

The Restorative Management of Hypodontia with Implants: 2. Planning and Treatment with Implants

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Abstract: The first paper discussed the clinical features of patients with hypodontia. A range of treatment options were considered with examples given. In this second paper, the implant treatment option for patients is discussed in detail.

Dent Update 2004; 31: 22–30

Clinical Relevance: There is a wealth of experience in the established treatment options for hypodontia patients. Implants now supplement our armamentarium and may be considered to be the ideal form of tooth replacement in these patients.

TREATMENT PLANNING FOR THE PROVISION OF IMPLANTS IN PATIENTS WITH HYPODONTIA (TABLE 1)

Any factor which precludes surgery for the patient will contraindicate implants as part of the treatment plan, such as certain medical conditions¹ (Table 2). There are also other patient factors, such as smoking² which, although they do not contraindicate implants *per se*, are considered high risk factors (Table 3) and therefore reduce their prognosis. As with any tooth replacement, it is important to begin with a healthy mouth with no active disease, including caries and that of periodontal or endodontic origin. Once it is deemed that implants are the preferred restoration, further planning needs to take place before their final prescription. This may include further diagnostic radiographs, planning of

implant position and type and the provision of whatever preparatory treatment is necessary.

Age

Implants should not be placed until growth is complete, owing to infra-occlusion of the implant relative to adjacent teeth as growth continues. This is assessed from patients by finding out about changes in height and shoe size and using an approximate age of 17 years. However, some suggest that it should be confirmed with serial cephalometric radiographs taken one year apart.³

Many hypodontia patients will present in the mixed dentition stage⁴ and may therefore be too young for the placement of implants. A long-term treatment plan must therefore be considered for these patients, along with the necessity for other initial treatment and provisional replacement of teeth. A time scale must be considered and the patient and parents made aware of this. Although implants can be placed once growth is completed, this can also be a particularly busy time in young adults' calendars owing to

examinations and interviews. It is therefore important that the stages, timing and prosthetic implications of treatment be fully discussed at the outset.

Controversially, implants have been placed in children with ectodermal dysplasia,⁵ although vertical dento-alveolar growth results in their submergence relative to adjacent natural teeth. Abutments can be changed for longer ones as growth progresses or implants can, if necessary, be removed. It is not thought that they impede growth, though it is not recommended that a fixed bar be used across the midline in the maxilla for fear this could restrict transverse maxillary sutural growth.⁵

Number and Position of Developmentally Missing Teeth

When considering which type of implant

- Age;
- Number and position of developmentally missing teeth;
- Lip line;
- Deciduous teeth;
- Permanent teeth;
- Orthodontic treatment and tilting of teeth;
- Interocclusal space;
- Bone quality and quantity;
- Radiographs;
- Soft tissues;
- Temporization.

Table 1. Considerations for implant treatment planning in the hypodontia patient.

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- Growth incomplete;
- Uncontrolled diabetes mellitus;
- Severe neuroses/psychoses;
- Significant immunodeficiency;
- Significant bleeding disorders;
- Patients who have irradiated jaws (without hyperbaric oxygen treatment);
- Presence of uncontrolled periodontal disease and caries.

Table 2. Contraindications for implants.

- Tobacco smoking;
- Bruxism or other parafunctional activity;
- Drug/substance abuse (including alcohol).

Table 3. Risk factors for implants.

restoration to use, the number and position of developmentally missing teeth is relevant. Single tooth implants (Figures 1 and 2) are used when there is one tooth missing, or multiples of single teeth, anteriorly. These have the advantage in the anterior region of being able to produce diastemas if required. The standard implant is approximately 4 mm wide and a minimum width of 6–7 mm of bone is required. There may be occasions where a narrow implant (3.3 mm diameter) is necessary, for example in the maxillary lateral incisor or mandibular incisor position, owing to lack of space (Figures 2a, b and c); 5.5 mm of bone is required for the placement of this implant. In the molar region, a wide-bodied implant (5 or 6 mm in diameter) can be used if there is adequate bone. Alternatively, two standard implants linked in the restoration may be used to distribute the loading for molar area placement.

