Chapter 3

Paediatric dentistry

Contents

Principal sources and further reading J. O. Andreasen *et al*. 2007 *Textbook and Color Atlas of Traumatic Injuries to the Teeth* (4e), Blackwell Publishing. COPDEND/DOH 2007 *Child Protection and the Dental Team* http://www.cpdt.org.uk. M. S. Duggal *et al*. 2002 *Restorative Techniques in Paediatric Dentistry*, Dunitz. R. R. Welbury *et al*. 2012 *Paediatric Dentistry* (4e), OUP. BSPD policy documents and clinical guidelines http://www.bspd.co.uk. International Association of Dental Traumatology guidelines http://www.dentaltraumaguide.org

The child patient

▶ Treat the patient not the tooth.

Principal aims of Rx

- Development and maintenance of healthy, functional, and attractive 1° and 2° dentitions.
- Freedom from pain and infection.
- A happy and cooperative patient.
- Prevention is priority.

Points to remember

- Praise good behaviour (reinforcement ➔ Techniques for behaviour management, p. 60), ignore bad.
- Involve parents (they determine whether child will return).
- Do not offer choice where there is none. Avoid rhetorical questions (Would you like to sit on my chair?).
- Children have short attention spans (↑ with age).
- Children have ↓ sensory acuity (may confuse pressure with pain, sensibility tests less reliable).
- Children have ↓ manual dexterity, therefore need help with toothbrushing <7yrs.
- Formulate a comprehensive Rx plan, which should address both operative and preventive care.
- Start with easy procedures (e.g. OHI) and progress, at child's pace, to more complicated Rx.
- Set attainable targets for each visit and attain them.

The first visit

- Children should first visit a dentist as soon as they have teeth (i.e. about 6 months of age). For young children, watching other members of the family receive Rx prior to their turn may be preferable.
- Let parent accompany child: check medical history and reason for attendance.
- Talk to child: communication is the key to success!
- Show patient chair, mirror, light, and explain purpose ('Tell, show, do' ➔ Techniques for behaviour management, p. 60).
- Count the patient's teeth.
- If good progress, polish a few teeth, but don't tire child by attempting too much.
- Show parent child's teeth and what has been done that visit.
- If child in pain, the source of this needs to be determined and dealt with as quickly as possible.
- Younger children can be more successfully examined if a parent sits with child facing them and then lowers child back on to his/her arm or the dentist's lap.

Notebox:
Summary points for managing the child patient (you write here)

Treatment planning for children

Diagnosis

Dental caries is often a rapidly progressing condition in children. It is essential to secure an accurate Δ before making a Rx plan. This is achieved by taking a history, doing an examination, and, where appropriate, taking bitewing radiographs.

► Bitewings are important for an accurate Δ unless approximal surfaces of the primary molars can be visualized (i.e. the dentition is spaced).

Treatment plan

The ultimate aim in dentistry for children is for the child to reach adulthood with good dental status and a positive attitude towards dental health and dental Rx. The final Rx plan will take into account the following considerations:

- Behaviour management (➔ Techniques for behaviour management, p. 60).
- Prevention (see Chapter 2).
- Restorative Rx (➔ Restoration of carious primary teeth, p. 82).

► Remember to consider the developing occlusion:

- Long-term prognosis for first permanent molars (➔ Extraction of poor quality first permanent molars, p. 138).
- Palpate for 3|3 at 10yrs (➔ Palatally displaced maxillary canines, p. 142).
- Beware disturbances in eruption sequence (➔ Failure of/delayed eruption, p. 64) and asymmetry.
- Early referral to specialist for skeletal discrepancies, and for any significant abnormal findings.

The Rx plan is drawn up visit by visit. Each visit has both preventive and operative components (optimally aiming to deliver only one key preventive message per visit).

As it is considered to be easier to administer LA for maxillary teeth, these teeth are usually treated before mandibular teeth.

Restorative care (i.e. repair) without prevention is of limited value. Dental caries is treated by 'preventive' measures; 'restoration' primarily repairs the damage caused by the carious process.

Children with caries in primary molars treated by prevention alone are likely to experience toothache/infection, especially if the child is young when the caries is first diagnosed. Therefore a combination of prevention and restorative/surgical treatment is usually indicated for most children with caries in the 1° dentition.

Other considerations

Pain or evidence of infection may influence the order of the Rx plan.

Temporization (i.e. hand excavation and dressing) of open cavities at the start of Rx:

- Gives a good introduction to dentistry.
- Helps to minimize the risk of pain before Rx is completed.

- Improves comfort (e.g. during brushing and eating).
- Reduces salivary *Streptococcus mutans* count.
- Produces a preliminary coronal seal, enhancing the chances of pulpal recovery and survival.
- May provide slow release of fluoride in the short term if a GI cement is used.

Delivery of care

Once the Rx needs have been decided upon:

- Discuss with parent and patient the Rx options.
- LA/sedation/GA—consider and discuss risks vs benefits of each (➔ Sedation, p. 61; ➔ General anaesthesia, p. 61).
- Plan operative care at a pace appropriate to the child's ability to cope. Be prepared to reconsider method of delivery of care (e.g. sedation/GA) if patient proves unable to accept Rx using original delivery strategy.

Look out for any signs of underlying medical or social problems which may modify the Rx plan:

- Systemic disease.
- Failure to thrive.
- Evidence of abuse or neglect (➔ Safeguarding children, p. 96).
- Small stature.

Notebox:
Summary points for treatment planning (you write here)

The anxious child

Techniques for behaviour management

Most of these are fancy terms to describe techniques that come with experience of treating children over a period of time.

General principles

- Show interest in child as a person.
- Touch > facial expression > tone of the voice > what is said.
- Don't deny patient's fear.
- Explain—why, how, when.
- Reward good behaviour, ignore bad.
- Get child involved in Rx, e.g. holding saliva ejector.
- Giving the child some control over the situation will also help them to relax, e.g. raising their hand if they want you to stop for any reason ('enhancing control').

Tell, show, do Self-explanatory, but use language the child will understand.

Behaviour shaping Aim to guide and modify the child's responses, selectively reinforcing appropriate behaviour, whilst discouraging/ignoring inappropriate behaviour.

Reinforcement This is the strengthening of patterns of behaviour, usually by rewarding good behaviour with approval and praise. If a child protests and is uncooperative during Rx, do not immediately abandon session and return them to the consolation of their parent, as this could inadvertently reinforce the undesirable behaviour. Try to ensure that something is completed, (e.g. placing a dressing or even an examination) and focus on the successful completion of this, rather than the failure to complete what might have been originally planned.

Modelling Useful for children with little previous dental experience who are apprehensive. Encourage child to watch other children of similar age or siblings receiving dental Rx happily.

Desensitization Used for child with pre-existing fears or phobias. Involves helping patient to relax in dental environment, then constructing a hierarchy of fearful stimuli for that patient. These are introduced to the child gradually, with progression on to the next stimulus only when the child is able to cope with previous situation.

Should parent accompany child into surgery? Essential on first visit, thereafter depends upon child's age and clinician's preference. If in doubt ask child's preference. However, if parent is dental phobic, their anxiety in the dental environment can be detrimental, so in these cases it is worth considering leaving the parent in the waiting room. Younger children are more likely to suffer 'separation anxiety', and many parents nowadays wish to be involved in, and informed about, their child's Rx. In the event of anxiety-related behaviour being encountered, parental presence in the surgery does enable consent for any adjustment in treatment to be easily maintained. Ideally parents should be motivated positively and instructed implicitly to act in the role of the 'silent helper'.

Sedation

Sometimes indicated for the genuinely anxious child who wishes to cooperate and also may help children with over-active gag reflexes and those where analgesia additional to LA may be needed (e.g. for difficult extractions such as 6s).

Oral Drugs such as midazolam and chloral hydrate have been advocated, although specialized knowledge and skills are required.

Intramuscular Rarely used in children.

Intravenous Rarely used in children >12yrs of age.

Per rectum Popular in some Scandinavian countries.

Inhalation Uses nitrous oxide/oxygen mixture to produce RA and is most popular technique for use with children. Effective for ↓ anxiety and ↑ tolerance of invasive procedures in children who wish to cooperate but are too anxious to do so without help. It is a good idea not to carry out any Rx during the visit when the child is introduced to 'happy air'. Let child position nose-piece themselves. See also Chapter 14.

Hypnosis

Produces a state of altered consciousness and relaxation, though it cannot be used to make subjects do anything that they do not wish to do.[1] Appropriate training is necessary for those wishing to practise hypnosis. It can be described as either a way of helping the child to relax, or as a special kind of sleep.

General anaesthesia

Allows dental rehabilitation &/or dental extractions to be achieved at one visit. GA should only be used for dental Rx when absolutely necessary (i.e. when other methods of management, e.g. LA or sedation, are deemed unsuitable). Alternative strategies and the risks of GA must be discussed to enable parents to make an informed decision. The risk of unexpected death of a healthy person:

- under GA has been estimated to be about 3 or 4 in 1 million.
- under sedation has been estimated to be about 1 in 2 million.

Other behaviour problems and their management

- Some children attempt to delay Rx by a barrage of questions. This is usually a sign of anxiety, and firm but gentle handling is needed. Tell the patient that you understand their anxieties and that you will explain as you go along.
- The temper tantrum—try to establish communication. Praise good and ignore bad behaviour. Set an easily achievable goal, e.g. brushing teeth and make sure it is achieved—comment on the positive outcome, rather than what was not achieved.

1 J. Hartland 2001 *Medical and Dental Hypnosis*, Churchill Livingstone.

The child with toothache

When faced with a child with toothache, pulpal or periodontal pathology are the commonest causes. The dentist has to use clinical acumen to try and determine the state of the affected tooth/teeth, as this will decide the Rx required (Table 3.1). To that end the following investigations may be employed:

History Take a pain history (see ➔ Dental pain, p. 222) from the child and parent. Beware of variations in accuracy; anxious children may deny being in pain when faced with an eager dentist, whereas parents who feel guilty for delaying seeking dental Rx may exaggerate pain. Remember some pathology is painless, e.g. chronic periradicular periodontitis.

Examination Swelling, temperature, lymphadenopathy? Intraorally look for caries, abscesses, chronic buccal sinuses, mobile teeth (? due to exfoliation or apical infection), and erupting teeth.

Percussion Can be unreliable in children. Gentle finger pressure first. Care needed to establish a consistent response and compare with unaffected 'control' teeth.

Sensibility testing Using thermal (e.g. ethyl chloride on cotton wool) or electrical stimulation. Again, establish a consistent, reliable response on a 'control' tooth before testing the tooth/teeth in question. Check for false-positives, by altering the intensity of stimulus (e.g. cotton ball with ethyl chloride, followed by a dry cotton ball). Less reliable in primary teeth.

Radiographs Bitewing X-rays may be useful. Not only are they less uncomfortable for small mouths than periapicals, but they also often show the bifurcation area where radiolucency secondary to periodontitis is often first apparent.

Diagnosis Fleeting pain on hot/cold/sweet stimuli = reversible pulpitis. Longer-lasting pain on hot/cold/sweet stimuli &/or spontaneous pain with no initiating factor (? child kept awake) but no mobility, not TTP = irreversible pulpitis. Pain on biting and pressure &/or swelling and tenderness of adjacent tissues, mobility = acute periradicular periodontitis. Remember, the only 100% accurate diagnostic method is histological!

With a fractious child keep examination and operative intervention to a minimum, doing only what is necessary to alleviate pain and win child's trust.

If extractions under a GA are required consider carefully the long-term prognosis of remaining teeth to try and avoid a repeat of the anaesthetic in the foreseeable future.

Other common potential causes of toothache:

- Dentoalveolar trauma (➔ Dental trauma, p. 94).
- Mucosal ulceration (➔ Recurrent aphthous stomatitis (ulcers), p. 416).
- Teething (➔ Abnormalities of tooth eruption and exfoliation, p. 64).

