MTA BIOREP

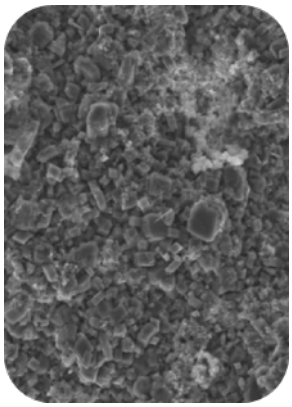
# WHITE PAPER

# Product description

| Powder | Action |
|---|---|
| Silicate tricalcium | Initial set & early strength |
| Silicate dicalcium | Long term strength |
| Aluminate tricalcium | Initial set |
| Calcium oxide | Calcium ions release |
| Calcium tungstate | Radiopacity |

| Liquid | Action |
|---|---|
| Distilled water | Carrier |
| Activating agent | Plasticity |

MTA BIOREP is a Bioceramic high-plasticity reparative cement, based on top quality mineral oxide C3S/C2S.
It also includes Calcium Tungstate, which is one of the most effective radiopacifier, preventing any risk of staining or tooth discoloration.



**Main advantages:**

- Setting time of 15 minutes, permitting treatment in a single session.
- Hydrophilic behaviour, enabling its use in humid conditions.
- Expansion during setting, resulting in a high marginal sealing and preventing the migration of microorganisms and fluids.
- Low solubility, allowing a prolonged action and quicker tissue repair.
- Regeneration process, providing excellent biological sealing of root perforations (canal & furcation)
- Formation of a dentin barrier when used on pulp exposures, resulting in pulp tissue regeneration.
- Peri-radicular tissue remineralisation, resulting in the lesion repair

