Report

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Management of the pulp in primary teeth – An update

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ABSTRACT

Management of the pulpal tissue in primary teeth is a clinical challenge facing dental practitioners on a regular basis. This article reviews the most common treatments used at the present time in the management of the pulp in deciduous teeth. It gives an overview of treatment options and the indications and contra-indications for the different treatment modalities. The evidence behind the medicaments used, their actions and success rates are discussed. Practical guidelines for choosing to retain or extract deciduous teeth and management of the primary tooth pulp with different clinical presentations are discussed. Areas of future research are highlighted.

INTRODUCTION

The aim of this article is to review the current strategies employed in the management of the pulp in deciduous teeth. Managing the pulp in children has always been a challenging task for dentists. Where possible it is important to preserve the vitality of the pulp and the tooth as a whole until its natural exfoliation time, thus preserving arch integrity (Fuks, 2002). Many medicaments have been used over the past 90 years, and recent moves to discontinue formalin-based materials have lead to more research investigating alternative materials to dilute formocresol for pulpotomy in primary teeth. It has also lead to reviewing some of the techniques for managing the compromised primary tooth pulp.

DIAGNOSIS AND TREATMENT PLANNING

The decision to extract or retain a primary tooth depends upon a multiplicity of factors. Premature loss of primary teeth can lead to occlusal, aesthetic, speech, and functional problems (Levine, 1988). Treatment decisions must be based on a thorough history of signs and symptoms, extra-oral and intra-oral examination and other appropriate investigations including radiography. These can be accompanied by further clinical tests such as palpation, percussion, and assessment of mobility (Fuks, 2005; McDonald. 2004). Sensibility tests to heat, cold or electric stimuli have been found to be of little or no value since they lack specificity in the case of primary teeth (Fuks., 2000). The type of pulpal therapy indicated depends on the status of the pulp (vital with no inflammation, vital with inflammation or non-vital). This can be partly determined by clinical and radiographic findings but ultimately by what is found when the tooth is being treated. Clinical symptoms such as pain can be difficult to determine in young children because of limited communication (Easton et al, 2008). Questions about changes in eating, sleeping and behaviour patterns may indicate chronic intra-oral pain when children present with early childhood caries (ECC). Gentle finger pressure can be used to determine teeth mobility or tenderness. The size and appearance of lesions also indicate the possibility of pulp involvement. When the marginal ridge is broken, caries has usually involved the pulp (Duggal et al 2002). Bitewing radiographs (if the child can manage), are recommended for examination of the extent of carious lesions, pulpal pathology and inter-radicular radiolucencies in posterior primary teeth. Even if the problem appears unilateral, both sides of the mouth should be radiographed to ensure that treatment planning involves all the teeth, especially if the child is likely to need a general anaesthetic. Any radiolucency associated with a non-vital primary tooth is usually located in the furcation area and does not always involve the root apices (Fuks, 2000) and bitewing views will show this more clearly (Figure 1).

The early involvement of the bifurcation area is attributed to the presence of accessory canals in the pulpal floor. The developing premolar tooth buds are often superimposed and obscure the furcation region in periapical radiographs. Posterior bitewing and anterior occlusal radiographs will indicate the presence or absence of succedaneous teeth. It is recommended to routinely take anterior occlusal views (usually upper only) for the anterior teeth. This will indicate the severity of the caries, and pathology associated with apical areas and presence or absence of succedaneous teeth or supernumerary teeth (Figure 2).

The treatment options for a primary tooth with a compromised pulp include: indirect pulp treatment, direct pulp capping, pulpotomy, pulpectomy (partial pulpectomy) or extraction. The success of each of these techniques is discussed below but it should be noted that the success is also dependent on an appropriate restoration that seals the pulp-treated tooth.

Figure 1. Posterior bitewing radiographs taken in the primary dentition showing caries of varying severity. There are radiolucencies in the bifurcation areas of 74 and 84.

Figure 2. Upper anterior occlusal radiograph in the early mixed dentition showing interproximal restorations and developing incisors.

