José Luis Cebrián-Carretero
Doctor in Medicine. Specialist in Oral and Maxillofacial Surgery. Graduate in Dentistry. La Paz University Hospital of Madrid. Private practice.

Javier González Martín-Moro
Graduate in Medicine. Specialist in Oral and Maxillofacial Surgery. Graduate in Dentistry. La Paz University Hospital of Madrid. Private practice.

José Andrés Sobrino del Riego
Graduate in Medicine. Specialist in General Surgery. Graduate in Dentistry. Private practice.

Gastón Demaría Martínez
Graduate in Medicine. Specialist in Oral and Maxillofacial Surgery. Graduate in Dentistry. Private practice.

Manuel Chamorro Pons
Doctor in Medicine. Specialist in Oral and Maxillofacial Surgery. Chief of Oral and Maxillofacial Surgery Department of Hospitales Sanitas Madrid.

Indexed in:
- IME
- IBECS
- LATINDEX
- GOOGLE SCHOLAR

Correspondence address:
José Luis Cebrián Carretero
Servicio de Cirugía Oral y Maxillofacial.
Hospital Universitario La Paz.
Paseo de la Castellana 261,
28046 Madrid.
jlcebrian@clinicalaluz.es
Tel.: 917 277 336

Received: 7 May 2013.
Accepted (or accepted for publication): 30 October 2013.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

Case report

Implant-supported mandibular rehabilitation on microvascularised fibular graft. Use of computer-guided surgery

Published in Spanish Científica Dental Vol. 10. Nº 3. 2013.

ABSTRACT

Introduction: in the treatment of patients affected by malignant tumours of the oral cavity, surgery combines the resection and the immediate reconstruction with the aim of preserving the functions that are concentrated in the oral cavity (articulation, swallowing, mastication, aesthetics). The use of microvascularised flaps consists of a usual practice in those patients in order to replace the resected tissues. Dental rehabilitation in these patients is usually very complex, and the use of guided implant surgery systems avoids many of the problems that are presented in these patients.

Clinical case: a patient subjected to a hemimandibulectomy without reconstruction and adjuvant treatment with radiotherapy who is referred for reconstruction. Initially, a microvascularised fibular flap is practiced that contributes bone and soft tissue. Subsequently, a hybrid prosthesis is used over implants, which are placed by means of a mucosa-supported surgical guide after planning with the FacilitateTM tool.

Discussion: the microvascularised fibular flap is the spearhead in mandibular reconstruction of the oncological patient. Its main disadvantage is the difficulty in placing the dental implants and their subsequent rehabilitation. The use of guided implant surgery avoids many of these problems.

Conclusions: the reconstruction of the oral cavity in oncological patients using microvascularised grafts and the subsequent dental rehabilitation with osseointegrated implants allows offering the patient an acceptable quality of life.

KEYWORDS

Oral cancer; Squamous cell carcinoma of the oral cavity; Microvascularised fibular flap; Dental implants; Guided surgery; Quality of life.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

INTRODUCTION

In recent decades, advances in the treatment of tumours of the maxillae have allowed us to treat and even cure patients that previously were considered untreatable. In this way, today the resection of tumours is as important as the immediate reconstruction of the defects created, which allow offering our patients the sufficient quality of life and to continue performing the typical functions of the removed structures.

In the field of bone reconstruction of the facial skeleton, we must take into account that both the mandible and the maxilla are the carriers of the dental pieces and consequently the preservation of the masticatory function must also be the objective of our surgical treatment.

The placement of implant-supported prostheses on the reconstructed bones offers these patients a definitive solution for the recovery of the masticatory function in addition to helping to improve other sequelae such as labial support[1-3].

The microvascularised fibular flap has been one of the principal options for this bone and dental rehabilitation. The flap was initially described by Taylor and Gilbert at the end of the 1970's and used by Hidalgo in 1989 for mandibular reconstruction. Since then, its use has been generalised, thanks basically to its versatility in offering a long length of bone[4, 5]. Its disadvantage in the dental rehabilitation is that the precise insertion of the implants is complicated in situations in which, after the resection, the occlusal relation has been lost and the morphology of the reconstructed bone is notably different from the original mandible. Therefore, many implants inserted in it cannot then be rehabilitated adequately (Figure 1), and many rehabilitations are complex and lead to dental occlusions that are not very functional[2, 6-8].

Currently the guided implant surgery allows planning and placing implants virtually on a computerised tomography image (CT) that duplicates the bone anatomy of the patient. By means of computer support, a guide is prepared that, supported on the patient's tissues during the surgery, will indicate the precise position of each implant so that it coincides with the planned situation. In addition, it allows us to sketch what the definitive prosthesis will be like, avoiding the problems of malocclusion and non-rehabilitated implants[9].