# Indications

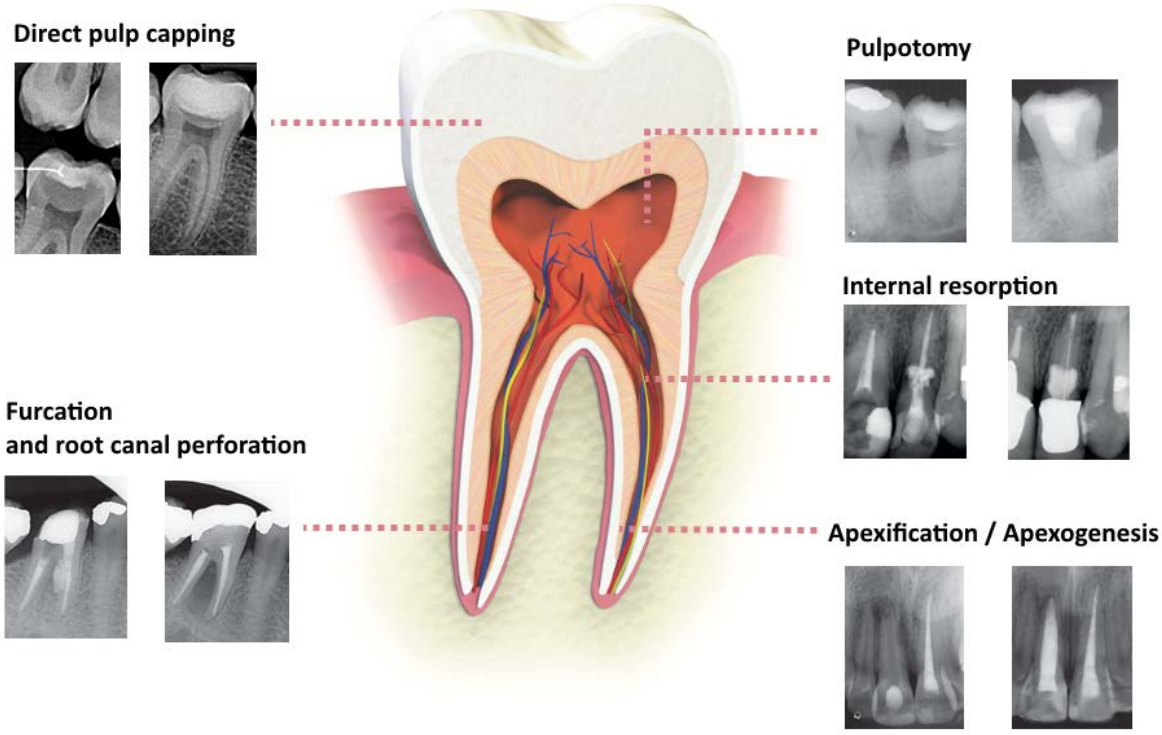



**Fig1. MTA BioRep indications**

# Mechanism of action

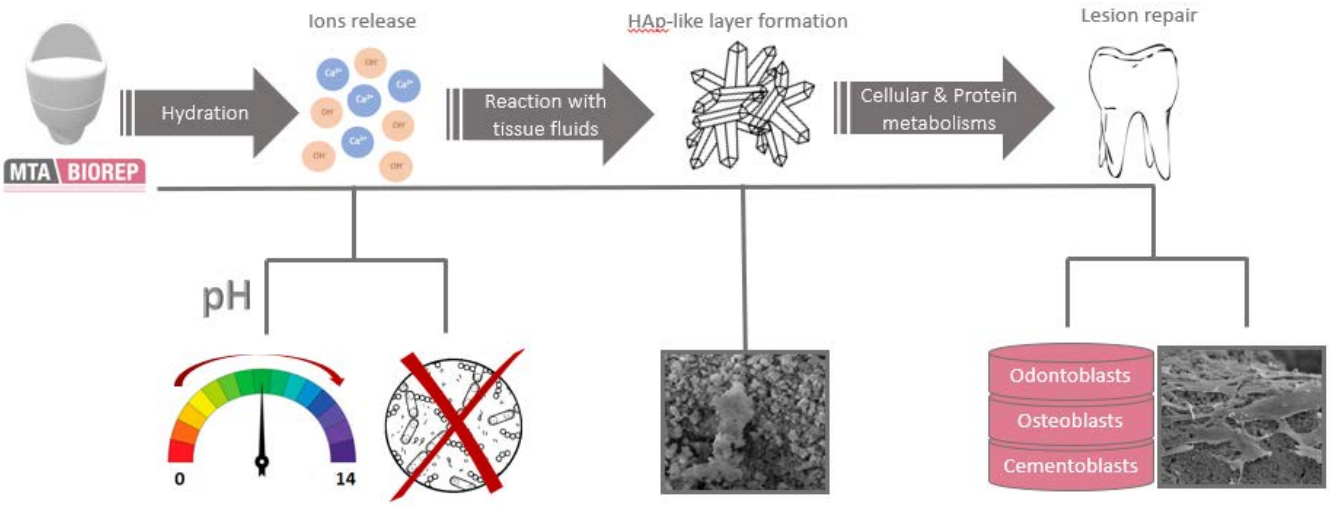



**Fig 2: MTA action mechanism (ITENA)**

Mineral Trioxide Aggregate is a bioactive material that induces the healing of periapical lesions. It stimulates the formation of cementum, bone and indirectly, periodontal ligament. It is the first material known in Endodontics that allows the growth of cementum layer directly on its surface (Torabinejad *et al*., 1995) [1]

MTA BIOREP has a high concentration of free calcium oxide in its composition. These oxides react with water, forming calcium hydroxide.
Calcium hydroxide is currently the most used intracanal medication and its effectiveness has been proven by extensive scientific research.
Through dissociation, Hydroxide and Calcium ions are then released from the material, leading to a highly alkaline local pH. This environment is known to be inhospitable to bacterial proliferation.
Plus, Gandolfi *et al.* (2014) have shown that hydroxide ions stimulate the release of Alkaline Phosphatase and Bone Morphogenetic Protein 2, indicators of mineralization processes. [2]

During MTA hydration, mineral precipitates are formed. When in contact with fluids from the surrounding tissues, the formation of an hydroxyapatite-like layer is induced.
This will lead to the formation of a MTA-dentin interface, enhancing the sealing ability of the material. (Chang SW, 2012) [3].
This aggregation will also trigger cellular differentiation and proliferation processes, leading to cementum and bone formation.
In the end, the periapical lesion is repaired.

