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Principles of Surgery

surgery *n. manual treatment of injuries or disorders of the body, operative therapeutics.*
surgeon *n. a person skilled in surgery.*

Exodontia, the removal of teeth, involves the manipulation of hard and soft tissues and the amputation of the dentition or parts thereof in order to treat or prevent disease, or as part of an overall treatment plan. The surgeon who carries out this treatment must possess qualities, skills, and decision-making abilities to the standard of any other trained surgeon who diagnoses and treats disease. It is the responsibility of this surgeon to provide the highest standard of care of which they are capable, and when they cannot provide it to a suitable level, to refer to the appropriate specialist service.

It is somewhat self-evident, though easily forgotten, that the surgeon's responsibility is not limited to the operation only, but also involves preoperative consultation and postoperative monitoring, as well as other aspects of care such as liaising with other practitioners and communicating treatment plans. Surgeons are trained to possess several qualities and characteristics not limited to procedural skills:

- **Knowledge.** Knowledge can be considered the facts, information, skills, and experience gained through education, training, and professional practice. It is a fundamental and essential aspect of the carrying out of dentoalveolar extractions. It includes technical and medical expertise, which facilitate safe patient management. As scientific knowledge evolves over time, there is a need for ongoing maintenance through continuing professional development and keeping up to date with evidence-based practice.
- **Quality and Safety.** Quality is the commitment to excellence, providing a service that is guided primarily by the best interests of the patient. This is achieved through recognition of one's own strengths and limitations, stringent self-audit, and the fortitude to request assistance when needed. Safety is the avoidance of risk or injury to oneself, one's staff, and one's patients. Maintenance of a safe workplace is the responsibility of all individuals employed in a health environment, and requires appropriate training and awareness of risk-mitigation strategies such as aseptic and sterilisation techniques. Quality and safety are dynamic components of surgery and necessitate constant refinement and improvement to ensure the wellbeing of patients and a high standard of care.
- **Communication and Collaboration.** Good communication is essential in the interaction both with patients and with other health professionals. Clear, concise, and relevant documentation of patient management will improve interactions with specialists and foster a culture of collaboration and professional development. This is particularly important when patients are

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Companion website: www.wiley.com/go/delpachitradentoalveolarextractions

undergoing tooth extraction as part of a wider treatment plan where multiple other medical comorbidities require interdisciplinary management. In such situations, good communication minimises delays to receiving time-critical treatment, such as in the case of dental extractions prior to head and neck radiotherapy or bisphosphonate treatment.

- **An Individualistic Approach.** Patients will have a wide variety of backgrounds, demands, and prior medical knowledge. A tailored and individualised approach is required in order to ensure they understand the proposed procedure, its risks, and its expected outcomes, and are able to compare options in order to make an informed decision.
- **Leadership and Management.** A surgeon will often find themselves the leader of a multifaceted treatment team, including nursing staff, dental assistants, anaesthetic staff, and sterilisation technicians. This leadership comes with great responsibility: the expert surgeon must guide others in the team, provide feedback and education, and thus help maintain a standard of excellence. The surgeon must ensure that all staff are orientated towards the goal of achieving the best outcome for the patient. When the highest standard of care is compromised, the responsibility is on the surgeon to make sure the team gets back on track.
- **Decision Making.** The word 'decision' shares a common root with another word often associated with surgery: incision. Both are derivatives from the Latin word *caedis*, meaning 'to cut'. Incision means to cut into something, such as the operative site; decision literally means 'to cut away'. A decision thus precludes other options, and sets one upon a particular course of action. A skilled surgeon will be able to make treatment planning decisions that are in the best interests of their patients.

1.1 Wound Healing

Good outcomes following surgery depend on satisfactory wound healing. This involves a range of inflammatory, biochemical, and physiologic changes at the operative site, which will ultimately lead to resolution, healing, and bone remodelling. Wound healing does not always follow a predictable course, and therefore an understanding of its key aspects will serve as a foundation for interpreting clinical signs and determining when it is compromised.

There are four key stages in wound healing (Figure 1.1):

1) Haemostasis.
2) Inflammatory phase.
3) Proliferative phase.
4) Remodelling and resolution.

An interruption at any one of these stages will lead to a protracted recovery period.

