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Digital planning and guided surgery in oral rehabilitation: a case report

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ABSTRACT | Digital planning of the prosthesis associated with surgical planning increased predictability, since surgical guides indicate the best place for implant installation, thus reducing the number of complications, and the CAD/CAM system provides predictability in the preparation of final restorations, according to the procedure previously planned. Our study reported a digital workflow used for the guided installation of two dental implants in regions 14 and 16, extraction of tooth 15 and installation of a fixed prothesis over implants. After anamnesis and clinical evaluation, intra- and extra-oral photographs of the patient were performed, molding the upper arch with polyvinylsiloxane (2-step putty/light-body technique) and requesting computed tomography. The plaster model obtained was sent to the laboratory and scanned. The generated file (STL) was used to create a diagnostic wax-up that was aligned to the tomography (in DICOM format), enabling the three-dimensional planning of the implants, which generated a partial printed surgical guide after approval of the dentist. After six months, the patient received the provisional fixed prosthesis printed in PMMA (polymethylmethacrylate) on an intermediate in PEEK (polyetheretherketone) aiming to condition an emergency profile to receive a definitive prosthesis two months later, with zirconia-milled infrastructure on a ti-base. The correct understanding of the operator about the steps of the digital workflow (diagnosis, prosthetic planning, surgical planning, guide preparation, temporary and final restorations) gives the operator improved predictability at the time of surgery as well as satisfactory aesthetic and functional result of definitive restorations.

DESCRIPTORS | Digital Planning; Guided Surgery; Zirconia; CAD/CAM.

RESUMO | **Planejamento digital e cirurgia guiada em reabilitação oral: relatório de caso** • Planejamento digital de prótese associada a planejamento cirúrgico aumenta a previsibilidade devido às guias cirúrgicas que indicam o melhor local para instalação do implante, reduzindo o número de complicações, e o sistema CAD/CAM permite previsibilidade ao preparar as restaurações finais, de acordo com o procedimento planejado anteriormente. Nosso estudo relata um fluxo de trabalho digital usado para a instalação guiada de dois implantes dentários nas regiões 14 e 16, extração do dente 15 e instalação de prótese fixa no lugar de implantes. Após anamnese e avaliação clínica, fotografias intra e extraorais do paciente foram tiradas, moldando o arco superior usando polivinilsiloxano (técnicas da dupla mistura e reembasamento) e solicitando tomografia computadorizada. O modelo de gesso obtido foi enviado para o laboratório e escaneado. O arquivo gerado (STL) foi usado para criar um diagnostic wax-up alinhado à tomografia (em formato DICOM), permitindo o planejamento tridimensional dos implantes, o que gerou uma guia cirúrgica parcialmente impressa após aprovação pelo dentista. Após seis meses, o paciente recebeu uma prótese fixa provisória impressa com PMMA (polimetilmetacrilato) em um intermediário em PEEK (Poli(éter-éter-cetona)) para condicionar um perfil emergencial e receber uma prótese definitiva dois meses depois, incluindo infraestrutura de zircônia moída em uma base TI. O entendimento adequado do operador a respeito dos passos envolvidos no fluxo de trabalho digital (diagnóstico, planejamento de prótese, planejamento cirúrgico, preparação da guia, restaurações temporárias e finais) forneceu ao operador maior previsibilidade no momento da cirurgia e um resultado estético e funcional satisfatório para as restaurações definitivas.

DESCRITORES | Planejamento Digital; Cirurgia Guiada; Zircônia; CAD/CAM.

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INTRODUCTION

Teeth are organs responsible for functions that are essential to humans, such as chewing and phonation. The loss of a single dental element may result in an individual developing disorders in the stomatognathic system, as well as functional and psychiatric disorders due to dissatisfaction with aesthetics. Alternatives for oral rehabilitation are being sought to minimize the damage caused by tooth loss.

None of the existing dental replacement methods has a more positive impact than implants. Possible failures and complications in rehabilitation treatments result in longer treatment and additional costs and discomfort for the patient.[1]

For many years, implants were diagnosed and planned by clinical evaluation as well as periapical and panoramic radiographies. However, the need for a three-dimensional visualization made cone beam computed tomography (CBCT) the most indicated examination for surgical planning since it provides a three-dimensional view of anatomical structures. However, only CBCT could not provide a prognosis of surgical and prosthetic outcome, since there was no type of mechanism that transmitted theoretical planning to practice, making surgery a highly operator-dependent procedure, increasing the risk of complications such as perforation of the palatal wall and invasion of the alveolar nerve, compromising aesthetic restoration and potentially leading to application of unfavorable occlusal forces in the prosthesis, which is transmitted directly to the implant.[2,3]

With the association of CBCT with the CAD/CAM (computer-aided design and manufacturing) system, planning became available virtually and in 3D, allowing the professional to transfer virtual information to clinical procedures, reducing postoperative discomfort and enabling the manufacture of prosthetic structures before surgery.[4] This CBCT–CAD/CAM association originated the concept of guided surgery.

