



Basic implant surgery

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Successful implant surgery is largely dependent upon good planning and meticulous technique. The former requires an appreciation of the restorative requirements and visualisation of the desired end result of treatment, whereas the latter requires adequate surgical training and experience of the selected implant system.

The essential pre-requisites before proceeding to implant surgery are:

- The patient should be medically fit to undergo the surgery. Placement of one or two implants is equivalent to relatively minor oral surgery whereas placement of five or six implants increases the magnitude significantly. The medical history should be checked with particular relevance to:

- Poorly controlled diabetes
- Blood dyscrasias
- Medications
- Irradiation to jaws
- Mucosal diseases
- Psychoses
- Substance abuse including tobacco and alcohol
- Need for antibiotic cover.

- The patient should understand the procedure and be warned of any complications. They should have agreed the treatment plan, treatment schedule, costings, and given their consent.
- The diagnostic set-up surgical stent and relevant radiographs should be available.
- The surgeon should have a clear idea of the number, size and planned location of the implants. They should be trained in the procedure and able to cope with any unforeseen circumstances.

Operative requirements

Most implant surgery can be carried out in a well equipped dental surgery. Ideally the surgery should be designed to permit surgical procedures under good aseptic conditions. The following should be available:

- Good operating light
- Good high volume suction
- A dental chair which can be adjusted by foot controls or by a third party
- A surgical drilling unit which can deliver relatively high speeds (up to 3000 rpm) and low drilling speeds (down to about 10 rpm) with good control of torque
- A purpose designed irrigation system for

keeping bone cool during the drilling process

- The appropriate surgical instrumentation for the implant system being used and the surgical procedure
- Sterile drapes, gowns, gloves, suction tubing etc.
- The appropriate number and design of implants planned plus an adequate stock to meet unexpected eventualities during surgery
- The surgical stent
- The complete radiographs including tomographs
- A trained assistant
- A third person to act as a runner between the sterile and non-sterile environment.

Anaesthesia and analgesia

Most implant surgery can be carried out under local anaesthesia, although some patients will require sedation or general anaesthesia. The surgical time will vary greatly between different operators and cases. Short cases, for example under 1 hour for placement of one or two implants do not usually present problems with anaesthesia. Complex cases may take 2 or 3 hours and it is essential to use regional block anaesthesia (infra-orbital, palatal, inferior dental) and to supplement this during the procedure. Local infiltrations are also administered as they improve the anaesthesia and more importantly control haemorrhage. Sedation is recommended for operations of long duration eg more than 90 minutes. It is a good idea to give analgesics, such as ibuprofen or paracetamol, immediately prior to surgery.

Sterile technique

Every effort should be made to conduct implant surgery under sterile operating conditions. Chlorhexidine 0.2% is used as a pre-operative mouthwash and skin preparation circumorally. The patient is draped as for other oral surgical procedures, and drill leads should be autoclaved or covered with sterile tubing. Light handles should be autoclaved or covered with sterile aluminium foil. It is convenient to use sterile disposable suction tubing and stents. The instrument tray and any other surfaces which are to be used are covered in sterile drapes.

Surgical techniques for implant installation

Surgical installation of implants requires good visualisation of the bone ridge profile and

Implant surgery protocols differ slightly with individual systems. However, basic surgical principles are required to ensure successful osseointegration of the implant in the correct location which allows good aesthetics and loading.

In this part, we will discuss:

- Operative requirements
- Surgical techniques for implant installation
- Post-operative care
- Surgery for abutment connection

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Surgical technique for implant installation

- Anatomical considerations
- Flap design
- Surgical preparation of the bone
- Implant placement
- Implant insertion

meticulous preparation of the bone site to accept the implant (figs 1, 2 and 3).

Anatomical considerations

The implant surgeon should be fully conversant with all anatomical structures that they are likely to encounter or that will affect implant placement, including:

- *In the maxilla*
 - Air sinuses
 - Nasopalatine canal
 - Floor of nose and nasal spine
 - Palatine and pterygoid vessels
- *In the mandible*
 - Sublingual vessels
 - Mental nerve
 - Inferior dental nerve
 - Incisive branch of inferior dental nerve
 - Genial tubercles
- *Teeth*
 - Position, length and angulation of roots adjacent to implant sites
- *Available bone*
 - Ridge morphology
 - Bone density
 - Cortical
 - Medullary
 - Localised deformities
 - tooth sockets
 - residual cysts/granulomata.

