Magic Dust: Objectives

- A little history
- What are their properties?
- How are they used?
- What do they do?
- How do they do it?
- How are they dispensed?
- How are they placed?
- How are they removed?

Properties

- White powder
- Slaked lime
- CaO(quicklime)+H₂O→Ca(OH)₂
- pH 12.5
- Insoluble
- Unstable in air

Ca(OH)₂ Properties

- Nonsoluble
- Insoluble
- pH 12.5
- Unstable in air

MTA

1838- Nogaro, Pierre, in medical and surgical practice drew up a formula of calcium oxide that has been used in France for over 100 years.

1910 - Colgate only trade name.


1938- Hermann, J., in 1938, the cement was named. J. Am. Dent. Assoc., 27, 118.

1987- Torabinejad, M., in 1987, the study of the material. J. Endod., 13, 152.

Some History

Ca(OH)₂: 1838- Nogaro, Pierre, in medical and surgical practice drew up a formula of calcium oxide that has been used in France for over 100 years.

1910 - Colgate only trade name.


1938- Hermann, J., in 1938, the cement was named. J. Am. Dent. Assoc., 27, 118.

1987- Torabinejad, M., in 1987, the study of the material. J. Endod., 13, 152.

MTA

Ca(OH)₂: 1838- Nogaro, Pierre, in medical and surgical practice drew up a formula of calcium oxide that has been used in France for over 100 years.

1910 - Colgate only trade name.


1938- Hermann, J., in 1938, the cement was named. J. Am. Dent. Assoc., 27, 118.

1987- Torabinejad, M., in 1987, the study of the material. J. Endod., 13, 152.

Some History

Magic Dust

**Chemical Name:**

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Chemical Formula (sum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colophony</td>
<td>C_{10}H_{16}O_4</td>
</tr>
<tr>
<td>Calcium Hydroxide</td>
<td>Ca(OH)$_2$</td>
</tr>
</tbody>
</table>

**Physical State:**

- Solid (Powder)

**Odor:**

- No distinct odor

**Color:**

- Off white (powder)

**pH:**

- 12 to 13

**Solubility in Water:**

- Slightly soluble (0.1 to 1.0%)

**Auto Ignition Temperature:**

- Not combustible

**Upper Explosive Limit:**

- None

**Lower Explosive Limit:**

- None

**Flash Point:**

- None

**Melting Point:**

- Not applicable

**Boiling Point:**

- Not applicable

**Evaporation Rate:**

- Not applicable

**Specific Gravity (H$_2$O = 1.0):**

- 4 to 4.5

**Vapor Pressure:**

- Not applicable

**Density:**

- 2.94

**Reactivity:**

- Fast and complete

**Carcinogenic Potential:**

- Not classified by IARC as a known human carcinogen.

**Other Effects:**

- Irritation to the moist mucous membranes of the nose, irritation to the conjunctiva, allergic reactions, and delayed lung injury from long term exposure.

**Carcinogenicity:**

- Classified by NTP, OSHA, or CRCS as not a carcinogen.

**MITIGATION MEASURE:**

- Use personal protective equipment (PPE) as directed on the material data sheet.

**STORAGE:**

- In a dry, well-ventilated area.

**HAZARDOUS INGREDIENTS:**

- Calcium Hydroxide

**PRECAUTIONS:**

- Avoid inhalation, ingestion, and contact with the skin and eyes.

**Inhalation Exposure:**

- Effects may cause irritation to the nasopharyngeal mucosa, conjunctiva, and upper respiratory system.

**Ingestion Exposure:**

- Material may cause abdominal pain.

**Eye Contact:**

- Material may cause conjunctivitis.

**Skin Contact:**

- Material may cause irritation, sensitization, and dermatitis.

**OTHER EFFECTS:**

- Neurotoxicity due to hydrogenation.

**Carcinogenicity:**

- Unclassified by NTP, OSHA, or CRCS.

**Other Effects:**

- Irritation to the mucous membranes of the nose and respiratory system.

**Toxicity:**

- Neurotoxic

**Natural Resin:**

- Colophony (rosin) is obtained from the sap of certain coniferous trees in the genus Pinus.