1.1.1 Haemostasis

Any tissue trauma will result in bleeding from the local vasculature supplying the tissues. The immediate physiologic reaction is haemostasis, which involves reactive vasospasm, formation of a platelet plug, and activation of the coagulation cascade.

Reactive vasospasm occurs in the seconds to minutes following damage to the blood vessels. This is mediated through neurologic mechanisms, as well as the local release of endothelin. It rapidly reduces blood loss from trauma. In surgery, exogenous vasoactive medications such as adrenaline utilise this response to improve visual access to the surgical field by reducing blood flow.

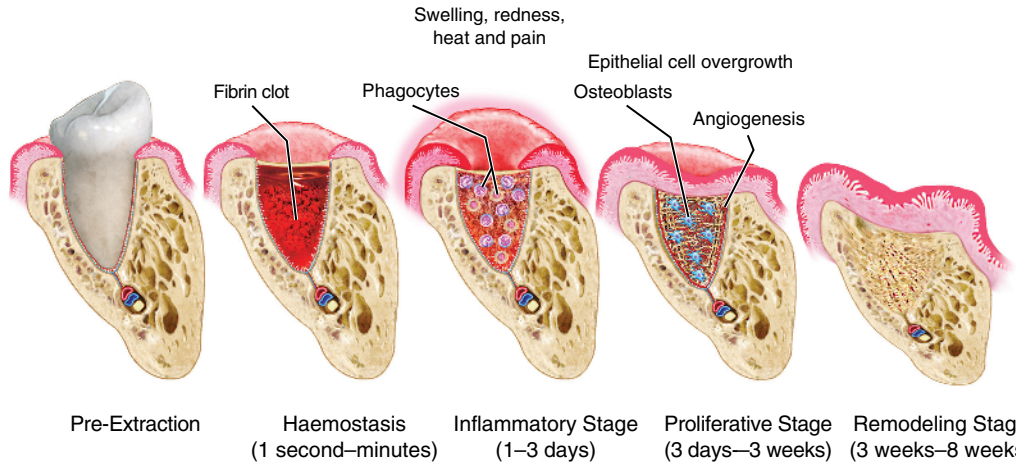

Figure 1.1 Phases of wound healing.

Damaged endothelial cells result in a conformational change in von Willebrand factor expressed on the cell surface. Von Willebrand factor interacts with glycoprotein Ib on circulating platelets, resulting in activation and aggregation of the platelets, forming links to fibrinogen via the GpIIb/IIIa receptor. This leads to the formation of the platelet plug. Antiplatelet medications inhibit aspects of platelet plug formation and increase the risk of bleeding during surgical procedures.

The coagulation cascade is a series of successive reactions that occur in order to activate thrombin and form a stable fibrin clot (Figure 1.2). There are two pathways in this cascade: intrinsic and extrinsic. The intrinsic pathway is activated within the vascular system through exposure

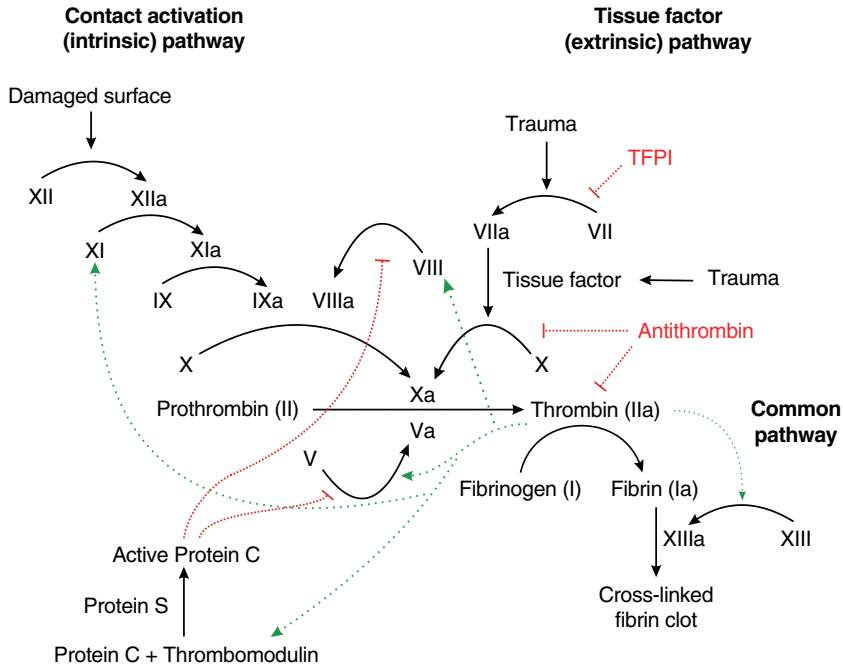

Figure 1.2 The coagulation cascade.

