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Efficacy of spirally filled versus injected non-setting calcium hydroxide dressings

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Abstract – The aim of this study was to evaluate the adequacy of spirally filled vs injected non-setting calcium hydroxide (NS $Ca(OH)_2$) in the management of traumatized permanent teeth undergoing endodontic treatment for apexification, control of infection or the management of root resorption. A random selection of patients with traumatized teeth undergoing endodontic procedures was made. A total of 100 cases were assigned for placement of NS $Ca(OH)_2$ by spiral filling and 50 cases by injection of the dressing directly into the canal. Post-operative radiographs were assessed for complete canal obturation and in particular, the density and length of the dressing within the canal. The results revealed that the injected NS $Ca(OH)_2$ dressing consistently produced better results than the spirally placed dressings. It also completely removed the chance of instrument fracture and as a result of this trial, the department of child dental health has now adopted the use of this injectable system.

Trauma to the permanent dentition is common during adolescence and treatment outcome is heavily related to the stage of tooth development, the severity and the type of injury sustained by the teeth (1). Unfortunately, common sequelae of significant dental trauma especially to anterior teeth are pulpal necrosis secondary to direct pulp involvement or damage to the supporting periodontal structures. The prevalence of pulpal necrosis following a luxation type injury has been reported to be in the region of 15–59% (2).The necrosis in combination with the trauma itself can lead to several signs and symptoms including pain, swelling, discoloration of the crown, sinus formation and abnormal mobility of the tooth.

Once pulpal necrosis or its sequelae occur it is recommended that the affected teeth be debrided and dressed with a suitable inter-appointment medicament, as it is possible for some bacteria to survive in the canal system even after chemo-mechanical preparation (3). Different inter-appointment medicaments have been used (4) including non-setting calcium hydroxide (NS $Ca(OH)_2$), which was first described by Frank (5) in 1966. Research into the efficacy of NS $Ca(OH)_2$ has proven it to be a useful agent to provide a favourable environment for apexification (induction of a hard tissue barrier at the apex) (6, 7), arrest and repair of external inflammatory root resorption (6), elimination of microorganisms (6), induction of periradicular healing (8) and as an inter-appointment medicament (1). The therapeutic effect is reported to be due to the dissociation of the calcium hydroxide ($Ca(OH)_2$) into hydroxyl (OH^-) and calcium (Ca^{2+}) ions (9), with the antibiotic effect highly dependent on the hydroxyl ions in solution (10). In addition as an inter-appointment medicament, the NS $Ca(OH)_2$ will break up and therefore aid the dissolution of necrotic tissues (11) and reduce inter-appointment symptoms (12). Kinirons et al. (7) established in their two-centre study the importance of good placement of NS $Ca(OH)_2$ in the apical third of the prepared canal. Inadequate placement in the apical region of the canal would necessitate replacement of the dressing to prevent formation of the hard tissue barrier coronal to the apex. This observation supported earlier evidence by Sigurdsson et al. (13), which concluded that to achieve its effect, the entire canal should be obturated with an homogenous mass. Kinirons et al. (7) also concluded that the dressing should be changed on a three-monthly basis to avoid ingress of material from the apex if the NS $Ca(OH)_2$ dissolves. The prognosis of traumatized teeth can be greatly influenced by the quality of the dressings placed, especially if apexification is required or root resorption is to be avoided. Therefore, an efficient and effective system is required for the placement of NS $Ca(OH)_2$ dressings that can be used by both inexperienced and experienced operators alike.

In this Dental Hospital prior to 2002, NS $Ca(OH)_2$ was commonly placed in canals using the spiral instrument technique. Anecdotal evidence suggested that the quality and time needed to place a spiral filling is relative to the skill of the operator. The aim of this paper was to compare the placement of NS $Ca(OH)_2$ using spiral fillers with a recently introduced injectable type for quality and efficiency.

