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Computerised Dental Implant Rehabilitation Planning and Execution Following Mandibular Resection: A Case Report

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Abstract - *This paper discusses the merits of Computer Tomography (CT) based dental implant planning in the rehabilitation of patients following oral cancer. This case report describes the process of prosthetic work-up, computerised implant planning, surgical treatment and successful prosthetic oral rehabilitation of a patient following segmental mandibulectomy and post-operative radiotherapy for intra-osseous squamous cell carcinoma (SCC).*

KEY WORDS: Oral cancer, computer aided, prosthetic rehabilitation, dental implant

INTRODUCTION

Radical ablative surgery, with or without radiotherapy, is effective in the treatment of oral carcinoma with good published survival rates[1]. This treatment, however, inevitably alters the anatomy and function of the oral and facial structures resulting in a decreased quality of life for the patient. Future oral rehabilitation can also be compromised if not given adequate consideration at the time of initial surgery. This is especially true when considering segmental mandibulectomy, although most authors are in favour of immediate reconstruction with a vascularised composite flap[1].

During the rehabilitation of patients following segmental mandibulectomy standard prosthodontic techniques involving removable prostheses, whilst possible, are invariably unsuccessful. This is due to the altered oral anatomy, occurrence of xerostomia post radiotherapy, and the poor quality of the supporting mucosa or skin flap. Consideration must also be given to the increased caries risk in providing removable partial dentures[2]. The use of osseointegrated dental implants has revolutionised the oral rehabilitation of cancer patients and various degrees of implant success have been reported in the literature[3,4].

Careful preoperative planning is essential for all patients to ensure accurate implant positioning in order to provide an aesthetic and functional fixed prosthesis. For those patients who have been irradiated, there may be a role for hyperbaric oxygen therapy in maximising the lifespan of the implants, although strong evidence is lacking at present[5,6,7]. Patients should also demonstrate good manual dexterity and motivation towards optimal oral hygiene before such complex treatment can be considered. Other factors such as alcohol, smoking habits and parafunctional bruxism should also be taken into account prior to treatment. Smoking cessation therapy should be advised prior to elective secondary oral rehabilitation with dental implants, as continued smoking is not only related to implant failure and surgical complications but also continues to put the patient at higher risk of developing further malignant disease.

CASE REPORT

A 53 year old non-smoking female caucasian patient first presented to the maxillofacial department in June 2002 complaining of significant mobility of her mandibular anterior teeth. She was medically fit and well, had never smoked tobacco and did not drink alcohol. Radiographs revealed extensive bone loss around the mandibular incisor teeth as well as a significant radioleucency within the symphysis (figure 1). An incisional biopsy taken from the oral mucosa confirmed a diagnosis of invasive squamous cell carcinoma. A computerised tomography (CT) scan revealed destruction of the mandible involving the midline and extending to the left mandibular ramus and the inferior border of the mandible on the left side. A whole body scan ruled out metastatic disease at distant sites.

A segmental mandibulectomy extending from the region of the lower left second molar to the lower right second premolar was carried out together with a selective level III bilateral neck dissection. Immediate reconstruction was with a vascularised iliac crest flap with internal oblique muscle. The muscle was used to line the bone flap which was osteotomised with a single cut. The patient had a stormy post-operative course and developed infections in the midline neck incision and also in the hip. This delayed discharge from hospital and she subsequently required debridement of both wounds together with removal of the bone reconstruction plate. Some weeks later definitive histology confirmed the resection of an undifferentiated carcinoma of the central mandible and the patient subsequently underwent post-operative radiotherapy to the mandible and upper neck (60Gy in 30 fractions).

In September 2003 the patient was referred to discuss options for oral rehabilitation. Her main presenting complaints

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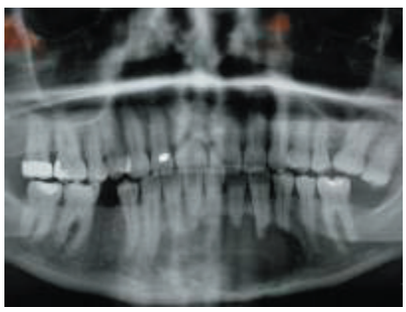

