Case Report

International Journal of Dental and Health Sciences
Volume 03, Issue 01

MANAGEMENT OF OPEN APEX IN PERMANENT TEETH WITH CALCIUM HYDROXIDE PASTE

Abu-Hussein Muhamad* , Jabareen Ayah , Abdulgani Mai , Abdulgani Azzaldeen

ABSTRACT:

Calcium hydroxide is a multi purpose agent, and there have been an increasing number of indications for its use in endodontics. Some of its indications include inter-appointment intracanal medicaments, endodontic sealers, pulp capping agents, apexification, pulpotomy and weeping canals. The aim of this study was to report the 10 year follow-up data of an apexification treatment applied to a permanent incisor of a young patient treated with calcium hydroxide.

Key Words: Calcium hydroxide , Apexifacation, one-visit apexification

INTRODUCTION:

Endodontic treatment of immature necrotic teeth with necrotic pulps and open apex involves induction of apical closure by apexification procedures to create optimal conditions for conventional root canal filling [1]. Apexification therapy is initiated when clinical and radiographic evidence of pulpal necrosis has been unequivocally established and the incompletely formed root has an apical diameter greater than coronal diameter. Apexogenesis, in contrast refers to vital pulp therapy to encourage continued physiological root and apex formation with its normal dentin and cementum composition [2].

In the past, techniques for management of the open apex in non-vital teeth were confined to custom ? tting the ? lling material [1], paste ? lls[1] and apical surgery [1,2]. Anumber of authors [3] have described the use of custom ? tted gutta-percha cones, but this is not advisable as the apical portion of the root is frequently wider than the coronal portion, making proper condensation of the gutta-percha impossible. Sufficient widening of the coronal segment to make its diameter greater than that of the apical portion would signi? cantly weakens the root and increases the risk of fracture. The disadvantages of surgical intervention include the difficulty of obtaining the necessary apical seal in the young pulp less tooth with its thin, fragile, irregular walls at the root apex. [1,2,3,4]

Apicoectomy further reduces the root length resulting in a very unfavourable crown root ratio. The limited success enjoyed by these procedures resulted in signi? cant interest in the phenomenon of continued apical development or establishment of an apical barrier, ? rst proposed in the 1960s [1,3]

Most of these techniques involve removal of the necrotic tissue followed by

*Corresponding Author Address: Dr Abu-Hussein Muhamad Email: abuhusseinmuhamad@gmail.com

debridement of the canal and placement of a medicament. However, it has not been conclusively demonstrated that a medicament is necessary for induction of apical barrier formation. [4,5] Table.1

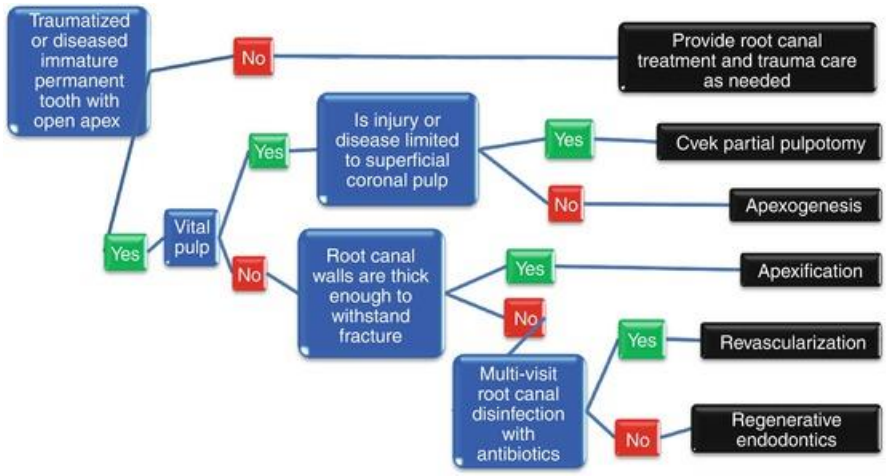

Table.1; Flow chart of treatments for traumatized or diseased immature teeth

Nygaard- Ostby hypothesized that laceration of the periapical tissues until bleeding occurred might produce new vital vascularised tissue in the canal. He suggested that this treatment may result in further development of the apex [6]

The most widely used material until recently was calcium hydroxide that was replaced over intervals for several months, to stimulate calcific barrier formation. Torabinejad and Chivian introduced mineral trioxide aggregate (MTA) as an apical plug and now it is an accepted material for apexification till date.

