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THERACAL... FUTURE OF PULP CAPPING ????

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ABSTRACT

Pulp Capping represents an important endodontic treatment in dentistry since it preserves the vitality of the tooth in contrary to Root canal Therapy after which the tooth is left brittle. Very few recent pulp capping materials have gained popularity because of the gold standards set by Dycal and MTA which are used since years. One such material which deserves to be highlighted is TheraCal–LC which was introduced by Bisco Inc, Schamburg, IL, USA. Hence, We will compare TheraCal with the two Giants of pulp capping materials on the basis of published literature.

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INTRODUCTION

Pulp Capping represents an important endodontic treatment in dentistry since decades. It has become a necessity amongst selected cases in day to day practice as it helps in preserving the vitality of the tooth in contrary to Root canal Therapy after which the tooth is left brittle. Calcium oxide based and calcium hydroxide based materials have been the benchmark of pulp capping materials. One of the first materials to be used for capping was Dycal in 1960's. Another material which gained importance was MTA which was introduced in early 1990's at Loma Linda university. MTA received great attention in the field of dentistry because of its excellent properties and its ability to set in the presence of blood. But it had some drawbacks like prolonged setting time and high solubility during setting. Apart from this, MTA requires water for setting hence the number of appointments required to place a final restoration is increased which may affect the outcome of the treatment due to leakage of the temporary restorative material. This led to the foundation of a new material – TheraCal–LC which was introduced by Bisco Inc, Schamburg, IL, USA. It is a new light-cured resin-modified calcium silicate-filled base/ liner material designed for direct and indirect pulp capping.

Composition

1. 45% weight Type III Portland cement
2. 10% weight Radiopaque content
3. 5% weight hydrophilic thickening agent (fumed silica) and
4. 45% resin which consists of a hydrophobic component consisting of Urethane Dimethacrylate (UDMA), Bisphenol A-Glycidyl Methacrylate (BisGMA), Triethylene Glycol Dimethacrylate (TriEDMA or TEGDMA) and a hydrophilic component consisting of Hydroxyethyl methacrylate (HEMA) and Polyethylene glycol dimethacrylate (PEGDMA)[1]

Hence we will compare Theracal with the two giants of pulp capping materials in all the aspects.

Databases - literature from 2008 – 2016 amongst PubMed, Scopus, Medline, Google Scholar was searched.

Words searched-: Theracal, Theracal-LC, Light cured/curable MTA, Calcium silicate based cement, New Pulp Capping Material, Pulp capping agents.

1)Mechanical properties

A) Nielsen MJ carried out an in vitro study in 2016 which compared the compressive strength, flexural strength, and flexural modulus of TheraCal LC, Biodentine, Mineral trioxide aggregate (MTA), and Calcium hydroxide at three different time periods of 15 mins, 3 hours and 24 hours. They concluded that TheraCal LC had the greatest amounts of compressive and flexural strengths at all time periods. Whereas, Biodentine had maximum flexural modulus after 3 and 24 hours. TheraCal LC had greater early strength in order to resist fracture during immediate placement of a final restorative material and Biodentine had greater stiffness after 3 hours which provides better support to the overlying restoration over time. (Nielsen *et al*., 2015)

B) Cantekin K evaluated the Shear bond strength of Methacrylate-based composites (MB), Silorane-based composites (SB), and Glass-ionomer cement (GIC) in comparison to TheraCal and MTA in 2015. They concluded that the bond strength of TheraCal with the MB composite subgroup and the SB composite subgroup was more as compared to MTA with statistically significant difference ($p<0.05$); however, there was no significant difference in bond strength for the GIC subgroup. (Cantekin, 2015)

C) A study by Bisco inc. concluded that the shear bond strength after 24 hours of Theracal was significantly more as compared to reference pulp capping material Dycal. (Ross Nash, 2015)

