A review of implant provision for Hypodontia patients within a Scottish referral centre.

Authors:

Mrs Beth Burns, BDS MSc (MedSci) FDS (Rest Dent) RCPS (Glas), Consultant Restorative Dentistry, Glasgow Dental Hospital and School, 378 Sauchiehall Street, Glasgow, G2 3JZ

Ms. Vicki Greig BDS MFDS (Glas), Specialty Registrar Oral Surgery, Glasgow Dental Hospital and School, 378 Sauchiehall Street, Glasgow, G2 3JZ

Professor Vincent Bissell, BDSBChD PhD FDS RCSEd MRD RCSEd FDS RCPS(Glasg) FHEA, Professor of Restorative Dentistry and Dental Education, Deputy Head of Glasgow Dental School Glasgow Dental Hospital and School, 378 Sauchiehall Street, Glasgow, G2 3JZ

Mr Lee Savarrio BDS MSc (Med Sci) FDS (Rest Dent) RCPS (Glas), Clinical Director and Consultant Restorative Dentistry, Glasgow Dental Hospital and School, 378 Sauchiehall Street, Glasgow, G2 3JZ

Abstract

Implant treatment to replace congenitally missing teeth often involves multi-disciplinary input, in a secondary care environment. High quality patient care requires an in-depth knowledge of treatment requirements. This service review aimed to determine treatment needs, efficiency of service and outcomes achieved in hypodontia patients. It also aimed to determine any specific difficulties encountered in service provision, and suggest methods to overcome these.

Introduction

Multi-disciplinary care is well established in many clinical fields. With particular relevance to dentistry are the Multi-Disciplinary Teams (MDT's) working in Head and Neck Cancer and Cleft Services. Since their inception these specialist teams of professionals have helped to ensure provision of the highest standards of care (Epstein[1]).

Patients who have developmentally missing teeth have complex needs that may benefit from a multi-disciplinary approach. The successful implementation of multidisciplinary care requires effective organisation, informed by knowledge of typical (and atypical) patient pathways that, in themselves, will reflect the clinical needs of the patients and the resources and limitations of the particular healthcare provider. The multi-disciplinary hypodontia clinics within the NHS referral centre reviewed, have been in existence for more than 15 years. This review seeks to uncover some of the issues present and assumes that the outcomes will be of interest to other providers of similar care. The use of implants in patients with hypodontia may offer significant advantages but can also present particular challenges; hence these patients are the focus of interest for this review. Patients who after multi-disciplinary input opted for tooth replacement with bridgework, were not included in this review.

Clinical outcome recording is key to measuring the success of any treatment approach. As Yap and Klindeberg found in 2009, literature examining implant outcomes in hypodontia patients is scarce. These authors were able to include only 12 articles in their critical review of the literature pertaining to implants in hypodontia and ectodermal dysplasia patients, none of which were case- or randomised-case controlled studies (Yap, Klineberg[2]).

This review therefore aimed to address the following questions:

1. What were the multi-disciplinary treatment needs of hypodontia patients accepted for implant treatment?
2. How well did the organisation of this care function, in terms of facilitating the most efficient and evidence-based patient pathways?
3. What were the outcomes of treatment in terms of
    - Implant survival
    - Implant success
    - Aesthetic acceptability

Materials and Methods

Hypodontia patients in the Unit of Periodontics of the Scottish referral centre under consideration, who had implant placement and fixed restoration or review completed

over a 31 month period, were included. A standardised data collection form was developed and completed with reference to the patient's clinical record. The only exclusion criterion was the absence of sufficient detail regarding date of implant surgery, implant position, type of implant (submerged vs. transmucosal), timing of 2nd stage surgery, loading or final restoration placement.

Information was collected with regard to:

- The indication for implant treatment and its extent.
- The need for, complexity and duration of Orthodontic treatment, including the interface with other specialties.
- The need for bone grafting and the techniques employed
- Indicators of implant success

As the data pertaining to implant success was collected at subsequent review appointments, not all of the restored implants had this data present. These implants were still included in the review where other relevant data was available.

