Anaesthesia for paediatric dentistry

Lola Adewale MBChB DCH FRCA

Revalidation
FOR ANAESTHETISTS
RCA Revalidation matrix
Matrix reference 2D02, 3D00

Key points

All children requiring dental treatment should be assessed before operation in order to determine the most appropriate form of pain and anxiety management. Adequate patient preparation is particularly important before the use of general anaesthesia.

Management of the airway requires careful consideration and may present specific problems when a nasal mask is used with the child in the sitting position.

A throat pack is often required and must be carefully positioned and always removed after the surgical procedure has been completed.

Conscious sedation may be used as an alternative to general anaesthesia for dental treatment in older children.

Local anaesthetic techniques are often used for paediatric dentistry, either alone or in combination with general anaesthesia or sedation.

Lola Adewale MBChB DCH FRCA
Consultant Paediatric Anaesthetist
Birmingham Children's Hospital
Steelhouse Lane
Birmingham B4 6NH
UK
Tel: +44 (0)121 333 9623
Fax: +44 (0)121 333 9621
E-mail: lola.adewale@bch.nhs.uk
(for correspondence)

Dental treatment is one of the most common reasons for administering general anaesthesia to children. Most operative paediatric dentistry is carried out to treat dental caries, which is a preventable disease of the mineralized tissues of the teeth. Dental treatment may involve the restoration of teeth, extraction or surgical removal of teeth that cannot be restored, and scaling of teeth to prevent periodontal problems. In children, these procedures are often associated with a significant amount of pain and anxiety, for which pharmacological behaviour management is required.

Human dentition

When complete, the primary (deciduous) dentition consists of 20 teeth, while there are 32 permanent (succedaneous) teeth. The most commonly used dental identification system divides the dental arch into four quadrants. All primary central incisors are designated tooth 'A' and followed posteriorly in alphabetical order, so that the primary second molars are designated tooth 'E'. The permanent central incisors are designated tooth number '1' and are similarly followed posteriorly in numerical order to tooth number '8', which is the third molar or 'wisdom tooth' (Figures 1 and 2).

Perception of pain in children

Children's perception of pain is related to cognitive development.[1] Before the age of 2 yr, a child is generally unable to distinguish between pressure and pain. Because of this, all forms of dental treatment will usually require general anaesthesia for these younger children. Between the ages of 2 and 10 yr, a child may be able to understand the sensation of pain and differentiate it from other sensations such as pressure or vibration. Nevertheless, many dental procedures will still require general anaesthesia in this age group. Children over the age of 10 yr are more likely to have the ability to think abstractly and respond appropriately to explanations. Children in this age group may therefore be able to cooperate with dental treatment performed under local anaesthesia, with or without sedation. A child's ability to cope with dental treatment is also influenced by other factors such as fear, family learning, and previous experiences of pain.[2]

Pharmacological behaviour management

Pharmacological management of the pain and anxiety associated with paediatric dentistry includes:

(i) general anaesthesia;
(ii) sedation (i.v., transmucosal, oral, inhalation);
(iii) local anaesthesia.

The most appropriate method of management is determined by factors such as the cognitive development and medical status of the child, and also the complexity of the proposed dental surgical procedure.

General anaesthesia

Indications for general anaesthesia

General anaesthesia may be required for paediatric dentistry in circumstances where:

- the use of local anaesthesia is either contraindicated, or inappropriate due to the presence of acute orofacial infection;
- there has been previous failure of local anaesthesia or sedation;
- the patient is unable to cooperate with the proposed treatment due to immaturity, disability, or language difficulties;
- the patient suffers from a psychological disorder such as severe anxiety;
- extensive treatment is required.

