

Pre- and post-operative management of dental implant placement. Part 2: management of early-presenting complications

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VERIFIABLE CPD PAPER

IN BRIEF

- Highlights early presenting complications associated with dental implant placement.
- Provides practical recommendations for the management of post-operative haemorrhage following dental implant placement.
- Provides practical recommendations for the management of post-operative swelling following dental implant placement.

Despite morbidity factors that include pain and complications with healing, there is currently little available guidance regarding optimal pre- and post-operative protocols for dental implant placement. While the first paper of this two-part series discussed the management of post-operative pain, the second instalment reviews pre- and post-operative means of managing early complications associated with dental implant placement.

INTRODUCTION

Although the use of dental implants to restore edentulous sites is recognised as a safe and successful treatment modality, longitudinal outcome studies have identified the existence of associated early and late complications.¹ Late complications are purported to arise three months post-operatively or following restoration and include; failure of the supported prosthesis, implant mucositis, perimplantitis and implant fracture.^{2,3} In contrast, early complications relate to those arising before osseointegration¹ and are generally due to the inherent traumatic nature of the procedure to the mucosal and alveolar tissues and adjacent anatomical structures. These complications may include: swelling or bruising, prolonged bleeding, pain, neuro-sensory disturbance, mandibular fracture, infection or failure of the dental implant to osseointegrate. Presently there is surprisingly little consensus on the role that pre- and post-operative management of the surgical phase of dental implant placement plays on minimising the risk of these early-presenting complications.

In the first paper of this two-part series, guidance on appropriate implant analgesic prescription was offered to the general dental practitioner. The second instalment aims to review the relevant dental literature and

provide recommendations on aspects of pre- and post-operative patient management that can be employed to reduce the risk of the following early complications:

1. Post-operative haemorrhage
2. Post-operative swelling
3. Post-operative infection and optimisation of the osseointegration process
4. Neurosensory disturbance.

POST-OPERATIVE HAEMORRHAGE

Although vascular haemorrhage is commonly encountered during the operative phase of implant placement,⁴⁻⁶ late onset post-operative bleeds are also reported.^{7,8} The haemostatic process is driven by both direct- (physical injury) and indirect- (chemicals released by endothelial cells, pain receptor activation) stimulation of vascular endothelial smooth muscle. Smooth muscle contraction results in vascular constriction that reduces blood flow to the ruptured vessels with a subsequent reduction in blood loss. Concurrently, rapid platelet aggregation onto damaged endothelial cells forms a platelet plug that acts to temporarily seal the vessel walls. Reinforcement of this initial platelet plug occurs from both the deposition of further platelets and the formation of a fibrin meshwork, derived as an end-product of a clotting cascade of plasma proteins.⁹ Post-surgical haemorrhagic lesions may be classified by the extent of their surface diameter as follows; petechiae (<2 mm), purpura (2-10 mm) and ecchymosis (>10 mm).

General patient factors that may result in unexpected post-operative haemorrhage include underlying medical conditions (for example, clotting factor disorders, platelet

disorders, blood dyscrasias) or prescription medications (for example, oral anticoagulants). Local factors that may result in unexpected post-operative bleeds include: the size of the surgical flap,⁹ the wearing off of the vasoconstrictor contained within the local anaesthetic, physical disruption of the clot or infection. With implant procedures, the fixture exerts positive pressure within the alveolar site, encouraging coagulum deposition and subsequent haemostasis. In uncomplicated implant placements, with no underlying medical history, post-operative bleeds are more likely to originate from the soft tissues and haemorrhagic lesions of both the intra- and extra-oral tissues are commonly encountered.²

Challenging dental implant placements, such as those associated with extensive bone grafting or sinus augmentation procedures, may increase the risk of both intra- and post-operative bleeds. The highly vascularised nature of the maxillary sinus¹⁰ explains why post-operative bleeding is commonly reported,¹¹ in such cases presenting with ecchymosis or epistaxis (nose-bleed) that may alarm the uninformed patient.¹¹