When several teeth are missing, implant-retained bridges can be considered. This may be appropriate where an implant per tooth is not possible owing to lack of space and also for the larger edentulous spans. The number of implants used will depend on length of span and size of implants that can be placed. A balance is required between maintaining simplicity with fewer implants and incorporating a safety margin by using more implants. When planning the placement of implants to

support bridges their position must be determined by the dimensions of permanent-sized teeth rather than deciduous teeth, which are too small (Figures 3b and c).

Those with a complete arch of missing teeth will require either an implant-retained bridge or an overdenture. The bridge requires less maintenance in the long term. It, however, requires more bone for six implants in the maxilla as opposed to four (joined) for an overdenture.⁶ In the mandible four or five implants are needed for the fixed bridge, as opposed to two (joined or separate) for the overdenture option.⁶

Lip Line

This is particularly important in the hypodontia patient who lacks bone. With a low lip line, cervical appearance may be of little consequence. However, when the lip line is high, poor appearance can be a problem if there is no bone in the desired



Figure 1. A single tooth implant replacing a lateral incisor producing a good aesthetic result.

position. It may be possible to compromise by using different abutments to place the tooth in the correct position rather than resort to grafting (Figures 3a and f). Abutment types such as angled, preable, customized (Figures 2d and 3f) and all porcelain can be used in different circumstances to improve appearance.⁶

Deciduous Teeth

Extraction is not always the ideal treatment



Figure 2. (a) Developmentally missing lateral incisors. (b) Paralleling technique periapicals showing minimum amount of space for implants. (c) Periapicals with narrow platform implants in situ. (d) Preamble abutments. (e) Lateral implant retained crowns in situ.