Figure 1. *Pre-operative OPG*

Figure 2. *Post-operative intra oral view*

Figure 3. *Post-operative OPG showing over erupted UL7*

Figure 4. *Radio-opaque stent on model*

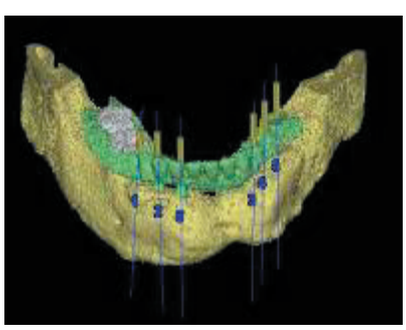

Figure 5. *Simplant positioning of implants*

Figure 6. *Bone supported surgiguide on stereiolithographic model*

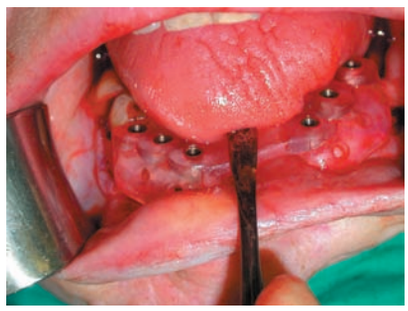

Figure 7. *Surgiguide in situ*

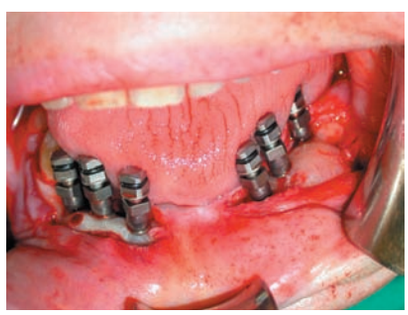

Figure 8. *Primary implant surgery fixtures in situ*

Figure 9. *Post-exposure ,showing local necrosis around LR 3 fixture*

Figure 10. *Prosthesis on model*

were of difficulty eating due to lack of opposing teeth and of a dry mouth. She was a regular attender at her own dental practitioner and her oral hygiene was satisfactory. On examination, her mouth opening was excellent and the bony reconstruction of the left mandible appeared to have been a success both intra-orally and radiographically (figures 2 and 3). The only remaining lower teeth were two molars in the lower right quadrant. She was fully dentate in the upper arch, the UL 7 was over-erupted and in contact with the lower ridge. The periodontal probing depths were normal and there were minimal deposits of plaque and supragingival calculus visible.

The patient appeared to be an excellent candidate for oral rehabilitation with implant retained fixed bridgework. Initially a diagnostic tooth set-up was undertaken to determine the ideal tooth position and a radiographic stent with radio-opaque teeth (Ivoclar) was constructed using standard prosthetic techniques (figure 4). Subsequently a CT scan was carried out with the stent in place. The CT scan data was read using a 3-D imaging programme (Simplant Pro). The optimal site, size and number of implants to support the prosthesis were determined within the software (figure 5). Specific emphasis was placed on the ideal tooth position, as marked by the stent and the quantity and quality of bone available for implant as identified from the scan. This information was then used to produce a 3-D CAD-CAM stereolithographic model of the mandibular bone and a subsequent bone supported surgical guide (surgiguide) to dictate implant positioning during surgery (figure 6).

Prior to primary implant surgery the patient underwent a course of hyperbaric oxygen therapy (2atm/90minutes), according to the Marx protocol,[8] with 20 dives prior to surgery and 10 dives post surgery. The patient was referred to a hygienist for a course of oral hygiene instruction and supragingival scaling in order to ensure that her periodontal condition remained favourable and to idealise her oral hygiene regime.

The placement of six endosseus dental implants (Astratech, Sweden) was carried out under general anaesthetic, using the bone supported surgiguide (figure 7). A minimal flap approach was used and the previously infected area in the region of the previous osteotomy cut was left undisturbed. Implants were placed in the region of the LL6, LL5, LL4, LR3, LR4 and LR5, with good primary stability (figure 8). The over-erupted upper left molar tooth was also extracted and a two stage healing protocol adopted.

Following a further three month period the patient remained asymptomatic and her implants were exposed under local anaesthetic. A limited vestibuloplasty and free keratinised graft was carried out in the LR 543 region, harvesting tissue from the palate using a scalpel. This was undertaken to improve sulcus depth, provide keratinised peri-implant tissue and improve access for oral hygiene measures.