The majority of severe post-operative bleeds can be avoided by identifying medically-at-risk patients, via the taking of a thorough medical history and managing these cases appropriately. Post-operative instructions that detail common sense, preventative measures to reduce the risk of bleeding should include: the avoidance of strenuous exercise, maintenance of a soft diet and employing an oral hygiene regime that limits the risk of brushing-induced trauma to the surgical site. These instructions should also specify advice on the

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management of bleeding via the application of direct physical pressure using pressure packs such as; gauze dampened with chlorhexidine solution, in a manner that reduces the risk of trauma to the healing mucosa. The patient should be advised that pressure needs to be applied to the site for at least 30 minutes, before checking for clotting.⁹ Regarding post-operative nose bleeds, most are likely to be self-limiting but the patient should be provided with guidance on the management of epistaxis using established techniques such as head-tilting combined with the application of finger pressure to the nasal area for up to 20 minutes or the application of nasal compresses.¹²

Much of the advice regarding the clinical management of post-operative haemorrhage has been derived from studies that have assessed the management of post-extraction bleeding within patients undergoing warfarin therapy or suffering from bleeding disorders. Haemostasis can be achieved via a variety of means that include the use of: chemical agents (adrenaline-containing local anaesthetic, ferric sulphate,⁹ aluminium chloride [4.8% tranexamic acid])¹³, clotting-inducing sub-structures (oxidised cellulose, fibrin meshes, collagen gauzes) or physical measures (compression, pressure dressing, electrocautery or the placement of sutures). Effective haemorrhage control is situation-dependent and, as no method has been shown to be optimal, the clinician should house a variety of materials for use in such an eventuality.

POST-OPERATIVE SWELLING

Placement of dental implants physically insults both mucosal and alveolar tissues, causing a classical acute inflammation process that aims to eradicate damaged tissues and prepare the site for healing/osseointegration. Swelling is a classical feature of acute inflammation that within the surgical phase of implant therapy may cause increased pain, loss of function or neural damage.¹⁴

Treatment provided to manage post-operative pain or swelling should not be at the expense of the healing process. Prevention of additional trauma to the wounded mucosa is important in reducing the extent and longevity of tissue swelling. Many of the post-operative care factors, discussed previously as part of managing haemostasis (such as soft-bristled tooth brushing regime), have additional benefits in reducing the risk of further trauma to the wound.

An additional aspect to consider is the importance of a correctly contoured and adjusted immediate restoration in influencing mucosal healing. If a fixed immediate restoration is to be placed, it is essential that

both the occlusal and emergence profiles of the prosthesis are suitably adjusted to, respectively, avoid occlusal overload of the implant and facilitate optimal mucosal healing. If an immediate removable prosthesis is to be employed, appropriate adjustment should be undertaken to account for tissue swelling and to ensure that the prosthesis does not impinge upon the surgical site or interfere with the healing process.

Despite the established efficacy of non-steroidal anti-inflammatory drugs (NSAIDs) and steroids in reducing post-operative swelling,¹⁵ some evidence suggests that these medications impose a negative effect on the osseointegration process.^{16,17} Cold compresses are an established method of managing post-operative swelling following oral surgical procedures^{18,19} and offer either an alternative or adjunct to prescribed medications.²⁰ Cold therapy aims to cool the skin from 33 °C to 10–15 °C; a temperature that has been shown to reduce vascular flow,^{20,21} cellular inflammatory responses²² and also pain,²³ while having a minimal effect in delaying the healing process.²⁰ Forms of cold compresses include frozen home produce (frozen peas etc), commercial compresses (Instant Cold Pack®, KoolPak®) and individual clinician suggestions, such as the application of water-filled and frozen surgical gloves. Various recommendations for cold compress regimes exist and range from continuous applications²⁴ to cycles of 10–30 minutes on/off.²⁰ Given that the desired cooled tissue temperature is achieved by 10 minutes,^{25,26} and that there is some evidence to suggest that continuous cooling may result in peripheral nerve damage²⁰ or frostbite injuries,²⁷ a regime is recommended that consists applications of 10 minute exposures (with 20 minutes off) for the first 4 hours. The patient should also be advised that continuing cold compresses up to 48 hours post-operatively can further reduce swelling.^{20,28}