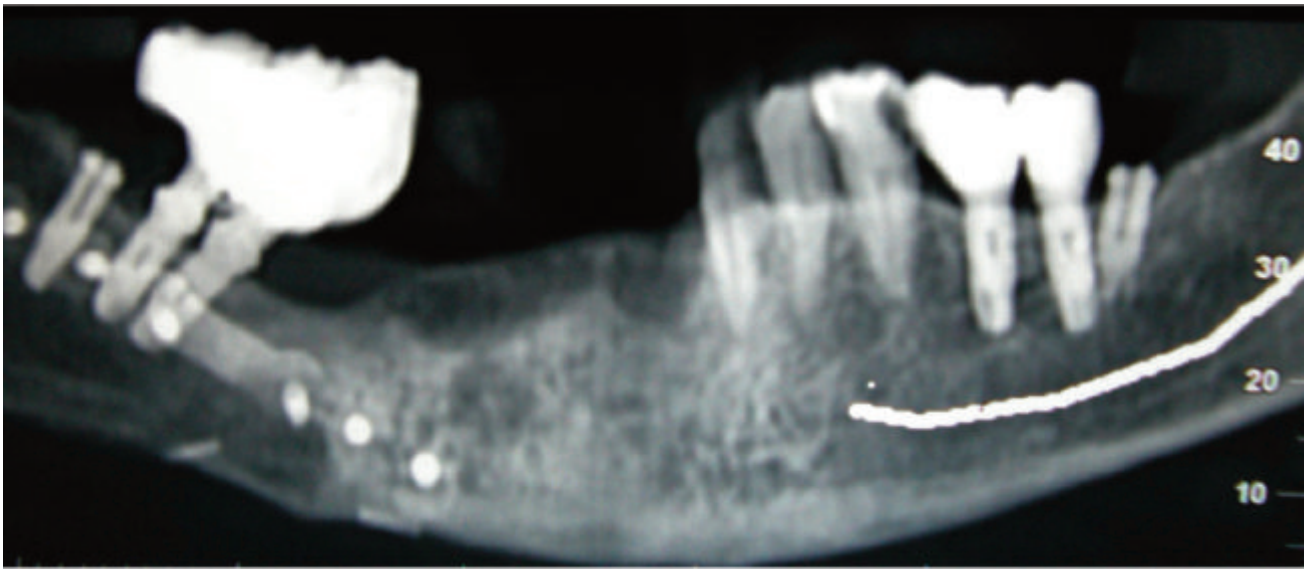

Figure 1. Incomplete oral rehabilitation on microvascularised graft. Implants not rehabilitated.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

CLINICAL CASE

We present the case of a 54 year-old patient who has been subjected to a hemimandibulectomy due to suffering squamous cell carcinoma of the retromolar trigone with extension to the bone. At first no reconstruction of the removed area was performed and the defect was obliterated, suturing the tongue to the mucosa of the cheek after the removal of the left mandibular body. Functional cervical dissection was also performed and post-operative radiotherapy was also indicated.

Three years after the surgery the patient is free of disease, although he has had a very poor quality of life. He depended on gastrostomy for his nutrition, with severe alteration of his articulation, masticatory and swallowing functions. In these conditions he was referred to the Oral and Maxillofacial Surgery Department to improve his clinical situation (Figure 2).

At first the bone reconstruction was performed with a microvascularised fibular flap (fixated with a reconstruction plate) that improved the facial symmetry and articulation and swallowing functions, allowing the removal of the gastrostomy (Figure 3). However, the patient continued subsisting on a soft diet, for which reason the rehabilitation of the masticatory function was posed.

Given that the patient presented mandibular edentulism, a complete prosthesis was prepared, that was very poorly tolerated due to the problems of support and retention related to the complex anatomy of the area. Therefore, the only possibility for achieving satisfactory masticatory function was to make an