D) Esra Cengiz evaluated Micro shear bond strength of Tri-calcium silicate-based materials to different restorative materials like : Fuji IX, Fuji II, Equia Fil, Vertise Flow, Filtek Bulk Fill Posterior Restorative, Filtek Z250 with Prime & Bond NT and with Clearfil SE Bond and concluded that TheraCal LC showed significantly higher Micro shear bond strength values as compared to Biodentine. (Cengiz and Ulusoy, 2016)

E) An vitro study in 2016 by Velagala Deepa evaluated the bonding ability of resin composite (RC) to three different liners: TheraCal LC (TLC), A novel resin-modified (RM) calcium silicate cement, Biodentine (BD), and resin-modified glass ionomer cement (RMGIC) using an universal silane-containing adhesive and characterizing their failure modes and found the results showing no significant difference between TheraCal LC (TLC) and resin-modified glass ionomer cement (RMGIC) but biodentine showed the least bond strength values with a highly significant difference. (Deepa *et al*., 2016)

F) Alzraikat H in 2016 evaluated the shear bond strength (SBS) of TheraCal LC to resin composite was evaluated in comparison to Mineral trioxide aggregate (ProRoot MTA) and conventional glass ionomer cement (GIC) using two adhesive systems and concluded that TheraCal LC displayed the highest SBS. (Alzraikat *et al*., 2016)

G) Karadas M *et al* in 2016 evaluated the bond strength of different adhesive agents to a resin-modified calcium silicate material (TheraCal LC) and concluded that The total-etch adhesive system more strongly bonded to TheraCal LC compared to the bond with other adhesives. TheraCal LC bonded significantly more strongly than AMTA regardless of the adhesive agents tested. (Karadas *et al*., 2016)

Conclusion- Literature suggests that Mechanical properties of TheraCal were far more superior to other pulp capping materials like MTA, Dycal and Biodentine.

2) Chemical properties-: A) Gandolfi *et al* in 2014 compared the chemical-physical properties of new calcium silicate cements and conventional pulp capping calcium-hydroxide materials. The conclusion drawn were as follows:

1. Theracal released less Calcium ions as compared to MTA Plus gel and Biodentine but more than that by Dycal.
2. Porosity, Water sorption and Solubility were least seen with Theracal as compared to other materials like Dycal, MTA Angelus, Biodentin , MTA plus etc.
3. The thickness, continuity of Calcium Phosphate deposits after aging was least seen in TheraCal. (Gandolfi *et al*., 2015)

B) Cannon *et al* in 2014 compared the effectiveness of a TheraCal LC,(Bisco), pure Portland cement, resin based calcium hydroxide or glass ionomer in the healing of bacterially contaminated primate pulps. Both the Portland cement and light cured TheraCal LC groups had significantly more frequent hard tissue bridge formation at 28 days than the GIC and VLC Dycal groups and TheraCal LC histologically appeared to be more pulpally kind as compared to other groups with very mild pulpal inflammation and minimal necrosis but There were no statistically significant differences between the groups in regard to pulpal inflammation (P=1.00). (Cannon *et al*., 2014)

C) A study by Gandolfi *et al* in 2011 evaluated the ability of Theracal and proroot MTA to form hydroxyapatite crystals, when immersed in a phosphate-containing solution and found that Both TheraCal and MTA demonstrated the capacity to form apatite on the surfaces after 24 hours immersion in DPBS but the values weren't significant. However this ability of Theracal to form apatite may play a positive role in new dentin formation. (Gandolfi *et al*., 2011)

D) Gomes-Filho carried out a research on the Rat teeth (2008) to evaluate the subcutaneous response of pulp tissue to light-cure MTA and Angelus MTA which stated that the inflammatory response was more intense in case of Theracal at both the intervals of 30 and 60 days as compared to Angelus MTA. Also Theracal did not stimulate mineralization which was seen in Angelus MTA. (Gomes-Filho *et al*., 2008)

