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Immediate Load in Units using the Indexed Prosthesis in the Sensitive System

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Abstract— *This clinical case report emphasizes the significant variations in implant placement systems, which denotes an emerging need for systems that minimize deviations in order to ensure implant placement at the intended bone level. The present work suggests a protocol for a simplified indexing technique using the Index Sensitive® technology (Conexão Sistema de Prothesis, São Paulo, Brazil), with the immediate placement of an implant-supported prosthesis with an indexed abutment in the implant, minimizing errors and distortions in the final result. of surgery arising from the process of making the surgical guide and the surgical procedure. The objective of this case report was to prove the efficiency of the Sleeve Index Sensitive® system in the manufacture of implant-supported prostheses in exoplan and dentalcad software prior to implant installation and to assess whether the transfer of the planning in the software to the patient's mouth is accurate. Alternative hypothesis that the Sleeve Index Sensitive® system is efficient in reproducing the indexed schedule and preserves the natural emergence profile. Patients were included with root fractures, and after previous analysis, it was proposed and the installation of dental implants of immediate loading in single units using the prosthesis indexed in the Sensitive® System. The data needed for indexing was imported into the Exoplan software, Exocad. Surgical planning was performed with the prosthetic component, Ti-Base S NP, virtually indexing the prosthesis, determining the positioning of the tooth to the implant, generating the surgical guide. The surgical guide has been incorporated into Sensitive® ferrules with a lock in a single position. Then it was exported in an STL file to be printed. The surgical plan was exported to manufacture the prosthesis. With the printed guide, milling was performed to install the Flash Vulcano implant with a diameter of 3.5 mm and height variation according to each case, distinctly.*

I. INTRODUCTION

Tooth loss from trauma, infection, caries, periodontal inflammation, tooth abscess or extraction, and congenital disease occur frequently and are the most pressing problem facing dentists today (BENTO et al., 2021; NØRGAARD PETERSEN; JENSEN; DAHL, 2022).

Severely damaged teeth that cannot be restored can be replaced by dental implants in order to maintain the normal anatomical contour, eliminate the edentulous space, and improve the aesthetic-functional aspect of patients (TITSINIDES; AGROGIANNIS; KARATZAS, 2019).

In recent years, innovations in the technology market in the dental field, the optimization of oral rehabilitation treatments and the improvement of techniques that provide patient satisfaction have shown significant growth, concomitantly with the aesthetic market, when referring, including, to the front teeth (HOLDEN, 2018).

As in all areas that involve this market, implantology has been a potential for valorization, as it is in many situations that require oral rehabilitation, an important area in determining the attractiveness of a face, also playing a fundamental role in human social interactions (WITTNEBEN et al., 2018).

With the development of new digital technologies in the planning and installation of dental implants, through the surgical guide, an exponential increase in the therapeutic spectrum of modern surgical-prosthetic dentistry has become possible (FLÜGGE et al., 2022).

Several types of surgical guides have been reported in the literature, among them the computer generated one that is able to provide a link between the simulated plane accurately to the surgical site. This surgical guide is made by stereolithography process, rapid prototyping technology, custom-made for each patient (EFTEKHAR ASHTIANI et al., 2021).

Stereolithographic models require the CT image of the patient, as it is a method of surface shaded display and volume rendering that generate 3D reconstructions of the entire dental arch and its relevant structures, including nerves, which makes CT the most accurate and comprehensive radiological technique for dental implant planning (FRIEDLANDER-BARENBOIM et al., 2021; YILMAZ et al., 2019).

Thus, the surgical guide, 3D guide plays an imperative role in this process, as they facilitate the ideal positioning and angulation of the implants. Thus, they become essential elements to transfer the information generated in the programs, which allows the performance of virtual surgeries, without the need for extensive cuts, reducing surgery time, providing a faster and more comfortable recovery for the patient, by allowing a much minor trauma (AL YAFI; CAMENISCH; AL-SABBAGH, 2019).

The accuracy of a guided procedure is defined by the deviation in position or angle from the plane compared to the result. It includes errors from the acquisition of the image to the quality of the computed tomography, intrinsically related to the thickness of the slices and the influence of possible artifacts to the surgical positioning of the implant (LIU et al., 2021; MA et al., 2018).

Despite the predictability of the technique, previous studies report a certain degree of error resulting from the entire process, involving from the tomographic guide, capture, transfer and segmentation of the image, virtual planning, preparation and placement of the surgical guide and, finally, the final positioning of the implants. Thus, these errors, although they rarely occur, can be cumulative in the process of planning and execution of the procedure and can negatively influence the intended result (KU et al., 2022; SKJERVEN et al., 2019).

Another point to be highlighted is the significant variations in implant installation systems, which denote an emerging need for systems that minimize deviations, to guarantee implant placement at the planned bone level (YEUNG et al., 2020).