Table 3.1 Management of child with toothache

Diagnosis	Emergency management	Definitive management
Reversible pulpitis	LA Excavate soft caries Restore temporarily with a zinc oxide/eugenol cement. If exposed and vital—dress polyantibiotic paste (e.g. Ledermix®)	Pulpotomy or extraction
Irreversible pulpitis	LA Excavate soft caries Dress polyantibiotic paste. Restore temporarily with a zinc oxide/eugenol or GI cement	Pulpotomy/pulpectomy or extraction
Acute periradicular periodontitis	LA (may not be necessary if loss of vitality is certain) Excavate soft caries until pulp chamber accessed—dress pulp chamber with polyantibiotic paste on cotton wool. Seal with temporary dressing	
Acute periodontitis with facial swelling If: No or mild pyrexia (<38°C) Localized acute erythematous tender soft tissue swelling No significant involvement of 'danger areas' (see below) Not otherwise systemically unwell	Antibiotics and analgesics Ensure adequate fluid intake Establish drainage via tooth (and dress) if possible Review every 24h to ensure resolution	Extraction of tooth (or pulpectomy in selected cases) once acute phase has resolved
If: Significant pyrexia >38°C Poorly localized, spreading infection Systemically unwell: dehydration, lethargy, nausea, and vomiting Swelling involving a 'danger area', i.e. floor of mouth	Aggressive antibiotic Rx (e.g. amoxicillin and metronidazole) Immediate referral to specialist centre	Extraction of tooth &/or intra-/extra-oral drainage

Abnormalities of tooth eruption and exfoliation

Natal teeth are usually members of the 1° dentition, not supernumerary teeth, and so should be retained if possible. Most frequently occur in lower incisor region and because of limited root development at that age, are often mobile. If in danger of being inhaled or causing problems with breast-feeding, they can be removed under LA.

Teething As eruption of the 1° dentition coincides with a diminution in circulating maternal antibodies, teething is often blamed for systemic symptoms. However, local discomfort, and so disturbed sleep, may accompany the actual process of eruption. A number of proprietary 'teething' preparations are available, which usually contain a combination of an analgesic, an antiseptic, and anti-inflammatory agents for topical use. Having something hard to chew may help, e.g. teething ring. Some are designed to be cooled in the fridge, which can enhance their soothing ability.

Eruption cyst is caused by an accumulation of fluid or blood in the follicular space overlying an erupting tooth. The presence of blood gives a bluish hue. Most rupture spontaneously, allowing eruption to proceed. Rarely, it may be necessary to marsupialize the cyst.

Failure of/delayed eruption

► Disruption of normal eruption sequence (see Fig. 3.1) and asymmetry in eruption times of contralateral teeth >6 months warrants further investigation.

It must be remembered that there is a wide range of individual variation in eruption times. Developmental age is of more importance in assessing delayed eruption than chronological age.

General causes Hereditary gingival fibromatosis, Down syndrome, Gardner syndrome, hypothyroidism, cleidocranial dysostosis, rickets.

Local causes

- Congenital absence. Is the most likely cause for failure of appearance of 2 (➔ Hypodontia (oligodontia), p. 66).
- Crowding. Rx: extractions.
- Retention of primary tooth. Rx: extraction of 1° tooth.
- Supernumerary tooth. Is the most likely reason for failure of eruption of 1 (➔ Hyperdontia, p. 66).
- Dilaceration (➔ Dilaceration, p. 72).
- Dentigerous cyst.
- Trauma to 1° tooth leading to apical displacement of 2° incisor.
- Abnormal position of crypt. Rx: extraction or orthodontic alignment. See options for palatally displaced 3 (➔ Palatally displaced maxillary canines, p. 142).
- Primary failure of eruption usually affects molar teeth. The aetiology is not understood. Although bone resorption proceeds above the unerupted tooth, they appear to lack any eruptive potential. Refer for advice, usually extraction only option.

Infraoccluded (ankylosed) primary molars Occur where the 1° molar has failed to maintain its position relevant to the adjacent teeth in the developing dentition and is therefore below the occlusal level of adjacent teeth. Often due to ankylosis secondary to disruption in normal resorptive/repair cycle of exfoliation. This is usually self-correcting (if the permanent successor is present and not ectopic) and the affected tooth is exfoliated at the normal time. However, where the premolar is missing or where the infraoccluded molar appears in danger of disappearing below the gingival level, extraction may be indicated (monitor carefully—if in doubt get a specialist opinion).

Impaction of the upper first permanent molars against the E occurs in 2–5% of children. It is an indication of crowding. In younger patients (<8yrs) many self-correct ('jump'). If still present after 4–6 months ('hold') or in older children, insertion of an orthodontic separating spring may allow the 6 to jump free. More severe impactions should be kept under observation. If the E becomes abscessed or the 6 is in danger of becoming carious then the 1° tooth should be extracted. The resulting space loss can be dealt with later as part of the overall orthodontic Rx plan.

Premature exfoliation Most common reason for early tooth loss is extraction for caries. Traumatic avulsion is less common. More rarely, systemic disease such as neutropenia or leukaemia may result in an abnormal periodontal attachment and thus premature tooth loss. Alveolar bone loss in a young child is a serious finding and warrants referral.

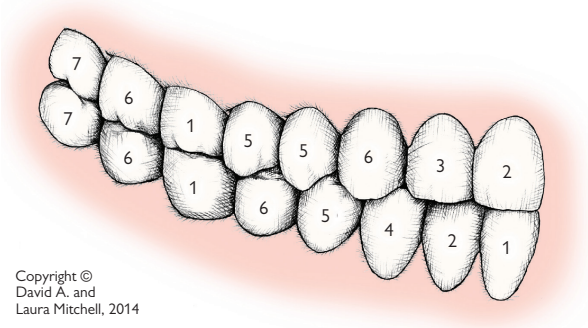

Fig. 3.1 Normal sequence of eruption (permanent dentition).

Abnormalities of tooth number

Anodontia

Means complete absence of all teeth. Rare. Partial anodontia is a misnomer.

Hypodontia (oligodontia)

Developmental absence of one or more teeth.

Prevalence 1° dentition: 0.1–0.9%, 2° dentition: 3.5–6.5%.[2] In Caucasians most commonly affected teeth are 8 (25–35%), $\underline{2}$ (2%), lower 5 (3%). Affects F > M and is often associated with smaller than average tooth size in remainder of dentition. Peg-shaped $\underline{2}$ often occurs in conjunction with absence of contralateral $\underline{2}$ *NB* $\underline{3}$ migrates down guided by the distal aspect of $\underline{2}$. When $\underline{2}$ is absent, peg-shaped, or small-rooted, it is important to monitor the maxillary canine for signs of ectopic eruption.

Aetiology Often familial—polygenic inheritance. Also associated with ectodermal dysplasia and Down syndrome.

- Rx: 1° dentition—none. 2° dentition—depends on crowding and malocclusion.
- $\underline{8}$—none.
- $\underline{\underline{2}}$—see ➔ Management of missing incisors, p. 112.
- $\underline{5}$—(*NB* $\underline{5}$ sometimes develop late). If patient crowded, extraction of $\overline{E}$, either at around 8yrs for spontaneous space closure or later if space is to be closed as a part of orthodontic Rx. If lower arch well-aligned or spaced, consider preservation of $\overline{E}$, and bridgework later.

Hyperdontia

Better known as supernumerary teeth.

Prevalence 1° dentition 0.8%, 2° dentition 2%.[1] Occurs most frequently in premaxillary region. Affects M > F. Associated with cleidocranial dysostosis and CLP. If $ in 1° dentition is followed in about 50% cases by $ in 2° dentition, so warn mum!

Aetiology Theories include: offshoot of dental lamina, third dentition.

Classification either by shape or position (Table 3.2) and orientation (e.g. 'upright, 'inverted', etc.).

2 A. H. Brooks 1974 *J Int Assoc Dent Child* **5** 32.

Table 3.2 Classification of abnormalities by shape and position

Shape	or	Position
Conical (peg-shaped)		Mesiodens
Tuberculate (barrel-shaped)		Distomolar
Supplemental		Paramolar
Odontome		

Effects on dentition and treatment

- No effect. If unerupted keep watch (X-ray occasionally to exclude cystic change/damage to adjacent teeth—both relatively rare). If erupts—extract.
- Crowding. Rx: extract; if supplemental, extract tooth with most displaced apex.
- Displacement. Can cause rotation &/or displacement. Rx: extraction of $ and fixed appliance, but tendency to relapse.
- Failure of eruption. Most likely cause of 1 to fail to erupt. Rx: extract $ and ensure sufficient space for uneruptd tooth to erupt. May require extraction of primary teeth &/or permanent teeth and orthodontic appliance. Then *wait*. Average time to eruption in these cases is 18 months.[3] If after 2yrs unerupted tooth fails to erupt despite sufficient space, may require conservative exposure and orthodontic traction.

3 D. D. DiBiase 1971 *Dent Pract Dent Rec* **22** 95.

Abnormalities of tooth structure

Disturbances in structure of enamel

Enamel usually develops in two phases, first an organic matrix and second mineralization. Disruption of enamel formation can therefore manifest as:

Hypoplasia

Caused by disturbance in matrix formation and is characterized by pitted, grooved, or thinned enamel.

Hypomineralization

Hypocalcification is a disturbance of calcification. Affected enamel appears white, yellow, or brown and opaque. May become more discoloured post-eruptively. Affected enamel may be weak and prone to breakdown. Most disturbances of enamel formation will produce both hypoplasia and hypomineralization, but clinically one type usually predominates.

Aetiological factors (not an exhaustive list)

Localized causes Infection ('Turner tooth'), trauma, irradiation, idiopathic (see ➔ Enamel opacities, p. 74).

Generalized causes

- Environmental (chronological hypoplasia):
  - Pre-natal, e.g. rubella, syphilis.
  - Neo-natal, e.g. prolonged labour, premature birth.
  - Post-natal, e.g. measles, congenital heart disease, fluoride, nutritional.
- Hereditary:
  - Affecting teeth only—amelogenesis imperfecta.
  - Accompanied by systemic disorder, e.g. Down syndrome, tuberous sclerosis.

Chronological hypoplasia

So called because the hypoplastic enamel occurs in a distribution related to the extent of tooth formation at the time of the insult. Characteristically, due to its later formation, 2 is affected nearer to the incisal edge than 1 or 3.

Fluorosis See ➔ Fluoride, p. 28.

Treatment of hypomineralization/hypoplasia depends on extent and severity

Posterior teeth Small areas of hypoplasia can be fissure-sealed or restored conventionally, but more severely affected teeth will require crowning. SS crowns (➔ Stainless steel crowns, p. 86) can be used in children as a semi-permanent measure.

Anterior teeth Small areas of hypoplasia can be restored using composites, but larger areas may require veneers (➔ Veneers, p. 250) or crowns.

Molar incisor hypomineralization (MIH) (Fig. 3.2)

- Aetiology unknown. Prevalence ↑ over the past two decades in developed countries.
- Primarily affects 6s, but ~50% also have defects on permanent incisors.

- Affected 6s have hypomineralized defects of enamel, varying from discoloration to severe enamel dysplasia with post-eruptive breakdown. Sensitivity ↑, 2° caries ↑. Defects may affect anything from one to all 6s.
- Yellow/white opacities on buccal surface of affected incisors. Distribution often asymmetrical. No clear chronological pattern. Inc less prone to enamel breakdown than 6.

Rx options include intracoronal restoration, SS crowns, or extraction (➔ Extraction of poor quality first permanent molars, p. 138). Consider partial composite veneering for incisors.