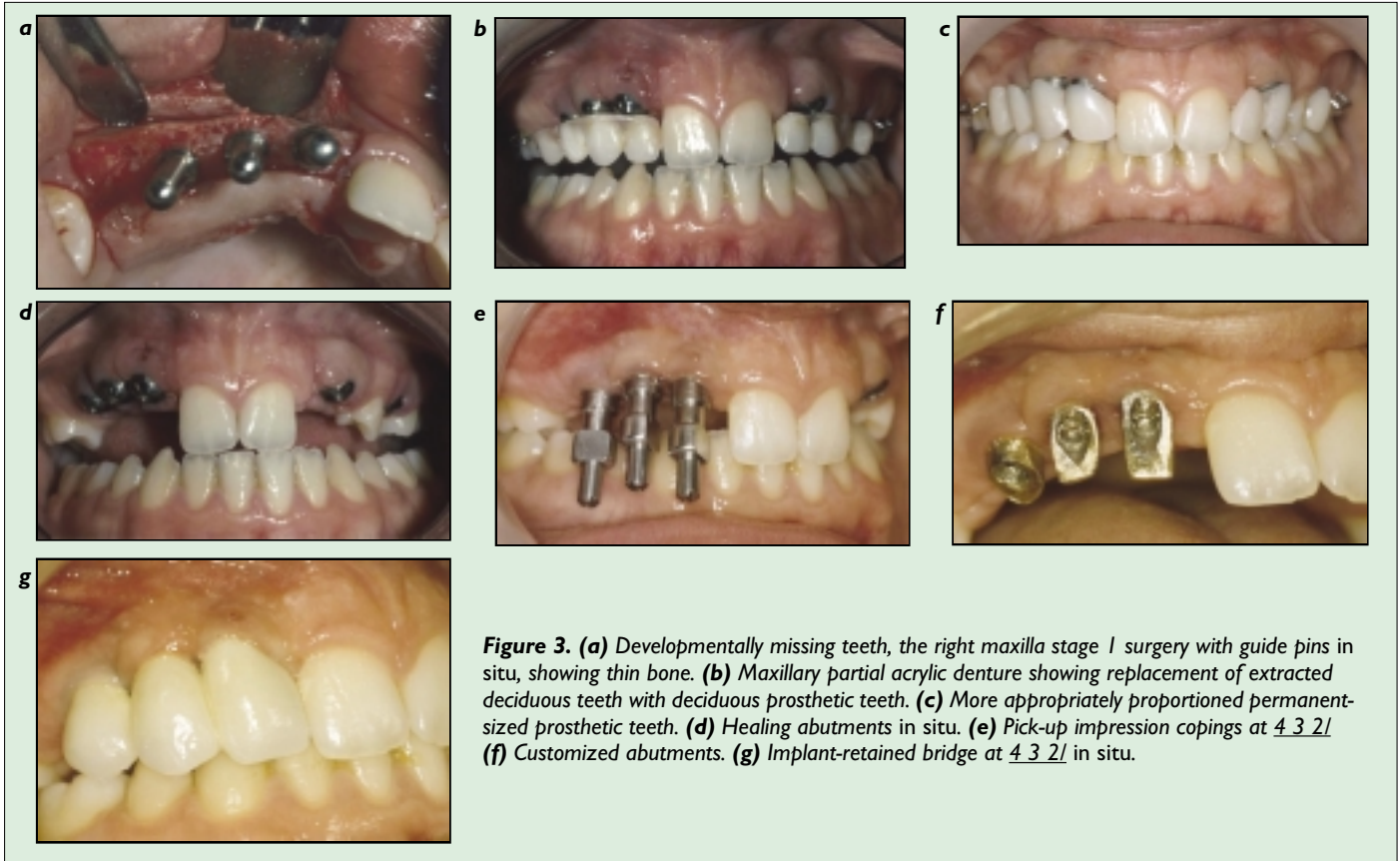


Figure 3. (a) Developmentally missing teeth, the right maxilla stage I surgery with guide pins in situ, showing thin bone. (b) Maxillary partial acrylic denture showing replacement of extracted deciduous teeth with deciduous prosthetic teeth. (c) More appropriately proportioned permanent-sized prosthetic teeth. (d) Healing abutments in situ. (e) Pick-up impression copings at 4 3 2/ (f) Customized abutments. (g) Implant-retained bridge at 4 3 2/ in situ.

option for deciduous teeth. The prognosis for primary anterior teeth is generally not good, though for primary molars it can be better.⁷ An assessment of their appearance and function is relevant and the status of root resorption should be examined radiographically. It will then be possible to decide if extraction is necessary or desirable.

Healthy deciduous teeth can be retained to maintain bone, appearance and function until implants are possible. Where there are retained deciduous lower incisors of adequate appearance and root formation it may be undesirable to extract these and place implants, which can severely compromise aesthetics in this region owing to lack of bone. The dimension of an implant is far greater than that of a mandibular deciduous incisor. Similarly, it would be unnecessary to extract an otherwise healthy retained second deciduous molar simply (Figure 4a) to place an implant.

Where there is early ankylosis in the deciduous molar or root resorption is advancing it may be desirable to extract. In

patients with severe hypodontia, with functional and aesthetic deciduous teeth, it may be considered prudent to extract these as their presence simply complicates

the overall implant treatment plan and they may occupy essential sites for implant placement.

