# AVOIDING AND MANAGING COMPLICATIONS

# IN MINOR ORAL SURGERY

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"In all things success depends upon previous preparation, and without such preparation there is sure to be failure." (Confucius 550 - c 478 BC)

# INTRODUCTION

The majority of complications involve the operative site and may occur perioperatively or postoperatively. The prevention and management of these categories of complications is the aim of this chapter. While most complications are fortunately minor, occasionally, major life-threatening systemic complications such as a respiratory or cardiac arrest will occur. These medical emergencies are often totally unexpected and likely to become more common as the general age of the population increases and more patients with severe underlying medical conditions require oral surgical procedures. It is beyond the scope of this chapter to cover in detail the necessary precautions needed for, and the management of, patients with complicating medical and dental histories and the reader is referred to the many excellent texts available that cover this subject in depth (1, 2).

In many ways the term "minor oral surgery" is unfortunate and misleading as it implies that the procedure to be performed is simple and that postoperative sequelae are negligible. It may also give the false impression that less skill and care is required than for the performance of "major oral surgery". This is a dangerous misconception. There can be few experienced oral & maxillofacial surgeons who have not been humbled by a lowly third molar tooth. Moreover, complications following such surgery are poorly tolerated by patients whose expectation is that minor surgery should not produce major morbidity.

Following the axiom that prevention is better than cure, the best way to manage complications is not to produce them in the first place. For while a few complications following minor oral surgery are truly unavoidable, most can and should be prevented.

## Preoperative Assessment And Treatment Planning

It is a *sine qua non* of all medical and surgical practice that the clinician must be in possession of the requisite expertise and skill to perform the scheduled procedure. The wise surgeon is aware of any personal limitations in this area and will not elect to perform any operation beyond his or her capabilities. To a certain extent and with some qualifications this principle may also be applied to managing complications. If a surgeon lacks the ability to remove a fractured and retained root or close an oro-antral fistula then one must seriously question the wisdom of embarking on the extraction of the tooth in the first place. Furthermore, all but the simplest of procedures will require the help of a skilled and knowledgeable assistant. This is particularly important for junior surgeons in training who are all to often left to "finish the list" with only the theatre scrub nurse to act as first assistant.

### Medical History Taking And Resuscitation Training

The majority of patients who are at increased risk of developing surgical and medical complications should be identified preoperatively following the taking of a comprehensive medical and dental history which should be updated at each subsequent visit. Specific questions should be asked concerning previous cardiac and respiratory diseases, pregnancy, diabetes, excessive bleeding following minor injuries,

current and past drug therapy including anti-coagulants and steroids, previous local and general anaesthetic experience and drug allergies. A history of difficult extractions, post extraction haemorrhage and radiotherapy to the operative area should be taken seriously.

Obviously, the management of the more serious complications of minor oral surgery will be beyond the capability of the relatively inexperienced surgeon, especially if they occur outwith the hospital environment where there is ready access to all the necessary equipment, drugs and support services. In this situation the operating surgeon has a duty of care to the patient to recognise that a complication has arisen and to consult with or refer the patient to a more experienced colleague (usually the local consultant oral & maxillofacial surgeon) for advice and treatment. Depending on the severity of the problem referral *via* the telephone rather than the traditional letter may be more appropriate. To err is human but failure to recognise the error and take immediate and appropriate action to remedy it is negligent.

It is essential that all those directly involved in treating patients are fully conversant with the theory and practice of basic life support and resuscitation. This applies to the surgeon who only ever treats patients under local anaesthetic as well as those who routinely employ sedation or general anaesthesia in their practice. Once learned, basic life support skills must be regularly practised by the entire surgical team until everyone is fully conversant with their individual roles. Emergency medical and resuscitation equipment must be regularly checked, maintained and serviced.

Simple and seemingly obvious measures such as keeping a list of emergency service contact numbers by the telephone, which should ideally be in the patient treatment area, can save valuable and potentially life saving minutes should a patient suffer a cardiac arrest.

**Surgical Equipment**

Most minor oral surgical procedures do not require large numbers of instruments. Nonetheless, the surgeon must satisfy him or herself before embarking on the procedure that all the equipment necessary to complete the procedure safely and deal with any complications commensurate with their experience are available, clean and sterile. Perhaps one of the most often neglected items of surgical kit is the operating light. A light that is just adequate to visualise a lower third molar may be totally inadequate when one's attention turns to removing the opposing partially erupted upper third molar. Especially if bone needs to be removed in order to facilitate tooth delivery. Lack of adequate lighting can make an otherwise straightforward procedure difficult and a difficult procedure almost impossible. Similar consideration should be given to the suction apparatus to be used. In the United States (US) clinicians are required to have some form of suction apparatus available at all times and also to have a backup battery supply in case of mains power failure. While a low volume salivary aspirator may easily deal with the minimal bleeding consequent on raising a mucoperiosteal flap it will be unable to cope with the sometimes alarming haemorrhage that can arise from a severed nutrient vessel or inferior alveolar artery. The threat to the patient's airway and the likely consequences are obvious.

**Radiographs**

If damage to vital structures is to be avoided the surgeon must have a very clear understanding of the anatomy of the operative area including the presence of any local variations that may complicate an otherwise normal procedure (Figure 1). Only

then can a surgical treatment plan be produced. This process must take place prior to each and every operative procedure to be performed. Minor oral surgical procedures involving the hard tissues require that information derived from clinical examination of the patient is supplemented by preoperative imaging. For the most part this means plain radiographs of the area. It is axiomatic that radiographs must show the area to be operated on, and they must also be of good quality to enable the differentiation of adjacent structures from each other. A radiograph showing a third molar that is blurred, overexposed and streaked is worse than useless and basing an operation on such a radiograph is foolhardy. For apicectomies an intraoral radiograph is acceptable providing it also shows the apices of the adjacent teeth on either side of the index tooth. If an apicectomy is to be performed and a cyst enucleated the entire cyst outline should be visible on the planning radiograph. Radiographs of lower third molars must show (3, 4):

- The entire third molar and hence the type of impaction
- The entire configuration of the second and first molars if present
- The immediate investing bone and the entire pericoronal space
- The relationship of the third molar tooth/roots to the neurovascular canal
- The presence and extent of any associated pathological changes

In the majority of situations these requirements will preclude the sole use of the intraoral periapical radiograph for preoperative planning of lower third molar extractions. The use of survey radiographs such as the lateral oblique view and rotational tomography allow these requirements to be met (3).

The orthopantomogram (OPT) is probably the commonest type of rotational tomogram in use in the United Kingdom (UK) and provides an excellent view of all

the teeth and related structures on one film. A preoperative OPT or equivalent radiograph is a mandatory investigation prior to extracting any lower third molar, regardless of its eruption status and type of impaction. If there is any doubt over the relationship of the tooth to the neurovascular canal on the preoperative OPT a high quality intraoral radiograph of the area should also be obtained. Although perhaps not essential, it is a wise precaution to obtain a radiograph prior to extracting any tooth if unpleasant surprises are to be minimised. Again the OPT is ideal for this purpose. All radiographs should be indelibly marked with the patients' name or case note number and thoroughly checked to ensure that they are correctly orientated with respect to right and left.

**Local Anaesthesia**

Where a local anaesthetic is to be given, as with all drugs it is vital to ensure that the solution is unused and not past its expiry date. An aspirating syringe or technique should be used in all cases to avoid intravascular injections. Where local anaesthetic infiltrations into the periodontal ligament are used it is important to use a specially designed syringe that not only delivers small increments of solution but also fully encloses the glass cartridge. Using a normal dental syringe for ligamentous injections will frequently result in fracture or explosion of the local anaesthetic cartridge due to the high pressures generated. The danger to patient and surgeon alike from flying glass are obvious and avoidable.

Occasionally, patients are labelled as being "resistant" to local anaesthetics. This usually centres around failure to achieve surgical analgesia with an inferior alveolar nerve block. Once local infection has been exclude as a cause of failure to achieve surgical analgesia the commonest cause is faulty technique. If the surgeon is

sure that his or her technique is correct it is likely that there is a local anatomical variation in the region of the lingula. This may be due to an abnormally high or low foramen or the lingula itself may be larger than normal presenting a physical barrier to the hypodermic needle. Close inspection of the OPT in the region of the lingula will usually show the problem. Thereafter, slight variation in technique, usually injecting a centimetre or so higher resolves the problem.

If after repositioning the syringe and repeating the injection surgical analgesia is still not achieved, in order to avoid unwanted toxicity and possible cardiac complications it is important that the surgeon does not continue to inject more and more anaesthetic in the blind hope of success. The maximum safe dose of lignocaine containing a vasoconstrictor is 7.0 mg/Kg (0.35 ml/Kg of a 2% solution) and the total dose of adrenaline should not exceed 200μg (16 ml of a 1:80,000 solution) (2).