Flap design

There are many different flap designs for implant surgery. In practically all situations a mid-crestal incision can be employed. Access and elevation of the flaps can usually be improved by the additional use of vertical relieving incisions (fig. 1a,b) Relieving incisions close to adjacent teeth can be made to include the elevation of the (interdental) papilla, but some surgeons prefer to avoid raising this in case future aesthetics are compromised. Care should be taken to ensure that incision lines are not placed over structures such as the mental nerve and the palatine arteries. All incisions are made through periosteum down to bone.

Full thickness mucoperiosteal flaps are raised carefully to expose the entire extent of the edentulous ridge where the implants are to be placed (fig. 1b). The flaps should be elevated sufficiently far apically to reveal any bone concavities, especially at sites where perforation might occur. Important anatomical structures in the area of operation which might be damaged, such as the mental nerve, should be identified and protected.

Surgical preparation of the bone

It is essential not to allow the bone to be heated above 47°C during preparation of the site as this will cause bone cell death and prevent osseointegration. This problem may be avoided by:

- Using sharp drills
- Employing an incremental drilling procedure with increasing diameter drills

- Avoidance of excessive speed (no more than 3,000 rpm) and pressure on the drills — ensuring that the drill is withdrawn from the site frequently to allow the bone swarf to clear. This is particularly important in dense/hard bone

- Using copious sterile saline irrigation. This can be delivered from a sterile infusion bag in a pressure cuff or a peristaltic pump. The drills can be adequately cooled by spraying the external surface of the drill. However, some systems use internally irrigated drills.

A typical sequence of drilling and implant insertion is shown in figure 1. Preparation of the sites commences with penetration of the outer cortex with a small round bur followed by twist drills of increasing sizes. The drills are marked to indicate the corresponding lengths of implants. The spacing and angulation of the implant sites are checked carefully with direction indicators throughout the drilling sequence, in relation to the stent and the opposing jaw/dentition. The angulations should be checked from different viewpoints (eg buccal and occlusal) as it is very easy to make errors when viewing from a single aspect.

Implant placement

The ideal siting and orientation of the implant is dictated by the restorative requirements, but this may have to be modified by the existing ridge morphology and adjacent anatomical structures. Following elevation of the flaps the surgical stent should be tried in. In partially dentate cases the stent should be stabilised on adjacent teeth and provide guidance of where the planned labial faces, occlusal surfaces or cingulae of the teeth to be replaced are to be located. An example of a suitable stent is shown in figure 1c. In edentulous cases it is far more difficult to provide a stable stent as it will have to rely upon a mucosal fit in areas where the mucoperiosteum has not been raised.

Ideally an implant should be placed such that:

- It is within bone along its entire length. Exposure of limited areas of implant surface associated with bone defects such as dehiscences or fenestrations may be acceptable, but larger ones may require augmentation (Part 8).
- It does not damage adjacent structures such as teeth, nerves, nasal or sinus cavities. It is acceptable to engage the nasal or sinus floor with a small degree of penetration (eg 1 to 2 mm). An adequate safety margin of about 2 mm above the inferior dental canal is recommended.
- It is located directly apical to the tooth it is replacing and not in an embrasure space.
- The angulation of the implant is consistent with the design of the restoration. This is particularly important with screw retained restorations where it is desirable to have the



