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Intracanal dressing and root canal filling materials in tooth replantation: a literature review

INVITED REVIEW

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Abstract – The prognosis of tooth replantation is usually related to the need of endodontic treatment, which has a direct relationship with the occurrence of root resorptions. Several studies have been undertaken in an attempt to prevent, delay, or treat these complications, which are the main causes of loss of replanted teeth. This literature review examines research evidence on intracanal dressings and root canal filling materials used in cases of tooth replantation. A comprehensive search was performed in the Medline/Pubmed, Bireme and Scielo full-text electronic journal databases to retrieve English-language articles referring to these topics that had been published between 1964 and 2010. Calcium hydroxide (CH) remains the usually recommended choice as an intracanal medicament in replanted teeth; however, there is evidence to support the initial use of a corticosteroid-antibiotic combination such as Ledermix paste to control potential early resorption, prior to the introduction of CH where the beneficial effect in the treatment of progressive root resorption has been well proven. Regarding root filling materials, CH-containing sealers are a good option because of their biological properties. Accurate diagnosis and adequate treatment plan may constitute very complex tasks, particularly in tooth avulsion because several variables are involved. In addition to the technical knowledge and clinical experience directed toward the quality of treatment, patient education may favorably influence the survival of replanted teeth.

Tooth avulsion because of trauma deserves great attention in dentistry because of its esthetic and functional implications. The ideal procedure in case of avulsion is the immediate replacement into the socket, followed by splinting and careful observation for revascularization in cases with incomplete root development or endodontic treatment in mature teeth, so that maintenance of natural teeth can be achieved. Replantation of teeth with a poor prognosis because of a prolonged extra-oral dry time can postpone the placement of a prosthodontic replacement and so help the patient assimilate the ultimate loss of the replanted tooth.

When a tooth is avulsed, the apical blood supply is severed and the periodontal ligament (PDL) is severely damaged. While pulp necrosis is certain, under specific circumstances, it is possible for the pulp space of the replanted tooth to revascularize. Hence, when the avulsed tooth is immature with an open apex, all efforts should be made to promote revascularization. When an apex is closed or nearly closed (< 1 mm), revascularization is highly unlikely and root canal treatment is recommended (1–7).

If root canal treatment is indicated (teeth with closed apex), the ideal time to begin treatment is 7–10 days postreplantation. Calcium hydroxide (CH) is recommended as intracanal medication for up to 1 month followed by root canal filling with an acceptable material. An exception is a tooth that has been dry for more than 60 min before replantation; in such case, root canal treatment can be performed prior to replantation (2). In teeth with open apexes that have been replanted immediately or kept in appropriate storage media, pulp revascularization is possible. Root canal treatment should be avoided unless there is clinical and radiographic evidence of pulp necrosis (2).

Clinical experience has shown that immediate replantation rarely occurs because of factors such as the presence of extensive life-threatening injuries, complex damage to the recipient site, or simply lack of knowledge of replantation procedures. In most situations, avulsed teeth are exposed to dry conditions for long periods (8) and the cemental PDL is necrotic at the moment of replantation, needing to be removed (9). In these cases, if the contamination is controlled by means of endodontic treatment and systemic antibiotic therapy, inflammatory root resorption might also be prevented, but the occurrence of ankylosis and replacement resorption is expected because of the loss of the PDL (10). Newly formed alveolar bone tissue fills the space previously occupied by the PDL fibers, and the entire root is slowly replaced by bone (11).

The prognosis of tooth replantation is usually related to the need of endodontic treatment because of its direct relationship with the occurrence of external inflamma-

tory root resorption. Several studies (10, 12–19) have demonstrated that root resorption secondary to replantation may be prevented or controlled with endodontic therapy, and several substances have been used for such purpose (9, 12, 14, 15, 19–34). This article presents a literature review on intracanal dressings and root canal filling materials used in cases of tooth replantation.

Literature review

External root resorption is a very frequent event in cases of tooth replantation, and the endodontic therapy is an important step of the treatment to avoid the loss of replanted teeth. Several substances have been used as intracanal dressings, namely CH paste associated with hydrosoluble and non-hydrosoluble vehicles (9, 12, 14, 20–22, 25, 27–30, 32), antibiotics (24), corticosteroids (34), combinations of corticosteroids and antibiotics (15, 19, 23, 26, 31, 33), and inhibitors of osteoclastic bone resorption such as calcitonin (35–38), gallium nitrate, acetazolamide, and alendronate (16–18).