Venue and facilities for general anaesthesia

General anaesthesia for paediatric dentistry should only be administered within a hospital setting.[3] The Department of Health in England defines a hospital setting as being at least

doi:10.1093/bjaceaccp/mks045 Advance Access publication 7 August, 2012

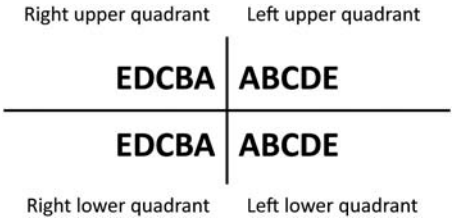

Fig 1 Primary/deciduous dentition. A, incisor; B, incisor; C, canine; D, molar; E, molar.

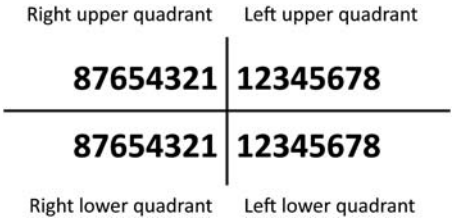

Fig 2 Permanent/succedaneous dentition. 1, incisor; 2, incisor; 3, canine; 4, premolar; 5, premolar; 6, molar; 7, molar; 8, molar.

equivalent to that of a hospital within the NHS, including clinics and day-care facilities associated with those institutions, where the following criteria are also satisfied:

- Surgery or procedures which involve the use of general anaesthesia, with or without local anaesthesia, are regularly undertaken.
- Trained personnel are immediately available to assist the anaesthetist with the resuscitation of a collapsed patient.
- Facilities and staff are present to support and maintain a collapsed patient pending recovery or supervised transfer to a critical care facility that may, in some instances, be on a separate hospital site.[4 5]

The availability of anaesthetic and resuscitation equipment should be in accordance with guidelines published by the Royal College of Anaesthetists,[6] and the use of perioperative monitoring should comply with standards published by the Association of Anaesthetists of Great Britain and Ireland.[7]

Conduct of general anaesthesia

Children who require general anaesthesia for dental treatment should receive the same standard of care as those who require general anaesthesia for any other procedure. For the majority of patients, dental extractions, restorations, or both may be performed as day-case procedures. In-patient care may be required for children with co-existing medical conditions such as cardiac disease or coagulation disorders. Other conditions requiring special consideration include anatomical or functional abnormalities of the airway, congenital syndromes such as epidermolysis bullosa, or conditions associated with increased anaesthetic risk, such as the mucopolysaccharidoses.

Preoperative assessment and preparation

As for all episodes of paediatric anaesthesia, the aim should be to ensure that the child is in the best possible physical and psychological condition to undergo the dental procedure.

Assessment of children before general anaesthesia should ideally take place during a separate hospital visit, and incorporate dental, medical, and preliminary anaesthetic assessments. This may, however, be precluded in urgent clinical cases, or where there are geographical or social limitations. The treatment plan for the child should be confirmed and the various options for the proposed treatment should be discussed with the parent/carer(s) and the child (where appropriate). In particular, the risks of general anaesthesia should be discussed before obtaining informed consent. Relevant information, such as fasting instructions, pain management, and arrangements after discharge home, should also be provided at this stage.[8 9]

A comprehensive medical history should be obtained, followed by a physical examination and appropriate clinical investigations, including dental radiology. The involvement of play therapists and child psychologists should also be considered at this stage because, in some cases, such preparation might obviate the need for general anaesthesia. Management strategies for the uncooperative child should be discussed with the parent/carer(s) and clarified before operation.

Anaesthetic assessment

On the day of the procedure, an anaesthetist must review the child before operation in order to determine the child's fitness for general anaesthesia, and also to identify any condition(s) that may potentially complicate the process of general anaesthesia. In particular, the child's airway should be carefully assessed to allow planning for intraoperative airway management. The presence of facial swelling, due to either dentofacial infection or trauma, is of particular significance as this may limit mouth-opening.