Amelogenesis imperfecta

Many classifications exist, but generally these are classified by the type of enamel defect &/or the mode of inheritance. There are now known to be >25 mutations in four different genes (*AMELX, ENAM, KLK4, MMP20)* that are associated with AI).[4]

Main types

- *Hypoplastic*—enamel may be thin (smooth or rough) or pitted. Most commonly autosomal dominant inheritance.
- *Hypocalcified*—enamel is dull, lustreless, opaque white, honey, or brown coloured. Enamel may breakdown rapidly in severe cases. Sensitivity ↑, calculus ↑ common. May be autosomal dominant or recessive.
- *Hypomaturation*—mottled or frosty looking white, opacities, sometimes confined to incisal third of crown ('snow-capped teeth').

Usually both 1° and 2° dentitions and all the teeth are affected. The different subgroups give rise to a wide variation in clinical presentation, ranging from discoloration to soft &/or deficient enamel. It is therefore difficult to make general recommendations, but it is wise to seek specialist advice for all but the mildest forms. Rx: in more severe cases, SS crowns and composite resin can be used to maintain molars and 2° inc, prior to more permanent restorations when child is older.

Disturbances in the structure of dentine

Include dentinogenesis imperfecta, dentinal dysplasias (types I and II), regional odontodysplasia, vitamin D-resistant rickets, and Ehlers–Danlos syndrome—all of which are rare.

Dentinogenesis imperfecta (hereditary opalescent dentine)

Is more common affecting 1 in 8000. Both 1° and 2° dentitions are involved, although later-formed teeth may be less so. Main types:

- I—associated with osteogenesis imperfecta.
- II—teeth only.

Affected teeth have an opalescent brown or blue hue, bulbous crowns, short roots, and narrow flame-shaped pulps. The ADJ is abnormal, which results in the enamel flaking off, leading to rapid wear of the soft dentine. Rx: along similar lines as for severe amelogenesis.

4 J. T. Wright *Developmental defects of the teeth* (℞ http://www.dentistry.unc.edu/research/defects/pages/ai.htm).

► Early recognition and Rx of amelogenesis and dentinogenesis imperfecta important to prevent rapid tooth wear.

Disturbances in the structure of cementum

Hypoplasia and aplasia of cementum are uncommon. The latter occurs in hypophosphatasia and results in premature exfoliation. Hypercementosis is relatively common and may occur in response to inflammation, mechanical stimulation, or Paget's disease, or be idiopathic. *Concrescence* is the uniting of the roots of two teeth by cementum.

Fig. 3.2 Upper first permanent molar in a patient with molar incisor hypomineralization, prior to restoration.

Notebox:
Summary points on abnormalities of tooth eruption, number, and structure
(you write here)

Abnormalities of tooth form

Prevalence.[5]

Normal width 1 = 8.5mm, 2 = 6.5mm.

Double teeth

Gemination ccurs by partial splitting of a tooth germ.

Fusion occurs as a result of the fusion of two tooth germs. As fusion can take place between either two teeth of the normal series or, less commonly, with a $ tooth, then counting the number of teeth will not always give the correct aetiology.

As the distinction is really only of academic interest, the term 'double teeth' is to be preferred. Both 1° and 2° teeth may be affected and a wide variation in presentation is seen. The prevalence in the 2° dentition is 0.1–0.2%.

Rx for aesthetics should be delayed to allow pulpal recession. If the tooth has separate pulp chambers and root canals, separation can be considered. If due to fusion with a $ tooth, the $ portion can be extracted. Where a single pulp chamber exists sometimes the tooth can be contoured to resemble two separate teeth or the bulk of the crown reduced.

Macrodontia/megadontia

Generalized macrodontia is rare, but is unilaterally associated with hemifacial hypertrophy. Isolated megadont teeth are seen in 1% of 2° dentitions.

Microdontia

Prevalence 1° dentition <0.5%. In 2° dentition overall prevalence is 2.5%. Of this figure 1–2% is accounted for by diminutive 2. Peg-shaped 2 often have short roots and are thought to be a possible factor in the palatal displacement of 3 (➔ Palatally displaced maxillary canines, p. 142). 8 also commonly affected.

Dens in dente

This is really a marked palatal invagination, which gives the appearance of a tooth within a tooth. Usually affects 2, but can also affect premolars. Where the invagination is in close proximity to the pulp, early pulp death may ensue. Fissure sealing of the invagination as soon as possible after eruption may prevent this, but is often too late. Conventional RCT is difficult and extraction is usually required.

Dilaceration

Describes a tooth with a distorted crown or root. Usually affects 1. Two types seen, dependent upon aetiology (Table 3.3).

5 A. H. Brooks 1974 *J Int Assoc Dent Child* **5** 32.

Table 3.3 Types of dilaceration

Developmental*	Traumatic
Crown turned upward and labially	Crown turned palatally
Regular enamel and dentine	Disturbed enamel and dentine formation seen
Usually no other affected teeth	
Affects F > M	

*D. J. Stewart 1978 *Br Dent J* **145** 229.

The traumatically induced type is caused by intrusion of the 1° incisor, resulting in displacement of the developing 2° incisor tooth germ. The effects depend upon the developmental stage at the time of injury.

Rx: depends upon severity and patient cooperation. If mild it may be possible to expose crown and align orthodontically provided the apex will not be positioned against the labial plate of bone at the end of the Rx, otherwise extraction indicated.

Turner tooth

Term used to describe the effect of a disturbance of enamel and dentine formation by infection from an overlying 1° tooth therefore usually affects premolar teeth. Rx: as for hypoplasia ➔ Hypoplasia, p. 68.

Taurodontism

Of academic interest only, but seems to crop up on X-rays in exams much more frequently than in clinical practice. Means bull-like, and radiographically an elongation of the pulp chamber is seen. Rx: none required.

Abnormalities of tooth colour

Extrinsic staining

By definition this is caused by extrinsic agents and can be removed by prophylaxis. Green, black, orange, or brown stains are seen, and may be formed by chromogenic bacteria or be dietary in origin. Chlorhexidine mouthwash causes a brown stain by combining with dietary tannin. Where the staining is associated with poor oral hygiene, demineralization and roughening of the underlying enamel may make removal difficult. Rx: a mixture of pumice powder and toothpaste or an abrasive prophylaxis paste together with a bristle brush should remove the stain. Give OHI to prevent recurrence.

Intrinsic staining

This can be caused by:

- Changes in the structure or thickness of the dental hard tissues, e.g. enamel opacities.
- Incorporation of pigments during tooth formation, e.g. tetracycline staining (blue/brown), porphyria (red).
- Diffusion of pigment into hard tissues after formation, e.g. pulp necrosis products (grey), root canal medicaments (grey).

Enamel opacities

Are localized areas of hypomineralized (or hypoplastic) enamel. Fluoride (➔ Fluoride, p. 28) is only one of a considerable number of possible aetiological agents.

Treatment Four possible approaches:

Approach 1 Acid pumice abrasion technique is effective for some types of diffuse (surface) enamel defects. Two methods (take pre-op photos to monitor improvement):

Hydrochloric acid technique (quicker, but great care needed)
A mixture of 18% hydrochloric acid and pumice is applied to the affected area using a wooden stick. Careful isolation with rubber dam, use of a neutralizing agent (e.g. sodium bicarbonate) and protection of the soft tissues/patient is essential. The mixture is rubbed into the surface for 5sec and then rinsed away. These two steps are repeated (max. 10 times—removing <0.1mm enamel) until the desired colour change is achieved. The enamel is then polished and a fluoride solution applied.[6]

Phosphoric acid technique (slower but potentially safer)
A number of variations of this technique are in use. A commonly used method is to etch with 30–50% orthophosphoric acid for 1–2min, wash, then use pumice and water slurry with rubber prophy cup for 1min (take care not to overheat the tooth). Wash. Repeat etch and pumice stage ×2, washing between. Dry tooth and apply topical fluoride solution (avoid pigmented varnishes). May be repeated up to ×2, but leave at least 6 weeks before each repeat to check for improvement.

6 T. P. Croll & R. Cavanaugh 1986 *Quintessence Int* **17** 81.

Approach 2 Bleaching → Tooth whitening, p. 248.

Approach 3 Veneers → Veneers, p. 250.

Approach 4 Crowns → Anterior crowns for vital teeth, p. 252.

Notebox:
Summary points on abnormalities of tooth form and colour
(you write here)

Anatomy of primary teeth (& relevance to cavity design)

Primary teeth differ in several respects from permanent teeth, affecting both the sequelae of dental disease and its management (Fig. 3.3).

Thinner enamel (1) Enamel in 1° teeth is ~1mm thick, which is 1/2 that of 2° teeth.

Larger pulp horns (2) The pulp chamber in 1° teeth is proportionately larger, with more accentuated pulp horns. DE—3 pulp horns MB, DB, and palatal. Lower DE—4 pulp horns MB, ML, DB, and DL. These features mean that caries will affect the pulp sooner and there is a greater likelihood of pulp exposure during cavity preparation. Aim for 0.5–1.0mm penetration dentine only, except where caries determines deeper preparation.

Pulpal outline (3) follows the amelo-dentinal junction more closely in 1° teeth, therefore cavity floor should follow external contour of tooth sinuously to avoid exposure.

Narrower occlusal table Greater convergence of the buccal and lingual walls results in a proportionately narrower occlusal table. This is more pronounced in D than E therefore, over-extension of an occlusal cavity or lock can lead to weakening of the cusps.

Broad contact points (4) This makes detection of interproximal caries more difficult, and means that in 1° molars divergence of the buccal and lingual walls towards the approximal surface is necessary to ensure cavity margins are self-cleansing. Isthmus should not extend >1/2 intercuspal distance.

Bulbous crown (5) 1° molars have a more bulbous crown form than 2°, molars, making matrix placement more difficult.

Inclination of the enamel prisms (6) In the cervical 1/3 of 1° molars the enamel prisms are inclined in an occlusal direction so there is no need to bevel the gingival floor of a proximal box.

Cervical constriction (7) is more marked in 1° molars, therefore if the base of the proximal box is extended too far gingivally it will be difficult to cut an adequate floor without encroaching on the pulp.

Alveolar bone permeability This is ↑ in younger children, thus it is usually possible to achieve local anaesthesia of 1° mandibular molars by infiltration alone, up to 6yrs of age.

Thin pulpal floor and accessory canals (8) may explain the greater incidence of inter-radicular involvement following pulp death.

Root form (9) 1° molars have proportionately longer roots than their permanent counterparts. They are also more flared to straddle the developing premolar tooth. The roots are flattened mesio-distally, as are canals within.

Radicular pulp (10) follows a tortuous and branching path, making complete cleansing and preparation of the root canal system almost impossible, although instrumenting canals is often easier than suggested in some texts. In addition, as the roots resorb, a different approach to RCT is needed for the 1° dentition, pure zinc oxide and eugenol being the obturation material of choice.

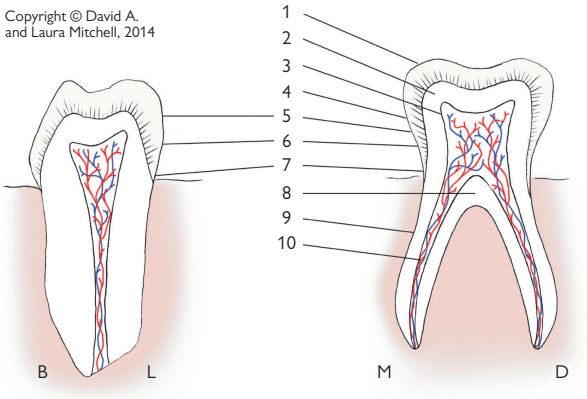

Fig. 3.3 Cross-sections of second deciduous molar showing features of anatomy of primary molars.

Extraction versus restoration of primary teeth

Despite a welcome reduction in the prevalence of dental decay, the dilemma of whether to restore or extract a 1° tooth is still all too familiar. In making a decision a number of factors should be considered:

Age This will influence the likely cooperation for restorative procedures, the expected remaining length of service of the affected tooth, and the severity of sequelae following early tooth loss (as the earlier the tooth is lost, the greater the potential for space loss).

