

# TOTALFILL®



**SCIENTIFIC OVERVIEW**  
**10/2021**



### **TotalFill® BC Sealer™**

**Bioceramic sealers are indicated for the following uses:**

- Permanent obturation of the root canal following vital pulp-extirpation.
- Permanent obturation of the root canal following removal of infected or necrotic pulp and placement of intracanal dressings.

*TotalFill® BC Sealer™ for cold obturation or TotalFill® BC Sealer™ HiFlow for warm obturation.*

### **TotalFill® BC RRM™**

**Bioceramic repair materials are indicated for the following uses:**

- Repair of Root Perforation
- Repair of Root Resorption
- Root End Filling
- Apexification
- Pulp Capping

The current literature overview aims to identify all articles published on the TotalFill range of products. To do so, the pubmed (*National Center for Biotechnology Information (NCBI). Bethesda (MD), USA, 2021. Available from: <https://www.ncbi.nlm.nih.gov/>*) database was searched using the keyword “Totalfill”. All articles published until October 1<sup>st</sup>, 2021 were selected. No other restriction was applied to the search.

All articles retrieved during the search were regrouped in 6 different categories:

**In vivo** - highlights the articles that report studies performed on living subjects (human and animal).

**Biocompatibility & Bioactivity – (Biocomp)** articles that focus on body response (e.g. cytotoxicity, inflammatory reaction, mineralization, calcium release, ...) induced by the material.

**Antibacterial Effect** – articles that investigate the effect of the material on bacteria (e.g. inhibition, bactericide, ...).

**Retreatability** – articles that investigate retreatability of the material.

**Pulp Capping** – articles reporting on vital pulp therapies (e.g. pulp capping and pulpectomy).

**Properties of the Material** – articles assessing the chemical and/or the physical properties of the material.

IN VIVO	BIOCOMPATIBILITY & BIOACTIVITY	ANTIBACTERIAL EFFECT	RETREATABILITY	PULP CAPPING	PROPERTIES OF THE MATERIAL	
						<p><b>(1) M. A. Elsayed et al. <i>Eur. Endod J.</i> 2021</b></p> <p><b>Compared with:</b> MTA Fillapex</p> <p><b>Comments:</b> TotalFill exhibits high apatite formation, high Ca<sup>2+</sup> ion release, and high Ca/P ratio. This is linked to better biological sealing ability and stimulation of new bone deposition. In comparison, MTA Filapex showed lower and delayed bioactivity.</p>
						<p><b>(2) R. F. Zancan et al. <i>Int. Endod. J.</i> 2021</b></p> <p><b>Compared with:</b> AH+, BioRoot RCS, MTA Fillapex</p> <p><b>Comments:</b> Removal of smear layer was correlated with improved bacterial reduction in the dentinal tubules. The irrigation protocol (2% NaOCl vs. 2% NaOCl + 17% EDTA) did not influence the antibacterial effect of TotalFill. BioRoot RCS exhibited the highest antibacterial effect and dentinal tubule penetration.</p>
						<p><b>(3) J. M. Santos et al. <i>Biomedicines.</i> 2021</b></p> <p><b>Compared with:</b> TotalFill Hiflow, AH+</p> <p><b>Comments:</b> On a rat model, inflammatory reaction, macrophage infiltrate, and mineralization were observed after 8- and 30-days implantation. AH+ presented a higher inflammatory score at both days when compared to TotalFill BC Sealer and Hiflow. Hiflow showed a higher mineralization potential and macrophage infiltrate than AH+. Biocompatibility and bioactivity potential was demonstrated for TotalFill BC Seler and TotalFill Hiflow. AH+ did not induce bioactivity.</p>

IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
x					<p>(4) H. S. G. Tan et al. <i>J. Endod.</i> 2021</p> <p><b>Compared with:</b> AH+</p> <p><b>Comments:</b> 163 patients were recruited for a study aiming at comparing <b>postoperative pain</b>. No difference between TotalFill and AH+ was observed. The postoperative pain level is related to the preoperative pain level rather than the obturation material</p>
				x	<p>(5) P. J. Palma et al. <i>Clin. Oral Investig.</i> 2021</p> <p><b>Compared with:</b> Biodentine, Pulp capping material (Coltene)</p> <p><b>Comments:</b> <b>Bond strength</b>. No statistical difference was observed between the tested materials at day 0. TotalFill and Biodentine showed a superior shear bond strength than PCM at day 7.</p>
x	x				<p>(6) E. C. A. Silva et al. <i>Int. Endod. J.</i> 2021</p> <p><b>Compared with:</b> Experimental sealer based on tricalcium silicate, AH+</p> <p><b>Comments:</b> TotalFill showed the highest bioactivity and biocompatibility among the commercial sealers on a rat model. The inflammation due to the treatment gradually reduced over time. The slowest recovery was observed for AH+.</p>
x				x	<p>(7) E. J. N. L. Silva et al. <i>Clin. Oral Investig.</i> 2021</p> <p><b>Compared with:</b> BioC Sealer, AH+, Sealapex</p> <p><b>Comments:</b> Compare in vitro vs. in vivo methods to test the setting time of different sealers. Setting times were different in-vitro and in vivo. AH Plus, BioC sealer and TotalFill BC sealer had set at 7 days in vivo. Sealapex did not set in vivo.</p>

IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
2020 - TotalFill® BC Sealer					
	x			x	<p>(8) M.-M. Almeida et al. <i>J. Clin. Exp. Dent.</i> 2020</p> <p><b>Compared with:</b> AH +, MTA Fillapex</p> <p><b>Comments:</b> TotalFill showed the longest setting time (initial and final), lower radiopacity than AH+ but similar to MTA Fillapex, and lower flowability than AH+ but higher than MTA Fillapex. AH+ and TotalFill were associated with lower volumetric changes than MTA Fillapex. TotalFill also exhibits the highest pH (7.07-8.6) and calcium release over time. Regarding biocompatibility, TotalFill showed the best results (lowest cytotoxicity) of all tested sealers.</p>
		x			<p>(9) R. Bose et al. <i>J. Clin. Med.</i> 2020</p> <p><b>Compared with:</b> BioRoots RCS, AH +, Tubli-seal</p> <p><b>Comments:</b> Significant difference of reduction in viable counts was observed between BioRoot RCS and AH+. The highest biofilm inhibition was demonstrated for TotalFill and BioRoot RCS. BioRoot RCS presented with the highest microbial killing, followed by TotalFill BC and Tubli-seal. Alkalizing activity was seen from the onset by BioRoot RCS, TotalFill BC and AH Plus. Effective microbial properties were superior for TotalFill and BioRoot RCS when compared to epoxy-based and zinc oxide-eugenol-based sealers.</p>
		x		x	<p>(10) A. Katakidis et al. <i>Restor. Dent. Endod.</i> 2020</p> <p><b>Compared with:</b> BioRoots RCS, Sealapex</p> <p><b>Comments:</b> TotalFill BC Sealer demonstrated the highest flow. The bioceramic sealers initially presented higher alkaline activity than the polymeric calcium hydroxide sealer. However, at 3 and 4 weeks post-immersion (i.e. when the sealers had fully set), all sealers had similar pH values.</p>



IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
					<p>(11) M. Hadis and J. Camilleri. <i>Dent. Mater. Off. Publ. Acad. Dent. Mater.</i> 2020</p> <p><b>X</b> <b>Compared with:</b> TotalFill BC Sealer Hiflow  <b>Comments:</b> None of the sealers are irreversibly affected by the heat generated during warm vertical obturation. After cooling down, the chemical compositions returned to initial status.</p>
					<p>(12) A. Almohaimede et al. <i>Eur. Endod. J.</i> 2020</p> <p><b>X</b> <b>Compared with:</b> AH+  <b>Comments:</b> No significant difference was observed between TotalFill and AH+ in terms of resistance to fracture.</p>
		<b>X</b>			<p>(13) M. Garrib and J. Camilleri. <i>J. Dent.</i> 2020</p> <p><b>Compared with:</b> None  <b>Comments:</b> 17% EDTA and 10% formic acid applied for 5 minutes used in conjunction with mechanical instrumentation achieved over 95% removal of GP and sealer. This protocol also achieved patency and reestablishment of the working length while not damaging the dentin.</p>
					<p>(14) Y. T. Mohammed and I. M. Al-Zaka. <i>J. Contemp. Dent. Pract.</i> 2020</p> <p><b>X</b> <b>Compared with:</b> AH+, GuttaFlow 2, MTA-Fillapex  <b>Comments:</b> TotalFill BC sealer with BC cones enhanced the in-vitro fracture resistance of endodontically treated teeth compared to the other sealers tested.</p>
		<b>X</b>			<p>(15) M. Šimundić Munitić et al. <i>Acta Stomatol. Croat.</i> 2020</p> <p><b>Compared with:</b> BioRoots RCS, MTA Fillapex, AH+  <b>Comments:</b> TotalFill and AH+ presented a significant superior antibacterial (<i>E. faecalis</i>) effect when compared to BioRoot RCS and MTA Fillapex</p>

IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
					<p>(16) <b>A. R. Atmeh et al. <i>Int. Endod. J.</i> 2020</b></p> <p><b>Compared with:</b> AH+, Pulp Canal Sealer, BioRoot RCS</p> <p><b>Comments:</b> It is not recommended to heat zinc oxide-based sealers. Epoxy resin and calcium silicate-based sealers shall be heated above 100°C. However, TotalFill recovered its initial composition after cooling down.</p>
					<p>(17) <b>F. F. E. Torres et al. <i>Int. Endod. J.</i> 2020</b></p> <p><b>Compared with:</b> Sealer Plus BC, Bio-C Sealer, AH+</p> <p><b>Comments:</b> The epoxy resin showed the least changes after immersion in PBS and distilled water. No difference between TotalFill and Sealer Plus BC was observed in terms of mass loss and volumetric change. Both sealers exhibited less mass and volume loss than Bio-C Sealer. The presence of voids was similar for all tested sealers.</p>
<b>2019 - TotalFill® BC Sealer</b>					
	x	x			<p>(18) <b>A. Koutroulis et al. <i>Sci. Rep.</i> 2019</b></p> <p><b>Compared with:</b> TotalFill RRM, Bio-C Pulpo, Biodentine, Theracal, ACTIVA BioACTIVE Base/Liner, TCS replaced with 30% ZO radiopacifier (TCS/ZO), TCS/ZO with 15% CP replacement in the cementitious phase (TCS-CP/ZO), TCS/ZO with 10 or 20% micro-silica replacement of the cement (TCS-mS10/ZO, TCS-mS20/ZO respectively).</p> <p><b>Comments:</b> Increased calcium release (bioactivity), antibacterial activity, and effect in cell metabolic activity were highlighted for TotalFill RRM, Bio-C Pulpo, and Biodentine. High cell viability (&gt;70%, biocompatibility) and effective antibacterial effect for all tested strains was reported for TotalFill RRM</p>
	x				<p>(19) <b>S. López-García et al. <i>Materials.</i> 2019</b></p> <p><b>Compared with:</b> Bio-C, AH+</p> <p><b>Comments:</b> Bioceramic sealers demonstrated better cytocompatibility in terms of cell viability, migration, cell morphology, cell attachment and mineralization capacity than AH Plus.</p>

IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
					<p>(20) C. L. Zordan-Bronzel et al. <i>J. Endod.</i> 2019</p> <p><b>Compared with:</b> Bio-C, AH+</p> <p><b>Comments:</b> No difference regarding radiopacity, volumetric change, and pH was observed between TotalFill and Bio-C Sealer. AH+ had the highest radiopacity and the lowest flowability, pH, solubility, and volumetric change</p>
					<p>(21) A. S. Al-Hiyasat and S. A. Alfirjani. <i>J. Dent.</i> 2019</p> <p><b>Compared with:</b> AH+</p> <p><b>Comments:</b> <b>Bond strength.</b> TotalFill has a higher bond strength than AH+. The obturation technique (cold lateral compaction, single cone, and warm vertical compaction) did not influence the bond strength of TotalFill.</p>
					<p>(22) P. Reszka et al. <i>Dent. Med. Probl.</i> 2019</p> <p><b>Compared with:</b> GuttaFlow Bioseal</p> <p><b>Comments:</b> The authors claim that TotalFill showed a higher degree of purity compared to GuttaFlow.</p>
					<p>(23) S. Alsubait et al. <i>Odontology.</i> 2019</p> <p><b>Compared with:</b> BioRoots RCS, AH+</p> <p><b>Comments:</b> This study showed that calcium silicate sealer have a higher antibacterial activity than epoxy resin based sealer. On day 7, TotalFill showed the highest amount of dead bacteria. BioRoot reduced the bacterial load by 61.75% at day 30.</p>
					<p>(24) C. L. Zordan-Bronzel et al. <i>Int. Endod. J.</i> 2019</p> <p><b>Compared with:</b> Experimental calcium silicate-based sealer, AH+</p> <p><b>Comments:</b> All sealers were rated as non-cytotoxic. In addition, TotalFill and the experimental sealer were significantly more effective in terms of antibacterial and antibiofilm effect</p>



IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
	x				<p>(25) F. Zamparini et al. <i>Clin. Oral Investig.</i> 2019</p> <p><b>Compared with:</b> TotalFill RRM Putty, TotalFill RRM paste</p> <p><b>Comments:</b> These materials exhibit excellent physicochemical properties and bioactive properties. Their marked ability to nucleate B-type carbonate apatite, offer many biological advantages over materials used for similar indications.</p>
					<p>(26) Z. U. Aydın et al. <i>Odontology.</i> 2019</p> <p><b>Compared with:</b> None</p> <p><b>Comments:</b> <b>Sealer penetration in tubules.</b> Deeper sealer penetration in tubules was observed in teeth treated with EDTA and QMix when compared to chitosan nanoparticles.</p>
2018 - TotalFill® BC Sealer					
			x		<p>(27) F. Kakoura and O. Pantelidou. <i>J. Conserv. Dent. JCD.</i> 2018</p> <p><b>Compared with:</b> AH26, BioRoot RCS</p> <p><b>Comments:</b> To evaluate residual filling material and re-establishment of working length and apical patency after retreatment of BioRoot RCS, versus TotalFill BC Sealer and AH26 used in single cone obturation.</p> <p>All the sealers were removed to a similar extent. The working length and patency were reestablished sufficiently in all groups.</p>
					<p>(28) S. Osiri et al. <i>J. Endod.</i> 2018</p> <p><b>Compared with:</b> AH+</p> <p><b>Comments:</b> <b>Fracture resistance.</b> No difference between the sealers was observed. They exhibited the same resistance than intact roots.</p>
					<p>(29) S. Germain et al. <i>J. Contemp. Dent. Pract.</i> 2018</p> <p><b>Compared with:</b> Experimental BC sealer, AH+</p> <p><b>Comments:</b> <b>Sealing ability.</b> No difference in terms of voids was observed between the tested sealers and conditions.</p>

IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
				X	<p>(30) E. M. Kamal et al. <i>Dent. Med. Probl.</i> 2018</p> <p><b>Compared with:</b> Biodentine, TheraCal LC</p> <p><b>Comments:</b> Similar results were obtained for the 3 direct pulp capping materials in terms of dentin bridge thickness.</p>
	X				<p>(31) V. Taraslia et al. <i>Eur. J. Dent.</i> 2018</p> <p><b>Compared with:</b> MTA Fillapex, GuttaFlow 2, BioRoot RCS, Roth's 801, AH+</p> <p><b>Comments:</b> TotalFill and BioRoot RCS showed no or mild cytotoxic effect whereas all other sealers were moderately to severely cytotoxic. The bioceramic sealers were too soluble in regards of the ISO 6876. TotalFill and EasySeal killed all bacteria independently of the time point tested in the direct contact test.</p>
	X			X	<p>(32) M. Colombo et al. <i>J. Clin. Exp. Dent.</i> 2018</p> <p><b>Compared with:</b> MTA Fillapex, BioRoot RCS, Sealapex, EasySeal, AH+</p> <p><b>Comments:</b> TotalFill and BioRoot RCS showed no or mild cytotoxic effect whereas all other sealers were moderately to severely cytotoxic. The bioceramic sealers were too soluble in regards of the ISO 6876. TotalFill and EasySeal killed all bacteria independently of the time point tested in the direct contact test.</p>
		X			<p>(33) V. Kapralos et al. <i>J. Endod.</i> 2018</p> <p><b>Compared with:</b> RoekoSeal, GuttaFlow 2, AH+</p> <p><b>Comments:</b> TotalFill was the only efficient sealer against planktonic bacteria (<i>E. faecalis</i>, <i>S. mutans</i>, <i>S. epidermis</i>, and <i>S. aureus</i>). On biofilms AH+ was the most effective followed by TotalFill. RoekoSeal and GuttaFlow 2 showed no antibacterial effect</p>
				X	<p>(34) S. Kadić et al. <i>Clin. Oral Investig.</i> 2018</p> <p><b>Compared with:</b> MM-MTA, Biodentine, TotalFill BC RRM</p> <p><b>Comments: Bond strength.</b> TotalFill RRM showed a significant higher bond strength when compared to the other materials. Similar fracture modes were observed for the 3 root-end filling material.</p>

IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
2017 – TotalFill® BC Sealer					
					<p>(35) <b>M. Tanomaru-Filho et al. <i>J. Endod.</i> 2017</b></p> <p><b>Compared with:</b> GuttaFlow Bioseal, AH+</p> <p><b>Comments:</b> TotalFill showed the highest values in terms of setting time, pH, solubility, and flow. High pH and calcium release are considered as the mechanisms for mineralized tissue repair.</p>
					<p>(36) <b>C. Poggio et al. <i>J. Clin. Exp. Dent.</i> 2017</b></p> <p><b>Compared with:</b> BioRoot RCS, MTA Fillapex, Sealapex, EasySeal, Pulp Canal Sealer, N2, AH+</p> <p><b>Comments:</b> TotalFill and BioRoot RCS showed the highest solubility and pH.</p>
		x			<p>(37) <b>C. Poggio et al. <i>J. Clin. Exp. Dent.</i> 2017</b></p> <p><b>Compared with:</b> BioRoot RCS, MTA Fillapex, Sealapex, EasySeal, Pulp Canal Sealer, N2, AH+</p> <p><b>Comments:</b> The highest bactericidal effect was observed for TotalFill and EasySeal. N2 showed the highest antibacterial activity.</p>
	x				<p>(38) <b>C. Poggio et al. <i>J. Clin. Exp. Dent.</i> 2017</b></p> <p><b>Compared with:</b> BioRoot RCS, MTA Fillapex, Sealapex, EasySeal, Pulp Canal Sealer, N2, AH+</p> <p><b>Comments:</b> TotalFill and BioRoot RCS showed no or mild cytotoxic effect whereas all other sealers were moderately to severely cytotoxic. AH+ was non-cytotoxic at 24h but ended as severely cytotoxic at 72h. Moderate and severe cytotoxicity induced cell death (apoptosis).</p>
					<p>(39) <b>E. Turkel et al. <i>Photomed. Laser Surg.</i> 2017</b></p> <p><b>Compared with:</b> AH+</p> <p><b>Comments:</b> <b>Sealer penetration in tubules.</b> The activation method did not influence the penetration depth of TotalFill into tubules. Superior tubular penetration was observed for TotalFill when compared to AH+.</p>

IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
					<p>(40) W. Y. Yap et al. <i>Med. Princ. Pract. Int. J. Kuwait Univ. Health Sci. Cent.</i> 2017</p> <p><b>Compared with:</b> EndoREZ, AH+</p> <p><b>Comments:</b> Bond strength. TotalFill and AH+ showed the highest bond strength independently of the obturation system. Their bond strength increased with time. EndoRez has a significant lower bond strength and it decreases with time.</p>
					<p>(41) D. Hrab et al. <i>Clujul Med.</i> 2017</p> <p><b>Compared with:</b> Experimental material based on hydroxyapatite with silver and zinc</p> <p><b>Comments:</b> TotalFill showed a radiopacity of 4±0.15 mmAl, which is higher than the minimal requirement of 3 mmAl set into the ISO standard 6876. The experimental sealer presented similar results than TotalFill.</p>
	x				<p>(42) F. J. Rodríguez-Lozano et al. <i>Int. Endod. J.</i> 2017</p> <p><b>Compared with:</b> MTA Fillapex, AH+</p> <p><b>Comments:</b> TotalFill showed significantly higher bioactivity (cell proliferation and cell adhesion) and lower cytotoxicity than MTA Fillapex and AH+.</p>
2015 – TotalFill® BC Sealer					
			x		<p>(43) A. Agrafioti et al. <i>Eur. J. Dent.</i> 2015</p> <p><b>Compared with:</b> MTA Fillapex, AH+</p> <p><b>Comments:</b> TotalFill allowed retreatment (working length and patency reestablished) in 100% of the cases. Similar results were obtained for the 2 other sealers. Time required for retreatment was longer for the TotalFill group.</p>