Fig. 1a The pre-operative view of the upper left lateral incisor space

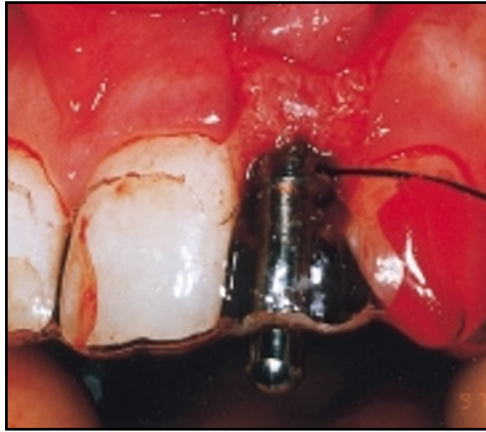


Fig. 1d A guide or indicator post is placed in the site to check on the position and angulation of the implant. Small adjustments can be made at this stage



Fig. 1b A full thickness mucoperiosteal flap has been elevated to completely expose the alveolar ridge to determine its shape and whether any concavities are present. The flap has vertical labial relieving incisions, a crestal incision mesio-distally and has included elevation of the papillae to give good access to the narrow edentulous space



Fig. 1e The site is enlarged by a pilot drill. This has a non-cutting end of the same diameter as the previous twist drill and a wider cutting portion. It should therefore maintain the line of the previous drill

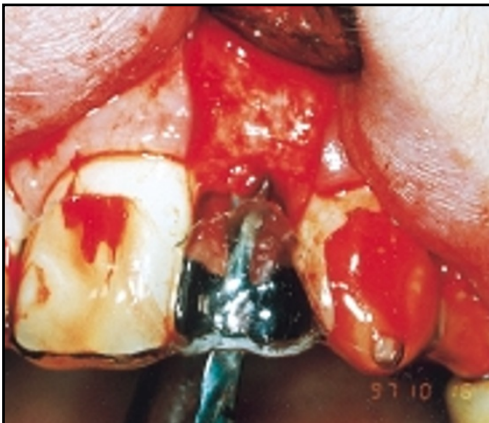


Fig. 1c A clear blow-down stent has been placed over the adjacent teeth and provides the surgeon with the position of the labial face and gingival margin of the tooth which is to be replaced. The initial preparation of the implant site is with a round bur which readily penetrates the cortex, and this is followed by a twist drill (illustrated) which determines the initial angulation and depth of the implant



Fig. 1f The site is enlarged with the final twist drill which is slightly narrower than the implant itself. The drill has marks on it corresponding to the available implant lengths. All drilling to this stage is carried out at moderate speeds (about 1,500 rpm) with copious saline irrigation

Fig. 1 This series of photos show a standard sequence of surgery for the placement of an individual implant (Nobel Biocare) in the upper lateral incisor space



Fig. 1g The surface of the bone is countersunk to accept the head of the implant. The depth of countersinking is determined by the need to sink the head of the implant to allow a good emergence profile of the restoration. The head of the implant should therefore be about 2 to 3 mm apical to the labial cement-enamel junction on the adjacent teeth or apical to the planned gingival margin determined by the stent



Fig. 1k A cover screw is placed on top of the implant



Fig. 1h The depth of the implant site is verified with a measuring guage



Fig. 1m The flap is closed with black silk sutures



Fig. 1j A self tapping implant is inserted into the prepared site at slow speed and with irrigation

restoration (fig. 2). However most systems allow convergence/divergence of up to 30° without the use of angled/customised abutments.

- The top of the implant is placed sufficiently far under the mucosa to allow a good emergence profile of the prosthesis. This is often achieved by countersinking the head of the implant (fig. 1g). For example, it is suggested that the top of a standard diameter implant (about 4 mm) when used to replace a single upper incisor tooth, should be 2 to 3 mm apical to the labial cement enamel junction of the adjacent natural tooth.
- There is sufficient vertical space above the implant head for the restorative components.
- The implant should be immobile at placement. A loose implant at this stage will fail to osseointegrate.
- Adequate bone is present between adjacent implants, and between implants and adjacent teeth (fig. 2). This should preferably be about 3 mm and never less than 1 mm. In some cases 1 mm of bone may be acceptable implant spacing, but the abutments may have a larger diameter and therefore prevent proper abutment seating, thereby complicating the restorative procedure. A distance of 3 mm will also allow better soft tissue adapta-

screw access hole in the middle of the occlusal surface or cingulum of the final restoration. Multiple implants are placed in a fairly parallel arrangement, to facilitate seating of the

tion and may allow the maintenance of an 'interdental papilla'.

