

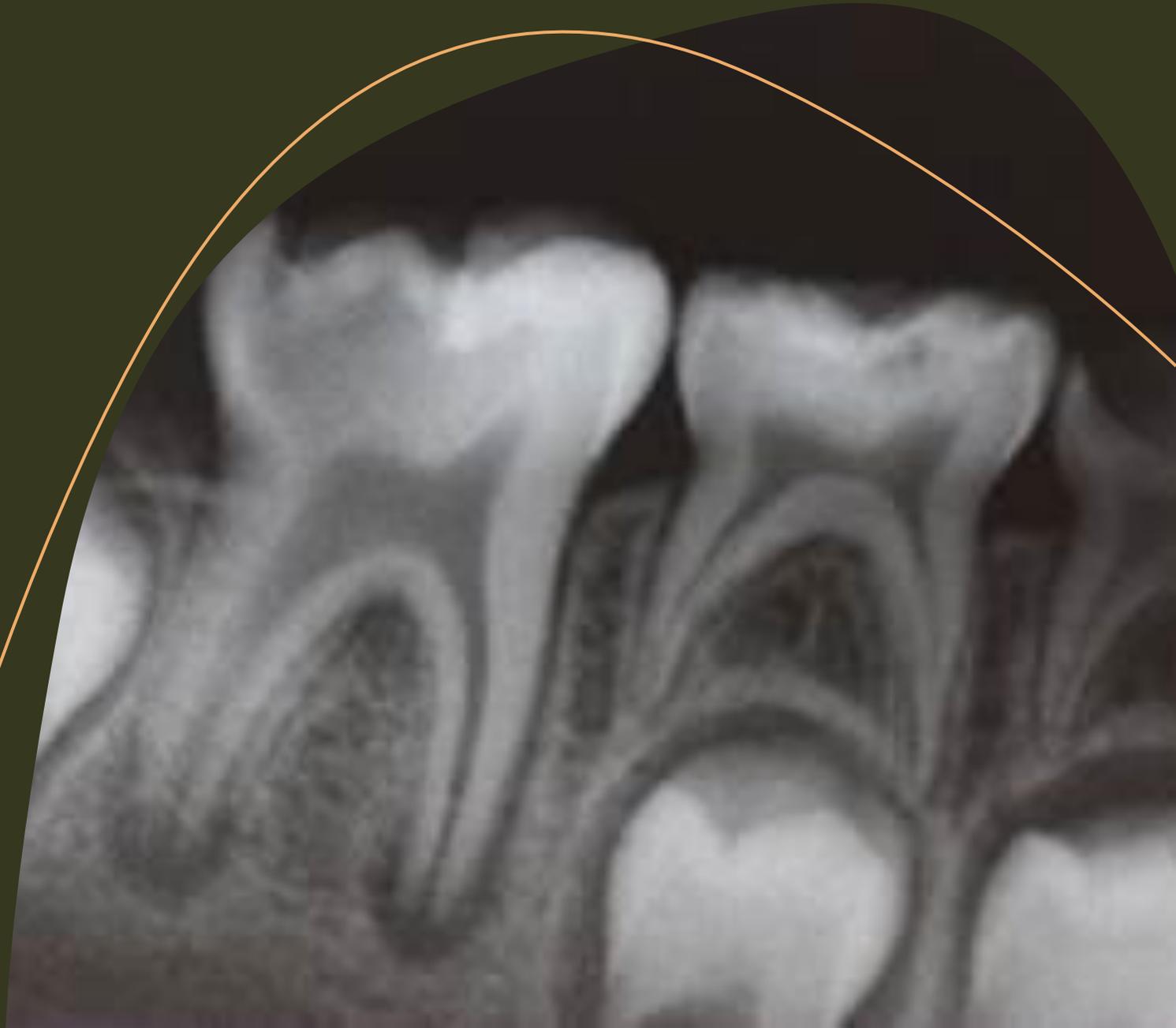
Endodontic Management of Immature Permanent Teeth

Inland Empire Perio Study Club

Logan Hazard

January, 2022

Why this topic?



Quick Sources

- American Academy of Pediatric Dentistry
 - <https://www.aapd.org/research/oral-health-policies--recommendations/pulp-therapy-for-primary-and-immature-permanent-teeth/>
- American Association of Endodontists
 - <https://www.aae.org/specialty/wp-content/uploads/sites/2/2017/06/ecfespring2013.pdf>

Why initiate endodontic therapy?

- We want to save the tooth
 - Long term prognosis
 - Importance of tooth
 - Timing