POST-OPERATIVE INFECTION AND OPTIMISATION OF THE OSSEOINTEGRATION PROCESS

Osseointegration may be defined as the direct interface between an implant and bone without intervening soft tissue. Both osseointegration and good healing of the mucosal structures are required for dental implant placement to be successful. Although oral mucosa wounding undergoes phases of haemostasis, inflammation, proliferation and remodeling that are similar to dermal healing, the process is both faster and results in reduced scar tissue formation.²⁹ Attempts to explain this rapid healing process have included; the action of salivary

growth-promoting factors (EGF, NGF, TGF),³⁰ and reduced levels of both inflammatory cell infiltrates and cytokines.³¹ Epithelialisation is normally re-established within 5 days, although some animal studies indicate that well approximated wounds may achieve point contact inhibition within 24 hours,³¹ facilitating a protective environment for osseointegration of the implant.

In theory, the risk of early implant failure due to infection is greatest before re-epithelialisation of the wound. However, one-stage implant placement and restoration techniques have high success rates^{32,33} and this suggests that other protective mechanisms may support the osseointegration process. The densely-mineralised cortical bone layer provides excellent immediate stability³⁴ for the implant and the slow resorption/remodeling of this layer may also provide additional protection to the main body of the implant (embedded within the cancellous bone), during the early healing phase. The underlying cancellous bone's greater vascularity permits rapid formation of new blood vessels and encourages the migration of mesenchymal cells which, in turn, act as precursors for the formation of woven bone (new immature bone) around the dental implant. Subsequently, cancellous bony turnaround is faster than its cortical counterpart and osseointegration of this portion of the implant occurs more rapidly. Despite the varying speeds of cortical and cancellous bony remodeling, osseointegration will generally be complete by 3–6 months post-placement.^{35–37} Early implant failures are characterised by a lack of osseointegration and fibrous tissue encapsulation of the implant.³⁸ Various theories have been proposed to explain the causes of early implant failure and include; compromised healing capability of the host, insufficient primary implant stability and infection of the surgical site.³⁸

Although infection of the implant site is infrequent,³⁹ some general and local factors (Table 1) have been identified as contributors to increased risk of post-operative infection or early implant loss. Many of these factors may also compromise patients' healing responses and impact on implant stability.

The taking of a thorough medical history should identify patients with medical conditions, as detailed in Table 1. Diabetes mellitus is one condition that has been found to negatively impact osseointegration⁴⁰ and increase the risk of implant failure. If appropriately controlled, Diabetes mellitus does not directly contra-indicate implant provision^{40–42} although it is important that patients affected by this, and other conditions that negatively impact the osseointegration

Table 1 Factors contributing to implant failure

General factors	Local factors
Systemic medical conditions eg - Diabetes-mellitus (poorly controlled) - Osteoporosis - Vitamin D deficiency	Site of implant placement - Maxilla - Type IV (highly cancellous) bone
Medical therapy: - Radiotherapy - Chemotherapy	Bone augmentation
Smoking	Poor oral hygiene
Excessive alcohol consumption	Operator factors: Poor surgical technique, ineffective cooling of surgical bur
Malnutrition	

Table 2 Risk factors associated with osteonecrosis of the jaw

General factors	Bisphosphonate specific factors
Ethnicity (caucasian >black)	IV bisphosphonate
Smoking	Longevity and frequency of treatment
Diabetes mellitus (poorly controlled)	Potency of bisphosphonate: zoledronate > pamidronate > oral bisphosphonates
Excessive alcohol intake	
Longer term corticosteroid therapy	
Dental disease: - Periodontal disease - Periapical abscess	

process, are informed as to the increased risk of both early and delayed implant failure.