IN VIVO BIOCOMP ANTIBACTERIAL RETREATABILITY PULP CAPPING PROPERTIES					
2021 – TotalFill® BC RRM					
x				x	<p>(44) J. M. Santos et al. <i>J. Endod.</i> 2021</p> <p><b>Compared with:</b> ProRoot MTA, BioDentine, Experimental material</p> <p><b>Comments:</b> TotalFill BC RRM Putty, ProRoot MTA, and BioDentine are considered as suitable for pulp capping procedures. Preoperative inflammation did not influence the outcomes of full pulpectomy.</p>
				x	<p>(45) A. S. Al-Hiyasat et al. <i>BMC Oral Health.</i> 2021</p> <p><b>Compared with:</b> MTA Angelus Gray, ProRoot White MTA, Biodentine, TheraCal LC</p> <p><b>Comments: Tooth discoloration.</b> By the presence of blood, TotalFill and Biodentine showed the least tooth discoloration. In saline solution, Biodentine causes less discoloration than all other materials. ProRoot White MTA and MTA Angelus Gray showed the most tooth discoloration.</p>
				x	<p>(46) R. Krug et al. <i>Clin. Oral Investig.</i> 2021</p> <p><b>Compared with:</b> ProRoot MTA, Medcem MTA, Medcem Medical Portland Cement</p> <p><b>Comments: Tooth discoloration.</b> No significant difference in tooth discoloration was observed between the tested sealers.</p>
2020 – TotalFill® BC RRM					
				x	<p>(47) S. Alsubait et al. <i>BMC Oral Health.</i> 2020</p> <p><b>Compared with:</b> ProRoot MTA</p> <p><b>Comments: Bond strength.</b> To compare the influence of intracanal medicaments (Ca(OH)<sub>2</sub> and mTAP) on the dislocation resistance of sealers. AH+ lose bond strength when combined with intracanal medication. However, the bond of TotalFill BC root repair material fast set putty remains stable.</p>



<div> <div>IN VIVO</div> <div>BIOCOMP</div> <div>ANTIBACTERIAL</div> <div>RETREATABILITY</div> <div>PULP CAPPING</div> <div>PROPERTIES</div> </div>						2019 - TotalFill® BC RRM
					x	<p>(48) S. Kadić et al. <i>Lasers Med. Sci.</i> 2019</p> <p><b>Compared with:</b> None</p> <p><b>Comments:</b> The highest dentin/RRM bond strength was achieved for cavities prepared with Er:YAG.</p>
				x		<p>(49) K. W. Al-Saudi et al. <i>Saudi Dent. J.</i> 2019</p> <p><b>Compared with:</b> Neo MTA Plus</p> <p><b>Comments:</b> TotalFill showed superior dentin bridge thickness at 3 months post-treatment. These more favorable conditions for pulp repair are probably due to high calcium release. Complete dentin bridge formation and an absence of inflammatory pulp response were observed for both materials at 3 weeks and 3 months post-treatment.</p>
					x	<p>(50) J. H. R. Chu et al. <i>Aust. Endod. J. J. Aust. Soc. Endodontology Inc.</i> 2019</p> <p><b>Compared with:</b> MTA Angelus White</p> <p><b>Comments:</b> Evaluate the effect of 5% NaOCl and 17% EDTA on the microhardness of MTA Angelus and TotalFill RRM Putty after 24hrs and 8 days. Allowing the materials to set for a week before exposing them to the irrigants improves their microhardness. Significant for perforation repair.</p>
					x	<p>(51) M. Juez et al. <i>J. Conserv. Dent. JCD.</i> 2019</p> <p><b>Compared with:</b> ProRoot White MTA, BioDentine</p> <p><b>Comments:</b> To compare the sealing ability of White MTA, BioDentine and TotalFill Root Repair Materials with a glucose leakage model after orthograde obturation using an open apex model. There was no statistical difference in leakage between the groups. Note: Different methods of placement of the materials add variables to the study.</p>

IN VIVO	BIOCOMP	ANTIBACTERIAL	RETREATABILITY	PULP CAPPING	PROPERTIES
	X				<p>(52) M. R. W. Ali et al. <i>Eur. J. Oral Sci.</i> 2019</p> <p><b>Compared with:</b> White MTA Angelus, Biodentine</p> <p><b>Comments:</b> The duration and the concentration of the materials had an influence on the cell inhibition(human bone marrow mesenchymal stem cells). The differences observed were inconclusive in order to determine a material that would be superior to the others.</p>
				X	<p>(53) M. R. W. Ali et al. <i>Acta Biomater. Odontol.</i> 2019</p> <p><b>Compared with:</b> White MTA ANGELUS, Biodentine, Gutta percha and AH+</p> <p><b>Comments:</b> No statistical difference between the cements was observed in terms of resistance to fracture.</p>
	X			X	<p>(54) P. Lertmalapong et al. <i>J. Investig. Clin. Dent.</i> 2019</p> <p><b>Compared with:</b> ProRootMTA, Biodentine, RetroMTA</p> <p><b>Comments: Leakage.</b> To investigate bacterial leakage and marginal adaptation of bioceramic apical plugs.TotalFill BC RRM putty (3 and 4mm), Biodentine (3 and 4mm), ProRoot MTA (4mm) groups showed the best sealing ability and marginal adaptation of apical plugs.</p>
	X			X	<p>(25) F. Zamparini et al. <i>Clin. Oral Investig.</i> 2019</p> <p><b>Compared with:</b> TotalFill BC Sealer, TotalFill RRM Putty, TotalFill RRM paste</p> <p><b>Comments:</b> These materials exhibit excellent physicochemical properties and bioactive properties. Their marked ability to nucleate B-type carbonate apatite, offer many biological advantages over materials used for similar indications.</p>