...48 months later

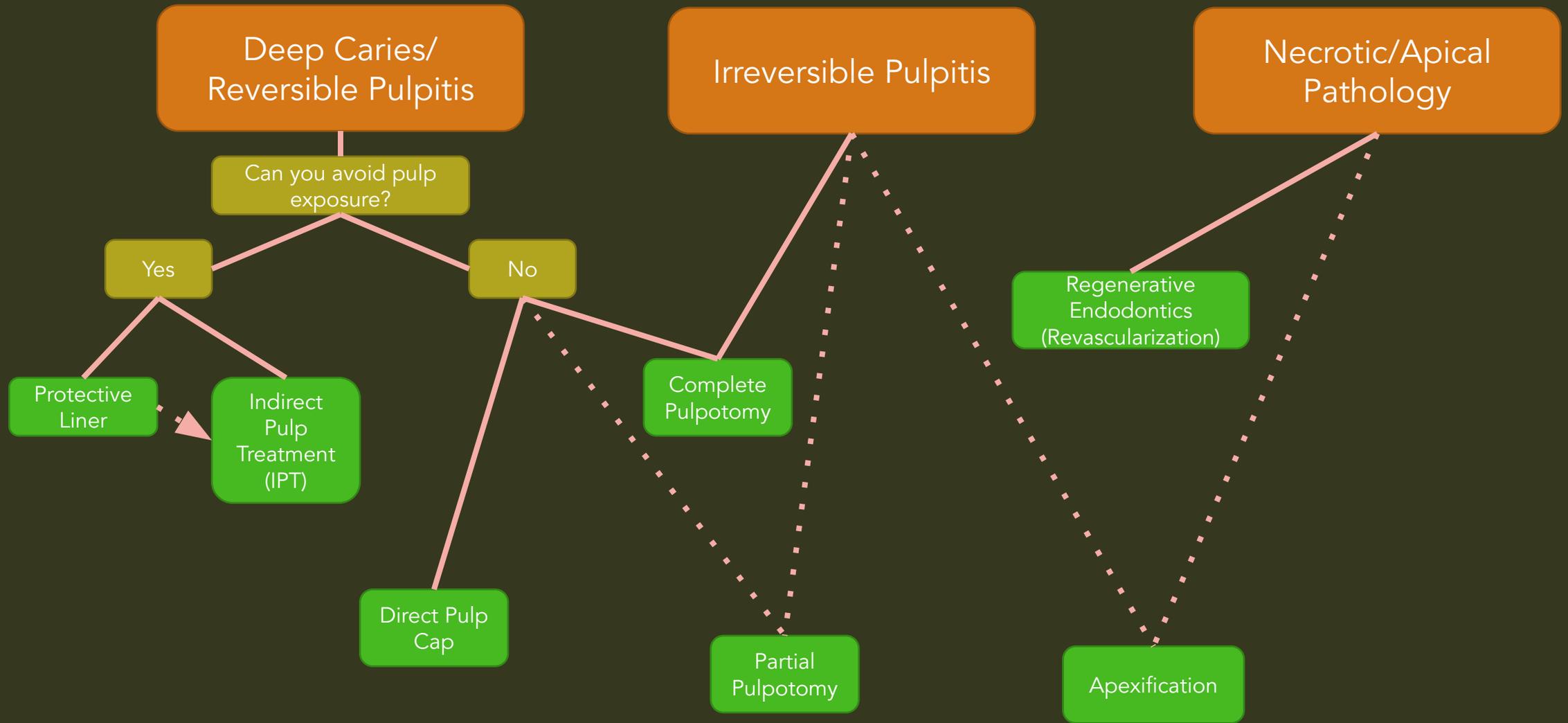


Tough Choice for Young First Permanent molars: To Do Pulp Treatment or to Extract?

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Advanced Education Program in Pediatric Dentistry
Loma Linda University, School of Dentistry

<https://cdn.ymaws.com/sites/cspd.site-ym.com/resource/resmgr/2015-speakers/DPAAnnaChenToughChoiceforYoun.pdf>

Diagnosis and Treatment Planning



MATERIALS

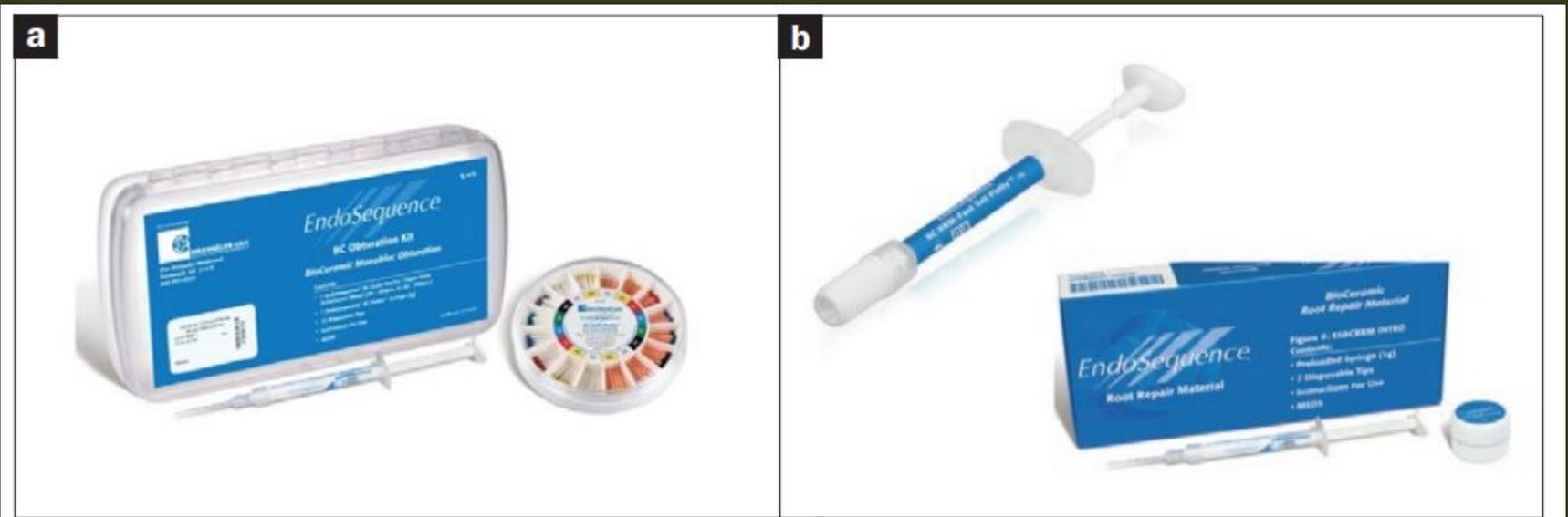
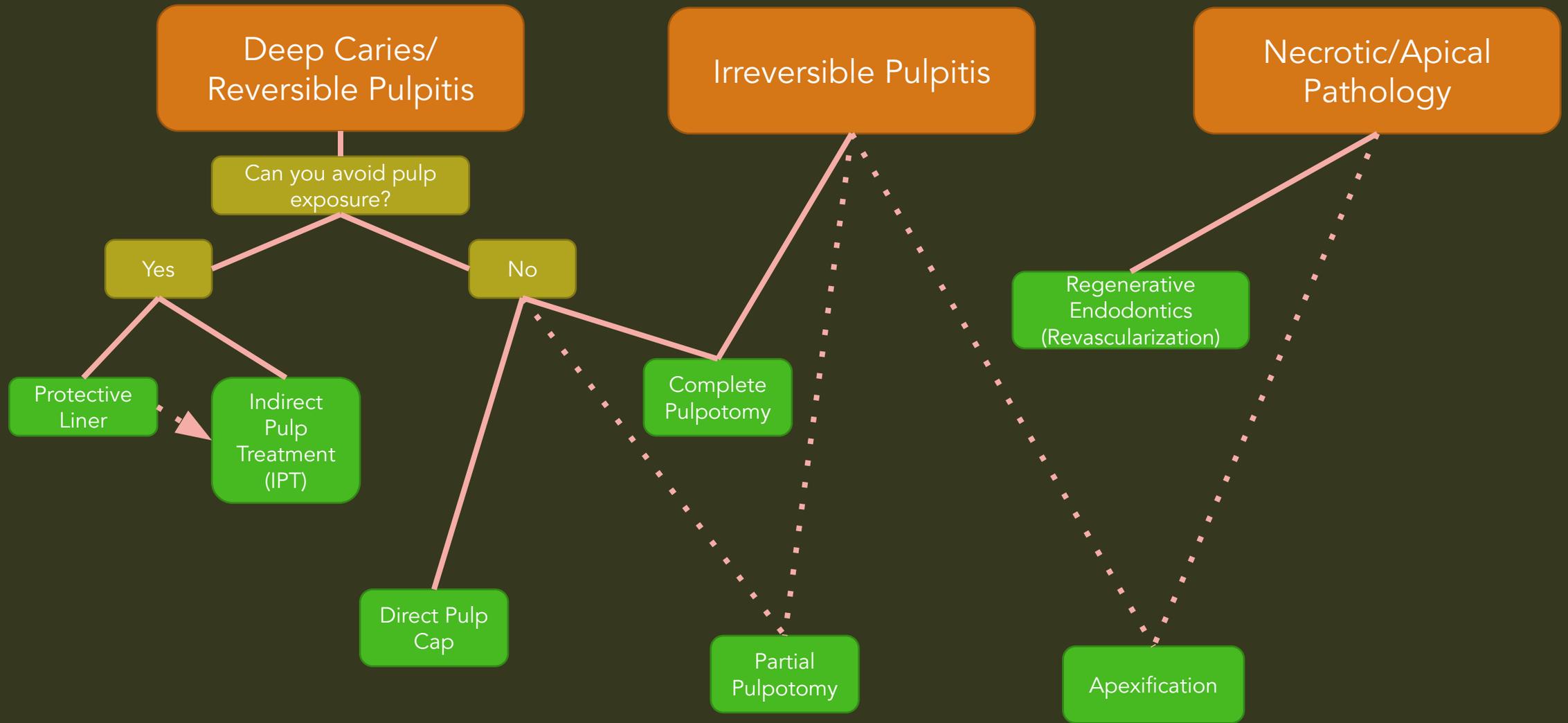


