Rehabilitation of an atrophic maxilla

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The rehabilitation of a patient with atrophic jaws can be challenging for the dental team. Costs, healing periods, morbidity and complications can also be elevated for the patient. However, cone beam computed tomography (CBCT) and 3D implant planning software allow us to treat these patients in a less invasive and a more predictable way.

Traditionally, treatment of patients with atrophic jaws requiring implant therapy involved complex grafting procedures and extended healing periods. Many patients rejected these treatment modalities due to their high complication and morbidity rates and costs.

Since computer guided implant surgery was first introduced in 2002, digital technology has evolved into a very accurate tool. Inaccuracies in implant placement are considerably reduced, benefitting to a great extent those patients with atrophic jaws, in whom a very precise use of that limited bone for implant therapy is paramount.

This article will discuss this approach and present a case report of a 56-year-old woman with an edentulous maxilla who wanted a fixed restoration. The lack of teeth and use of a complete denture for 25 years had resulted in a considerable bone resorption.

She was treated using 3D planning and a surgical guide to place five implants that allowed us to transform her complete denture into an immediate fixed temporary restoration, and three months later she was restored with a permanent metal-ceramic fixed restoration.

Introduction

The treatment of edentulous patients with dental implants has proved to be highly successful, and a paradigm shift in the management of patients with complete dentures (Dudley 2015).

The loss of natural dentition along with the use of complete mucosa-borne dentures is related to different degrees of maxillary atrophy, on occasion making it very difficult to deliver fixed rehabilitation with implants. In the presence of an atrophic maxilla, different surgical techniques have been described for the surgical correction of such deficiencies to enable implant therapy (Sorní et al, 2005).

Sinus lifts, autogenous block grafts and guided bone regeneration procedures have been well described in the literature with good results. Nevertheless, it is a well-established fact that these complex procedures entail a high risk of surgical and postoperative complications such as infection, wound dehiscence, bone graft resorption or damage to adjacent anatomical structures (Boffano and Forouzanfar, 2014; Faverani et al, 2014).

Cost, the need for general anaesthesia, a second surgical site for bone harvesting, number of surgeries, extended healing periods and long treatment time – as well as the previously-mentioned complications – are factors that negatively impact on patient acceptance for these treatment modalities.

Since computer-guided implant surgery was introduced in 2002, the advances in 3D diagnosis and surgical and prosthetic planning allow the dental team to treat many edentulous patients in a simpler and safer way (Ganz, 2015). With this technology,

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clinicians can accurately transfer the pre-planned position of the implants from the 3D software into the patient's mouth, having the advantage of predictably performing minimally invasive (flapless) surgery with immediate load in many cases.

With 3D implant planning software, it is possible to integrate the patient's surgical and prosthetic treatment into one single platform. Having the restorative plan on the computer screen before placing the implants is a key point in the diagnosis and execution of a prosthetically-driven implant treatment (Mora et al, 2014).

The transfer of CBCT images to 3D implant software considerably improves treatment planning, ensuring controlled implant insertion by the means of guided surgery. Doing this allows a surgical template to be created that will guide the implants into the right position, depth, angulation and orientation. Better use of the patient's existing bone can be made, thus considerably reducing the amount of patients that require complex reconstructive surgeries before implant therapy.

Case report

A 56-year-old woman, medically fit and with no allergies, wanted to replace her complete upper denture with a fixed implant restoration. On initial examination, photographs and an OPG were taken. This radiograph revealed extensive sinus pneumatization, with very little available bone for implants in the posterior regions (Figures 1 and 2).

The current complete denture met with the aesthetic criteria (incisal edge, mid line, smile line, lip support), so it was used as a reference to prosthetically guide the implant planning. To transfer her denture – and with it, the position of the teeth – into the 3D planning software (Nemoscan, Nemotec) a 'dual scan' protocol was utilised.

This involved inserting eight gutta percha markers into her denture; four in the buccal flange and four in the palate. A CBCT was taken with the patient wearing the denture, and a second CBCT was taken of the denture alone.