The use of calcium hydroxide affects various mechanical properties of radicular dentin (2). The alkaline pH of calcium hydroxide increases the chances of fracture due to denaturation of dentinal organic proteins. Hence, it is not recommended in teeth with thin dentinal walls. [7]

Calcium hydroxide can be mixed with a number of different substances (Camphorated mono chlorophenol, distilled water, saline, anesthetic solutions, chlorhexidene, cresatin) to induce apical closure [8]. The mechanism by which calcium hydroxide induces the formation of a solid apical barrier are not fully understood. Some attribute its action solely to its antibacterial activity, while others emphasize its high pH or its direct effect on the apical and periapical soft tissues [9]. The alkaline pH and calcium ions might play a role either separately or synergistically. The calcium required for apical bridge formation comes through thesystemic route as demonstrated by Pisanty and Sciacky [10].

Siqueira and Lopes discussed the mechanism of its antimicrobial activity in detail. Calcium hydroxide assists in the debridement of the root canal, as it increases the dissolution of necrotic tissue when used alone or in combination with sodium hypochlorite.[11]

Mitchell and Shankwalker studied the osteogenic potential of calciumhydroxide and other materials when implanted into the connective tissue of rats [12] . Of the [11] materials used in comparative studies, only three gave any evidence of induced calcification. They concluded that calcium hydroxide had a unique potential to induce formation of heterotopic bone in this situation.[11,12]

Since in the vast majority of cases non vital teeth are infected, the first phase of treatment is to disinfect the root canal system to ensure periapical healing. The canal length is estimated with a parallel preoperative radiograph and confirmed radiographically with the first endodontic instrument. The root length cannot be determined with apex locator as it is not reliable in teeth with open apices [20]. Preparation of the canal owing to the thin dentinal walls is performed very lightly and with copious irrigation using 0.5% sodium hypochlorite (NaOCl). Lower strength of NaOCl is used because of the increased danger of extruding NaOCl through open apex .The canal is dried with paper points and a creamy mix of calcium hydroxide is spun into the canal with lentulo spiral. The calcium hydroxide is left in the canal for at least one week to be effective in accomplishing disinfection[13].

At the second visit, a thick paste of calcium hydroxide will be packed in the root canal. Ca(OH)2 placement methods vary from injection of paste, using lentulo spirals and condensation or even using packed dry powder. Many authors consider a continuous intimate contact of calcium hydroxide with apical and periapical tissue as desirable [14]. Therefore it should be beneficial to use calcium hydroxide placement method that will provide the best retention of the material in the canals.

Metzger et al concluded from their study that injection of calcium hydroxide paste was the easiest method to use.[14]

However, the injected paste was poorly retained in the canals. Condensation of calcium hydroxide with hand pluggers was the most demanding and time consuming procedure, yet retention of the paste in the canals was superior to retention with either of the two methodsfilling with lentulo spirals and injection method used [15].

Reports vary as to the time required to achieve the goal of apical barrier formation. Heithersay achieved apical closure in the time range of 14 to 75 months. Chawla [15] used calcium hydroxide paste and achieved closure within 6 to 12 months. Kleier [16] found closure of apex within 1 to 30 months.

The aim of this study was to report the 10year follow-up data of an apexification treatment applied to a permanent incisor of a young patient treated with calcium hydroxide.

CASE DETAILS:

A 10-year-old female patient reported complaining of pain in the upper front tooth since 3 days. [Fig.1]There was a history of trauma to the same tooth due to fall about 4 days back. On clinical examination, Elli's Class III fracture in permanent maxillary right central incisor was evident. Periapical radiograph showed incomplete root formation with wide open apices for the same tooth [Fig.2] . Apexification with calcium hydroxide dressing was planned. In the first visit, an access cavity was prepared with a straight line entry into the root canal . The working length was established within one mm of the radiographic apex by using size 30 Hedstrom file. Next, pulp extirpation and complete debridement of the canal was done using H file number 40 followed by copious irrigation with normal saline. After drying of the canal using paper points, calcium hydroxide powder was mixed with normal saline and this