Premedication

Preoperative application of topical local anaesthetic creams (e.g. Ametop®, EMLA®, LMX4®) may facilitate i.v. cannulation. Premedication with oral analgesic agents, such as paracetamol, ibuprofen, or both, is useful for the treatment of pain associated with paediatric dentistry, and should be administered ~1 h before general anaesthesia.

Many paediatric dental patients may have special needs, requiring specific preoperative arrangements, including sedative premedication. Midazolam is effectively administered via the oral, buccal, or intranasal routes.

Management of the uncooperative child

It is common for children to refuse general anaesthesia for dental treatment. This refusal may be a reflection of fear, anxiety, obstinacy, lack of understanding, or the child's genuine belief that the

procedure is not in their best interest.[10] The use of physical restraint in the management of an uncooperative child is considered to be a major infringement of the individual's right to civil liberty and the decision to proceed with treatment should be based on the following guiding principles:

(i) first do no harm;
(ii) act in the best interests of the child;
(iii) respect the child's right to refuse.

It is important to remember that, in most cases, the child will not die if the dental procedure is not performed at that particular time, although it is recognized that there are situations where the patient may suffer undue pain and distress if treatment is not provided as planned.[11,12]

Induction of anaesthesia

Whenever general anaesthesia is administered, clinical observation of the patient should be supplemented by core standards of monitoring that allow the physiological state of the patient, the depth of anaesthesia, and the function of the anaesthetic equipment to be assessed. These standards of monitoring should be uniform irrespective of the duration, location, or mode of general anaesthesia.

The induction of general anaesthesia may occur via the inhalation route typically using sevoflurane, or the i.v. route, using an agent such as propofol. Regardless of the method of induction, i.v. access should be considered in all cases and obtained at the earliest possible opportunity. If problems with the airway are anticipated, the anaesthetic technique used should allow the maintenance of spontaneous ventilation. Antisialagogue agents (e.g. atropine, glycopyrrolate) administered at induction may be useful to control excessive secretions.

Unless specifically advised by a cardiologist, antibiotic prophylaxis against infective endocarditis is no longer indicated for children with cardiac lesions who undergo dental procedures.

Intraoperative management

Intraoperatively, the main considerations are the 'shared airway' and the potential presence of blood or debris in the pharynx. The airway device used is usually determined by the anaesthetic assessment and the nature and length of the planned surgical procedure.

Uncomplicated dental extractions are commonly performed using a nasal mask (Fig. 3). Nasal masks are designed to fit over the nose, allowing the dental surgeon to have full access to the mouth during general anaesthesia. The patient is usually managed in the sitting position, which offers the dental surgeon access to all the teeth, with a theoretically reduced risk of blood and debris being aspirated from the oropharynx. However, this position is associated with decreased venous return from the lower part of the body, which may lead to a reduction in cardiac output. It is therefore essential that the patient can be quickly placed in the supine position, should the need arise. Spontaneous ventilation is maintained using inhalation anaesthesia, most commonly with sevoflurane in oxygen

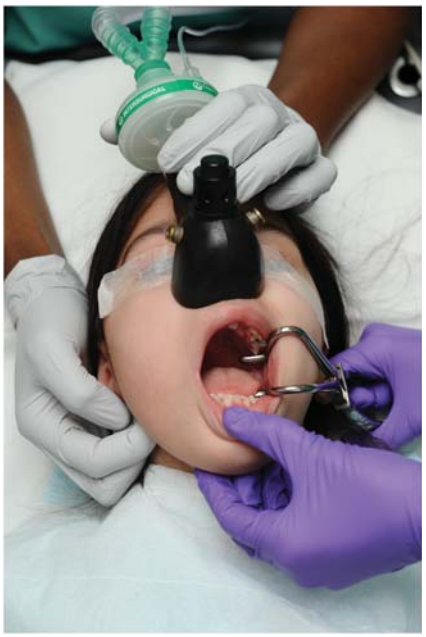

Fig 3 Child in the sitting position with nasal mask and Ferguson mouth-gag in use. Figure reproduced with the consent of the patient's mother.

