Update of Management and root canal treatment of non-vital immature permanent incisor teeth guideline 2010

Clinical Guidelines in Paediatric Dentistry

Management and Root Canal Treatment of Non-Vital Immature Permanent Incisor Teeth

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Update of guidelines

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Since the National Clinical Guidelines were published in the International Journal of Paediatric Dentistry in 1998 subsequent publications include \textit{in-vitro} and \textit{in-vivo} experimental studies carried out on animal and human teeth, review articles and a Cochrane systematic review is currently under way.

Studies \textit{in-vivo} and \textit{ex-vivo} have demonstrated that prolonged dressing of non-vital immature teeth with non-setting calcium hydroxide results in a reduction in the fracture strength of root dentine. In view of these findings there is a need to consider alternative methods of managing these teeth (Andreasen \textit{et al.} 2002, Cvek 1992, Rosenberg \textit{et al.} 2007).

The use of Mineral Trioxide Aggregate (MTA) has become an accepted method of creating an apical barrier in non-vital immature teeth. Two recent prospective studies have shown MTA promotes periapical healing (Simon \textit{et al.} 2007, Felippe \textit{et al.} 2007).

The production of an apical barrier using MTA can usually be achieved in a single visit. Subsequently, the remainder of the root canal may be obturated using any acceptable technique. The coronal part of the canal should be restored using composite resin to reinforce the neck of the tooth and reduce the risk of fracture.

Whilst current available evidence may not meet the strict criteria set out by Cochrane collaboration, it should not be overlooked owing to the substantial number of studies supporting the use of MTA. Developing a prospective randomised control trial on treatment outcome comparing calcium hydroxide with MTA for managing non-vital immature permanent incisor teeth with an appropriate follow up period may be difficult to undertake. Some authorities still favour the calcium hydroxide method because of the availability and lower cost of calcium hydroxide. The disinfection and
preparation of the root canal space is common to both methods and this will be described first, followed by the two methods of barrier formation.

These guidelines are intended to provide clinicians with an update on the currently available and published literature on the management of non-vital immature permanent incisor teeth.

The evidence has been graded according to the SIGN classifications and these guidelines should be read in this context.

For the update of these guidelines, an electronic search of the dental literature was carried out through PUBMED using the following keywords:

Quality of root canal treatments in anterior teeth
Root canal irrigants
Irrigation of infected root canals
Intracanal medicaments
Open drainage
Working length estimation
Rubber dam isolation in endodontic treatment
Hard tissue formation in infected teeth
Apical barrier formation in immature teeth
Apexification
Evaluation of ultrasonically placed MTA and fracture resistance

A total of 1852 abstracts in English and foreign languages from 1998 to 2009 were identified, in addition to the articles cited in the original guidelines.
Management and root canal treatment of non-vital immature permanent incisor teeth

INTRODUCTION

According to the 2003 Child Dental Health Survey, 13 per cent of children in the United Kingdom traumatised their permanent incisor teeth by age 15 (for definition of immature tooth see Explanatory note 1).

(Children’s dental health in the UK 2003, Office for National Statistics: March 2005)

There is a possibility these teeth will become non-vital and require endodontic treatment (Explanatory note 2).

The aim of treatment is to eliminate infection and promote periapical healing. An apical barrier is needed to allow placement and containment of the root filling (Explanatory note 3).

The successful management of non-vital immature incisor teeth requires accurate diagnosis, appropriate emergency treatment, a meticulous endodontic technique and appropriate follow-up. It is also mandatory to keep good records (Explanatory note 4).

Section 1. Initial Management

1.1 Diagnosis of non-vital immature permanent incisor tooth.

Before commencing endodontic treatment it is essential to confirm that the pulp is irreversibly damaged and pulpal health unlikely to be regained. This diagnosis is based on clinical signs and symptoms including sensitivity testing and radiographic examination. If there is uncertainty about the health of the pulp, endodontic treatment should not be undertaken. The tooth should instead be kept under review (Explanatory note 5).