## Obtaining Patient Consent

Prior to performing any operative procedure the surgeon must obtain the patient's consent for treatment. Failure to obtain consent will leave the surgeon open to a claim for negligence and possible criminal prosecution for battery. Consent must be given voluntarily and the patient must be capable of understanding the proposed treatment, have been appropriately informed beforehand and given the opportunity to ask any questions regarding their treatment (5). In some circumstances this may require an interpreter to be present and for multi-lingual information and consent sheets to be available.

It is vital to understand that obtaining consent does not mean simply requesting the patient's verbal permission to submit themselves to treatment. In order for a

patient to adequately consent to an operation or treatment he or she must be *fully informed* and be in possession of and understand the likely consequences and any complications of that treatment. Moreover, it is extremely important that the patient is made fully aware of the advantages and disadvantages of any alternative management strategies to the planned treatment. In many cases this may include no treatment at all. The type of anaesthetic to be used and any possible side effects and complications such as drug reactions and phlebitis must also be fully discussed with the patient when obtaining consent.

If a patient suffers a complication of a procedure which he was not warned about preoperatively, without suggesting negligence, the surgeon may be sued for breach of his duty of care to the patient (5).

Much debate has taken place concerning which complications patients should be explicitly warned about. It has been suggested that patients should be specifically warned about any complication that occurs with a minimum frequency between 1% and 10% (6). However, it is currently accepted that patients should receive specific warnings about any temporary condition that occurs in 5% or more of cases and any permanent condition that occurs in 0.5% of cases (7). This means that all patients should be warned about the risks of postoperative pain, bleeding, bruising, swelling and limitation of function. Patients undergoing lower third molar removal must be warned about the risk of lingual and inferior alveolar nerve anaesthesia, paraesthesia and dyseasthesia. It is thus of some concern that a recent study showed that 4% of UK oral & maxillofacial surgeons did not routinely warn their patients about possible nerve damage following lower third molar surgery (8).

Similarly, patients undergoing procedures in the territory of the terminal divisions of the facial nerve such as skin biopsies, botulinum toxin injections for

masseteric hypertrophy and arthrocentesis/arthroscopy etc must be warned about the possibility of permanent facial weakness. It is also important to ensure that patients (especially those caring for young children at home) are aware that they may well need to take leave of absence from work and require help and support for several days post-operatively.

Unfortunately, although giving verbal warnings as outlined above will ensure that the surgeon complies with the "letter of the law" they may not be sufficient to ensure that he or she complies with the "spirit of the law". Almost 50% of patients may fail to recall being verbally warned about at least one complication postoperatively (5). Patient recall of preoperative warnings and by implication the extent to which their consent was fully informed can be increased by the use of written information to supplement the standard verbal warnings (9, 10). Audio and video tapes can also be used during the consultation and while obtaining patient consent. These have the benefit of standardisation and ensuring that all the points deemed to be relevant are covered for every patient.

It is important that consent is obtained from the patient not only preoperatively but also in quiet surroundings, before any drugs have been administered and in an area remote from that where the procedure is to be performed (11). This means that it is unacceptable for a patient to be interviewed and consented by the operating surgeon in the anaesthetic room immediately prior to the operation being performed.

The clinician charged with obtaining the patients' consent must have a clear understanding of the procedure to be performed and the possible complications if he or she is to be able to adequately answer patients' questions and concerns. This task is frequently delegated to the most junior member of the team who is often too inexperienced to obtain fully informed patient consent and has probably never been

instructed on the medico-legal requirements of doing so (12). When completing the proposed treatment section of the consent form the clinician must always consult the relevant sections in the patients' case notes and satisfy himself or herself that the patient is being consented for the intended treatment. One must never rely on operating theatre lists or departmental theatre books etc for this information. All too often these records will be incorrect due to typographical or transcription errors. If there is any doubt concerning the exact nature of the treatment proposed the supervising clinician, usually the consultant oral & maxillofacial surgeon should be consulted.

Everyone involved in obtaining patient consent in the UK should read and understand the National Health Service Executive document *A guide to consent for examination and treatment* (13).

Children under the age of 16 years (18 in the US unless the patient is married) may give or withhold their consent for treatment without recourse to their parent or guardian if the clinician believes that they are mentally capable of making an informed decision. Whenever the clinician is not satisfied that a child is able to fully understand the proposed procedures and their complications, consent must be sought from the child's parent or legal guardian except in emergency situations where there is insufficient time to obtain it (13). In exceptional circumstances, and after full discussion with the child's parents in the presence of a witness, if the clinician believes that a parent's refusal to give consent for treatment is likely to prejudice the continuing health of the child, he or she may seek to have the child made a ward or court and request consent from a judge. If time does not permit this process, then the surgeon in charge of the child's care (normally the consultant oral & maxillofacial surgeon) should seek and obtain a written report from a consultant colleague

supporting the view that the child's life would be in danger if treatment were to be withheld. Where adult patients lack the mental capacity to give informed consent no-one may give consent on their behalf although the law allows treatment to be performed provided it can be demonstrated to be in the best interests of the patient. Such treatments should be discussed with the patients' next of kin where possible but ultimately the decision to proceed with treatment rests with the clinician in charge of the patients' care.

Provided the surgeon follows the above procedures and is demonstrably acting in the patient's best interests it is unlikely that his or her actions will be criticised by a court or their professional body (13). Indeed, in certain circumstances failing to provide necessary treatment may be construed as negligent. If time permits, the surgeon would be wise to consult his or her medical indemnity association to seek expert legal guidance before commencing any treatment for which the patients' written consent has not been obtained.

Having obtained fully informed consent, all warnings and explanations given should be recorded in the case notes and the patient or parent requested to sign a consent form stating that they have been informed of, and understand the nature and likely consequences of the procedure. Specimen consent forms which conform to the above standards and guidelines are available for patients being treated within the UK National Health Service (13). A patients' signature on a consent form in the absence of having obtained fully informed consent is no protection in law against a claim for failing in one's duty of care to the patient.

## Final Checks

Not infrequently, patients will have been on a waiting list for some time prior to their operation. It is vitally important to check that the problem for which they are about to be operated on has not resolved and no longer requires treatment or that the original signs and symptoms have not altered such as to present a different diagnosis and treatment plan to the original ones. In this situation, and if operative treatment is still indicated the entire process of obtaining informed consent should be repeated.

Written consent should be contemporary with the treatment to be undertaken and where it has been obtained some time in the past it should be repeated. In the US some hospitals have their own rules on the appropriate timing of consent prior to treatment although it is left up to the discretion of the individual surgeon when working from his or her own office.

Immediately prior to making the initial incision or the application of forceps and elevators to a tooth the operating surgeon must re-check the patients' notes and consent form to ensure that the correct procedure is about to be performed at the correct site and on the correct patient! This is particularly important where the operating surgeon is not the person who obtained the patients' consent. Where multiple teeth are to be extracted and in every case of extractions for orthodontic purposes it is wise for the surgeon to clearly note the teeth to be extracted on a chart or wall board that is legible from the chair/table side to act as a final check before proceeding to extract each and every tooth.

It is imperative that there is adequate surgical access to and exposure of the operative site. Incisions must enable the operator to fully and safely visualise the

entire operative area with minimal need for tissue retraction and be sited with due regard to surrounding vital structures and aesthetics. All other things being equal, an incision 2 cm long will heal as well and as quickly as one 1 cm long. It thus makes little sense to operate through a “key hole” as this will increase the risk of damage to surrounding tissues as a result of traction and tearing.

It should be remembered, particularly by junior surgeons in training that it is the operating surgeon who is ultimately responsible morally and legally for his or her own actions. This is especially relevant in the hospital setting where not infrequently the surgeon performing the operation is not the one who obtained the patients consent (8).

On completion of the operation all extracted teeth, roots, instruments, needles and swabs must be accounted for to ensure nothing has been left in the surgical wound. Where a throat pack has been placed preoperatively in order to protect the airway it is the surgeons responsibility to ensure that this has been removed, to directly inform the anaesthetist that he or she has done so and to ensure that it has been recorded in the patients operation notes. Failure to follow this protocol will one day result in a patient suffering a respiratory arrest shortly after extubation with potentially fatal consequences.

Before discussing individual complications in more detail it is worth stating that even in the best and most experienced of hands accidents will happen and operations will go wrong. In these situations, having expedited all necessary measures and treatment commensurate with the surgeons skill and experience, it is vital that every detail is recorded in chronological order and dated in the patients’ case notes. Once recorded, alterations to the original entries must not be made. The patient must be fully informed of what has happened, why it happened and the steps that have and

will be taken to remedy the situation. In all things "honesty is the best policy" and many medicolegal claims can be averted by adopting this strategy.