This allowed the 3D planning software to superimpose the denture onto the maxillary CBCT, thus showing the bony architecture, the desired position of the future teeth, and the shape of the soft tissue (this being the gap between the denture and the bone) in one single screen. A key step is to ensure the perfect adaptation and stability of the scanning appliance (in this case, the patient's denture) before taking the CBCT (Figures 3-7).

After careful examination of this CBCT, a surgical plan was made to place five implants where bone was sufficient, but still obtaining proper prosthetic support, combining two anterior implants with three posterior ones, two of which were tilted to avoid the sinus. This option, as well as alternative grafting techniques, was explained to the patient, and the decision was made to continue with this original plan.

A mucosa-borne surgical guide was prepared from this 3D planning, and used to place the implants using flapless surgery (Figures 8 and 9).

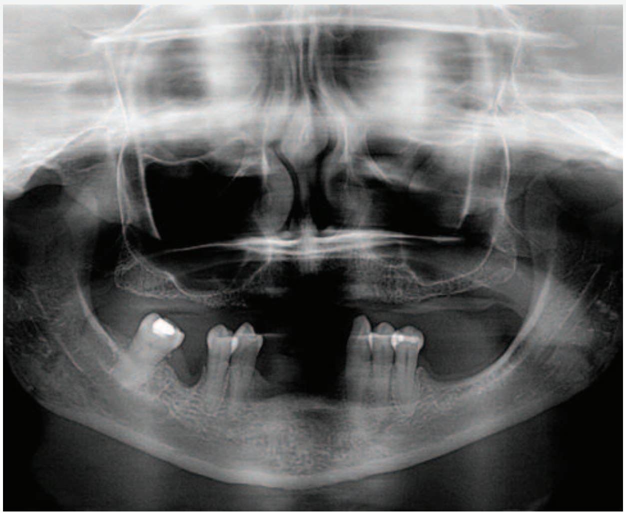
The patient took amoxicillin 2000mg two hours before the surgery, and articaine was used for anaesthesia.

The surgical guide was fitted onto the maxilla, checking its perfect adaptation by direct visualisation and tissue blanching. It was fixed to the maxilla with three titanium pins, and once in place, osteotomies as well as implant insertion were completed through the guide.

All implants achieved an insertion torque in excess of 40Ncm, and over 66 ISQ. After removing the surgical

Table 1. Implant deviation from planning to final position

Implant	Deviation at platform level (in mm)	Deviation at apex (in mm)
UR4	0.8	0.9
UR1	0.6	0.4
UL2	0.1	0.6
UL4	1	1.9
UL6	0.8	1.55



Figures 1 and 2: Preoperative OPG and intraoral view.

guide, another CBCT was taken to ensure all implants were correctly placed between the bony housing, allowing also to make a comparison between the final implant position and the 3D planning (Figures 10 and 11; Table 1).

Multiunit abutments were connected to all implants (Figure 12), using 30° angulated abutments on the tilted implants to correct the emergence and keep it in the prosthetic corridor.

The patient's conventional denture was converted into a screw-retained temporary fixed restoration (Figures 13 and 14) using titanium abutments and a pick-up technique. The patient was given a postoperative prescription of ibuprofen (400mg) for analgesia and a chlorhexidine 0.20% mouthwash, and instructed to keep a soft diet for three months.

Healing was uneventful and three months after implant placement the temporary prosthesis was unscrewed to find all five implants well integrated. The final prosthetic phase was to fabricate a screw retained metal-ceramic fixed restoration, which met with the patient's aesthetic and functional needs (Figures 15-17).

Discussion

In a society where time is important, more and more patients are looking for immediate results, reluctant to go through longer and more uncomfortable treatments.