A further dilemma can present

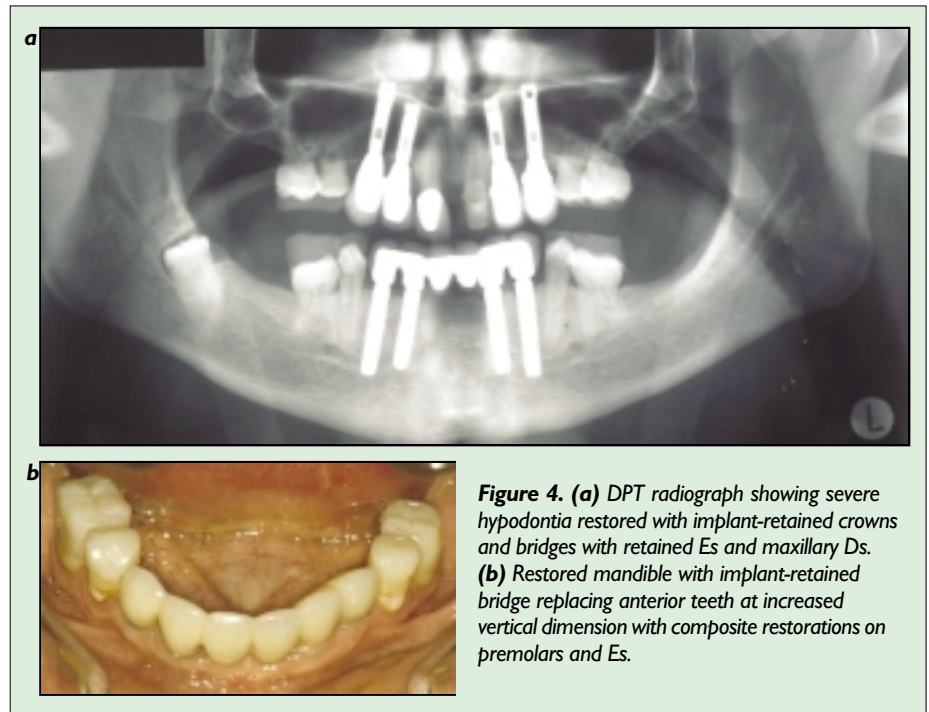


Figure 4. (a) DPT radiograph showing severe hypodontia restored with implant-retained crowns and bridges with retained Es and maxillary Ds. (b) Restored mandible with implant-retained bridge replacing anterior teeth at increased vertical dimension with composite restorations on premolars and Es.

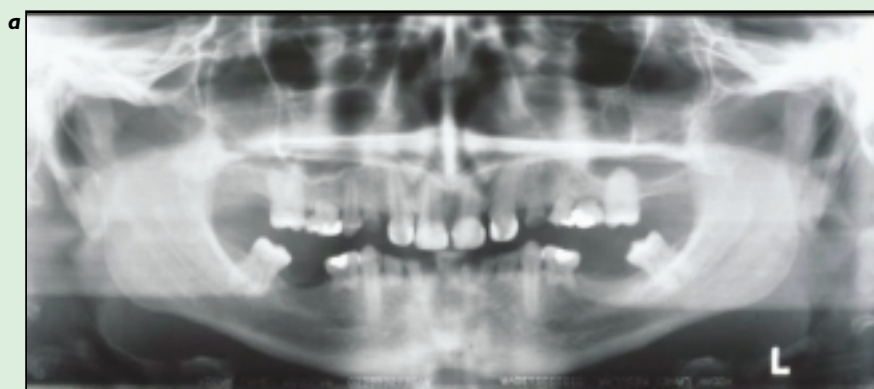


Figure 5. (a) DPT radiograph showing retained deciduous teeth in severe hypodontia. (b) Following extraction of deciduous teeth partial acrylic resin dentures are provided with the prosthetic teeth in the desired position. Note the retained mandibular first premolars to help stabilize the partial acrylic partial denture. (c) DPT radiograph showing radiographic markers in situ. (d) DPT radiograph after stage 2 surgery showing implants in situ. (e) DPT radiograph following mandibular first premolar extractions, abutment attachment and prosthetic tooth replacement. (f) Final result with maxillary and mandibular implant retained prosthesis and replaced veneers on the maxillary incisors and canines.



Figure 6. Apparent lack of space for implants requiring some space creation by increasing the occlusal vertical dimension.

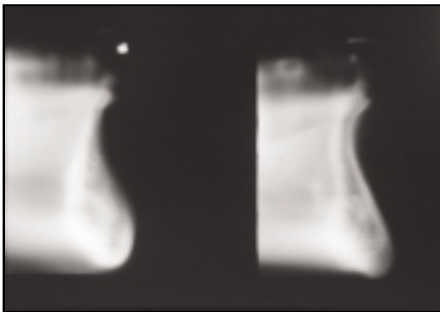


Figure 7. Vertical Scanora section of the mandible showing inadequate bone for implant placement.

regarding when to extract a tooth and when to place the implant. It is generally agreed that an implant should not be placed directly into a diseased site or one where it cannot be stabilized in bone. There may be occasions where it is possible to extract a deciduous tooth and place an implant at the same time, particularly where the deciduous tooth has short roots.

