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Review Article

TheraCal LC: A boon to dentistry

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ABSTRACT

TheraCal LC, the focus of this article, is a material that creates a new category of resin-modified calcium silicates (RMCS). It is a light-cured, resin-based, and highly radiopaque liner designed to release calcium to promote hard-tissue formation, and is indicated for use under direct restorative materials as a replacement to calcium hydroxide and other calcium silicate-based materials, glass ionomers, eugenol-based sedative materials, and pulp capping restoratives. TheraCal LC exhibits several properties to help maintain ideal hard-tissue health and to reduce the incidence of postoperative sensitivity. This article is aimed to review the composition, method of application, setting reaction, properties and uses of TheraCal LC.
Conclusion: TheraCal LC is interesting and promising product, which have the potential of creating major contributions to maintaining pulp vitality.

1. Introduction

Primary objective of restorative dentistry is to preserve pulpal health of vital teeth.[1] For the modern approach in restorative dentistry, the major challenge is to induce the remineralization of hypomineralized carious dentine, and thus, protecting and preserving the vital pulp.[2]

Traditionally, management of deep caries often resulted in pulp exposure and subsequent root canal treatment. But nowadays, management strategies for the treatment of the cariously exposed pulp are shifting with avoidance of pulpectomy, claiming the superiority of vital pulp treatment (VPT) techniques such as pulp capping, partial and complete pulpotomy.[2] Various bioactive materials introduced into the dentistry in last few decades which showed promising results in pulp capping.

Calcium silicate-based materials like MTA, Biodentin and MTA derived materials are proved to be bioactive and shows several properties like:

1. Antibacterial activity
2. Property of reparative dentine formation.
3. Maintain pulp vitality.
4. Establishing a tight bacterial seal.
5. Resist forces during restoration placement and function.
6. Adhere to dentine as well as the restoration.
7. Radiopacity
8. Prevent post-operative sensitivity by sealing the dentinal tubules.[3]

Recently various Calcium silicate-based materials are introduced in dentistry which are bioactive materials as they are capable of forming apatite by using calcium silicates or calcium aluminates.[1] In the last decade, calcium silicate based hydraulic cement, known as Mineral

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Trioxide Aggregate (MTA)was introduced by Mohmoud Torabinajad at Loma Linda University, California, USA in 1993.[4,5] Mineral trioxide aggregate (MTA) and MTA-derived materials have been suggested as direct/indirect pulp-capping agents and have shown favourable results in clinical trials. It has been reported that MTA is more effective than calcium hydroxide due to its enhanced interaction with pulp tissue and fewer negative responses to pulp.[6] MTA exhibited comparable or better clinical and radiographic success rates than Calcium Hydroxide for pulp capping of mechanically exposed human teeth and hence, become a popular alternative to calcium hydroxide over the last two decades.[7,8] However, MTA exhibits many drawbacks as a pulp capping material such as difficult handling, long setting time, high solubility during setting time, induction of tooth discoloration, and incompatibility with other dental materials when layered.[4–9] Second-generation calcium silicate–based materials indicated to be used as pulp capping materials are modified and exhibit a reduced setting time, thus making them more suitable in clinical use.[7] Biodentine (Septodont, Saint Maur-desFosses, France) is a modified MTA-like material that was introduced to overcome the drawbacks presented by MTA as a pulp capping material and became commercially available in 2009.[10,11] It has good mechanical properties as well as excellent biocompatibility and bioactive behaviour. Additionally, it sets in approximately 12 minutes and does not cause tooth discoloration. The main drawback of Biodentine is its water-based chemistry and thus poor bonding to the overlying resin restoration. Biodentine exhibited micro-leakage and surface erosion when etched with 37% phosphoric acid used under composite resin restorations. To overcome this, a light-curable resin-modified tricalcium silicate (TheraCal LC) was introduced as a pulp capping material aiming to achieve a bond between the different layers of materials thus reducing micro-leakage.[1–9]

TheraCal LC is a new light-cured, resin-modified calcium silicate-filled base/ liner material designed for direct and indirect pulp capping.[12] After more than five years of extensive research and development, TheraCal LCwas made available to clinicians in November 2011 by Bisco Inc, Schamburg, IL, USA.[13] It has been reported that, TheraCal LC released calcium, stimulating the formation of apatite and secondary dentin. TheraCal LC (fig. 1) has good sealing capabilities with simple application due to its handling characteristics and improved flowability compared with MTA. Material's high physical properties and low solubility permit immediate placement of the final restorative material, after light-cure.[8] This article is aimed to review the composition, method of application, setting reaction, properties and uses of TheraCal LC.