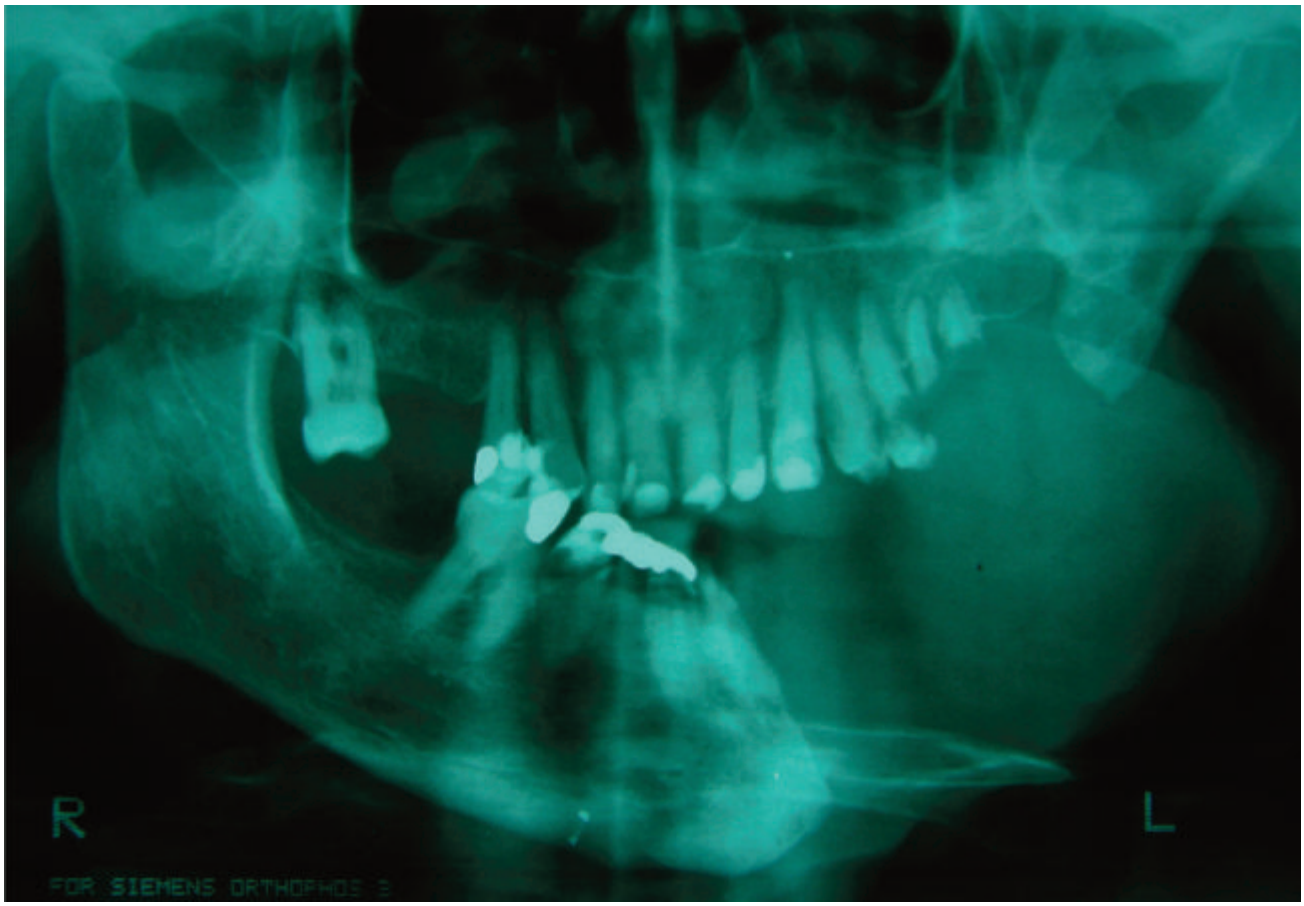

Figure 2. Orthopantomography in which is shown the state in which the patient arrived at our office after segmentary mandibulectomy due to squamous cell carcinoma of the mandibular gum.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

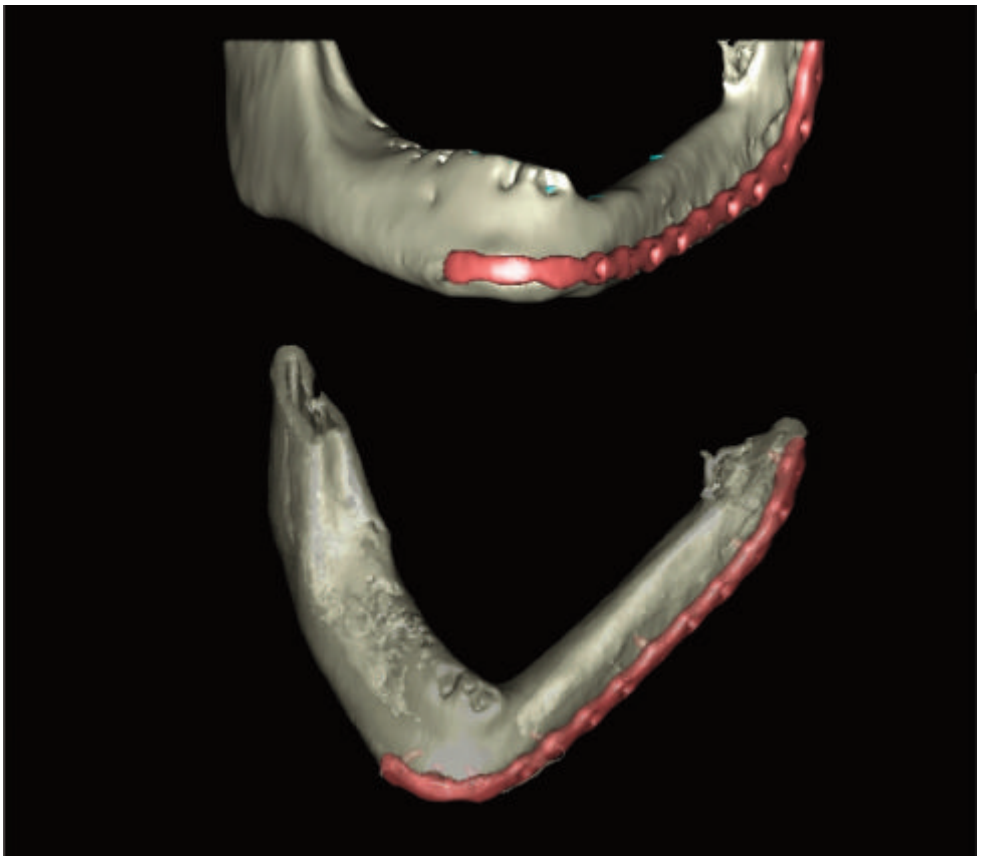

Figure 3. Scanned image after the mandibular reconstruction with microvascularised fibula graft.

implant-supported prosthesis, placing the fixations in the healthy mandible as well as in the fibular section.