Permanent Teeth

One of the features seen in teeth of hypodontia patients is microdontia and enamel hypoplasia. This may be unaesthetic and require other restorative treatment. In severe hypodontia, where an increase in vertical dimension is required to accommodate implant-retained crowns, it may be necessary to increase the height of permanent teeth in order to achieve this. Where necessary, permanent teeth can be restored with indirect gold or composite onlays.

Sometimes it is desirable to extract permanent teeth of questionable prognosis adjacent to planned implant sites and replace them at the same time. In severe hypodontia, the position of a

healthy permanent tooth may complicate implant placement and/or the prosthesis and therefore extraction may simplify the treatment (Figures 5b, d and e).

Orthodontic Treatment

Orthodontic treatment may be required as part of the overall treatment plan, to improve appearance and function and to facilitate ideal implant placement. Bonding of brackets can be a problem in hypodontia patients, especially with microdontia and those with enamel hypoplasia. Another potential problem is the lack of anchorage due to lack of teeth. Implants can be placed to provide anchorage, either along the alveolar ridge or sometimes in the palate, zygomatic process, retromolar region and ramus. However, if the same implants are later to be used for tooth replacement, then very careful planning of their position will be required.⁸

In mild hypodontia, tilting of roots can prove a major problem, leaving inadequate mesio-distal space for implant placement. Orthodontics will be required to correct this by uprighting the teeth either side of the space. A paralleling technique periapical radiograph is required to confirm this has been achieved, with an ideal width of 7 mm required between the entire length of adjacent roots for standard implant placement. If orthodontics is carried out, then the patient should be seen by the restorative dentist prior to debonding, so that correct tooth position and root angulation can finally be assessed.

Contrary to other fixed restorative techniques, when a large number of teeth are missing, it is better to have spacing concentrated into larger areas than discrete single units. This enables implant-retained bridges to be placed, providing greater flexibility.

Interocclusal Space

Hypodontia results in a lack of alveolar development. Overeruption of unopposed permanent teeth or those opposed by deciduous teeth can lead to the development of grossly disordered occlusal planes (Figure 6). This may require combined pre-implant restorative



Figure 8. Radiographic stent with markers.

and orthodontic treatment.

The minimum interocclusal space from the head of the implant to the occlusal plane to achieve a retentive and aesthetic restoration is about 5 mm. If it is established that limited interocclusal space may be a problem, the implant should be placed in a deeper position in the alveolus to produce adequate restorative space. Alternatively, in patients with severe hypodontia where there is an apparent reduced interalveolar space, this can safely be increased in a controlled manner to accommodate appropriate-sized restorations (Figures 4a and b).

Bone Quality and Quantity

Radiographs are required for all patients who have been prescribed implants. The approximate width of the alveolar ridge can be estimated by palpation. In borderline cases, where it is difficult to be certain, vertical radiographic slices can help. Sometimes bone width can only be determined accurately at the time of surgery.

By definition, the hypodontia patient with developmentally missing teeth fails to develop alveolar bone.⁹ Therefore there is reduced width and height of bone present in which to place implants (Figures 3a and 7). Many of these patients may require bone grafting procedures which may complicate treatment. The greater the number of missing teeth the potentially greater the area of bone grafting required. This will lead to the use of distant donor sites, such as the hip, with increased morbidity. With the wide range of prosthetic components available, it is sometimes possible for patients to be treated successfully with compromised