# PERIOPERATIVE COMPLICATIONS

## Extraction Of The Wrong Tooth

Extraction of the wrong tooth is an avoidable error which can easily be prevented by ensuring that proper identification of the patient and tooth to be extracted is made (14). Teeth commonly extracted in error are upper canines instead of upper first premolars, lower permanent premolars simultaneously with lower deciduous molars and upper second molars instead of upper third molars. The latter is particularly liable to occur if the upper third molar is partially erupted and difficult to visualise. Being aware of the possibility of these errors and "counting out" the tooth to be extracted will go some way to minimising their occurrence. A common source of confusion is the correct identification of one of 2 molar teeth when the other molar is missing or absent. Although a naming convention exists for just this situation, long hand notation such as "the first standing lower right molar" instead of the lower right 7 or 47 may help avoid confusion where the third molar is erupted and the first molar is absent. A similar situation occurs when only one of 2 unerupted and adjacent teeth are to be extracted. Again, this is commonly requested as part of an orthodontic treatment plan and as such should be avoided at all costs (Figures 2 & 3).

If the wrong tooth is extracted the surgeon should proceed with removing the correct tooth unless the extractions are for orthodontic purpose when it may be better to seek the advice of the patients' orthodontist first. The tooth extracted in error, particularly if it is otherwise healthy, should be immediately replaced in its socket. If

mobile it should be held in place with a custom made vacuum-formed splint for approximately 4 weeks (14). It is likely that it will subsequently require to be root filled and if there is any doubt about its prognosis the advice of a consultant restorative dentist should be sought .

## Fractured And Damaged Teeth And Restorations

Teeth adjacent to the index tooth may be fractured, loosened in their sockets, subluxed or even extracted by the injudicious application and use of elevators. This is particularly likely to occur if the adjacent tooth rather than the inter-radicular bone is used as a fulcrum for the elevator and the elevator is being used as a lever against the adjacent tooth. Fracture of the distal root of the upper second molar during elevation of an impacted upper third molar may occur following excessive use of force consequent on inadequate bone removal.

Damage to adjacent tooth roots can occur during bone removal performed for apicectomies and surgical extractions. Close inspection of the preoperative radiographs and noting the long axis of the tooth to be operated on is vital if only the bone overlying the index tooth is to be removed. Special care should be paid to apicectomies on previously post-crowned teeth. Not uncommonly, the long axis of the crown will be divergent from the long axis of the root. If this is not appreciated preoperatively extensive bone removal in an area distant to the index root apex may be performed and the wrong root apicected. Root apices may be very close together, particularly in the mandibular and maxillary incisor regions. Close attention must be paid to crown/root orientation when apicecting these teeth if collateral damage is to be

avoided. Frequently, a sinus will perforate the buccal plate acting as a guide to the site of the root apex beneath it.

Opposing teeth and restorations may be damaged if excessive force is applied to a tooth *via* forceps or elevators and the tooth suddenly "gives" resulting in the instrument forcibly contacting teeth in the opposing jaw. Not uncommonly, the distal box of a restoration or an overhanging ledge on an inlay or crown in a lower second molar will be dislodged if the adjacent lower third molar is elevated against it. If possible the restoration should be attended to by the patients' dental surgeon before the third molar is removed. If a restoration is dislodged it is vital that all debris is thoroughly removed from the extraction socket and the tooth dressed with a temporary restoration until such time as it can be made permanent.

Fracture of a tooth or root during exodontia is the commonest complication encountered in minor oral surgery (3, 14). Poor extraction technique, in particular using the wrong extraction forceps, applying the forceps too close to the amelo-cemental junction and too far from the root apex and injudicious use of elevators are undoubtedly the major causes of tooth/root fractures during exodontia. This complication is thus inversely proportional to the experience of the operator. Indeed, complications of all types following the surgical removal of impacted third molars have been reported to be significantly higher when performed by less experienced surgeons (15). There is thus a strong case to be made for suggesting that ambulatory oral surgery operating lists should be performed by the most senior clinician available if unnecessary complications and unplanned hospital admissions are to be avoided.

Simple exodontia involving forceps and elevators depends on the ability of the index tooth to expand the bony tooth socket walls to facilitate its own delivery. If the alveolar bone is too dense to allow sufficient expansion to occur or the tooth roots are

too brittle to expand the bone failure is assured. In some cases the age, sex, racial origin and physique of the patient may alert the surgeon to the possibility of a difficult extraction although in community dwelling adults age is not a risk factor for complications following simple extractions (16). Patients with a history of "difficult extractions" often have non-vital and brittle teeth surrounded by dense unyielding bone. These "glass in concrete" teeth are also better tackled *via* an elective transalveolar approach. Even then the surgeon may have to use the bur to cut out every last fragment of tooth root due to repeated fractures when elevators are applied.

If preoperative radiographs have not been taken the surgeon will be unaware of the teeth that have grossly curved, divergent, dilacerated, hypercementosed or fused roots. Attempting simple forceps extraction of such teeth will inevitably result in failure to complete the procedure or severe collateral damage. Where these dental conditions are diagnosed on a preoperative radiograph the surgeon will be forewarned of the problem and can take appropriate measures to circumvent complications. For the most part this will involve electing to remove the tooth *via* a transalveolar approach following judicious removal of overlying buccal bone (Figure 4).

As a general rule all fractured roots should be removed as soon as they are produced. However, it is important to realise that in some circumstances root removal may do more harm than good, particularly if they are close to structures such as the neurovascular canal, maxillary sinus and lingual plate of the mandible. Small apices, especially if associated with a previously vital and uninfected root can be safely retained (17). The advice of the Arabian physician Avicenna (A.D. 980-1037) "The cure of a disease must never be worse than the disease itself " is particularly relevant here. If it is elected to leave a root *in situ* the patient should be informed and the reasons for the decision documented in their case notes.

## Tooth Displacement

Instead of the tooth being delivered safely from its socket into the mouth it may be displaced into any one of a number of potentially hazardous areas including:

- The maxillary sinus
- Tissue spaces
- Inferior dental canal
- Aerodigestive tract

### The Maxillary Sinus

The apices of the upper premolars and molars are normally close to the floor of the maxillary sinus. Uncontrolled upwards pressure from extraction forceps or elevators may force a tooth into the sinus. This is particularly prone to occur with conical single rooted premolars and the palatal roots of molars, especially when a Coupland elevator is forcibly inserted up the periodontal ligament. If a tooth is displaced into the sinus it is imperative that it is removed as soon as possible. If the tooth cannot be readily visualised then radiographs of the area in 2 planes at $90^0$ to each other should be taken to locate it (Figures 5 & 6). The transalveolar route should then be used and the tooth/root delivered into the mouth *via* inferiorly directed pressure from a suitable elevator. If there is to be any appreciable delay in removal broad spectrum antibiotics should be prescribed to minimise the risk of infection and subsequent breakdown of the mucosal repair.

**Tissue Spaces**

It is usually the third molars that fall victim to displacement into adjacent tissue spaces. Unerupted upper third molars in particular are at risk from this complication but no tooth is immune. The majority of upper third molars have a natural path of withdrawal that takes them posteriorly and inferiorly. When the tooth is erupted this will usually ensure safe delivery into the mouth. However, when the tooth is unerupted and a buccal mucoperiosteal flap has been elevated the tooth may slip behind the maxillary tuberosity and into the pterygomaxillary space from where it may migrate into the deep structures of the neck (Figure 7). To prevent this potentially disastrous situation occurring it is imperative that an instrument is always placed behind the upper third molar which is kept under direct vision at all times during its extraction. The Laster retractor, inserted around the back of the tuberosity is arguably the most useful instrument in this situation as not only does it physically prevent the upper third molar being displaced posteriorly but it also forms a light reflective guide channel for the elevator thus improving visibility and protecting the soft tissues of the lip and commisure which are frequently injured during this manoeuvre (Figure 8).

Lower teeth are less prone to displacement than uppers but they can be so affected. Lingually placed lower third molars and their roots may occasionally be pushed through a thin or absent lingual plate into the floor of the mouth or below the mylohyoid from where they can migrate into the neck. Similarly, lingually placed lower premolars, particularly when unerupted may be displaced into the lingual tissues. The latter situation is prone to occur if these teeth are “tapped out lingually” using a mallet and elevator. On occasions, direct upwards digital pressure below the mandible will bring the displaced tooth or root into sight and facilitate its removal. As

with displaced upper teeth it is vital that the position of the lost tooth or root is located *via* radiographs before attempting extirpation unless it can be easily and directly visualised immediately post-displacement for fear of exacerbating the situation. Radiographs in 2 planes at $90^0$ should be taken and a lower occlusal and OPT are the radiographs of choice. If the situation cannot be rectified immediately the patient should be placed on antibiotics and referred to a consultant oral & maxillofacial surgeon for urgent assessment and treatment. It may be possible to remove the tooth or root *via* a standard transalveolar approach but more often the floor of mouth or even extraoral route will be required depending on its position.