It was a case of an unfavourable anatomical situation, worsened by the presence of a titanium plate with many screws that was complicated to remove, for which reason it was decided to carry out a guided implant surgical procedure.

To do this, a radiopaque guide was prepared on a model of the patient. A scan was requested that was processed by the company Materialise (Leuven, Belgium). and on it, using the tool *Facilitate*™ from *SimPlant*™ (Leuven, Belgium) seven implants were planned, 4 mm in diameter and of different lengths *Osseospeed (Astratech, Sweden)*. Of these, three were situated on the native hemimandible and four on the fibula, to make a screwed hybrid prosthesis. Given the good adaptation of the radiological guide on the mandibular edge of the patient, a mucosa-supported surgical guide could be made (Figures 4-8).

The surgery was performed without complications. The seven planned implants were inserted and the cover plugs were placed. After three months, the implants were uncovered, verifying their osseointegration and transepithelial plugs were put into place (Figure 9). Three weeks later, the prosthetic phase began, taking impressions with individual trays, an implant-supported hybrid prosthesis was elaborated. The seven implants could be rehabilitated (Figures 10, 11).

With regard to the antagonist arch and using the remaining teeth, a mixed metal-porcelain prosthesis was made in the anterior sector with attachments to support a skeletal prosthesis and to rehabilitate the posterior maxillary sector.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

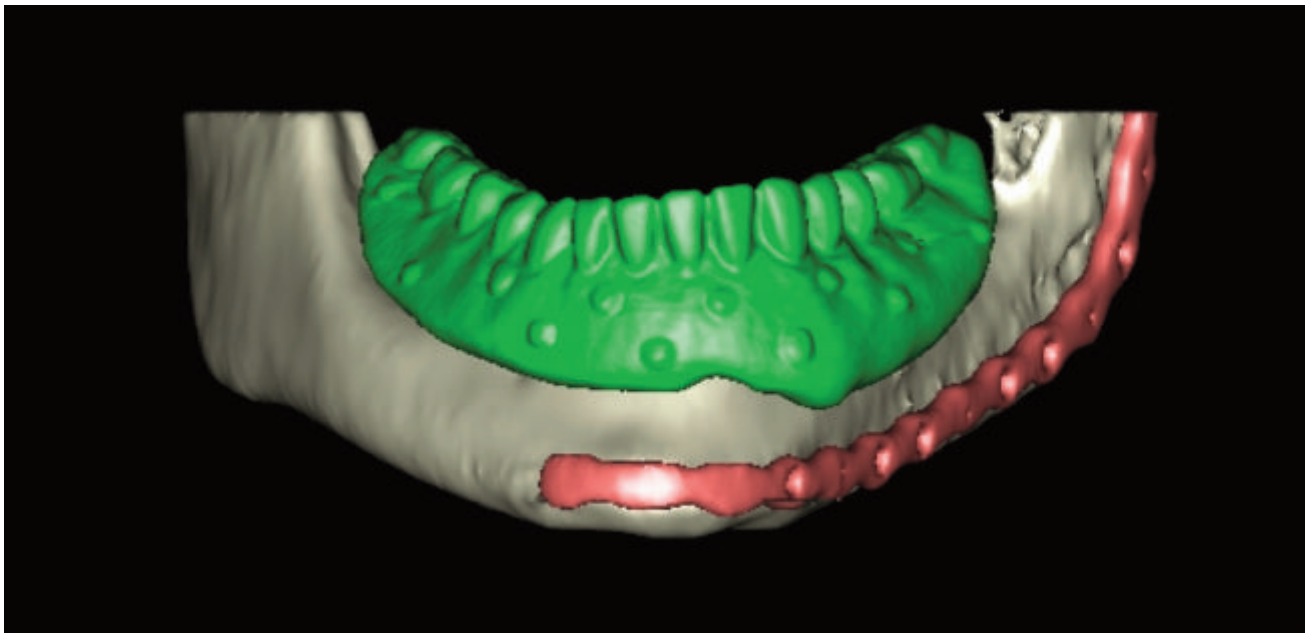

Figure 4. Image of the radiological guide designed for the realisation of the virtual surgery.

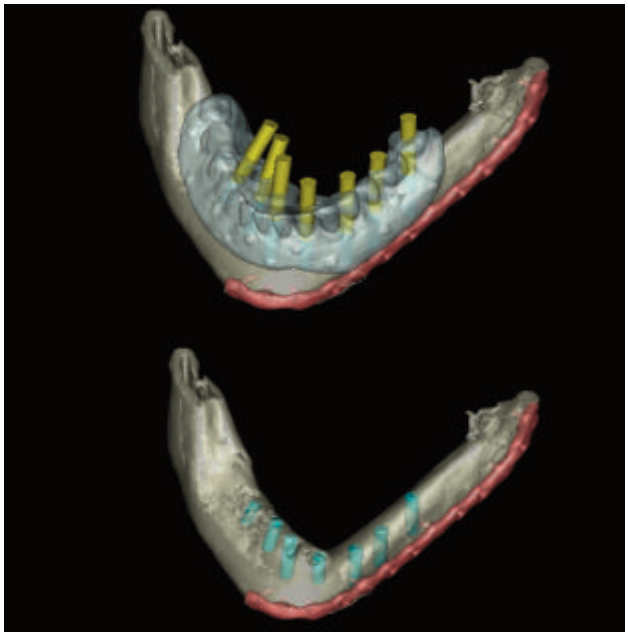

Figure 5. Implants planned on scanned mandibular image using the FacilitateTM tool for Simplant.