# Technical properties

## Calcium ions release:

The release measures of Ca ions indicate that the material promotes a release of Calcium ions within the first 24 hours after cementation.

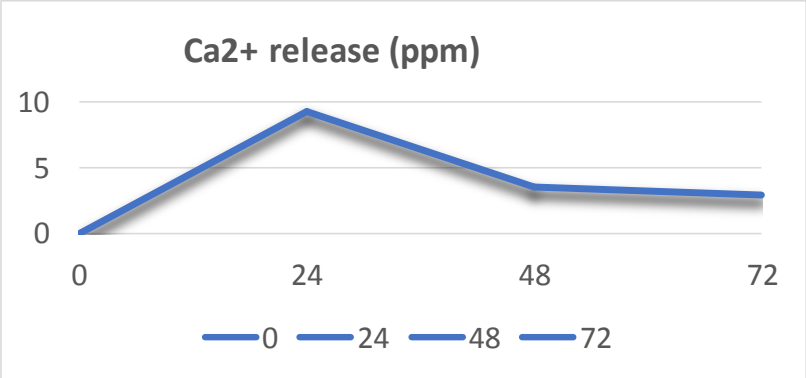



**Fig 3. $Ca^{2+}$ release of MTA BIOREP within 72h [4]**

## Hydroxide ions release:

The behavior of the curve shows high values of local pH, meaning that material promotes the release of hydroxide ions at least during a period of 3 days after cementation.

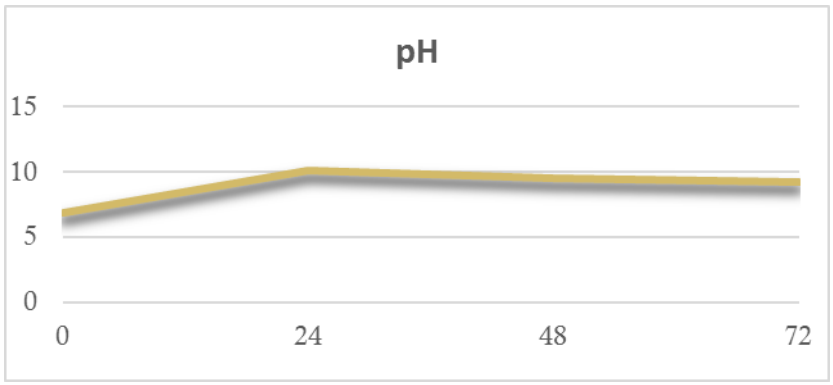



**Figure 4: Release of Hydroxide ions for 72 hours after MTA BIOREP mixing [5]**

The accumulation of hydroxide ions leads to a locally high pH which gives the MTA BIOREP its bacteriostatic properties

# Technical properties /Market

Gandolfi *et al.* (2003) have shown that the ability to release calcium ions, able to diffuse through dentin and inside the surrounding tissues, is a key factor for successful endodontic therapies because of the action of calcium on the differentiation of mineralizing cells. [2] [6] [7].

**MTA BIOREP releases more calcium ions than other products on the market, awarding the product with better biological action and tissue reparation function.**

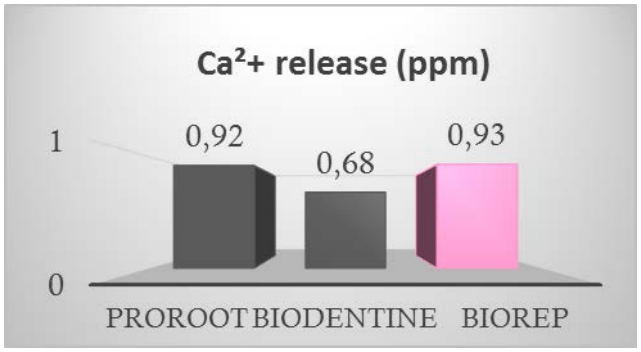



**Fig. 5: Ca²+ release of MTA BioRep & other products**

Microorganisms play a key role in endodontic treatment failures. Treatment outcome will depend on successful elimination of the associated microorganisms and infected tissues and antibacterial action of used materials in order to prevent future recontamination.