**Inferior Dental Canal**

If lower molar roots are fractured during elevation and the decision is taken to proceed with their removal it is important that they are lifted out of the socket rather than displaced further into its depths by the incorrect use and application of elevators. Over zealous use of the Cryer elevator in particular can gouge out the roof of the inferior dental (ID) canal into which the root can be subsequently pushed. As in all situations, adequate exposure and illumination so as to afford good surgical access is a pre-requisite. A fine round bur should be used to remove a channel of bone adjacent to the retained root sufficient to allow its elevation upwards out of the socket. If a root fragment is displaced and not readily visualised radiographs in 2 plains should be taken. Again a lower occlusal and OPT are the radiographs of choice. Once localised judicious removal of the roof of the ID canal is undertaken until the retained fragment is found. Thereafter a blunt instrument such as a curved Warwick James elevator can be insinuated beneath the fragment which is carefully lifted off the neurovascular bundle.

**Aerodigestive Tract**

It is all to easy for an extracted tooth or dislodged fragment to be swallowed or worse still inhaled. Teeth with single conical roots are sometimes ejected from their sockets unexpectedly during exodontia and patients will occasionally move violently just as a tooth is being delivered (especially if they are nervous and/or the depth of analgesia is inadequate). In these circumstances the tooth may disappear over the dorsum of the tongue into the pharynx upon which the patients gag reflex is activated compounding the problem. This complication is more likely to occur if surgery is performed with the patient supine and without adequate airway protection. Wherever possible extractions and surgical procedures performed under local anaesthesia with or without sedation in the dental chair should be executed with the patient placed at about $60^0$ to the horizontal. Any tooth or restoration fragments should be immediately removed by the surgeon or the assistant. Where patients are to be treated under general anaesthesia if the airway is not protected *via* an endotracheal tube or laryngeal mask etc. the patient should be placed at about $60^0$ and a well fitting pharyngeal pack placed to protect the airway. In most circumstances this will consist of an opened out surgical swab or a sponge laid across the back of the tongue to occlude the oropharynx. Even when an endotracheal tube has been placed the airway is still at risk and the pharynx should be occluded with a throat pack. Many anaesthetists use ribbon gauze for this purpose which although adequate for the task can abrade the delicate mucosal lining of the pharynx both on insertion and removal adding to the postoperative discomfort. In contrast, 2 tampons inserted one either side of the endotracheal tube ensure complete pharyngeal occlusion without traumatising the mucosa. As mentioned previously, it is the surgeons responsibility to ensure that any throat pack is removed on the completion of treatment.

If a tooth is dislodged into the unprotected pharynx with any luck the patient will swallow it and it will pass naturally in several days time. However, it may well be inhaled, and due to the manner in which the trachea branches at the carina not infrequently becomes lodged in the right main bronchus. This situation will usually be greeted by violent fits of coughing but may be silent. If such a situation occurs or the tooth cannot be immediately accounted for an urgent chest and abdominal x-ray should be ordered. If the patient is being treated outside of a hospital environment they should be immediately referred *via* telephone to the local accident and emergency or oral & maxillofacial unit. If the tooth is seen to be lying in the lung the patient is urgently referred to either a cardiothoracic surgeon or respiratory physician for bronchoscopy. If the tooth is seen within the stomach the patient is reassured that all should be well and is recalled for repeat abdominal x-ray in a weeks time. If the tooth has failed to pass a general surgical opinion should be obtained as soon as possible.

## Fractures And Dislocations

### Extraction Sockets And Access Cavities

Minor and inconsequential fractures of the tooth socket and inter-radicular bone occur frequently during exodontia. Provided that any bone chips are removed from the wound little harm is done. It is important to ensure that the socket edges are smoothed and no sharp spicules remain. Uneven and sharp alveolar ridges are a major source of postoperative discomfort and severely compromise the patients' ability to wear a denture comfortably. One manoeuvre to be particularly deprecated is the placement of the beaks of extraction forceps outside a tooth socket and then crushing the enclosed bone in order to deliver a fractured and retained root fragment. This

causes excessive damage to the bone and often mutilates the overlying mucosa. If large pieces of devitalised alveolar bone or bone dust from rotary instruments are left behind postoperative pain and infection is almost assured. Following transalveolar surgery of any type it is vital that the operative area is thoroughly irrigated with copious amounts of 0.9% saline. One should pay particular attention to the depths of buccal mucoperiosteal flaps and the lingual aspect of lower third molar sockets if a lingual flap has been elevated.

**Alveolus**

The same factors that predispose to fractured teeth also predispose to alveolar fractures, namely poor extraction technique, malformed teeth and dense alveolar bone. Upper canines and upper molars, especially in well built young males are particularly prone to result in alveolar fracture. On rare occasions, large sections of buccal or palatal bone may be avulsed with the offending tooth. Again, many cases can be avoided by thorough preoperative clinical and X-ray examination and the avoidance of forceps extractions in high risk teeth and patients.

Fractures of the maxillary tuberosity are a special sub-group of alveolar fractures. Tuberosity fracture is prone to occur if elevators are used to extract fully erupted upper third molars or excessive force is used during the forceps extraction of lone standing upper molars. In the latter case, loss of neighbouring teeth frequently results in marked alveolar bone loss with encroachment of the maxillary sinus floor towards the alveolar crest. If preoperative radiographs suggest tuberosity fracture is likely then an elective transalveolar approach should be used.

Where an alveolar fracture occurs, immediate management will depend on its extent. Small avulsed fragments effectively confined to the extracted tooth socket

require no special treatment although the postoperative alveolar form will not be ideal and may compromise future prosthetic rehabilitation. Larger fragments still attached to mucoperiosteum should ideally be replaced and the segment immobilised *via* arch bars or a vacuum-formed splint for approximately 4 weeks. Following which the offending tooth is extracted *via* an elective transalveolar approach. If a substantial alveolar segment is avulsed and detached from the overlying mucoperiosteum it is likely that it will not survive if replaced. Maxillary tuberosity fractures not uncommonly fall into this category. The avulsed bone should be carefully released from any remaining soft tissues using a periosteal elevator. A large oro-antral communication is virtually inevitable in this situation. However, following the loss of the bone there is usually sufficient soft tissue to allow for a tension free closure. Sutures should be left in for at least 10 days and the patient prescribed a broad spectrum antibiotic together with 0.5% ephedrine nasal drops and enjoined not to blow his or her nose for 2 weeks for fear of causing the soft tissue closure to breakdown. All surgeons who practice exodontia must be able to manage this complication in the manner described on-site immediately the problem occurs.

**Fractured Mandible**

This is probably the most feared of all complications following minor oral surgery and like the majority of them is largely preventable (Figure 9).

Close inspection of preoperative radiographs will demonstrate the impediments to tooth delivery and facilitate the formation of a treatment plan designed to overcome the problems. Judicious bone removal and tooth division followed by controlled elevation will be successful in virtually all cases. Very rarely the tooth to be removed may be situated in an area where the bone is extremely thin as a result of

pathological loss or age changes. Even in this situation fracture is not inevitable although it may be prudent to apply direct fixation to the jaw either internally or externally to support the area in the early postoperative period. Patients should be advised to consume a soft diet for several weeks and to return immediately if they become aware of any abnormalities in the jaw. These patients should be treated in a hospital environment with access to the necessary equipment should a fracture occur. If a mandible is fractured unexpectedly and the patient is already under general anaesthesia the surgeon should proceed directly to fixing the fracture and fully explain the situation to the patient postoperatively. If the fracture occurs under local anaesthesia and outside of a hospital environment the patient should be immediately referred *via* telephone to the local oral & maxillofacial surgery unit for urgent assessment and treatment.

**Temporomandibular Joint Dislocation**

It can be extremely uncomfortable for patients having a lower molar extracted not because of pain at the surgical site but because of traction on the temporomandibular joints (TMJ) consequent on the surgeon pushing down on the tooth with the extraction forceps. It is important that the surgeon fully supports the mandible during extractions in order to relieve stresses on the TMJ. Some patients find even light pressure uncomfortable and in this situation placing a rubber bite prop between the contralateral posterior teeth and asking them to gently bite on it will usually allow the extraction to proceed to completion. Where extractions are performed under general anaesthesia it is all too easy to forget the TMJ. On completion of treatment immediately prior to removing the throat pack the surgeon should manipulate the mandible into centric occlusion to ensure that it is not

dislocated. If it is then the dislocation should be reduced before the anaesthetic is reversed and the patient woken up.

## Soft Tissue Damage

### Mechanical Trauma

The rich blood supply to the head and neck region usually ensures that all but the most abused and damaged tissues will eventually heal. However, it cannot be stated too frequently that the key to minimising surgical complications is meticulous preoperative planning and surgical technique. In particular, gentle handling and respect for the oro-facial soft tissues is mandatory. This is particularly important when making elective incisions around the face. Wherever possible incisions should be placed in the lines of election which are at right angles to the direction of the resultant action of the underlying muscles of facial expression (18). Gentle handling of the soft tissues specifically avoiding crushing and tearing the wound margins and approximating the skin edges without tension is vital to success ("tight enough today - too tight tomorrow"). Patients with a previous history of hypertrophic or keloid scar formation should be treated by surgeons with considerable expertise in facial soft tissue surgery.

