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Modern Restorative Management of Patients with Congenitally Missing Teeth: 4. The Role of Implants

Abstract: In this fourth and final paper on the management of patients with congenitally missing teeth, the use of dental implants is considered. This group of patients often provides unique challenges when implant reconstruction is considered. Often a multidisciplinary approach is required involving orthodontists, oral surgeons and restorative dentists. The use of dental implant systems is a rapidly developing area of dentistry and its implications on hypodontia are discussed. This paper identifies the problems associated with a congenital absence of teeth and addresses their management in relation to the use of implants.

Clinical Relevance: The use of dental implants in hypodontia patients should always be considered as a treatment option. These groups of patients, however, require careful planning, often of a multidisciplinary nature, so that the timing of the various treatment modalities is seamless.

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In 1969, Brånemark *et al* [1] described a technique which provided a predictable outcome for titanium implants in the facial skeleton. Since that time, numerous publications have confirmed the predictability of the procedure in edentulous and partially dentate patients, as well as in the restoration of the single missing tooth.[2,3] The biological and procedural factors affecting outcome have also been well documented.[4-6]

Although there are numerous implant systems on the market, there are only a limited number with proven long-term relevant survival data.[3,7] Recent advances have involved single stage and flapless surgery, immediate loading and the introduction of temporary implants.[3,8,9]

With respect to patients with congenitally missing teeth, the following factors need to be contemplated when considering the possibility of using osseo-integrated implants:

- Age and growth;
- Implant requirements;
- Quality and quantity of bone;
- Fixture dimensions;
- Prostheses design; and
- Compliance and access to care.

Age and growth

Osseo-integrated implants behave like ankylosed teeth in that they do not move during subsequent growth of the facial skeleton.[10-15] As a result, just like ankylosed teeth, they can become infra-occluded and the gingival margin more apically placed than surrounding teeth. Placement of an implant in areas where growth is still to occur may cause it to become isolated and positioned outside the line of the arch (Figure 1).

In the maxillary anterior region, where growth results in the relative movement of the nasal floor anteriorly and inferiorly, an implant may eventually become infra-occluded and palatally

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Figure 1. A case illustrating early placement of an implant and the subsequent growth of the alveolus leaving the implant infra-occluded.

placed. In addition, the fixture may protrude and possibly become exposed into the nasal cavity. In animal and clinical studies, where metallic pins have been used to evaluate growth, a high degree of failure has been associated with implants placed in sites with significant growth potential.[10,12,13,14] In the developing maxilla, anterior implants will tend to move further apart owing to midline suture growth, whilst any cross arch fixed prostheses, particularly if it affects the posterior regions, will restrict transverse growth.[12]

In the maxillary and mandibular posterior segments, where growth results in a relative buccal movement of the jaws, the fixture may become more palatally/lingually placed. In the maxilla this may be significant, whilst in the mandible it would be less of a problem owing to the nature of the growth pattern.[12-14] During growth, the natural mesial drift of teeth distal to the implant may also be stopped and the eruption of adjacent teeth inhibited. The relative angulation of the implant to the occlusal plane and adjacent teeth may also change as anterior or posterior rotational growth occurs.[12-14, 16-19] These problems can be overcome by replacing the abutment and coronal restoration. The fixture does, however, become more deeply embedded in bone and soft tissue, making maintenance more difficult, and can cause aesthetic problems. The ratio of the bone coverage of the implant to coronal restoration length also becomes less favourable, which may have an effect on the long-term survival of the fixture.

a

b

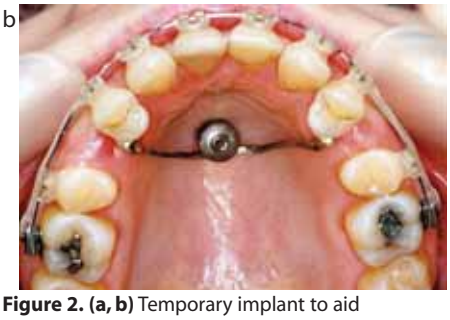

Figure 2. (a, b) Temporary implant to aid orthodontic anchorage. (Courtesy of Richard Coulsley.)