Soft tissue healing, however, was poor with limited graft take. Around the LR3 fixture there was a localised necrosis of exposed coronal bone (figure 9). Over the course of a month, satisfactory granulation took place, a small sequestra of bone was lost at LR3 and as the area of the graft matured the coronal thread of the fixture became exposed. The implants were subsequently restored with a screw-retained 11 unit porcelain fused to metal bridge with great care being taken to ensure a passive fit. The patient was delighted with the result both in terms of the aesthetics and function (figures 10 and 11)

The patient was put onto an implant maintenance programme and at three months, one year and two year reviews, has demonstrated excellent oral hygiene and stability of the peri-implant tissues. Radiographically there has been no evidence of progressive bone loss (figure 12).

DISCUSSION

This case report discusses the implant based oral rehabilitation of a patient following treatment for a SCC of the mandible. It highlights the use of computer programs to both plan and execute implant treatment in these difficult cases.

The vascularised iliac crest graft, based on the deep circumflex iliac artery, is an excellent way of reconstructing the body and ramus of mandible and has some advantages over other composite reconstruction flaps, although its use is technically very demanding for reconstructive surgery. It provides excellent quantity of bone to support dental implants whilst also providing good bone height for facial support[9]. Whilst other composite grafts, such as the fibular flap are increasingly popular, the authors prefer the use of an iliac crest graft for reconstruction of the dentate mandible where possible.

Careful consideration needs to be given to the design of the final prosthesis prior to planning, in this case a fixed prosthesis was chosen mainly due to the lack of occlusal vertical dimension making a removable appliance difficult

Figure 11. *Intra-oral view of prosthesis*

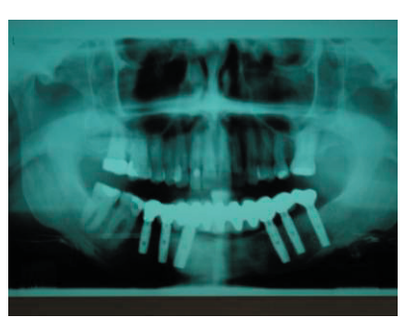

Figure 12. *Radiographic appearance two years post-completion of treatment*

to construct. Fixed appliances are often favoured more by patients both in terms of comfort and function but can be more difficult to clean. Post radiotherapy there is little if any rinsing action of saliva due to xerostomia again compromising prosthesis hygiene. In this case the patient was highly motivated and demonstrated an excellent level of oral hygiene before treatment commenced.

Potential benefits of removable appliances include ease of oral hygiene and the ability to more readily adapt/modify the prosthesis should the defect change or should fixtures be lost in the poorer quality bone. Modification of fixed prosthesis is becoming more readily achievable especially in light of the newer composite materials that can be used.

In our experience, the use of conventional tissue supported surgical guides is fraught with difficulty and will often result in the inaccurate placement of dental implants, leading to subsequent prosthetic compromise in the final restoration. The use of a bone supported surgical guide is advised when treating complex partially dentate patients with mandibular reconstruction in order to ensure accurate implant placement. This is especially important in cases where there is limited good quality bone for implant placement. Several papers have shown that implant placement is more accurate when computer aided planning and surgical guides are used and that there is also a reduction in the amount of surgical time required [10,11,12]. Computer aided planning also facilitates implant placement to avoid reconstruction plates and screws, as well as any anatomically important structures.

The use of computerised planning techniques in patients with complex anatomy, resulting in the production of a bone supported CAD-CAM fabricated surgical guide, ensures that implant placement occurs in the ideal positions to support a fixed, screw retained prosthesis. This allows for a prosthesis having minimal bulk with adequate access for oral hygiene measures with minimum unfavourable loading on the components. In addition a screw-retained fixed restoration also supports retrievability for prosthesis maintenance or to perform routine screening for recurrent disease.

The stereolithographic model and surgiguide can also be used for other applications such as production of an implant retained dressing plate should peri-implant soft tissue grafting or vestibuloplasty be planned. In oncology cases these procedures are often carried out to provide attached keratinised mucosa around the fixtures rather than skin from the flap. Attached keratinised mucosa appears to be less subject to inflammation, subjectively more comfortable to brush and histologically a tighter seal to the fixture [13].