In order to assess bone loss around an implant a 'baseline' radiograph taken immediately post placement and one taken at follow up review examination were required. All radiographs for bone level assessments were periapicals taken with Rinn holders and F Speed film. Bone levels were measured from baseline and follow up radiographs. Implants were regarded as positive for bone loss if it was judged there had been >2mm bone loss on the rough surface of the implant from time of initial placement (Misch et al[3]). Radiographs were divided between two calibrated assessors, for evaluation, neither of whom had been involved in treatment of the patients.

The 'Pink Esthetic Score' (PES) system used to assess the appearance of the peri-implant soft tissues was that developed by Fürhauser *et al.* in 2005. This system is designed to be used in single tooth restorations only. As the authors were unable to identify a similar tool for the objective aesthetic assessment of implant supported bridgework, the PES system was also used to assess these restorations in the study. The allocation of a PES score was only possible where post-restoration photographs were available. Patients with photographs available were randomly divided between the two examiners for assessment following calibration. One of the limitations of any aesthetic assessment tool is the potential for bias. Although the authors acknowledge

this potential, no members of the study team who undertook the aesthetic assessments had been involved in provision of implant treatment. Where PES score judgements were felt to be uncertain they were discussed and an outcome agreed.

Results

It was possible to collect data for 32 hypodontia patients, Seventy-seven implants were placed. Of these, review data was available for 24 of 32 patients receiving implant treatment. The remaining 8 patients had either failed to attend their review appointments or had not yet been reviewed.

The minimum age at implant placement was 15 years, maximum age 52 years. Mean age at implant placement was 23 years. 56% of patients treated were male, 44% female.

41% of patients receiving treatment were missing only 1 tooth. The average number of missing teeth was 3. The most commonly replaced tooth was the maxillary lateral incisor (36%, n=28). The maxillary canine was the second most common tooth replacement site (21%, n=16).

Adjunctive Orthodontics

Table 1.

As demonstrated in Table 1, for the majority of patients there was a joint Orthodontic-Restorative assessment prior to the patient commencing treatment. Orthodontic treatment usually consisted of upper and lower fixed appliances. Orthodontic therapy was a mean of 31 months (minimum 9 months, maximum of 71 months).

Adjunctive Bone Augmentation

Bone grafting was required in 53% of patients, *(n=17). Three patients required pre-implant autogenous bone grafts harvested from the iliac crest. 48% (n=18) of implants that required grafting were placed in these 3 patients. Seven patients

required block grafts harvested from intra-oral sites. 26% of total implants placed (n=10) were in these patients.

Table 2.

Where grafts were placed prior to implant placement, the mean time separating the two procedures was 27 weeks. However, there was a significant range. The minimum time between the grafting procedure and implant placement was 17 weeks.

Implant survival and success

As stated, review data was not available for all patients. 8 patients had either failed to attend their review appointments or had not yet been reviewed at the time this review was undertaken. The success data (Bone Loss, Periodontal Probing Depths and Bleeding on probing) presented in Table 3 thus relates to 63 implants in 24 patients. The mean time from implant placement to the latest available review data was 2 years 7 months (min 5 months, max 9 years and one month).

Table 3.
*Not applicable applies to those cases where radiographs were not available
**Not recorded indicates the information had not been recorded in the clinical notes at review.

Aesthetic Analysis

Table 4.

Aesthetic analysis was possible for approximately 52% of implants (21 Patients). For the remainder, no clinical photographs were available. The majority of implants (83%) (15 patients) were found to have aesthetically acceptable or favourable restorations. 6 patients had unacceptable aesthetic outcomes.