If implants become infra-occluded, this can be resolved by modifying the suprastructure during growth. This maintains the inter-occlusal and inter-proximal contacts. It is advantageous, therefore, to use screw-retained restorations if possible and use a composite material for the crown or bridge to which additional material can be added.

For these reasons, implants should not, ideally, be placed until growth has either finished or where expected residual growth will be minimal. A fixed chronological age should not be used. Instead, reference should be made to serial growth records and, possibly, radiographic techniques. Other contra-indications to the placement of implants in young patients include difficulties with compliance, the risk of damaging developing tooth germs and the probable need for a general anaesthetic.

Implant therapy may be indicated in young patients when there are functional or psychosocial reasons and where multiple teeth are missing, or where predicted alveolar growth may be minimal.[20] The only area where growth is limited is the anterior mandible after the age of 6–7 years. The transverse growth in the lower incisor and canine regions ceases early[21] and, as such, fixtures may be considered in this area in cases of severe hypodontia. However, sagittal and rotational mandibular growth will continue influencing labial segment inclinations and inter-arch relationships and these must be appreciated when considering early fixture placement.

Where implants are required before growth is complete, to reinforce orthodontic anchorage, temporary implants can be considered and these removed at the end of orthodontic therapy (Figure 2 a, b). This option is particularly useful in the maxilla, where insufficient bone is present to place definitive implants in the ideal position for the long-term suprastructure. An implant placed in the palate can also be used in such situations. In the young patient it would seem sensible to place this away from the mid-line because of the relative lack of bone.[22,23]

A common finding reported in the literature relating to patients with a significant number of congenitally missing teeth is an 'increased freeway space'. Hobkirk and Brook[24] suggested that this was due to a delay in development and relative lack of alveolar growth. Goodman *et al* [25] agreed with this conclusion, but also considered that a lack of posterior support also contributed to the problem.

Interestingly, Hobkirk and Brook[24] likened the profile of such patients to that observed in edentulous patients with mandibular protrusion and lip eversion on occlusion. Freeway space in non-edentulous patients is an adaptive position and, even following immediate and significant changes in the occlusal vertical dimension, reverts quickly to its pre-operative size.[26-28] While development of the facial skeleton is unaffected, the alveolar process may not develop normally, but this deficiency is primarily bucco-lingually rather than in height.[29] The eruption of secondary teeth is also associated with a change in lower face height, primarily due to growth of the ramus, as the mandible moves forward and downwards and as the alveolus shows a marked growth. A number of authors have observed, in patients with four or more missing teeth, a more rotational anterior growth pattern of the mandible, which may also contribute to the appearance seen in edentulous patients.[16,30] It is, therefore, more likely that the observed profile in non-edentulous patients is a reduced lower face height which is either due to, or a combination of,:

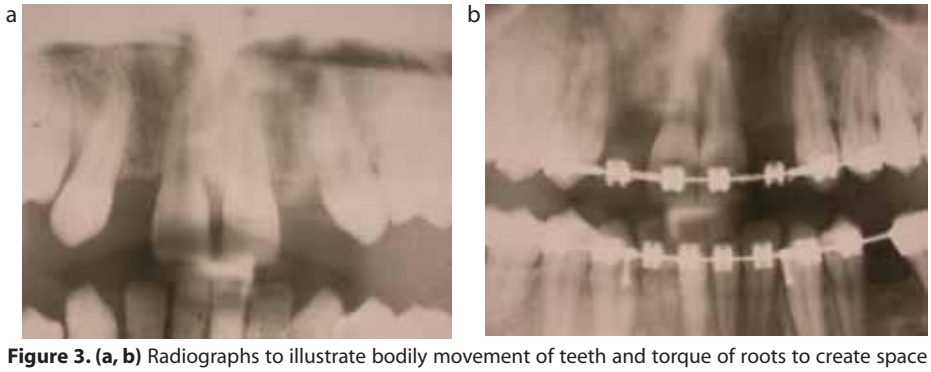

Figure 3. (a, b) Radiographs to illustrate bodily movement of teeth and torque of roots to create space for dental implants. (Courtesy of Mrs Angharad Brown.)