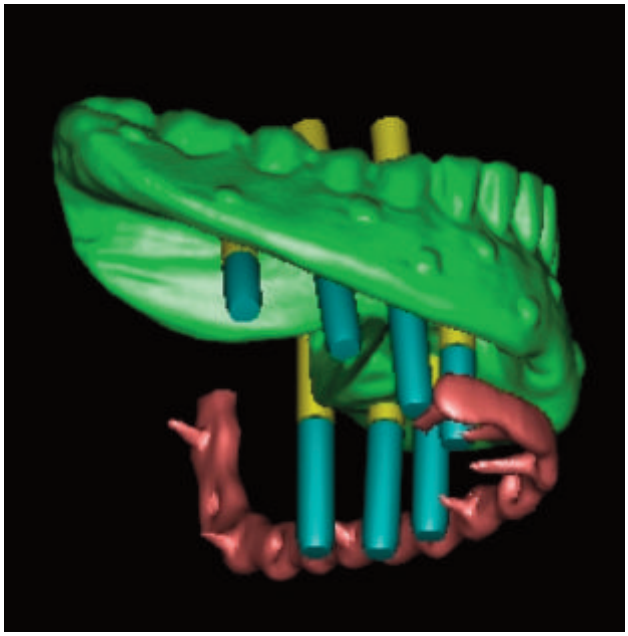

Figure 6. Surgical guide. Details of the placement of the implants, avoiding the screws of the osteosynthesis plate.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

Figure 7. Surgical guide for guided surgery (Surgiguide, SimPlant-FacilitateTM).

Figure 8. Mucosa-supported guide positioned in the oral cavity.

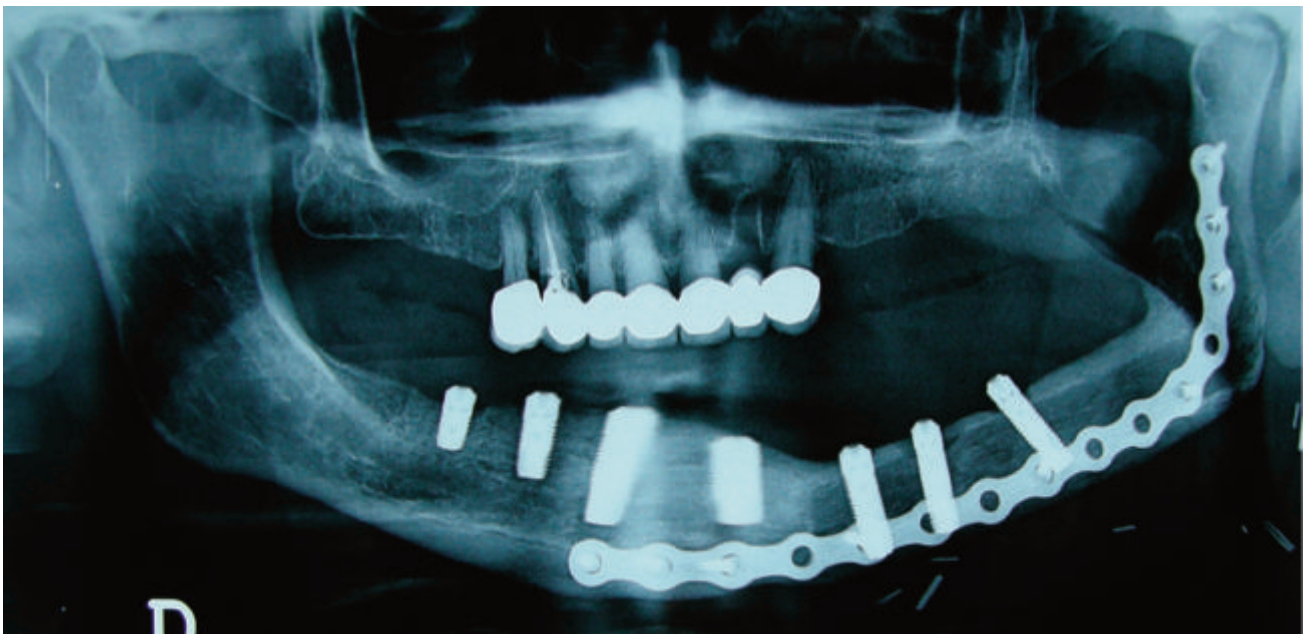

Figure 9. Implants correctly positioned and integrated six months after insertion.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