Fig. 1: TheraCal LC (Photo courtesy- TheraCal LC_Broucher.)

Fig. 2: Step 1: Isolate the tooth. Removeinfected infected carioustooth structure. Leavepreparation visibly moist.(Photo courtesy- TheraCal LC_Broucher.)

Fig. 3: Step 2: TheraCal LC directly applied to preparation in 1mm incremental layers. (Photo courtesy- TheraCal LC_Broucher.)

Fig. 4: Step 3: Each increment is light-cured for 20 seconds. (Photo courtesy- TheraCal LC_Broucher.)

Fig. 5: Step 4: Surrounding enamelis etched. (Photocourtesy- TheraCal LC_Broucher.)

Fig. 6: Step 5: Bonding agent is applied and light cured. (Photo courtesy- TheraCal LC_Broucher.)

Fig. 7: Step 6: Final restoration. (After core buildup)(Photo courtesy- TheraCalLC_Broucher.)

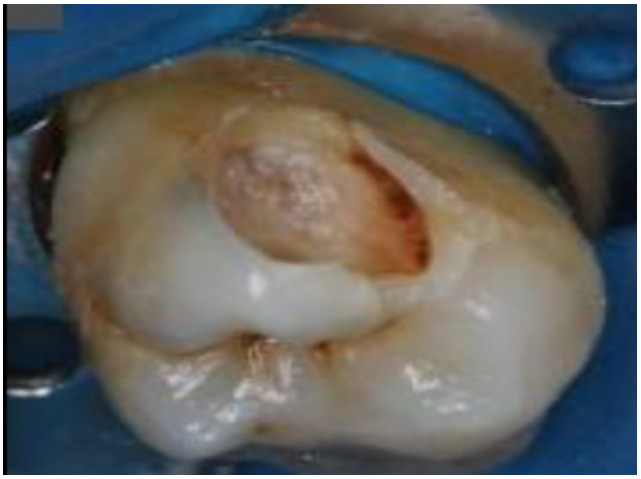

Fig. 8: Step 1: Isolate tooth.(Photo courtesy- TheraCalLC_Broucher.)

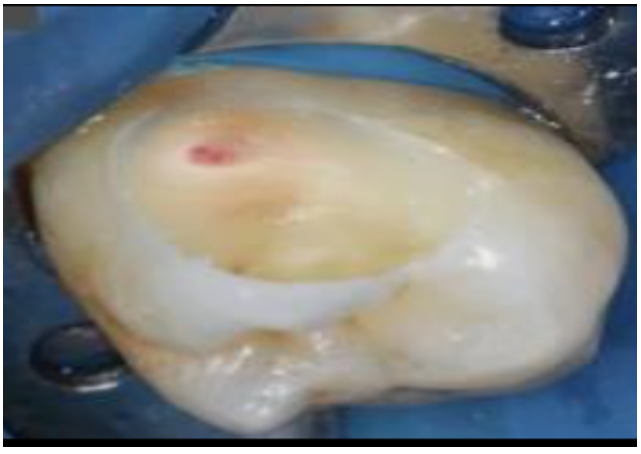

Fig. 9: Step 2: Remove infected carious tooth structure. Achieve hemostasis. Leave preparation visibly moist. (Photocourtesy- TheraCal LC_Broucher.)

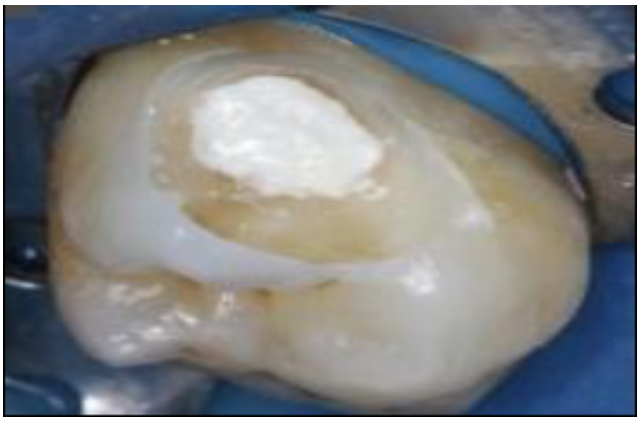

Fig. 10: Step 3: Apply TheraCal LC directly to exposed pulp. Layer is not to exceed 1 mm in depth. Cover all the exposed areasand extend TheraCal LC at least 1 mm onto sounddentin surrounding the exposure. Light-cure for 20 seconds. (Photo courtesy- TheraCalLC_Broucher.)