Guided surgery can be classified as static or dynamic. Dynamic-guided surgery occurs through a computational navigation system that allows real-time implantology surgery, enabling the adjustment of the planned position for the implant during the operation, whereas static-guided surgery is based on three-dimensional data obtained by tomography, scanning and CAD/CAM technology. The surgical guide can be supported in teeth (partially edentulous patients), supported by mucosa (fully edentulous patients) or directly on the bone.[5]

Static-surgical guides can also be classified according to visibility: closed, which prevents the drill from escaping during milling; or open, which allows better visibility of a palatine view. According to the positioning in the mouth, it can be fully or partially guided.[6]

Resistance to masticatory stress is important for restorative materials on implants since implants do not have the same proprioception of a natural tooth. Therefore, the correction of the occlusal adjustment of the prosthetic part and a careful selection for each case is important when choosing the material. To prevent the hardness of fully ceramic zirconia restorations from damaging the implant platform, a titanium base (TiBase) in conjunction with a scan body was created to connect implant and zirconia. With perfect adaptation to both the implant and the zirconia abutment, TiBase allows cementation of the pillar inside and outside the mouth, preventing the remains of cement from accumulating and inflaming the site.[7]

Although the use of fully digital protocols is a reality in current dentistry, there are still doubts about the indication, advantages and disadvantages of this treatment. Our study presents and describes a planned and executed clinical case integrating CAD/CAM technology with computed tomography that guided all stages of treatment, from surgery to the installation of definitive prosthesis.

CASE REPORT

MALMS. Male patient, leucoderma, without relevant systemic involvement attended the private clinic to replace teeth 14, 15 and 16. In his report, he mentioned masticatory difficulty and aesthetic complaint.

After anamnesis, clinical evaluation and extra- and intra-oral photographs, the patient had the upper arch molded using polyvinylsiloxane (Elite HD, Zhermack) by the 2-step putty/light-body technique and was referred to tomographic examination (Cranex 3D – Soredex, Tuusula, Finland) with total exposure of the jaw, in which the extraction of tooth 15 and implant installation in the region of 14 were recommended, as well as sinus lifting and implant installation in the region of 16. Due to the important infectious process in the region of 15, we opted for a fixed prosthesis on implant with element 15 in pontic (Figure 1).

The association of tomographic examination, photographic images and a maxilla model created the subsidies necessary for the realization of the digital workflow for the prosthetic and surgical planning stages, as well as the design of the surgical guide (Implant Studio 3 shape) and its printing.

To request the study, we filled in a form provided by the Smart Solutions laboratory specifying the elements to be implanted (14 and 16), need for maxillary sinus lifting, tooth to be extracted (15), and implant system that would be used, NEODENT Helix GM 4.3 X 10 mm (Neodent, Curitiba, Brazil).

The model obtained in type IV plaster (Elite Rock, Zhermack SPA, Italy) was sent to the laboratory, where it was scanned. Based on the file generated by the scan, a diagnostic wax-up was created and used as a reference for three-dimensional planning of the implants (Figure 2). The wax-up was then aligned with the tomography of the patient (Figure 3). After confirmation of the proposed planning, a 3D printed model (Stratasys 3D printer, Stratasys Ltda, USA) of the partial surgical guide was generated (Figure 4).