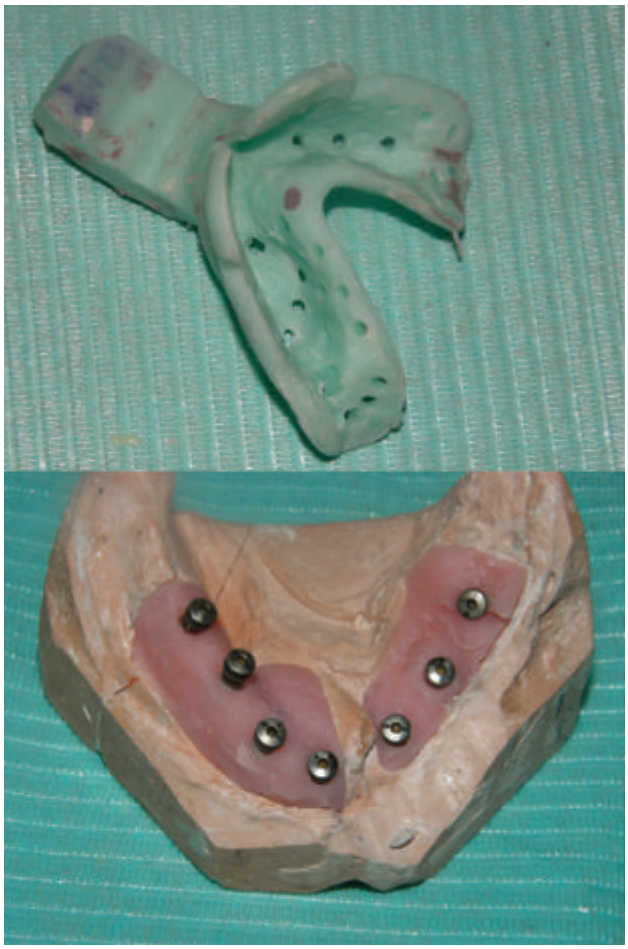

Figure 10. Individual tray and close-up of the working model.

Three years have passed and the prosthesis remains installed and in use. The dental occlusion is correct and the patient has normalised the masticatory function, being able to eat a normal diet (Figure 12).

The lack of saliva related to radiotherapy is an additional problem that makes difficult the management of the bolus, and it has been treated with symptomatic measures (abundant water intake, saliva substitutes, gum…).

Another objective of the reconstruction was the contribution of soft tissues to achieve adequate lingual mobility and to favour swallowing and articulation.

DISCUSSION

The development of reconstructive surgery of the facial skeleton in the recent decades has permitted improving to a great measure the quality of life of cancer patients. Being able to have a normal diet depends directly on the good masticatory and swallowing function. The use of microvascularised flaps and the development of implantology has helped to a great extent to achieve these objectives[5,6].

With respect to the flaps used, the fibula has been shown to be the most versatile in bone reconstruc-

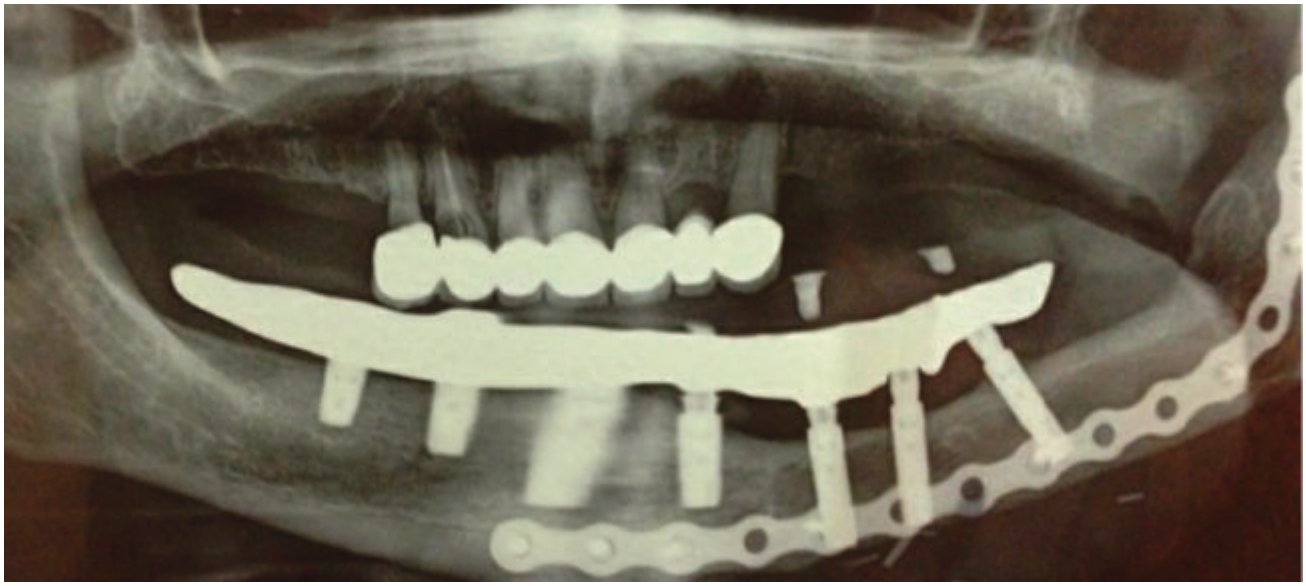

Figure 11. Orthopantomography in which it shows the correct adaptation of the hybrid prosthesis placed on the implants.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

Figure 12. Close-up of the prosthesis placed in the oral cavity.

tion. The principal advantages are: its length, which allows reconstructing defects up to 25 cm, the possibility of moulding it, realising multiple osteotomies, and the minimum morbidity of the donor area. It is indicated, among others, for the mandibular reconstruction associated with important defects of intraoral soft tissues, the reconstruction of symphyseal mandibular defects, either subtotal or total, the reconstruction of the branch and condyle and the reconstruction of posterior maxillary defects[4, 5, 10, 11].

