Computerized Implantology for the Irradiated Patient

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Reconstruction of the irradiated head and neck cancer patient continues to be a challenge. Conventional prosthodontics can be very unpredictable and difficult in these patients. Implant-supported fixed prostheses are good alternatives. It is well-accepted that maxillofacial surgery for the irradiated head and neck cancer patients should be performed in an atraumatic fashion to minimize postoperative complications. We propose the use of computer generated surgical guides and flapless surgery for the placement of dental implants in the irradiated head and neck cancer patient. With these techniques, implants can be placed in an atraumatic, predictable, and accurate manner, according to a prosthetically driven treatment plan.

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Reconstruction in head and neck cancer patients continues to be a surgical, reconstructive, and prosthetic challenge. The ablative nature of the surgery required to treat these patients leads to significant problems with esthetics, deglutition, mastication, and speech.[1] As a result of the disease, these patients often require adjuvant radiotherapy, which subsequently may lead to further side effects such as xerostomia, mucositis, ageusia, dysphagia, odynophagia, dental caries, soft tissue necrosis, and osteonecrosis.[2,3] These issues may lead to difficulty maintaining adequate nutritional status. Mekhail et al[4] have shown adequate nutritional status to be an important prognostic factor.

It has been estimated that over 50% of head and neck cancer patients are malnourished.[5] This is a result not only of the disease but also its treatment. Conventional removable prostheses may help contribute to the maintenance of adequate nutritional stores. However, the mucosa in these patients is more likely to experience tissue breakdown. This is due in part to xerostomia and endothelial changes, which result in decreased blood flow.[6] As head and neck cancer patients recover, it is important for them to maintain and optimize their nutritional intake. An implant-supported fixed prosthesis is a good alternative for these patients.

Unfortunately, because of the hypovascular, hypoxic, and hypocellular changes in irradiated tissues, as described by Marx,[7] these patients are at increased risk for the development of osteoradionecrosis (ORN). In addition, any oral and maxillofacial surgery should be performed as atraumatically as possible.[7] Computer-generated surgical guides for flapless surgery allow the surgeon to provide these patients with optimal positioning of implants, according to a restoratively driven treatment plan, with as minimal surgical trauma to the bone and associated soft tissues as possible.

We present a case of a patient diagnosed with squamous cell carcinoma of the tongue treated with radiation therapy who underwent surgical placement of dental implants. The implants were placed by use of a computer-generated surgical guide and flapless surgery.

Report of a Case

A 63-year-old woman presented to our office in 2005 for the removal of nonrestorable teeth and possible placement of dental implants (Fig 1). She had a history of hypothyroidism, and a T1 N1 M0 squamous cell carcinoma of the lateral tongue. In February 2001 she underwent a right partial glossectomy and a right

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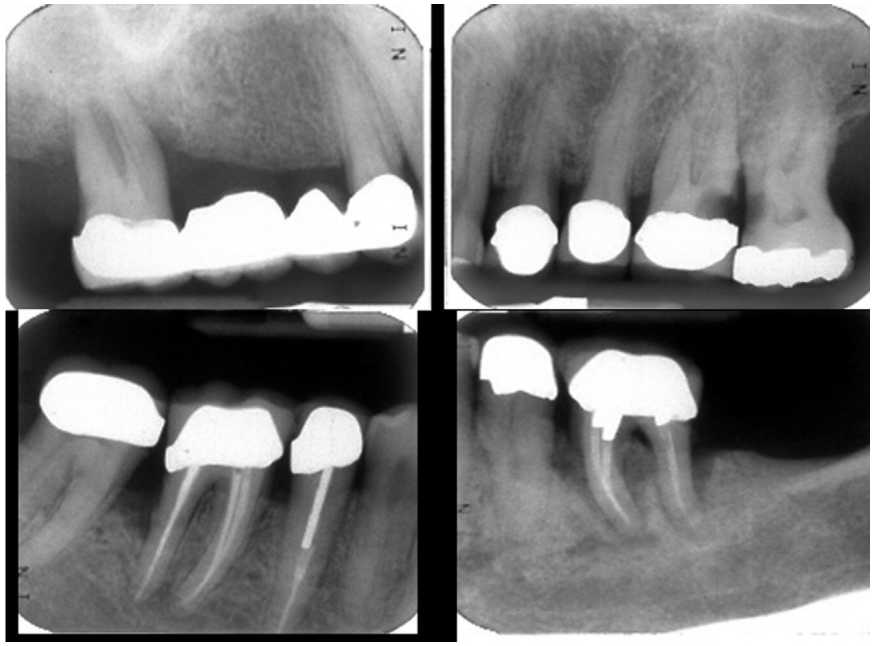

FIGURE 1. Preoperative periapical radiographs of nonrestorable teeth.