to endothelial collagen, whilst the extrinsic pathway is activated by tissue trauma and release of intracellular tissue factor. Anticoagulant medications and coagulopathies increase the tendency to bleed by inhibiting aspects of the coagulation cascade, and awareness of these effects may be clinically relevant in surgical planning.

Coagulation studies used clinically can assess the function of either the intrinsic, the extrinsic, or the shared common pathway. Prothrombin time screens for factors II, V, VII, and X and fibrinogen; these are all part of the extrinsic pathway, which is used to guide treatment for patients treated with warfarin. Warfarin inhibits vitamin K-dependent factors common to both pathways, but because factor VII has the shortest half-life, the extrinsic pathway is used to determine coagulability. The partial thromboplastin time will screen for factors in the intrinsic pathway affected by medications such as heparin and low-molecular-weight heparin.

1.1.2 Inflammatory Phase

This will commence on day one after the procedure and will continue for approximately three days. Important aspects of the inflammatory response include the release of pro-inflammatory mediators and vasoactive factors such as the prostaglandins, leukotrienes, interleukins, and histamine, and recruitment of phagocytes to remove dead tissue and foreign debris. The inflammatory mediators lead to the swelling, redness, heat, pain, and loss of function associated with inflammation. Anti-inflammatory medications are commonly prescribed after dentoalveolar procedures in order to mitigate the postoperative pain and swelling.

1.1.3 Proliferative Phase

This typically starts around day three and lasts for up to three weeks. The proliferative phase relies on the formation of granulation tissue and type III collagen, mediated by fibroblasts; wound contraction starts due to the action of myofibroblasts. Angiogenesis takes place as new capillaries are formed to provide blood and nutrients in order to help the wound heal. A number of growth factors, including vascular endothelial growth factor (VEGF), are also involved. At the wound edges, epithelial cells proliferate and begin to grow over the granulation tissue scaffold that has formed. Bone healing starts to take place as osteoprogenitor cells arrive, differentiating into osteoblasts, which begin depositing an osteoid matrix. Note that any systemic conditions or medications which prevent or suppress components of angiogenesis or inflammation may delay or prolong healing.

1.1.4 Remodelling and Resolution

At the completion of three weeks of healing, granulation tissue and immature bone will fill the extraction site, and the socket should be completely covered by a layer of epithelium. Bone remodelling will continue to take place with active resorption and deposition mediated by osteoblasts and osteoclasts. This important step can be impeded by medications that inhibit osteoclast function, such as bisphosphonates or denosumab. Radiographic evidence of bone remodelling will not become evident until after six to eight weeks.

1.2 Patient Assessment

Any medical or dental intervention requires a comprehensive patient history. This includes: a detailed medical history, including current and past medical treatments; documentation of known drug allergies and reactions; a social history comprising occupation and use of alcohol, cigarettes,

and illicit substances; prior surgeries, dental treatments, and adverse outcomes; and, finally, the patient's chief complaint or main concerns.

Secondary to this is the clinical assessment of the patient's orofacial region, including both extraoral and intraoral examination. This should include an assessment of the temporomandibular joint, soft and hard tissue pathologies, and the presence of any dental pathology. Simultaneously, a difficulty and risk assessment for dentoalveolar surgery can be undertaken, paying particular attention to mouth opening, gingival biotype, gag reflex, patient anxiety, and previous heavily restored dentition.

Diagnostic tests should be carried out as necessary, including pulp testing, palpation for mobility, and percussion testing. A periodontal probe can be used to examine partially erupted or unerupted teeth, to assess soft tissue opercula, or to explore other communications with the oral cavity.