Fig 4 Flexible LMA *in situ* with throat pack and McKesson mouth-prop. Figure reproduced with the consent of the patient's mother.

combined with air or nitrous oxide. The airway is maintained by performing a jaw thrust, which may also be augmented by the dental surgeon pulling the mandible forward during the extraction of teeth from the lower jaw. A pharyngeal pack is usually positioned by the dental surgeon in order to prevent mouth-breathing and to protect the airway from soiling. A Ferguson mouth-gag or McKesson mouth-prop is then used to maintain mouth-opening during the dental extractions. The pharyngeal pack should always be removed before emergence from general anaesthesia.

A laryngeal mask airway (LMA) is often used for longer procedures, such as surgical extraction of impacted teeth. This device may be used for spontaneous or controlled ventilation. The flexible LMA is sometimes more difficult to insert in children; however, the reinforced tubing of this device provides more versatility and allows better access to the teeth (Fig. 4).

Fig 5 Nasal tracheal tube *in situ* with retractors and McKesson mouth-prop. Figure reproduced with the consent of the patient's mother.

Although the LMA protects the larynx from the contents of the oropharynx to some extent, a throat pack is sometimes still required to absorb any blood or particulate matter that may result from the surgical procedure. Displacement of the LMA may occur after insertion of the throat pack or positioning of the mouth-gag/mouth-prop.

More extensive dental surgery, such as the extraction of wisdom teeth, may require tracheal intubation (Fig. 5). The nasal route is preferred by some dental surgeons, since this provides unobstructed access to all four quadrants of the mouth, facilitating the assessment of tooth alignment and occlusion (bite). Tracheal intubation via the oral route may be used when nasal intubation is contraindicated, or to avoid trauma to the adenoidal tissue in younger children. Pre-formed oral (RAE®) tubes are particularly useful when access is required to either side of the mouth.

After the induction of anaesthesia, tracheal intubation may be facilitated by using a neuromuscular blocking agent or a short-acting opioid agent such as remifentanil or alfentanil. This is usually followed by controlled ventilation using either a volatile agent or a target-controlled i.v. infusion of propofol to maintain general anaesthesia. Alternatively, a spontaneously breathing technique for tracheal intubation may be used, using sevoflurane in oxygen with or without nitrous oxide. The latter would be the method of choice for patients with limited mouth-opening or other features suggestive of difficult tracheal intubation, particularly if fibreoptic intubation is required.

After tracheal intubation, a throat pack is usually inserted to protect the airway from soiling. This may cause airway obstruction if positioned incorrectly. The National Patient Safety Agency advises that whenever a throat pack is inserted, there should be visual and documented evidence of its presence. There should also be a clearly established procedure to ensure that the throat pack is always removed at the end of the procedure, before the patient's emergence from general anaesthesia.

Uncomplicated dental extractions and other short dental procedures are usually associated with levels of pain that are adequately treated with paracetamol, non-steroidal anti-inflammatory agents (NSAIDs), or both. These may be administered before operation, intraoperatively, or after operation. Opioid analgesics are not usually required for such procedures; however, codeine may be indicated for persistent postoperative pain, or when paracetamol or NSAIDs are contraindicated. Longer, more complex dental procedures may require the intraoperative administration of opioid analgesics, such as fentanyl, morphine, or both. The use of remifentanil by intraoperative infusion contributes to haemodynamic stability, particularly for complicated surgical extractions or when total i.v. anaesthesia is used. However, there is an associated risk of apnoea when this drug is administered to the spontaneously breathing patient.

Anti-emetic agents, such as ondansetron, dexamethasone, or both, may be indicated for certain patients and should always be considered whenever opioid analgesics are administered. Dexamethasone has additional anti-inflammatory effects and has been demonstrated to reduce the swelling associated with some dental surgical procedures.