**Dangerous Substances:**

- Calcium Hydroxide

**Other Ingredients:**

- Zinc Oxide

**Pyrrolidone Carboxylic Acid**

- Silicone

**References:**

Case report - gingiva

27 yo/m #9 started
Difficulty finding canal but file appears centered after correcting angle.
No inter-appointment dressing placed


Case report - gingiva

Could not complete due to wet canal.
Ca(OH)₂ placed. Gross overfill noted.
24 hours swollen lip
2 days later gingival perforation


Case report - gingiva

Ortho and retrograde treatment 6 months later
Same visit
Perforation repaired with glass ionomer


Case report - embolia cutis medicamentosa

34 y/o/m, tooth #18
Forceful injection of Ca(OH)₂ paste
Hemostasis
Patient hospitalized
Single dose corticosteroid, heparin, clindamycin
5 days released
Limited skin necrosis 5 x 8 mm left to heal spontaneously
3 years later
Mild scarring

Tooth #19
12 y/o

• 4/25/2018
  • Opened and medicated with Ca(OH)₂
• 5/30/2018
  • Acute Apical Abscess
  • PANO

---

Magic Dust

MTA (mineral trioxide aggregate)

• Gray and white varieties
• Both comparable in:
  • Biocompatibility (Camilleri, Montesin et al. 2004)
  • Sealing ability (Ferris and Baumgartner 2004)
  • Tissue regeneration (Menezes, Bramante et al. 2004)

---

Magic Dust

MTA (mineral trioxide aggregate)

• However,
  • White still discolored
  • Bismuth oxide

References:


Magic Dust
MTA (mineral trioxide aggregate)

- Compressive strength
- Solubility
- Radiopacity

Magic Dust: Objectives
- A little history
- What are their properties?
- How are they used?
- What do they do?
- How do they do it?
- How are they dispensed?
- How are they placed?
- How are they removed?

How are they used?
- Ca(OH)₂
- Interappointment medicament
- Obturation
- Apexification
- Regeneration
- Direct/indirect pulp cap

MTA
- Surgical
- Non-surgical

Ca(OH)₂

How are they used?
- Ca(OH)₂ in two appointments (Bystrom, Claesson et al. 1985)
- CMCP and CMP in 3 – 4 appointments (Sommer 1962)
- E. faecalis (Evans, Davies et al. 2002)
- Mechanisms (Siqueira and Lopes 1999)
  - Cytoplasmic membrane
  - Proteins
  - LPS (Buck, Cai et al. 2001)

Inter-appointment
- Anti-inflammatory
- Resorption (Tronstad 1988),
- Hygroscopic (Kouassi, Michailesco et al. 2003)
- Tissue Dissolution
  - Direct contact
    - Hasselgren, Olsson et al. 1988), (Andersen, Land et al. 1992), (Morgan, Carnes et al. 1991)
  - Within canals
    - Metzler and Montgomery 1989), (Yang, Rivera et al. 1995), (Wadachi, Anaki et al. 1998)

Ca(OH)₂

Inter-appointment
- Sinus Tracts
  - Unintentional (Fava 1993)
  - Intentional
    - Çalişkan, Şen et al. 1995
    - Gutmann and Fava 1992
- Post-operative Pain Prevention
  - Siqueira, Rôças et al. 2002)
  - (Walton, Holton et al. 2003)
  - (Sebastian, Drum et al. 2016)
**Obturation**

- **Cones**
  - Calcium Hydroxide PLUS Points (Coltene)

- **Indications**
  - Temporary root canal filling material
  - Emergency root canal treatment
  - Root resorption
  - Trauma

- **pH release** 8.5 vs Ca(OH)_2 + H_2O (Economides, Koulaouzidou et al. 1999)
Surgical
- Root end filling material (Torabinejad, Watson et al. 1993)
- Perforation repair (Lee, Monsef et al. 1993)
- Perforative resorptive lesions
- Iatrogenic
- Subcrestal
- Strip

Pt referred for surgery due to history of perforation
- Pt asymptomatic
- Furcation radiolucency
- Hx of nonsurgical retreatment

Flap 29-31
- Granulomatous tissue removed
- Perforation noted Distal of mesial root concavity
- Place MTA
- Demineralized freeze-dried bone
- Resorbable membrane
**Magic Dust**

**Non-Surgical**

- Vital pulp therapy
  - (Ward 2002)
  - (Carrotte 2005)
  - (Waterspoon, Small et al. 2006)
  - (Camp 2008)
  - (Bakland and Andreasen 2012)
  - (Parirokh, Torabinejad et al. 2017)
- Pulp capping
- Pulpotomy
- Regeneration
- Immediate apexification/Obturation

**Magic Dust**

**Non-Surgical**

- Pulp capping
  - (Ford, Torabinejad et al. 1996)
  - (Hilton 2009)
  - (Mente, Geletneky et al. 2010)
  - (Hilton, Ferracane et al. 2013)
  - (Li, Cao et al. 2015)
- Pulpotomy
- Regeneration
- Immediate apexification/Obturation