Medical history For patients where recurrent bacteraemia carries ↑ risks (e.g. immunocompromised, risk of endocarditis) it is generally considered that 1° tooth pulp therapy should be avoided, with extraction (taking appropriate precautions where necessary) often being more appropriate. Conversely, in haemophiliacs, extractions should be avoided and 1° teeth preserved, if possible, until their exfoliation. Prevention is particularly important in all such patients.

Motivation and cooperation of parents As it is the parents that bring the child to the surgery, we must explain to them the benefits of maintaining the 1° dentition. Unfortunately, a small proportion of the population may regard a dentist that fills 1° teeth with suspicion—after all, everyone knows that baby teeth fall out!

Extent of caries In a child with an otherwise caries-free mouth every attempt should be made to preserve an intact dentition. Where there is extensive caries, restoration of Es and loss of Ds can be an acceptable compromise.

Pain If a child is suffering pain from one or more teeth, this needs to be alleviated as soon as possible. If symptom-free, then the dentist will have more time to explore the extent of the lesion(s) and the child's cooperation.

Extent of lesion(s) In 1° molars destruction of the marginal ridge indicates a high probability of pulpal involvement.[7] If several 1° molars require pulp therapy, and cooperation/motivation is poor, serious thought should be given to extraction rather than restoration.

Position of tooth Although early loss of 1° incisors will have little effect, extraction of C, D, or E will, in a crowded patient, lead to localization of the crowding. Extraction of Es, particularly in the upper arch, should be deferred, if possible, until the 6 has erupted.

7 M. S. Duggal 2002 *Eur J Paed Dent* **3** 112.

Presence/absence of permanent successor Bear in mind the amount of crowding present and the likelihood of spontaneous space closure.

Malocclusion If still undecided, it is worth considering the occlusion. In a particularly crowded case, restoration of a decayed tooth may be indicated if further space loss would mean that extraction of more than one premolar per quadrant would be required. Much has been written about compensating (same tooth in opposing arch) and balancing (contralateral tooth) extractions, although this is still an area of some controversy.[8] The rationale is that a symmetrical problem is easier to deal with later but if taken to its logical conclusion, gross caries of $\underline{\text{D}}|$ and $\overline{|}\text{E}$ will result in a clearance! In general, loss of Cs in a crowded patient should be balanced to prevent a centre-line shift. Balancing Ds in a child with ↑ risk of caries also has the advantage of removing very caries prone contacts (i.e. E–D and D–C).

So much for the theory; in practice, it should be remembered that a happy and cooperative patient is more important long term. When treating a child under local analgesia leaving extractions unbalanced and monitoring for centreline shift may be preferable to prolonging intervention in the dental chair.

8 W. P. Rock & British Society of Paediatric Dentistry 2002 *Int J Paed Dent* **12** 151.

Local analgesia for children

Although there is no scientific evidence to suggest that 1° teeth are less sensitive than 2° teeth, clinically it is sometimes possible to complete cavity preparation of minimal cavities without LA, especially on 1° anterior teeth. However, Walls et al. found that restorations placed without LA did not survive as long as those where LA was used.[9] Adequate management of approximal caries in 1° molars usually requires LA.

General principles

- Explain to patient in terms they will understand what you are trying to do and why.
- Use flavoured topical anaesthesia (e.g. 20% benzocaine).
- Warm anaesthetic solution to room temperature only.
- Use fine-gauge (e.g. 30-gauge) disposable needle.
- Always have dental nurse to assist.
- Hold mucosa taut. Verbal distraction can help at the moment of needle penetration.
- Use slow rate of injection.
- Warn about post-op numbness and avoidance of self-inflicted trauma (e.g. lip chewing/sucking).

Choice of anaesthetic agent

1st choice Lidocaine 2% with 1:80 000 adrenaline. Maximum dose = 4.4mg/kg.

2nd choice Prilocaine 3% with felypressin (0.03IU/mL)—may give slightly less profound anaesthesia. Maximum dose = 6.6mg/kg.

In both lidocaine and articaine maximum dosage equates to (i) 2.2mL for a healthy 10kg 1.5yr-old child and (ii) 4.4mL for a healthy 20kg 5yr-old (i.e. 1 × 2.2mL cartridge per 10kg). This may need to be reduced for children with certain medical conditions.

Articaine 4% with adrenaline may be used (maximum dose 7mg/kg) and there is some evidence that 1° molar teeth can be more reliably anaesthetized by infiltration alone. However, articaine is not licensed for children <4yrs of age and greater care needed to avoid exceeding maximum dose. Some evidence suggests greater risk of prolonged anaesthesia/paraesthesia when articaine used for ID blocks, so some suggest avoiding the use of articaine for blocks.

Infiltration injection

Used for maxillary teeth, mandibular incisors and lower 1° molars before lower 6 has erupted. After 6yrs of age bone permeability is reduced and an IDB is required (infiltration with articaine may be an alternative). Infiltration technique as for adults (➔ Local analgesia—techniques, p. 608). In children, the malar buttress overlies 6, so it is often advisable to deposit some solution over the more permeable bone mesial and distal to this tooth.

9 A. W. G. *et al.* Walls 1985 *Br Dent J* **158** 133.

Block injection

Inferior dental block Using thumb and forefinger, find the shortest width of ramus. Penetrate about 1cm into lingual tissues from internal oblique ridge, on a line between thumb and finger. An aspirating syringe is essential. *Note*: mandibular foramen is lower on ramus in young children (about same level as occlusal plane).

Posterior superior alveolar block is rarely required in children and carries a significant risk of post-injection haematoma. If necessary due to failure of infiltration for 6, the technique should be modified by depositing solution distal to the zygomatic buttress and massaging it backwards towards the posterior superior alveolar foramen (maxillary molar block).[10]

Alternative techniques

Intraligamentary injection These purpose-designed syringes have an ultra-short needle and a 'gun' or 'pen' appearance. This makes it helpful for children with a needle phobia, or as a more acceptable alternative or adjunct to an IDB. In addition, as the lips and tongue are not anaesthetized it is useful for young or disabled children, in whom there is a greater risk of post-operative soft-tissue trauma.

Jet injection In this technique a jet syringe (e.g. Syrijet® or Injex®) is used to inject LA solution under pressure through mucosa and bone to a depth of about 1cm. Useful for producing soft-tissue analgesia prior to conventional LA injection or for infiltration analgesia, and for some patients who will not contemplate LA using a needle, but not widely used.

Computer-controlled delivery (e.g. The Wand) Allows carefully controlled slow delivery via a line and needle resembling an IV giving set. Especially useful for direct palatal analgesia and for anxious patients.

10 A. K. Adatia 1976 *Br Dent J* **140** 87.

Restoration of carious primary teeth

Making an accurate pre-operative Δ (including appropriate radiographs) and Rx plan is essential. This will enable Rx to be provided as efficiently as possible (Treatment planning for children, p. 58).

Local anaesthesia See Local analgesia for children, p. 80.

Isolation Ideally, rubber dam should be used routinely for all restorative procedures. It not only protects the airway, but also improves moisture control and visibility, and aids in patient management. It is essential for all root canal and pulp therapy for permanent teeth, and advisable for restoration of primary teeth. If placement of rubber dam is not possible, plastic disposable salivary ejectors are better tolerated than the metal flange type.

Instruments

Burs High-speed; pear-shaped bur numbers 330 and 525, and short fissure bur number 541. Slow-speed: a selection of pear-shaped and round burs are most useful. For access use a small bur and for caries removal use the largest round bur which fits into the cavity.

Handpiece A miniature-head handpiece is invaluable. Some children are apprehensive of the aspirator tip, making use of a high-speed, water-cooled handpiece difficult; others find the vibration of the slow-speed handpiece distressing, and may confuse it with pain. In these cases distraction or counting (i.e. 'I will count to thee each time, then I will stop') can help. Occasionally it is possible, but time-consuming, to complete cavity preparation with hand instruments.

Material selection for intracoronal restorations

Amalgam Because of concerns about toxicity and environmental pollution, plus the availability of alternative materials, amalgam is less frequently used. However, it still remains an acceptable and durable material for class I and II restorations in 1° molars.

GI cement Has advantages of adhesion and fluoride release, but is more technique sensitive and less wear resistant than amalgam. Useful in non-load bearing class III and V cavities, temporization of 1° teeth in young, pre-cooperative children, or teeth near to exfoliation.

Resin modified GI cement Has been demonstrated to have excellent performance in 1° teeth.

Compomer A modified composite-type material with some of the properties of GI cement. More technique and moisture sensitive than amalgam, but studies suggest similar longevity.

Composite resin Early studies suggested poor performance in 1° teeth, but modern materials placed with good isolation (i.e. rubber dam) perform as well, or better than amalgam, but take longer to place.

► Plastic, intracoronal restorations perform best in 1° molars with small class I and II cavities. SS crowns (Stainless steel crowns, p. 86) give superior longevity where lesions are more extensive.

Principles of cavity design

Outline form Should include any undermined enamel. Extension for prevention is now outmoded, but any suspect adjacent fissures should be included. Do not cross transverse marginal ridges unless they are undermined.

Caries removal Caries should be excavated from the ADJ first. If necessary, you may need to re-establish outline form to improve access to ensure ADJ is caries free. Then progress to carefully removing caries from floor.

Resistance form/retention form Whilst not as crucial with adhesive materials, ensuring reasonable resistance form is of value in load bearing situations.

Reasons for failure of restorations in primary teeth

- Recurrent caries, often due to failure to adequately complete caries removal because of flagging patient cooperation or failure to use adequate LA. If unable to finish cavity it is better to place a temporary dressing (GIC often best) and try again at another visit.
- Cavity preparation does not satisfy the mechanical requirements of the filling material.
- Inadequate moisture control, especially true of GI cements, compomers, and composites.
- Presence of occlusal high spot.

Many others, but these are the most common.

Useful tips

- Let the child participate by 'looking after' the saliva ejector or cotton wool.
- If the child is nervous give them some control by asking them to signal, e.g. by raising their hand, if they want you to stop.
- If the child's cooperation runs out before the cavity is completed, try and ensure all caries is removed from the ADJ and place a dressing of either zinc oxide or GI cement. This should suffice for several visits, until you are ready to try again.
- Vibration is less of a problem with lower teeth, therefore if possible start with a lower tooth.
- LA is easier in to give in the maxilla, so most advocate starting with an upper tooth.
- Don't try to do too much at 1 visit—plan Rx at a pace the child can accept.

Communication

► It is important to explain to the child what you are doing, and why, in terms they can understand.

It may be helpful to describe some of the instruments we use in ways that can make them seem less threatening to a child ('childrenese') (e.g. see Table 3.4).

Table 3.4 'Unthreatening' names for instruments

Slow-speed handpiece	Mr Buzz/buzzy bee/bumble bee
High-speed handpiece	Mr Spray/wizzy brush/tooth tickler
Handpiece and prophylaxis cup	Electric toothbrush/tooth polisher
Aspirator tip	Vacuum cleaner/hoover
Rubber dam	Tooth raincoat
Saliva ejector	Straw
	Curly-wurly (coiled type only)
Air from 3-in-1	Wind
Fissure sealant	Plastic coating
Etchant solution	Tooth shampoo/cleaner
	Lemon juice
Cotton wool roll	Snowman
Dental light	The sun/car light

Plastic restoration in primary molars

See ➔ Anatomy of primary teeth (& relevance to cavity design), p. 76 for anatomy of 1° molars and effect upon cavity design. Have all necessary instruments and filling materials ready so that appointment is kept as short as possible.

- Explain and show child (and parent) what you are going to do.
- Appropriate LA (➔ Local analgesia for children, p. 80). Waiting for the LA to work is sometimes a good opportunity to deliver/reinforce preventive advice,
- In small cavity gain access with a high-speed handpiece and pear-shaped bur. The outline can then be established and caries removed.
- *Approximal caries*—cut down through the marginal ridge to allow access for caries removal. Ideally should just extend into embrasures and walls of box should converge occlusally (i.e. the box is wider at the base than at occlusal level) (Fig. 3.4).