The above requirements are not always easy to achieve and in many circumstances would be impossible without a properly designed stent produced from the diagnostic set up. Inevitably there are situations where a careful balance is needed between the ideal 'set up' and possible implant placement.

Implant insertion

The technique for insertion of the implant depends largely upon the system being used. In general the final bone preparation site diameter is slightly smaller than the implant. The size of the site can be adjusted according to bone quality or density. In poor quality bone the site can be made relatively smaller to produce compression of the surrounding bone on implant insertion which will improve the initial stability. In dense bone the site has to more closely match the size of the implant. In bone with relatively poor medullary quality, where initial stability may be difficult to achieve, it is often advisable to secure the implant at each end in cortical bone (bicortical stabilisation) providing anatomical structures, length of implants and ability to provide adequate cooling allow this. The implant is supplied in a sterile container, either already mounted on a special adapter or unmounted necessitating the use of an adapter from the implant surgical kit. In either case the implant should not touch anything (other than a sterile titanium surface) before its delivery to the prepared bone site. Screw shaped implants are either self tapped into the prepared site (fig. 1j and 2c) or inserted following tapping of the bone with a screw tap (fig. 3a). Cylindrical implants are either pushed or gently knocked into place. The installation of the implants should be done with the same care as the preparation of the site by maintaining the cooling irrigation and placing the implant at slow speeds. Screw shaped implants and tapping of sites are performed at speeds of less than 20 rpm. Following placement the head and inner screw thread of the implant is protected with a 'cover' or closure screw (fig. 1k and 3c).

The mucoperiosteal flaps are carefully closed with multiple sutures either to bury the implant completely (fig. 1m) or around the neck of the implant in non-submerged systems (fig. 3c). Silk sutures are satisfactory and others such as PTFE or resorbables (eg vicryl) are good alternatives.

Post-operative care

After implant surgery, patients should be warned to expect:

- Some swelling and possibly bruising
- Some discomfort which can usually be controlled with oral analgesics
- Some transitory disturbance in sensation if

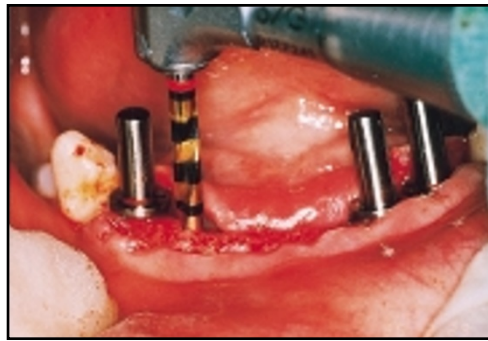


Fig. 2a Flaps have been raised and four sites are being prepared. Direction indicators are inserted into the sites to allow the surgeon to verify the planned angle and in this case to keep them fairly parallel to one another. A stent was used in the initial positioning but has been removed to allow easier visualisation

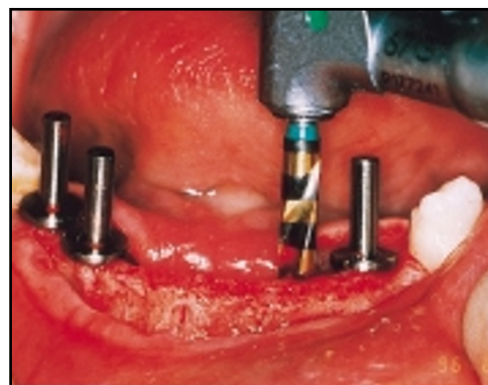


Fig. 2b This shows a later part of the procedure in which a twist drill is enlarging the sites further. The surgeon has been working sequentially from left to right with each of the drilling stages

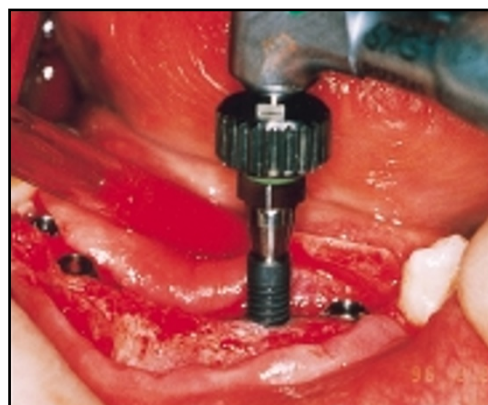


Fig. 2c An implant is being driven into the site. It is connected to a slowly rotating handpiece by an implant mount and handpiece connector

surgery has been close to a nerve.