1.2 Emergency visit

Patients may present as an emergency with pain and/or swelling. At this first visit, treatment should consist of drainage if needed and commencement of root canal treatment. However, if the tooth is acutely infected or extremely sensitive, treatment at this visit may need to be limited to emergency measures. These may include:

- Drainage
- Sedative dressing (see 1.2.2)
- Prescription of antibiotics and/or analgesia
- Review in 24 – 48 hours

1.2.1 Open drainage

Open drainage is very rarely advised.
1.2.2 Sedative dressing

If sensitivity is encountered and adequate anaesthesia cannot be obtained to allow removal of pulp tissue, a sedative dressing, such as an anti-inflammatory, may be placed into the root canal. At the next visit, local anaesthesia is usually successful, allowing removal of pulp remnants.

1.2.3 Prescription of antibiotics

It may not be possible or it maybe inappropriate to carry out clinical treatment at this visit, for example if there is presence of a swelling resulting in limitation in opening or the local anaesthetic being ineffective, or systemic symptoms, antibiotics should be prescribed to manage infection and treatment postponed to a later date.

1.3 Root canal treatment

1.3.1 Anaesthesia

Local anaesthetic should be used as there may be vital tissue remaining in the root canal or at the apex and also for application of a rubber dam clamp. Palatal anaesthesia may also be necessary for clamp placement.

1.3.2 Rubber dam.

The tooth is isolated with rubber dam (Explanatory note 6). Precautions should be taken against leakage of root canal irrigants into the mouth. In exceptional cases it may be impossible to use rubber dam but alternative methods of dam application and tooth isolation should be employed so that asepsis is not compromised.

1.3.3 Access cavity

Adequate access is essential to allow thorough cleaning and complete disinfection of the wide root canal. The access cavity should be designed so that the root canal space is fully accessible to instruments and irrigants.

1.3.4 Working length determination and preparation of root canal

A file is placed into the root canal to the estimated working length and a periapical radiograph taken. The working length is then adjusted accordingly, to within 1 mm of the radiographic apex. Electronic apex locators are not generally used to determine working length in teeth with immature apices as they can give inaccurate readings. If they are to be used it is still recommended that a preoperative radiograph is taken initially.

As the canals walls are relatively thin, excessive filing should be avoided. Irrigants have an important role in cleaning the root canal. Care must be taken not to force irrigant beyond the apex.
Although different solutions may be used, the irrigant should possess antimicrobial and tissue-dissolving properties. Sodium hypochlorite is considered the irrigant of choice and fulfils these requirements (Explanatory note 6).

1.3.5 Root canal dressing

At this stage the canal may be dressed with calcium hydroxide if it cannot be rendered clean and dry, if it is considered inappropriate to continue treatment at this visit, or the long term calcium hydroxide method is being used (Explanatory note 7).

- Other root canal dressing materials
  There are alternatives to calcium hydroxide (Explanatory note 8).

1.3.6 Mineral Trioxide Aggregate (MTA) method

A hard apical barrier can be produced using MTA. This material has been shown to promote healing of the periapical tissues. It is essential to ensure the canal is adequately disinfected and thoroughly cleaned prior to placement of MTA as its removal at a later date can be challenging or impossible (Explanatory note 9).

All the calcium hydroxide or other dressing materials are removed and the root canal irrigated thoroughly and dried. MTA is inserted into the root canal to form a 4-5 mm apical plug using a specially-designed delivery device or placed into the pulp chamber using an amalgam plugger and carefully condensed using measured root canal pluggers. A radiograph is taken to ensure that the MTA barrier is satisfactory. If necessary, any corrections should be made at this visit before the MTA sets. Depending on future treatment planned, the remainder of the canal is either filled with MTA or backfilled with gutta-percha. In view of the long setting time of MTA this is usually carried out at a subsequent visit. (Explanatory note 10).

The neck of the tooth may be restored using composite resin to reinforce it against possible cervical root fracture. (Explanatory note 11).