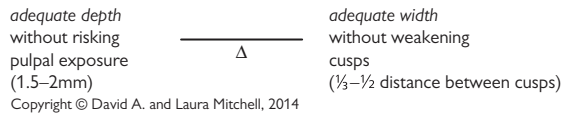

Fig 3.4 Adequate depth and width.

- In larger cavities an excavator or large round bur can be used to start caries removal from the walls. Any undermined enamel should be cut back.
- If caries deep, stop and re-assess whether pulpotomy (➔ Primary molar pulp therapy, p. 91) required. If outline form extends beyond acceptable limits consider an SS crown, especially in class II cavities.
- Check retention and that walls are caries free.
- Wash and dry cavity.
- Line with hard-setting calcium hydroxide if using amalgam.
- Check occlusion.

► Reinforce good aspects of child's behaviour with praise and possibly sticker/badge/toothbrush.

Stainless steel crowns

► SS crowns are the most durable restoration for 1° molars with extensive caries and those where pulp Rx has been performed.

► SS crowns do contain small traces of nickel and are therefore not suitable for patients with a known nickel allergy.

Indications

- Badly broken down 1° molar.
- After pulp therapy in 1° molars.
- As interim measure for 2° molars, where crowns are required but the patient is too young.
- Temporary coverage during preparation of cast crown for premolar or 2° molar.
- Developmental anomalies.
- Severe tooth loss due to bruxism/erosion.

Instruments High-speed tapered diamond bur (e.g. 582) and diamond occlusal wheel. Straight handpiece and a stone. Slow-speed handpiece and burs as required. Crown scissors, dividers, selection of suitable crowns and Adam's pliers. Johnstone contouring pliers (no. 114) and Abel pliers (no. 112) can also be useful, but are not essential.

There are two principal methods for placement:

Conventional technique

SS crowns rely for retention only on a tight adaptation at the gingival margin of the preparation, therefore taper of preparation walls is not critical (Fig. 3.5).

- LA and if possible rubber dam.
- Measure M–D length with dividers to aid crown selection.
- Remove caries.
- Occlusal reduction (~1mm), roughly following cuspal planes.
- Approximal reduction (~20° from vertical) using tapered diamond, without producing a ledge at gingival margin.
- Remove buccal and lingual bulbosities only sufficient to seat crown (often little/no reduction required).
- Select crown. Correct size will be a 'click' fit.
- Check height and occlusion. Minor prematurity is not a problem. If extensive blanching of surrounding tissues or over-extended, trim crown. Usually not necessary.
- Use pliers to adapt contact points and crimp margins. Smooth trimmed margins with stone.
- Cement with zinc polycarboxylate or GI cement.

Technique for 2° molars (Fig. 3.6) is similar but more careful adjustment is necessary.

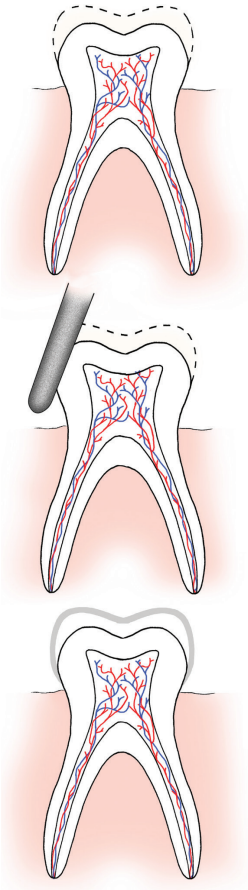

Fig. 3.5 Preparation for stainless steel crown.

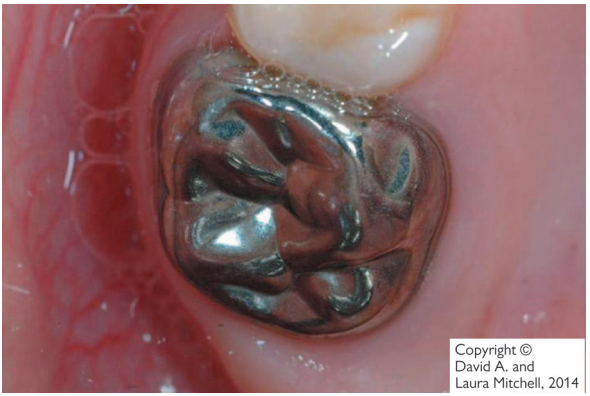

Fig. 3.6 The same tooth as in Fig. 3.2 following placement of a stainless steel crown.

'Hall' technique

In this relatively new technique, no conventional preparation or caries removal is normally carried out. After simply removing any loose debris, a crown is cemented over the carious, unprepared molar. LA is not usually required, with the child 'biting' the cement-filled crown down into place. Advocates of the technique suggest its use is restricted to asymptomatic teeth with no evidence of pulpal inflammation/necrosis/periodontal involvement.

Basic 'Hall' technique

- Separators placed a few days before may aid placement.
- Check carious 1° molar free from obvious pulpal or periradicular pathology.
- Select correct-size crown, fill with a suitable cement (GI is recommended) and place on tooth.
- Get child to bite down on crown, seating it onto the tooth.
- Clear away excess cement
- Crown is likely to be in premature occlusion, but as long as this is not gross, occlusion usually evens out by dento-alveolar compensation within a few weeks.

Success rates

A number of studies have demonstrated that conventionally placed SS crowns have a far superior longevity to other types of restoration in 1° molars. Initial studies of 'Hall' technique SS crowns have also indicated very favourable results probably due to creation of an effective pericoronal seal.[11]

11 N. P. Innes *et al*. 2007 *BMC Oral Health* **7** 18.

Class III, IV, and V in primary teeth

Carious 1° incisors and canines are seen less frequently than molars and are usually indicative of a high caries rate during early infanthood (see 'Severe early childhood caries' ➔ Severe early childhood caries, p. 90).

Management Objectives are relief of pain and prevention. Aesthetics are less important.

Rx options include:

- Extraction.
- Topical 2% sodium fluoride and observation. Intervene if caries progresses.
- Discing (safer to use flat fissure no. 1 bur, than disc) plus topical fluoride.
- Restoration with adhesive materials.

Class III restoration Similar technique to that used for permanent incisors, but omit incisal retention groove.

Class IV restoration If restoration is essential the greater strength of composite is required. Polycarboxylate (strip) crowns are advocated by some paedodontists, for the well-motivated child.

Class V restoration Remove caries with a small round bur and restore with GIC/composite.

Composite strip crowns Cellulose acetate crown forms for primary incisors. Enable restoration of primary incisors using composite resin.

Severe early childhood caries

Aetiology Frequent ingestion of sugar &/or reduced salivary flow.

Nursing bottle or bottle mouth caries Terms used to describe patterns of ECC associated with frequent consumption of a sugar-containing drink, especially from a feeding-bottle Commonly the child falls asleep with the bottle or suckles during the night. Occasionally seen in some cases of prolonged on-demand breast-feeding, especially where children >1yr old suckle frequently during the night, possibly due to the lactose in breast milk.[12] Characteristically, starts with the maxillary 1° incisors, but in more severe cases the first 1° molars are also involved. The mandibular incisors are relatively protected by the tongue and saliva.

Severe ECC may also be associated with the prolonged and frequent intake of sugar-based medications; however, both pharmaceutical companies and doctors are more aware of the problem and the number of alternative sugar-free preparations is increasing. See Table 3.6 for list.

Rampant caries A term with no specific definition, but often used to describe extensive, rapidly progressing caries affecting many teeth in the primary &/or permanent dentition.

Radiation caries Radiation for head and neck cancer may result in fibrosis of salivary glands and salivary flow. Patients often resort to sucking sweets to alleviate their dry mouth, which exacerbates the problem. Management of radiation caries requires specialist referral.

12 G. J. Roberts 1982 *J Dent* **10** 346.

Primary molar pulp therapy

NB Primary molar roots resorb.

Where the carious process has jeopardized pulpal sensibility there are two alternatives: (i) extraction; (ii) pulp therapy.

Indication and contraindications

See ➔ Extraction versus restoration of primary teeth, p. 78.

- Any medical condition where a focus of infection is potentially dangerous is a contraindication to pulp therapy.
- Pulp therapy may be preferable to extraction in children with bleeding disorders.
- Tooth must be restorable following pulp therapy.

Diagnosis of state of the pulp can be difficult, as not only is a child's perception of pain less precise than an adult's, but the clinical picture may also be complicated by death of one root canal whilst the other(s) remain vital.

Indicators of possible pulp involvement

- Breakdown of marginal ridge.
- Symptoms.
- Tenderness to percussion, ↑ mobility, buccal swelling/sinus.
- Inter-radicular radiolucency seen radiographically (usually on bitewings).

Definitions

- Indirect pulp treatment: treatment without exposure of the pulp.
- Direct pulp capping: management of exposure by direct capping—not usually advocated in primary molars due to poor outcomes.
- Pulpotomy: removal of coronal pulp and Rx of radicular pulp.
- Pulpectomy: removal of entire coronal and radicular pulp.

Pulp therapy techniques

Indirect pulp treatment

Indicated for asymptomatic, vital 1° molars with no pulp exposure after removal of all soft caries.

Technique Removal of all soft caries. Leaving carious, but firm, affected dentine in vital, asymptomatic 1° molars has been shown to be reasonably successful. Margins of cavities should be rendered caries free to ensure an adequate coronal seal. Works best in occlusal cavities: less likely to be successful in approximal caries due to early pulpal involvement. Setting calcium hydroxide can be used in the deepest portion, with GIC, composite or SS crown (see Stainless steel crowns, p. 86). If pulp exposure occurs, pulpotomy/pulpectomy are usually more appropriate restorative techniques.

Pulpotomy (for the vital primary molar pulp)

In 1° molars the relatively larger pulps result in earlier pulpal involvement, therefore amputation of the coronal pulp leaving healthy radicular pulp *in situ* (pulpotomy) gives more consistent results than techniques that attempt to retain vitality of the whole pulp, e.g. indirect pulp capping.

Materials The most commonly used medicaments are:

- *Ferric sulfate*—the technique currently recommended by most authorities.[13]
- *Formocreosol*—still used by some, however, recent concerns about the toxicity and potential mutagenicity of formalin-containing compounds has led many authorities to advise against its use where suitable alternatives exist.
- *Calcium hydroxide*—time consuming to use and success not as good as ferric sulfate.
- *MTA (mineral trioxide aggregate)*—initial trials show promise. Very expensive.
- *Devitalizing paste (paraformaldehyde)*—has fallen out of favour (for the same reasons as formocresol).

Success rates >90% for vital pulps.[14]

Technique

- Give LA and place rubber dam.
- Complete cavity preparation and excavate caries.
- Remove roof of pulp chamber.
- Amputate coronal pulp with a large excavator or sterile round bur.
- Wash chamber and arrest bleeding with damp cotton wool.
- Place cotton wool pledget dampened with 15.5% ferric sulfate on exposed pulp stumps for at least 1min, then remove.
- Apply dressing of reinforced ZOE cement.
- Restore tooth, usually with a stainless steel crown (Fig. 3.7).

Problems

- *Necrotic pulp*—proceed with non-vital technique or extract.
- *Profuse haemorrhage*—indicates more serious inflammation of the radicular pulp. Intermediate dressing with Ledermix® followed by non-vital technique or extraction.

13 BSPD 2006 *Int J Paed Dent* **16** (suppl) 16.

14 V. Srinivasan *et al.* 2006 *Int J Paed Dent* **16** 117.

Pulpectomy (for non-vital primary molar pulp)

A pulpectomy is often considered difficult in 1° molars because of the complexity of ribbon-shaped canals (although instrumentation is often easier than some texts might suggest). The risk of damage to the permanent successor also needs to be considered, but if conditions are favourable it is the Rx of choice for non-vital pulps.[15] The technique can be carried out in one or two visits.