It is recognised that the placement of dental implants within patients that have undergone head and neck radiotherapy holds increased risk of both causing osteoradionecrosis^{43,44} and failure of the implant to osseointegrate.⁴⁵ Increased failure rates of dental implants have been found to be influenced by placement within the maxilla, higher radiation dose and longer durations between radiotherapy and implant placement.⁴⁶

Recently, attention has been appropriated to both impaired osseointegration within osteoporotic patients and also the risk of bisphosphonate-induced osteonecrosis of the jaw. Bisphosphonate therapy may be delivered orally (to treat Paget's disease, osteoporosis, osteogenesis imperfecta) or intravenously (to treat skeletal complications associated with lung, breast and other cancers). It has been established that there is a relationship between osteonecrosis of the jaw, bisphosphonate therapy and dental extractions. Although no conclusive evidence exists to restrict the use of implants in either drug group,⁴⁷⁻⁴⁹ the consequences of osteonecrosis of the jaw are such that particularly careful preoperative assessment is warranted. The American Dental Association guidelines state that attention should be paid to the patient's

systemic disease, the method of bisphosphonate delivery (oral *versus* intravenous), type of bisphosphonate (potency of drug), longevity of past- or ongoing- therapeutic regime (Table 2). It is generally reported that oral bisphosphonate therapy entails less risk of developing osteonecrosis (0.7 cases in 100,000) than its IV counterpart.⁵⁰ Guidelines on the dental management of patients taking frequent (4-12 times/year), potent IV bisphosphonates (zoledronic acid and pamidronates) suggest that elective traumatic procedures, such as dental implant placement, are not advised.⁵¹ Although guidelines on the dental management of patients taking oral bisphosphonates do not contra-indicate the undertaking of dental implant procedures, due attention should be paid to aforementioned osteonecrosis risk factors, especially for those who have been taking oral bisphosphonates for over 3 years and concomitantly with steroids such as prednisolone.⁴⁹ Three-dimensional imaging, close liaison with the patient's medical team and informed consent are essential before embarking on dental implant therapy.⁵¹

Smoking imposes multiple effects on the oral mucosa both directly (via vasoconstriction, increased temperature and the toxic effects of by-products such as; nicotine, carbon monoxide, hydrogen cyanide) and indirectly (via inhibition of inflammatory

cell mechanisms).^{52,53} Subsequently, smokers are associated with increased risk of post-operative infection and failure of both grafting procedures and implant osseointegration.⁵³ Ideally, smoking cessation should be undertaken at least 3 months before surgery, when the negative effects of smoking on implant success have been shown to be reduced.⁵⁴ In cases where smoking cessation is not feasible, some of the direct effects of smoking can be reduced if the patient can be persuaded to cease smoking 24 hours pre-operatively and for 5 days post-operatively.⁵⁵

Effective pre- and post-operative plaque control has been identified as an important factor in improving the outcome of periodontal surgery.⁵⁶ While effective oral hygiene should be established before embarking on dental implant provision, maintenance of plaque control post-operatively is complicated by the risk of tooth-brushing trauma to the healing soft tissues. The use of soft-bristled brushes (for example, Chirugia®, Vitus, Barcelona, Spain) for post-operative plaque control has been suggested as an effective means of managing plaque control around the surgical site, while minimising the risk of trauma to the wound.⁵⁷ Except for cases that have involved bone augmentation procedures (where delayed suture removal may be necessary), suture removal should be undertaken 7 days post-operatively, to allow sufficient time for flap stabilisation but before the build-up of plaque deposits.⁵⁸