- Abnormal development of the facial skeleton;
- Lack of compensatory alveolar growth following wear of the occluding erupted primary teeth or vertical growth of the facial skeleton;
- Lack of alveolar development associated with widespread absence of secondary teeth following vertical growth of the facial skeleton.

A reduced face height is unlikely to cause any long-term functional problems, providing there is no deterioration in the dentition or, if a significant number of teeth are subsequently lost, it is not an aesthetic concern. As such, the treatment options should be aimed at preventing a deterioration in the dentition and restorative intervention should be aimed at maintaining the occlusal vertical dimension. Restorative care may also be required to restore the edentulous spaces, possibly in association with orthognathic surgery, if the dental base relationship requires correction.

An increased overbite is often observed in patients with multiple congenitally missing teeth. This should not be a problem to the periodontal tissues unless a complete overbite is present and the patient has poor oral hygiene either due to compliance or access problems. The presence of this occlusal relationship does, however, make potential restorative intervention in the area more difficult. For these reasons, particularly in young patients, it would seem reasonable to correct an increased overbite, particularly if orthodontic intervention is already indicated. This would help to prevent problems later in life, when orthodontics may not be acceptable, and where a restorative resolution may be difficult or destructive.

Implant requirements

Space

An implant requires at least 1 mm of bone between it, the adjacent teeth and the buccal and palatal alveolar plates. For this reason, the normal minimum interdental and alveolar widths are approximately 6–7 mm and 5 mm, respectively. If this is not achieved, damage to the adjacent teeth may occur or interdental periodontal and gingival problems may develop. Similar dimensions are required between implants and teeth in the opposing arch. If two fixtures are required, an interdental space of 13–14 mm is usually necessary and similar dimensions are necessary between implants in opposing arches.

It is important that, if adjacent teeth are moved orthodontically, they are moved bodily and the apices torqued away from the space (Figure 3 a, b). A prosthetic tooth of appropriate dimensions, placed into the space during orthodontic treatment, can act as a guide to the coronal space requirements.

In aesthetic areas, the head of the fixture should be placed so that the risk of early exposure or visible metal collars associated with a too superficial position is avoided. It has been suggested that the implant be placed approximately 3 mm below the level of the gingival margin of adjacent teeth and no more than 5 mm below the associated contact points.[31] Care should, however, be taken to avoid placing fixtures too deep, since this will result in resorption of the overlying alveolar bone and corresponding gingival recession and loss of interdental contours.

Currently, there is a trend, in aesthetic areas, to avoid traditional and extensive soft-tissue flaps, particularly if they include the adjacent interdental papillae and gingival margins. This has led to the introduction of 'flapless' surgical techniques as predictable procedures to aid the preservation of soft tissue profiles.[32] However, before using such techniques, it is important the operator is able to evaluate in three-dimensions the alveolar shape and proposed implant position fully, as well as have the knowledge and skill to use more traditional approaches if necessary.

In recent years, there has also been a move to use enhanced implant surfaces extending to the whole length of the implant. It is suggested that such surfaces enhance soft tissue stability.

If interdental space or alveolar bone width is limited, then narrow implants can be used but, owing to their potential inferior mechanical properties, they should be protected during function by adjacent natural teeth. One piece implants (abutment and fixture combined), such as the *Nobel Direct 3.00 mm* fixture (Nobel Biocare AB, Sweden), can overcome some of the concerns in respect to the physical properties of a narrow implant, but obviously introduce problems in relation to the limited number of abutment positions. In cases where the interdental space is reduced apically, a tapered implant may be considered.