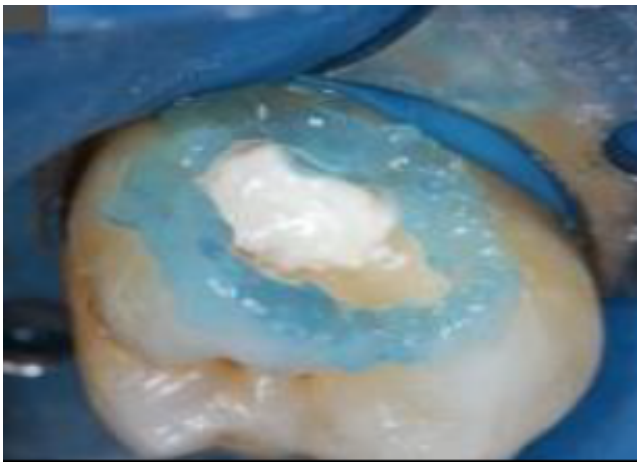

Fig. 11: Step 4: Apply adhesives. (Photo courtesy-TheraCal LC_Broucher.)

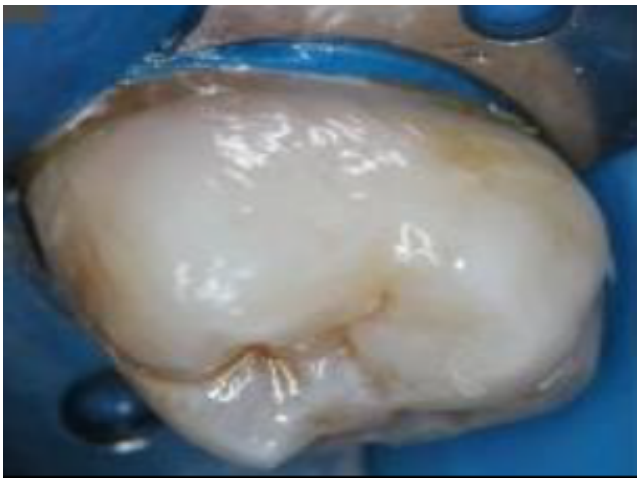

Fig. 12: Step 5: Continue tooth restoration. (Photo courtesy-TheraCal LC_Broucher.)

1.1. Composition of TheraCal LC

TheraCal LC is a hybrid material, consists of a single paste containing CaO, calcium silicate particles (type III Portland cement), Sr glass, fumed silica, barium sulphate, barium zircon ate & resin containing Bis-GMA & polydimethacrylate.[1–3] The original patent sheet of TheraCal LC stated that, it consists of Portland type III cement (45%), fumed silica as a thickening agent (7%), resin (43%), bismuth oxide (3%), and barium sulfate (3%) as radiopaquers.[1]

1.2. Application method

TheraCal LC is available in syringe form. Because of this, accurate placement of the flowable material is easy and is an advantage noted by clinicians, along with the light cured ability. According to the manufacturer, TheraCal is placed in the increments of 1mm and light cured for 20 seconds.[1–3]

1.3. Application method in indirect pulp capping:[14]

1. **Step 1**: Isolate the tooth. Remove infected carious tooth structure. Leave preparation visibly moist. (fig.2)
2. **Step 2**: TheraCal LC directly applied to preparation in 1mm incremental layers. (fig.3)
3. **Step 3**: Each increment is light-cured for 20 seconds. (fig.4)
4. **Step 4**: Surrounding enamel is etched. (fig.5)
5. **Step 5**: Bonding agent is applied and light cured. (fig.6)
6. **Step 6**: Final restoration. (After core buildup) (fig.7)

1.4. Application method in direct pulp capping[14]

1. **Step 1**: Isolate tooth. (fig.8)
2. **Step 2**: Remove infected carious tooth structure. Achieve hemostasis. Leave preparation visibly moist. (fig.9)
3. **Step 3**: Apply TheraCal LC directly to exposed pulp. Layer is not to exceed 1 mm in depth. Cover all the exposed areas and extend TheraCal LC at least 1 mm onto sound dentin surrounding the exposure. Light-cure for 20 seconds. (fig.10)
4. **Step 4**: Apply adhesives. (fig.11)
5. **Step 5**: Continue tooth restoration. (fig.12)

1.5. Setting reaction

TheraCal LC is a hydraulic silicate material that sets by hydration. Hydration is the chemical reaction that contributes to the setting of a hydrophilic cement. Setting starts when the material comes in contact with water. TheraCal LC does not include water for hydration of material. It depends upon the water taken up from the environment and its diffusion within the material. Hence, the manufacturer's instructions implement placing the

material on moist dentin.[1]