E) Gandolfi and his colleagues in 2014 compared the physical and chemical properties of Theracal with Dycal and MTA. They found that TheraCal released significantly more calcium than ProRoot MTA and Dycal throughout the test period. TheraCal had a good cure depth of 1.7 mm which avoids untimely dissolution and the solubility of TheraCal was low and significantly less than that of Dycal and ProRoot MTA. The amount of water absorbed by Theracal was significantly higher than Dycal and significantly lower than ProRoot MTA

F) Camilleri *et al* in 2016 assessed the hydration characteristics of Biodentine, Theracal LC, and a prototype radiopacified tricalcium silicate–based material after pulp capping and found that Biodentine and the prototype tricalcium silicate cement hydrated and reaction by-products were deposited in the cement

matrix both after pulp capping and when incubated in an aqueous solution. Therefore, Calcium hydroxide was formed and calcium ions were leached into solution Whereas, Theracal LC hydration was incomplete because of the limited moisture diffusion within the material. Thus, no calcium hydroxide was produced, and a lower calcium ion leaching was recorded.
Biodentine exhibited the highest calcium ion release in solution whereas Theracal the lowest. (Camilleri *et al*., 2014)

G) Also, Wasifoddin *et al* in 2016 compared calcium (Ca) ion-releasing capacity of four different light-cured calcium hydroxide [$Ca(OH)_2$] cements with self-cured $Ca(OH)_2$ cement, Septocal, TheraCal, Cal LC and they concluded that Hydrocal and TheraCal were found to be the highest light-cured Calcium ion releasing materials. (Chaudhari *et al*., 2016)

H) A randomized controlled trial was performed by Menon *et al* in 2016 to clinically and radiographically evaluate the reparative dentin formation in indirect pulp treatment (IPT) using mineral trioxide aggregate (MTA) and light cured calcium silicate (TheraCal) in primary molars over a period of 6 months. They found that MTA and TheraCal showed no statistical difference in reparative dentin formation ($P > 0.05$) and there was a significant increase in dentin thickness in both the MTA and TheraCal group. (Menon *et al*., 2016)

I) A study by Bisco inc. concluded that the Calcium release after 24 hours of Theracal was significantly more as compared to reference pulp capping material Dycal. (Ross Nash, 2015)

3) Sealing ability

A) Sameer Makkar in 2015 compared the sealing ability of Mineral Trioxide Aggregate (Angelus), Biodentine (Septodont) and Theracal (Bisco) as pulp capping agents on extracted human third molars and concluded that Theracal exhibited less interfacial microleakage and had a better sealing ability as a pulp capping agent than MTA and Biodentine. (Makkar *et al*., 2015)

B) Petrolo *et al* conducted an in vivo study in 2014 to check the effects of TheraCal on pulp when used as pulp capping agents in comparison to self etching adhesive system – Protect-Bond (kuraray) and GIC FUJI Type 9 and found that most number of vital teeth were seen in theracal group after a follow up period of 2 years and hence Theracal can be used for pulp capping effectively. (Petrolo *et al*., 2014)

4) Antibacterial property

Claudio Poggio in 2015 compared the In vitro antibacterial activity of different pulp capping materials like Dycal (Dentsply), Calcicur (Voco), Calcimol LC (Voco), TheraCal