Figure 3. The EndoSequence BC Root Repair Materials (RRMs) (Brasseler USA). All are premixed and differ only in their flowability due to the particle size of the silicate component (EndoSequence BC RRM, RRM Fast-Set Putty, and BC Sealer [Brassler USA]).

Diagnosis and Treatment Planning



Protective Liner

A protective liner is a thinly-applied liquid placed on the pulpal surface of a deep cavity preparation, covering exposed dentin tubules, to act as a protective barrier between the restorative material or cement and the pulp.

Protective Liner Considerations:

CaOH and MTA both have good track records. MTA seems to have better outcomes in most published studies.⁵

A small amount of affected dentin may be left at base of the prep to avoid pulp exposure. Leaving affected dentin and placing a liner has better clinical success than exposing the pulp.

A good peripheral seal is important to long-term success¹

Depending on quality of dentin at base of prep, indirect pulp treatment (IPT) may be considered.

Statistically, teeth restored using a single-visit technique are more likely to remain vital at follow-up appointments (96 percent vs 83 percent at a three-year follow up)*. There are many factors to consider though and case-by-case clinical judgement is important.²

Protective Liners: Clinical Procedure

- a) Preop
- b) Caries removal. Note that there was no exposure of pulp. A small amount of affected dentin was left in base of prep.
- c) Placement of protective liner (CaOH in this case)
- d) Final restoration



Indirect Pulp Treatment (IPT)

Stepwise evacuation of caries performed over two visits, with an intermediate restoration in between.

IPT Considerations:

The second-stage excavation several months later is carried out to firm dentin. It is easier to perform, as the consistency of the retained dentin should have changed.

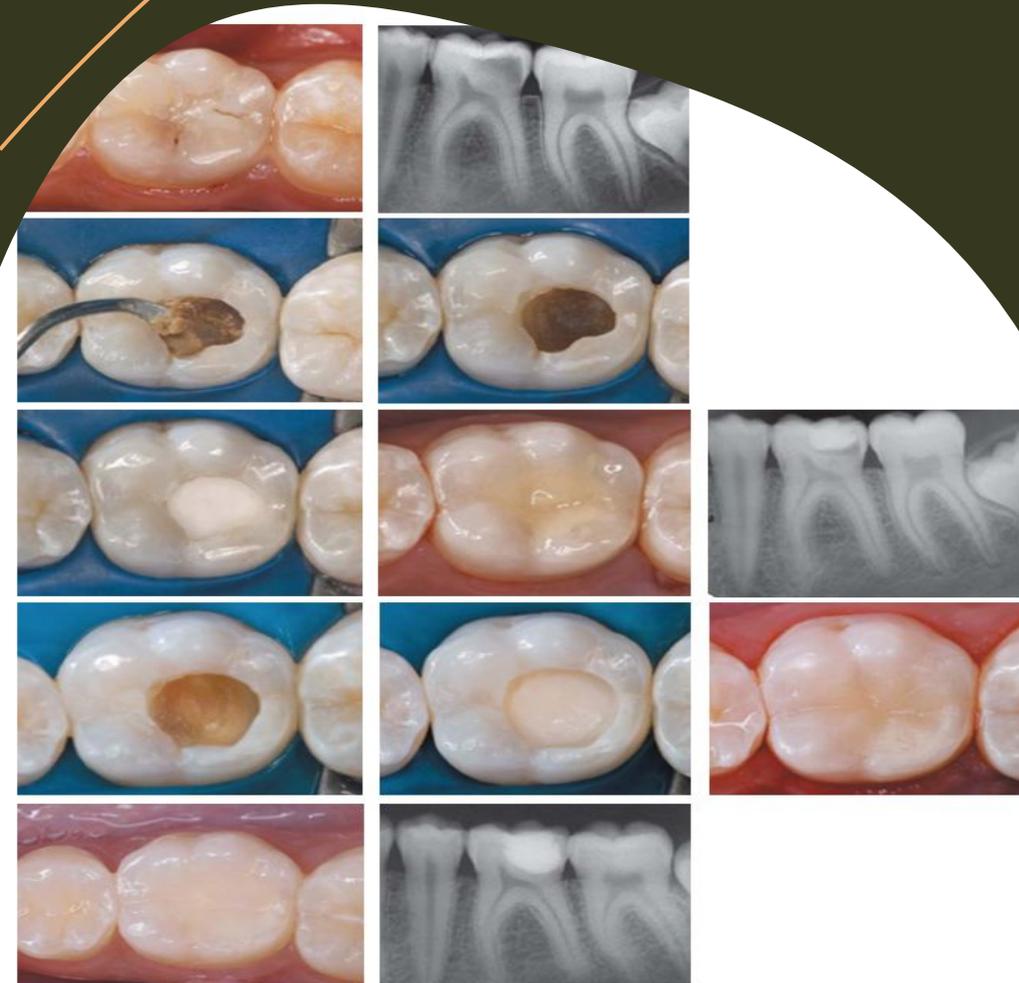
An excellent seal is required of the intermediate restoration that should last for up to a year.