During the course of many dental procedures, the surgeon will infiltrate a solution of local anaesthetic agent combined with a vasoconstrictor. This has the primary function of improving haemostasis, and may also contribute to postoperative analgesia.

Postoperative management

After completion of the procedure and removal of the throat pack, suction should be applied to the oropharynx, under direct vision where possible. Residual neuromuscular block should be appropriately reversed, the anaesthetic agent(s) discontinued and 100% oxygen administered. The patient should then be placed in the left lateral position. The tracheal tube or LMA should be removed with the patient breathing spontaneously either awake or deeply anaesthetized. The former allows return of the patient's respiratory and laryngeal reflexes, so that blood and secretions are less likely to be aspirated into the larynx. The latter avoids complications such as coughing and may reduce the risk of laryngospasm.

Regardless of the duration of treatment, the standards for recovery and discharge after general anaesthesia for dental surgery should be the same as for any other procedure performed under general anaesthesia. In the period immediately after general anaesthesia for dental treatment, the child should be managed in an appropriately equipped post-anaesthetic care unit by a designated member of staff who has received training in paediatric resuscitation. Supplemental oxygen should be administered until emergence from anaesthesia has occurred.

Complications associated with general anaesthesia for dental treatment

Minor complications of general anaesthesia for paediatric dentistry include postoperative headache, nausea, retching, and vomiting, particularly in the presence of swallowed blood. Damage may occur to soft tissues or teeth adjacent to the operative site. Postoperative cough and sore throat may occur due to either tracheal intubation or irritation from the throat-pack. Major

complications include complete respiratory obstruction from inhalation of foreign material. Airway obstruction may also occur due to the position of the throat pack or mouth-gag/prop, and also from the presence of blood or debris, particularly when the nasal mask is used for children in the sitting position. Injury to the neck may occur as a result of intraoperative positioning, as may dislocation of the temporomandibular joint. Although halothane is now rarely used to provide general anaesthesia for paediatric dentistry, cardiac arrhythmias may still occur intraoperatively and may result in cardiac arrest. Contributing factors are thought to include high levels of endogenous catecholamines, stimulation of the trigeminal nerve, and the use of epinephrine-containing local anaesthetic agents.

Sedation

Although there are no clear boundaries between them, the National Institute of Clinical Excellence defines three levels of sedation as minimal, moderate, and deep sedation[13] (Table 1).

In paediatric dentistry, the aims of sedation include reducing fear and anxiety, augmenting pain control, and minimizing movement. Children who cannot tolerate dental procedures with local anaesthesia alone may be managed using a conscious sedation technique, resulting in a moderately depressed level of consciousness. This technique is useful for long procedures such as dental conservation, where pain can usually be controlled using local anaesthesia.

To achieve conscious sedation, sedative drugs may be administered via the inhalation, oral, transmucosal, or i.v. routes. Inhalation sedation (relative analgesia) is achieved using a titrated mixture of up to 70% nitrous oxide in oxygen. This should be the first choice for paediatric dental patients who have a sufficient level of understanding to cooperate with the procedure but are who not able to tolerate local anaesthesia alone.

Oral sedation is commonly achieved using midazolam, which can also be administered via transmucosal routes (e.g. nasal, sublingual, rectal). The standard technique for i.v. sedation is a titrated dose of a single agent (e.g. midazolam).

The use of advanced sedation techniques, involving the administration of ketamine, propofol, and sevoflurane, has also been described for paediatric dentistry. Since these advanced techniques have a narrow margin of safety, the training required to administer these drugs requires careful consideration, together with the venue in which sedation is provided. Healthcare professionals providing sedation should be competent and experienced in delivering the particular sedation technique and able to manage any potential complications.

