples was recorded and data were analysed statistically by the Repeated measure ANOVA test at 95% significance level. **Results:** There was a decrease in the fracture strength of human teeth when exposed to $Ca(OH)_2$ and metapex in comparison to control group after 15 days. **Conclusions:** $Ca(OH)_2$ is not medicament of choice beyond 15 days and if treated for long duration then root reinforcement should be carried out.

KEYWORDS: Calcium hydroxide, Fracture strength, Root fracture

INTRODUCTION

The use of calcium hydroxide $Ca(OH)_2$, in dentistry is well established and widespread and was introduced by Hermann in 1920[1]. $Ca(OH)_2$ has been used in various formulations as a liner beneath restorations and as a pulp-capping agent in different pathological conditions. Calcium hydroxide is accepted as an interappointment intracanal medicament.[2] The endodontic treatment of teeth with immature root formation has always been a challenge due to the wide open apices that make obturation difficult. The apexification technique was first described in 1966 by Frank.[3] He described reduction of contaminants present within the root canal by precise instrumentation and canal irrigation and filling the endodontic space with resorbable paste such as calcium hydroxide. Rendering the canal aseptic, promotes apical closure. The canal can be then obturated with suitable obturating technique. The introduction of apexification by the use of calcium hydroxide was pioneered by Heithersay.[4]This treatment gave adequate apical healing due to induction of an apical barrier and due to agent's antibacterial capability caused by high pH.[5] However, therapy may extend from months to years when $Ca(OH)_2$ is used in these applications, before the desired effects are achieved.[6] Furthermore, it has been observed that $Ca(OH)_2$ treated immature teeth show a high failure rate because of an unusual preponderance of root fracture and it has been suggested that changes in the physical properties of dentin by the $Ca(OH)_2$ medicament may be responsible. The purpose of the present study is to determine if intracanal exposure of $Ca(OH)_2$ from first to 3o days alters the fracture resistance of human teeth.

MATERIALS AND METHODS

Forty five freshly extracted (for other purpose) permanent single rooted human teeth were obtained. After extraction, the teeth were immediately stored in saline. The teeth were sorted by size and type and subsequently randomly assigned to three groups so that each group comprises of 15 similar teeth. Coronal access was made with round bur using a hand piece under water coolant .The dental pulp was removed using barbed broaches and hedstroem files. After instrumentation, each root will be irrigated with 5 ml of 3.0% sodium hypochlorite and 5 ml of 17% EDTA to remove smear layer. 5 ml of 0.9 % normal saline in 5 cc irrigation syringe with 23 gauze needle was used as a final rinse. The canals of the teeth were filled with $Ca(OH)_2$ paste (Calcigel) in group 1, with Metapex (Metapex) in group 2 and with saline solution in group 3 and stored for 7 , 15 and 30 days. At

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the end of these selected time periods each tooth was then mounted in poly vinyl chloride (PVC) mold of height 3.5 cm and internal diameter of 1.5 cm containing self cure acrylic resin (DPI, India). The teeth were inserted within the PVC mould. The specimen were fixed in the jig (figure- 1) and they were subjected to load by Universal testing machine to the long axis of the tooth in a linguo-labial direction at the level of CEJ with a chisel-shaped tip. The peak load fracture was recorded.

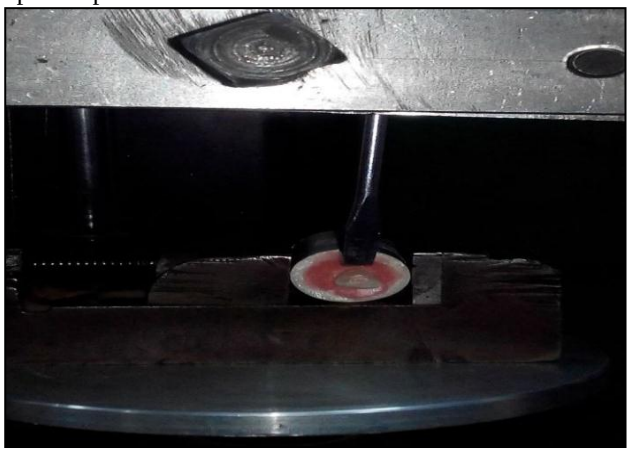


Figure – 1 : Evaluation of fracture resistance of the specimen using universal testing machine.