Protective liners are usually placed at second stage as well.

Based on a 5-year follow-up of a randomized clinical trial, a stepwise excavation approach for the management of deep carious lesions was superior to a complete carious removal procedure carried out in one visit, with less pulpal exposure, less pain and more teeth with vital pulps in the stepwise group.³

Indirect Pulp Treatment: Clinical Procedure

- a) Preop
- b) Initial excavation of decay
- c) Initial restoration (CaOH liner). 3 month wait time in this case.
- d) Secondary excavation and restoration (CaOH liner).
- e) 4-year recall



Direct Pulp Cap

Placement of a dental material over the exposed pulp to facilitate both the formation of protective barrier and the maintenance of vital pulp.⁷

Direct Pulp Cap Considerations:

CaOH and MTA both have good track records. MTA has better outcomes in most published studies.⁶

Good isolation, and quick haemostasias are important.

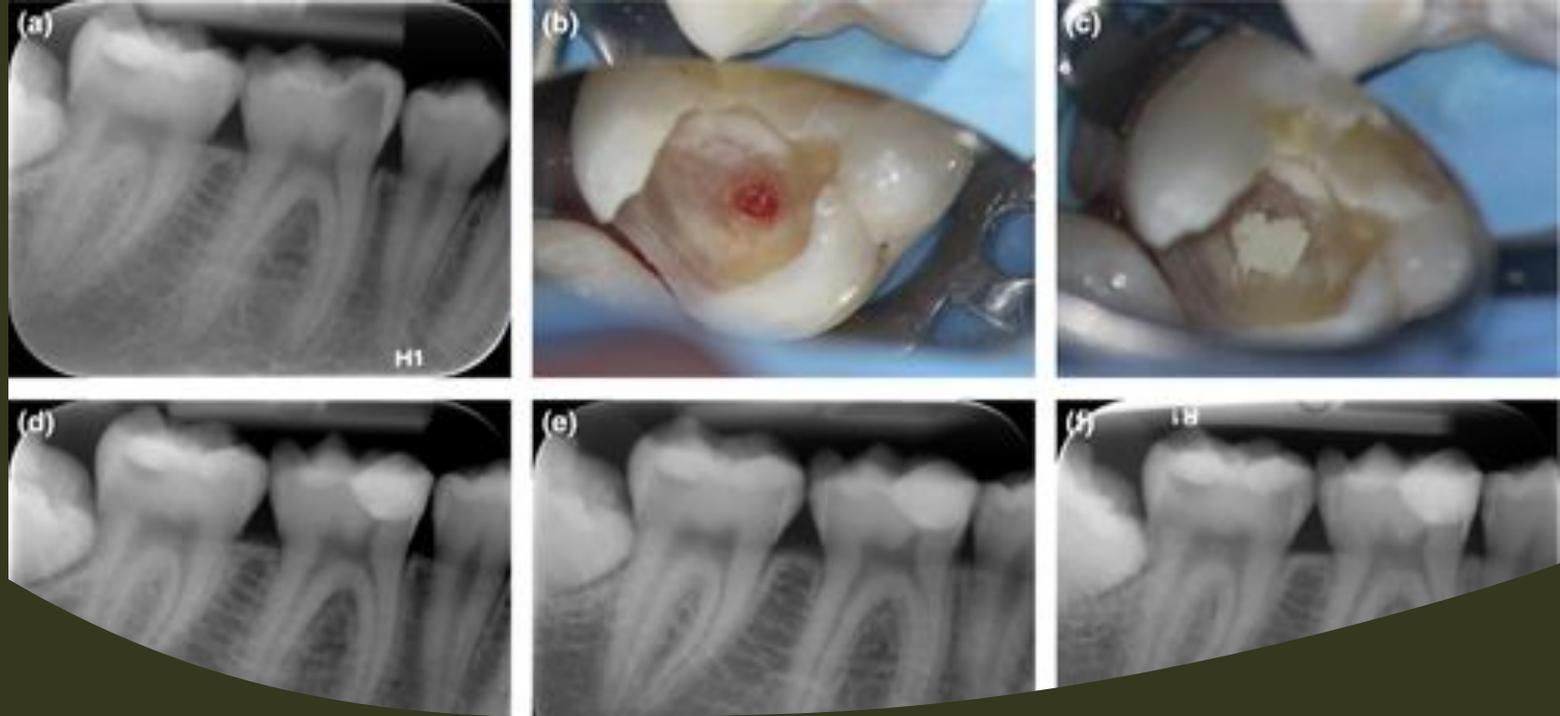
In some studies, NaOCl decreased bond strength to dentin. Etched dentin and enamel were relatively unaffected, and other studies show contradictory evidence with increased bond strengths. Short exposure time (<10min) to NaOCl seems relevant.⁸

A good final restoration is important

The quality of reparative dentin after a successful pulp capping procedure has been evaluated histologically and reveals many nonmineralized defects, so-called 'tunnel defects', that can easily be invaded by microorganisms.