MANAGEMENT OPTIONS AND MEDICAMENTS

Pain Management

All treatment should be performed with adequate anesthesia and with minimal discomfort to the child. Pre-emptive analgesia can be administered at least one hour pre-operatively. A surgical dose of oral paracetomol (30 mg/kg) is recommended prior to any procedure where there may be discomfort during or after the procedure (Baygin et al, 2011). This also helps the child to manage the local anaesthesia. The use of topical anesthetic such as 20% benzocaine is recommended prior to the injection. Anaesthesia in the maxillary arch can usually be achieved by local infiltration with xylocaine and adrenaline, or in children over 4 years of age, with articaine and adrenaline. In the mandibular arch an inferior alveolar nerve block using xylocaine with adrenaline has been recommended, although recent reports note the success of articaine infiltration, which many children manage more successfully (Leith et al., 2012). Where at all possible, rubber dam should be used to isolate the teeth, improve access and decrease contamination by oral bacteria.

Indirect Pulp Treatment (IPT)

Indirect pulp treatment is indicated for teeth with deep carious lesions approximating the pulp without signs or symptoms of pulp degeneration (Fuks et al., 2000). The objective of this treatment, termed "partial caries removal", is to carefully remove caries from the amelo-dentinal junction area and only remove very soft dentine from the base of the lesion, leaving the remaining dentine in an attempt to preserve vitality and seal the affected dentine from the oral environment with a restoration. A further aim is to line the tooth with a medicament that may stimulate pulpal repair such as calcium hydroxide or mineral trioxide aggregate (MTA) (Witherspoon et al., 2006). With growing evidence of the success rates of IPT from short and longer-term clinical studies, (Coll, 2008; Farooq et al., 2000; Vij et al., 2004; Ribeiro et al., 2012; Ricketts et al., 2006) and further understanding of the potential healing capacity of the pulp, IPT is now being considered more routinely for symptom-free deep dentinal lesions in primary teeth, provided an adequate coronal seal can be achieved with an appropriate restoration (often a stainless steel crown) (Fuks, 2008). It is understood that some viable bacteria remain in the deeper dentine layers after IPT but they remain dormant when the cavity is appropriately sealed. In the past IPT was carried out in a stepwise fashion, known as "stepwise excavation" (Ricketts & Pitts, 2009) in primary teeth using an intermediate dressing. This has been shown to demonstrate a reduction to zero of lactobacilli counts upon culture at second excavation (Paddick et al, 2005). More recent evidence would suggest that a second excavation is not necessary (Ranly et al., 2000). Re-opening the tooth poses a risk of pulp exposure and further insult to the pulp tissue (Dumshat, 1985). It also commits the child to a second procedure which is not ideal. The recommendation is to only remove very soft dentine in the base of the cavity while concentrating on achieving a 'clean' hard amelodentinal junction area to improve the chances of achieving a good seal (Ribeiro et al., 2012). Some authors recommend rinsing the cavity carefully with 5% sodium hypochlorite (Vargas et al., 2006), then placing non-setting calcium hydroxide or MTA on the floor and sealing with a resin modified GIC cement before restoring. The success of this technique relies on appropriate case selection, proper clinical and radiographic examination and preventing subsequent microleakage leading to bacterial invasion (Rodd, 2005, Fuks, 2000).

Direct Pulp Capping

The aim of direct pulp capping is to preserve the vitality of the remaining pulp and to achieve reparative dentine formation over the exposed site (Vann, 2009). In primary teeth this is only indicated for pinpoint traumatic pulp exposures or an iatrogenic exposure during an operative procedure with good isolation (Fuks, 2008). It is not recommended for carious pulp exposures (Fuks, 2005) unless teeth are close to exfoliation (within a few months) and have good isolation when exposed. The success rates are much lower than other procedures (Orhan et al., 2010). In the few instances where it is deemed appropriate, after exposure, the pulp is capped with non-setting calcium hydroxide or MTA (Fuks, 2000; Caicedo et al., 2006) and sealed with a resin-modified GIC cement before restoring the tooth.