## References

1. Elsayed MA, Hassanien EE, Elgendy AAE. Ageing of TotalFill BC Sealer and MTA Fillapex in Simulated Body Fluid. *Eur Endod J*. 2021 Apr 14;
2. Zancan RF, Di Maio A, Tomson PL, Duarte M a. H, Camilleri J. The presence of smear layer affects the antimicrobial action of root canal sealers. *Int Endod J*. 2021 Mar 24;
3. Santos JM, Coelho CM, Sequeira DB, Marques JA, Pereira JF, Sousa V, et al. Subcutaneous Implantation Assessment of New Calcium-Silicate Based Sealer for Warm Obturation. *Biomedicines*. 2021 Jan 1;9(1):24.
4. Tan HSG, Lim KC, Lui JN, Lai WMC, Yu VSH. Postobturation Pain Associated with Tricalcium Silicate and Resin-based Sealer Techniques: A Randomized Clinical Trial. *J Endod* [Internet]. 2020 Oct 22 [cited 2020 Dec 1]; Available from: <http://www.sciencedirect.com/science/article/pii/S0099239920307755>
5. Palma PJ, Marques JA, Antunes M, Falacho RI, Sequeira D, Roseiro L, et al. Effect of restorative timing on shear bond strength of composite resin/calcium silicate-based cements adhesive interfaces. *Clin Oral Investig*. 2021 May;25(5):3131–9.
6. Silva ECA, Tanomaru-Filho M, Silva GF, Lopes CS, Cerri PS, Guerreiro Tanomaru JM. Evaluation of the biological properties of two experimental calcium silicate sealers: an in vivo study in rats. *Int Endod J*. 2021 Jan;54(1):100–11.
7. Silva EJNL, Ehrhardt IC, Sampaio GC, Cardoso ML, Oliveira D da S, Uzeda MJ, et al. Determining the setting of root canal sealers using an in vivo animal experimental model. *Clin Oral Investig*. 2020 Aug 13;
8. Almeida M-M, Rodrigues C-T, Matos A-A, Carvalho K-K-T, Silva E-J-N-L, Duarte M-A-H, et al. Analysis of the physicochemical properties, cytotoxicity and volumetric changes of AH Plus, MTA Fillapex and TotalFill BC Sealer. *J Clin Exp Dent*. 2020 Nov;12(11):e1058–65.
9. Bose R, Ioannidis K, Foschi F, Bakhsh A, Kelly RD, Deb S, et al. Antimicrobial Effectiveness of Calcium Silicate Sealers against a Nutrient-Stressed Multispecies Biofilm. *J Clin Med*. 2020 Aug 24;9(9):E2722.
10. Katakidis A, Sidiropoulos K, Koulaouzidou E, Gogos C, Economides N. Flow characteristics and alkalinity of novel bioceramic root canal sealers. *Restor Dent Endod*. 2020 Nov;45(4):e42.
11. Hadis M, Camilleri J. Characterization of heat resistant hydraulic sealer for warm vertical obturation. *Dent Mater Off Publ Acad Dent Mater*. 2020 Jun 3;
12. Almohaimede A, Almanie D, Alaathy S, Almadi E. Fracture Resistance of Roots Filled With Bio-Ceramic and Epoxy Resin-Based Sealers: In Vitro Study. *Eur Endod J*. 2020;5(2):134–7.
13. Garrib M, Camilleri J. Retreatment efficacy of hydraulic calcium silicate sealers used in single cone obturation. *J Dent*. 2020 Jul;98:103370.
14. Mohammed YT, Al-Zaka IM. Fracture Resistance of Endodontically Treated Teeth Obturated with Different Root Canal Sealers (A Comparative Study). *J Contemp Dent Pract*. 2020 May 1;21(5):490–3.
15. Šimundić Munitić M, Budimir A, Jakovljević S, Anić I, Bago I. Short-Term Antibacterial Efficacy of Three Bioceramic Root Canal Sealers Against *Enterococcus Faecalis* Biofilms. *Acta Stomatol Croat*. 2020 Mar;54(1):3–9.
16. Atmeh AR, Hadis M, Camilleri J. Real-time chemical analysis of root filling materials with heating: guidelines for safe temperature levels. *Int Endod J* [Internet]. [cited 2020 Apr 7];n/a(n/a). Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1111/iej.13269>
17. Torres FFE, Zordan-Bronzel CL, Guerreiro-Tanomaru JM, Chávez-Andrade GM, Pinto JC, Tanomaru-Filho M. Effect of immersion in distilled water or phosphate-buffered saline on the solubility, volumetric change and presence of voids within new calcium silicate-based root canal sealers. *Int Endod J*. 2020;53(3):385–91.
18. Koutroulis A, Kuehne SA, Cooper PR, Camilleri J. The role of calcium ion release on biocompatibility and antimicrobial properties of hydraulic cements. *Sci Rep* [Internet]. 2019 Dec 13 [cited 2020 Apr 7];9. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6910940/>
19. López-García S, Pecci-Lloret MR, Guerrero-Gironés J, Pecci-Lloret MP, Lozano A, Llena C, et al. Comparative Cytocompatibility and Mineralization Potential of Bio-C Sealer and TotalFill BC Sealer. *Materials* [Internet]. 2019 Sep 22 [cited 2020 Apr 7];12(19). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6804055/>