The patient's psychological state and level of anxiety can be assessed by asking how well they have tolerated dental treatment in the past. This aspect of the assessment is important; by virtue of temperament, some patients will require a more detailed discussion about their treatment, and some may request or require treatment with sedation or general anaesthesia.

1.3 Radiographic Assessment

Plain-film orthopantomogram (OPG), periapical (PA) radiograph, and the three-dimensional (3D) cone-beam computed tomogram (CBCT) are the primary imaging modalities used in the assessment of patients prior to dental extractions. As part of the radiographic workup for dental extraction, the minimum required imaging of the tooth for extraction is an intraoral PA radiograph. Where multiple teeth are indicated for extraction, or where third molars are being assessed, a panoramic radiograph is the minimum requirement instead (Figure 1.3).

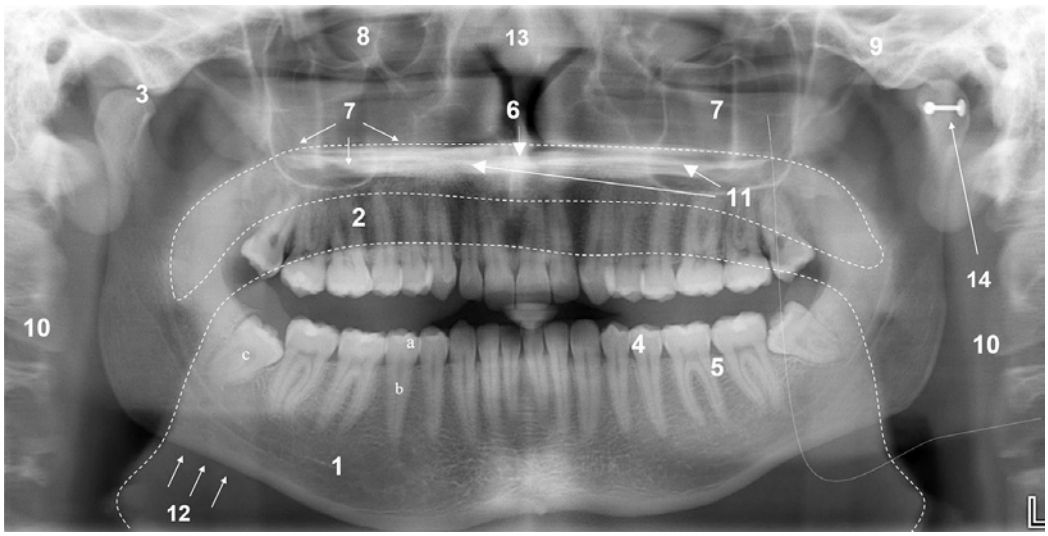

Figure 1.3 Panoramic radiograph: 1. mandible; 2. maxilla; 3. temporomandibular joint; 4. dentition; 5. alveolar process and periodontium; 6. anterior nasal spine; 7. maxillary antrum; 8. orbit; 9. zygoma; 10. cervical spine (double image); 11. hard palate (double image); 12. lower border of mandible; 13. nasal septum; 14. earring causing artifact. Outlines show oro- and nasopharyngeal airspaces and double image of mandibular ramus (left side). *Source:* Reproduced from The panoramic dental radiograph for emergency physicians by Anton Sklavos, Daniel Beteramia, Seth Navinda Delpachitra, Ricky Kumar, *BMJ* 36: 565–571. doi:10.1136/emermed-2018-208332. Copyright © 2019 with permission from BMJ Publishing Group Ltd.

A procedure should not be undertaken without a diagnostic radiograph, displaying the condition of the tooth, the relevant adjacent structures (inferior alveolar nerve canal, mental foramen, maxillary antrum), and the condition of the adjacent teeth. Generally, a PA radiograph has a limited application and should only be used for emergency single-tooth extractions or procedures limited to one part of the mouth performed under local anaesthesia. A PA radiograph is not considered an appropriate assessment for proximity of the inferior alveolar canal to the lower third molar teeth; errors in patient or film positioning may alter the radiographic relationship between the canal and associated tooth roots, producing a nondiagnostic image.