Pulpotomy

A pulpotomy involves the complete removal of the coronal pulp while preserving the vitality of the remaining radicular pulp, which has the potential for healing and repair. It is recommended that a pulpotomy should be performed for a primary tooth with extensive caries and a vital pulp when there is a carious or traumatic exposure (AAPD, 2009). The indications include teeth that have no prolonged pain on stimulation and the amputated pulp tissue undergoes haemostasis within a few minutes. The caries is removed initially and on exposure the roof of the pulp chamber is removed with a high-speed bur and appropriate water-cooling. The pulp is removed with a slow large round bur or a sharp spoon excavator and the cavity rinsed. The medicament is placed appropriately and the dentine sealed with a resin modified GIC cement. A flowable cement such as 3M Vitrebond is ideal for this purpose. Ranly (1994) classified pulpotomy therapy based on the mechanism of action of the available pulpal medicaments namely as: devitalization, preservation, or regeneration. Devitalization is to mummify the remaining vital tissue completely, and is achieved by using a medicament such as formocresol or glutaraldehyde. Preservation is retention of maximum vital tissue with no induction of reparative dentine, achieved with ferric sulphate, sodium hypochlorite, soft tissue laser or electrosurgery. Regeneration involves the stimulation of a dentine bridge, achieved with non-setting calcium hydroxide or MTA. The most common currently recommended medicaments are ferric sulphate, either alone or followed by lining with calcium hydroxide, or MTA.

The use of ferric sulphate aims to preserve the radicular tissue by imposing a minimal inflammatory insult to the superficial radicular pulp (Rodd, 2005). Numerous studies (up to three years) comparing 15.5% ferric sulphate pulpotomy with dilute formocresol (20% dilution) pulpotomy have reported similar success rates (Fei et al., 1991; Fuks et al., 1997; Huth et al., 2005; Ibricevic and Al-Jame et al., 2003; Nadin et al., 2003; Loh et al., 2004). Because ferric sulphate is a good hemostatic agent, caution is advised as it may achieve haemostasis and disguise irreversible pulpitis. Therefore the type of bleeding should be assessed before the application of ferric sulphate. Calcium hydroxide has long been known to have the capacity to induce reparative dentine formation (Zander, 1939). However, if it is

placed over a blood clot, chronic inflammation and internal dentine resorption are likely to occur (Schroder et al., 1971). When ferric sulphate is used to achieve haemostasis first, calcium hydroxide can be placed over the pulp canal openings to encourage pulpal healing and dentine bridge formation.

MTA has good biocompatibility, is anti-microbial, an excellent canal sealant, and has a high pH (12.5). The clinical and radiographic outcomes of MTA pulpotomies have been shown to be improved when compared with dilute formocresol pulpotomies over three-year periods (Ng et al., 2008; Eidelman et al., 2001; Jabbarifar et al., 2004; Holan et al., 2005). When MTA is used it is recommended that bleeding is controlled initially and it is placed after haemostasis has occurred. Some operators use ferric sulphate to achieve this. At the present time the drawback is the cost of MTA in most clinical environments. Very recent studies have also reported good success rates using 2.5% to 5% sodium hypochlorite. It appears to provide disinfection, amputate the blood clot chemically and have only superficial effects on vital pulp tissue (Shabzendedar et al., 2013; Vostatek et al., 2011). In a recent publication (Ackay & Sari, 2014) the use of 5% sodium hypochlorite as an anti-bacterial agent prior to application of the pulpotomy agent improved the success of calcium hydroxide pulpotomies to equal the success of mineral trioxide aggregate pulpotomies for observation up to 12 months.

Pulpectomy - Partial Pulpectomy

Complete pulpectomy in primary teeth is not achievable because of the many lateral canals and the more appropriate description used is partial pulpectomy. This is a routine procedure and particularly useful to maintain space when it is desirable to keep a primary tooth to guide the eruption of a permanent tooth – particularly a first permanent molar. Long-term success rates are not as high as other pulp treatments carried out on vital pulps (Chandra et al., 2014). The procedure involves removing the pulp, preparing the canals with rotary or hand files and sodium hypochlorite irrigation. Once prepared the canals are filled with a resorbable material. The most common material used is calcium hydroxide and iodoform paste (Vitapex – Noe Dental, Tokyo, Japan) or plain zinc oxide eugenol (no acrylic fillers) (Figure 3). Where a permanent successor is absent and the tooth is to be kept for as long as possible, the canals can be filled with gutta percha.