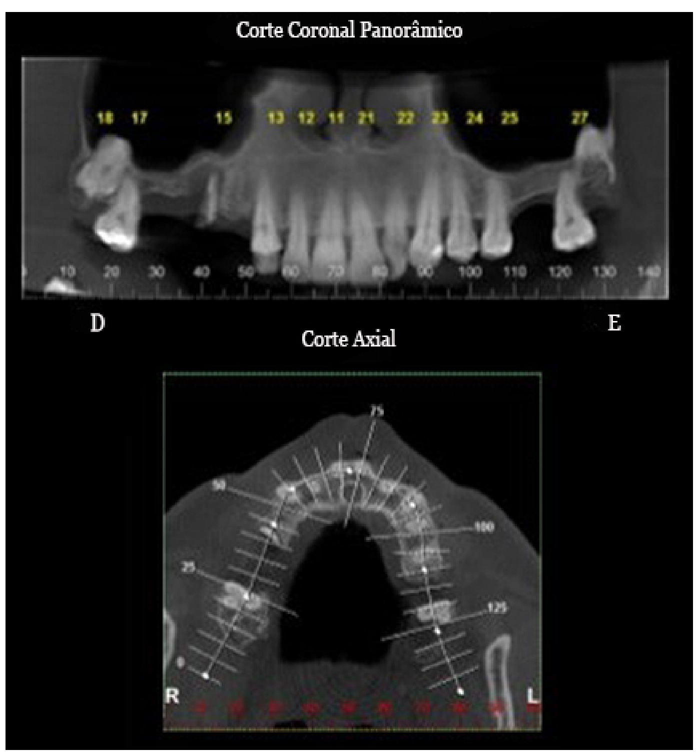

Figure 1 | CT scan (coronal and axial sections).

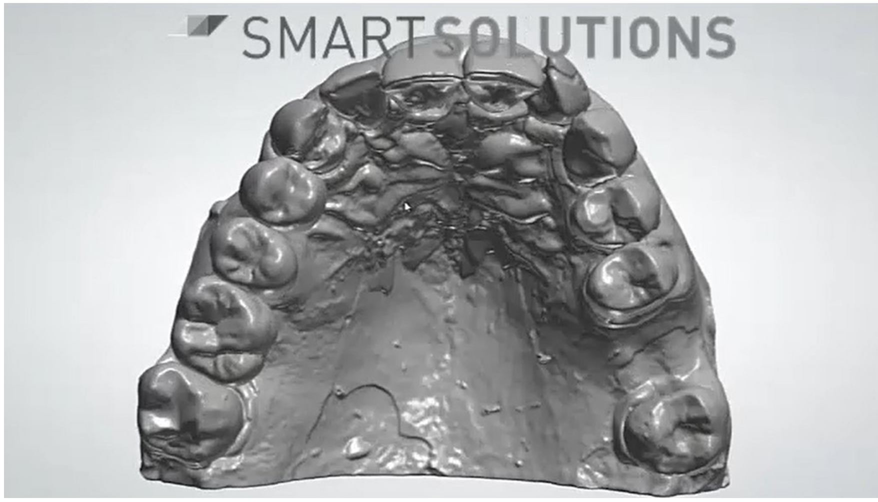

Figure 2 | Digital Waxing.