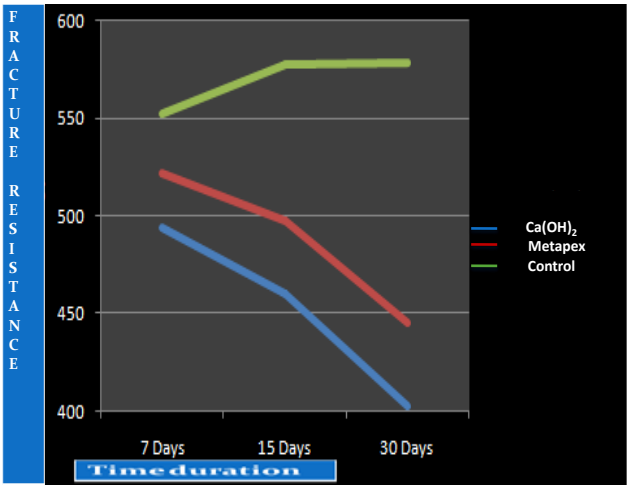
Statistical analysis: The statistical analysis was carried out using statistical package for social sciences (SPSS) version 17 for windows. Repeated measure ANOVA test was used to compare the intergroup variation of fracture resistance of teeth respectively. All the tests were performed at 95% confidence level with the level of significance set at 0.05.

RESULTS

All 45 teeth tested showed horizontal fractures through the cervical portion of the root. The control group exhibited the highest load value to fracture and Calcium hydroxide group followed by Metapex group exhibited the lowest load value to fracture. The mean peak load required to cause cervical root fracture in all three groups is shown in **(**Table 1, Graph 1). On applying statistical test a 0significant difference with decrease in the fracture strength of human teeth when exposed to $Ca(OH)_2$ and metapex in comparison to control group after 15 days (P=0.003) and (P=0.03) i.e (P<0.05) (Table 1).

Time interval	Group	Mean	P-value	Std. Deviation	N
Days- 7	Ca(oH)2	493.80	0.191	43.095	5
	Metapex	522.20	0.492	51.036	5
	Control	552.0		93.758	5
	Total	522.67		66.267	15
Days- 15	Ca(oH)2	460.00	0.15	113.745	5
	Metapex	497.80	0.317	168.345	5
	Control	577.60		51.116	5
	Total	511.80		122.943	15
Days- 30	Ca(oH)2	403.00	0.002	55.705	5
	Metapex	445.60	0.012	97.279	5
	Control	578.80		53.058	5
	Total	475.80		101.991	15

Table- 1 Mean values of fracture resistance of human teeth (N) at various time intervals.



Graph: 1 showing fracture resistance (Mpa) and time duration.

DISCUSSION

This study investigated whether short-term application of calcium hydroxide in the root canal system for 7, 15 and 30 days affects the fracture strength of human permanent teeth. We found when calcium hydroxide was placed in the root canal for 7,15 and 30 days a significant decrease in the fracture strength was observed. Marked decrease in fracture strength with increasing storage time was observed in sheep dentin treated with $Ca(OH)_2$,.[7] Similar results were obtained in a study conducted by Sahebi et al. (2010)[8] who also evaluated the effects of short-term calcium hydroxide application on the strength of human permanent dentin against the compressive forces with 50 extracted mature human mandibular single rooted permanent premolars and found that teeth subjected to 30 days application of calcium hydroxide required less compressive force to break root dentin cylinders. This is one of a few studies to examine whether short-term application of calcium hydroxide in the root canal system for 1 and 4 weeks affects the fracture strength of human permanent teeth. Rosenberg et al.(2007)[9] reported weakening of dentin by 23% after 28 days in human permanent maxillary incisors. Koshy M, Prabhu M and Prabhakar V (2011)[10] conducted an in vitro study to evaluate the long term effect of calcium hydroxide-glycerine combination on the microhardness of human radicular dentin. The authors concluded that the reduction in hardness can be attributed to the prolonged application of calcium hydroxide, which can have detrimental effect on teeth making it more vulnerable to fracture. Zarei M, Afkhami F and Poor ZM (2013)[11] conducted a study to evaluate the effect of calcium hydroxide on the fracture resistance of human root dentin at different time intervals. Results showed that using calcium hydroxide as a long-term intracanal dressing showed a significant decrease in peak load at fracture when compared with the control groups at the end of the first, third and sixth months of treatment and would suggest that using Ca(OH)2 for periods longer than 1 month should be used with caution. However, there are a few limitations in this study. The drawback of this study was that the method did not reproduce the clinical situations. Teeth were embedded in

acrylic resin cylinder block to the cemento-enamel junction. PDL act as shock absorbers to minimize external impact and studies have found that periodontal ligament (PDL) plays an important role in the mechanisms for tooth trauma. Rees reported that PDL plays an important role for distribution of stresses in load generated by application to the teeth

CONCLUSION

On the basis of the procedures performed and the results obtained using intracanal Calcium hydroxide and Metapex under universal testing machine to evaluate the fracture resistance suggested that there was a decrease in the fracture strength of human teeth when exposed to $Ca(OH)_2$ and metapex in comparison to control group after 15 days. $Ca(OH)_2$ in contact with root dentin beyond 15 days definitely affects the fracture resistance of the human teeth. $Ca(OH)_2$ is not medicament of choice beyond 15 days and if treated for long duration then root reinforcement should be carried out. However further studies with longer duration are needed.

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