The OPG gives a better indication of the overall state of the patient's dentition and of other pathological conditions that may affect the maxillofacial region compared to a PA radiograph. Because the OPG is taken in a standardised manner, it has formed the basis for a number of evidence-based risk-assessment tools in the current literature, including assessments of the risk of oroantral communication and inferior alveolar nerve injury.

CBCT is a relatively new and inexpensive method of producing 3D images of maxillomandibular structures (Figure 1.4). It is indicated when conventional 2D imaging does not produce enough diagnostic information for treatment planning. Most commonly, this is to investigate jaw

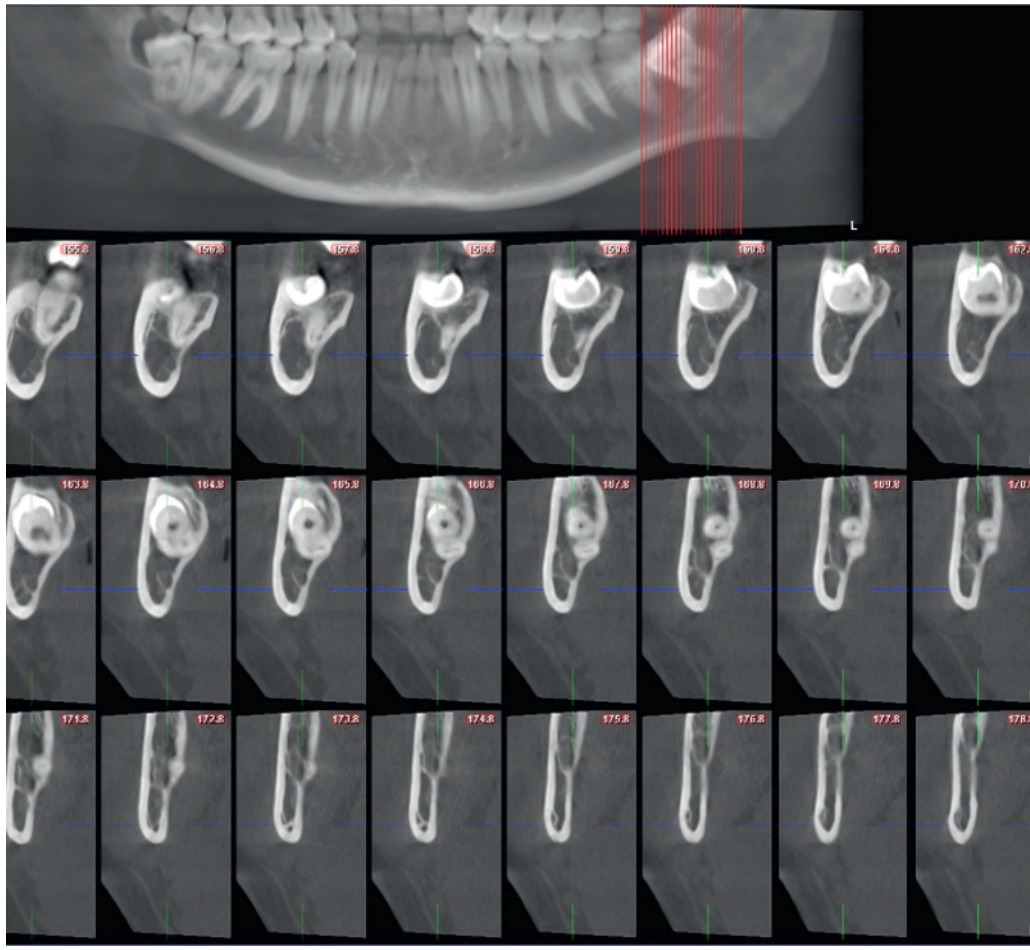

Figure 1.4 Slices of a serial transaxial CBCT.

pathology or the relationship of the inferior alveolar nerve canal to third molar teeth. Whilst CBCT images come in a variety of formats, the serial-transaxial reformat is useful for the determination of the pathway of the inferior alveolar nerve and its relationship to the mandibular teeth.

CBCT images provide a great deal more information than plain-film imaging, and therefore their interpretation can be challenging. For the surgeon who is not experienced with CBCT images, formal reporting by a specialist radiologist is essential; if they are not interpreted carefully, radiographic signs of nerve risk or bone pathology may be easily missed, likely resulting in a poor outcome for the patient and a litigious scenario for the surgeon.