One of the most disturbing sites to see on a postoperative ward round is the patient who has excoriated and swollen lips and commisures due to careless tissue retraction. This complication which is more likely to occur under general anaesthesia than local anaesthesia displays an unacceptably casual attitude on the part of the surgeon for the care of his or her patient. Copious amounts of vaseline or moisturising cream should be applied to the lips to lubricate them preoperatively and

repeated throughout the procedure. Highly polished instruments should be used and the commisures protected with a gauze swab and cheek retractor (Figure 10). The commonest scenario leading to damage to the lips and commisures is when they are trapped between a Howarth's periosteal elevator used as a flap retractor and the neck of the elevator being used to extract an upper third molar, especially if the extraction is difficult because of poor visibility and surgical access. It is all too easy to get carried away with the extraction and neglect the soft tissues. The Laster flap retractor provides unparalleled protection in this situation and is highly recommended.

Lacerations to the soft tissues can be caused by careless handling of scalpels, elevators, forceps scissors and sutures. In fact any surgical instrument may cause collateral damage if the surgeon loses concentration. Eye protection must always be used when treating patients supine. It is appropriate at this point to condemn the practice of the single handed operator who, in order to facilitate access to the mouth inserts one end of a cheek retractor in the patients' commisure and the other end through the waist tie on the surgical gown. This is an extremely dangerous technique which can easily lead to severe damage to the patients' soft tissues if the operator should slip backwards. A not uncommon occurrence!

**Thermal Trauma**

While all instruments should be autoclave sterilised wherever possible it is vital to ensure that they are cool before coming into contact with the patient. Surgical handpieces that are not serviced regularly and properly maintained are prone to bearing failure. This will cause the handpiece to overheat in normal use. Especially if old burs are used in an attempt to save money and excess pressure is applied to the blunt bur because it cuts inefficiently. The hot handpiece then comes into contact

with the patients' soft tissues resulting in a deep burn. This is an indefensible disaster and the cosmetic results can be truly appalling. If a surgical handpiece is running hot it should be immediately discarded and sent for repair or condemned. A note to this effect should be recorded in the operating theatre equipment log and the surgeon should refuse to use it. If a replacement instrument cannot be provided and there is no other safe way of completing the operation then the procedure should be abandoned and the patient informed of the reason why. If a surgeon injures a patient with an instrument that is known to be defective then he or she will only have themselves to blame when they are sued for negligence.

Poor vigilance while using an electrical cautery or laser is another indefensible cause of damage to surrounding soft tissues. When these instruments are in use, non-conducting and non-reflective retractors should be used and in the case of lasers all surrounding areas should be protected by wet swabs. Extreme care should be used when using monopolar cautery to coagulate a blood vessel *via* a non-insulated pair of tissue forceps in case they should come into contact with the surrounding soft tissues.

**Nerves**

The terminal branches of the trigeminal and facial nerves are the ones most at risk from accidental damage during minor oral surgical procedures. The inferior dental nerve is at risk of damage during removal of lower third molars, during apicectomy of lower premolar and molar teeth, the placement of intraoral implants and soft tissue surgery around the mental foramen, especially in the elderly where the mental nerve may lie at or close to the alveolar crest. The lingual nerve is at risk during the surgical removal of lower third molars the placement of intraoral implants and incisions in the floor of the mouth for the removal of submandibular duct calculi

and biopsies etc. Both nerves may be damaged by inadvertent direct nerve puncture while administering an inferior alveolar nerve block. Less frequently documented is damage to the infraorbital, buccal and incisive nerves. Mention has already been made about the risks to the facial nerve from facial skin incisions etc.

The incidence of transient inferior alveolar nerve damage following lower third molar removal varies between 1.3% (19) and 7.8% (20). Between 0.5% and 1% of all lower third molar extractions results in permanent damage to the inferior alveolar nerve (21). Following lower third molar extraction the incidence of permanent lingual nerve sensory disturbance necessitating nerve repair lies between 0.3% and 0.8% (22). The health, social and financial impact to the patient of these and other postoperative sequelae are frequently underestimated by clinicians (23). It is mandatory that patients are fully warned about these possible complications preoperatively. A few patients when so warned will decline their consent to undergo surgery.

Potential damage to the inferior dental nerve during third molar extraction can be anticipated in most circumstances by thorough examination of a high quality preoperative radiograph of the area. Narrowing, loss of definition or acute change in direction of the neurovascular canal in the immediate vicinity of the lower third molar roots is highly suspicious of root notching or actual perforation by the neurovascular bundle (Figure 11). In this situation, unless the tooth is symptomatic or there is an exceptionally good reason for its removal it should be left *in situ*. If removal is indicated then a transalveolar approach with wide access to the surgical field and root sectioning should be employed. With careful handling the root can be divided so as to free the entrapped neurovascular bundle (Figure 12).

Forcible elevation of a deeply impacted lower third molar, particularly one with a long mesial root is clumsy and can crush the contents of the neurovascular canal. This is symptomatic of hasty and ill planned surgery. It is far better and safer to section deeply mesioangular impacted teeth both horizontally and vertically and remove the crown and individual roots separately.

Transient labial paraesthesia following lower premolar/molar apicectomies is common as a result of mental nerve traction but permanent damage can and should be avoided. Broadly based 3 sided mucoperiosteal flaps carefully elevated from the bone afford excellent surgical access. Semi-lunar incisions should never be employed in this area. The mental foramen and the emerging mental nerve must always be identified and protected with a highly polished blunt flap retractor. Bone over the apices of the tooth to be apicected is removed carefully and under constant direct vision. In the case of lower molars it is safest to section the root near its midpoint rather than the apical third as this will take the bur away from the neurovascular canal and also make subsequent amalgam placement easier.

The lingual nerve not uncommonly lies superficially at the alveolar crest in the retromolar triangle. Careless mucosal incisions in this region can easily sever the nerve before any flaps are raised or bone is removed. The distal incision must always be angled laterally to take it away from the lingual aspect of the ramus. Standard teaching is that the incision should be taken up the external oblique ridge. It is important that this incision is kept as short as possible in order to avoid severing the buccal nerve as it crosses the anterior surface of the mandibular ramus in this area (24). Likewise, avoidance of a buccal relieving incision by the use of an envelope flap will minimise accidental damage to the buccal nerve in the sulcus while affording excellent surgical access (Figures 13 & 14).

The course of the lingual nerve may be very variable and in 17.6% of cases it may lie at or above the level of the alveolar crest (25). Incisions in the floor of the mouth must always be placed with due regard to the direction and level of the lingual nerve. In particular, dochotomy of the submandibular duct to release a calculus must be done with extreme care as occasionally fibrosis around the stricture will have pulled the underlying lingual nerve upwards placing it at risk from an incision over the duct. Similarly, sutures placed around the duct to prevent distal migration of the calculus can easily damage the lingual nerve if they are placed to deeply in the floor of the mouth.

Debate over how to protect the lingual nerve from damage during lower third molar removal has raged for many years. There is good evidence to show that rather than affording protection to the nerve and reducing lingual nerve damage, the placement of the traditional Howarth's periosteal elevator actually increases the frequency of nerve trauma (Figure 15). Robinson *et al* (22) have demonstrated a highly significant reduction in the incidence of temporary lingual paraesthesia when lower third molars were removed without placing a Howarth's down the lingual side of the mandible compared to when a Howarth's was used. This technique was not associated with an increased incidence of permanent lingual nerve problems. There will undoubtedly be occasions where lingual flap retraction followed by the careful and correct placement of an instrument to protect the lingual nerve is necessary in order to accurately and safely visualise a particular lower third molar. However, avoidance of the routine use of traditional lingual nerve protection *via* a Howarth's is to be recommended wherever possible.

Intraoral implants, particularly mandibular endosseous implants are emerging as yet another cause of litigation resulting from iatrogenic nerve damage (26). Poor

preoperative planning and imaging together with the careless siting of endosseous implants may damage the inferior alveolar nerve either within the mandibular canal or after its exit from the mental foramen. The prevalence of altered inferior alveolar nerve sensation following the placement of mandibular endosseous implants has been reported to be as high as 36% of which 23% of cases were transient and 13% of cases were persistent at 6 months or more post implant placement (26). Although uncommon, transient lingual nerve paraesthesia has also been reported where mandibular endosseous implants have perforated the lingual cortical plate (27).

Inferior alveolar nerve repositioning to facilitate the placement of endosseous implants posterior to the mental foramen is associated with a very high incidence of temporary inferior alveolar nerve damage. In one series inferior alveolar neurosensory dysfunction was present in 70% of patients at 1 week before falling to 20% at 6 months and 0% at 1 year postoperatively (28). However, the technique enables the placement of more and longer implants resulting in increased prosthesis strength and stability and has a lower permanent dysaesthesia rate than when a non-transposed nerve has been accidentally damaged by drilling or implant placement (29). If such a technique is to be used it is vital that the patient is fully informed about the possibility of temporary and permanent inferior alveolar nerve paraesthesia.