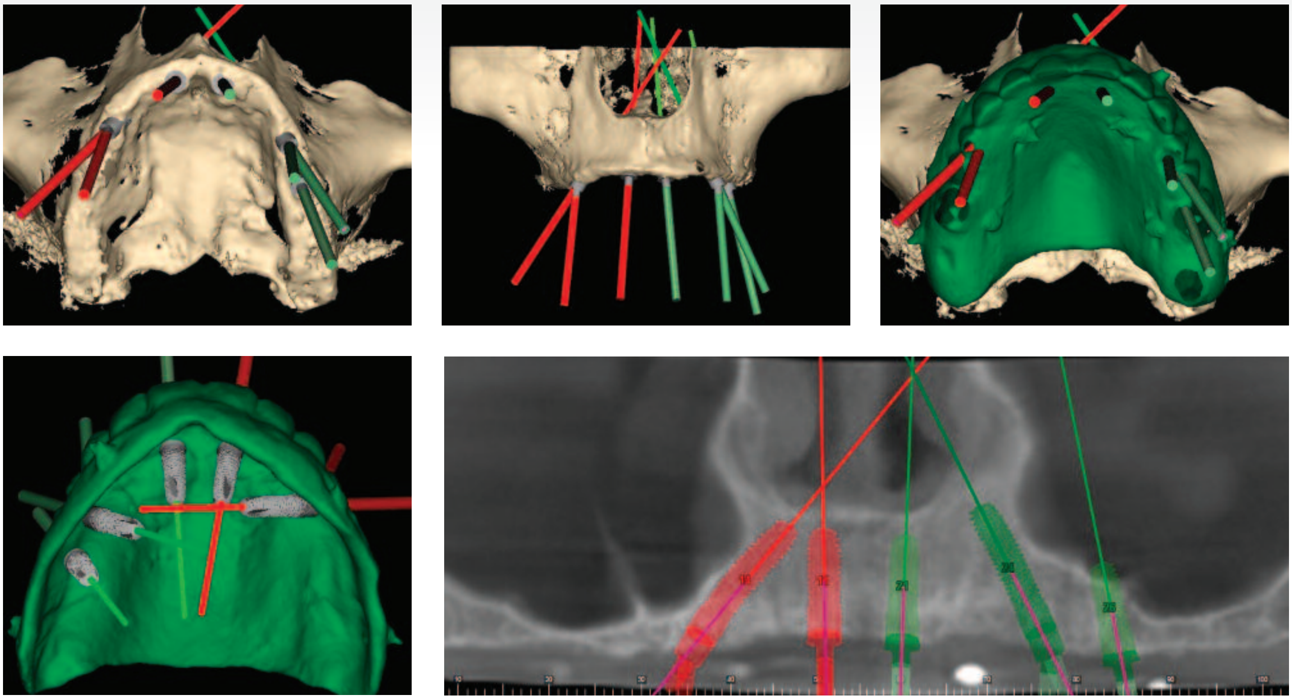
The possibility of performing the surgical and prosthetic techniques of implant dentistry in the same clinical visit represents a very effective approach that significantly reduces the treatment time and dramatically improves the patient's quality of life (Cannizzaro et al, 2008; Tarnow et al, 1997). Fewer hours spent chairside makes the experience more pleasant for the patient and less tiring for the clinician. Flapless surgery is also a very effective way of treating patients with a fear of surgery.

With no need to raise a flap or carry out suturing, postoperative pain and swelling are greatly reduced, as are recovery times (Van Steenberghe et al 2005). Intraoperative complications and bleeding are also minimised. Peri-implant tissues also benefit from flapless surgeries, as a quicker seal around the implants is possible from day one (Malo et al, 2007).

Current scientific evidence in implant dentistry has dramatically changed Brånemark's original guide for osseointegration. Immediate loading is a well-documented approach, with success rates similar to those of conventionally loading techniques (Salama et al, 1995).