Gutta-percha is the most frequently used root canal filling material (9, 28, 36, 39–43) in combination with zinc oxide and eugenol-based sealers (21, 22, 34, 44, 45) and CH-based sealers, such as Sealapex (37, 38, 46). The use of mineral trioxide aggregate (MTA) has also been investigated in immediate tooth replantation (47).

Intracanal dressings

CH paste

CH is by far the most widely used intracanal medication because it aggregates the largest number of desirable properties for such purpose (48–50), in particular two significant enzymatic properties: it inhibits bacterial enzymes, producing an antimicrobial effect, and it activates tissue enzymes like alkaline phosphatase, producing a mineralizing effect (50).

Clinical studies have investigated its use in replanted teeth for minimizing the sequelae of resorptive processes (20–22, 29, 47, 51). Andreasen and Kristerson (9) replanted experimentally monkeys' teeth after root canal filling with CH or gutta-percha and found a higher incidence of ankylosis when CH therapy was performed before replantation. On the other hand, Dumsha and Hovland (28) did not find significant differences between these conditions with respect to the occurrence of root resorption.

The influence of CH paste prepared with either aqueous or oily vehicles was analyzed in both immediate and delayed tooth replantation, and the results showed a predominance of surface resorption in all groups and a decrease in inflammatory root resorption, mainly when an aqueous vehicle was used (30, 32).

It is important to consider some factors regarding the use of CH as an intracanal medication, mainly those referring to the vehicles and associations of substances to CH as well as the duration of the CH therapy. The addition of different substances to the CH paste aims at improving some of its properties, such as antimicrobial action, ion dissociation rate, and physicochemical properties, creating favorable clinical conditions for its use (52). However, it should be discussed which is the best vehicle for each case and whether the highly alkaline pH of CH could inactivate the substances incorporated to the paste. Estrela et al. (53) investigated the effect of vehicle on antimicrobial properties of CH pastes and concluded that the vehicles play a supportive role in the process by giving pastes chemical characteristics such as dissociation and diffusion as well as allowing for an adequate filling of the canals. These factors are decisive for antimicrobial potential and tissue healing. Based on these chemical properties, scientific reasoning indicates the use of hydrosoluble vehicles (e.g., distilled water and saline) (30, 32, 47, 50).

The biological characteristics of CH, represented mainly by the excellent antimicrobial potential and tissue-healing capacity, make this substance a therapeutic option as an intracanal medication. However, as far as intracanal medications are concerned, it is important to know the microbiota of infected root canals and the mechanism of action of the material to be used. The medicaments must remain in the root canal system for insufficient time to reach and kill the bacterial cells, be able to act at distance, and neutralize the residues of aggressive agents (52).

The intracanal efficacy of CH is very well accepted, but the duration of the CH therapy is also important. As dentin alkalinization depends on the penetration of hydroxyl ions into the dentin tubules, it may be delayed by the physical resistance produced by the content of these structures and by the initial neutralization of the ions by the dentin buffering capacity. Some studies have demonstrated that the increase in dentin pH after CH therapy needs 2–4 weeks to reach the maximum dentin depth (54). The importance of the CH dressing changes has been confirmed histologically by Holland et al. (55) because of the greater probability of this material suffering alterations in the apical root third by either neutralization of its pH because of contact with the tissue fluids or its chemical reaction with tissue carbon dioxide or even its resorption.

Regarding the ideal moment for starting CH therapy in the treatment of root resorption, the literature shows that the placement of CH dressings in cases of delayed replantation produces more extensive areas of ankylosis and more severe cementum and dentin resorption compared with the cases in which CH-based dressings are not used, probably because of the alkaline pH of the paste, contraindicating its prolonged use (12). Kemp and Mourrino (56) has shown that the endodontic treatment before replantation prevents the occurrence of inflammatory root resorption and that the placement of CH dressings for longer periods than 1 week is more effective against established inflammatory root resorption. However, Gregoriou et al. (27) observed that CH therapy after replantation produced better results without significant differences regarding the occurrence of surface, replacement, or inflammatory resorption and concluded that the endodontic treatment should be performed 7–14 days after replantation, and not immediately, to reduce the occurrence of ankylosis.

Regarding the duration of CH therapy before the definitive obturation, the findings in the literature are controversial. Andreasen and Andreasen (57) recommend that the first change of dressing is performed 1 month after replantation and then after 3 or 4 months, if necessary. Trope et al. (25) reported evidence that short- and long-term CH treatment resulted in similar healing patterns when endodontic treatment is initiated 14 days after replantation of teeth. Overall, before the definitive obturation is performed, there must be clinical and radiographic evidence that the sequalae of replantation are under control and that the persistence of CH therapy may be an aggravating factor, potentially causing weakening of dental structure and coronal leakage at the margins of the provisional restoration (58–61).