The raising of full palatal flaps to gain access to impacted canines or supernumerary teeth can damage the incisive nerves as they exit the nasopalatine foramen. If at all possible the nasopalatine neurovascular bundle should be preserved intact as division of the nerves produces unpleasant premaxillary mucosal paraesthesia which may result in accidental thermal trauma to the premaxillary mucosa from hot food and beverages.

The infraorbital nerve is not commonly involved in procedures typically classified as minor oral surgery. However, it may be damaged by careless retraction of buccal flaps during upper incisor or canine apicectomies. It is also at risk from direct damage from infraorbital nerve local anaesthetic blocks. Gentle tissue handling and thorough appreciation of the local anatomy should prevent this complication arising.

**Blood Vessels**

Bleeding from severed vessels is inevitable and if excessive should be controlled by ligation or electro-cautery. If troublesome bleeding occurs from an intrabony vessel this can usually be arrested by crushing the surrounding bone walls with the tips of a curved haemostat or with small amounts of sterile bone wax. Bleeding from the pterygoid plexus can be worrying but will usually respond to direct pressure applied *via* a gauze swab. Occasionally profuse bleeding will be encountered from a severed inferior alveolar artery. This may occur because of inadequate preoperative planning, injudicious use of an elevator in the depths of the socket or cutting too close to the neurovascular canal while removing bone or sectioning a tooth. It is vital that adequate suction is always available should this event occur. The socket is packed under pressure with ribbon gauze which invariably will control the situation. This should be left undisturbed for 15 minutes and then slowly removed. If all bleeding has ceased the socket should be left open for a further 15 minutes before primary closure is undertaken in case a re-bleed occurs shortly after pack removal. If bleeding recurs the socket should be packed with ribbon gauze soaked with BIPP (Bismuth Subnitrate Paraform Paste BPC) and left *in situ* for 24 hours.

Very occasionally, a tooth socket may be involved with an arterio-venous malformation. Clinical clues to this possibility may be associated cutaneous haemangiomata, marked perioperative bleeding from around the tooth or a patient with the Sturge-Weber syndrome. The surgeon should be very wary if an otherwise healthy tooth becomes mobile, especially if it is a permanent tooth in a child as it may be being pushed out of the socket by an arterio-venous malformation. As always, thorough examination of preoperative radiographs should alert the surgeon to the presence of any local abnormalities (Figure 1). Any suspicious cases should be referred immediately to a consultant oral & maxillofacial surgeon who can arrange for CT scans and angiograms to be performed if appropriate. If torrential bleeding occurs when a tooth is extracted the tooth should be replaced in the socket and the patient should be instructed to bite firmly together as this will provide the closest fitting socket plug available. Otherwise gauze packing should be used. If the patient is not already in hospital an ambulance should be summoned and immediate transfer to the nearest specialist oral & maxillofacial surgery unit arranged.

It is beyond the scope of this chapter to fully discuss the management of patients taking oral anticoagulants. Suffice it to say that if a patients' INR (International Normalised Ratio) is greater than 2.0 minor oral surgery may result in persistent bleeding. Irrigating the operative site with 10ml of a 4.8% solution of tranexamic acid followed by an 8 hourly 2 minute mouthrinse for 7 days with 10ml of the solution has been shown to be highly effective in reducing postoperative bleeding in patients with INR's between 2.1 and 4.0 without having to modify their oral anticoagulation dosage (30). However, such patients should be referred to a consultant oral & maxillofacial surgeon for treatment as in some cases they will need to be admitted to hospital and heparinised prior to stopping their warfarin before surgery

can be safely undertaken. If the INR is less than 2.0 simple extractions with full local heamostatic control should not be problematical. Inferior alveolar nerve blocks should not be used in patients who are anticoagulated.

## Broken Instruments

Modern instruments are manufactured to high standards and are unlikely to fail if they are used correctly and properly maintained. Suture needles, hypodermic needles and surgical burs are the items that most frequently fail in use.

Suture needles are probably the commonest items to be broken during minor oral surgery. Careless handling and faulty technique probably account for the overwhelming majority of breakages. In order to minimise bending stresses on the suture needle the surgeon should always select a needle of the appropriate gauge. Attempting to force thin needles through thick and tough tissues will inevitably result in needle fracture. The suture needle should be grasped in the middle of its concavity by the tips of the needle holders and rotated not pushed through the tissues. Choice of needle holder is largely a matter of personal preference but serrated instruments such as artery forceps must never be used as needle holders. If the suture needle becomes bent it should be discarded, the surgeon must never attempt to straighten it because if the needle doesn't fracture immediately it is liable to do so when next inserted into the tissues. Suture needles are particularly prone to being damaged when placing interdental sutures as they often engage bone or tooth rather than passing cleanly in between the teeth.

A new disposable hypodermic needle should be used for each patient and should never be intentionally bent or grasped with forceps prior to use. Breakage is uncommon but when it does occur is usually due to either a sudden violent movement by the patient, faulty technique or a structural fault in the needle itself during either an inferior alveolar or posterior superior alveolar nerve block (4).

All burs should be clean, sharp and straight. Applying excessive force to a blunt, worn bur generates excessive heat in the substance being drilled, damages the handpiece bearings hastening their failure and increases the likelihood of bur fracture. As soon as the surgeon detects that the bur has lost its edge it should be discarded and replaced with a new one.

As a general rule all fragments of broken instruments should be removed immediately before they have time to migrate deeper into the tissues. Whenever administering a local anaesthetic injection there should always be a pair of artery forceps readily available in case the needle should break. If the broken end projects into the mouth it is easily grasped with the forceps and removed. Likewise broken suture needles and burs are best retrieved with fine artery forceps immediately on fracture. If the fragment cannot be found radiographs in 2 planes at $90^0$ should be taken of the operative area to locate it. At this point a decision will need to be made as to whether to remove the fragment or leave it *in situ* depending on its size and site. Small fragments lying subperiostealy can be safely left as they are unlikely to migrate and cause problems (4). If the decision is taken to remove the fragment the operative approach will depend on where it is located and a thorough knowledge of the local anatomy is essential if further complications are to be avoided. It should be remembered that small fine foreign bodies can be extremely difficult to locate and that blind exploration of tissue spaces is wont to displace them deeper. The use of image intensification can be very helpful in this situation.

# POSTOPERATIVE COMPLICATIONS

## Pain And Swelling

Apprehension over the severity and extent of postoperative pain and swelling is extremely common in patients about to undergo minor oral surgery, particularly third molar removal. Instituting active measures to maximise any reduction in postoperative pain and swelling is an integral part of high quality patient care.

The efficacy of systemic analgesics is greatly enhanced if patients are given regional local anaesthetic blocks or infiltrations perioperatively (31). Inferior dental nerve blocks administered perioperatively for patients undergoing lower third molar removal under general anaesthesia improves pain control in the early postoperative period. However, it is vital to warn patients about the possibility of accidental injury from biting or thermal burns from hot food and beverages whenever local anaesthetics are administered.

Some degree of postoperative swelling following minor oral surgery is inevitable although its extent is highly variable and unpredictable. This variation is due to patients having widely different inflammatory responses to similar surgical insults independent of operator variability. Postoperative pain, and patients ability to tolerate it is directly correlated with the degree of postoperative swelling present (32). Llewelyn *et al* (33) using magnetic resonance imaging (MRI) have shown that following the removal of third molar teeth patients sustain a mean swelling of almost 1cm on the first postoperative day.

Postoperative oedema can be lessened by careful tissue handling and its extent is dependent on the skill of the surgeon (34) In particular, retractors and elevators must be used with care. Rotating surgical drills must never be allowed to “snag” the

surrounding soft tissues or abrade the buccal and labial mucosa and the drill tip must be constantly cooled to ensure that the bone is never allowed to overheat. Standard air turbine dental handpieces generate very high vent pressures. They must never be used for bone removal or tooth section as the forward facing air jet can lead to massive emphysema of the surrounding soft tissues with the risk of subsequent pain, swelling, infection and tissue necrosis (Figure 16).

Extraction sockets and pathological cavities must be irrigated with copious amounts of 0.9% saline to remove all bone fragments and debris. Failure to accurately place a retrograde root filling in the root apex and failure to remove excess amalgam from the surgical cavity not only produces an embarrassing “shot gun” postoperative radiograph but also predisposes to surgical failure from chronic pain and infection. To prevent this error the surgical cavity should be occluded with a strip of ribbon gauze so that only the root apex access cavity is visible. Small volumes of amalgam should then be carefully introduced and condensed immediately. This procedure can be greatly facilitated by using specially designed amalgam carriers and magnifying loupes. On completion the gauze is removed and the cavity thoroughly irrigated and all traces of stray amalgam removed.

Pharmacological treatments can be used as an adjunct to meticulous surgery to reduce postoperative oedema. The combination of systemic steroids and non-steroidal anti-inflammatory drugs has been shown to produce marked reduction in postoperative pain and swelling following third molar removal (35). The administration of 40 mg methylprednisolone intravenously immediately prior to surgery has been shown to significantly reduce early postoperative oedema and pain and improve patient satisfaction following the removal of impacted lower third molars (36). No increased morbidity from infection or delayed healing was noted.