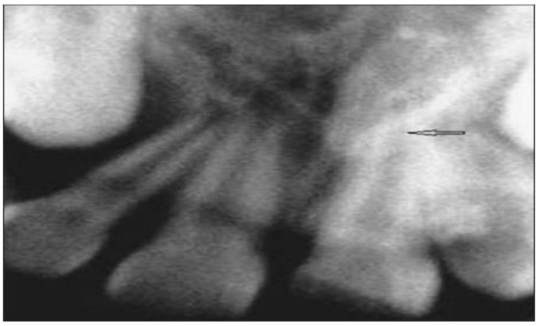

Figure 1: Periapical radiograph showing wide open apex in relation to 21

mixture was placed into the canal and pushed to the short of apex using plugger. Access opening was restored with glass ionomer cement . [Fig.3] Patient was called after 3 months. After 3 months when patient came back, a periapical radiograph was taken, which showed complete formation of the root apex in maxillary right central incisor, without any signs and symptoms and periapical radiolucency. Clinically, apical barrier formation was confirmed by using a size 30 Gutta-percha (GP) point to check for the presence of a resistant "stop" and absence of hemorrhage, exudates or sensitivity In the next visit, complete obturation was carried out with GP using lateral condensation technique followed by composite restoration. [Fig.4]

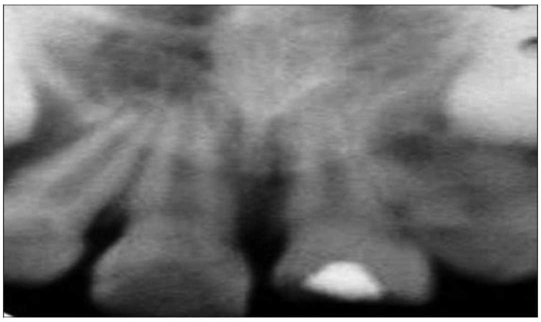

Figure 2: Periapical radiograph showing placement of CaOH dressing

DISCUSSION

The purpose of this paperwas to show the capacity of calcium hydroxide to ensure the long-term success of apexification in a case study. In powder form, calcium hydroxide (molecular weight = 74.08) is a strong base (pH = 12.5–12.8) that has poor water solubility (≈ 1.2 gL−1 at 25∘C) with thixotropic behavior and is insoluble in alcohol. It dissociates (dissociation coefficient = 0.17) into calcium (54.11%)

and hydroxyl (45.89%) ions [3]. It was introduced as a biocompatible endodontic agent for direct pulp-capping in 1920 [17]. Since 1966, it has also been employed in apexification [18].

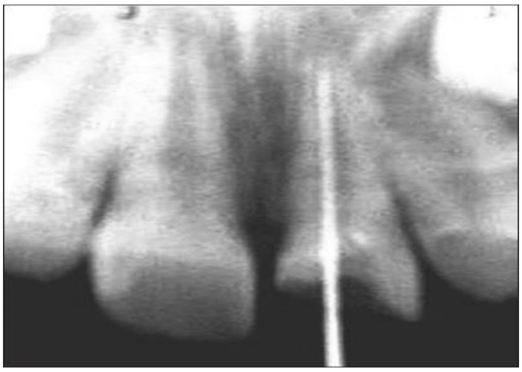

Figure 3: Periapical radiograph taken after 3 months shows confirmation of apical barrier with gutta-percha point

The drawbacks of calcium hydroxide apexification are, multiple visits leading to inevitable high costs; increased risk of root fracture; long time-span; root length compromised; thin lateral dentinal walls increasing the chances of root fracture; prevent apical pulp tissue regeneration due to calcific barrier formation; and it may damage the Hertwig's epithelial root sheath. To overcome the drawbacks of calcium hydroxide, mineral trioxide aggregate (MTA) was used which induced hard tissue formation within a short time-span and improved patient compliance.[19,20]

A new technique known as Revitalization/ Revascularization which is an attempt to revitalize tissues in the pulp space and continued root formation in immature nonvital pulps is being investigated. The results of clinical trials shows high success rate in terms of regeneration of pulp, increased root length, and thickening of lateral dentinal walls, however, these preliminary reports still needs to be analyzed before its clinical application.[21]