- LA and rubber dam.
- Remove the necrotic pulp, locate and file and irrigate canals (sodium hypochlorite 0.1%).
- Cleanse to within 2–3mm of apex, but avoid extending beyond.
- Fill canal with plain ZOE paste, non-setting calcium hydroxide or iodoform paste (e.g. Vitapex®) with a spiral filler.
- Restore with SS crown.

If there is evidence of any infection a two-stage Rx is recommended, leaving non-setting calcium hydroxide in the canals for 1–2 weeks prior to filling.

Success rate >80% at 3 years has been reported.

Pulp therapy for primary anterior teeth

Usual Rx is extraction, as A and B are exfoliated before patient is able to cooperate satisfactorily with more complicated Rx. However, C is exfoliated later and unilateral loss may result in centre-line shift, therefore pulp treatment is indicated for some patients. The root canal morphology is amenable to pulpectomy and the canal should be cleaned using files, with care (remember underlying successor). A resorbable filling material, e.g. calcium hydroxide or ZOE, should be used.

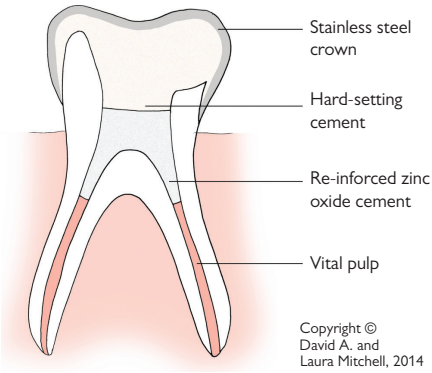

Fig. 3.7 Pulpotomy restored with stainless steel crown.

15 M. D. Duggal & M. E. Curzon 1989 *Dent Update* **16** 26.

Dental trauma

▶ If evidence of head injury, transfer patient to hospital immediately.

Note

- By 12yrs of age 33% of boys and 19% of girls have experienced at least one episode of dental trauma.[16]
- Prognosis ↑ with good immediate Rx, therefore see patient as soon as possible.
- Avulsed permanent teeth should be re-planted immediately.
- Child and parent may be upset, therefore handle accordingly and defer any non-urgent Rx.
- Take good notes for future reference and medico-legal purposes.
- If crown # this will have dissipated most of the energy of impact, therefore root # less likely.

History

Take a structured history as an *aide-mémoire* and for medico-legal purposes.

- Loss of consciousness? Concussion/headache (➔ Assessing head injury, p. 468). Refer immediately to hospital.
- Accompanied by? Parent/teacher? Consider consent issues.
- When? Time interval between injury and Rx affects prognosis.
- Where? Does patient need a tetanus booster? If so, refer to GMP or hospital.
- How? Be alert to the possibilities of other injuries and NAI.
- Tooth fragments? These may have been inhaled or embedded in soft tissues (e.g. lip). If fragment/tooth not accounted for &/or loss of consciousness, a CXR is mandatory.
- PDH—previous trauma may affect prognosis, cooperation in the dental setting.
- PMH—check for bleeding disorder and allergy to penicillin.

Aims of Rx

- 1° *dentition:* (i) preserve integrity of permanent successor; (ii) preserve primary tooth if cooperation good and compatible with first aim.
- 2° *dentition:* (i) preserve vitality of the tooth to allow maturation of the root; (ii) restore the crown to prevent drifting, tilting, and overeruption.

Principles of Rx

Emergency Rx

- Elimination of pain.
- Protection of pulp.
- Reduction and immobilization of mobile teeth.
- Suturing of soft tissue lacerations (IO—3/0 resorbable suture (Dexon®, Vicryl®); EO—refer to hospital).
- ? antibiotics, ? tetanus, ? analgesics, ? chlorhexidine mouthwash.

16 B. Chadwick 2004 *Children's Dental Health in the UK*, HMSO.

Intermediate Rx

- Pulp therapy.
- Consider orthodontic requirements and long-term prognosis of damaged teeth.
- Semi-permanent restorations.
- Keep under review, usually 1 month, 3 months, and then 6-monthly for 2yrs.

Permanent Rx

- Usually deferred until >16yrs (to allow pulpal and gingival recession and ↓ likelihood of further trauma); e.g. definitive crown.

Classification of tooth injuries

Several exist; some use roman numerals, others describe the injuries sustained (WHO system):

- Complicated #—pulp exposed.
- Uncomplicated #—pulp intact.

Prevention

- Prevalence ↑ as the o/j ↑ (>9mm prevalence doubles) ? early orthodontics.
- Mouthguard for sports (vacuum-formed thermoplastic vinyl best, triple thickness).

Be alert for evidence of NAI (➔ Safeguarding children, p. 96).

Safeguarding children

► All professionals involved with children need to be aware of the principles of safeguarding and alert to the possibility of child abuse or neglect.
NB The term 'child abuse' is now favoured over NAI.

The following signs are associated with abuse:
- Usually younger children are involved.
- The presenting injuries may not match the parent's account of how they were sustained. The account may change over time.
- Delay attending at a surgery or clinic for Rx of the injury.
- Bruises/injuries of different vintages are found on examination.
- Ear pinches and frenal tears in children <1yr old are highly suspicious.
- 50% of abused children will have signs on the head &/or neck.

'Child Protection and the Dental Team' is a detailed and practical web-based resource developed by COPDEND/DOH aimed specifically at dentists and other DCPs and can be accessed at: http://www.cpdt.org.uk

Management Local guidelines are produced by Local Safeguarding Children Boards (LSCBs) or Area Child Protection Committees. To find yours type 'LSCB' followed by your area into an Internet search engine. A copy of the local LSCB guidance should be kept in every practice.

If abuse is suspected
- Take a careful history and keep full records.
- Discuss concerns with an experienced/trusted colleague and decide if further action/referral is justified.
- Provide any urgent/emergency dental care.
- Talk to child and parents—tactfully explain your concerns, seeking consent to sharing of information. Rarely, if you feel informing the parents/carers may put the child or others (including yourself) at risk, you may still share information &/or refer if you believe it is in the child's best interests to do so.

Where to get help and advice (tip: write the telephone numbers of the first three on your copy of the local LSCB guidance)
- Child Protection nurse.
- Local consultant paediatrician.
- Social Services.
- Child's health visitor.
- Your defence organization.

Making a referral Referral should be made directly to Social Services and followed up in writing within 48 hours. The child's medical practitioner should also be informed. If a child presents with serious injuries which are suspicious, they should be referred to the nearest accident and emergency department, with the department informed of the situation before the child's arrival.

Tact and understanding is required when dealing with the patient's family. Try to avoid making accusations and concentrate on treating the patient's injuries, expressing the need to refer them on to experts who will be able to fully evaluate the situation and offer appropriate help.

Notebox:
Summary notes on safeguarding and your local policy (you write here)

Injuries to primary teeth

30–40% of 5yr-olds have experienced dental trauma,[17] most frequently at toddler stage. As alveolar bone is more elastic the younger the child, the most common injuries are luxation or avulsion. Crown and root # are relatively rare.

Management

For definitions see ➔ Definitions, p. 104. If X-rays are required, you may have to get parent to hold child and film. Alternatively, try placing a periapical film between the teeth (like an occlusal view) and angle the beam at 45°.

Need to consider the effect of any proposed Rx upon permanent successor.[18] Splinting of 1° incisors is exceedingly difficult and not indicated. When in doubt, extract 1° tooth!

Concussion of tooth Rx: reassurance and soft diet.

Subluxation If tooth near to exfoliation, extract. Otherwise, soft diet (for about 1 week). May become non-vital, therefore keep under observation. Give appropriate advice re possible complications.

Lateral luxation/extrusion Extraction if loose and tooth in danger of being inhaled, or if tooth interferes with occlusion. If crown displaced labially, ↑ risk of damage to underlying 2° incisor.

Intrusion Most common injury (>60%). If X-ray confirms that tooth has been forced into follicle of 2° tooth, extract 1° incisor. Otherwise leave tooth and wait to see if spontaneous eruption will occur (between 1 and 6 months). Unfortunately, pulpal necrosis often follows, necessitating either pulp Rx (➔ Pulp therapy for primary anterior teeth, p. 93) or extraction. Should the tooth fail to erupt, then extraction is indicated. It is prudent to warn parents about possible damage to underlying permanent tooth.

Avulsion Replantation not recommended due to risk of damage to permanent successor.

Crown fracture Rare. Minimal # can be smoothed and left under observation. Larger # either restore with composite &/or RCT if pulp involved, or extract.

Root fracture Provided not displaced and little mobility, advise soft diet and keep under review. If coronal fragment displaced or mobile, extract, but leave apical portion as it will usually resorb.

17 B. Chadwick 2004 *Children's Dental Health in the UK*, HMSO.

18 J. O. Andreasen *et al.* 2007 *Textbook and Color Atlas of Traumatic Injuries to the Teeth*, Blackwell Publishing.

Sequelae of trauma

Primary dentition

Discoloration If tooth becomes grey/reddish in early post-trauma period, pulp may be vital and discoloration reversible.

Greying later indicates pulp necrosis. Yellowing of tooth is suggestive of calcification of pulp—no Rx required.

Ankylosis Rx: extraction to prevent displacement of 2° incisor.

Pulp death Rx: RCT or extraction.

Permanent dentition

In >50% of children <4yrs trauma to 1° tooth affects underlying developing successor.[19] Effect depends upon stage of development, type of injury and severity, Rx, and pulpal sequelae. Can cause hypomineralization, hypoplasia (likelihood ↑ if <4yrs &/or injury more severe), dilaceration, severe malformation, and arrest of development.

19 G. Roberts 1996 *Oral and Dental Trauma in Children and Adolescents*, OUP.

Injuries to permanent teeth—crown fractures

Prevalence: 26–76% of injuries.

Enamel only

For small enamel #, smooth with white stone.

Enamel and dentine

Need to protect exposed dentine, preferably with a hard-setting calcium hydroxide cement and an acid-etch retained composite. If time permits, this can be done with a crown former to restore tooth contour. Keep under review. Veneer or PJC can be considered later. If # near to pulp, treat as for pulp involvement.

Acid-etch composite tip technique

- Place rubber dam, if possible.
- Place hard-setting calcium hydroxide on exposed dentine. No need to bevel enamel.
- Using contralateral tooth as guide, select a cellulose acetate crown former.
- Trim crown former to within 1–2mm of # line.
- Etch enamel for 20sec, wash, and dry.
- Place bonding resin and cure.
- Put sufficient composite and a little extra into crown former and position.
- Allow to cure and remove crown former.
- Trim, using soflex discs.
- Check occlusion.

Enamel, dentine, and pulp

Rx depends upon size of exposure; state of root development (1 root radiographically complete 10–11yrs, histologically 14–15yrs); time since injury and other injuries (e.g. root #). If apex open ↑ blood supply to pulp, therefore likelihood of pulp death ↓. This is advantageous as Rx should be directed towards retaining vitality of radicular pulp to allow root closure to continue. If pulp non-vital, see ➔ Root canal treatment—rationale, p. 330. Otherwise, Rx alternatives are:

Pulp cap

Indications: exposure <1mm; <24h; complete or incomplete root development; pulp still vital. Cover exposure with calcium hydroxide (e.g. Dycal®), and place composite tip. Review vitality.

Partial (Cvek) pulpotomy

Indications: exposure >1mm; >24h; complete or incomplete root development, pulp still vital.

- LA and rubber dam.
- Slightly enlarge access at site of exposure with high speed and amputate pulp to a depth of 2–4mm into healthy pulp tissue.

- Arrest bleeding with sterile, moist cotton wool (usually takes several minutes).
- Cover amputation site with non-setting calcium hydroxide.
- Seal with GI cement.
- Restore crown.

Full coronal pulpotomy

Indications: large, contaminated exposures; long duration; incomplete root development; coronal pulp demonstrates impaired vascularity.