Although the hypothalamic-pituitary-adrenal (HPA) axis is acutely depressed following a single intravenous dose of 8mg of dexamethasone the HPA response has normalised by 7 days postoperatively (37). It is the authors practice to administer 8mg dexamethasone (equivalent to 42.7 mg methylprednisolone (British National Formulary)) intravenously immediately prior to surgery and 400-600 mg ibuprofen 8 hourly postoperatively for all procedures requiring bone removal unless contraindicated for medical reasons.

## Infection

If infected and abscessed teeth and roots can be extracted easily using forceps or elevators, and providing a local anaesthetic injection is not instilled directly into an area of inflammation or acute infection their loss will hasten the resolution of symptoms by removing the source of infection. The use of regional local anaesthetic blocks in these circumstances can be useful although even then surgical analgesia may not be achievable.

As a general rule the transalveolar approach for the removal of teeth and roots is contraindicated in the presence of acute infection lest the infection be spread to deeper structures. This is particular so when lower third molars are associated with acute pericoronitis. Injudicious removal can result in a parapharyngeal space infection and upper airway obstruction. Wherever possible extraction should be deferred until the tooth has been infection free for 2-3 weeks.

In the normal course of events and in the absence of pre-existing infection postoperative pain and swelling will be on the wane after 48 hours or so. However, should the operative site become infected pain, swelling and trismus fail to resolve

and usually increase around this time. The infection rate following minor oral surgical procedures is low, and in a series of 6,713 third molar extractions was only 3.5% (38).

**Dry Socket**

Dry socket, also variously termed alveolar osteitis, fibrinolytic alveolitis and alveolitis sicca dolorosa is a well recognised complication of exodontia (4). It is characterised by increasingly severe pain which usually starts on the second or third post-operative day in and around the extraction site lasting for between 10 and 40 days. The normal post-extraction blood clot is lost from the tooth socket the bony walls of which are denuded and exquisitely sensitive to gentle probing. Halitosis is invariably present. There is great variation in reported incidence rates (1% - 65%) between series usually due to inconsistency in diagnostic criteria, variation in antimicrobial prophylaxis and study sample heterogeneity. The true incidence rate probably lies somewhere between 3% and 20% of all extractions.

The aetiology is multifactorial but essentially it results from lysis of the normal post-extraction blood clot. Increased concentrations of both direct and indirect plasminogen activators result in an increased local concentration of plasmin and subsequently an enhanced degradation of fibrin to soluble fragments with clot disintegration and loss. Direct plasminogen activators are released from damaged alveolar bone cells. Bacterial pyrogens and oestrogens, particularly those found in oral contraceptives are potent indirect plasminogen activators. It is thus hypothesised that a dry socket results from a complex interaction between surgical trauma, local bacterial infection and various systemic factors (39).

Dry socket is a painful, debilitating condition that results in considerable suffering, inconvenience and loss of productivity to the patient. It is also a costly and

time consuming condition for the attending clinician as 45% of patients will require at least 4 additional post-operative visits (40).

Several factors have been found to be associated with an increased risk of developing a dry socket (38, 39, 40, 41, 42):

- Extraction of mandibular rather than maxillary teeth
- Extraction of third molars, especially impacted lower third molars
- Singleton extractions
- "Traumatic" and unduly difficult extractions
- Female sex especially if concurrently using oral contraception
- Patient aged between 20 and 40 years
- Poor oral hygiene and plaque control
- Active or recent history of acute ulcerative gingivitis or pericoronitis
- Smoking, especially if >20cigarettes/day
- Increased bone density either locally or generally such as Paget's disease
- Previous history of dry socket(s) following extractions
- Inexperienced surgeon

Clinical application of the above data will minimise the incidence of dry socket. If appropriate, wherever possible oral hygiene measures to reduce plaque levels to a minimum should be instituted and all patients should be given a 0.12% chlorhexidine mouth rinse immediately preoperatively. Lower third molar extractions should be avoided in the presence of active pericoronitis or acute ulcerative gingivitis. For difficult full or partial bony lower third molar impactions where bone needs to be removed, for immunocompromised patients and for patients with a history or previous pericoronitis or acute ulcerative gingivitis, appropriate antibiotic prophylaxis should

be prescribed. Patients who smoke should be enjoined to cease the habit pre-operatively and for at least 2 weeks postoperatively while the extraction sockets heal. Wherever possible, for female patients using oral contraception, extractions should be performed during days 23 through 28 of the tablet cycle.

All extractions should be completed with the minimum amount of trauma, the maximum amount of care and as rapidly as possible commensurate with their degree of difficulty and the experience of the operator. On completion of the procedure the operative site should be irrigated with copious amounts of sterile saline followed by 15 ml of 0.12% chlorhexidine. Patients should be advised to avoid vigorous mouth rinsing in the immediate post-operative period but to use gentle tooth brushing and 0.12% chlorhexidine mouth rinses for the following 7 days. All patients should be advised to return to the surgery/hospital immediately if they develop increasing pain or a bad taste.

In cases of established dry socket patients should be managed along the following lines: The affected socket(s) should be gently irrigated with warmed 0.12% chlorhexidine and all debris dislodged and aspirated. In extremely painful cases local anaesthesia may be required before socket irrigation can be performed. Wherever possible regional nerve blocks should be employed. The socket should be lightly packed with a dressing that contains an obtundent for pain relief and a non-irritant antiseptic to inhibit bacterial and fungal growth. The dressing should prevent re-accumulation of food debris and protect the exposed bone from irritation. Ideally, the dressing should slowly dissolve without the need for its removal and should not excite a host inflammatory or foreign body response. Numerous commercial agents are available which fulfil these requirements to a greater or lesser extent. Alternatively, sterile ¼ inch ribbon gauze impregnated with BIPP (Bismuth Iodoform Subnitrite

Paste) can be used although it requires subsequent manual removal by the attending clinician. Providing there are no signs of systemic infection antibiotics are not routinely required. Suitable and effective systemic analgesics should be prescribed and the patients' progress should be reviewed the following day and frequently thereafter until full healing has occurred. Hospitalisation is rarely required.

For patients about to undergo surgical removal of full or partial bony impacted third molars the use of systemic antibiotics confers a significant reduction in postoperative infection rates (38). If prophylactic antibiotics are to be beneficial they need to be given preoperatively and no more than 2 hours prior to the commencement of surgery (43). There is no point in prescribing postoperative oral antibiotics for clean contaminated procedures (the majority of minor oral surgery) if preoperative systemic antibiotics have been given as they will confer no added benefit. If preoperative systemic antibiotics have not been given, prescribing postoperative oral antibiotics confers no benefit at all. The authors policy is not to use antibiotics for clean contaminated soft tissue surgery, simple extractions or soft tissue third molar impactions. For procedures involving bone removal such as third molars and apicectomies and providing there are no medical or pharmacological contraindications a single intravenous dose of 1.2g Co-Amoxyclav is given immediately prior to surgery commencing. Chlorhexidine 0.12% mouthwashes 6 hourly are prescribed for 1 week postoperatively but oral antibiotics are not given.

**Osteoradionecrosis**

Patients with head and neck cancer who are treated by radiotherapy either as sole modality or as part of a multi-modality treatment plan are at risk of developing osteoradionecrosis in bone in the treated area. Osteoradionecrosis results from

radiation induced tissue hypoxia, hypocellularity and hypovascularity (44, 45). Osteoblasts and osteoclasts within the radiotherapised bone may be lethally damaged by the ionising radiation although they are still able to perform their resting vegetative functions (44). Because of the extremely slow bone cell turnover rate this causes few problems until the cells are stimulated to divide. The most common stimulus to divide is provided by tooth extraction which then commonly results in massive bone destruction and secondary bacterial infection. Osteoradionecrosis is an extremely painful, debilitating and indolent disease that makes patients' lives an utter misery. This complication must be avoided at all costs. The most effective way of preventing osteoradionecrosis is to ensure that all patients who are to receive medical irradiation to the head and neck have a thorough oral examination including OPT screening. For head and neck cancer patients this should occur in the context of a multi-disciplinary head and neck oncology clinic. Any teeth in the proposed treatment area of doubtful prognosis by virtue of decay or periodontal disease should be scheduled for extraction. If the patient is to undergo surgical resection prior to radiotherapy the ideal time to extract the teeth is during the pre-surgical examination under anaesthetic (EUA). Otherwise the teeth should be extracted under local anaesthetic 1 to 2 weeks prior to commencing radiotherapy.