In spite of its excellent biological properties, CH has some disadvantages such as long treatment duration (62, 63), need of changes (64, 65), and weakening of the dental structure after prolonged intracanal therapy (58–61). Studies in monkeys' teeth have suggested that CH increases the risk of ankylosis in permanent teeth with severe PDL damage or in case of accidental extravasation to the periapical region (9, 12).

Calcitonin

Calcitonin is a hormone synthesized by the thyroid gland that has been proven a potent inhibitor of clastic cells and has been indicated for the treatment of external root resorptions. The influence of this hormone as an intracanal dressing after tooth replantation has been investigated, and it has been observed a decrease in inflammatory root resorption and better control of the sequelae of dental trauma even in cases with uncertain prognosis (35).

In an experimental study in dogs, Caldart (36) evaluated histometrically delayed replantation in teeth with canals obturated with gutta-percha and zinc oxide and eugenol-based sealer or filled with the following medications: CH paste, calcitonin, and CH/calcitonin paste. After 30 days, definitive obturation was performed with gutta-percha. The CH/calcitonin paste was more effective in controlling inflammatory root resorption than the use of these medications alone. Root replacement resorption was more effectively controlled by the use of calcitonin, while the other medications had a similar effectiveness in controlling this event.

Moro et al. (37) evaluated immediately replanted dogs' teeth that were medicated with CH paste associated or not with calcitonin and obturated with Sealapex sealer. The authors concluded that root canal obturation with Sealapex without placement of an intracanal medication produced similar results as those obtained with premedication. In 2004, Moro included Endofill sealer in the experiment and this material had worse results (38).

The association of calcitonin and CH as an intracanal medication for replanted teeth has been advocated in the last years mainly because of the recognized capacity of reducing the osteoclastic activity, interfering in the proliferation, motility, and vitality of these cells, and reducing the resorption rate (26, 35, 37, 38, 66). However, this association has not provided better results than the use of CH alone.

Antibiotics

The use of antibiotic as an intracanal medication points to a new direction in tooth replantation, because bacterial contamination is one of the factors responsible for the start and/or persistence of inflammatory root resorption processes. Rifocin has been used in an attempt to eliminate the persistent bacteria that induce the occurrence of inflammatory root resorption. Results have indicated a superior action of this antibiotic compared to saline. However, small resorption areas are formed in spite of the use of this medication (24).

Corticosteroids

Few studies have addressed the effect of corticosteroids on the periodontal healing pattern of replanted teeth. Kirakosova et al. (34) investigated the effect of potent intracanal corticosteroids (0.05% clobetasol and 0.05% fluocinonide) on periodontal healing of replanted avulsed teeth and evaluated the systemic absorption of these corticosteroids. They concluded that teeth treated with 0.05% clobetasol and 0.05% fluocinonide exhibited significantly more favorable healing than teeth filled with gutta-percha and Roth's sealer (zinc oxide-eugenol); the higher potency corticosteroid (clobetasol) showed significantly more favorable healing than the lower potency (fluocinonide), and no change in the systemic corticosteroid blood concentration after intracanal use of high potency corticosteroids was observed.

Antibiotic/corticosteroid association

The use of antibiotic alone as an intracanal medication has not presented much efficacy in the control of inflammatory resorption, which demonstrates the existence of an additional factor that is responsible for the persistence of inflammation. Corticosteroids are known to suppress inflammation, a property that, in cases of progressive root resorption, could temporarily reduce the inflammatory stimulus of resorption to allow healing (66).

Several studies have demonstrated that intracanal Ledermix, a corticosteroid/tetracycline water-soluble paste, is an effective antibacterial and anti-inflammatory medicament that has been shown to promote favorable periodontal healing and inhibits external inflammatory root resorption after the experimental avulsion and replantation in an animal dental trauma model (19, 31, 33, 35).

According to Pierce and Lindskog (66), the endodontic treatment with antibiotic and corticosteroid paste is superior to the use of antibiotics and CH alone to prevent inflammatory root resorption. Those authors concluded that Ledermix paste (1% triamcinolone associated with 3% tetracycline) is an effective medication for use in the treatment of progressive root resorption in traumatically injured teeth. Moreover, this form of

therapy results in no adverse local or systemic effects and is effective in reducing postoperative pain.