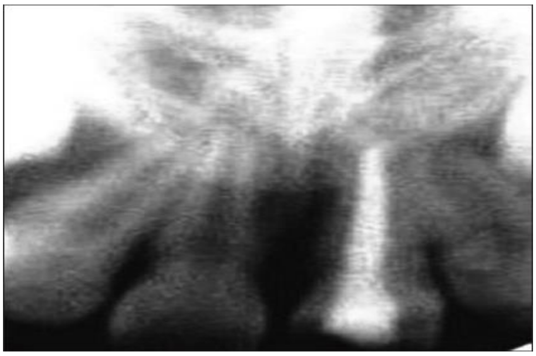

Figure 4: Radiograph showing complete obturation of 21

Calcium hydroxide should be refreshed every three months, which requires multiple visits with inevitable clinical costs and the increased risk of tooth fracture since many dressing changes are necessary till the formation of a calcified barrier [22]. In this case when new, clean calcium hydroxide paste had been introduced into the canal, it was changed in every three months. However, in very young patients with 'blunderbuss' apex, the paste may dissolve and wash out from the root canal so quickly that, at least at the beginning of the treatment, it may have to be changed more often than every three months. Granulation tissue which often grows into the apical area of a wide open root canal is sometimes difficult to remove with instruments. However, like in the presented case it necrotizes when calcium hydroxide is packed into the canal, and at the subsequent visit can be rinsed out of the canal with sodium hypochlorite [22,23,24]

There are two schools of taught regarding the need to replace the calcium hydroxide paste, some authors suggest a single application is sufficient to induce hard tissue barrier apically, because the calcium hydroxide paste acts only as a catalyst for deposition of calcified tissue and as a filler material in the canal space.[25]

Another group of authors recommend that renewal of paste is necessary in presence of a very wide foramen and inflammatory exudates in the apical region which increases the rate of dissolution of the paste. Therefore, renewal of calcium hydroxide paste in the initial stages cannot be under-estimated in infected immature teeth for the successful apical closure.[26]

The frequency of periapical healing and apical hard tissue closure of non-vital immature teeth after long-term calcium hydroxide treatment is in the range of 90-95%, which shows that the treatment has predictable outcome. On the other hand, if an apexification procedure is not performed prior to obturating the root canal of immature tooth, the success rate of the treatment is less than 50%. [24]

In the present case report, the case 1 was treated with replacement of calcium hydroxide paste because the tooth was necrotic with inflammatory exudates present in the canal, while in case 2, the tooth was left without renewal. The rate of barrier formation in case 2 was faster than the tooth in which replacement of paste was done. This may be due to the very wide open apex in the first case or the presence of inflammatory exudates in the canal.

The majority of dental trauma patients require multidisciplinary cooperation. Adequate integrated treatment planning, coordination, and execution are necessary for the proper management of complex cases .In the presented case, the patient regained his esthetic and function due to cooperation of Endodontics, Operative Dentistry, Periodontology and Prosthodontics departments. [26,27]

One of the long-term failures that have been reported in the literature are root fractures of teeth after apical barrier formation and obturation. This has been attributed to the prolonged use of calcium hydroxide as an apexification agen The hypothesis was that long-term exposure to calcium hydroxide may weaken the dentine, thus making the roots more susceptible to fracture. [19]

In a retrospective study of 885 luxated non-vital immature incisor teeth, treated with calcium hydroxide and followed-up for four years, it was observed that the main root fractures were at the cervical region in 77% of immature teeth compared to 2% in mature teeth. These results indicated that the thin dentine walls in immature incisors could be one of the reasons. This view was supported by finding a significant relationship between fracture and defects after inflammatory resorption of the root had arrested. [28]

Al-Jundi, performed an analysis of the outcomes of their previously reported retrospective study regarding complications due to the late presentation of dental trauma. Examination of dental records and radiographs of 195 children with 287 teeth aged from 15 months to 14 years old were performed then a clinical and radiographic follow-up was scheduled at 3, 6, 12, 24 and 36 months. Among the outcomes assessed in this study were root fractures as a long-term complication following apexification. It was reported in 83 patients who had apexification treatment, 32% had root fractures, 85% of these which had occurred spontaneously. The technique of apexification and type of restorations provided were among some key information that was not reported in the study. [29]

Andreasen et al., in an in vitro study on sheep's immature teeth concluded that a marked decrease in fracture strength occurred with increasing storage time (in saline) for teeth treated with calcium hydroxide dressing. It was also concluded that the fracture strength of calcium hydroxide-filled immature teeth was halved in about a year due to the root filling and this might explain the frequently reported fractures observed with long term use of calcium hydroxide or mineral trioxide aggregate. [19]

Rosenberg et al., in an in vitro study on human teeth concluded that the intra-canal calcium hydroxide weakened the dentine strength by 43.9% after 84 days of application. In this study all teeth were embedded in plaster blocks that were carved to end at the cervical margins of teeth and tested for fracture strength using a testing machine. One of the problems in interpretation of the results was related to a real-life situation, i.e. human teeth are functioning in the oral environment and lying within a unique system of highly specialised periodontium. The behaviour of these teeth under the experimental conditions when stored in saline for prolonged periods of time and then subjected to mechanical forces while embedded in plaster may be totally different from teeth that are subjected to physiological forces, and surrounded by the periodontium. Other forces may play a more important role in the increased fracture susceptibility (if present) in these teeth e.g. thin week dentine walls of immature teeth. [30]