No matter how careful and thorough the work-up there will always be circumstances where a patient will require extractions post-radiotherapy. Such extractions should be performed by the oral & maxillofacial surgeon attending the oncology clinic and not delegated to the patients' general dental practitioner. Broad spectrum antibiotics are administered intravenously immediately preoperatively along with 0.12% chlorhexidine mouthwashes and the gingival margins of the teeth to be extracted swabbed with iodine solution. Extractions are performed in the most

atraumatic way possible which may involve the elective use of a transalveolar approach and bone removal depending on the finding on the preoperative radiograph. Postoperative antibiotics and chlorhexidine mouthwashes are commenced and continued until the sockets are healed. There is extensive evidence that established osteoradionecrosis is best managed by hyperbaric oxygen therapy and subsequent surgical debridement (46). In patients at high risk of developing osteoradionecrosis it may also be prudent to use a pre-extraction hyperbaric oxygen therapy regime provided that this would not adversely delay starting primary treatment for the patients head and neck cancer.

"Learning without thought is labour lost; thought without learning is perilous"
(Confucius 550 - c 478 BC)

# REFERENCES

1. Scully C, Cawson RA. Medical Problems in Dentistry. 3rd ed. Oxford: Wright, 1993.
2. Rowe AHR, Alexander AG. A Companion to Dental Studies Volume 2. Oxford: Blackwell Scientific Publications, 1988.
3. Tetsch P, Wagner W. Operative extraction of wisdom teeth. Munich: Wolf Medical Publications, 1985.
4. Killey HC, Seward GR, Kay LW. An outline of oral surgery, part 1. Bristol: Wright, 1975.
5. Layton SA. Informed consent in oral and maxillofacial surgery: a study of its efficacy. British Journal of Oral & Maxillofacial Surgery 1992; 30: 319-322.
6. Lawton (The Right Hon Lord Justice Lawton). Legal aspects of iatrogenic disorders: discussion paper. Journal of the Royal Society of Medicine 1983; 76: 289-291.
7. Guralnick WC, Laskin DM. NIH consensus development conference for removal of third molars. Journal of Oral Surgery 1980; 38: 235-236.
8. Williams M. Post-operative nerve damage and the removal of the mandibular third molar: a matter of common consent. British Journal of Oral & Maxillofacial Surgery 1996; 34: 386-388.
9. Humphris GM, O'Neill P, Field EA. Knowledge of wisdom tooth removal: influence of an information leaflet and validation questionnaire. British Journal of Oral & Maxillofacial Surgery 1993; 31: 355-359.

10. O'Neill P, Humphris GM, Field EA. The use of an information leaflet for patients undergoing wisdom tooth removal. British Journal of Oral & Maxillofacial Surgery 1996; 34: 331-334.

11. Poswillo D. Obtaining consent to oral & maxillofacial surgery. Annals of the Academy of Medicine of Singapore 1989; 18: 616-621.

12. Richardson N, Jones P, Thomas M. Should house officers obtain consent for operation and anaesthesia? Health Trends 1996; 28: 56-59.

13. Department of Health NHS Executive. A guide to consent for examination or treatment London: Department of Health, 1990.

14. Gillbe GV, Moore JR. Complications of extractions. In: Moore JR. Surgery of the Mouth and Jaws. Oxford: Blackwell Scientific Publications, 1985: 395-408.

15. Sisk AL, Hammer WB, Shelton DW, Joy ED Jr. Complications following removal of impacted third molars: the role of the experience of the surgeon. Journal of Oral & Maxillofacial Surgery. 1986;44:855-9.

16. Vogler JC, Karuza J, Miller WA. Oral-surgeon-reported incidence of complications related to simple extraction in adults. Special Care in Dentistry 1994; 14: 92-95.

17. Weinberg S. Oral surgery complications in general practice. Journal of the Canadian Dental Association 1975; 41: 288-299.

18. McGreggor IA. Fundamental techniques of plastic surgery. 8th ed. Edinburgh: Churchill Livingstone, 1989.

19. Schultze-Mosgau S, Reich RH. Assessment of inferior alveolar and lingual nerve disturbances after dentoalveolar surgery, and recovery of sensitivity. International Journal of Oral & Maxillofacial Surgery 1993; 22: 214-217.

20. Rood JP. Permanent damage to inferior alveolar nerves during the removal of impacted mandibular third molars. Comparison of two methods of bone removal. British Dental Journal 1992; 172: 108-110.

21. Blackburn CW, Bramley PA. Lingual nerve damage associated with removal of lower third molars. British Dental Journal 1989; 167: 103-107.

22. Robinson PP, Smith KG. Lingual nerve damage during lower third molar removal: a comparison of two surgical methods. British Dental Journal 1996; 180: 456-461.

23. Bramley P. Sense about wisdoms? Journal of the Royal Society of Medicine 1981; 74: 867-868.

24. Hendy CW, Robinson PP. The sensory distribution of the buccal nerve. British Journal of Oral & Maxillofacial Surgery 1994; 32: 384-386.

25. Kiesselbach JE, Chamberlain JG. Clinical and anatomic observations on the relationship of the lingual nerve to the mandibular third molar region. Journal of Oral & Maxillofacial Surgery 1984; 42: 565-567.

26. Ellies LG, Hawker PB. The prevalence of altered sensation associated with implant surgery. International Journal of Oral & Maxillofacial Implants 1993; 8: 674-679.

27. Berberi A, Le Breton G, Mani J, Woimant H, Nasseh I. Lingual paraesthesia following surgical placement of implants: report of a case. International Journal of Oral & Maxillofacial Implants 1993; 8: 580-582.

28. Rosenquist B. Fixture placement posterior to the mental foramen with transpositioning of the inferior alveolar nerve. International Journal of Oral & Maxillofacial Implants 1992; 7: 45-50.

29. Krogh, PHJ. Does the risk of complication make transpositioning of the inferior alveolar nerve in conjunction with implant placement a last resort surgical procedure? International Journal of Oral & Maxillofacial Implants 1994; 9: 249-250.

30. Ramstrom G, Sindet-Pederson S, Hall G, Blomback M, Alander U. Prevention of post-surgical bleeding in oral surgery using tranexamic acid without dose modification of oral anticoagulants. Journal of Oral & Maxillofacial Surgery 1993; 51: 1211-1216.

31. Meyer RA, Chinn MA. Prolonged postoperative analgesia with regional nerve blocks. Journal of Oral Surgery 1968; 26: 182-184.

32. MacGregor AJ, Hart P. Effect of bacteria and other factors on pain and swelling after removal of ectopic mandibular third molars. Journal of Oral Surgery 1969; 27: 174-179.

33. Llewelyn J, Ryan M, Santosh C. The use of magnetic resonance imaging to assess swelling after the removal of third molar teeth. British Journal of Oral & Maxillofacial Surgery 1996; 34: 419-423.

34. Osbon DB. Postoperative complications following dentoalveolar surgery. Dental Clinics of North America 1973; 17: 483-504.

35. Schultze-Mosgau S, Schmelzeisen R, Frolich JC, Schmele H. Use of ibuprofen and methylprednisolone for the prevention of pain and swelling after removal of impacted third molars. Journal of Oral & Maxillofacial Surgery 1995; 53: 2-7.

36. Holland CS. The influence of methylprednisolone on post-operative swelling following oral surgery. British Journal of Oral & Maxillofacial Surgery 1987; 25: 293-299.

37. Williamson LW, Lorson EL, Osbon DB. Hypothalamic-pituitary-adrenal suppression after short term dexamethasone therapy for oral surgical procedures. Journal of Oral Surgery 1980; 38: 20-27.

38. Piecuch JF, Arzadon J, Lieblich SE. Prophylactic antibiotics for third molar surgery. Journal of Oral & Maxillofacial Surgery 1995; 53: 53-60.

39. Birn H. Etiology and pathogenesis of fibrinolytic alveolitis ("Dry Socket"). International Journal of Oral Surgery. 1973; 2: 211-263

40. Larsen PE. The effect of chlorhexidine rinse on the incidence of alveolar osteitis following the surgical removal of impacted mandibular third molars. Journal of Oral & Maxillofacial Surgery 1991; 49: 932-937.

41. Catellani JE, Harvey S, Erickson SH, Cherkin D. Effect of oral contraceptive cycle on dry socket (localized alveolar osteitis). Journal of the American Dental Association. 1980; 101: 777-780.

42. Meechan JG, Macgregor ID, Rogers SN, Hobson RS, Bate JP, Dennison M. The effect of smoking on immediate post-extraction socket filling with blood and on the incidence of painful socket. British Journal of Oral & Maxillofacial Surgery. 1988; 26: 402-409.

43. Classesn DC, Evans RS, Pestotnik SL, Horn SN, Menlove RL, Burke JP. The timing of prophylactic administration of antibiotics and the risk of surgical wound infection. The New England Journal of Medicine 1992; 326: 281-286.

44. Marx RE. Osteoradionecrosis: A new concept of its pathophysiology. Journal of Oral & Maxillofacial Surgery 1983; 41: 283-288

45. Wood GA, Liggins SJ. Does hyperbaric oxygen have a role in the management of osteoradionecrosis? British Journal of Oral & Maxillofacial Surgery 1996; 34: 424-427.

46. Marx RE. A new concept in the treatment of osteoradionecrosis. Journal of Oral & Maxillofacial Surgery 1983; 41: 351-357.