Thong et al. (15) found that PDL inflammation and inflammatory root resorption were markedly inhibited by the CH and corticosteroid-antibiotic pastes relative to untreated controls. Replacement resorption was the lowest in the corticosteroid-antibiotic group, and significantly more normal PDL was present in this group than in the CH and control groups.

Wong and Sae-Lim (33) evaluated the effect of immediate placement of intracanal Ledermix paste on root resorption of delayed-replanted monkey teeth. Bryson et al. (31) evaluated the effect of placing Ledermix paste and CH in the root canals of dog teeth immediately after replantation, which followed extended dry times of 60 min.

Teeth medicated with Ledermix paste when used as an intracanal dressing before replantation have shown smaller resorption areas and a more favorable periodontal repair compared to those treated with CH pastes and to non-medicated teeth (31, 33, 34). However, tetracycline in Ledermix paste has been shown to cause the unwanted discoloration of mature and immature teeth (67, 68). Such effects can be minimized if placement of the paste is restricted to below the gingival margin.

Chen et al. (19) evaluated the individual influence of triamcinolone and demeclocycline on external root resorption after extended extraoral dry time of 60 min. The teeth treated with Ledermix paste, triamcinolone, and demeclocycline had significantly more favorable healing than those filled with gutta-percha and replanted after 60 min dry time (positive controls). The authors concluded that the corticosteroid and tetracycline, as anti-inflammatory and antiresorptive agents, ceased or minimized the inflammatory reaction including clastic-cell mediated resorption, and thus promoted more favorable healing than the positive control group, which received no intracanal medicaments. Furthermore, they forecasted that in severe traumatic injuries, where a large surface area of PDL inflammation is expected, removing the pulp and placing corticosteroids into the canal at the emergency visit should become a standard protocol.

While CH undoubtedly remains the medicament of choice when hard tissue formation is required, there is considerable experimental and clinical evidence to support the early use of Ledermix paste as the initial intracanal medication. The use of a medicament with anti-inflammatory and antibacterial properties that potentially blocks the activity of clastic cells, such as Ledermix paste, can be beneficial in the initial healing phase after replantation of avulsed teeth. CH could then be introduced into the canal after the inflammatory reaction had diminished to maintain a bacteria-free pulp space while healing progresses (19, 31, 66).

The use of a commercially prepared antibiotic-corticosteroid product (Otosporin) has also been evaluated on root surface and as an intracanal dressing in immediate rat tooth replantation. The authors observed that the use of this substance did not prevent the occurrence of ankylosis and surface resorption, but was effective against inflammatory root resorption (23).

Bisphosphonates

Bisphosphonates have also be suggested as intracanal medicaments based on the theory that bone and root resorption processes are similar because these tissues share some morphological characteristics, enzymatic properties, and cellular functions that lead to dentin, cementum, and bone resorption (16–18).

Comparisons of gallium nitrate, acetazolamide solution, and alendronate solution to CH paste as intracanal dressings for cases of delayed tooth replantation show that all medications have a similar action, reducing but not preventing completely the occurrence of resorption (16–18). In a morphometric evaluation of the effect of acetazolamide solution as an intracanal therapeutic agent in late replanted rat teeth, no root resorption was observed in this group after 60 days, confirming the efficacy of the substance as a resorption inhibitor (17).

Substances that act as resorption inhibitors may be an alternative for cases of failure of tooth replantation. However, the mechanisms of action of these substances are still unclear and further studies are needed. In addition, the high cost of these products is a negative factor and makes their use impracticable in daily dental practice. The studies conducted so far have shown similar results to those of CH pastes, which are accessible to all dental professionals, justifying their use (16–18).

Osteoclastic inhibition may improve the prognosis of tooth replantation. However, none of the therapies indicated so far was capable of inhibiting completely the occurrence of resorption processes and only reduced the areas of resorption. This literature review shows that the association of CH pastes with other substances produces similar results to the use of CH pastes alone, without adding any advantage (15, 26, 31, 36–38).

Root canal filling materials

Gutta-percha

Gutta-percha has been used in endodontic therapy for over 100 years and still is the most widely used root canal filling material. It is a product of vegetable origin that presents low tissue toxicity, good adaptation to the root canal walls, heat or chemical softening and plasticization, good radiopacity, physicochemical stability, and ease of removal if needed (69). However, gutta-percha cones must be associated with endodontic sealers to promote adequate root canal seal.