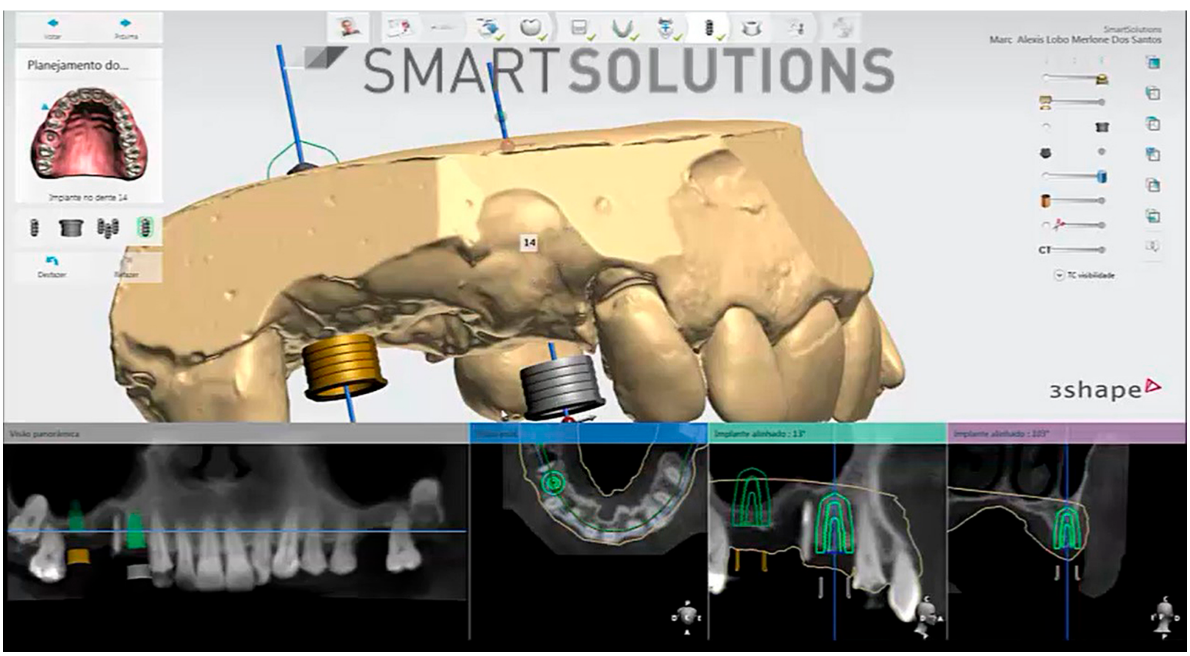

Figure 3 | Scanning and computed tomography relationship.

While digital planning was conducted, the patient received necessary instructions and a preoperative drug prescription: 2 g of amoxicillin and 8 mg of dexamethasone an hour before surgery.

After finishing and polishing, the guides were tested in the mouth for their laying and stability through the inspection windows. Because of their large laying surface, guides in partially toothed cases allow for good stability that can be refined using low contraction resin when necessary.

The surgical procedure was performed under local anesthesia (4% articain hydrochloride + epinephrine) with a terminal infiltrative technique, starting with the extraction of the root remnant of element 15 and alveolar curettage. After flap opening, we performed sinus membrane elevation, partial guide positioning, guided instrumentation sequencing and guided installation of implants in the 14 (torque 45Ncm) and 16 (torque less than 20Ncm) regions. The guide was removed, allowing for vestibular access, thus enabling the filling of the sinus cavity with lyophilized bovine mineral matrix (Botiss, Cerabone, Straumann, Basel, Switzerland).

Figure 4 | Printed surgical guide.

Six months after the surgery, we confirmed the success of the procedure with radiographs, and reopened the implants. Based on the initially generated STL files, the provisional fixed prosthesis in polymethylmethacrylate, the PMMA (Vipi Block Trilux, São Paulo, Brazil) (Figure 5) was printed and cemented on an abutment in polyceetacetone – PEEK (Neodent, Curitiba, Brazil) (Figures 6 and 7).

Figure 5 | Provisional printed in PMMA.

Figure 6 | Prosthetic intermediates in PEEK.

Figure 7 | Provisional in PMMA cemented on abutments in PEEK.

After two months, a transfer molding was made, and a scanning body was screwed to it. Based on a new scan, zirconia infrastructures were designed (LAVA 3M ESPE, St Paul, Minessota, USA) (Figure 8) and a feldspathic porcelain cover (VITA VM9, VITA Zahnfabrik, Bad Săckingen, Germany) of 2M2 color on the scale (Vitapan 3D master, VITA Zahnfabrik, Bad Săckingen, Germany) was applied, respecting the existing occlusal configuration (Figure 9). For milling, zirconia blocks in color A3 were used over the Ti-base intermediates (Neodent, Curitiba, Brazil). Occlusal analysis was then performed, allowing to control the intensity of contacts and possible interferences in the excursion movements, allowing a correct distribution of masticatory forces (Figure 10).

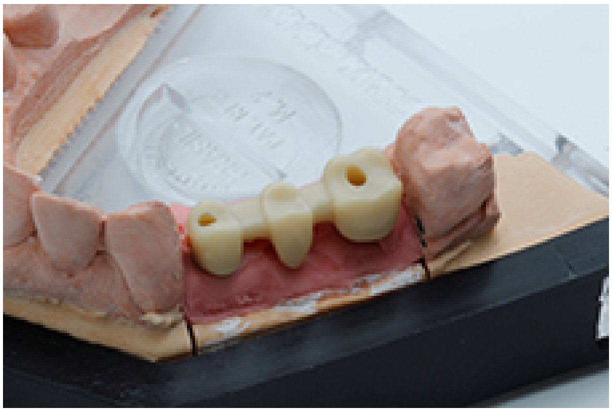

Figure 8 | Zirconia infrastructure.

Figure 9 | Feldspathic ceramics applied on zirconia.

Figure 10 | Fixed prosthesis on implant installed.

DISCUSSION

This case report described a fully digital workflow used for the installation of two osseointegrable implants and subsequent rehabilitation in milled zirconia of a fixed prothesis of three elements.