1.6. Properties

1.6.1. Cytocompatibility & antibacterial properties

TheraCal is well tolerated by immortalized odontoblast cells. TheraCal showed a decreasing antibacterial effect on S. mutans and very little effect on S. salivarius & S. sanguis.[3]

1.6.2. Calcium ion release

The bioavailability of calcium ions plays a key role within the material-induced proliferation and differentiation of human dental pulp cells and therefore the new formation of mineralized hard tissues. The calcium ions released from TheraCal LC are within the concentration range having potential stimulatory activity for dental pulp and odontoblasts. Studies showed that TheraCal LC release significantly more calcium than Dycal and MTA.[1–3]

1.7. PH

TheraCal LC has provided a very alkaline pH (10.66) after 3 hours, required for pulpal healing. After 24 hours, it displayed a nonsignificant reduction in pH (9.85).[1–3]

1.8. Density and porosity

The mechanical resistance of calcium silicate-based materials is dependent on their low level of porosity. Porosity and mechanical strength are inversely related: the lower the porosity, the higher the mechanical strength. TheraCal shows low porosity and high mechanical strength than MTA and Biodentin.[3]

1.9. Solubility

Ideally, a liner or base material should be reasonably insoluble and have high strength. TheraCal showed lower solubility and high strength than ProRoot MTA and Dycal.[12]

1.10. Bonding

TheraCal LC is having the ability to bond to deep moist dentine, unlike Dycal which lacks adhesion. TheraCal is self-sealing, which helps in antimicrobial activity with initial bonds to dentine to resist accidental air-drying removal.[3]

1.11. Flexural strength, flexural modulus & compressive strength

Strength is an crucial aspect of any liner as their function is to support an overlying restoration. TheraCal had the greatest flexural & compressive strength than MTA, Biodentin and Dycal, over 15 minutes, 3 hours and 24 hours. TheraCal had a greater early strength to potentially resist fracture during immediate placement of a final restorative material.[3]

1.12. Radiopacity

TheraCal is a radiopaque material according to the manufacturer.[3]

1.13. Uses of TheraCal LC

1.13.1. TheraCal™ LC is used as a direct pulp capping material

A direct-composite restoration performed by clinician for a patient presenting with an asymptomatic direct carious exposure. Light bleeding should be controlled with sterile saline compression. TheraCal LC should be placed directly over the exposure site, and then additional increments should be added to seal and provide a barrier for healing. TheraCal has been tested clinically as a direct pulp capping agent in primates by Cannon et al. The experiment concluded that TheraCal LC created complete dentinal bridges and mild pulpal inflammation suitable for pulp capping.[2,3]

1.13.2. TheraCal™ LC is used as an indirect pulp capping agent

Infected soft dentine is removed, leaving affected dentine. If radiographic examination shows a close approximation of an asymptomatic pulp, then TheraCal LC should be placed onto moist dentine. A base should be placed over the TheraCal LC and the restoration completed. Since TheraCal LC has low temperature changes during light curing, it is preferable to use in deep cavities as an indirect pulp capping agent.[2,3]

1.13.3. TheraCal™ LC is used as a cavity liner

TheraCal LC is promoted by the manufacturer for use as a protective liner with restorative materials, cement, or other base materials. TheraCal LC has been approved as “apatite stimulating” by the US Food and Drug Administration and secures a protective physical lining despite contact with dentinal or pulpal fluids. Studies showed that TheraCal may be considered as the material of choice as a liner in deep Class II cavities requiring pulp capping procedure as compared to RMGIC.[1–14]

1.13.4. TheraCal™ LC is used to seal root Canal orifices

TheraCal LC also protects endodontically treated teeth. In a particular case, endodontic retreatment was completed. The chemically softened, disinfected furcation floor required sealing of root orifices and softened dentine at the furcation floor. TheraCal LC should be added in 1mm increments to provide a visually discernible orifice and furcation floor seal.[3]

2. Conclusion

Recent modifications in the calcium silicate-based technology i.e., TheraCal LC exhibit good sealing ability to dentin when compared to conventionally used Mineral Trioxide Aggregate. TheraCal LC is interesting and promising product, which have the potential of creating major contributions to maintaining pulp vitality in patients judiciously selected for direct pulp capping. TheraCal LC addresses the needs of healing & pulpal protection (dentine bridging & remineralisation), as well as sustained alkalinity, calcium stimulation, immediate sealing to assist against bacterial invasion and the physical strength to uphold under pressure.

3. Source of Funding

None.

4. Conflict of Interest

None.

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