- LA and rubber dam.
- Open up pulp chamber and amputate coronal pulp to cervical construction with sterile bur/sharp excavator.
- Wash with sterile water.
- Place non-setting calcium hydroxide and restore tooth with polycarboxylate or GI cement and composite.
- Leave 6–8 weeks, then review symptoms and vitality. No need to investigate for presence or not of a calcific barrier.
- If tooth becomes non-vital, see ➔ Root canal treatment—rationale, p. 330.

All pulpotomized teeth should be kept under long-term review as pulp necrosis and calcification are common sequelae. Success rates of 72% for cervical pulpotomies and 96% for minimal (Cvek) pulpotomies have been reported.[20]

20 M. E. J. Curzon 1999 *Handbook of Dental Trauma*, Wright.

Root fractures

Prevalence: <10% of injuries to permanent dentition.

- Where root # is suspected, two X-ray views at different angulations in the vertical plane are advisable to improve chances of visualizing the # line.
- The prognosis for this type of injury depends upon whether the # line communicates with the gingival crevice. Actual Rx depends on position of #.

Apical 1/3 Usually no Rx required unless mobility ↑ significantly. However, tooth should be kept under observation as death of coronal 2/3 of pulp may occur. Only need to prepare canal to # line as apical 1/3 usually retains vitality. Prognosis good. If extraction required, apical 1/3 can be left *in situ* to preserve bone.

Middle 1/3 In majority of cases tooth is loosened, therefore rigid splinting advisable to attempt to achieve hard-tissue union of # line. 12 weeks previously advocated, but recent evidence suggests flexible splinting for 4 weeks may give similar outcome.[21] If coronal part not displaced loss of vitality unlikely. Where coronal fragment displaced, re-position, splint, and if loss of vitality occurs, RCT to # line. Calcium hydroxide should be used as an interim dressing to limit inflammation and resorption. Delay in Rx ↓ prognosis. If extraction required, consider leaving apical portion *in situ*.

Coronal 1/3 In this group there is a high risk of direct communication with the gingival crevice, allowing ingress of bacteria into pulp. Where no obvious risk, flexible splinting for a prolonged period (up to 4 months) is advocated.[21] Where the # line extends coronally, emergency Rx is either (i) temporary stabilization or (ii) extraction of the coronal fragment. Definitive treatment usually is extraction of both parts of tooth or, preferably, removal of the coronal fragment, and appropriate RCT of remainder, followed by placement of a dressing which will prevent gingival tissues overgrowing root surface. Can use a temporary post-retained crown, but repositioning of the coronal fragment using a dentine-bonding agent and composite has been described. Permanent Rx is post and core crown.

If # extends below alveolar crest, need improved access for crown fabrication. There are two alternatives shown in Table 3.5.

21 IADT 2007 *Guidelines for Treatment of Injuries to Permanent Teeth* (http://www.iadt-dentaltrauma.org).

Table 3.5 Improving access for crown fabrication

Ostectomy/gingivectomy	Orthodontic extrusion
Gives quicker result	Cervical circumference of crown ↓ compared to contra-lateral tooth
Needs post and diaphragm	Better crown:root ratio
Tend to get perio pocket	Gingival margin migrates with crown
Leads to ↓ gingival width	

For orthodontic extrusion will need either a URA or a sectional FA with an attachment bonded on to labial surface of temporary post and core crown or any available enamel. Gentle forces of 50–100g should be used. When sufficient extrusion has been achieved, retain for at least 3–6 months before fabricating a permanent restoration.

Oblique Provided # does not extend above alveolar crest, can treat as coronal #. Otherwise, consider extraction of coronal portion only, leaving apical portion *in situ* to preserve bone.

Vertical Extraction is often only option.

If tooth extracted, a P/- will need to be fabricated (➔ Treatment planning for patients with missing teeth, p. 264).

Luxation, subluxation, intrusion, and extrusion

Prevalence: 15–40% of injuries.

Definitions

Concussion Injury to supporting tissues of tooth, without displacement.

Lateral luxation Displacement of tooth (laterally, labially, or palatally).

Subluxation Actually means partial displacement, but commonly used to describe loosening of a tooth without displacement.

Intrusive luxation Displacement of tooth into its socket. Often accompanied by # of alveolar bone.

Extrusive luxation Partial displacement of tooth from its socket.

Treatment

Concussion Reassurance and soft diet.

Luxation Need to reposition tooth as soon as possible. Give LA and use fingers to push back into place. Then tooth should be splinted flexibly for 2–3 weeks. If there has been a delay of >24h since the injury, manual reduction is unlikely to be successful. In these cases the tooth can be repositioned orthodontically. If the displaced tooth is interfering with the occlusion an URA, with buccal capping, should be fitted as soon as possible. If root development is complete loss of vitality is a common sequelae following luxation (~70%), leading to inflammatory resorption (➔ Pulpal sequelae following trauma, p. 110). Teeth with immature apices have a much better chance of pulp survival. External or internal resorption and pulp canal obliteration may also occur, therefore keep under review.

Subluxation If minor, no Rx other than advising a soft diet is necessary. If mobile, splint for 1–2 weeks and watch vitality.

Intrusion[22] Teeth with immature roots frequently re-erupt and therefore no immediate Rx is required. Teeth with closed apices have a limited potential for re-eruption and will need orthodontic extrusion. This should be started as soon as possible to facilitate access for RCT. However, if displacement is severe (>6mm intrusion) consider surgical repositioning (whether apex is open or closed). Surgically repositioned teeth require flexible splinting for 1–2 weeks. Pulp death &/or root resorption can ensue rapidly after injury and early pulp extirpation and placement of the calcium hydroxide dressing is advisable. Pulp death is virtually certain in teeth with closed apices, and occurs in 2/3 of immature teeth. Replacement resorption is also a common sequel.

22 M. J. Kinirons (revised 2010) BSPD guideline: *Treatment of Traumatically Intruded Permanent Incisor Teeth in Children* (℞ http://www.bspd.co.uk).

Extrusion The affected tooth should be repositioned under LA with digital pressure and splinted for 1–2 weeks. Again, loss of vitality is a common sequel, so the tooth should be observed for any signs of resorption or pulp death.

If any of these situations occur in conjunction with # of the alveolar bone, the splinting period should be ↑ to 3–4 weeks to aid bony healing. If, however, the socket is comminuted, splinting may need to be extended to 6–8 weeks.

Splinting

Indications

- To stabilize a loosened tooth to allow periodontal healing and improve patient comfort. In order to promote fibrous rather than bony healing (ankylosis), a short splinting time with a flexible splint is recommended: avulsion 7–14 days; luxation <3 weeks; middle third root # 4 weeks.
- To stabilize a cervical-third root # and encourage healing with calcified tissue, flexible splinting for up to 4 months is indicated.

Methods

Direct Constructed on patient. An almost infinite variety has been described, but the following are the most popular:

- Acid-etch splint with composite/acrylic/epimine resin &/or wire.
- Orthodontic attachments and sectional archwire.
- Preformed metal (titanium trauma splint).
- Lone standing teeth can be supported by sling suture.[23]
- Lead foil &/or cement. Useful in Australian Outback, but better alternatives available in most dental surgeries!

Indirect This type of splint is removable, allowing an assessment of mobility or firmness, which may be of value in cases of reimplantation. The more common types are:

- URA with cribs 6|6 and occlusal coverage.
- Vacuum-formed thermoplastic polyvinylacetatepolyethylene 'Essix' type.

However, this approach requires an impression of traumatized mouth and involves some delay (few hours/days) before splint can be fitted, so in practice direct splinting is usually preferred.

Factors affecting choice of splint

- Type of injury and therefore length of time splint required. For example, coronal-third root # will need up to 4 months of splinting, therefore composite and wire splint advisable. For re-planted tooth prolonged splinting should be avoided as may lead to ankylosis.
- Number of teeth injured and availability of uninjured adjacent teeth, e.g. if both 1|1 traumatized and no adjacent teeth full coverage acrylic splint or sling-suture may be indicated.
- Facilities and time available.

23 M. E. J. Curzon 1999 *Handbook of Dental Trauma*, Wright.

Notebox:
Splinting—additional notes
(you write here)

Management of the avulsed tooth

Exarticulation = avulsion. Prevalence: 0–16% of injuries.

Factors affecting prognosis

Success depends upon re-establishment of a normal periodontium.

- *Time from loss to re-implantation*—as PDL cells rarely survive >60min extra-orally, immediate replacement (by whoever is available at the scene) is the Rx of choice.
- *Storage medium*—prognosis saline > milk > water > air (both tap-water and dry storage rapidly damage periodontal cells).
- *Splinting time*—7–10 days flexible splinting. Prolonged splinting may promote ankylosis.
- *Viability of pulp*—seepage of pulp breakdown products into PDL will contribute to the development of inflammatory resorption. Although re-vascularization is possible in a tooth with an open apex which is replaced within 30min, those teeth with closed apices and longer extra-alveolar times should be considered non-vital.

Immediate treatment (if avulsed tooth not already replaced)

- Avoid handling root surface. If tooth contaminated, hold crown and agitate gently in saline.
- Place tooth in socket. If does not readily seat, get patient to bite on gauze for 15–20min.
- Compress buccal and lingual alveolar plates.
- Splint a curved piece of light wire (a light twist-flex SS wire is ideal) to acid-etched enamel of affected and adjacent teeth using temporary crown material as this is less traumatic to remove than composite.
- Prescribe antibiotics, chlorhexidine mouthwash and arrange tetanus booster if necessary.

Intermediate treatment (7–10 days later)

- Review splinting. Stop if tooth appears firm, continue for further week if still mobile. If still mobile after 2 weeks, check nothing has been overlooked, e.g. root # or loss of vitality—in these cases prognosis is poor.
- If apex closed (or tooth with open apex, but extra-alveolar period >30min) extirpate pulp within 7–10 days, clean canal, and place an initial intra-canal dressing of calcium hydroxide. Some advocate an intermediate dressing of polyantibiotic/steroid (Ledermix®) paste placed for 1–2 weeks prior to placement of calcium hydroxide.
- Keep teeth with open apices under close observation, so that at the first sign of pulp death RCT can be instituted. Waiting for radiographic evidence of inflammatory resorption is too late.
- Keep tooth under review.

Prognosis

If described procedure followed, medium-term survival is relatively good[24] but long-term survival is generally poor.

- Incomplete root formation: 60% survive 5yrs.
- Complete root formation: 80% survive 5yrs.

Long-term survival is closely related to extra-alveolar dry-storage time. Teeth stored dry for >30min have a very poor long-term prognosis, but replantation may still be worthwhile, as failure is usually by replacement resorption which is slow (i.e. tooth may last several years) and maintains bulk of alveolus (facilitates future prosthetic replacement).

Where prognosis is deemed to be poor, premolar transplant can be considered at 10–12yrs old.

Sequelae

Surface resorption occurs as a result of minor trauma to PDL cells. Usually is self-limiting and affected areas are repaired by cementum. No Rx.

Replacement resorption (ankylosis) caused by damage to PDL cells during extra-alveolar period and promoted by prolonged splinting. It appears that the absence of vital periodontal ligament allows resorption of the root and replacement by bone. In growing child results in infra-occlusion of affected tooth. Once started is usually progressive, resulting in the eventual loss of the tooth.

Inflammatory resorption Development is dependent upon the presence of both damage to the periodontal ligament and breakdown products from pulp necrosis diffusing through the dentinal tubules to the PDL. Occurs rapidly, as soon as 1–2 weeks after injury. Once evident radiographically prognosis is poor, as it is progressive and Rx is not always successful. Inflammatory resorption can be prevented by extirpation of the pulp as soon as is practicable after injury and placement of non-setting calcium hydroxide. If resorption is halted a GP root filling can be placed.