1.4 Informed Consent

In order to carry out any medical or dental procedure, consent must be obtained from either the patient or their legal guardian. A valid consent may only be given when the patient possesses decision-making capacity; that is, when they have the ability to weigh up the pros and cons of treatment and come to a sound decision to either undergo or forgo a proposed procedure. This consent must be given voluntarily, without duress or coercion. The decision must be informed, which is to say that the patient must understand the procedure, the expected outcomes, the risks involved, the anticipated recovery time, and the costs of treatment.

For any planned surgical procedure, consent should be both written and verbal, and patients should be provided by the surgeon with a formal document detailing the procedure and its indications, risks, and expected outcomes (Figure 1.5). When seeking consent from a patient, the surgeon must always provide them sufficient time to ask questions. The patient may request more detailed information about particular risks or outcomes of surgery, and these should be elaborated on and explained in detail.

In addition, the consent should be specific for the particular patient and their individual circumstances. Alternatives to dentoalveolar extraction should be explained, and the reasons for and against their adoption detailed. In cases where extractions will render the patient without functional teeth, future treatment options for replacement should be discussed; this should include an approximate timeline, who will provide the treatment, and a rough cost estimate.

1.5 Anaesthesia

There are a number of different methods of anaesthesia available for dentoalveolar extractions. These include:

- Local anaesthesia only.
- Local anaesthesia with relative analgesia.
- Local anaesthesia with minor oral sedation.
- Local anaesthesia with intravenous (IV) sedation.
- Local anaesthesia with general anaesthesia.

Local anaesthesia alone can be administered for in-chair treatment, and is generally considered the safest option. It is appropriate for most simple dentoalveolar procedures and extractions. The main limitation of local anaesthesia is that it may be unsuitable for complex procedures, when a duration of more than 40 minutes is anticipated, or when the patient is anxious or otherwise uncooperative.

CONSENT FOR ORAL & MAXILLOFACIAL SURGERY

UR NUMBER:
SURNAME:
GIVEN NAME/S:
DATE OF BIRTH:

The doctor/dentist has explained that I/the patient have/has the following condition:

_____

This condition requires the following procedure:

_____

There are risks associated with undertaking this procedure. These risks include (please tick):

Expected Complications:

☐ postoperative pain
☐ minor bleeding or bruising
☐ dry socket, causing severe pain or discomfort
☐ normal post-operative swelling of the face

Specific Risks not otherwise mentioned (please specify):

Uncommon Complications:

☐ temporary or permanent facial numbness due to damage to the nerves supplying the lower lip, chin, and lower teeth
☐ loss of taste due to damage to the nerve supplying the tongue
☐ bleeding which may be significant and require transfusion
☐ post-operative infection, which may either require antibiotics or further surgery
☐ damage to surrounding structures, including the lips, teeth, and tongue
☐ fragments of tooth or bone left in the gum or jaw
☐ fragments of upper teeth entering the sinuses, requiring further surgery for removal
☐ creation of a communication between the sinus and the mouth, requiring further surgery
☐ chronic pain or problems of the temporomandibular (jaw) joints
☐ jaw fracture

In consultation with my doctor/dentist, this procedure will be performed under:

☐ LOCAL ANAESTHETIC
I will be awake and will have injections to numb the area.

☐ GENERAL ANAESTHETIC
I will be asleep for this procedure.

Patient Statement

I understand my/the patient's medical condition and the proposed treatment.
I acknowledge the risks as documented above as well as those specific to my/the patient's individual situation.
I understand that anaesthetic is required for this procedure and the processes involved with my/the patient's choice of anaesthetic.
I understand that treatment is provided in a day surgery unit, and that transfer to another institution may be required if there are immediate complications of surgery.
I have the right to change my mind at any time regarding the procedure and choice of anaesthetic.
I have had all questions answered by the doctor/dentist and consent to the above procedure.

NAME OF PATIENT/PARENT/GUARDIAN: _____ RELATIONSHIP TO PATIENT: _____

SIGNATURE: _____ DATE: _____

Doctor/Dentist Statement

I have explained to the patient or guardian the content in this consent form and am comfortable that the person signing this form has capacity to do so.