Discussion

Orthodontics

Three quarters of patients required orthodontic treatment prior to the implant/restorative phase. Timing orthodontic treatment so that it is completed just as craniofacial growth has stopped represents the ideal; provided implant placement can proceed shortly thereafter. This minimises the risk of orthodontic relapse. Should relapse occur further orthodontic therapy prior to implant surgery may be necessary to correct malpositioned teeth, or more commonly roots, converging into the space for implant placement. The requirement for multiple courses of orthodontic therapy was found to have significantly lengthened the treatment process for a number of the patients studied. Adequate, where possible fixed, orthodontic retention is essential to prevent this relapse. Where fixed retention is not possible, retainer wear is critical if patients wish to have implant treatment in the future. Patients must be fully consented in this regard prior to commencing any orthodontic therapy. It is not current practice to refuse repeat orthodontics for hypodontia patients who have not fully cooperated with retainer wear prior to implant treatment, however this may change in the future. Hypodontia, and in particular appearance concerns, have been shown to have a significant effect on oral health related quality of life (Anweigi et al.[5]). This may necessitate commencing treatment earlier in these patients and accepting that further orthodontic therapy may be necessary at a later date.

A Restorative assessment prior to orthodontic debond may minimise delays to implant treatment, or compromising implant results. Around one fifth of patients jointly assessed prior to debond were found to require additional Orthodontic therapy. However, often Restorative review was arranged by Orthodontists, in the knowledge that treatment had not yet been completed, to confirm finer details of the treatment plan and patient consent to Restorative phase of treatment.

In one female patient implant placement had taken place at age 15. These implants were placed in mandibular canine regions and not definitively restored until 18 months following placement. From the Thilander growth studies, we know that growth in the anterior mandible from ages 16-31 has been shown to be minimal both in terms of bone height and arch width change (Thilander[6]). This placement did not appear to have had any negative outcome for the patient.

Bone Grafting

Staged bone grafting was required in 53% of patients prior to implant placement. It is generally accepted that guided bone regeneration with deproteinised bovine bone matrix, or an alloplastic substitute, is likely to achieve a maximum increase in alveolar bone width of 4.5mm. (Buser et al.[7]) For patients in which the deficiency is greater, then usually block bone grafting techniques are preferable. (Schwartz et al.[8]) Patients with multiple missing teeth, replaced with fixed restorations aiming to achieve favourable gingival aesthetics, are more likely to require the larger amounts of bone. These volumes are generally harvested from the iliac crest. This was found to be the case in our severe hypodontia patients.

Timing of Treatment

The mean time delay between bone grafting procedures and implant placement was approximately 6 months. For 4 patients (7 implants), implant placement occurred greater than 6 months after graft surgery. Most commonly it was availability of clinical appointments and correspondence between involved specialties which was responsible for the variation and longer averages in treatment time, rather than clinical decision making. Volumetric changes in grafts 6 months after placement have been shown to be significant. (Dasmah et al.[9]) The most notable volumetric width change has been found to occur in the 1-3 month post-operative period. (Nyström et al.[10]) The optimal time for implant placement post grafting is therefore generally regarded as between 3-6 months. This allows for integration and stabilisation of the graft, avoiding unnecessary volumetric decrease. Practice in this field is evolving, and is likely to have changed over the period studied.

Implant treatment can be a lengthy process involving multiple stages and multi-disciplinary interaction from planning to surgical placement. The mean time patients took from initial implant assessment (formal) to implant placement was 12 months. Factors which increased the duration of time between initial planning and implant placement were need for cone beam CT, hospital appointment booking difficulties, need for further orthodontic treatment, bone grafting, and suboptimal oral hygiene or periodontal condition. In addition to this, implant placement to final restoration was found to take a mean of 12 months. The long duration of implant treatment should clearly be explained to patients as part of the ongoing consent process.

Implant survival and success

Implant survival rates compare favourably to other literature on survival (96% implants). A review carried out by Berglundh *et al.* examining longitudinal studies of up to 5 years, observed an implant survival rate of 97.5% up to the second stage of surgery. (Berglundh *et al.*[11]) However, the variable follow up period and number of implants not reviewed makes comparison of survival rates difficult.

From the data available none of the implants studied exhibited pathological bone loss. This is favourable compared to a recent meta-analysis, which found the prevalence of bone loss to be around 22% of implants (Derks & Tomasi[12]). The criteria used to determine bone loss and the length of follow up, are noted as variable in the literature. 2D assessment of bone loss on periapical radiographs, as most commonly described, and utilised in this study may be flawed. Labial onlay grafts, are more likely to be subject to short-medium term labial bone resorption, than the original recipient bone site. The 2D assessment of bone levels on a peri-apical radiograph would not demonstrate this loss of labial bone surface. This type of bone loss would therefore not be shown by this method of assessment.