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supraomohyoid neck dissection. Postoperatively, she underwent radiation therapy with a total cumulative dose of 6,300 cGy. As a result of the radiation, prominent mucositis and esophagitis developed, requiring narcotics for pain relief. Significant xerostomia subsequently developed, which led to dental caries.

Prior to treatment, options and their associated risks were reviewed with the patient. The options that were discussed included no replacement, removable partial dentures, or an implant-supported fixed prosthesis. Assuming that her postoperative course was uneventful, the patient desired to have an implant-supported fixed prosthesis.

Because of the level of radiation the patient received, hyperbaric oxygen (HBO) therapy was recommended before the extractions. A 20/10 HBO protocol was planned for the patient: after 20 preoperative "dives," the decayed teeth were extracted in an atraumatic fashion, followed by 10 postoperative dives.[8]

FIGURE 2. Panoramic radiograph 6 months after tooth extractions. No evidence of pathology was noted.

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Each dive consisted of 90 minutes in an HBO chamber at 100% oxygen in 2 atmospheres of pressure. Dives were performed on consecutive days.

Over a 5-month healing period, the patient showed no evidence of impaired healing or ORN (Fig 2). Thereafter, planning for implant placement by the use of Nobel Procera software (Nobel Biocare, Zurich, Switzerland) began. Radiographic guides and indexes, reproducing the ideal positioning of the planned restorations, were fabricated by the maxillofacial prosthodontist according to the NobelGuide double-scan protocol (Nobel Biocare).[9] Per the NobelGuide protocol, by use of the double-scan technique, the patient underwent medical computed tomography scans while wearing the radiographic guides and indexes. The computed tomography images were imported into the Nobel Procera software program, and 9 dental implants were planned "virtually" in the maxilla and mandible (Figs 3, 4). Once completed, the treatment plan was sent via the Internet to Nobel Biocare for fabrication of the surgical guide appliances (NobelGuide) (Fig 5).

Nine months after the extractions, 9 dental implants were placed in a flapless fashion, by use of the appropriate implant-specific instrumentation. Healing abutments were placed at that time (Fig 6). The patient tolerated the procedure well and was then treated with 10 additional HBO dives.

The immediate postoperative course was uneventful. Six months postoperatively, the patient presented for normal follow-up. At that time, there was evidence

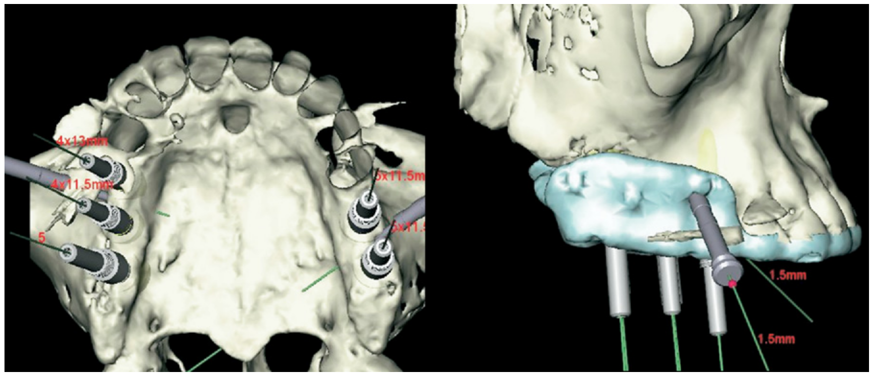

FIGURE 3. Computer-generated virtual treatment plan in maxilla.

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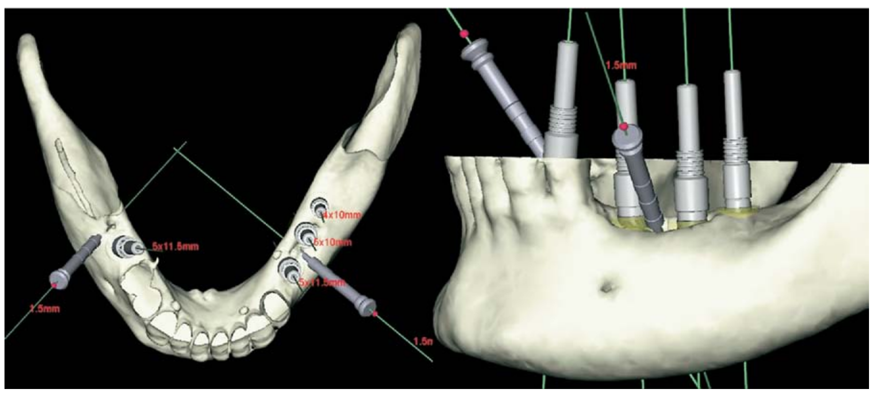

FIGURE 4. Computer-generated virtual treatment plan in mandible.