1.3.7 Calcium hydroxide method

Calcium hydroxide is inserted to fill the root canal space (Explanatory note 7). Calcium hydroxide has been the material most widely used for apexification. However, prolonged dressing with calcium hydroxide leads to dessication of dentine which is detrimental to the tooth long-term (Explanatory note 7). In addition, this method involves more clinical time, repeated visits and greater commitment from a, possibly, nervous child. There is also a greater risk of loss of the temporary restoration and subsequent re-infection of the root canal.

After thorough cleaning and disinfection, calcium hydroxide is inserted as above. A radiograph may be taken to confirm that the root canal is adequately filled with calcium hydroxide. If the canal is heavily infected it is disinfected and calcium hydroxide replaced after approximately one week. Thereafter this is repeated at intervals until a hard tissue barrier can be detected either radiographically or clinically (Explanatory note 7).
When the formation of an apical barrier is achieved, the root filling may be inserted. Gutta-percha combined with a sealer is usually used. Heat may be applied to improve the adaption of the gutta-percha to the wide or irregularly-shaped root canal space (Explanatory note 10).

Composite resin may be placed in the cervical region of the tooth to protect against root fracture (Explanatory note 11).

1.3.8 Alternative method- Revascularisation
(Explanatory note 12)

1.3.9 Follow-up

The frequency of follow-up appointments and review radiographs will depend on the nature of the trauma. Therefore, traumatised teeth should be followed up according to the appropriate trauma guidelines. All root canal treatment should be followed up after one year and annually thereafter for up to four years or until complete healing is radiographically evident.

Section 2. Restoration of the tooth

The tooth should be restored as soon as possible after completion of root canal treatment to ensure a good coronal seal. A good coronal seal is important to prevent reinfection of the root canal. The restorative options can include a direct restoration with composite resin or a fibre post if insufficient coronal tooth tissue remains (Explanatory note 11).

Section 3. Apical surgery

Endodontic treatment and root end closure techniques should be attempted before considering apical surgery. If a periapical radiolucency remains after well executed root canal treatment and after an appropriate follow-up period, this may indicate the presence of residual infection outside the tooth and apical surgery may then be required. A small radiolucency may remain as a result of scar tissue.

Section 4. Failure

Failures may be due to inadequate disinfection or a poor coronal seal leading to persistence or re-introduction of infection into the root canal space (Explanatory note 11). In addition, there may possibly be an undetected vertical root fracture.
EXPLANATORY NOTES

1. Definition of an Immature Permanent Incisor Tooth

An immature tooth is a tooth which is not fully formed, particularly the root apex. A vital pulp is necessary for the development and maturation of the tooth root. If vitality is lost, this maturation process will cease leaving the tooth with a wide root canal, thin canal walls and an open apex. Root canal treatment is complicated by the lack of an apical constriction against which to condense and contain a root filling.

2. Epidemiology of dental trauma in immature permanent incisor teeth

Crown fracture is the most frequent injury in the permanent dentition consisting of 26-76 per cent of dental injuries. The literature suggests 1 to 6 per cent of teeth with crown fractures involving enamel and dentine develop pulp necrosis.

In luxation injuries, 15-59 per cent of teeth have been reported to develop pulp necrosis post-trauma.


Level of evidence= B

3. Aims of root canal treatment of non-vital immature permanent incisor teeth

The aims are to eliminate infection and prevent re-infection of the root canal space thereby providing conditions conducive to healing of the periapical tissues.

4. Record keeping

The majority of non-vital immature permanent incisor teeth are the result of trauma. Claims for redress may be made and litigation may be involved. It is, therefore, especially important to keep full and accurate records including photographs where appropriate.

5. Diagnosis of non-vital immature permanent incisor teeth

Accurate diagnosis of the pulpal status of traumatised teeth can often be very difficult. The diagnosis may also be complicated by a history previous injury.