The incidence of other biological complications in the reviewed cohort was also low. No standardised guidelines for clinical or radiographic review were being utilised at the time of this review. Recording of bone loss or other biological complications was variable, with this data frequently not recorded in the clinical notes. However, the most appropriate means of monitoring the health of the peri-implant tissues has been a controversial topic in the past and the findings in this review may represent evolving opinion and confusion in this area (Todescan *et al.*[13]).

Photographs were available for 52% of implants (n=40) (21 patients). This meant implant restoration aesthetic analysis was not possible in every case. Given the importance of final aesthetics on implant success, it is important to document aesthetic outcomes. The suitability of PES scoring for determining aesthetic success for restorations has been confirmed in a number of studies (Cosyn *et al.*[14]; Dierens *et al.*[15]; Gallucci *et al.*[16]; Hof *et al.*[17]; Raes *et al.*[18]). There are however limitations. In particular, the PES system is an implant based analysis and does not take into account overall patient satisfaction, or smile line. This is a potential avenue for further study.

Conclusion

1. Implant survival and success rates were high for those patients reviewed. Incidence of biological complications compared very favourably with the literature.
2. This review highlighted a number of challenges to high quality implant service provision for hypodontia patients. In particular:
    a) Difficulty in ensuring effective communication between the specialties involved ensuring treatment is coordinated effectively.
    b) Importance of standardised review protocol to ensure implants are followed up and maintained as required.

Since this review was carried out a number of changes have been made to the design of the existing multi-disciplinary hypodontia service to improve the co-ordination of multi-disciplinary care and standardise follow up of patients.

Implant dentistry is a rapidly evolving field. Review and modification of practice in keeping with current knowledge and best practice is critical to ensure a high standard of care for patients. Repeat review following these service changes will be essential to continue improvements to service.

Implant treatment in the examined cohort has been found to be a lengthy process involving attendance at multiple appointments, with involvement of a variety of specialties. In order for treatment to proceed as efficiently as possible patient co-operation with appointment attendance and treatment is essential. Patients must be encouraged to take ownership and responsibility for this throughout the treatment pathway.

The significant challenge in organising multi-disciplinary treatment, so that each stage proceeds smoothly from the last, can be appreciated from some of the outcomes of this audit. Such challenges are likely to apply in any large institution. Although clinicians are likely to be aware of the difficulties on a day

to day basis, review helps quantify the problem and to provide evidence for change.

1. Epstein, N.E. Multidisciplinary in-hospital teams improve patient outcomes: A review. Surg Neurol Int. 2014; 5:295–303.

2. Yap A.K., KlinegergI.Dental implants in patients with ectodermal dysplasia and tooth agenesis: a critical review of the literature. Int J Prosthodont. 2009; **22:** 268-276.

3. Misch C.E., Perel M.L., Wang HL., et al. Implant success, survival and failure: the International Congress of Oral Implantologists (ICOI) Pisa consensus conference. Implant Dent 2008;**17:** 5–15.

4. Fürhauser R., Florescu D., Benesch T., Haas R., Mailath G., Watzek G. Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. Clin. Oral Impl. Res. 2005; **16:**639–644.

5. Anweigi L., Allen P.F., Ziada H. The use of the Oral Health Impact Profile to measure the impact of mild, moderate and severe Hypodontia on oral health-related quality of life in young adults. J Oral Rehabil. 2013; **40:**603-8.

6. Thilander B., Dentoalveolar development in subjects with normal occlusion. A longitudinal study between the ages of 5 and 31 years. *Eur J Orthod* 2009; 31:109-120.

7. Buser DA, Bragger U, Lang N, Nyman S. Regeneration and enlargement of jaw bone using guided tissue regeneration. Clin Oral Implants Res. 1990; **1:**22-32.