Table 1. Summary of published literature

Year of Study, Authors	Materials compared to Theracal	Property compared	Result /Conclusion
2008, Gomes-Filho	Angelus MTA	Inflammatory response and mineralization	Light-cured MTA did not induce mineralization and had more intense inflammatory response.
2009, Alberto Dagnain.	Vitrebond (VIT) , Ultrablend Plus (UBP)	Cytocompatibility	Theracal was least cytotoxic.
2011, Gandolfi et al.	Proroot MTA	Hydroxyapatite crystal formation	Both formed apatite crystals but there was no significant difference.
2014, Gandolfi et al	Calxyl, Dycal, Lime-Lite and ProRoot MTA, MTA Angelus, MTA Plus, Biodentine, Tech Biosealer capping,	1.Calcium and hydroxyl ion release, 2.Water sorption, 3.Porosity, 4 solubility and 5 Apatite-forming ability	1.Porosity, water sorption and solubility- Least in Theracal. 2. Calcium ion release and apetite forming- MTA Plus gel was the best.
2014, Petrolo et al	Self-etching adhesive system – Protect-Bond (kuraray) and GIC FUJI Type 9	Preservation of vitality	Most number of vital teeth was seen in TheraCal group.
2014, Bortoluzzi et al	Biodentine	Cytotoxic effects	Biodentin was more cytocompatible than Theracal on hDPSCs.
2014, Hebling et al	Dycal (Dentsply), Calcicur (Voco), Calcimol LC (Voco), MTA Angelus (Angelus), and Biodentine(Septodont	Cytocompatibility to Rat MDPC-23 cells.	1.Biodentine was most cytocompatible. 2.The lowest cytocompatibility was obtained with Dycal, Calcimol LC, and TheraCal LC.
2014, Gandolfi et al.	Dycal and MTA	Physical and chemical properties	1. TheraCal released most amount of calcium. 2. Least solubility and dissolution was seen with TheraCal.
2014, Cannon et al	Pure Portland cement, Resin based calcium hydroxide or glass ionomer	Healing of bacterially contaminated primate pulps	TheraCal LC - More frequent hard tissue bridge formation at 28 days, Minimal pulpal inflammation.
2015, Claudio Poggio	5 direct pulp capping materials.	Solubility and pH	1.Dycal and Calcicur - Lowest solubility. 2.Proroot MTA- Most alkaline pH.
2015, Claudio Poggio	Dycal (Dentsply), Calcicur (Voco), Calcimol LC (Voco), MTA Angelus, Biodentine (Septodont)	In Vitro antibacterial activity	Dycal had greatest antimicrobial activity whereas TheraCal and MTA Angelus – Active against Mutans streptococci
2015, Sameer Makkar	MTA(Angelus), Biodentine (Septodont)	Sealing ability	TheraCal – Less Microleakage and better sealing.
2015, Nielsen MJ	MTA.	Shear bond strength to different restorative materials	Bond strength to TheraCal was significantly more.
2016, Gandolfi MG	Biodentine, MTA, and Calcium hydroxide	Compressive strength, Flexural strength, and Flexural modulus	1. TheraCal- Greatest compressive strength and flexural strength. 2. Biodentine - Greater flexural modulus.
2016, Esra Cengiz	Biodentine	Micro shear bond strength to different restorative materials	TheraCal was superior.
2016, Alzraikat H	ProRoot MTA and conventional GIC	Shear bond strength (SBS) to resin composite	TheraCal displayed highest SBS.
2016, Wasifoddin et al	Four different light-cured calcium hydroxide cements, $Ca(OH)_2$ cement, Septocal, Cal LC	Calcium (Ca) ion-releasing capacity	Hydrocal and TheraCal were the best.
2016, Menon et al	Mineral trioxide Aggregate	Reparative dentin formation	No statistical difference.
2016, Camilleri et al	Biodentin, Prototype radiopacified tricalcium silicate–based material	Hydration characteristics	Calcium ions release- Biodentin highest, TheraCal Lowest.

LC (Bisco), MTA Angelus (Angelus), Biodentine (Septodont) against Streptococcus salivarius, Streptococcus sanguis and Streptococcus mutans strains and found that MTA-Angelus had the greatest zone of inhibition against mutans streptococci followed by Theracal amongst all the pulp capping materials whereas Dycal had greatest antimicrobial activity against S. Salivarius and S. Sanguis whereas theracal had a limited activity against these two bacteria. (Poggio *et al*., 2015)

5) Biocompatibility-:

A) Alberto Dagna in 2009 evaluated the cytotoxic effects of resin-based light-cured liners like TheraCal (TCMTA), Vitrebond (VIT), and Ultrablend Plus (UBP) by cell metabolism, total protein expression and cell morphology (SEM). They concluded that Theracal was least cytotoxic when compared to the rest materials with the cells from other groups showing significant morphological alterations. (Poggio *et al*., 2014)

