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Management of pulp exposure with new materials

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ABSTRACT
The hard dentin walls contain vascular connective tissue called dental pulp. As the primary cause of oral pain, it is also a major area of focus for endodontics and restorative care. In 2014, Garg & Garg Either severe traumas cause the pulp to become inflamed in an effort to protect it, or the caries process degenerates the dentinal framework, exposing the pulp. (Zakaria, 2016)
In order to preserve vital pulp and promote the development of reparative dentin, direct pulp-capping is a technique for applying dental material to exposed vital pulp.In 2016, Komabayashi et al.
Treatment results are influenced by the right case selection, aseptic care, bleeding control, suitable capping material, and sufficient restoration. As long as the right conditions are in place to promote pulp healing and dentinal regeneration, exposed pulp can be successfully treated. (Zakaria, 2016)
In order to encourage healing, Phillip Pfaff carried out the first pulp capping technique in 1756 by packing a little piece of gold over an exposed essential pulp.One of the first and most popular medications for promoting the creation of dentinal bridges after microscopic or large pulpal exposure is calcium hydroxide.These days, a variety of materials, including Mineral Trioxide Aggregate (MTA), Biodentin, and others, are available for the pulp capping process. (Pathak and others, 2017)

The exposed pulp
Pulpal exposures vary from one another. because pulpal exposures typically receive the same therapeutic treatment, despite the fact that the anatomy, physiology, and histology of the tissues involved will vary from tooth to tooth. The exposed site's visual appearance, the extent and duration of bleeding and exudation from the wound, the state of the affected tooth, and the prior medical history must all be taken into consideration while doing a clinical evaluation. *(Mjör, 2002)*

Indications of exposed Pulp Therapy
When the residual pulp shows signs of reversible pulpitis and can be specifically stimulated to create a reparative barrier that shields the tissue from microbiological threats, vital pulp therapy is recommended.Chandler and Bogen *(2008)*

Factors Affecting Pulp Capping and Repair Results
Although a number of factors influence pulp capping success, the following are the most crucial ones:

The type of restoration
Following pulp capping, the final repair ought to form a seal that successfully stops bacterial leakage. Until the dentinal bridge itself turns into an impermeable barrier, this kind of seal is especially crucial.

Type of exposure
The prognosis is better for an iatrogenic exposure through normal, unaffected dentin than through infected, carious dentin. (Mjör, 2002)

Size of pulpal exposure
According to a number of studies, case selection may be influenced by the extent of pulpal exposure. Many dentists think that an exposure of less than 1.0 mm is necessary for pulp capping to be successful.

Hemostatic regulation of plasma exudate and bleeding

The quantity of bleeding experienced may be increased by the stress of caries excision that resulted in the exposure. It is evident that applying materials to a bleeding pulp will not cause tertiary dentin to form and bridge later on, nor may it result in the preservation of important pulp tissue.In order to stop bleeding and enable the placement of capping materials in a somewhat dry environment, hemostatic agents are applied over the exposure. It has been proposed that sodium hypochlorite (NaOCl) can help build dentin bridges by removing the coagulum, controlling bleeding, and removing dentin chips.

The length of time the pulp is exposed

A key element in the effectiveness of pulp capping techniques is the length of pulpal contamination. Only uncontaminated pulpal exposures need to be treated, and the likelihood of success is decreased by prolonged contact to oral debris and microbes. *(Goodis, 2012)*

The location of Caries

The survival rate may be impacted by the exposure site (occlusal versus cervical/proximal). When the exposure site was restricted to the occlusal side rather than the cervical/proximal side, a higher survival rate was observed *(Cho, 2013)*.