Kawamoto et al., in vitro study that exposure to calcium hydroxide over 90 days increased the elastic modulus of dentine, making the effected tooth more prone to fracture [31]. The same finding was found in Twati et al.,[32] that the dentine was weakening by 50% after eight months of calcium hydride application. A more recent study stated that the prolonged contact of calcium silicate–based mineral had an adverse effect on the integrity of dentine collagen matrix that led to root fracture [33]

Although calcium hydroxide is the gold standard root canal disinfection material, it is not recommended to be used for teeth that are going to be treated with regenerative endodontic techniques. Banches and Trope [34] have suggested that the use of calcium hydroxide might be lethal to the remaining pulpal stem cells, which affect future regenerative treatment[35] or possibly disrupt the apical papilla cell reproduction.This is ultimately critical for stem cell survival and thus discontinued root development.[34]

CONCLUSION

Introduction of techniques for one-visit apexification provide an alternative treatment option in these cases. Success rates for calcium hydroxide apexification are high although risks such as reinfection and tooth fracture exist. Prospective clinical trials comparing multiple and one-visit apexification techniques are required. Calcium hydroxide has been included within several materials and antimicrobial formulations that are used in a number of treatment modalities in endodontics. Calcium hydroxide is an amazing material which has a number of applications in dentistry and especially in endodontics, apart from being very economical and ease in handling properties compare to other material like MTA (mineral trioxide aggregate) which is also being used in endodontics recently. Calcium hydroxide is still a material of choice which is widely being used for various reasons in endodontics, especially in rural practice.

REFERENCES:

1. American Association of Endodontics. American Association of Endodontics Glossary of endodontic terms, 7th edition. Chicago, IL: American Association of Endodontics, 2003.
2. Andreasen JO. Traumatic injuries of the teeth. 3. ed. Copenhagen: Munksggard;1984. 478p.
3. T. A. Strom, A. Arora, B. Osborn, N. Karim, T. Komabayashi, and X. Liu, "Endodontic release system for apexification with calcium hydroxide microspheres," Journal of Dental Research2012 , vol. 91, no. 11, pp. 1055–1059
4. L. R. G. Fava and W. P. Saunders, "Calcium hydroxide pastes: classification and clinical indications," International Endodontic Journal1999, vol. 32, no. 4, pp. 257–282
5. A. J. DiAngelis, J. O. Andreasen, K. A. Ebeleseder et al., "International association of dental traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations of permanent teeth," Dental Traumatology2012, vol. 28, no.1, pp. 2–12 .
6. Nygaard-Ostby B. The role of the blood clot in endodontic therapy. Acta Odontol Scand 1961;19:323–46.
7. Torabinejad M, Chiavian N ; Clinical application of mineral trioxide aggregate. Journal of Endodontics1993, 25, 197–205.
8. Estrela C, Sydney GB. EDTA effect at root dentin pH then exchange of calciumhydroxide paste.BrazEndod J. 1997;12-7.
9. O'Neil MJ (Ed.). The Merck index: an encyclopedia of chemicals, drugs andbiologicals. 13. ed. New Jersey: Merck & Co., Inc.; 2001