**Magic Dust**

**Non-Surgical**

- Pulpotomy
  - (Menezes, Bramante et al. 2004)
  - (Waterspoon, Small et al. 2006)
  - (Taha and Khazali 2017)
  - (Taha and Abdulkhader 2018)
- Regeneration
- Immediate apexification/Obturation

**Magic Dust**

**Non-Surgical**

- Regeneration
  - (Banchs and Trope 2004)
  - (Choubati, Ishii et al. 2011)
  - (Torabinejad and Turman 2011)
  - (Nosrat, Homayounfar et al. 2012)
  - Immediate apexification/obturation
  - (Hachmeister, Schindler et al. 2002)
  - (Simon, Rilliard et al. 2007)
  - (Steing, Regan et al. 2003)
  - Internal perforation repair (Lee, Monsef et al. 1993)
Contraindications:

- Not recommended for primary teeth
- Esthetics
- Final external restorations
  - Eventually breaks down in oral fluids
  - Compressive strength similar to IRM
Nonsurgical Perforation

MTA

Nonsurgical Furcal Perforation

MTA

Magic Dust: Objectives
- A little history
- What are their properties?
- How are they used?
- What do they do?
- How do they do it?
- How are they dispensed?
- How are they placed?
- How are they removed?

How do they do it?
- \( \text{Ca(OH)}_2 \)
  - Ionic dissociation of \( \text{Ca}^{2+} \) and \( \text{OH}^- \) ions
  - Initiates remineralization (Farhad and Mohammadzadeh 2005)
  - TCP-I (Graham, Cooper et al. 2006)
  - \( \text{Ca}^{3+} \) fibronectin synthesis (Mizuno and Banzai 2008)
  - \( \text{OH}^- \) antimicrobial
  - Dentin buffering (Siqueira and Lopes 1999)
  - Efficacy as dressing (Satheem, Parashos et al. 2007)

Ca(OH)_2

MTA

Forms Ca(OH)_2

Antibacterial

(Fridland and Rosado 2005)

Cytokines

Differentiation and migration

Forms HA

(Sarkar, Caicedo et al. 2005)

(Parirokh and Torabinejad 2010)

How are they dispensed?
- Aqueous solutions
- Viscous solutions
- Oils
- Pastes
- Adjuncts
- Commercial preparations

Magic Dust
Aqueous solutions
- Ultracal (Ultradent)
- Pulpdent (Pulpdent)
- Calasept (Nordiska)
- Sweden
- Aqueous suspension
- Methylcellulose
- Ca(OH)\(_2\) in sterile H\(_2\)O

Viscous
- Metapaste (Medidenta) Neta Biomed Co. Ltd
- Korea
- Ca(OH)\(_2\) in propylene glycol

Oil
- Vitapex (Diadent/Neo Dental Intl.)
- Canada
- Metapex (Mediadenta)
- Ca(OH)\(_2\) in iodoform and silicone oil

Pastes
- Frank (1966)
  - Ca(OH)\(_2\) + camphorated p-monochlorophenol (CMCP) + glycerine
- Fava and Saunders (1999)
- Less solubility therefore less dissociation
Table 2: The pH readings of all materials tested with different concentrations.

<table>
<thead>
<tr>
<th>Product</th>
<th>1.0 mg/mL</th>
<th>0.5 mg/mL</th>
<th>0.25 mg/mL</th>
<th>0.125 mg/mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca(OH)₂</td>
<td>9.39</td>
<td>8.7</td>
<td>8.34</td>
<td>8.05</td>
</tr>
<tr>
<td>Calsept®</td>
<td>8.96</td>
<td>8.46</td>
<td>8.07</td>
<td>7.93</td>
</tr>
<tr>
<td>Metapaste®</td>
<td>8.43</td>
<td>8.32</td>
<td>8.07</td>
<td>7.93</td>
</tr>
<tr>
<td>Vitapex®</td>
<td>8.42</td>
<td>8.18</td>
<td>8.06</td>
<td>7.93</td>
</tr>
<tr>
<td>Ultradent XS®</td>
<td>8.88</td>
<td>8.27</td>
<td>8.07</td>
<td>7.93</td>
</tr>
<tr>
<td>Pulpect®</td>
<td>9</td>
<td>8.42</td>
<td>8.09</td>
<td>7.94</td>
</tr>
</tbody>
</table>

Additive effects
- Setting time
- Ca⁺, OH⁻ release
- Homogeneity:
  - Methyl-cellulose improves (Pulpdent)

Additives
- Sets hard
- Difficult resorption
- Foreign body rxn
- Obscures apex

Commercial Preparations (pastes)
- Pulp capping
- Intracanal medications
- Root canal sealers
Physical Properties of Commercial CaOH Endodontic Intracanal Medicaments (IMs):

- Slow or non-setting
- More soluble than other Ca(OH)$_2$ products
- Less crushing strength than other products
- Easy to insert into canals and to remove

How are they placed?