Its major disadvantage is the scant height of the obtained bone that difficults the functional rehabilitation with osseointegrated implants[12], and also have to be placed in staggered form due to the incompati-

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

bility with the amount of material for osteosynthesis that is required to fixate the osteotomies[2]. In any case, whenever we have 10 mm of bone height and 5 mm of width, the rehabilitation with implants will be possible if they are placed precisely[12, 13].

As already commented, the final objective of the bone reconstruction is the placement of implants on these vascularised grafts for the rehabilitation of the masticatory function. The principal problem that implantology has posed on flaps has been the precision when situating the implants in the flap in order to achieve a correct emergence of the prosthetic attachments and, in short, a good occlusion. In this regard, it is not infrequent that many of the implants placed cannot be rehabilitated afterwards (Figure 1).

The guided implant surgery has been able to correct many of these problems. The virtual planning allows:

1. Situating the implants where the radiological quality of the bone is optimal, adjusting precisely the length and width of the implants.
2. Planning the emergence of the prosthetic attachments with the aim of the placed implants being able to be rehabilitated.
3. Avoiding the need to remove the osteosynthesis material when placing the implants, if possible, where there are not screws and also avoiding the osteotomy lines.
4. Performing minimally invasive surgery without the need for performing periosteal stripping of the grafted bone.
5. Planning immediate prostheses that can be placed in the postoperatory period, improving the function and the adaptation of the soft tissues[9, 14-16].

In order to perform the guided surgery it is necessary to have:

1. An image from a computerised tomography that allows us to evaluate with precision the maxillary or mandibular bone for the virtual placement of the implants.
2. An appropriate software, a planning program, which in our case has been the Facilitate tool for the SimPlant program of Materialise Dental.
3. A stereolithographic guide that translates the information of the planning from the scanned image to the real patient[14, 17].

In this sequence of necessities, that we must take into account are:

1. Before referring the patient to the radiology room, we must decide the type of support for the surgical guide. If we are going to perform surgery without a flap, which is ideal, the CT on the patient must be done with a barium radiological guide. So that the guide is useful, it must be adjusted precisely to the mucosa of the patient and remain stable so that the thickness of this mucosa can be inferred and the planning is correct with regard to the diameter and length of the implants. This is usually complicated in complete mandibular reconstructions. In case it is impossible to adapt the radiological guide to the mucosa (very frequent in reconstructed patients with alteration of the bone profile and distortion of the soft tissues) the surgical guide will be of bone support. If the patient has dental pieces in the arch to be reconstructed, we can opt for a dental support. In the rest of the cases in which the radiological guide adapts well to the mucosa, that will be the chosen support for the final surgical guide[18-20].
2. As for the planning program, it is necessary to know well its characteristics in order to be able to use all the tools and advantages that it offers.
3. Finally, in reference to the surgical guide, one must take into account that, if we add the height of the guide to that of the housing through which the implants are placed, there is a distance to the bone that requires that the drills be very long, usually between 18 and 25 mm. This can complicate the surgery in the case where we are action on the mandibular region, especially in cancer patients who frequently present limitations in the mouth opening as sequela of the operation and the radiotherapy[14, 17-20].

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

In any case, the concordance between the simulated planning and the actual result after the surgery in cases in which we are attentive to all these premises, is very high, with differences of position of less than 1 mm. All of this allows, in these very complex cases, managing to rehabilitate all the implants and achieve acceptable occlusions. In addition, thanks to the stability of the implant-supported prostheses, the complications that the soft tissues poise can be avoided, without the need for complex retouching of the flap or the mucosa of the patient (thinning of the skin paddle, vestibuloplastia, ...)

As for the prognosis of these implants, there are authors that insist that the microvascularised bone flaps statistically accept better the implants than the normal alveolar bone due to their high vascularisation[10].

Finally, the prosthetic solution must be individualised according to each case, with attention to the number of implants that can be placed, the biomechanical situation of the masticatory system, the dentition of the antagonist arch, the sensorial deficits of the patient and his oral hygiene. In free ends we will usually use fixed ceramo-metallic prostheses, while in complete reconstructions we must evaluate that the fixed prostheses require a higher number of implants, a more complex occlusal adjustment and exhaustive hygiene. This usually leads to greater satisfaction for the patient although it is a most costly treatment.