Methods

This investigation involved the random selection of patients with asymptomatic traumatized teeth undergoing endodontic procedures in the department of child dental health. The sample included 100 cases using

spirally placed calcium hydroxide dressings and 50 cases using the injectable system (Ultradent; Ultradent products Inc, South Jordan, Utah, USA). All teeth were prepared with standard triangular-shaped palatal access cavities to gain access to the pulp chamber and then isolated using rubber dam. Pulp tissue was grossly removed using a barbed roach and the neck of the canal system refined with increasingly sized gates glidden files to improve straight-line access. Working length radiographs were taken to establish a clinical working length and the canal was gently cleaned and shaped up to at least a number 70 file (for maxillary central incisors). Canals were irrigated with a combination of sodium hypochlorite solution and sterile normal saline and then dried accordingly with paper points. In both samples, UltraCal® XS (Optident Ltd, International Development Centre, West Yorkshire, UK) was used as the calcium hydroxide paste to reduce variability between groups. This is an aqueous and radiopaque paste containing barium sulphate with a pH of 12.5. Spiral application was completed with a staged technique with paper-point condensation as previously described by Sheehy (4). The injectable application was via a suitably sized disposable tip placed 2 mm short of the apex and withdrawn on placement. It is important to select the correct size of the application tip (NaviTip/Capillary Tip, Optident Ltd., Ilkley, UK) as this must sit passively in the canal to prevent its occlusion and allow the material to flow. Cavities were then sealed with dry cotton wool placement in the pulp chamber and glass ionomer cement in the access cavity. Post-operative radiographs were assessed for complete canal obturation and in particular density and length of the dressing. Cases were carried out by staff at all levels within the department from house officer to consultant who were blind to the study. Case notes were retrospectively examined by an independent assessor to determine the reason for the dressing, initial injury, tooth involved and adequacy of the NS $Ca(OH)_2$ dressing. The results were analyzed using observational statistics.

Results

The results were compiled and tabulated to show comparison between the two methods used. The most common teeth involved were the upper central incisors (82%). The commonest types of sustained injuries requiring endodontic treatment were enamel/dentine fractures (27%) and extrusions (29%) (Fig. 1). Fig. 2 shows the assessment of the post-operative radiographs for each technique. From the results, 74% of the dressings completed with the injected NS $Ca(OH)_2$ had uniform density throughout the canal and were within 2 mm of the radiographic apex (Fig. 3) compared with only 36% of the spirally filled cases. Furthermore, 23% of spirally filled canals had totally unsatisfactory dressings (Fig. 4) with poor apical third fill and irregular density that would be likely to result in poor efficacy.

There were no complications associated with the placement of the injectable type whereas there were two cases of instrument separation with the spiral fillers (Fig. 5).

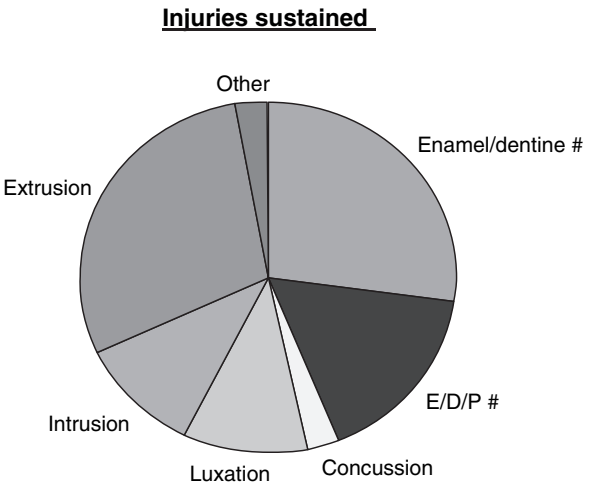

Fig. 1. Pie chart showing the types of injuries requiring treatment.

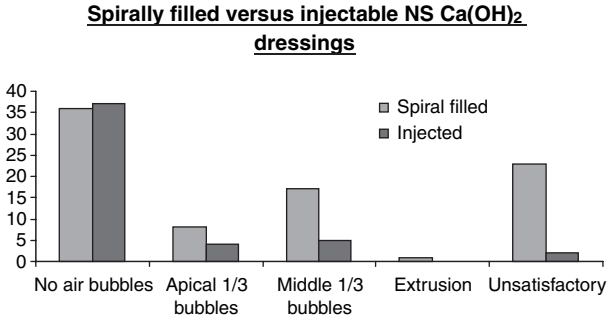

Fig. 2. Bar chart showing quality of dressings.