For successful immediate load protocols, a number of factors must be considered. Firstly, a careful examination of the radiologic images for implant planning is key. New computer-assisted three-dimensional image technologies have revolutionised this field, allowing the implant surgeon to study the different possibilities for implant number and position for each patient in a virtual model. This way the most favourable surgical protocol can be established for each case (Marchack, 2007). Bone density can also be accurately measured in order to ensure that immediate load will be predictable (Shahlaie et al, 2003).

Another key point is implant selection. Implants with a roughened surface that will improve osseointegration, and a macro geometry that will allow high insertion torques and



Figures 3-7: Superimposition of scanned denture and the maxilla in order to prosthetically plan implant positioning.

good primary stability, are essential for immediate load.

These implants must always be splinted to provide favourable absorption and distribution of the load, and to reduce any micromovement during the healing phase.

Avoiding micromovement is paramount if immediately loaded implants are to osseointegrate, so the patient has to keep to a soft diet for at least six weeks, progressively introducing soft chewing after this period elapses.

It is well documented that an edentulous maxilla can be immediately loaded and restored with a fixed prosthesis using as few as four implants placed in strategic positions. The 'All-on- four' technique that was first described by Malo et al (2003) advocates the placement of two vertical implants in the anterior region and two more implants placed mesial to the sinus in a 30-45° angulation.

When implant placement in the posterior maxilla is not possible in a conventional way due to sinus pneumatization, this technique offers a very effective way of using the existing bone in the premaxilla to anchor the implants while still reducing distal cantilevers.

Scientific literature also supports that tilted implants have similar success to axially placed implants when they are splinted (Aparicio et al, 2001). Thus, tilted implants in the premaxilla present a very safe and predictable outcome to sinus augmentations.

An essential advantage of computer-assisted techniques is the precision with which the implants are placed. This accuracy can be measured by comparing the 3D planning with the final surgical position and angulation of the implants (Widmann and Bale, 2006).

It has been demonstrated that computer-assisted implant placement is more precise than manual insertion (Brief et al 2005). However, it is also necessary to have a minimum safety margin of 1mm from important anatomical structures, since some error can be accumulated from the transfer of the radiologic images to the 3D software, and the positioning of the surgical guide. Despite this, it is the opinion of this author that computer-assisted surgery should be considered the safest way of placing implants, since it is the technique least influenced by human error.

One study showed that an experienced surgeon can have an average of 6.1mm deviation when drilling an osteotomy manually, compared to an average of 0.5mm when using computer guided surgery (Schermeier et al, 2001).

Figure 8: Surgical guide in place, fixed to the maxilla with three pins.

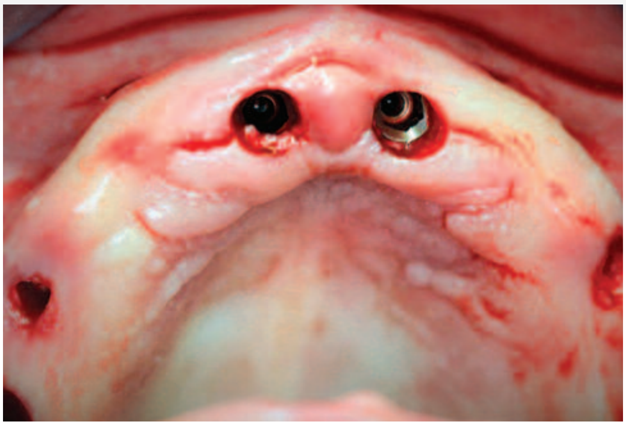


Figure 9: Implants placed without raising a flap.

Figure 10: Postoperative CBCT showing final implant position.

Another study compared implant selection and planning between conventional radiographs and 3D software, and the length of the implants was increased in 77.7% of the cases when using the 3D software (Siebegger et al, 2001).

Longer, wider implants increase the contact surface between the implant and the bone, which is a very important factor in immediate load protocols, where functional load of these implants happens before actual osseointegration occurs (Sanna et al, 2007).