They should be advised:

- In most circumstances, not to wear dentures over the surgical area for at least 1 week (possibly 2 weeks) to avoid loading the implants and the possibility of disrupting the sutures
- To use analgesics and ice packs to reduce swelling and pain

PRACTICE

dental implants

Fig. 3 shows part of a sequence for the placement of a non-submerged implant (ITI Straumann) in an edentulous maxilla

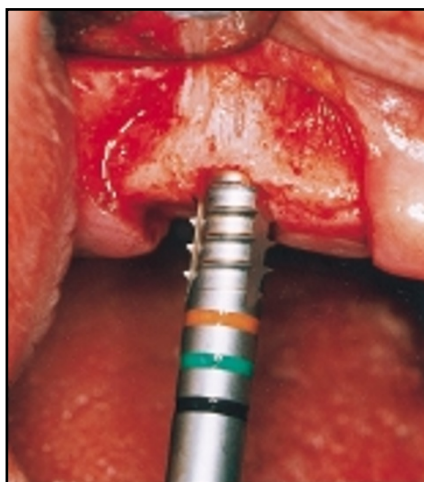


Fig. 3a The drilling sequence has been completed and a tap is being used to cut a thread in the bone. The coloured marks refer to the length of standard implants

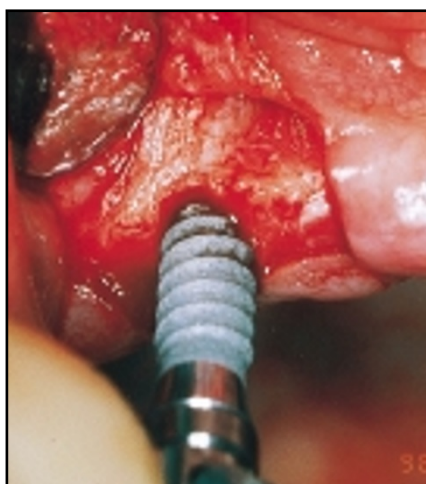


Fig. 3b The solid threaded implant is being screwed into the site using a hand ratchet. This is done slowly with irrigation



Fig. 3c A closure screw has been placed on top of the implant and the flaps sutured around the implant neck

- To keep the area clean by using chlorhexidine mouthwash 0.2% for 1 minute twice daily
- Not to smoke. This compromises healing of



Fig. 4 Small incisions have been made in the mucosa overlying submerged implants to allow removal of cover screws and placement of healing abutments

soft tissue and bone and may increase the risk of implant failure. Ideally patients should stop smoking for some weeks before surgery and for as long as possible thereafter.

The need for systemic antibiotic cover should be considered. The original protocols recommended an antibiotic such as amoxycillin 250 mg 8 hourly for 5 to 7 days, unless the patient is allergic where a suitable alternative should be prescribed. Alternative regimes include administration of 3 grams of amoxycillin 1 hour before surgery, or 500 mg every 8 hours for 48 hours. Treatment plans which have used provisional bridges have an advantage in that they do not load the implant sites and can be refitted immediately after the surgery, providing some allowance has been made to accommodate some swelling. All patients should be seen after 1 week for review, suture removal and adjustment and refitting of dentures with adequate soft linings. In some cases the tissues will not be able to accept a denture for 2 weeks. This is most likely with surgery in the edentulous mandible and with surgical flap designs which affect the sulcus shape. Patients will require regular review and change of soft liners. In some cases there may be exposure of cover screws, but this has little effect on the success of the implant providing they are kept clean.