20. Zordan-Bronzel CL, Esteves Torres FF, Tanomaru-Filho M, Chávez-Andrade GM, Bosso-Martelo R, Guerreiro-Tanomaru JM. Evaluation of Physicochemical Properties of a New Calcium Silicate-based Sealer, Bio-C Sealer. *J Endod*. 2019 Aug 22;
21. Al-Hiyasat AS, Alfirjani SA. The effect of obturation techniques on the push-out bond strength of a premixed bioceramic root canal sealer. *J Dent*. 2019 Jul 18;
22. Reszka P, Nowicka A, Dura W, Marek E, Lipski M. SEM and EDS study of TotalFill BC Sealer and GuttaFlow Bioseal root canal sealers. *Dent Med Probl*. 2019 Jun;56(2):167–72.
23. Alsubait S, Albader S, Alajlan N, Alkhunaini N, Niazy A, Almahdy A. Comparison of the antibacterial activity of calcium silicate- and epoxy resin-based endodontic sealers against *Enterococcus faecalis* biofilms: a confocal laser-scanning microscopy analysis. *Odontology*. 2019 Mar 29;
24. Zordan-Bronzel CL, Tanomaru-Filho M, Rodrigues EM, Chávez-Andrade GM, Faria G, Guerreiro-Tanomaru JM. Cytocompatibility, bioactive potential and antimicrobial activity of an experimental calcium silicate-based endodontic sealer. *Int Endod J*. 2019 Jul;52(7):979–86.
25. Zamparini F, Siboni F, Prati C, Taddei P, Gandolfi MG. Properties of calcium silicate-monobasic calcium phosphate materials for endodontics containing tantalum pentoxide and zirconium oxide. *Clin Oral Investig*. 2019 Jan;23(1):445–57.
26. Aydın ZU, Özyürek T, Keskin B, Baran T. Effect of chitosan nanoparticle, QMix, and EDTA on TotalFill BC sealers' dentinal tubule penetration: a confocal laser scanning microscopy study. *Odontology*. 2019 Jan;107(1):64–71.
27. Kakoura F, Pantelidou O. Retreatability of root canals filled with Gutta percha and a novel bioceramic sealer: A scanning electron microscopy study. *J Conserv Dent JCD*. 2018 Dec;21(6):632–6.
28. Osiri S, Banomyong D, Sattabanasuk V, Yanpiset K. Root Reinforcement after Obturation with Calcium Silicate-based Sealer and Modified Gutta-percha Cone. *J Endod*. 2018 Dec;44(12):1843–8.
29. Germain S, Meetu K, Issam K, Alfred N, Carla Z. Impact of the Root Canal Taper on the Apical Adaptability of Sealers used in a Single-cone Technique: A Micro-computed Tomography Study. *J Contemp Dent Pract*. 2018 Jul 1;19(7):808–15.
30. Kamal EM, Nabih SM, Obeid RF, Abdelhameed MA. The reparative capacity of different bioactive dental materials for direct pulp capping. *Dent Med Probl*. 2018 Jun;55(2):147–52.
31. Taraslia V, Anastasiadou E, Lignou C, Keratiotis G, Agrafioti A, Kontakiotis EG. Assessment of cell viability in four novel endodontic sealers. *Eur J Dent*. 2018 Jun;12(2):287–91.
32. Colombo M, Poggio C, Dagna A, Meravini M-V, Riva P, Trovati F, et al. Biological and physico-chemical properties of new root canal sealers. *J Clin Exp Dent*. 2018 Feb;10(2):e120–6.
33. Kapralos V, Koutroulis A, Ørstavik D, Sunde PT, Rukke HV. Antibacterial Activity of Endodontic Sealers against Planktonic Bacteria and Bacteria in Biofilms. *J Endod*. 2018 Jan 1;44(1):149–54.
34. Kadić S, Baraba A, Miletić I, Ionescu A, Brambilla E, Ivanišević Malčić A, et al. Push-out bond strength of three different calcium silicate-based root-end filling materials after ultrasonic retrograde cavity preparation. *Clin Oral Investig*. 2018 Apr;22(3):1559–65.
35. Tanomaru-Filho M, Torres FFE, Chávez-Andrade GM, Almeida M de, Navarro LG, Steier L, et al. Physicochemical Properties and Volumetric Change of Silicone/Bioactive Glass and Calcium Silicate-based Endodontic Sealers. *J Endod*. 2017 Dec 1;43(12):2097–101.
36. Poggio C, Dagna A, Ceci M, Meravini M-V, Colombo M, Pietrocola G. Solubility and pH of bioceramic root canal sealers: A comparative study. *J Clin Exp Dent*. 2017 Oct;9(10):e1189–94.
37. Poggio C, Trovati F, Ceci M, Colombo M, Pietrocola G. Antibacterial activity of different root canal sealers against *Enterococcus faecalis*. *J Clin Exp Dent*. 2017 Jun;9(6):e743–8.
38. Poggio C, Riva P, Chiesa M, Colombo M, Pietrocola G. Comparative cytotoxicity evaluation of eight root canal sealers. *J Clin Exp Dent*. 2017 Apr;9(4):e574–8.
39. Turkel E, Onay EO, Ungor M. Comparison of Three Final Irrigation Activation Techniques: Effects on Canal Cleanliness, Smear Layer Removal, and Dentinal Tubule Penetration of Two Root Canal Sealers. *Photomed Laser Surg*. 2017 Dec;35(12):672–81.
40. Yap WY, Che Ab Aziz ZA, Azami NH, Al-Haddad AY, Khan AA. An in vitro Comparison of Bond Strength of Different Sealers/Obturation Systems to Root Dentin Using the