A locally alkaline pH environment contributes to hinder bacterial proliferation as high pH values triggers bacterial shock responses. (Taglich *et al*.) [8]. **As a result of Hydroxide ions release through the material, MTA BIOREP possesses higher pH values**. This characteristic gives the material a higher defence against bacterial proliferation AND enhances biological processes.

The accumulation of Hydroxide ions has been shown to stimulate the release of bone inducing proteins, leading to dental tissue repair and remineralization (Torabinejad *et al*., 1995, 1997, 2010). [9abc]

**With a higher Hydroxide ions release, MTA BIOREP presents outstanding clinical results.**

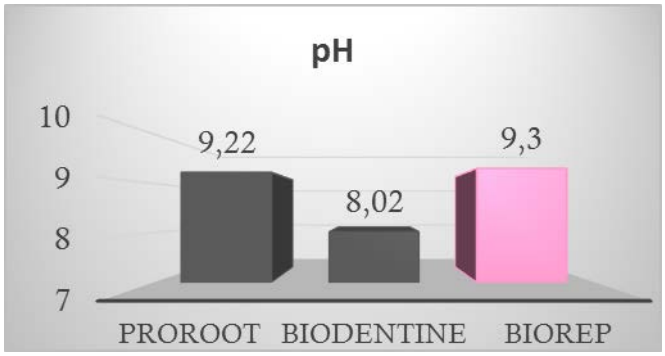



**Fig. 6: pH of MTA BioRep & other products**

Bismuth Oxide is now known to cause dental discoloration when used with water & hypochlorite solutions as well as when in contact with tooth structure (Marciano *et al*., 2014) [10b] Moreover, (Coomaraswamy *et al.,* 2007) [11] have shown that Bismuth Oxide radiopacifier also increases the porosity and decreases the compressive strength of MTA-like materials.

**MTA BIOREP is Bismuth Oxide free, as the radiopacifier used in the formula is Calcium Tungstate**. This component is not linked to colour and structures instabilities when used in dental materials. MTA BIOREP also possess higher radiopacity values, making it easier to visualize on x-rays and facilitating practitioners' procedures.

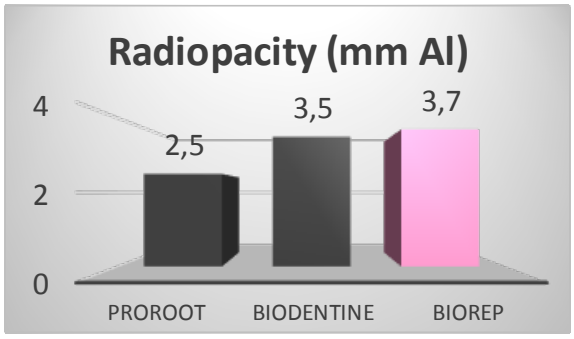



**Fig. 7: Radiopacity of MTA BioRep & other products**

| Product | Radiopacifier used |
|---|---|
| Proroot MTA | Bismuth Oxide $Bi_2O_3$ |
| Biodentine | Zirconium Dioxide $ZrO_2$ |
| MTA BioRep | Calcium Tungstate $CaWO_4$ |

**Fig. 8: Radiopacifier of MTA BioRep & others**

Solubility of dental filling material is a key factor in the success of endodontic treatments as it is linked to the material deterioration and bacterial infiltration.

**MTA BIOREP has a lower solubility compared to other products actually on the market.**
These values mean that the material does not lose any mass during cementation but actually acquires volume with time.
This controlled expansion behavior occurs between the mineral particles present in the MTA BIOREP and surrounding fluids during the hydration chemical reaction. [12].