- Inject under pressure
- Condense with Pluggers
- Rotate files, lentulos, Pastinject
- Combinations of the above


- Condensation better than lentulo or commercial paste injection
- Better retention: 22% gone in 6 months vs 68% for others
- BaSO$_4$ obscured apex formation in immature teeth
- Recommend discontinue its use

Problems with Lentulos

- Broken instruments
- Voids
- Overfills

Research/Opinions advocating Overfilling with Ca(OH)$_2$

Gutman & Fava, IEJ 1992;25:307 quoting:

- Saliba (1988): "Higher success rate with Ca(OH)$_2$ overfills compared to short fills. May eradicate cysts."
- Souza (1989): "Ca(OH)$_2$ cleans root and has antibacterial and anti-inflammatory activity in PA tissues."
Ex-UNL Endo Resident Technique (Anonymous):

“Insert Vitapex needle to maximum depth and inject under pressure, until it hurts.”

Çalışkan M. EDT;1996:12:215

Compare healing of 58 overfill cases to 102 non-overfill human cases:

* Overfill, 80% comp, 7% part, 13% fail
* Non-overfill: 82%, 8%, 10%
** Overfilled paste disappeared in 50% in 2-9 mos.

Magic Dust: Objectives

- A little history
- What are their properties?
- How are they used?
  - What do they do?
  - How do they do it?
- How are they dispensed?
- How are they placed?
- How are they removed?

Magic Dust: How are they dispensed?

- Powder
- Putty
- Sealer

MTA How are they dispensed?

- Powder
- ProRoot
- Dentsply
- MTA Angelus
  - Angelus Dental
  - BioAggregate
  - Innovative Bioceramix Inc.
- NeoMTA Plus
  - Angelus Dental
- MTA Plus
  - Prevent Dentsply Ltd.

MTA How are they dispensed?

- Putty
  - Endosequence RRM
  - Brassler
  - Biodentine
  - Septodont
  - iRoot BP Plus
    - Innovative Bioceramix, Inc.
How are they dispensed?
- Sealer
  - MTA Fillapex
  - Angelus Dental
  - EndoSequence BC Sealer
  - Brasseler
  - Endoseal MTA
  - Maruchi Osseo Dust
  - Iroot SP Injectable
  - Innovative Bioceramix, Inc.

How are they placed?
- Powder
- Putty
- Sealer

How are they placed?
- Powder
  - Amalgam carrier
  - MAP system
  - “Adams technique”
  - Condensers
  - Ultrasounds
    - Indirect + manual
    - (Ghasemi, Jatani et al. 2017)

How are they placed?
- Putty
  - MAP system
  - Dovgan carrier
  - Instrument
    - Flat surface
    - Condensers

How are they placed?
- Sealer
  - Cone coating
    - Incremental application
  - Instrument coating
    - Incremental application

Magic Dust: Objectives
- A little history
- What are their properties?
- How are they used?
- What do they do?
- How do they do it?
- How are they dispensed?
- How are they placed?
- How are they removed?
Calcium hydroxide

- Bhuyan, Seal et al. 2015
- Raghu, Pradeep et al. 2017

MTA

- Poggio, Lombardini et al. 2007
- Routsioukis, Noula et al. 2008
- Nandini, Natanasabapathy et al. 2010
- Saghiri, Garcia-Godoy et al. 2013
- Al-Haddad and Che Ab Aziz 2016

Removable

Root Canal Sealer Properties

- It should be tacky when mixed to provide good adhesion between it and the canal wall when set.
- It should make a hermetic seal.
- It should be radiopaque so that it can be visualized on the radiograph.
- The particles of powder should be very fine so that they mix easily with liquid.
- It should not shrink upon setting.
- It should not discolor tooth structure.
- It should be bacteriostatic or at least not encourage bacterial growth.
- It should set slowly.
- It should be insoluble in tissue fluids.
- It should be well tolerated by the periapical tissue.
- It should be soluble in common solvents if it is necessary to remove the root canal filling.

Magic Dust

Questions?

Thank you for your kind attention.