Delayed presentation Where viability of PDL cells doubtful, Andreasen has suggested chemical Rx of the root surface with fluoride to limit resorption.[24] Following RCT with GP, the tooth is immersed in 2.4% sodium fluoride solution for 20min. Then tooth is replanted and splinted for 6 weeks. As some replacement resorption is inevitable, perhaps best limited to adults. If the extra-alveolar period is >24h, leave and consider instead whether the resulting space should be maintained with a P/- (➔ Treatment planning for patients with missing teeth, p. 264).

24 J. O. Andreaen 1992 *Atlas of Replantation and Transplantation of Teeth*, Mediglobe.

Pulpal sequelae following trauma

Damage to the pulp can occur as a result of disruption of the apical vessels or exposure of the pulp by a crown or root #, or be caused by haemorrhage and inflammation of coronal pulp, resulting in strangulation.

Pulp death

Remember that no response to vitality testing indicates damage to the nerve supply of a tooth, but not necessarily to the blood supply. Therefore following trauma, you should assess vitality in the light of symptoms, tooth colour, mobility, presence of buccal swelling, and radiographic evidence. Except where a tooth has been replanted, it is best to adopt a 'wait and see' approach if in doubt about vitality. When pulp death has occurred, subsequent Rx depends upon whether the apex is closed or open.

RCT of teeth with immature apices

As achievement of an apical seal is difficult in a tooth with an open apex, Rx should aim to produce apexification (i.e. a hard-tissue barrier across the apex). Under rubber dam, the necrotic pulp should be extirpated. The working length is set 1–2mm short of the radiographic apex (unless vital pulp tissue is encountered earlier) and narrow files are used in order to negotiate any undercuts. The canal should then be filled with a radiopaque non-setting calcium hydroxide (e.g. Hypocal™ or Ultracal®) to the apex and sealed. The calcium hydroxide should be replaced every 3 months, until a calcific apical barrier is detectable by gentle probing with a paper point. The average time for a calcific barrier to be formed is 9 months.[25] Then the canal can be filled. Usually, because of the width of the canal, a large GP point (a conventional point upside down) can be used. This should be warmed in a flame before pressing into place and then lots of laterally condensed points used to obtain a good seal. Alternatively, thermoplasticised GP (e.g. Obtura®) can be used. A 5yr survival rate of 86% has been reported[26] but many teeth will fail eventually secondary to cervical root fracture. This probably results from weakening of the tooth due to large access cavity and brittleness of dentine which may be associated with long-term dressing with calcium hydroxide. Some now advocate MTA as an alternative to calcium hydroxide, allowing obturation to be achieved more quickly over fewer visits.

Resorption

Commonly seen after avulsion, luxation, intrusion, or extrusion.

Internal resorption is associated with chronic pulpal inflammation, which results in resorption of dentine from the pulpal surface. Is progressive, therefore the pulp needs to be carefully extirpated. Dressing the tooth with calcium hydroxide appears to help arrest the resorption and once controlled, a GP filling may be placed. If perforation has occurred the prognosis is ↓ considerably. Raising a flap, removal of granulation tissue, and direct repair can be attempted.

25 I. C. Mackie & V. N. Warren 1988 *Dent Update* **15** 155.

26 I. C. Mackie *et al.* 1993 *Br Dent J* **175** 99.

External resorption Three types are seen: surface (transient), replacement, and inflammatory. Replacement resorption is usually 2° to irreversible damage to the cementum, leading to ankylosis (usually associated with a high percussion note). Replacement resorption is usually progressive, is not influenced by endodontic therapy, and eventually leads to the root being replaced by bone. Inflammatory resorption is frequently related to pulp necrosis and can often be halted by appropriate endodontic management.

Root canal calcification

Occurs in 6–35% of luxation-type injuries. Prophylactic endodontic Rx is not necessary as pulp necrosis occurs in only 13–16% of cases. A high rate of success (80%) has been reported for subsequent RCT, despite a hairline or no root-canal detectable on X-ray.

Notebox:
Summary notes on dental trauma and management (you write here)

Management of missing incisors

1 Rarely congenitally absent; usually lost following trauma or because of dilaceration.
2 Congenitally absent in ~2% of population (with ↑ likelihood of displacement 3). May also be lost following trauma.

Missing upper anterior teeth are noticed by the general public before other types of malocclusion. The aim of Rx is to provide 321|123 smile. Although Cary Grant did well enough with a missing upper central incisor, symmetry is usually preferable. The management of missing incisors involves either recovery or maintenance of space for prosthetic replacement, or orthodontic space closure. Previous studies have shown that patients were more satisfied with space closure than prosthetic replacement;[27] however, with the introduction of implants and newer materials this may change.

For each patient a number of factors need to be considered:

Skeletal relationship In a class III case, space closure in the upper arch could compromise the incisor relationship, whereas in a class II/1 it would facilitate o/j ↓. Consider also the vertical relationship, as space closure is easier in patients with ↑ LFH and vice versa in ↓ LFH.

Crowding/spacing In a patient with no crowding, space closure is difficult and requires prolonged retention. Before opening space it is important to ensure that sufficient will be available at the end of Rx for an adequate prosthetic replacement (minimum width for implant to replace 2 is 6.5mm). A Kesling set-up may be useful.

Colour and form of adjacent teeth Although much can be done with veneers, composite additions and grinding, if 3 is significantly darker &/or caniform in shape, it will be difficult to turn it into convincing 2 if space closure planned. 2 can only be used to mimic 1 if root length and circumference at gingival margin are not significantly smaller.

Inclination of adjacent teeth The final axial inclination of the teeth will determine the aesthetics of the finished result.

Buccal occlusion If a good Class I buccal interdigitation exists this may C/I bringing the posterior teeth forward to close space.

Unilateral loss A symmetrical result is more pleasing, therefore maintenance or opening of space is preferable. If a 2 is missing and the contralateral tooth is peg-shaped, thought should be given to extracting this tooth to achieve symmetry.

27 S. Robertsson & B. Mohlin 2000 *Eur J Orthod* **22** 697.

Smile line If the patient has a high smile line then need to consider gingival level. In some cases may need gingival surgery.

Patient's wishes and cooperation Only after assessing the earlier listed factors can the patient be given an informed choice. If the patient refuses fixed appliances this may alter the Rx plan.

Kesling set-up Requires duplicate models of both arches, including at least two of the upper arch. Using a small hacksaw, the teeth which will require orthodontic movement are removed from the model and repositioned using wax. As many alternatives as desired can be tried to find the best result.

Space closure In the presence of crowding elsewhere in the arch, this can be facilitated by early extraction of the primary teeth on the affected side; therefore the earlier the decision is made to close space, the better. Active space closure requires FA to achieve correct axial inclination. It is sometimes better to carry out any masking procedures before orthodontic Rx, e.g. contouring 3 to resemble 2 (by removal of enamel incisally, interproximally and from the palatal aspect &/or composite addition) as this will facilitate final positioning and occlusion. Retain with a bonded retainer.

NB The average difference in width between 3 and 2 is 1.2mm, which can easily be removed mesially and distally from 3.

Space-maintenance/opening If an incisor is selectively extracted and space maintenance is desired, a P/- or acid-etch bridge should be fitted immediately. Where 2 congenitally missing, space may need to be opened orthodontically with FA. Some advocate encouraging the 3 to erupt adjacent to the 1 and then retracting it to open space to give better bone levels for implant or bridge. Following space opening, retention with a P/- for 3–6 months is advisable to allow the teeth to settle. If an acid-etch retained prosthesis is planned, ensure that there is sufficient room occlusally for the wings.

Resin bonded bridge See ➔ Resin-bonded bridges, p. 278.

Transplantation of a lower premolar into the socket of an extracted incisor can be considered if lower arch is crowded.

Implant when growth complete (➔ Implantology, p. 316).

Common childhood ailments affecting the mouth

▶ Refer any patient with an ulcer that doesn't heal within 3 weeks or with any soft-tissue lesion of unknown aetiology.

See Chapter 10.

Most common disease is gingivitis (see Chapter 5).

Viral

Primary herpetic gingivostomatitis Occurs >6 months of age. Symptoms: febrile, cervical lymphadenitis, vesicles → ulcers on gingiva and oral mucosa. Rx: soft diet with plenty of fluids. Self-limiting, lasts for ~10 days.

Secondary herpes labialis Vesicles form around the lips, and crust. Self-limiting, but 5% aciclovir cream will speed healing.

Hand, foot, and mouth disease Rash on hands and feet plus ulcers on oral mucosa and gingiva. Little systemic upset. Self-limiting.

Herpangina Febrile illness with sore throat due to ulcers on soft palate and throat. Usually lasts about 3–5 days. Rx: soft diet.

Warts Check hands. Usually self-limiting.

Also chickenpox (vesicles → ulcers), mumps (inflamed parotid duct), glandular fever (ulcers), measles.

Bacterial

Impetigo Very infectious staphylococcal (&/or streptococcal) rash. Starts around mouth and may be mistaken for 2° herpes.

Streptococcal sore throat Can contract associated streptococcal gingivitis (rare as hen's teeth!).

Necrotizing ulcerative gingivitis Rare <16yrs (➔ Necrotizing periodontal diseases, p. 193).

Fungal

Candida Commensal of the mouth, which may become pathogenic when oral environment favours its proliferation. Two types of manifestation are seen in children. (i) Acute pseudo-membraneous candidiasis (thrush). Seen in newborn, under-nourished infants after prolonged use of antibiotics or steroids. Presents as white patches that rub off. Rx: miconazole (24mg/mL) and correct underlying problem. (ii) Chronic atrophic candidiasis. Most commonly URA and poor OH &/or high sugar intake. Rx: OHI for appliance and teeth. Chlorhexidine mouthwash or miconazole gel.

Miscellaneous

Aphthous ulceration See ➔ Recurrent aphthous stomatitis (ulcers), p. 416.

Common causes of oral ulceration in children

In order of frequency: aphthous; trauma; acute herpetic gingivostomatitis; herpangina; hand, foot, and mouth disease; glandular fever.

Common causes of soft-tissue swellings in children

Abscess; mucocele; eruption cyst; epulides; papilloma.

▶ Oral cancer does occur in children, therefore if in doubt refer for biopsy.

Sugar-free medications

The potential cariogenic effect of long-term medication sweetened with sugar is now well-recognized. Therefore sugar-free preparations should be prescribed whenever possible. Unfortunately, there is no evidence that rinsing out or brushing the teeth after use of a sugar-based medicine will significantly ↓ the incidence of caries. Current medical advice is for liquid medicines to be given to children by disposable syringes. This approach has the advantage that an accurate dose can be directed at the back of the mouth.

Table 3.6 is a list of some sugar-free medicines. It is not exhaustive and where required reference should be made to the *British National Formulary*.

Table 3.6 Sugar free medicine

Analgesics	
Aspirin (>12yrs)	Dispersible aspirin tablets
Paracetamol	Disprol® paediatric
	Panadol® soluble
Paracetamol and codeine	Paracodol® dispersible tablets
	Solpadeine®
Ibuprofen	Ibuprofen oral suspension SF
Antacids	
Aluminium and magnesium	Mucogel®
	Maalox® suspension
Cimetidine	
Ranitidine	Zantac® dispersible tablets
	Zantac® suspension
Anticonvulsants	
Carbamazepine	Tegretol® liquid
Phenobarbital	Phenobarbital elixir 30mg/10mL
Sodium valproate	Epilim® crushable tablets/elixir
Anti-infectives	
Aciclovir	Zovirax® suspension
Amoxicillin	Amoxil® sachets SF
Amphotericin	
Ampicillin and cloxacillin	
Erythromycin	
Miconazole	Daktarin® oral gel

Respiratory agents	
Salbutamol	Salbutamol syrup
	Ventolin® syrup
Miscellaneous	
Folic acid	Lexpec® syrup
Iron edetate	Sytron®
Vitamins A, B, C, D, and E	

Notebox:
Summary points for paediatric dentistry (you write here)