Mouthwashes such as saline,^{59,60} povidone iodine,⁶¹ cetylpyridinium chloride⁶² and chlorhexidine gluconate⁶³ have been shown to positively influence healing within oral surgical disciplines. In particular, the use of chlorhexidine gluconate (CHX) solution has achieved popularity due to its broad-spectrum antimicrobial effects (exerting its action via disruption of bacterial membrane activity),⁶⁴ substantivity properties that facilitate continued anti-microbial effect for up to 4 hours post usage,⁶⁵ limited bacterial resistance to the medicament and minimal side-effects on the healing process. Given that bacterial contamination of the implant at placement may result in biofilm formation⁶⁶ and lead to early failure,³⁸ decontamination of the surgical field is a sensible precaution for any operative procedure. A 1 min pre-operative rinse of 0.2% CHX is recommended as this has been demonstrated to reduce the oral bacterial load by 97%.⁶⁷ Three times daily mouth rinses of 0.2% CHX for 7 days (or until the sutures are removed) is also advised as an effective adjunct for post-implant placement wound care.⁶³

The use of antibiotics

A variety of prophylactic and post-operative antibiotic regimes have been evaluated to

Table 3 Summary of pre-/post-operative recommendations

	Pre-operative	Post-operative	Complications
Management of haemorrhage	<p>Consent: Likelihood of post-operative bruising, periorbital ecchymosis</p> <p>Clinical: Comprehensive medical history to rule out haemorrhagic conditions and medications. Pre-operative assessment with 3D imaging where appropriate</p>	<p>Instructions: Avoidance of exercise Prevention of clot-disruption (including appropriate oral hygiene methods) Management of post-operative bleeds using pressure. CHX-soaked gauze for 30 minutes -</p>	<p>Instructions: Management of epistaxis via head tilting/nasal compression.</p> <p>Clinical: Post-operative haemorrhage protocol. 1. Minor bleeds: Assessment of site, placement of additional LA with vasoconstrictor, application of pressure via dampened gauze onto the bleeding site. 2. Moderate – severe bleeds: As for minor bleeds + placement of additional sutures, haemostatic agents. Use of gauze dampened with transexamic acid.</p>
Management of swelling	<p>Consent: Likelihood of swelling, pain and reduced function</p>	<p>Instructions: Cold compress 10 mins on/20 mins off for 4 hours. Advise patient that further reduction in swelling can be achieved by repeated applications throughout first 48 hours.</p> <p>Clinical: NSAIDs as per paper one.</p>	<p>Clinical: 4 mg dexamethasone daily for 7 days</p>
Reduction of risk of post-operative infection and optimisation of osseointegration process	<p>Consent: Low risk of post-operative infection and high success rates in uncomplicated implant cases. Discuss factors that increase risk of failure/ infection.</p> <p>Instructions: Smoking cessation 3 months before placement. As a minimum, 24 hours pre- and 5 days post-operatively.</p> <p>Medical history. Liaison with GMP to determine stability of diabetes mellitus, other conditions and therapies (for example, bisphosphonate or similar).</p> <p>Clinical: 2 g or 3 g amoxicillin 1 hour pre-operatively/ 600 mg clindamycin 1 hour pre-operatively in penicillin intolerant patients 1 min rinse of CHX mouthwash</p>	<p>Instructions: CHX mouth rinse 3 times daily for 7 days or until sutures are removed. The use of soft-bristled brushes to assist plaque control within the surgical site (may be commenced post-operatively and continued until mucosal healing is judged to be complete). Additional advice for sinus floor elevation procedures: Avoidance of swimming, flying for at least 2 weeks Not to stifle sneezes for 2 weeks No nose-blowing for 2 weeks</p>	<p>Clinical: Amoxicillin 500 mg TDS 7 days for 10 days 300 mg Clindamycin TDS 7 days for 10 days (for penicillin sensitive patients). Additional measures for sinus floor elevation: Prescription of antihistamine tablets and/or nasal sprays for patients suffering from hay fever or Type I Hypersensitivities.</p>
Neurosensory disruption	<p>Clinical: Pre-operative evaluation including 3D imaging where necessary</p>	<p>Instructions: Need to report altered sensation to clinic Prescription of dexamethasone (6-8 mg daily for 7 days) NSAIDs as per paper one</p>	<p>Clinical: Reversal of implant away from neurovascular structure (if complications recognised at early stage) Explantation of implant</p>

assess their effectiveness in reducing the rate of post-implant placement infections and optimising the osseointegration process. Although the results of individual studies vary with regard to conclusions drawn, a recent Cochrane review of the literature concluded that the provision of a 2 g pre-operative dose of amoxicillin may improve the success rate of osseointegration.⁶⁸ For patients who suffer from penicillin intolerance or allergy, a 600 mg 1 hour pre-operative dose of clindamycin is recommended.⁶⁹