Before considering root canal treatment, the clinician must be confident that the pulp is irreversibly damaged and that revascularisation is unlikely. The blood supply of an immature, luxated tooth may be interrupted but revascularisation may occur. A negative response to conventional sensitivity tests should not be the sole reason for root canal treatment.
5.1 Previous History

- Trauma
- Treatment

5.2 Symptoms
- Spontaneous pain
- Tooth tender to bite
- Tooth mobile
- Swelling

5.3 Signs
- Swelling
- Sinus tract
- Tooth tender to pressure
- Crown darkening in colour
- Timing of colour changes
- Increased mobility

5.4 Sensitivity tests
- Cold
- Electric pulp test
- Heat
- Laser Doppler

5.5 Radiographs
- Periapical radiolucency
- Arrested root development compared with contralateral tooth

If there is doubt about the health status of the pulp, it is more appropriate to monitor the tooth.

If the child presents with a facial swelling and systemic symptoms antibiotics should be prescribed. Antibiotic therapy usually is not indicated if the dental infection is contained within the pulpal tissue or the immediately surrounding tissue. In these instances root canal therapy needs to be commenced.

Guideline on use of antibiotic therapy for pediatric dental patients. American Academy of Pediatric Dentistry (AAPD); 2009.

Level of evidence= D

6. Working length determination and preparation of the root canal

Rubber dam protects the airway and prevents oral contaminants entering the root canal.


Level of evidence= D

If the tooth has an extensive coronal fracture or is very tender to touch, the “split dam” or “trough” technique can still be used with caulking agent to improve isolation.
Sodium hypochlorite is the most widely accepted root canal irrigant. It has antimicrobial and tissue-dissolving properties. Chlorhexidine has been reported to be a suitable alternative irrigant, however it is not a tissue solvent and there is a risk of tooth staining. No general consensus exists regarding the optimal concentration of sodium hypochlorite or chlorhexidine. A range of concentrations from 1 per cent to 5.25 per cent for sodium hypochlorite and 0.1 per cent to 2 per cent for chlorhexidine have been used.


Level of evidence = B

Irrigant may be delivered using a dedicated endodontic needle and syringe or an ultrasonic system. Irrigants should be delivered without excessive force, especially if a needle and syringe is used.


Level of evidence = D

7. Root Canal Dressing

The dry root canal should be filled to the apex with a calcium hydroxide paste. Several methods have been reported in the literature for placement of calcium hydroxide; these include:

- Lentulo spiral filler
- Condensing with the blunt end of a paper point or using an endodontic plugger
- Injection of non-setting calcium hydroxide

There is limited evidence to support the efficacy of one method of placement over another.
Although different studies have reported varying efficacy for calcium hydroxide, at present, it remains the most popular and widely accepted intracanal medicament.


**Level of evidence = A**

Calcium hydroxide produces a layer of necrosis. It has been postulated that this layer of necrosis generates a low-grade irritation of the underlying tissue to produce a matrix which then re-mineralises.

**Level of evidence = B**

Prolonged dressing of the immature tooth with non-setting calcium hydroxide has been shown to result in a reduction in the fracture strength of dentine. A retrospective study of luxated non-vital maxillary incisors treated with calcium hydroxide found that the frequency of cervical fracture was higher in these teeth.

**Cvek M.** Prognosis of luxated treated with calcium hydroxide and filled with gutta percha. A retrospective clinical study. Endodontics and Dental traumatology. 1992; 8:45-55.
**Level of evidence = C**

*Laboratory studies have also shown a significant reduction of resistance to fracture of teeth following prolonged use of calcium hydroxide.*

**Level of evidence = B**


**Level of evidence = D**

8. **Other Root Canal Dressing Materials**

*Other root canal dressing materials have been advocated. Polyantibiotic pastes, various antiseptics and disinfectants have been recommended to eliminate infection in the root canal.*

**Manzur A, Gonzalez AM, Pozos A, Silva-Herzog D, Friedman S.** Bacterial quantification in teeth with apical periodontitis related to instrumentation and
Level of evidence = B

9. Mineral Trioxide Aggregate

After the canal has been cleaned and shaped, MTA is placed to form a 4-5 mm apical plug. This technique is greatly facilitated by the use of magnification and enhanced illumination. MTA has a setting time of 4 hours (Torabinejad 1999); therefore, obturation of the remainder of the root canal should be deferred to a subsequent visit. MTA is biocompatible and has been shown to promote healing of periapical tissues.