NAME OF DOCTOR/DENTIST: _____

DESIGNATION: _____

SIGNATURE: _____ DATE: _____

Witness/Interpreter's Statement

I have provided an explanation to the patient of this consent form and any verbal information given to the patient.

NAME OF INTERPRETER/WITNESS: _____

LANGUAGE: _____

SIGNATURE: _____ DATE: _____

Figure 1.5 Example consent form for dentoalveolar surgery.

Table 1.1 Comparisons between commonly used oral benzodiazepine sedatives.

Drug name	Dose	Onset
Temazepam	10–20 mg	30–120 minutes
Diazepam	10–15 mg	30–90 minutes
Oxazepam	15–30 mg	2–3 hours

Relative analgesia involves the use of inhaled agents, such as nitrous oxide, to produce conscious sedation. It can be used as an adjunct with local anaesthesia, to improve patient comfort without significant airway risk. Nitrous oxide is usually administered through a nasal hood at concentrations of 50–70%. The advantage of this method is that it can be titrated and rapidly adjusted. However, there is a variable dose–response relationship between individuals, and patients may experience a number of unpleasant side effects if too high a dose is administered. Use of relative analgesia requires additional training, and it is recommended that at least two trained personnel are present in the clinic room when employing this technique.

Oral sedation, when employed effectively, can provide a greater level of sedation than nitrous oxide. Common drug classes used for oral sedation include benzodiazepine and barbiturate medications (Table 1.1). These drugs have a significant depressant effect on the central nervous system, and hence carry the serious risk of respiratory depression and loss of airway reflexes. Therefore, the use of oral sedation should only be considered when the surgeon and clinic personnel are sufficiently trained in anaesthesia, resuscitation, and airway management.

IV sedation typically involves more powerful sedative agents, such as midazolam, propofol, or fentanyl. It can only be administered in a setting which is fully prepared for airway management, such as a hospital theatre. As with all methods of anaesthesia where the airway is not secure, there is a risk that the patient will aspirate on any foreign object present in their mouth. This can be particularly dangerous when their reflexes are not protecting the airway. The administration of IV sedation may only be undertaken by a suitably qualified medical specialist or dental specialist with advanced training.

General anaesthesia will render the patient completely unconscious, and involves securing the airway using a laryngeal mask or endotracheal tube. It should be provided by a specialist anaesthetist or a suitably qualified medical professional. Dentoalveolar extractions carried out under general anaesthesia involve a shared airway, and communication with the anaesthetist throughout the procedure is essential.

1.6 Preparation of Equipment

Preparation for dentoalveolar extractions must follow the principles of asepsis, with strict maintenance of an aseptic operative field (Figure 1.6). The fundamental reason for this is to prevent transmission of microorganisms, which may cause surgical-site infections, transmit bloodborne diseases, and prolong postoperative healing. Inadequate or insufficient adherence to appropriate aseptic techniques or inadequate sterilisation of surgical instruments can result in harm to patients.

In hospital settings, sterilisation of instruments is usually performed through a hospital-wide central sterile services department. In the clinic setting, surgeons and their staff are responsible for the setup and proper maintenance of appropriate sterilisation facilities.

Figure 1.6 Clinic room with defined administrative, operative, and hygiene areas.

Prior to sterilisation, instruments should be wiped clear of obvious blood and debris, then cleaned in an ultrasonic (a machine that uses ultrasonic sound waves to vibrate instruments in order to remove small debris). The instruments should be wrapped or bagged, and chemical indicators that will change when sterilisation conditions are met placed on the equipment. Any practice that provides outpatient surgical procedures must ensure that staff are appropriately trained in sterilisation procedures and understand the basic minimum requirements.

Sterilisation of surgical equipment will fall into one of three categories: dry heat, moist heat, or sterilisation with gas. The sterilisation equipment must undergo regular and annual checks to ensure it is adequately maintained.

1.7 The Surgeon's Preoperative Checklist

When preparing for a procedure, the surgeon should run through a checklist to ensure that everything is in order. This includes:

- A signed consent (to be reviewed with the patient on the day of surgery).
- Confirmation of any allergies.
- A current radiograph, displayed in the surgical room (to be visible to the surgeon during the procedure).
- Confirmation of the correct side and site of the procedure.
- Use of personal protective equipment.
- Surgical handwash, gowning, and gloving.