This characteristic allows MTA BIOREP to form a perfect interface with dentin, creating a very efficient sealing and avoiding fluids micro infiltration.

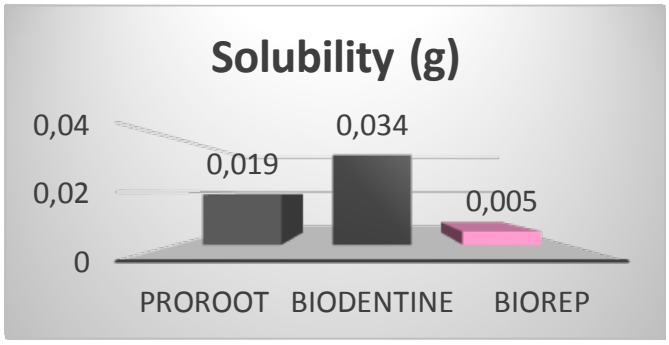



**Fig. 9: Solubility of MTA BioRep compared to other products [13]**

# Biological properties

The biologic activity of Mineral Trioxide Aggregate is attributed to the high pH level, associated with formation of calcium hydroxide.

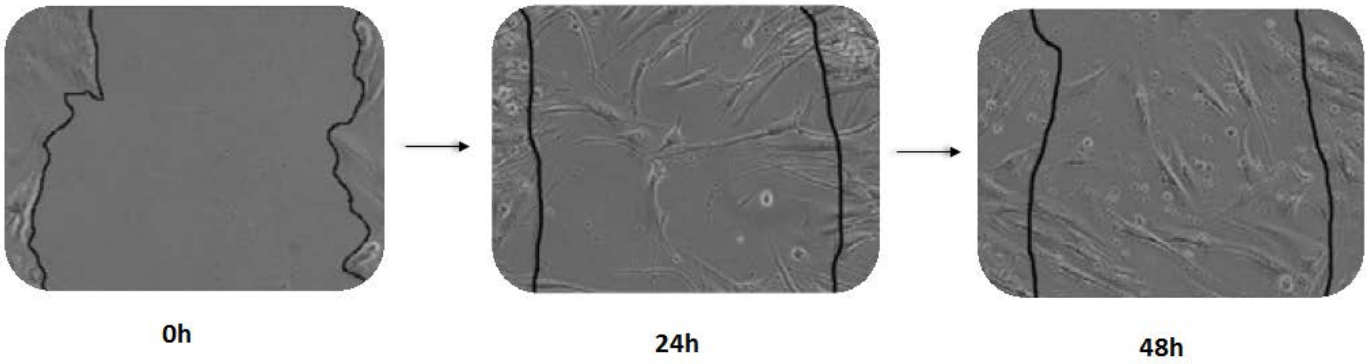



**Fig 10: Wound healing assay of hDPSCs cells incubated with MTA BioRep [14]**

Current studies indicated that the biological activity of MTA is attributed to the formation of an hydroxyapatite-like precipitate on its surface, leading to the formation of an interface between dentin and this crystalline surface.

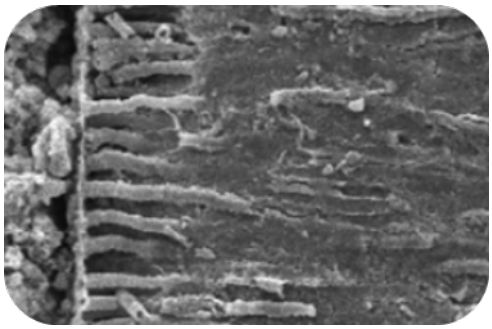


**Fig. 11: Observation of the dentin-MTA BIOREP interface [15]**

This Hydroxyapatite-like structure can release calcium and phosphorus, promoting the regeneration and remineralization of hard tissues and increasing the sealing ability of MTA.
In the end, MTA BIOREP promotes adequate biological responses in terms of cellular processes resulting in tissue repair (Tomàs-Catalá *et al.,* 2017)