Quality and quantity of bone

Assessing the quality and quantity of bone of a potential implant site from a plain film radiograph is not always predictable. Lekhom and Zarb[33] concluded that, in many cases, a true evaluation could only be obtained during the surgical procedure. More recently, 3-D imaging based on CT scans have become popular, eg *Materialise NV*, Leuven, Belgium. These techniques allow a detailed evaluation of the bone quality and quantity, as well as allowing implants to be 'placed' prior to surgery

Figure 4. Narrow ridge associated with hypodontia, which would require grafting prior to implant placement.

and steriolithographic models and surgical stents constructed. Such techniques are probably not necessary for simple cases, where traditional radiography, together with localized tomography, provide adequate information. In cases where multiple implants are envisaged, or where significant bone grafts are required, the use of these methods may reduce surgical time considerably, as well as offering higher levels of predictability.

In patients with congenitally missing teeth, where alveolar growth may be limited, ridge augmentation may be necessary using bone grafts (Figure 4). This may involve the limited placement of locally collected bone and a protective membrane at the time of implant insertion or, in more severe cases, bone collected from the iliac crest and implants subsequently placed. To protect the bone in the later case, the implants should be placed approximately four months after the graft, otherwise significant resorption may occur.

In poor quality bone, the traditional time before loading that can occur (3–6 months) may not be appropriate and a more prolonged period may be necessary. The use of resonance frequency analysis (*Oststell*, Biolin Medical AB, Stockholm) would appear to provide an objective method of evaluating when fixtures can be loaded.

Fixture dimensions

In general, implants should be as long as possible and achieve cortical anchorage. In situations where there is a reduced alveolar bone height, eg posterior maxilla or mandible, a wider implant can be utilized, since the reduction in available surface area associated with a shorter fixture is offset by the increase in width and the potential to engage buccal and palatal cortical plates. Alternatively, ridge augmentation may be indicated, although a wide-bodied fixture with a minimal length of 7 mm may perform equally as well as a longer implant in the posterior maxilla which has been grafted.[34,35]

Prostheses design

Fixed prostheses provide the most stable of appliances but, in general, require more implants for support and place more demands on the fixtures. For this reason, removable appliances may be considered more appropriate when bone quality or quantity is questionable. This might be converted to fixed appliance later when integration is found to have been achieved.

Removable appliances place fewer demands on the patient's dexterity in relation to oral hygiene practices, but tend to require more maintenance owing to wear of the prosthesis and resorption of the underlying alveolar ridges. They also require more coverage of the oral mucosa when compared to a fixed appliance, but allow a more extensive occlusal table to be achieved. A removable appliance also restores lost soft tissue and facilitates support of the facial musculature and, initially, is less expensive than a fixed prosthesis although, in the long-term, the difference may be less significant.[36,37]

Compliance and access to care

Although initial implant integration is now predictable, access to long-term maintenance and support is essential for long-term success.[4,5] Patients need to be able to demonstrate a good level of oral hygiene prior to embarking on implant therapy, as well as a commitment to the treatment. Patients should also be aware, at the outset, of the potential financial implications of implant treatment.

Conclusions

The management of hypodontia patients with the use of dental implants can be complex. Combined planning with a multidisciplinary team is essential to enable the correct timing of treatments. This will provide maximum benefit to the patient. Whilst implant placement is generally delayed until patients have stopped growing, there are times when earlier placement will aid the orthodontists in their ability to get teeth in the most appropriate position for either further implant placement or for more conventional restorative options. The decision to use implants in this group of patients, particularly when they are young, needs to be carefully considered. The patient needs to be fully aware of what is involved, not only of the number of surgical procedures (particularly if bone grafting is involved), but also of the maintenance implications of such treatment. Although implants seem to provide a predictable outcome, they should not be considered the only option. Patients should be given the options from the most simple to the most complex.

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CPD ANSWERS

JANUARY/FEBRUARY 2007

1. A, B, C	6. A, B, D
2. B, D	7. B, C, D
3. B, C, D	8. A, D
4. A, B	9. A, B, D
5. A, C, D	10. C