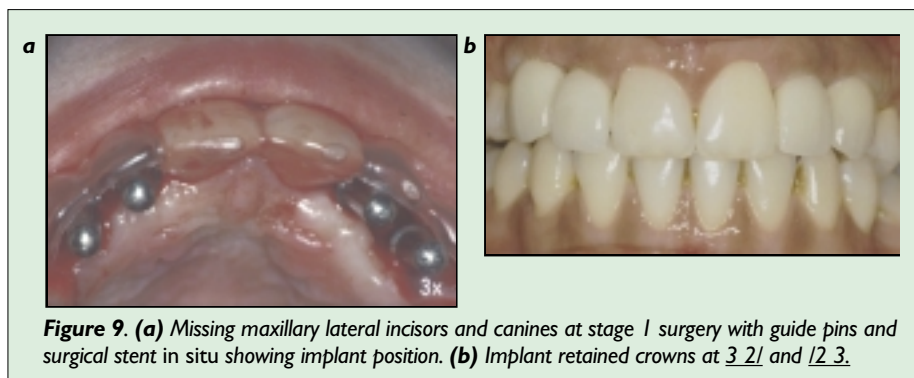


Figure 9. (a) Missing maxillary lateral incisors and canines at stage 1 surgery with guide pins and surgical stent in situ showing implant position. (b) Implant retained crowns at 21 and 12.

implant positions based on existing bony contours, rather than subjecting the patient to further surgery.

Radiographs

Relevant radiographs are essential for all implant patients in order to assess quality and quantity of bone present and determine bony anatomy. They are also needed to identify the position of anatomical structures such as the nasal aperture, maxillary sinuses, the incisive canal in the maxilla, the ID canals and mental foramina in the mandible.

The dental panoramic tomograph (DPT) (Figure 5a) provides the best overall view, particularly where multiple implants are planned. Standard machines use linear tomography and, although some modern machines have programmes to take vertical slices, they are extremely operator sensitive. The *Scanora*SM (Soredex Orion, Helsinki, Finland), which uses spiral tomography, also gives the option of taking vertical slices (Figure 7), is easier to use and gives better resolution. In addition, computerized tomography (CT) gives cross-sectional images, though these can also be manipulated and produce 3D images. The radiation dosage for CT is quite high and the images are expensive to produce compared to conventional radiography, however, it is recommended where cross-sectional images of a complete jaw or jaws is required.¹⁰ The lateral cephalometric radiograph is sometimes used to assess width of midline bone in the anterior mandible. Paralleling technique periapical radiographs are important when studying the amount of mesio-distal

space present for a single implant and determining the health of adjacent teeth. Another imaging technique currently being investigated for use in implant planning, which offers the advantage of not using ionizing radiation, is magnetic resonance imaging (MRI).¹⁰

Radiographic stents (Figure 5c) will help to locate the exact position of the slice where *Scanora* or CT images are taken. These are made by positioning of radio-opaque markers on a carrier such as a soft 'blow down' (Figure 8) or a partial denture. It is important that these are of different shapes and therefore readily identifiable radiographically to determine their position.

Magnification of most standard DPT machines is in the order of 1.2. When using the *Scanora* machine for implant DPTs, the magnification is 1.7, whilst CT is actual size.

Soft Tissues

It is apparent that the lack of teeth in hypodontia is associated with a diminished width and thickness of keratinized gingival tissue. Non-keratinized tissue is more delicate and can become sore where plaque control is compromised. It is sometimes necessary to carry out supplementary surgery involving free gingival grafts and interpositional subepithelial connective tissue grafts using the palate as a donor site.⁶

Temporization

Temporary restorations need to be planned for the period following surgery. Following stage 1 surgery the

soft tissues must not be loaded for at least a week in order to allow healing. There will be some soft tissue swelling and an added problem, particularly in the hypodontia patient, may be reduced interocclusal space. At stage 2, this can be a further problem owing to the projecting healing abutments. In severe hypodontia, when increasing the occlusal vertical dimension, it is important that the temporary restorations establish the occlusal relationships likely to be achieved by the final restorations from the start (Figure 3c). This confirms that the patient will accept the change and it will provide appropriate space for temporary restoration.

Temporary tooth replacement may not be necessary in some cases where appearance is of little consequence, as is often the case with missing second premolars.

Partial acrylic dentures, if adequately relieved, can be replaced immediately after implant placement, but should not be used for eating to prevent loading of the surgical site. After one week the dentures can be relined and used normally. They can be useful in the planning stage when there are missing upper anterior teeth to be replaced with implants. The denture can be constructed without a flange to help determine tooth position and emergence profiles. They are also used as an aid to the construction of radiographic and surgical stents.