Surgery for abutment connection

(Second stage surgery)

In non-submerged systems (fig. 3), a second surgical stage is not required and abutments are simply exchanged for the closure screws after a period of about 3 months. In general, submerged implants placed in the mandible are exposed and loaded earlier than those in the maxilla (around 3 months compared with 6 months) because of differences in bone quality. Exposure of the implant at stage 2 surgery can be achieved with minimal flap reflection or



Fig. 5a A buccal flap has been raised to expose the cover screws attached to the heads of two implants. The crestal incision has been placed towards the palatal aspect so that the overlying keratinised tissue can be mobilised towards the buccal aspect

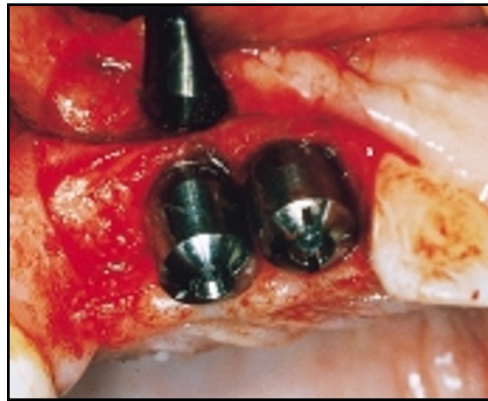


Fig. 5b The cover screws have been removed and healing abutments placed. These are simple titanium cylinders which should just protrude through the mucosa

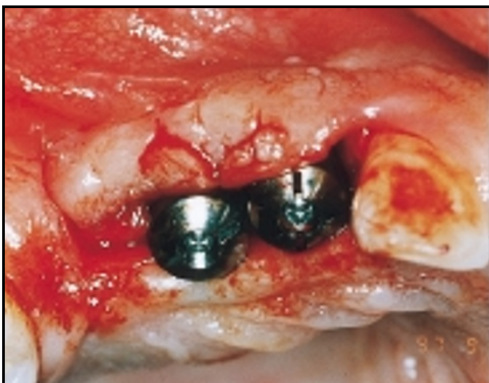


Fig. 5c The buccal flap is shaped with a scalpel to more accurately fit the healing abutments. The small pieces of tissue have been left attached rather than being removed as they can be rotated and positioned between the implant to optimise coverage of the bone



Fig. 5d The flaps have been sutured so as to fit neatly around the healing abutments

sometimes making a very small incision over the implant just to allow removal of the cover screw and attachment of an abutment (fig. 4). In some cases bone grows over the cover screw and this necessitates greater soft tissue reflection to allow bone removal with hand instruments, burs or specially designed mills prior to abutment connection. Most systems employ specially designed healing abutments which allow good mucosal adaptation and healing before selection of the abutment for the final restoration. Ideally the healing abutment should protrude about 1 mm above the mucosa. It is important to check that the abutments are fully seated on the implant. This can be achieved during surgical exposure by direct vision and radiographically at later stages.

Handling of the soft tissue at abutment connection surgery should aim to preserve keratinised (and preferably attached) mucosa on the labial and lingual aspects (fig. 5). The position of the crestal exposing incision should serve to achieve this goal. For example, keratinised tissue overlying

the implant or towards the palatal aspect can be repositioned to the buccal aspect. A number of techniques have been described to optimise soft tissue contours to produce well formed interdental tissues and aesthetic papillae (fig. 5c and 5d). An overlying prosthesis will need to be adjusted to accommodate the protruding abutment. Prostheses which are designed and made with this in mind help considerably. The patient should expect some post-operative discomfort and be advised to take analgesics. They should use chlorhexidine mouthwash until adequate oral hygiene can be re-established. The soft tissue healing will allow the restorative phase to commence in 3 to 4 weeks.

Conclusions

Implant surgery is highly technique sensitive and requires adequate training and an understanding of the restorative requirements of the proposed treatment. However, control of these factors can produce a highly predictable, aesthetic and long-lasting result. In instances where there is insufficient bone and or soft tissue to allow successful implant placement and subsequent restoration, grafting and augmentation procedures will be required, and these are dealt with in Part 8.

Fig. 5 shows the second surgical stage for submerged implant systems