CONCLUSIONS

As a final conclusion of this paper, we have to say that, despite the fact that curing continues being our primary objective, the development of the microsurgical techniques and osseointegrated implantology has ostensibly improved the integral treatment of cancer patients. Therefore, we want to highlight the real possibility that we have to offer to the patients subjected to mandibular bone resections and reconstructed with bone flaps, dental rehabilitation with implant-supported and/or implant-retained prosthesis, which are going to improve facial harmony and quality of life. The index of satisfaction with this type of treatment is very high given that, after surgery and radiotherapy, the majority of patients demand the possibility of having teeth again and recover normal chewing.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

BIBLIOGRAPHY

1. Lindström J, Brånemark PI, Albrektsson T. Mandibular reconstruction using the preformed autologous bone graft. Scand J Plast Reconstr Surg 1981; 15 (1): 29-38.
2. Zlotolow MI, Huryn JM, Piro JD, Lenchewski E, Hidalgo DA. Osseointegrated implants and functional prosthetic rehabilitation in microvascular fibula free flap reconstructed mandibles. Am J Surg 1992; 164 (6): 677-81.
3. Hotz G. Reconstruction of mandibular discontinuity defects with delayed nonvascularized free iliac crest bone grafts and endosseous implants: a clinical report. J Prosthet Dent 1996; 76 (4): 350-5.
4. Hidalgo DA. Fibula free flap: a new method of mandibule reconstruction. Plast Reconst Surg 1989; 84 (1): 71-79.
5. Hidalgo DA, Rekow A. A review of 60 consecutive fibula free flap mandible reconstructions. Plast Reconstr Surg 1995; 96 (3): 585-96
6. Urken ML, Buchbinder D, Costantino PD, et al. Oromandibular reconstruction using microvascular composite flaps: report of 210 cases. Arch Otolaryngol Head Neck Surg 1998; 124 (1): 46-55.
7. Navarro Vila C, Borja Morant A, Cuesta M, López de Atalaya FJ, Salmerón JI, Barrios JM. Aesthetic and functional reconstruction with the trapezius osseomyocutaneous flap and dental implants in oral cavity cancer patients. J Craniomaxilofac Surg 1996; 24 (6): 322-9.
8. Cuesta Gil M, Ochandiano S, Barrios JM, Navarro Vila C. Rehabilitación oral con implantes osteointegrados en pacientes oncológicos. Rev Esp Cirug Oral Maxilof 2001; 23:171-82.
9. Block MS, Chandler C. Computed Tomography–Guided Surgery: Complications associated with scanning, processing, surgery, and prosthetics. J Oral Maxillofac Surg 2009; 67(11 Suppl): 13-22.
10. Navarro Cuéllar C, Ochandiano Caicoya S, Riba García F, et al. Rehabilitación implantosoportada en el colgajo libre de peroné. Rev Esp Cirug Oral Maxilofac 2006; 28 (5): 263-275.
11. Burgueño García M, Cebrián Carretero JL, del Castillo Pardo de Vera JL, Martorell Martínez V. Double skin paddle fibula free flap in orofacial reconstruction. Case report. An Otorrinolaringol Ibero Am 2005; 32 (1): 77-85.
12. Moscoso JF, Keller J, Genden E, Weimberg H, Biller HF, Buchbinder D, et al. Vascularized bone flaps in oromandibular reconstruction. A comparative anatomic study of bone stock from various donor sites to asses suitability for endosseous dental implants. Arch Otolaryngol Head Neck Surg 1994; 120 (1): 36-43.
13. Frodel JL, Funk GF, Capper DT, Fridrich KL, Blumer JR, Haller JR, Hoffman HT. Osseointegrated implants: a comparative study of bone thickness in four vascularized bone flaps. Plast Reconstr Surg 1993; 92 (3): 449-55.
14. Ozan O, Turkyilmaz I, Ersoy AE, McGlumphy EA, Rosenstiel SF. Clinical accuracy of 3 different types of computed tomography-derived stereolithographic surgical guides in implant placement. J Oral Maxillofac Surg 2009; 67 (2): 394-401.
15. Ersoy AE, Turkyilmaz I, Ozan O, McGlumphy EA. Reliability of implant placement with stereolithographic surgical guides generated from computed tomography: Clinical data from 94 implants. J Periodontol 2008; 79(8): 1339-45.
16. Di Giacomo GA, Cury PR, de Araujo NS, Sendyk WR, Sendyk CL. Clinical application of stereolithographic surgical guides for implant placement: Preliminary results. J Periodontol 2005; 76 (4): 503-7.
17. Nkenke E, Eitner S, Radespiel-Tröger M, Vairaktaris E, Neukam FW, Fenner M. Patient-centred outcomes comparing transmucosal implant placement with an open approach in the maxilla: A prospective, non-randomized pilot study. Clin Oral Implants Res 2007; 18 (2): 197-203.
18. Van Steenberghe D, Naert I, Andersson M, Brajnovic I, Van Cleynenbreugel J, Suetens P. A custom template and definitive prosthesis allowing immediate implant loading in the maxilla: A clinical report. Int J Oral Maxillofac Implants 2002; 17 (5): 663-70.
19. Van Assche N, van Steenberghe D, Guerrero ME, Hirsch E, Schutyser F, Quirynen M, Jacobs R. Accuracy of implant placement based on pre-surgical planning of three-demensional cone-beam images: A pilot study, J Clin Periodontol 2007; 34 (9): 816-21.
20. Sarment DP, Sukovic P, Clinthorne N. Accuracy of implant placement with a stereolithographic surgical guide. Int J Oral Maxillofac Implants 2003; 18 (4): 571-7.