In The Name Of the Most Merciful God

He is God, the Creator, the Evolver, the Fashioner, to him belong the most beautiful names, the Glorious, the Knowing, the Loving-Kind

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Cellular behavior and Scanning Electron Microscope Evaluation of Pro-root MTA, Root MTA and Modified MTA on Fibroblast L929

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Chapter 1:

Introduction

Introduction

In contemporary dentistry, root canal treatment is considered to be one of the most successful treatments. Different investigators have reported variety of success rates for root canal treatment. Morse et alat temple university reported 95.2% success rate at the end of 1 year follow up by gutta-percha euchapercha method(1). Sjogren et al, reported 8-10 years after first root canal treatment, 96% success rate following root canal treatment for teeth with vital pulp, 86% for teeth with necrotic pulps and periradicular lesions prior to treatment. To recap, Nearly 95% of all endodontically treatment teeth are successful(2).

Even though the success rate of non-surgical treatment is high, failures do occur. In recent years, there has been an increasing interest among practitioners in endodontic retreatment procedures on the cases of failure, mean while , the success rate of this treatment protocol is as low as 62% to as high as 98% which insist on the indications for surgical interventions (3).

Periradicular surgery is the treatment of choice when non-surgical retreatment is failed or existing restorative or prosthetic treatment is to be endangered by orthograde re-treatment (3).

Endodontic surgery encompasses surgical procedures performed to remove the causative agents for periradicular pathosis and to restore the periodontium to a state of biologic and functional health. One of the most arguing issues among the periradicular surgery is retrofilling materials. The main objective for an apical retrofilling is to provide an apical seal that prevents the movement of bacteria and their products form the root canal system into the periradicular tissues (3,4).Various root–end filling materials have been introduced such as Gutta-percha, cavit, Intermediate Restorative Material (IRM), super–EBA,Glass Ionomer, Composite resin and mineral trioxide aggregate (MTA) (3); Root–End filling materials which are designed to stimulate soft and hard tissue repair in the periradicular tissue are highly recommended. (5)

In recent years, MTA has been identified as the best material of choice, due to its good properties.Many investigations indicated exellent properties such as the least cytotoxicity, biocompatibility, being hydrophilic and radiopacity that will be discussed in details later. These advantages have made it the best choice for retrofilling except some of its disadvantages such as its difficult handling and prolonged setting time (6). An interesting phenomenon happens on the surface of MTA is deposition of new cementum and formation of hard tissue (3,6,7) which is so beneficial for healing of periradicular tissues. This material has been marketed as Pro-root MTA by Denstply company.

Recently a material similar to Pro-root MTA was developed by Dr. Lotfi at Tabriz, named Root- MTA which was claimed to have the exact properties of original MTA(8). Different studies investigated the tissue response to its subcutaneous implantation (9,10,11,12) and its ability to prevent leakage at different time periods from 48 hours to 1 month and all reported an acceptable results for Root-MTA compared with Pro-root MTA(8,13,14); but there is no cell culture study, evaluating the amount of its cell cytotoxicity and its potency in producing a good environment for cell coverage and further bone formation.

Additionally, we assume that hard tissue formation of MTA can be enhanced at the presence of an osteoinductabe material such as calcitonin which is a polypeptidic hormone secreted by thyroidal prafollicular cell (C-cells) and induce its effect on bone due to inhibition of resorptive osteoclast activity, which is a good benefit in bone healing process(15,16).

Overall, because of the importance of hard tissue formation and bone healing during endodontic procedures and apical surgery in particular , any modification that can enhance and promote the induction ability of MTA and accelerate this senario , should be investigated.

In conclusion , the goals of this study are:

1) To investigate the fibroblast coverage of Root-MTA in comparison to Pro-root MTA at three different time periods.

2) To investigate the effect of calcitonin as an osteoinductable material when added to Pro-root MTA at the same time periods.

Chapter 2:

Root end filling materials and methods of their cytotoxic evaluation

As mentioned in previous chapter, the main objective for an apical retrofilling is to provide an apical seal that prevents the movement of bacteria and their products from the root canal system into the periradicular tissues(3,4).