B) A study by Hebling *et al* in 2014 compared the cytocompatibility towards rat MDPC-23 Cells of six different pulp-capping materials: Dycal (Dentsply), Calcicur (Voco), Calcimol LC (Voco), TheraCal LC (Bisco), MTA Angelus (Angelus), and Biodentine (Septodont) and found that the highest cytocompatibility was seen with Biodentine. MTA-Angelus showed a little lower cytocompatibility whereas The lowest cytocompatibility was obtained with Dycal, Calcimol LC, and TheraCal LC. (Hebling *et al*., 2009)

C) Bortoluzzi *et al* evaluated the effects of Biodentine and TheraCal LC on the viability and osteogenic differentiation of human dental pulp stem cells (hDPSCs) in comparison with MTA Angelus and concluded that the cytotoxic effects of both the materials were time- and concentration-dependent and Osteogenic differentiation of stem cells was enhanced after exposure to Biodentine. This effect was less readily observed with TheraCal LC (Bortoluzzi *et al*., 2015)

D) Claudio Poggio in 2015 compared the solubility and pH of 6 direct pulp capping materials. They concluded that Dycal (Dentsply Tulsa Dental) and Calcicur (Voco GmbH) provided the lowest solubility after both 24 hours and 2 months. All of the materials tested provided a very alkaline pH after 3 hours while ProRoot MTA (Dentsply Tulsa Dental) showed the highest value among the materials tested. (Poggio *et al*., 2015)

DISCUSSION

TheraCal standed out as superior in most of the above studies in terms of physical and chemical properties, Sealing ability, Biocompatibility and Antimicrobial properties. With the evolving trends in dentistry, it is very important for the dentist to cope up with the recent advances. Theracal allows us to complete Direct/Indirect pulp capping procedure very easily within the single appointment without any operator error. Its setting time is controllable hence there is no problem of solubility while setting. Also the chairside time is less as compared to other materials because there is no need to mix or manipulate Theracal as it is available in Syringe and disposable tips.

On the basis of these studies, Some of the important advantages of Theracal are

A) Improved Physical and chemical properties because it had overcome the shortcomings of MTA due to light curing and ability to complete the treatment within single appointment.
B) Excellent Handling characteristics leading to decreased operator error and Good Sealing property.
C) Good antimicrobial and cytocompatibility property.
D) Mild nature to the pulp due to alkaline pH.

The Table 1 below highlights some of the studies included in our article.

Conclusion

According to the present literature, TheraCal proves to be a promising material and can well be the future of pulp capping materials. Though more extensive research are required to confirm its effectiveness.

REFERENCES

Alzraikat H, Taha NA, Qasrawi D, Burrow MF. 2016. Shear bond strength of a novel light cured calcium silicate based-cement to resin composite using different adhesive systems. *Dental Materials Journal*, 35(6):881-7.

Bortoluzzi EA, Niu LN, Palani CD, El-Awady AR, Hammond BD, Pei DD, Tian FC, Cutler CW, Pashley DH, Tay FR. 2015. Cytotoxicity and osteogenic potential of silicate calcium cements as potential protective materials for pulpal revascularization. *Dental Materials*, 31;31(12):1510-22.

Camilleri J, Laurent P, About I. 2014. Hydration of Biodentine, Theracal LC, and a Prototype Tricalcium Silicate–based Dentin Replacement Material after Pulp Capping in Entire Tooth Cultures. *Journal of Endodontics*, 30;40(11):1846-54.

Cannon M, Gerodias N, Vieira A, Percinoto C, Jurado R. 2014. Primate pulpal healing after exposure and TheraCal application. *Journal of Clinical Pediatric Dentistry*, 1;38(4):333-7.

Cantekin K. 2015. Bond strength of different restorative materials to light-curable mineral trioxide aggregate. *Journal of Clinical Pediatric Dentistry*, 1;39(2):143-8.