- Push-Out Test at 2 Weeks and 3 Months after Obturation. *Med Princ Pract Int J Kuwait Univ Health Sci Cent.* 2017;26(5):464–9.
41. Hrab D, Chisnoiu AM, Badea ME, Moldovan M, Chisnoiu RM. Comparative radiographic assessment of a new bioceramic-based root canal sealer. *Clujul Med* 1957. 2017;90(2):226–30.
  42. Rodríguez-Lozano FJ, García-Bernal D, Oñate-Sánchez RE, Ortolani-Seltenerich PS, Forner L, Moraleda JM. Evaluation of cytocompatibility of calcium silicate-based endodontic sealers and their effects on the biological responses of mesenchymal dental stem cells. *Int Endod J.* 2017;50(1):67–76.
  43. Agraftioti A, Koursoumis AD, Kontakiotis EG. Re-establishing apical patency after obturation with Gutta-percha and two novel calcium silicate-based sealers. *Eur J Dent.* 2015 Dec;9(4):457–61.
  44. Santos JM, Marques JA, Diogo P, Messias A, Sousa V, Sequeira D, et al. Influence of Preoperative Pulp Inflammation in the Outcome of Full Pulpotomy Using a Dog Model. *J Endod.* 2021 Jul 3;S0099-2399(21)00473-8.
  45. Al-Hiyasat AS, Ahmad DM, Khader YS. The effect of different calcium silicate-based pulp capping materials on tooth discoloration: an in vitro study. *BMC Oral Health.* 2021 Jul 2;21(1):330.
  46. Krug R, Ortmann C, Reich S, Hahn B, Krastl G, Soliman S. Tooth discoloration induced by apical plugs with hydraulic calcium silicate-based cements in teeth with open apices—a 2-year in vitro study. *Clin Oral Investig.* 2021 Jun 21;
  47. Alsubait S, Alsaad N, Alahmari S, Alfaraaj F, Alfawaz H, Alqedairi A. The effect of intracanal medicaments used in Endodontics on the dislocation resistance of two calcium silicate-based filling materials. *BMC Oral Health* [Internet]. 2020 Feb 18 [cited 2020 Apr 7];20. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7029461/>
  48. Kadić S, Baraba A, Miletić I, Ionescu AC, Brambilla E, Ivanišević Malčić A, et al. Influence of different laser-assisted retrograde cavity preparation techniques on bond strength of bioceramic-based material to root dentine. *Lasers Med Sci.* 2019 Jul 4;
  49. Al-Saudi KW, Nabih SM, Farghaly AM, AboHager EA-A. Pulpal repair after direct pulp capping with new bioceramic materials: A comparative histological study. *Saudi Dent J.* 2019 Oct;31(4):469–75.
  50. Chu JHR, Chia KY, Qui AL, Moule A, Ha WN. The effects of sodium hypochlorite and ethylenediaminetetraacetic acid on the microhardness of Mineral Trioxide Aggregate and TotalFill Bioceramic Putty. *Aust Endod J J Aust Soc Endodontology Inc.* 2019 May 3;
  51. Juez M, Ballester ML, Berástegui E. In vitro comparison of apical microleakage by spectrophotometry in simulated apexification using White Mineral Trioxide Aggregate, TotalFill Bioceramic Root Repair material, and BioDentine. *J Conserv Dent JCD.* 2019 Jun;22(3):237–40.
  52. Ali MRW, Mustafa M, Bårdsen A, Bletsa A. Tricalcium silicate cements: osteogenic and angiogenic responses of human bone marrow stem cells. *Eur J Oral Sci.* 2019 Jun;127(3):261–8.
  53. Ali MRW, Mustafa M, Bårdsen A, Bletsa A. Fracture resistance of simulated immature teeth treated with a regenerative endodontic protocol. *Acta Biomater Odontol Scand.* 2019;5(1):30–7.
  54. Lertmalapong P, Jantarat J, Srisatjaluk RL, Komoltri C. Bacterial leakage and marginal adaptation of various bioceramics as apical plug in open apex model. *J Investig Clin Dent.* 2019 Feb;10(1):e12371.



## NOTES

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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