Table 1 Levels of sedation

Level of sedation	Features	Effect on airway, ventilatory, and cardiovascular function
Minimal	Child is awake and calm, responding normally to verbal commands	No effect on ventilatory or cardiovascular function
Moderate level I (conscious sedation)	Child is sleepy but responds purposefully to verbal commands	No interventions required to maintain a patent airway Spontaneous ventilation is adequate Cardiovascular function is usually maintained
Moderate level II	Child is sleepy and requires light tactile stimulation to produce a purposeful response	No intervention required to maintain a patent airway Spontaneous ventilation is adequate Cardiovascular function is usually maintained
Deep	Child is asleep and cannot be easily aroused	Child may require assistance in maintaining a patent airway Responds purposefully to repeated or painful stimulation Spontaneous ventilation may be inadequate Cardiovascular function is usually maintained

Local anaesthesia

Local anaesthetic agents used during paediatric dentistry include lidocaine and prilocaine, which are commonly supplied in cartridges containing 2.2 ml (Table 2). These drugs are usually administered by the dental surgeon and used in combination with vasoconstrictor agents such as epinephrine or felypressin (octapressin) to improve haemostasis. The techniques for achieving local anaesthesia in children are similar to those performed in adults; however, the reduced bone density of the maxilla and mandible in children leads to a more rapid diffusion and absorption of local anaesthetic solution. This results in a faster onset of action and shorter duration of effect, with smaller volumes of local anaesthetic solution being required. Conversely, if a local anaesthetic solution is injected into an area of infection, the onset of action will be delayed or even prevented. This is because the pH of the extracellular tissue is reduced in the presence of infection, thus increasing the degree of ionization of the local anaesthetic drug, reducing its lipid solubility, and hence decreasing the diffusion across nerve membranes.

Table 2 Maximum dosage of local anaesthetic agents commonly used for paediatric dentistry

Local anaesthetic solution	Maximum dose
2% lidocaine/1:80 000 epinephrine	4.4 mg kg^{-1}
3% prilocaine/felypressin	6.6 mg kg^{-1}
4% prilocaine	5 mg kg^{-1}

Fig 6 Buccal infiltration of local anaesthetic solution combined with vasoconstrictor agent.

The techniques for administering local anaesthesia for dental treatment in children are similar to those used in adults and are outlined below.

Maxillary anaesthesia

The maxillary teeth receive their sensory nerve supply from the anterior, middle, and posterior superior alveolar (dental) nerves, which are all branches of the maxillary division of the trigeminal nerve. The technique of local infiltration can be used to block the peripheral fibres of these nerves at the apical foramina of the teeth. Injection of local anaesthetic solution in the sulcus adjacent to the tooth requiring treatment is usually effective, although some modifications may be required due to variations in local anatomy. The buccal and labial soft tissues are anaesthetized by infiltration to these areas (Fig. 6). Anaesthesia of the hard and soft palate requires injection directly into the palate. The infra-orbital nerve is a terminal branch of the maxillary nerve and can be blocked from the upper labial sulcus opposite the canine tooth. The block will also include branches of the anterior superior alveolar nerve and provides anaesthesia to the anterior maxilla and upper lip.

Mandibular anaesthesia

All of the lower teeth receive their sensory nerve supply from the inferior alveolar (dental) nerve, which is a branch of the mandibular division of the trigeminal nerve. The inferior dental nerve may be blocked before it enters the bone at the mandibular foramen on the medial aspect of the ramus, just behind the lingula. This provides anaesthesia to the bone of the mandibular body and the pulps of all the teeth on that side of the mouth, except perhaps the central incisor where there may be some cross-over supply from the inferior dental nerve on the opposite side. Injection of local anaesthetic solution at the mental foramen will block the mental nerve, providing anaesthesia to the soft tissues of the labial gingiva, the lower lip, and chin. The anaesthetic solution will also diffuse via the mental foramen to reach the incisive branch, which supplies the pulps of lower teeth, namely the first premolar, the canine, and incisor teeth. There is some communication with the nerve supply on the opposite side. The incisive nerve may also be blocked by buccal infiltration in the lower incisor region, due to the thin buccal cortex of bone at this site. In the young child, the labial cortex of the mandible in the incisor region is very thin, which allows the diffusion of sufficient local anaesthetic solution, providing anaesthesia to the pulps of the teeth. In older children, a periodontal ligament injection may be required to achieve adequate pulpal anaesthesia of each mandibular tooth.[14]