Computed tomography is used for the virtual planning of implants, allowing a three-dimensional view of noble anatomical structures such as the location of the maxillary sinus, the roots of the teeth and the bone structure. With the advance of technology, a virtual model of the teeth could be integrated with the data obtained by tomography, enabling a three-dimensional planning of the implant.[2-4] This virtual model of the teeth is obtained using digital teeth libraries or can be developed based on intraoral scans of two patients: the main patient to be rehabilitated and someone with similar dental arch characteristics.[8]

The guided surgery showed an increase in the predictability of implantodontic surgery and reduced the number of failures during installation by the operator, which could compromise the final aesthetic result of the prosthesis. However, any error due to operator's failure during any of the planning processes or lack of technical experience may influence the surgery outcome.[2,5] Guided surgery shows angular deviation rates lower than the conventional technique when comparing the final position of the implant installed to the planned position.[9,10]

The reported case is considered a fully guided static surgery where a static surgical guide positioned in the mouth is responsible for transmitting the prosthetic and surgical planning before the surgery.[6] The fully guided static surgery is the one whose guide remains in the mouth during the whole procedure, allowing for a flapless surgery when there is enough bone and keratinized mucosa. However, it makes any change during surgery impossible, even if there has been some error during the planning stage.[6] In the reported case, the non-option for the flapless technique was due to the need for a concomitant maxillary sinus lifting.

We could use a guide supported in patient's teeth, which provides a better stabilization in the mouth. When flap opening is necessary, such as in our case report, some studies have reported failures in the transfer of the implant position.[6,10]

The integration of the CAD/CAM system, computed tomography and prosthetic planning software allowed for greater predictability in the case result. The data transfer obtained with the planning of the prosthesis (STL) to the laboratory allowed to prepare temporary restorations milled in PMMA in minutes, with structural characteristics conferring satisfactory aesthetic and functional results, without the need for the molding stage. Unlike other polymers, PMMA has a wide variety of colors, excellent mechanical properties, and less risk of porosity incorporation.[11]

As an alternative to the use of metal prosthetic intermediates, materials such as PEEK, manufactured by CAD/CAM technology, have been used as they are considered more aesthetically pleasant and biocompatible when compared with metal, in addition to presenting the main characteristic necessary in prosthetic intermediates, which is the ability to reduce and dissipate the load received by the implant while chewing.[12]

Recent studies present a workflow in which a second intraoral scan is performed after soft tissue management facilitated using the 3d-printed interim implant restoration. The new STL file resulting from this second intraoral scan can be associated with the previous STL from the initial intraoral scan and no implant scan bodies are required for intraoral scanning.[13]

For the manufacture of definitive crowns on implants, the material of choice is one that has good aesthetic characteristics, fracture resistance and biocompatibility with the implant structure. When zirconia is chosen for the preparation of the final restoration, the need for a link between the implant and the zirconia structure (Ti-Base) must be considered. Zirconia in direct contact with the implant could cause damage to the implant platform.[14]

Although some studies show a better marginal adaptation between zirconia screwed directly on the implant platform, the adaptation between zirconia and Ti-Base is clinically acceptable while also minimizing the risk of fracture.[14] In cone-morse implants, the use of a fully ceramic abutment would result in a ceramic thickness in the internal region of the connection, facilitating the possibility of fracture. Zirconia, on the other hand, can damage the implant head in restorations that do not use a metal link, since it has a higher hardness than titanium.

Zirconia has excellent mechanical characteristics compared to other ceramics on the market. Despite the existence of translucent and ultratranslucent zirconias that minimize its anti-aesthetic characteristics due to its high degree of opacity and its inability to mimic the natural stratifications of dental elements, we chose to use the two-layer system (bilayers), that is, in its stratified form, which decreases the resistance of zirconia to chipping but provides more satisfactory aesthetic results.[15]

CONCLUSION

Based on the existence of a learning curve on the part of the professional, we concluded that the correct management of operator and operator-laboratory communication in stages constituting a digital workflow allow for correct planning, giving the dentist greater predictability in the installation of implants, avoiding surgical complications, and providing a satisfactory aesthetic and functional result for definitive restorations.

A digital workflow can even be performed by dentists that do not yet have intraoral scanners in their offices. A digital workflow means much more than replacing molding material by scanning. Includes diagnosis, prosthetic planning, surgical planning, preparation of guides, temporary and final restorations.

DISCLOSURE STATEMENT

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