Direct Pulp Cap: Clinical Procedure

- a) Preop
- b) Isolation; Nonselective caries removal; Haemostasis using NaOCL.
- c) Placement of pulp capping material (MTA in this case)
- d) Final restoration
- e) 1 year
- f) 2 year



Partial Pulpotomy

Inflamed pulp tissue beneath an exposure is removed to a depth of one to three millimeters or deeper to reach healthy pulp tissue. Pulpal bleeding is then controlled, and the remaining pulp is covered with CaOH or MTA before final restoration.

Partial Pulpotomy Considerations:

Isolate like you would for RCT (Rubber dam)

CaOH has been used successfully. MTA is way better and should be used most of the time. It's way more predictable.

MTA must be 1.5mm thick

Bleeding must be controlled for several minutes using bactericidal agent such as NaOCl or Chx.

Has been used successfully in cases of acute pulpitis (in immature teeth)

Has also been used successfully in trauma cases when done up to 9 days following the pulpal exposure.

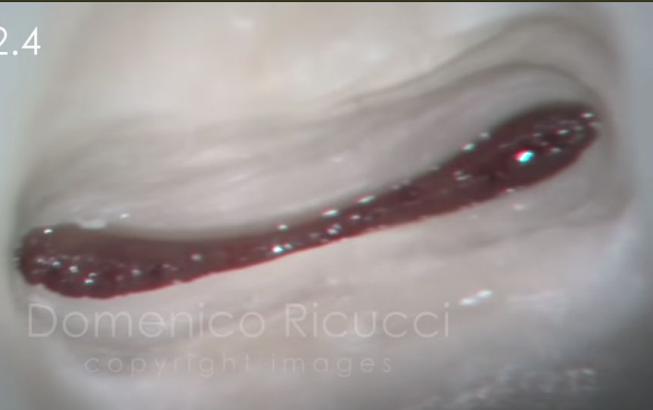
Keep in mind that MTA may cause tooth discoloration. A lot of trauma occurs on front teeth, so maybe CaOH is worth considering in these cases.

A few good examples can be seen here:

Partial Pulpotomy: Clinical Procedure

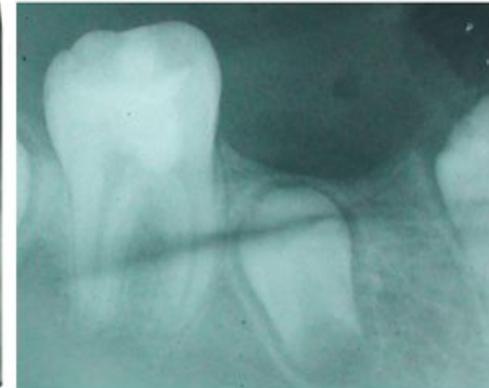
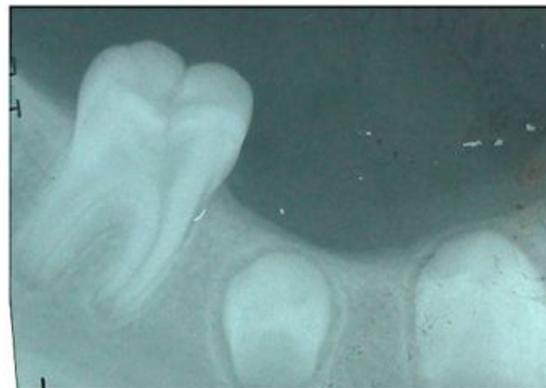
- a) Preop. "8 year-old boy presented with acute provoked pain in the lower right posterior area that lingered after removal of stimulus, and the parent reported the child taking painkillers." Note the open apex
- b) Immediately following treatment. Excavation was done with round bur, spoon instruments, and water. Haemostasis with light irrigation and loose cotton pellet.
- c) 24 month follow-up. Note the closed apex on #30

Tooth 2.4



Demonstration of what pulp should look like prior to fill. Clean, homogenous, red, blood filled tissue, surrounded by healthy tooth.

<https://youtu.be/2SusuxTRIng>



Complete Pulpotomy

A complete or traditional pulpotomy involves complete surgical removal of the coronal vital pulp tissue followed by placement of a biologically acceptable material in the pulp chamber and restoration of the tooth. The main intent is to promote apexogenesis. The secondary intent is to retain vitality of radicular pulp.

Complete Pulpotomy Considerations:

MTA is pretty much the gold standard.

Bleeding must be controlled for several minutes using bactericidal agent such as NaOCl or Chx.

Has been used successfully in irreversible pulpitis.

- This treatment is not indicated if there is apical pathology.
- Partial pulpotomy?

Complete Pulpotomy: Clinical Procedure

- a) Preop. 6 year-old boy presented with pain in the lower right posterior area that lingered after removal of stimulus, but with no pain on percussion. Note the open apex.
- b) Abundant hemorrhage on access of pulp chamber indicates vitality. Pulp tissue was removed with spoon and bleeding was controlled, in this case, with saline and cotton.
- c) 2mm MTA and final restoration with resin composite
- d) 12 month follow-up. Note development of apex. The tooth tested vital at this appointment.



Apexification

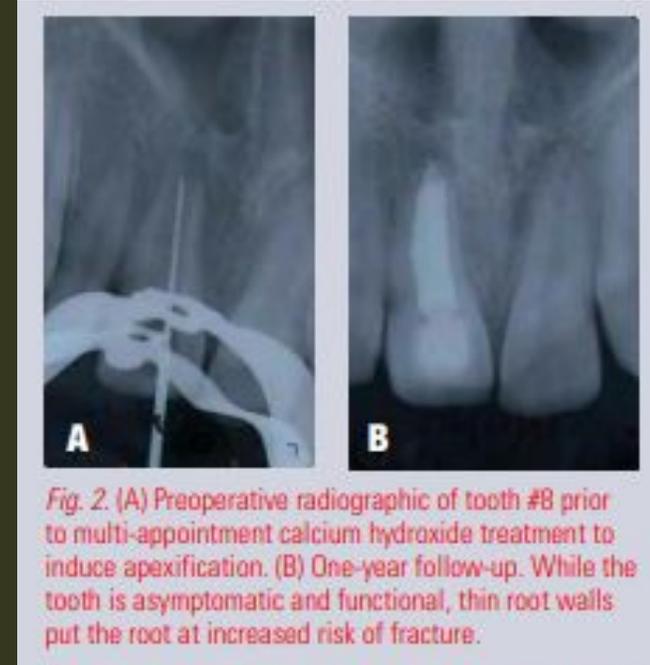
Historically, this has been the go-to procedure for immature teeth

Inducing root end closure of an incompletely formed non-vital permanent tooth by removing the coronal and non-vital radicular tissue just short of the root end and placing a biocompatible agent such as calcium hydroxide or MTA in the canals.