Healing of exposed pulp

One of the main objectives of vital pulp therapy is to heal exposed pulp by forming a protective dentinal bridge through tertiary dentinogenesis. The movement of progenitor cells, or undifferentiated mesenchymal cells, from the cell-rich and deep pulp subodontoblastic layers to the wounded region, where they develop into new odontoblast-like cells, is what orchestrates the repair of pulpodentinal lesions.Other bloodstream-migrating cell populations, like perivascular and bone marrow stem cells, have been suggested as potential precursors at the material–pulp interface. As early as day one, a steady stream of newly differentiating odontoblast-type cells with initial matrix formation was seen 8. At least two deoxyribonucleic acid (DNA) replications had taken place between the first treatment and differentiation, as evidenced by the odontoblast-like cells' variations in cell types and grain counts between zones. Chandler and Bogen *(2008)*

Pulp capping material

The ideal pulp capping material should be sterile, radiopaque, provide a bacterial seal, stimulate reparative dentin formation, maintain pulpal vitality, release fluoride to prevent secondary caries, be bactericidal or bacteriostatic, adhere to dentin and restorative material, and resist forces during restoration placement and under restoration for the duration of the restoration. In 1994, Cohen and Combe

The new material used the managed the exposed pulp

Mineral trioxide aggregate

An aggregate of mineral oxides added to "trioxides" of tricalcium silicate, tricalcium aluminate, and tricalcium oxide silicate oxide is known as mineral trioxide aggregate (MTA). *(Lee and others, 1993)*

Direct pulp capping was once thought to be unpredictable and frequently avoided, however treatment results have changed since MTA was introduced as a pulp capping material in modern dentistry.When compared to calcium hydroxide, MTA had better marginal adaptation to dentin, increased mechanical strength, and decreased solubility when used in direct pulp capping. Additionally, some of the drawbacks of calcium hydroxide, including absorption of the capping material, mechanical instability, and consequently insufficient long-term sealing ability due to leakage, are eliminated when MTA is used for direct pulp capping.

.It is well known that calcium silicate cements, such as MTA, not only set in the presence of blood and moisture, but also have the capacity to release calcium and hydroxyl ions upon contact with cell and tissue fluid.On its surface, it also forms crystals of hydroxyapatite. By filling the space along the contact and interacting with dentin during intrafibrillar apatite deposition, the apatite production helps to reduce leakage. *(Dammaschke and colleagues, 2014)*

In essential pulp therapy, MTA is the sensible substitute for calcium hydroxide and the preferred material for direct pulp capping. *(Cho and others, 2013)*

Pulp responses to Mineral trioxide aggregate.

Mineral trioxide aggregate has been shown to promote a variety of positive cellular responses in vitro when applied directly to the dental pulp. It also has a substantial effect on the mitosis index of progenitor cells and stimulates hard tissue formation after direct pulp capping. Progenitor cells are multipotent adult stem cells that have the potential to differentiate into odontoblast-like cells after injury or damage to the primary odontoblasts. MTA most probably stimulates mineralization by up-regulation of bone morphogenic protein

MTA stimulates the synthesis of mineralization matrix genes in vitro, which are involved in the mineralization process.The activation and production of vascular endothelial growth factor (VEGF), a platelet-derived protein growth factor essential for angiogenesis and demonstrated to be involved in dentinogenesis, are markedly increased when MTA comes into direct contact with pulp cells.*(Dammaschke and colleagues, 2014)*

Comparing the effects of mineral trioxide aggregate and calcium hydroxide on pulp responses,

- Aeinehchi et al. *(2003)* discovered that when exposed pulp was capped with MTA, the newly

formed reparative dentin was thicker, exhibiting a more uniform odontoblast-like cellular layer at the bridge interface and exhibiting less hyperemia and necrosis than exposed pulp.

- When compared to those who were capped with calcium hydroxide, the exposed who were capped with MTA exhibited a more uniform dentin bridge formation and fewer tunnel defects (Nair et al., 2008). Additionally, the exposed who were capped with MTA showed noticeably less inflammation *(Parolia et al. 2010)*.

Biodentine

The calcium-silicate-based substance known as biodentine has gained popularity recently and is being promoted for use in a number of therapeutic procedures, including pulp capping, apexification, resorptions, retrograde fillings, root perforations, and dentine replacement. Tricalcium silicate, dicalcium silicate, calcium carbonate and oxide filler, iron oxide shade, and zirconium oxide make up biodentine. Zirconium oxide acts as a radiopacifier, whereas tricalcium silicate and dicalcium silicate are designated as the primary and secondary core materials, respectively *(Malkondu et al., 2014)*.