10. Pisanti S, Sciaky I. Origin of calcium in the repair of wall after pulp exposure in the dog. J Dent Res 1964;43:641-644
11. Siqueira JF, Lopes HP. Mechanism of antimicrobial activity of calcium hydroxide: a critical review.IntEndod J1999;32:361
12. Mitchell DF and ShankwalkerGB.Osteogenic potential of calcium hydroxide and other materials in soft tissue and bone wounds. J Dent Res 1958;37:1157-1163
13. Bakland LK. Traumatic dental injuries.In: Ingle JI, BaklandLK,Endodontics, 4th ed. Baltimore: Williams and Wilkins 1994:764-814
14. Metzger Z, Solomonov M, Mass E. Calcium hydroxide r e t e n t i o n i n wi d e r o o t c a n a l s wi t h f l a r i n g apices.DentTraumatol 2001;17:86-92
15. Walia T, Chawla H, Gauba K. Management of wide open apices in non vital permanent teeth with calcium hydroxide paste. JClinPediatr Dent 2000 ;25(1):51-56
16. KleirDJ,Barr ES.A study of endodontically apexifiedteeth. Endod Dent Traumatol 1991;7:112-117
17. Z. Mohammadi and P. M. H. Dummer, "Properties and applications of calcium hydroxide in endodontics and dental traumatology," International Endodontic Journal2011, vol. 44, no. 8, pp. 697–730
18. A. L. Frank, "Therapy for the divergent pulpless tooth by continued apical formation,"TheJournal of the AmericanDental Association1966, vol. 72, no. 1, pp. 87–93
19. Andreasen JO, Farik B, Munksgaard EC. Long-term calcium hydroxide as a root canal dressing may increase risk of root fracture. Dent Traumatol. 2002; 18:134–7.
20. Cvek M. Prognosis of luxated non-vital maxillary incisors treated with calcium hydroxide and filled with gutta-percha: A retrospective clinical study. Endod Dent Traumatol. 1992; 8:45–55.
21. Shabahang S, Torabinejad M, Boyne PP, Abedi H, McMillan P. A comparative study of root-end induction using osteogenic protein-1, calcium hydroxide, and mineral trioxide aggregate in dogs. J Endod. 1999; 25:1-5.
22. Huang GTJ. Apexification: the beginning of its end. Int Endod J. 2009; 42(10):855-66.
23. Andreasen JO, Farik B, Munksgaard EC. Longtermcalciumhydroxideas a root canal dressing may increase the risk of root fracture. Dent Traumatol.2002;18:134-7.
24. Rafter M. Apexification: a review. Dent Traumatol. 2005;21:1-8.
25. Leif Tronstrad ; Clinical Endodontics: A Textbook, 2nd revised edition edn., NY: Thieme.2007
26. Chawla HS. Apical closure in a nonvital permanent tooth using one Ca(OH)2 dressing. ASDC J Dent Child. 1986; 53:44-7.
27. Leonardo MR, Silva LAB, Leonardo RT, Utrilla LS, Assed S. Histological evaluation of therapy using a calcium hydroxide dressing for teeth with incompletely formed apices and periapical lesions. J Endod. 1993; 19:348–52.
28. Ertugrul F, Eden E, Ilgenli T. Multidiciplinary treatment of complicated subgingivally fractured permanent central incisors: two

case reports. Dent Traumatol. 2008;24:61-6.

29. Leroy RL, Aps JK, Raes FM, Martens LC, De Boever JA. A multidisciplinary treatment approach to a complicated maxillary dental trauma: a case report.Endod Dent Traumatol. 2000;16:138-42.
30. CVEK, M ; Prognosis of luxated non-vital maxillary incisors treated with calcium hydroxide and filled with gutta-percha. A retrospective clinical study. Endodontics & Dental Traumatology1992, 8**,** 45-55.
31. AL-JUNDI, S. ; Dental emergencies presenting to dental teaching hospital due to complications from traumatic dental injures. Dental Traumatology2002, 18 181-185.
32. ROSENBERG, B., MURRAY, P. & NAMEROW, K. ;The effect of calcium hydroxide root filling on dentin fracture strength. Dental Traumatology2007, 23**,** 26-29.
33. KAWAMOTO, R., KUROKAWA, H., TAKUBO, C., SHIMAMURA, Y., YOSHIDA, T. & M., M. Change in elastic modulus of bovine dentine with exposure to a calcium hydroxide paste. Journal of Dentistry2008, 36**,** 959-64.
34. TWATI, W., WOOD, D., LISKIWEICZ, T., WILLMOTT, N. & DUGGAL, M. An evaluation of non setting calcium hydroxide on human dentine: a pilot study. European Archives of Paediatric Dentistry 2009,10**,** 104-109.
35. LEIENDECKER, A., QI, Y., SAWYER, A., NIU, L., AGEE, K., LOUSHINE, R., WELLER, R., PASHLEY, D. & TRAY, F. Effects of Calcium Silicate–based Materials on Collagen Matrix Integrity of Mineralized Dentin. J DentinEndod2012, 38**,** 829–833.
36. BANCHS, F. & TROPE, M. ; Revascularization of immature permanent teeth with apical periodontitis: new treatment protocol? J Endod 2004,30**,** 196 - 200.
37. LIU, H., GRONTHOS, S. & SHI, S. Dental pulp stem cells. Methods Enzymol2006, 419**,** 99 -113.