Resin-bonded bridges can be placed immediately after implant surgery, provided they will accommodate soft tissue swelling. To allow for easy adjustment, pontics should be made out of acrylic or composite resin. It is important that the resin-bonded bridges are easily removable by using a perforated framework, as in the Rochette design, or when using a solid framework a weak cement such as glass ionomer is preferred.

Alternatively, under special planned circumstances, implants can be restored immediately after placement. Temporary implant-retained crowns are placed, giving time for the soft and hard tissues to heal. The patient's bone quality must

- Pre-implant treatment;
- Autogenous block bone grafts (3–6 months);
- Stage 1 surgery (3–6 months);
- Stage 2 surgery (2–4 weeks);
- Prosthodontics;
- Follow-up.

Table 4. Stages involved in the provision of implants in the hypodontia patient.

be good, with perfect primary stability, and the occlusal forces applied to the temporary must be minimal and controlled. Although there is little data available, the prognosis is thought to be somewhat reduced compared to implants left to integrate prior to restoration.

STAGES INVOLVED IN THE PROVISION OF IMPLANTS IN HYPODONTIA PATIENTS (TABLE 4)

Pre-implant Treatment

As previously discussed, this could involve any extractions, orthodontic and restorative treatment that is prescribed in order to make the implants possible.

Surgery

This can be divided into several stages: bone grafting if required, implant placement known as stage 1 and implant exposure, stage 2. There are implant systems which are not submerged and therefore do not require a second stage. The technique for implant placement should be meticulous and the operator be adequately trained.

Bone grafting may be more common in the hypodontia patient owing to lack of alveolar bone. Autogenous bone is the 'gold standard'. Where small amounts of bone are required, the chin, maxillary tuberosity and mandibular ramus can be good sites. There is often concern that removal of chin bone will lead to alteration in facial profile, however, this has not been found to be the case, though patients should be warned of

possible altered sensation. For larger areas where more bone is required, extra-oral donor sites, such as the hip, can be used. The bone must be placed in the correct position for the implant placement and therefore some prosthodontic planning will be required at this stage. Onlay block grafts can be used to increase alveolar width and height. These will generally be fixed *in situ* with screws for a period of three months prior to implants being placed within them. If left longer than six months, bone resorption may prevent the placement of an implant. The sinus lift procedure may be used to increase bone height in the maxillary sinus region.

A surgical stent is necessary to provide the operator with the desired tooth position (Figures 9a and b). In the hypodontia patient where there is minimal bone, a compromise between the ideal implant position prosthetically and surgically may be acceptable. The type and size of implants are chosen prior to surgery, often the longest possible are used. Ideally, they are placed in the long axis or slightly palatal to the tooth they are replacing. Particular care is taken to ensure they will not be in a potential embrasure space between pontics. It is important to provide adequate safety margins to avoid encroaching upon adjacent anatomical structures, they should therefore be placed at least 2 mm above the inferior dental canal, though a few millimetres penetration of the nasal or sinus floor is permissible.⁶ Depending on the implant system, about 1.5 mm space is required between implants and implant and natural teeth. The top of the implant must be placed sufficiently deep to achieve a good emergence profile. Using a standard implant, the head should be placed 3 mm below the cervical or gingival margin of the restoration. In mild hypodontia, the cervical margins of teeth adjacent to the implant sites can be used to gauge this. Multiple implants are placed as parallel as possible to allow seating of the prosthesis but most systems will allow a difference of up to 40°. A cover screw is placed to protect the implant head.

The second stage surgery can take

place at 3–6 months, dependant on the site quality of bone. The cover screws are removed and a healing abutment placed. This should protrude a few millimetres above the mucosa (Figure 3d).

Prosthodontics

Once the soft tissues have healed after about 2–4 weeks⁶ the final restorative phase can take place. A variety of abutments are available for selection. Either the impression is taken of the chosen abutment or an impression made of the implant head (Figure 3e) and the abutment chosen out of the mouth.