The surgeon and trained staff should ensure that all equipment has been sterilised, is in suitable condition, and is handled in accordance with aseptic non-touch techniques. All equipment that is anticipated to be used or which may be required in the event of a complication should be ready. In some cases, it may be useful to have a 'scout' nurse to collect additional equipment as required.

Surgical Handrubbing Technique

- Handwash with soap and water on arrival to OR, after having donned theatre clothing (cap/hat/bonnet and mask).
- Use an alcohol-based handrub (ABHR) product for surgical hand preparation, by carefully following the technique illustrated in Images 1 to 17, before every surgical procedure.
- If any residual talc or biological fluids are present when gloves are removed following the operation, handwash with soap and water.

Put approximately 5ml (3 doses) of ABHR in the palm of your left hand, using the elbow of your other arm to operate the dispenser.

Dip the fingertips of your right hand in the handrub to decontaminate under the nails (5 seconds).

Images 3-7: Smear the handrub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds).

Images 8-10: Now repeat steps 1-7 for the left hand and forearm.

Put approximately 5ml (3 doses) of ABHR in the palm of your left hand as illustrated, to rub both hands at the same time up to the wrists, following all steps in images 12-17 (20-30 seconds).

Cover the whole surface of the hands up to the wrist with ABHR, rubbing palm against palm with a rotating movement.

Rub the back of the left hand, including the wrist, moving the right palm back and forth, and vice-versa.

Rub palm against palm back and forth with fingers interlinked.

Rub the back of the fingers by holding them in the palm of the other hand with a sideways back and forth movement.

Rub the thumb of the left hand by rotating it in the clasped palm of the right hand and vice versa.

When the hands are dry, sterile surgical clothing and gloves can be donned.

Repeat this sequence (average 60 sec) the number of times that adds up to the total duration recommended by the ABHR manufacturer's instructions. This could be two or even three times.

World Health Organization

Figure 1.7 WHO surgical handrubbing technique. *Source:* From Surgical Handrubbing Technique, https://www.who.int/gpsc/5may/hh-surgicalA3.pdf, WHO. © WHO.

Figure 1.8 Dentist with sufficient sterile and personal protective attire for dentoalveolar surgery.

All surgical procedures require adequate lighting in order to visualise the operative field. This is particularly important when working in a small area such as the mouth. An overhead light should be used to ensure that both the surgeon and the assistant have adequate visual access to the field. The surgeon may also use a personal headlamp.

The surgeon should perform a surgical handwash prior to the procedure, as per the World Health Organization (WHO) surgical handrubbing technique, to ensure disinfection of contaminated skin of the hands, arms, and elbows (Figure 1.7). Typically, this will involve the use of a chlorhexidine- or iodine-based surgical handwash.

After the handwash, the surgeon must apply a sterile gown and gloves, so that they may enter the sterile field without contamination (Figure 1.8).

1.8 Operative Note

Following a surgical procedure, detailed clinical notes should be completed as soon as possible, listing all medications or anaesthetics administered and steps taken, the difficulty of the procedure, any intraoperative complications that arose, and any postoperative discussions with or instructions given to the patient. At a minimum, the operative note should include:

- Indications for the procedure and a summary of intraoperative findings.
- Type of anaesthesia used (relative anaesthesia, oral or IV sedation, general anaesthesia):
  - specifically, the type of local anaesthesia, dose administered, concentration, and use of vasoconstrictors.
- A detailed procedural note, including:
  - methods used for extraction ('simple' versus 'surgical'), with a detailed description of each step;
  - any complications encountered;
  - difficulty of the procedure;
  - haemostatic agents used;

  - suture type;
  - ease in obtaining haemostasis.
  - Additional notes on any medications prescribed, including type, dose, and duration.
- Any postoperative orders that were given to the patient, and how they were transmitted (written, verbal, or both).
- The date and time of the follow-up appointment.

The operative note must reflect a legal memorandum outlining the specific intraoperative details of every case; a good clinical note enables continuity of care, provides a basis for informative evidence for any future complaints or complications, and enhances communication between healthcare professionals.