CONCLUSION

The management of oral malignancy patients is multidisciplinary in nature. In cases requiring jaw resection pre-operative discussion should be undertaken between the treating surgeon and the rehabilitationist if effective oral rehabilitation is to be undertaken. The use of detailed prosthetic work up is mandatory prior to implant placement. The use of CT scanning and computerised implant planning enables the provision of an ideal prosthesis which is retrievable, functional and aesthetic.

MANUFACTURERS DETAILS

- Ivoclar: Ivoclar Vivodent, Liechtenstein
- Simplant Pro: Materialise, Belgium
- Coe-pak: GC America inc, Alsip IL, US

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REFERENCES

1. Brown J.S, Blackburn T.K, Woolgar J.A, Lowe D, Errington R.D, Vaughan E.D, Rogers S.N. A comparison of outcomes for patients with oral squamous cell carcinoma at intermediate risk of recurrence treated by surgery alone or with post-operative radiotherapy. *Oral Oncol.* 2007 Sept; **43(8):** 764-73
2. Jepson N.J.A, Moynihan P.J, Kelly P.J, Watson G.W. Thomason J.M. Caries incidence following restoration of shortened dental arches in a randomised control trial. BDJ 2001; Aug **191(3):** 140-144
3. Schoen P.J, Reintsema H, Raghoebar G.M, Vissink A, Roodenburg J.L. The use of implant retained mandibular prostheses in the oral rehabilitation of head and neck cancer patients. A review and rationale for treatment planning. *Oral Oncol.* 2004 Oct;**40(9):**862-71
4. Oechslin C.K, Zimmermann A.P, Gratz K.W, Sailer H.F. Histological evidence of osseointegration in the irradiated and reconstructed mandible: a case report. *Int J Oral Maxillofac Implants.* 1999 Jan-Feb;**14(1):**113-7
5. Kanatas A.N, Lowe D, Harrison J, Rogers S.N. Survey of the use of hyperbaric oxygen by maxillofacial oncologists in the UK: *Br J Oral Maxillofac Surg.* 2005 Jun;**43(3):**219-25
6. Shaw R.J, Sutton A.F, Cawood J.I, Howell R.A, Lowe D, Brown J.S, Rogers S.N, Vaughan E.D. Oral rehabilitation after treatment for head and neck malignancy. *Head Neck.* 2005 Jun;**27(6):**459-70
7. Schoen P.J, Raghoebar G.M, Bouma J, Reintsema H, Vissink A, Sterk W, Roodenburg J.L. Rehabilitation of oral function in head and neck cancer patients after radiotherapy with implant-retained dentures: Effects of hyperbaric oxygen therapy. *Oral Oncol.* 2007 Apr; **43(4):** 379-88
8. Marx R.E, Ames J.R. The use of hyperbaric oxygen therapy in bony reconstruction of the irradiated and tissue deficient patient. *J Oral Maxillofac Surg.* 1982 Jul; **40(7)**: 412-20
9. Rogers S.N, Lakshmiah S.R, Narayan B, Lowe D, Brownson P, Brown J.S, Vaughan E.D. A comparison of the long-term morbidity following deep circumflex iliac and fibula free flaps for reconstruction following head and neck cancer. *Plast Reconstr Surg.* 2003 Nov;**112(6):**1517-25
10. Balshi S.F, Wolfinger G.J, Balshi T.J. Surgical planning and prosthesis construction using computed tomography, CAD/CAM technology, and the internet for immediate loading of implants. *J Esthet Restor Dent.* 2006; **18(6):** 312-323
11. Fortin T, Bosson J.L, Coudert J.L, Isidori M. Reliability of preoperative planning of an image-guided system for oral implant placement based on 3- dimensional images: an in vivo study. *Int J oral Maxillofac Implants.* 2003 Nov-Dec; **18(6):** 886-93
12. Di Giacomo G.A, Cury P.R, de Arauujo N.S, Sendyk W.R, Sendyk C.L. Clinical applications of stereiolithographic surgical guides for implant placement: preliminary results. *J Periodontol* 2005 Apr; **76(4);** 503-7
13. Chung D.M, Oh T-J, Shotwell J.L, Misch C.E, Wang H-L. Significance of Keratinised Mucosa in Maintenance of Dental implants with different Surfaces. *J Periodontol* 2006; **77:** 1410-1420