8. Schwarz F, Rothamel D., Herten M et al. Immunohistochemical characterization of guided bone regeneration at a dehiscence-type defect using different barrier membranes: an experimental study in dogs. Clin Oral Implants Res. 2008; **19:**402-15.

9. Dasmah A., Thor A., Ekestubbe A., Sennerby L., Rasmusson L. Particulate vs. block bone grafts: Three-dimensional changes in graft volume after reconstruction of the atrophic maxilla, a 2-year radiographic follow-up. J Cranio Maxillofac Surg.2012; **40:**654–659.

10. Nyström E., Legrell P.E., Forssell A., Kahnberg K.E. Combined use of bone grafts and implants in the severely resorbed maxilla. Postoperative evaluation by computed tomography. Int J Oral Maxillofac Surg.1995;**24:**20-5.

11. Berglundh T, Persson L, Klinge B. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. J Clin Periodontol 2002;**29:**197–212.

12. Derks J., Tomasi C. Peri-implant health and disease. A systematic review of current epidemiology. J Clin Periodontol.2015; **42:**158-71.

13.TodescanS.**,** LavigneS. **,** Kelekis-CholakisA.J Can Dent Assoc 2012;**78:**107.

14. Cosyn, J., De Bruyn, H. & Cleymaet, R. Soft tissue preservation and pink aesthetics around single immediate implant restorations: a 1-year prospective study. Clin Implant Dent Relat Res.2013;**15:** 847–857.

15. Dierens, M., De Bruecker, E., Vandeweghe, S., Kisch, J., de Bruyn, H. & Cosyn, J. Alterations in soft tissue levels and aesthetics over a 16-22 year period following single implant treatment in periodontally-healthy patients: a retrospective case series. J Clin Periodontol.2013 **40:** 311–318.

16. Gallucci, G.O., Grutter, L., Nedir, R., Bischof, M. & Belser, U.C. Esthetic outcomes with porcelain-fused-to-ceramic and all-ceramic single implant crowns: a randomized clinical trial. Clin Oral Implants Res.2011;**22:** 62–69.

17. Hof, M., Pommer, B., Strbac, G.D., Suto, D., Watzek, G. & Zechner, W. Esthetic evaluation of single-tooth implants in the anterior maxilla following autologous bone augmentation. Clin Oral Implants Res.2013;**24:** 88–93.

18. Raes, F., Cosyn, J. & De Bruyn, H. (2013) Clinical, aesthetic, and patient-related outcome of immediately loaded single implants in the anterior maxilla: a prospective

study in extraction sockets, healed ridges, and grafted sites. Clin Implant Dent Relat Res.2013 **15:**819–835.

Table 1

	Hypodontia
Joint Ortho-Restorative Assessment	**Yes** 72% (23)
	No 28% (9)
Orthodontic Treatment	**Yes** 78% (25)
	No 22% (7)
Type of Orthodontics*	**U&L FA** 80% (20)
	UFA 20% (5)
	LFA 0% (0)
Length of Orthodontic Treatment	**Mean** 31 months
	Max 71 months
Joint Ortho-Restorative Assessment Prior to Debond	**Yes** 84% (21)
	No 16% (4)

Table 2.

Graft type	**Hypodontia Implants** (n = 38)		**Hypodontia Patients** (n=17)	
	No	**%**	**No**	**%**
Local Autogenous bone	10	26	7	41
Autogenous bone - Iliac crest	18	48	3	18
DBBM alone	10	26	7	41
Alloplastic graft material	0	0	0	0
Simultaneous grafting	8	21	6	35
Pre-implant grafting	30	79	11	65

Table 3.

Outcome	**Hypodontia Implants (n=63)**
Survival	95%

Bone Loss	0% (32%, N/A)*
PPD's >5mm	6% (41% N/R)**
BOP	8% (63% N/R)**

Table 4.

	Hypodontia Implants
Clinical Photos Present	Yes 52% (40)
	No 48% (37)
PES scores	Acceptable/Favourable 83% (33)
	Unacceptable 18% (7)