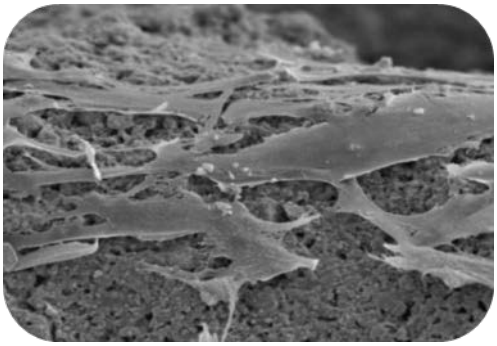


**Fig. 12: Morphology of hDPSCs onto MTA BIOREP disks specimens observed by SEM at 72 hours**

**Scientific Literature data:**

[1]: JOURNAL OF ENDODONTICS - Investigation of Mineral Trioxide Aggregate for root end filling in dogs, Torabinejad *et al.,* 1995

[2]: JOURNAL OF ENDODONTICS - Ion Release, Porosity, Solubility, and Bioactivity of MTA Plus Tricalcium Silicate, Gandolfi *et al.,* 2014

[3]: RESTORATIVE DENTISTRY & ENDODONTICS - Chemical characteristics of mineral trioxide aggregate and its hydration reaction, Chang, 2012

[4] & [5]: Internal certificate of analysis - Release of ions Ca, pH, conductivity, solubility and dimensional stability, 2013

[6]: JOURNAL OF ENDODONTICS - The Effect of Extracellular Calcium Ion on Gene Expression of Bone-related Proteins in Human Pulp Cells, Rashid *et al.*, 2003

[7]: JOURNAL OF ENDODONTICS - Effect of ProRoot MTA on pulp cell apoptosis and proliferation in vitro, Moghaddame-Jafari *et al.,* 2005

[8]: JOURNAL OF BACTERIOLOGY - An Alkaline shift induces the heat shock response in *Escherichia coli*, Taglicht *et al.,* 1987

[9a]: JOURNAL OF ENDODONTICS - Mineral Trioxide Aggregate: A Comprehensive Literature Review—Part I: Chemical, Physical, and Antibacterial Properties, Parirokh and Torabinejad, 2010

[9b]: JOURNAL OF ENDODONTICS - Mineral Trioxide Aggregate: A Comprehensive Literature Review—Part II: Leakage and Biocompatibility Investigations, Parirokh and Torabinejad, 2010

[9c]: JOURNAL OF ENDODONTICS - Mineral Trioxide Aggregate: A Comprehensive Literature Review—Part III: Clinical Applications, Drawbacks, and Mechanism of Action, Parirokh and Torabinejad, 2010

[10b]: JOURNAL OF ENDODONTICS - Dental discoloration caused by bismuth oxide in MTA in the presence of sodium hypochlorite, Marciano *et al.,* 2014

[11]: JOURNAL OF ENDODONTICS - Effect of bismuth oxide radioopacifier content on the material properties of an endodontic Portland cement-based (MTA-like) system, Coomaraswamy *et al.,* 2007

[12]: Internal analysis certificate - Release of ions Ca, pH, conductivity, solubility and dimensional stability, 2013

[13]: JOURNAL OF RESEARCH IN MEDICAL AND DENTAL SCIENCE - A comparison of physical and mechanical properties of Biodentine and MTA, Alzraikat *et al.,* 2018

[14]: JOURNAL OF ENDODONTICS - Biocompatibility of New Pulp-capping Materials NeoMTA Plus, MTA Repair HP, and Biodentine on Human Dental Pulp Stem Cells, Tomàs-Català *et al.,* 2017

[15]: JOURNAL OF ENDODONTICS - Mineral Trioxide Aggregate and Portland Cement Promote Biomineralization In Vivo, L.A.S Luonothar Antunes Schmitt Dreger *et al.,* 2012