Ideal properties of root-end filling materials have been reviewed by Dr. L.I Grossman as well as Gartner Dorne as follows(6,7):

1) Should be well tolerated by periapical tissues.
2) Should adhear (ideally bond) the tooth structure.
3) Should be dimensionally stable.
4) Should be resistant to dissolution.
5) Should promote cementogenesis.
6) Should be bactericidal or bacteriostatic.
7) Should be non-corrosive.
8) Should be electrochemically inactive.
9) Should not stain tooth or periradicular tissues.
10) Should be readily available and ready to handle.
11) Should allow adequate working time then set quickly.
12) Should be radiopaque.

With time passes , varions materials have been used as root end filling material such as cavit, Gutta percha, amalgam , IRM , super- EBA, Glass ionomer and MTA (3). Some of the more popular materials will be discussed in detial in this chapter.

Amalgam:

Zinc-free amalgam has traditionally been the retrofilling material of choic. A more plausible argument for the use of zinc-free amalgam is the lack of expansion found when contaminates with moisture(18). Like other materials, various studies have been done on amalgam specially because of its common usage before MTA marketing. Investigations which compared its sealing ability with other materials, showed superior ability of MTA (19,20,21,22),IRM(21,22),Super-EBA(19,21)to amalgam; on the other hard, Fogel et al found there was no difference on leakage amount between amalgam and IRM(23). Cytotoxicity evaluating studies showed its more cytotoxicity than IRM and super–EBA on osteoblast and periodontal cells(24), while Torabinejad found fresh and set MTA to be less cytotoxic than amalgam and amalgam less than IRM and super- EBA(25). Other disadvanatages of amalgam are technique sensitivity (26), risk of tattooing (27) and on lesser importance the risk of mercury releasing throughout the body(28).

Intermediate restorative material (IRM)

Intermediate Restorative material (IRM) is a zinc oxide eugenol cement which is reinforced by the addition of 20% polymethacrylate by weight to powder (6).To improve its properties, different amount of hydroxyapatite due to it's biocompatibility with bone were added to plain IRM. Addition of 10 and 20% of hydroxyapatite promote its sealing ability in studies but one of the most disadvantages of this new IRM was more disintegration rate which leads to leakage of irritants from the root canal to periradicular tissues, so it would be better to use the unmodified IRM for root end filling purpose (16).

Variaous studies have compared its sealing ability and biocompatibility with other materials; In comparing IRM with MTA, all of the reported studies indicated more leakage for IRM than MTA (19,20,21), On the other hand, IRM showed less leakage than amalgam (21). However, Fogel et al, found no signficant difference between dye leakage of amalgam and IRM(23).

Different researchers have compared the cytotoxicity of IRM with other root end filling materials and indicated less cytotoxicity of IRM than amalgam (24). However, Torabinejad et al reported MTA to be the least cytotoxic material among other materials (24,25,30).

Super Ethoxy Benzoic Acid (Super-EBA)

Super-EBA is a zinc- oxide eugenol cement modified by EBA to alter the setting time and increaseing the strength of the mixture. The cement also modified by the partial substitution of eugenol liquid with ortho-ethoxy benzoic acid and the addition of fused quartz or alumina to the powder (6).Super-EBA is the strongest and the least soluble of all zine-oxide eugenol formulations. It has a high compressive and tensional strength. Theodosopoulou et al stated Super-EBA showed the most leakage among other materials such as composite, Glass Ionomer. Cement and amalgam when used as root end filling material (31); while other studies reported more leakage of Super-EBA when compared with MTA (19,20,29) and less leakage than amalgam (21,31).

Studies that have been focused on cytotoxicity of Super-EBA, indicated that it is less cytotoxic than IRM (21) and amalgam (19), but Torabinejad et al found Super–EBA to be more cytotoxic than amalgam (25); like all other materials that had been tested in above mentioned studies, MTA showed to be the least cytotoxic material.

Glass Ionomer Cements

Glass Ionomers are materials consisting of ion-cross-linked polymer matrices surrounding glass-reinforcing particles. The design of the original glass-ionomer cements was a hybrid formulation of silicate and polycarboxylate cements. Glass Ionomers used the aluminosilicate powder from silicates and the polyacrylic acid liquid of polycarboxylates(32).

During years, many modifications took place for improving properties of glass ionomers, such as altering the liquid and powder ratio as well as structural alterations.

Despite these changes, however earlier materials were very technique sensitive as well as newer products.