Sealers

Root canal sealers can be classified as zinc oxide and eugenol-based, CH-containing and resinous sealers. Zinc oxide and eugenol-based sealers are the most widely used, despite the reports of intense/severe periapical inflammatory response to their use. Deposition of mineralized tissue at the apex has been shown to occur in a few cases and only partially covered the apical foramen (70). On the other hand, CH-based sealers may

be a good option for replanted teeth because the gradual and slow release of hydroxyl and calcium ions from these materials maintains the high alkaline environment achieved with the placement of the intracanal dressing (71, 72). This is a key point for eradication of bacterial cells that remain viable after chemomechanical preparation of the canals. In addition, these sealers have biocompatibility (52), which is an important propriety in cases of delayed replantation in which replacement resorption is expected and exposure of material is unavoidable (46).

Zinc oxide and eugenol-based sealers

Zinc oxide and eugenol are among the most common components of root canal filling materials, and there are divergences as to the biocompatibilidade of their material when the results of experiments in teeth and subcutaneous tissues are compared. The literature has shown that the presence of zinc oxide and eugenol induces chronic periapical inflammation because of the toxicity to the tissues (70, 73).

Zinc oxide and eugenol-based sealers have also been used in cases of replantation (30, 36, 39, 44, 45). Knight et al. (39) evaluated the effect of root canal therapy on replanted dogs' teeth using gutta-percha and zinc oxide and eugenol-based sealer as the filling material. Overall, the endodontically treated teeth showed better tissue characteristics both clinically and histologically. However, the occurrence of resorption areas, ankylosis, periapical inflammation, and even cyst formation was not avoided. These findings are consistent with those in the literature (40–43).

CH-containing root canal sealers

CH-containing root canal sealers have been launched to the market with the aim of taking advantage of the biological properties of CH, notably its capacity of stimulating calcification. It is interesting to compare its action in replanted teeth because a similar behavior would make possible to replace the prolonged use of a CH dressing by an immediate and definitive obturation with a CH-based sealer.

Studies have found similar results when the root canals were obturated with Sealapex with and without the placement of a CH dressing in both immediate and delayed tooth replantation (37, 38). Definitive root canal filling with Sealapex CH-based sealer provide better results than Endofill zinc oxide and eugenol-based sealer (38).

In a microscopic study evaluating tissue response in delayed rat tooth replantation after root canal filling with CH paste, Sealapex and Endofill without gutta-percha cones resorption was observed in the three groups and, although inflammatory root resorption occurred less frequently in the teeth treated with CH, there was no statistically significant difference among the three groups. The authors concluded that compared to the paste, filling the root canals with Sealapex and Endofill sealers without the placement of gutta-percha cones did not provide better results (46).

MTA

MTA has been developed to seal the pathways of communication between the root canal system and the external surface of the tooth. The mechanism of action of CH and MTA has some similarities and these materials share the same antimicrobial and tissue-healing properties (74).

Karp et al. (75) reported a case in which MTA was used as root canal filling material in an avulsed maxillary central incisor. Two and a half years after the replantation, the tooth was asymptomatic and exhibited clinical and radiographic evidence of periodontal healing.

MTA has been shown to create favorable conditions to healing, including induction of apexification (76). Jacobovitz et al. (77) reported the outcome of the endodontic treatment of a replanted maxillary central incisor with open apex after 8 years and 7 months of follow-up. According to the authors, the treatment was successful without pathoses up to 7 years of follow-up. After the institution of orthodontic treatment, a localized and late root resorption was noticed at the last radiographic examination and the use of MTA promoted a mild crown gray discoloration.

The obturation of root canals with MTA has been investigated in immediate (47) monkey tooth replantation compared to CH paste, and the results were similar in both groups. PDL repair and absence of inflammatory root resorption were observed in the immediate replantation, and absence of inflammatory root resorption and presence of replacement resorption were observed in the delayed replantation. The authors concluded that MTA may be a good option for the obturation of replanted teeth.

MTA has shown good results as a root canal filling material. However, it is important to consider that its physical properties make it difficult or even impossible to remove the material completely from the root canals in case of retreatment or postspace preparation (74–78).

Conclusions

CH is still the intracanal medication that congregates that largest number of ideal properties for the eradication of endodontic infections, control of root resorption, and induction of mineralization. However, the literature has shown that the use of intracanal dressings with antibiotic associated with corticosteroid in the initial phase of the endodontic therapy followed by a CH dressing can be beneficial for the treatment of progressive root resorption and for periodontal healing. Accurate diagnosis and adequate treatment plan may constitute very complex tasks, particularly in tooth avulsion because several variables are involved. In addition to the technical knowledge and clinical experience directed toward the quality of treatment, patient education may favorably influence the survival of replanted teeth.

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