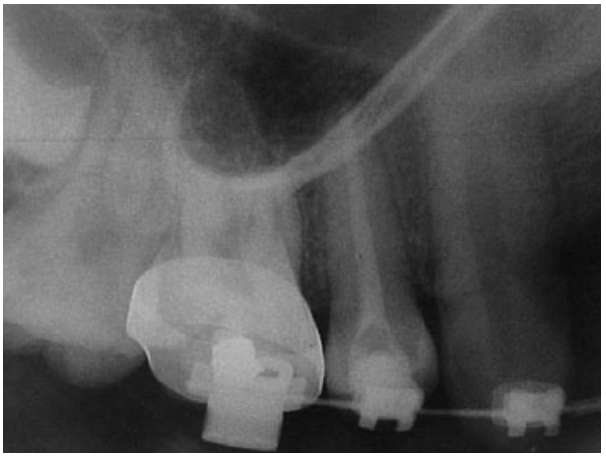

Fig. 3. Radiograph showing well-condensed dressing using the injectable type.

Discussion

Borssen and Holm (14) reported in 2000 that 35% of the 16-year-olds studied have suffered either primary or secondary dentition trauma with a male differential. This highlights the common nature of trauma especially in

Fig. 4. Radiograph showing a poor quality dressing using the spiral filler.

Fig. 5. Radiograph showing fractured spiral filler.

adolescents and makes it even more important that efficient and effective procedures are in place to handle the volume of work created. The above results are supported by previous *in vitro* studies performed by Filippi et al. (15) that a retrograde injectable system is quicker and simpler than the alternative spiral fill technique and the later technique confers no additional advantages. Our study furthermore infers that the injectable technique is more reliable for less experienced operators or those practitioners not performing the treatment on a regular basis. As well as producing a more reliable result, the placement of NS $Ca(OH)_2$ with the injectable tips avoids the dangers of instrument separation (Fig. 5) as they are single use units and improves access to posterior teeth. Instrument separation can be troublesome for the treating dentist possibly necessitating the involvement of a specialist. In the worst cases, this could jeopardize the prognosis of the affected teeth. As a result if instrument separation is avoidable completely, then this infers a significant advantage to the procedure.

During the process of apexification, NS $Ca(OH)_2$ is placed into an open-ended canal to provide a favourable environment for the formation of a hard tissue barrier. As the injectable system allows the easy deposition of the paste to the apex it is possible to inadvertently extrude it through the open apex into the periradicular tissues, especially if a chronic or large lesion was present. Tronstad et al. (16) speculated that the direct effect on inflamed tissue and epithelial cyst linings would favour healing and encourage osseous repair; whereas Himel et al. (17) considered bone necrosis a possibility in a similar fashion to cellular damage following early calcium hydroxide dressing of avulsed teeth. De Moor (18) examined this further in 2002 and concluded that overextensions into periradicular lesions, in general lead to mild and transient tissue reactions and extensive extrusion did not compromise healing but was not advocated.

The quality of the placement of calcium hydroxide in the canal system, especially in the early stages after extirpation/debridement, can be affected by the degree of remaining adherent tissue within the canal and persistent exudation. In such situations, the properties of the NS $Ca(OH)_2$ when placed as an inter-appointment medicament allow the inflammatory symptoms to subside and allow better fill at the second visit.

The long-term use of NS $Ca(OH)_2$ as an adjunct to apexification has been suggested by *in vitro* studies by Andreasen et al. (19) to reduce the fracture strength of the treated tooth. There is also the risk of re-infection of the tooth the longer the apexification takes. Since the introduction of mineral trioxide aggregate (MTA), several authors have investigated its use for apexification (20) along with repair of iatrogenic root perforations (21) and direct pulp capping (22). The use of MTA for one-visit apexification produces an artificial apical stop that would allow the root canal to be filled after the initial setting period. This technique would negate the need for multiple visits with the risk of failure of the temporary coronal seal and subsequent re-infection of the tooth. Witherspoon and Ham(23) concluded that this is a viable option for treating immature teeth with necrotic pulps and should be considered as an effective alternative to calcium hydroxide. Further prospective trials comparing these techniques are required, but it does seem that one-visit apexification is an alternative to long-term apexification with calcium hydroxide(24).

Conclusion

Injected NS $Ca(OH)_2$ consistently produced better results than the spirally placed dressings and placement of quality dressings is predictable with injectable NS $Ca(OH)_2$. As a result of this trial, our unit has adopted the use of the injected NS $Ca(OH)_2$ and spiral fillers are also available for more experienced operators.

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