Properties of biodentine

- It is advised to utilize biodentine as a dentine alternative for restorations. The quality of the filling depends on how well the restorative ingredients and biodentine bond.
- Biodentine is poor in the early stages of setup. In order to allow the biodentine to cure and mature sufficiently to withstand the contraction stresses of the resin composite, it is best to wait at least two weeks prior to applying the overlying composite. Additionally, applying Biodentine to troublesome pulp would provide for sufficient time for the tooth to be examined *(Hezaimi et al, 2011)*.
- Zones of bacterial suppression were observed in all evaluated bioactive cements, albeit with varying diameters. Biodentine had the biggest inhibitory zone, followed by the light-cured resin-modified glass ionomer group. According to Aggarwal et al. *(2013)*, light cure calcium hydroxide displayed the smallest inhibitory zone with a significant difference across all groups.
- The pulp's reactions to biodentine were comparable to those of MTA. At the site of the injury, the dentin bridge was observed to form exactly beneath the capping materials using both materials. While the reparative tissue occasionally looked heterogeneous with cell inclusions, dentin was linked to an uneven hard tissue. According to Nowicka et al. (2013), the Biodentine and MTA groups' mean hard-tissue dentin bridge thicknesses were 211.56 mm and 230.31 mm, respectively. According to Koubi *(2013)*, biodentine is a good substitute for MTA and does not show the discoloration that MTA causes.
- When dentin and biodentine come into contact, tag-like structures form along with an interfacial layer known as the "mineral infiltration zone," where the collagenous component of the interfacial dentin is broken down by the alkaline caustic action of the calcium silicate cement's hydration products *(Hashem, 2014)*.

BioAggregate

A tricalcium silicate-based substance called Bio Aggregate was developed for use in apexification treatments, vital pulp therapy, perforation repair, and root-end filling. Tricalcium silicate, hydroxyapatite, amorphous silicon dioxide, and tantalum oxide make up Bio Aggregate. Tantalum oxide is added as a radiopacifier to the primary component phase, tricalcium silicate.Calcium phosphate and silicon dioxide were among the ingredients included in Bio Aggregate, which was free of aluminum. Apatite crystalline formations precipitated when Bio Aggregate was exposed to physiological solution, and these structures grew over time.

This implies that the substance is bioactive. Additionally, it has been demonstrated that BioAggregate is biocompatible and promotes the development of human mesenchymal cells, osteoblasts, and fibroblasts. Furthermore, it demonstrated antibacterial and antifungal qualities (Camilleri et al., 2014).

Theracal

After blood seeping from the pulp canal is stopped, this light-cured, resin-modified calcium silicate-filled liner design is employed for both direct and indirect pulp capping. It serves as a foundation for cements, amalgams, composites, and other foundation materials. The pulp is shielded and protected by theracal LC. Theracal LC is made up of tricalcium silicate particles in a hydrophilic monomer, which releases calcium and promotes the production of secondary dentin bridges and hydroxyapatite.Vijaya and Sollete *(2014)*

Platelet Rich Fibrin (PRF)

Known as a second-generation platelet concentrate, it has been demonstrated to offer a number of benefits over conventionally made Platelet Rich Plasma (PRP). A platelet concentrate called PRF has been utilized extensively to speed up the healing of both soft and hard tissues. Platelet-rich fibrin's superior wound healing, tissue regeneration, and osteogenic qualities make it a potentially useful material for direct pulp capping.It has been demonstrated that pulp tissue has a population of progenitor/stem cells that are highly clonogenic and proliferative, and that these

cells can differentiate into hard tissue-forming cells upon damage *(Yamini, 2014)*.

CONCLUSION

To achieve a successful outcome, the operator must appropriately choose the case, achieve hemostasis, disinfect the exposure and cavity preparation, and sufficiently seal the exposure and cavity preparation.

MTA and biodentine are intriguing medicines that have the potential to significantly contribute to preserving pulp vitality in patients chosen for direct pulp capping. The disagreement has centered on the pulp-capping agent utilized, not the surgery itself.

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