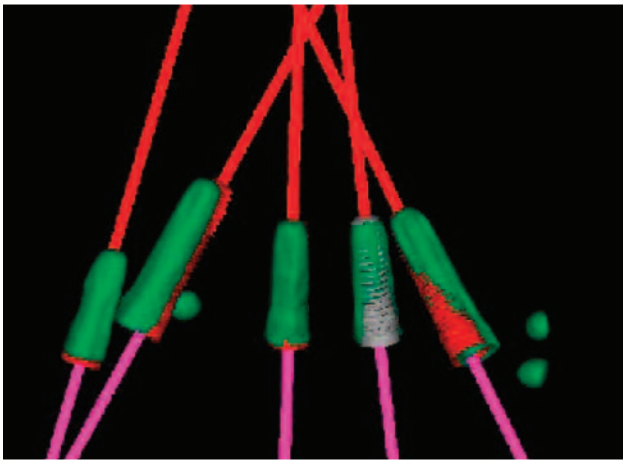


Figure 11: Comparison between final implant position (green) and 3D planning (red and grey).

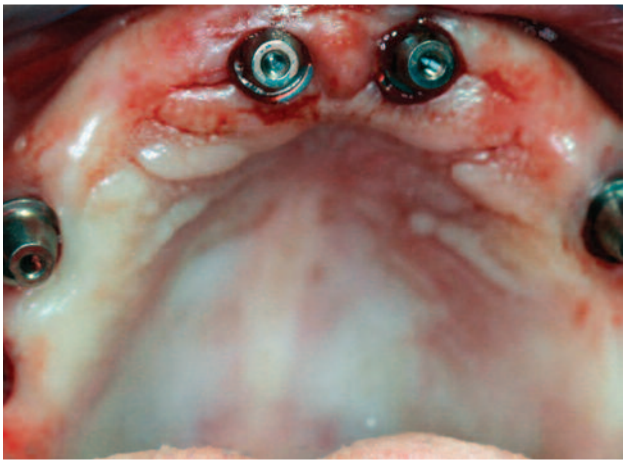


Figure 12: Multiunit abutments connected.

Figure 13: Transforming the complete denture into a screw retained provisional fixed prosthesis, using direct pick up technique.

Figure 14: Immediate postoperative – showing provisional restoration.

In order to achieve an accurate transfer of implant position from the virtual platform to the oral cavity – and therefore achieve successful guided surgery – a strict protocol must be adhered to. The clinician should ensure that all steps, from the scanning of the patient to the surgical placement of the implants, are carried out meticulously. The scan appliance must be perfectly adapted and thoroughly assessed – relining it intraorally if necessary – before taking the CBCT.

From here, the accuracy of the procedure is determined by the surgeon's ability and proficiency with the technology, the precision the surgical guide is made with, the compatibility and tolerance of the surgical drills and transfers and the correct fitting and fixing of the surgical drill.

It must be stressed that the stability and position of the surgical guide has to be checked during all steps of the implant surgery.

Conclusions

By reducing the number of surgeries to one, implementing immediate load protocols, and decreasing patient morbidity and complications with a minimally invasiveness philosophy, both the clinician and patient can benefit from more predictable and safer implant dentistry.

Three dimensional images help the implant surgeon plan the number, location, diameter and length of the implants. The surgical stent guides the surgery, enabling the correct and precise placement of the implants to be able to load them with a fixed restoration at the same surgical session

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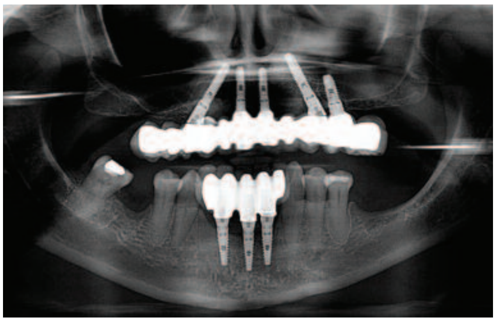

Figures 15-17: The final metal-ceramic screw retained prosthesis.

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