Apexification Considerations:

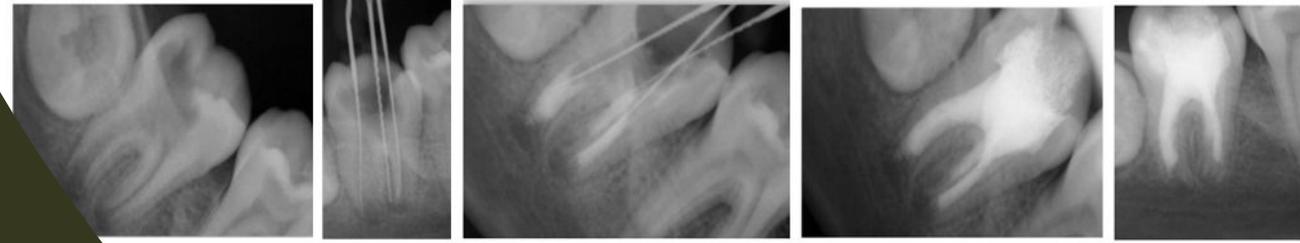
Traditionally, CaOH has been used. Multiple appointments are usually necessary to re-apply. Today, it seems that MTA is used more often.

Although root end closure occurs, root development stops. This leaves thin root walls that are prone to fracture.⁹



Apexification: Clinical Procedure

- a) Preop. "13-year-old boy was reported with pain in the right mandibular 2nd molar 3 weeks ago. Hard tissue examination revealed presence of deep dental caries in relation to the lower 2nd molar. The tooth did not respond to electric and thermal testing. Radiographic examination revealed deep pit communicating with pulp and presence of blunderbuss canals"
- b) Working length determination and minimum instrumentation with NaOCl irrigation.
 - b.5) CaOH was placed. Patient returned 2 weeks later with no symptoms.
- c) Placement of MTA plug. "Initially, 25 gutta-percha cones were used to transfer it [MTA] to the apical third followed by final condensation using small endodontic plugger. Repeated radiographs were obtained to check adequacy of MTA. The blunt end of a large paper point was moistened with water and left in the canal to promote setting for 4–6 hours. A cotton pellet was placed in chamber and the tooth restored with temporary cement. After 4–6 hours, the tooth was isolated and accessed as before. A hand plugger was lightly tapped against MTA plug to confirm a hardened set. The canals were dried using sterile paper points and obturated using ZOE sealer and injectable thermoplasticized gutta-percha."
- d) 8 month follow-up



Regenerative Endodontics

More of a concept than a procedure. Regenerative Endodontics is the engineering of the patient's natural tissues to replace or regenerate what has been lost. Various regenerative endodontic treatment protocols have been associated with a successful clinical outcome and currently there is no single recommended protocol.⁹

Regenerative Endodontics Considerations:¹⁰

Biological principles

Stem Cells- Undifferentiated cells. In RE these usually come from the blood/apical papilla

Scaffolds- Provide support for cell organization, proliferation, differentiation and vascularization. In RE these usually are derived from the blood clot and dentin. Sometimes PRF. Maybe even noninfected necrotic tissue.

Growth Factors- proteins that bind to receptors on the cell and act as signals to induce cellular proliferation and/or differentiation.

Regenerative Endodontics

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Regenerative Endodontics Considerations:¹⁰

Biologic Principles

Stem Cells- Differentiate into all cell types. In RE these usually come from the gingival papilla

Scaffolds- Provide support for cell organization, proliferation, differentiation, and vascularization. In RE these usually are harvested from the food clot and dentin. Sometimes PRF. Maybe even noninfected necrotic tissue.

Growth Factors- proteins that bind to receptors on the cell surface and act as signals to induce cellular proliferation and/or differentiation.

Regenerative Endodontics Considerations:

Case Selection

Necrotic tooth. If it's not necrotic, other treatment modalities are more predictable and less invasive.

Immature apex. Better vasculature. *Maybe* more stem cells since some may come from apical papilla.

No post needed. Pulp space barrier is placed over the canal space as part of the procedure, eliminating the use of this space for retention.

Compliant patient. Procedure takes multiple visits, and follow-through is mandatory for success.

Informed Consent

At least two appointments. If they can't follow through, don't start.

Minocycline and MTA can cause tooth staining

As with all endodontic procedures, there is a possibility of pain and/or swelling after the procedure and that there may be a lack of response to treatment.

Regenerative Endodontics Considerations:

Visit 1)

Clean the tooth- GENTLY.

Place Triple Antibiotic Paste (TAP)

...3-4 weeks...

Visit 2)

Remove TAP

Stimulate bleeding (Stir the pulp)

Place MTA and final restoratio

...6-12 months...

Visit 3)

Follow-up.

No symptoms. No PARL. Root development.

Regenerative Endodontics: Suggested Clinical Procedure

First appointment:

- Local anesthesia, rubber dam isolation, access
- Copious, gentle irrigation with 20 mL NaOCl using an irrigation system that minimizes the possibility of extrusion of irrigants into the periapical space (eg, needle with closed end and side vents, or EndoVac). To minimize potential precipitate in the canal, use sterile water or saline between NaOCl; lower concentrations of NaOCl are advised, to minimize cytotoxicity to stem cells in the apical tissues.
- Dry canals
- Place antibiotic paste or calcium hydroxide. If the triple antibiotic paste is used: (1) consider sealing pulp chamber with a dentin bonding agent to minimize risk of staining, and (2) mix 1:1:1 ciprofloxacin/metronidazole/minocycline (or, if esthetics are crucial, then consider a 1:1 mixture of ciprofloxacin/metronidazole).
- Deliver into canal system via lentulo spiral, MAP system, or Centrix syringe
- If triple antibiotic paste is used, ensure that it remains below the CEJ (to minimize crown staining)
- Seal with 3 to 4 mm of Cavit, followed by immediate restorative material, glass ionomer cement, or another temporary material
- Dismiss patient for 3 to 4 weeks

Second appointment:

