

## INTRODUCTION

The most common cause of inflammation of the pulp is dental caries. Caries can cause infection and even tooth loss. Loss of primary or permanent dentition can lead to aesthetic, phonetic or malocclusion which can result in functional problems. The main objective in the primary dentition is to maintain the arch length and occlusal balance to support the oral tissues and hold the space for the succedaneous tooth. When caries penetrate a tooth, depending on the depth of caries and pulpal response different treatment modalities can be evaluated. When pulpal tissue is still viable, vital pulp therapies can be done such as an indirect pulp cap, direct pulp cap or a pulpotomy. In cases where a carious lesion progresses to pulp necrosis, non-vital pulp therapy such as pulpectomy or root canal therapy can be performed.

### Indirect Pulp Cap

Leaves deep caries to avoid pulp exposure, covering them with a biocompatible material for biological seal. Studies showed that removal of soft carious dentin has an effect on pulp regardless of the dental liner medicament. (Lopes et al., 2021)

Opinions vary on whether capping should be a one- or two-step procedure. Two-step procedure rationale: viable bacteria may remain in deeper layers of dentin but become inactivated after seal. When reparative dentin has formed, bacteria can re-enter the tooth. The two-step process allows time to return and excavate previous carious dentin to confirm formation of reparative dentin. (Koshy et al., 2004)

Higher clinical success rate than pulpotomy: Primary molars with IPT vs. formocresol pulpotomy concluded that IPT success was higher. In the study 55 primary molars were treated with IPT using GI cement as a cap and then a SSC. This had a 93% success rate, while the formocresol pulpotomy had a success rate of 74%. (Koshy et al., 2004)

The hall technique (adapted IPT approach) showed 78% success versus a 76% success of pulpectomy. (Lopes et al., 2021)

The survival rate was 96% for primary molars and 93% for permanent teeth. This study shows that indirect pulp therapy performed in primary and permanent teeth of young patients may result in a high 3-year survival rate. (Cohenca et al., 2013)

### Direct Pulp Cap

Pulp exposure that is covered with a biocompatible material. Has an 88.8% success rate regardless of the applied material (CAOH, MTA etc). (Lopes et al., 2021)

CAOH has many antibacterial properties, allows reparative dentin formation and, as a pulp cap, significantly decreases bacterial numbers in deep carious dentin.

The three disadvantages of CAOH:

1. Porosity of dentinal bridge that is produced which allows re-colonization of bacteria
2. Calcium hydroxide adhering poorly to dentin
3. Inability to provide a long-term seal against microleakage

As a capping material, MTA is found to have a better outcome than CAOH, resulting in less inflamed and necrotic odontoblastic layers and better frequency of dentin bridge formation (less porous dentin). MTA was clinically easier to use as a direct pulp capping agent and resulted in less pulpal inflammation and more predictable hard tissue barrier formation than CAOH. (Cohenca et al., 2013)

Direct pulp capping has less clinical success than pulpotomy. DPC will not work if the pulp is irreversibly inflamed. The degree of hemorrhage on pulpal exposure is the predictor of clinical success. Direct pulp capping of carious exposures in primary teeth has a poor prognosis because of the likely sequel of internal resorption.

Due to the poor success rate of pulp capping and the higher success rate of formocresol pulpotomy, DPC is rarely used on primary teeth. It is only recommended when a small traumatic exposure occurs during cavity preparation of a vital non-infected pulp. (Koshy et al., 2004)

### Pulpotomy

Entire coronal pulp is removed and hemostasis of radicular pulp is maintained; the remaining radicular pulp is treated with a medicament. Pulpotomy is indicated when an exposure either mechanical or traumatic is greater than 0.5mm.

The ideal material is bactericidal, biocompatible and promotes radicular pulp healing.

A pulpotomy can be done in a single or two steps.