When bone grafting or sinus augmentation procedures are required to facilitate implant placement there is greater risk of site infection and antibiotic regimes, consisting

of either amoxicillin 500 mg TDS or clindamycin 300 mg TDS for 10 days, have been advocated.^{11,70} Patients who have undergone maxillary sinus floor elevation should be advised not to undertake activities that may apply additional pressure to the maxillary sinus such as; the avoidance of flying or swimming for two weeks post-operatively and to not internalise sneezes (patients that suffer seasonal hay fever, or from similar allergic-type reactions that induce sneezing, may require the prescription of antihistamine tablets and nasal sprays). If infection of the surgical site is encountered, osseointegration of the fixture will be impaired and explantation of the implant may be necessary.

When prescribing antibiotics, it is important that the clinician weighs the potential benefits of improved implant success against the risk of well documented complications that may include: direct toxicity (nausea, vomiting, diarrhoea), haematological complications (neutropenia, thrombocytopenia), anaphylactic reaction, microbial flora disruptions, nephrotoxicity, drug interactions and acquired bacterial resistance to antimicrobials.⁷¹

NEUROSENSORY DISRUPTION

The placement of dental implants can result in damage to both maxillary and mandibular branches of the trigeminal nerve that include

the inferior alveolar nerve, the mental nerve, the lingual nerve, the incisive nerve and the infra-orbital nerve. Neural trauma may occur both directly, due to section during the surgical procedure, or indirectly, as a result of nerve compression by either the implant or subsequent inflammatory process. Studies indicate that a range of post-operative implant-induced neurosensory disruption exists between 0%–44%.⁷² Nerve injuries are commonly classified by the severity of neuron axon damage and encompass neuropraxia (structure of axon intact), axonotmesis (some axon damage but nerve structure intact) and neuromesis (structural damage of the nerve). The extent of the nerve injury will normally dictate the extent of the symptoms encountered and may present with paraesthesia (altered sensation), dysaesthesia (unpleasant altered sensation) or anaesthesia (loss of sensation).⁷³ Although cases of idiopathic facial pain are reported following implant placement,⁷⁴ the incidence of such events is likely to be low.

A thorough pre-operative assessment that employs appropriate 3D imaging and planning can reduce the risk of neural trauma and subsequent neurosensory disruption. It has been advised that, when planning implant placement within the mandible, a minimum safety margin of 2 mm should be left between the coronal aspect of the nerve and dental implant.⁷⁵ The patient should be appropriately forewarned of neurosensory complications as part of the consent process.

In the event of altered sensation, the patient should be informed of the need to contact the clinician immediately. A comprehensive post-operative assessment should ascertain the extent of the nerve injury (using both nociceptive and mechanoreceptive tests)⁷⁶ and whether the injury has been caused by direct or indirect trauma. In cases of mild neurosensory disruption, the use of NSAIDs (600 mg ibuprofen QDS)⁷⁷ and steroids (6–8 mg dexamethasone daily),⁷² to reduce inflammation and subsequently pressure on the nerve, has been suggested. In addition, the use of steroids may inhibit peripheral neural axon sprouting and reduce the risk of the development of dysaesthesia.^{72,78,79} In cases where neuromesis is suspected, early reversal of the implant away from the nerve or explantation of the implant, with referral of the patient to a neurosurgical specialist, is advised.⁸⁰

CONCLUSION

In general, many of the complications encountered within dental implant placement can be prevented by sound pre-operative assessment and intra-operative technique. It is essential that a robust consent process

informs the patient of possible complications and that they are also prepared to manage expected problems with the provision of comprehensive post-operative instructions, medications and medicaments. A summary of these recommendations is provided in Table 3.

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