Cengiz E, Ulusoy N. 2016. Microshear Bond Strength of Tri-Calcium Silicate-based Cements to Different Restorative Materials. *Journal of Adhesive Dentistry*, 1;18(3).

Chaudhari WA, Jain RJ, Jadhav SK, Hegde VS, Dixit MV. 2016. Calcium ion release from four different light-cured calcium hydroxide cements. *Endodontology*., 1;28(2):114.

Deepa VL, Dhamaraju B, Bollu IP, Balaji TS. 2016. Shear bond strength evaluation of resin composite bonded to three different liners: TheraCal LC, Biodentine, and resin-modified glass ionomer cement using universal adhesive: An in vitro study. Journal of conservative dentistry: JCD. 19(2):166.

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Gandolfi MG, Siboni F, Botero T, Bossù M, Riccitiello F, Prati C. 2015. Calcium silicate and calcium hydroxide materials for pulp capping: biointeractivity, porosity, solubility and bioactivity of current formulations. *J Appl Biomater Funct Mater*, 1;13(1):43-60.

Gandolfi MG, Siboni F, Prati C. 2012. Chemical–physical properties of TheraCal, a novel light-curable MTA-like material for pulp capping. *International Endodontic Journal*, 1;45(6):571-9.

Gandolfi MG, Siboni F, Taddei P, Modena E, Prati C. 2011. Apatite-forming ability of TheraCal pulp-capping material. *J Dent Res*., 18;90:2521.

Gomes-Filho JE, de Faria MD, Bernabé PF, Nery MJ, Otoboni-Filho JA, Dezan-Júnior E, de Moraes Costa MM, Cannon M. 2008. Mineral trioxide aggregate but not light-cure mineral trioxide aggregate stimulated mineralization. *Journal of Endodontics*, 31;34(1):62-5.

Hebling J, Lessa FC, Nogueira I, Carvalho RM, Costa CA. 2009. Cytotoxicity of resin-based light-cured liners. *American Journal of Dentistry*, 22(3):137-42.

Karadas M, Cantekin K, Gumus H, Ateş SM, Duymuş ZY. 2016. Evaluation of the bond strength of different adhesive agents to a resin-modified calcium silicate material (TheraCal LC). Scanning, 1;38(5):403-11.

Makkar S, Kaur H, Aggarwal A, Vashisht R. 2015. A confocal laser scanning microscopic study evaluating the sealing ability of mineral trioxide aggregate, biodentine and a new pulp capping agent-TheraCal. *Dent J Adv Stud*., 3:20-5.

Menon NP, Varma BR, Janardhanan S, Kumaran P, Xavier AM, Govinda BS. 2016. Clinical and radiographic comparison of indirect pulp treatment using light-cured calcium silicate and mineral trioxide aggregate in primary molars: A randomized clinical trial. *Contemporary Clinical Dentistry*, 7(4):475.

Nielsen MJ, Casey JA, VanderWeele RA, Vandewalle KS. 2015. Mechanical properties of new dental pulp-capping materials. *General dentistry*, 64(1):44-8.

Petrolo F, Comba A, Scansetti M, Alovisi M, Pasqualini D, Berutti E, Scotti N. Effects of light-cured MTA like material on direct pulp capping. *Dental Materials*. 2014 Jan 1;30:e151.

Poggio C, Arciola CR, Beltrami R, Monaco A, Dagna A, Lombardini M, Visai L. 2014. Cytocompatibility and antibacterial properties of capping materials. *The Scientific World Journal*, 18.

Poggio C, Beltrami R, Colombo M, Ceci M, Dagna A, Chiesa M. 2015. In vitro antibacterial activity of different pulp capping materials. *Journal of clinical and experimental dentistry*, 7(5):e584.

Poggio C, Lombardini M, Colombo M, Beltrami R, Rindi S. 2015. Solubility and pH of direct pulp capping materials: a comparative study. *Journal of applied Biomaterials & Functional Materials*, 1;13(2).

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