Restoring Teeth after Pulp Treatment

An excellent final restoration that reliably seals the tooth is crucial for the long-term success of pulp treatment. An adhesive restoration with composite resin is acceptable when the restoration is small and involves only one surface. However, when significant tooth structure is removed, the tooth should be restored with a stainless steel crown or in the anterior region a strip crown, veneered stainless steel crown or zirconia crown. (Randall,. 2002; Seale. 2002) (Figures 4,5,6,7). The traditional preparation for stainless steel crowns has shown excellent success after four years (Drummond et al, 2004). This technique ensures that crowns can be placed even where there is significant space loss or it is important not to open the occlusion. A more recent technique, the Hall Crown (Innes et al., 2009) is also useful but can be difficult when there is significant space loss. Anterior strip crowns can provide a good outcome, although they are technique sensitive. The more recent stainless steel crowns with ceramic facings and zirconia crowns give an excellent aesthetic result and are well retained (Waggoner, 2006).

Follow up

It is always recommended that teeth have a radiographic follow-up within six months of pulp treatment to ensure there are no problems with chronic infection that might involve the developing tooth if left unmanaged. When internal root resorption or enhanced periapical resorption is seen, although considered a sign of failure, this may be monitored regularly as long as the child is well, there are no clinical problems and it is not involving the developing tooth.

Figure 4. Radiograph of stainless steel crowns on pulpotomised teeth: 65,75,74.

Figure 5. Restorations of 51,61 with Stainless steel faced crowns Zirconia crowns.

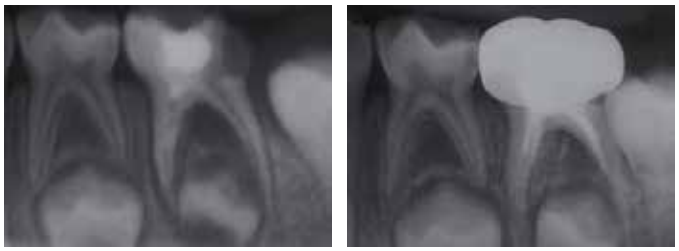

Figure 3. Pre-operative and post-operative radiographs of a pulpectomy on 75.

Figure 6. Restoration of 51,61 with composite strip crowns.

Figure 7. Stainless steel crowns on teeth: 75,74,84,85.

Extraction:
Extraction of severely carious primary teeth is a treatment option for several reasons. This can be considered during treatment planning when the child's age and the time to exfoliation are considered. The developing dentition should also be assessed to evaluate developing problems that may worsen with early extraction, such as mesial movement of erupting first permanent molars when primary second molars are removed, or worsening of a deep bite when lower first primary molars are removed. In these cases, pulp treatment should be attempted to try to avoid extraction. Extraction is still indicated for children who are immune-compromised, have ventriculo-atrial shunts or have significant cardiac defects. Extraction may also be considered in very young children when teeth are non-vital and the child requires treatment under general anaesthetic where there may not be time for longer partial pulpectomy procedures. The dental indications for extraction include teeth that are broken down and not restorable, significant infection with facial swelling, or a tooth with extensive internal/external root resorption or more than two thirds root resorption. When an extraction is planned, consideration should be given to managing the subsequent growth and development. This may involve the use of a space maintainer or a balancing extraction (removing a contralateral tooth to avoid a midline shift) or a compensating extraction of the opposing tooth to avoid over eruption. Longer term monitoring of the dentition should assess for ectopic, early or delayed eruption of successor permanent teeth to manage the problems these may present.

SUMMARY

This review has discussed the current management of the pulp in primary teeth, treatment options in the management of pulpal conditions and the recommended treatment modalities reported in the literature. A better understanding of pulp biology, pathophysiology, and its potential healing capacity has created new understanding of the aims and anticipated outcomes of pulp therapy. There is much room for further research in this area.

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