Restorations are generally metal ceramic, though the greater the number replaced the more likely that composite or acrylic on a gold framework will be used. The prosthesis can be either cemented or retrievable and screw retained. It is important not to overload the implant-retained prosthesis remembering that they do not behave as teeth and are firmly fixed in bone. Light contact is preferred in intercuspal position with no contact in excursive movements. Should this be impossible, then shared contact is appropriate. In the hypodontia patient where lack of space can be a real problem, careful planning of the occlusion is required.

Follow-up

Baseline radiographs taken initially (Figures 2c and 5d) should be repeated every year for the first few years in order to establish bone stability after initial loading. Patients should be reviewed annually to avoid problems and oral hygiene reviewed regularly.

POTENTIAL PROBLEMS WITH IMPLANTS

Patients who are about to embark on implant treatment need to be aware of some of the potential problems as well as advantages.¹

Early problems include inadequate bone for placement, perhaps not evident until the time of surgery, which may then require bone grafting. All the

complications of surgery will apply such as bleeding, bruising and swelling about which the patient must be warned. Failure to achieve primary implant stability and post-operative infection may cause early loss of the implant. If implants are placed in incorrect positions, despite the different abutments available, it may be impossible to use them.

Later loss may result from: peri-implantitis, inflammatory disease around implants; or what is often referred to as occlusal overload when the occlusal concepts of implants are not observed. Mechanical failure can occur due to fracture of the implant, screw or superstructure.

Patients must therefore be made aware of maintenance implications, particularly when placed in a young patient where the restoration may be expected to last for many decades. This should include discussion of not only the practical implications but also the cost.

CONCLUSIONS

The hypodontia patient presents with multiple features that can make implant treatment complex. In summary, specific problems include:

- The presentation of a patient for treatment who is too young for implants;
- Decisions on the extraction of primary teeth;
- Permanent teeth may be in the wrong position;
- A lack of interocclusal space may

require an increase in occlusal vertical dimension; and, perhaps the most important

- The lack of alveolar tissue, in particular bone.

Careful planning may make situations treatable without resorting to bone grafting. However, it must be stressed that hypodontia patients are an extremely diverse and complex group. Therefore, except in the simplest of cases, dental management of the hypodontia patient should be co-ordinated by a multidisciplinary group of specialists in order to achieve the optimum care.

Implants are now widely used in dentistry and, as discussed, are particularly useful for the hypodontia patient in whom good aesthetic results can be achieved (Figures 1a, 2e, 3g, 4b, 5f and 9b). Their provision is not dependant on abutment teeth, implants are therefore biologically conservative and suited to the unrestored dentition of today. Equally, they offer advantages in situations where bridges have a poor prognosis, either due to the quality of abutment teeth or length of span. The gain for patients treated with implants is immeasurable. The success rates for implants compared with other restorative techniques remain extremely good.

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FURTHER READING

For further information on implant placement and restoration the reader is referred to *Implants in Clinical Dentistry* Martin Dunitz, 2002 by Richard M. Palmer, Brian J. Smith, Leslie C. Howe and Paul J. Palmer.

ACKNOWLEDGEMENTS

With thanks to: Richard M. Palmer and Paul J. Palmer for carrying out the implant surgery, advice on the section on Surgery and Figures 3a and 9a. Mahmood K. Suleiman for Figure 2. Eric Whaites for advice on the section on Radiographs.

ERRATUM

The Restorative Management of Hypodontia with Implants: 1. Overview of Alternative Treatment Options Claire Morgan and Leslie Howe *Dent Update* 2003; **30**: 562–568

The following figures in the above article, which was Part 1 of a series of two articles, became distorted during the production process: 1b, 3, 4, 5c and 6b.

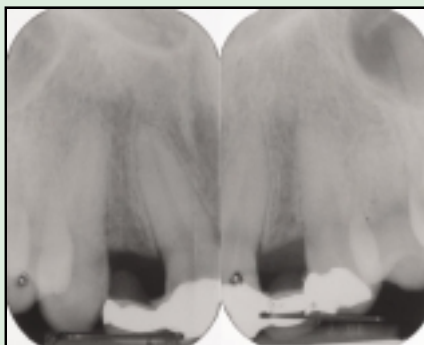


Figure 5c.



Figure 6b.