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of implant failure at the site corresponding to the left mandibular second molar. This implant was subsequently removed. After soft tissue healing at the site of the failed implant, the patient returned to the maxillofacial prosthodontist for fabrication of the final prosthesis (Figs 7-12).

FIGURE 5. Maxillary and mandibular computer-generated surgical guides.

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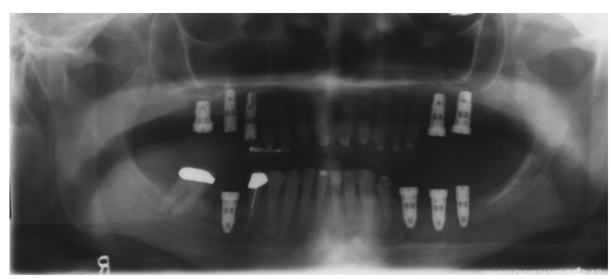

FIGURE 6. Immediate postoperative panoramic radiograph after implant placement.

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Currently, more than 2 years after implant placement, the patient has no evidence of further implant failure or other complications.

Discussion

The use of dental implants for tooth replacement is the preferred treatment for many patients. Conventional prosthodontics can be very unpredictable and difficult in head and neck cancer patients. These pa-

FIGURE 7. Maxillomandibular occlusal relationship of the final prosthesis.

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FIGURE 8. Right lateral view. Note excellent appearance of final prosthesis on maxillary right first molar, second premolar, and mandibular right first molar.

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FIGURE 9. Left lateral view of final prosthesis. Note excellent result of permanent crowns placed on the implants corresponding to the left maxillary first and second molars and the left mandibular first molar and second premolar.

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FIGURE 10. Final prosthesis in maxilla.

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FIGURE 11. Final prosthesis in mandible.

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FIGURE 12. Final prosthesis.

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tients are often lacking the hard and soft tissue that would otherwise serve as support for dental restorations.[10] If xerostomia is present, the mucosa may not tolerate removable prostheses. The anatomy of the areas requiring restoration is frequently distorted and scarred. Postoperative radiation therapy and the resultant hypovascularity of the bone and soft tissue in the area may leave these patients with a less-than-ideal situation for the placement of dental implants. Surgical procedures performed in irradiated tissues present a major risk for ORN as compared with nonirradiated tissues.[11] In addition, the placement of dental implants in these patients was originally considered to be contraindicated.[12]

Today, there still remains no consensus as to how these patients should be managed. Some authors advocate placement of dental implants primarily, at the time of reconstruction,[13] whereas others advocate delayed placement.[1] In addition, the use of HBO therapy as a requirement before implant placement is a debated topic.[14,15] Granström reported[16] a study of the placement of 4,392 dental implants that showed an improved survival rate of implants with HBO. The American Association of Oral and Maxillofacial Surgeons outlines HBO as a therapeutic standard for irradiated bone.[17] Although HBO has been successful in improving implant survival rates, it is prudent that the complications of radiation therapy, such as ORN, be minimized.

Minimally invasive surgery has become popular in many areas of medicine and may be applicable in performing reconstruction in the head and neck cancer patient. Sarment et al[18] showed that implants placed using a surgical guide fabricated from a stereolithic model were nearly 2 times more accurate than those placed with a conventional surgical guide. van Steenberghe et al[19] showed that implants can be placed within 0.8 mm of the location of the planned placement. Because of the often distorted anatomy in head and neck cancer patients, computerized implantology can be of great benefit in the reconstruction of these patients.

Computerized implantology allows the surgeon to place dental implants in an accurate, predictable fashion, according to a prosthetically driven treatment plan. It allows the surgeon to visualize the underlying bone and plan the accurate placement of dental implants before implant surgery. It facilitates the accurate placement of implants without reflecting the soft tissue (flapless surgery). Computerized implantology minimizes the postoperative bleeding and discomfort and, ultimately, the overall surgical trauma.[20] Computerized implantology and flapless surgery may decrease the risk of postoperative complications from implant surgery in patients susceptible to ORN.

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