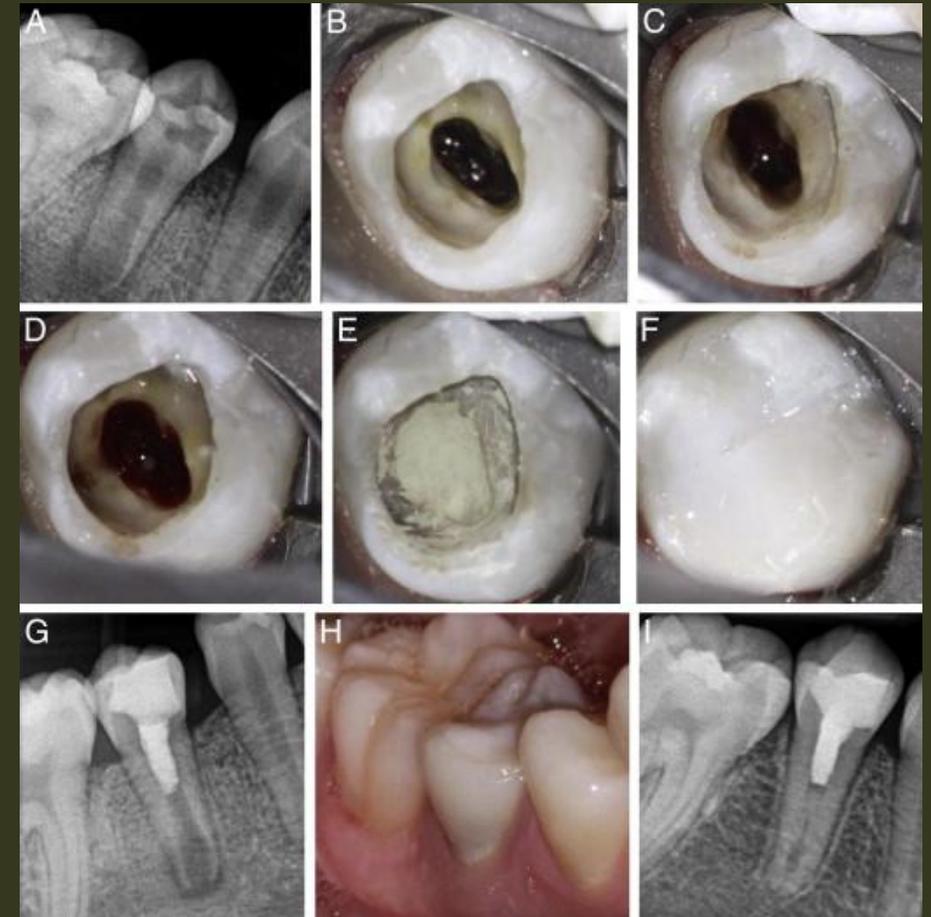
- Assess response to initial treatment. If there are signs/symptoms of persistent infection, consider additional treatment time with antimicrobial, or alternative antimicrobial.
- Anesthesia with 3% mepivacaine without vasoconstrictor, rubber dam, isolation
- Copious, gentle irrigation with 20 mL of ethylenediamine tetraacetic acid, followed by normal saline, using a similar closed-end needle
- Dry with paper points
- Create bleeding into canal system by overinstrumenting (endo file, endo explorer)
- Stop bleeding 3 mm from CEJ
- Place CollaPlug/CollaCote at the orifice, if necessary
- Place 3 to 4 mm of white MTA and reinforced glass ionomer and place permanent restoration

Follow-up:

Clinical and radiographic examination:

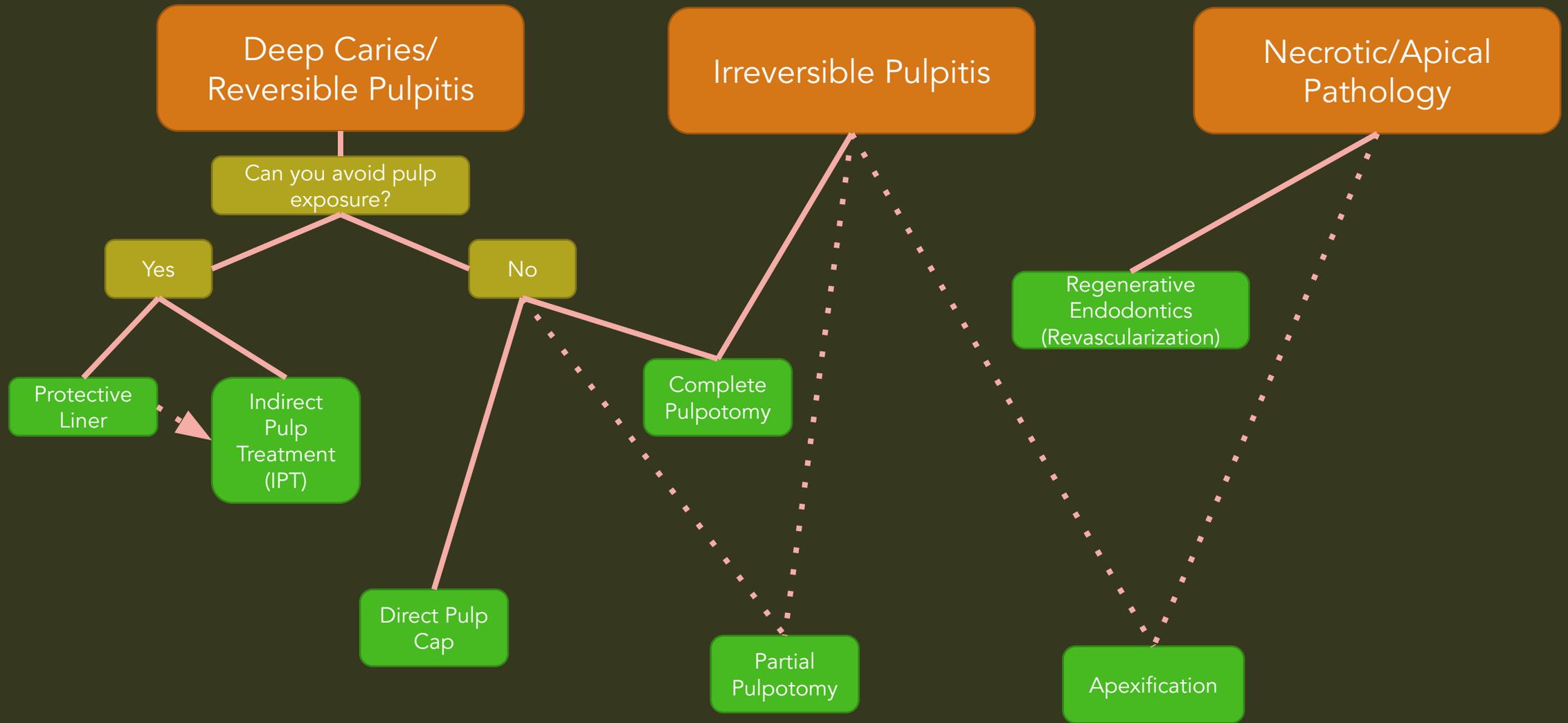
- No pain or soft tissue swelling (often observed between first and second appointments)
- Resolution of apical radiolucency (often observed 6–12 months after treatment)
- Increased width of root walls (this is generally observed before apparent increase in root length and often occurs 12–24 months after treatment)
- Increased root length