There is no statistically significant difference in clinical success rate between pulpotomy and pulpectomy in primary incisors. (Lopes et al., 2021)

MTA has better long-term treatment outcomes than ferric sulfate, formocresol and CAOH. Ferric sulfate vs formocresol had no significant difference. MTA > Formocresol/ ferrous sulfate > CAOH (worst clinical performance) (Lopes et al., 2021)

Formocresol: pulpotomy may induce early exfoliation of teeth which can lead to functional issues.

Final restoration of the pulpotomies also plays a role in the success rate. Formocresol pulpotomies that were temporalized with IRM and then SCC were less successful than immediate placement of crowns. IRM used as a temp seals the pulp poorly and allows microleakage.

CAOH: Success rate of 31% in one study with two-year follow-up and 49% in a study with a one-year follow-up. Failures were due to internal resorption and chronic pulpal inflammation. (Koshy et al., 2004)

Cvek Pulpotomy: traumatic pulp exposure with partial pulpotomy and CAOH - 94% success. (Cohenca et al., 2013)

### Pulpectomy

Indicated when irreversible pulpitis or necrotic pulp occurs. Hard to do RCT due to morphology of the root canal system in primary teeth. The objective of instrumentation is debridement rather than precise shaping of the canal. The paste used for RCT should resorb similarly to the primary root. The material of choice for root canal filling is ZnO-eugenol. The reported a success rate following ZnO-eugenol obturation is 89% at 6 months and 76% at 12 months postoperatively for anterior teeth, and 92% and 84% for the 6- and 12-monthly reviews for posterior teeth. Major disadvantage due to the difference in the rate of resorption of the ZnO-eugenol compared to the root. (Koshy et al., 2004)

ZOE (zinc oxide eugenol) pulpectomies had similar outcomes to vitapex and sealapex. Not enough evidence to support one medicament is better than another. (Lopes et al., 2021)

For pulpectomy on primary teeth that are near exfoliation, CAOH/iodoform was the best filling material. Iodoform pastes resorb too quickly from the canal. CAOH alone is not recommended because of risk of internal resorption. Studies found that a mixture of calcium hydroxide and iodoform resorbed at a rate a little faster than the rate of resorption of primary teeth, and suggested this as an ideal root filling material. (Lopes et al., 2021)

### Regenerative Endodontics

Can be used in apicoectomy. Allows for revascularization of root for immature teeth with pulp necrosis and apical periodontitis. This involved the introduction of stem cells that originated in the apical papilla (SCAP).

SCAP, isolated mesenchymal stem cells residing in the apical papilla of incompletely developed teeth, help form primary dentin to aid in root development. (Cohenca et al., 2013)

Also used in studies of trauma cases. The implantation of autologous human deciduous pulp stem cells were seen to regenerate 3D pulpal tissue and promote root development.

Further research is being done. (Xuan et al., 2018)

### Apexification/Apexogenesis

Apexogenesis: When there is an open apex, maintaining vital pulp is essential for development of the root and maturation of the tooth. Performed to allow root formation.

Apexification: Inducing a calcified barrier in a root with an open apex with necrotic pulp. MTA was suggested as a replacement of long-term apexification with calcium hydroxide. Moreover, the use of an intracanal medication is not necessary when using MTA as an apical plug. The clinical applications of MTA have significantly improved the treatment outcome.

However, even if rendered successfully, apexification procedures will leave a short root with thin dentinal walls and a high risk of root fracture. Root fractures commonly occur in the cervical third, and have been shown to have a success rate of about 28-77% depending on the stage of root development. (Cohenca et al., 2013)

## CONCLUSION

Both vital and nonvital pulpal therapies have a high clinical efficacy in primary teeth. Through a comprehensive assessment of patient symptoms, radiographic interpretation, pulp vitality and depth of caries, different treatment modalities can be performed. The correct diagnosis is critical to determine which treatment option is best. The anatomy of primary teeth is unique; each has its own internal road map. Characteristics such as anatomy of the root canal system, divergence of the roots and crown root ratios vary from tooth to tooth. Each tooth should be evaluated individually to determine the best course of follow-up. Further research is ongoing on materials and methods on pulpal therapies should routinely be reviewed.

## References

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