Complications associated with the use of local anaesthesia in paediatric dentistry

Local complications include failure of the block, infection, intravascular injection, haematoma, nerve damage, facial nerve palsy, and needle fracture. There is also the risk of trauma to the anaesthetized region of the face caused by biting and chewing, particularly in children who are very young, or who have developmental delay.

Systemic complications include dose-related toxicity of the local anaesthetic agent and dose-independent hypersensitivity reactions. Children over 6 months of age absorb local anaesthetic agents more rapidly than adults and toxicity in children occurs at doses that are well below toxic levels in adults. Cardiovascular effects include arrhythmias and are due to the combined action of the local anaesthetic agent and vasoconstrictor. Effects on the central nervous system include seizures, unconsciousness, and respiratory arrest.

Summary

The management of anxiety and pain is a very important aspect of paediatric dentistry and includes the use of general anaesthesia, sedation, and local anaesthetic techniques. Adequate preoperative assessment is required in order to determine the most appropriate method of management, with consideration of the child's cognitive development and the proposed dental procedure.

Declaration of interest

None declared.

References

1. O'Rourke D. Measurement of pain in infants, children and adolescents: from policy to practice. *Phys Ther* 2004; **84**: 560–70
2. Twycross A, Dowden S, Bruce E. *Managing Pain in Children: A Clinical Guide*. Oxford: Wiley-Blackwell, 2009, p29
3. Department of Health. *A Conscious Decision: A Review of the Use of General Anaesthesia and Conscious Sedation in Primary Dental Care*. London, 2000
4. Chief Dental Officer. *General Anaesthesia for Dental Treatment in a Hospital Setting with Critical Care Facilities*. London: Department of Health, 2001
5. Department of Health. *Comprehensive Critical Care—A Review of Adult Critical Care Services*. London, 2000
6. Royal College of Anaesthetists. *Guidance on the Provision of Paediatric Anaesthetic Services*. London, 2009

7. Association of Anaesthetists of Great Britain and Ireland. *Recommendations for Standards of Monitoring During Anaesthesia and Recovery*, 4th Edn. London, 2007
8. Tochel C, Hosey M-T, Macpherson L *et al.* Assessment of children prior to dental extractions under general anaesthesia in Scotland. *Br Dent J* 2004; **196**: 629–33
9. Association of Paediatric Anaesthetists of Great Britain and Ireland/ Association of Dental Anaesthetists. *Guidelines for the Management of Children Referred for Dental Extractions Under General Anaesthesia*. Available from www.apagbi.org.uk/publications/guidelines-other-organisations-0 (accessed 3 July 2012)
10. Walker H. The child who refuses to undergo anesthesia and surgery—a case scenario-based discussion of the ethical and legal issues. *Paediatr Anaesth* 2009; **19**: 1017–21
11. Nunn J, Foster M, Master S *et al.* British Society of Paediatric Dentistry: a policy document on consent and the use of physical intervention in the dental care of children. *Int J Paediatr Dent* 2008; **18**(Suppl. 1): 39–46
12. Royal College of Nursing. *Restraint, Holding Still and Containing Children and Young People. Guidance for Nursing Staff*. London, 2003
13. National Institute for Health and Clinical Excellence. *Sedation for Diagnostic and Therapeutic Procedures in Children and Young People*. (Clinical Guideline 112), 2010. Available from http://guidance.nice.org.uk/CG112 (accessed 3 July 2012)
14. Robinson PD, Pitt Ford TR, McDonald F. *Local Anaesthesia in Dentistry*. Oxford: Wright, 2003; p31–80

Please see multiple choice questions 9–12.