Level of evidence = C

MTA is carried into the canals using a variety of devices and then condensed with endodontic pluggers. It has also been suggested that MTA may be condensed using ultrasonics to produce a significantly improved apical seal.

Level of Evidence = B

One-visit MTA apexification is gaining popularity over the use of calcium hydroxide. Studies have demonstrated periapical healing and resolution of symptoms when used in non-vital immature teeth.

Level of evidence = D

Recent prospective studies also favour MTA for managing immature teeth. However, human studies are limited with short follow-up times.

Level of Evidence = B

Studies comparing MTA with calcium hydroxide have shown MTA to be clinically superior in terms of periapical healing and providing an apical barrier. However, in the majority of studies, the sample size is small and follow-up period is short.

Level of evidence = B

A well recognised limitation of the use of grey MTA has been its effect in causing tooth discolouration. An alternative white form is now being used which has been shown to exhibit physical properties equal to grey MTA.

Level of evidence =D

In vitro studies have also demonstrated that MTA can also reduced the fracture resistance of dentine following long term application.

Level of evidence =D

10. Root filling techniques

The root filling is placed following the formation of an apical barrier either by apexification or the creation of an artificial barrier with MTA. The aim of the root filling is to completely obturate the root canal space. This may be by lateral condensation of gutta-percha combined with a sealer with or without the application of heat, or using a thermoplasticised injected gutta-percha technique. The canal may be completely obturated with MTA if it is unlikely that this will need to be removed from the canal in the future however this can lead to a greater risk of discolouration potential.

11. Final Restoration

An in-vitro study comparing fracture resistance of immature teeth filled with gutta-percha, MTA, calcium hydroxide and composite resin found that the fracture resistance of the teeth filled with composite resin was significantly greater than that with gutta-percha alone.

Fibre posts have been used in the restoration of endodontically treated teeth with insufficient crown. Laboratory based studies have demonstrated that they have a high tensile strength and a modulus of elasticity similar to that of dentine (Bateman et al., 2003), therefore, reducing the incidence of tooth fracture. The current literature available relates to mature incisors. More randomised control trials are needed to confirm whether fibre posts are clinically superior to metal posts (Al Ansari, 2007).


Level of evidence = B


Al Ansari A. Which type of post and core system should be used? Evidence based Dentistry. 2007; 8:5-6.

Level of Evidence= A

A well sealed coronal restoration is important to protect the root filling from contamination from the oral environment.


Level of Evidence= D

12. Revascularisation

Revascularisation is described as an alternative to current endodontic techniques used in the treatment of immature teeth. The rationale is that in the absence of infection and presence of a suitable scaffold within the root canal ingrowth of tissue from the periapical region leads to revascularisation of the reticular pulp. The technique involves disinfection of the root canal by use of a suitable root canal irrigant and placement of a triantibiotic paste. Following successful disinfection gentle instrumentation is carried out to create bleeding into the root canal producing a blood clot and new tissue. Through the process of continued root development this technique aims to promote the thickening of dentinal walls and apical closure. At present evidence is limited to case reports and thus more research is needed before advocating this technique as an alternative to current methods.

Level of Evidence= D

References

Al Ansari A. Which type of post and core system should be used? Evidence based Dentistry. 2007; 8:5-6.


Children’s dental health in the UK 2003, Office for National Statistics: March 2005


Guideline on use of antibiotic therapy for pediatric dental patients. American Academy of Pediatric Dentistry (AAPD); 2009.