Data from Available at: www.aae.org/Dental_Professionals/Considerations_for_Regenerative_Procedures.aspx.

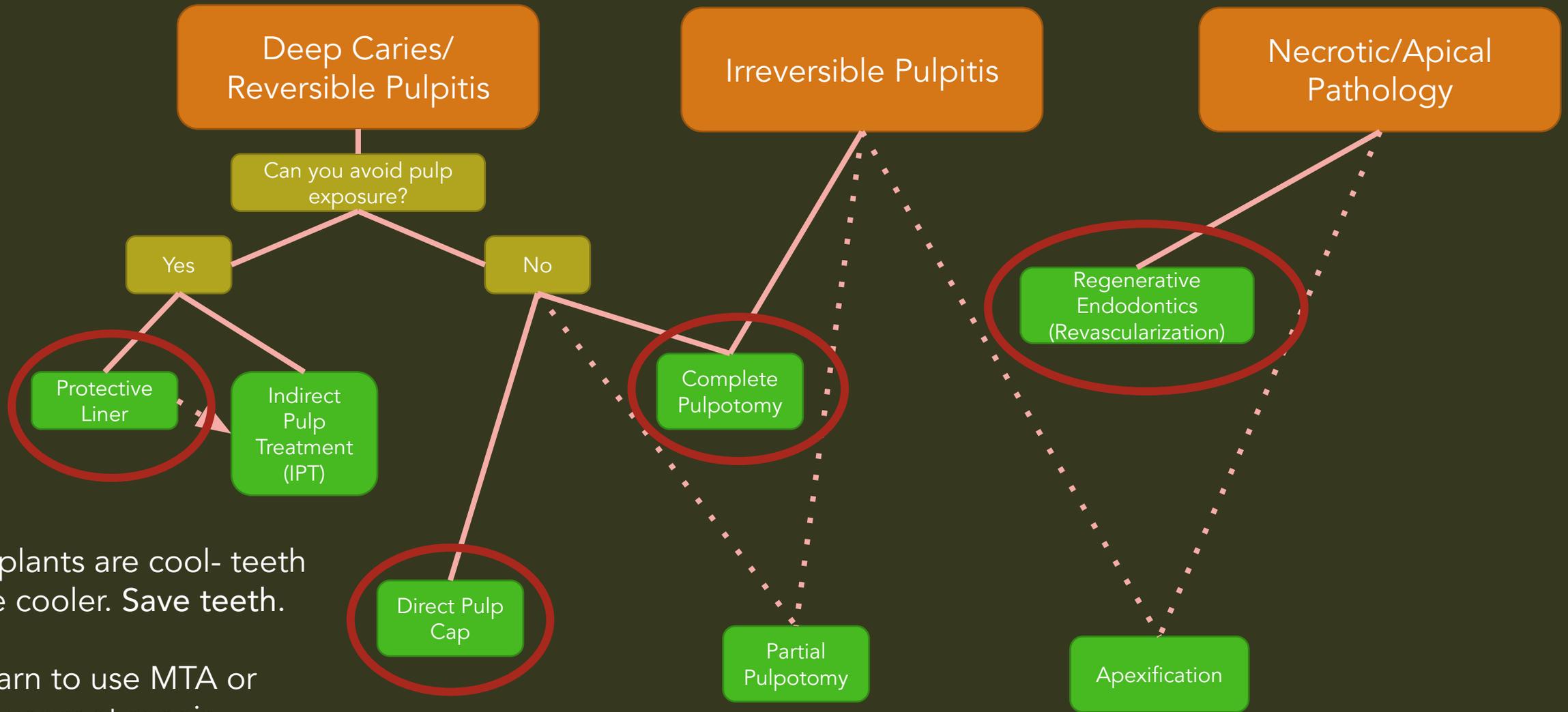


Images from regenerative endodontic procedures (REPs). (A) Periapical radiograph of mandibular right second premolar before the initiation of treatment showing occlusal caries, immature apex, and apical lesion. (B) Clinical photograph from the second appointment showing a bluish color of TAP in the canal immediately after the removal of temporary, (C) vital tissue in the apical third of the canal evident after irrigation to remove TAP, (D) the formation of blood clot, (E) the placement of white MTA, and (F) composite restoration. (G) A periapical radiograph made immediately after the placement of final restoration showing MTA covering pulp space and composite restoration. (H) A photograph at the 14-month follow-up showing grayish discoloration in the cervical third of the crown. (I) A periapical radiograph made at the 14-month follow-up showing increased root wall thickness.

Diagnosis and Treatment Planning



Diagnosis and Treatment Planning- Take Home Message



Implants are cool- teeth are cooler. Save teeth.

Learn to use MTA or newer root repair materials. They can be as useful as implants.

1. Alleman DS, Magne P. A systematic approach to deep caries removal end points: the peripheral seal concept in adhesive dentistry. *Quintessence Int.* 2012 Mar;43(3):197-208. PMID: 22299120.
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3. Bjørndal L, Fransson H, Bruun G *et al.* (2017) Randomized clinical trials on deep carious lesions: 5-year follow-up. *Journal of Dental Research* **96**, 747–53
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