The present work suggests a protocol for a simplified indexing technique using the Index Sensitive® technology (Prosthesis System Connection, São Paulo, Brazil), with the immediate placement of implant-supported prostheses with abutment indexed to the implant, minimizing errors and distortions in the result of the implant. surgery arising from the process of making the guide and the surgical procedure.

The objective of this case report was to prove the efficiency of the Sleeve Index Sensitive® system in the manufacture of implant-supported prostheses in exoplan and dentalcad software prior to implant installation and to assess whether the transfer of the planning in the software to the patient's mouth is accurate.

II. METHODOLOGY - CLINICAL CASES

Study Design and Population

The clinical case report was proposed in a single private center, in which seven patients between 35 and 60 years of age with root fractures were included, treated and followed up.

At the first consultation, all patients were duly informed about the nature of the study and a Free and Informed Consent Term was obtained authorizing the performance of the procedure.

During the anamnesis, the patients did not report having deleterious habits, and systemic involvement. They presented root fractures in dental elements 11, 13, 14, 17, 21 and 26 with questionable prognosis, after the initial procedures implemented. The causes of root fractures were due to trauma/contusion.

In view of this, the need for immediate extraction was presented and the installation of immediate loading dental implants in single units was proposed using the prosthesis indexed in the Sensitive® System (Conexão Sistema de Protese, São Paulo, Brazil) for functional and aesthetic recovery.

Clinical and Laboratory Procedures

The professional had similar experience in both extraction and implant dentistry workflows. Before the start of the study, the clinical procedure and assessment techniques were standardized.

To address the main complaint of the patients, the rehabilitation treatment with implant-supported prostheses in the central incisors, canines, first and second premolars constituted an orderly workflow: clinical sequence, planning and surgical phase.

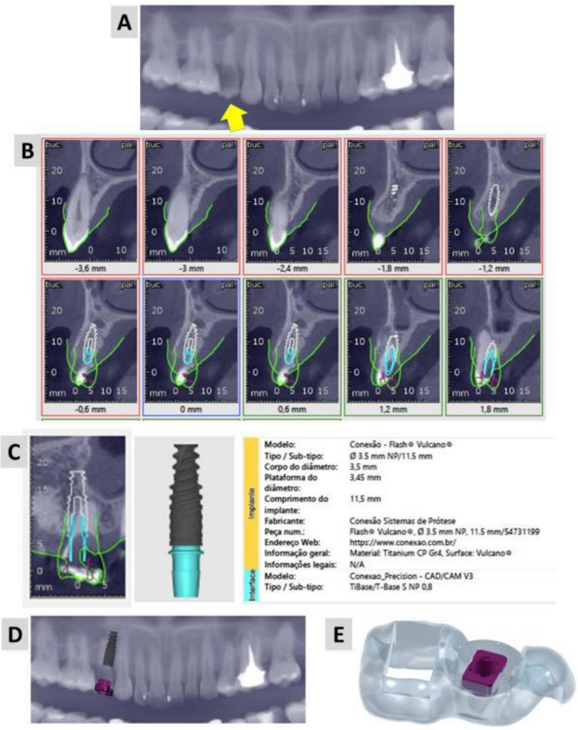

Fig. 1: Preoperative planning for implant placement using index-guided surgery. A) Initial panoramic X-ray image showing involvement in unit 14 (yellow arrow); B) CBCT images show the virtual surgical planning of the implant with the indexed prosthetic component (ti-base) positioned in the sectional slices of the alveolar bone; C) Data obtained from the implant and the interface; D) Panoramic X-ray image of the final planning; E) Final production of the surgical guide with the Sensitive® index ring

Clinical sequence

The digital workflow was initiated using the intraoral scanner (Ominican, Software version 5.1.3, DentsplySirona, Bensheim, Germany), following the manufacturer's instructions.

Subsequently, the patient was referred for cone beam computed tomography, CBCT, scanning phase performed by the Accuitomo XYZ Slice View Tomograph (3D Accuitomo, J. Morita Mfg. Corp., Kyoto, Japan), to allow a complete inspection of the three-dimensional bone topography.

Virtual Planning

The resulting section image data were imported into implant planning software (Exoplan, Exocad, GmbH, Germany), STL file (Standard Tessellation Languag), meshing with the reconstructed three-dimensional images, DICOM file (Digital Imaging and Communications in Medicine) sent by radiology.

In the exoplan software, the Precision CAD/CAM v3 connection system library was used, exclusive to the implants digital connection, in which the data used in the indexing were obtained.

Surgical planning was performed with the prosthetic component, Ti-Base S NP, virtually indexed to the implant, determining the positioning of the tooth to the implant, generating the surgical guide.

The prototyped surgical guide was incorporated into the Sensitive washers (Sleeve Index Sensitive®) with the exact dimensions for coupling the guide rods for drills and also the exact diameter for the implants to pass during implantation (3.6x4.5x4.5mm), with a lock in a single position.

Then it was exported in an STL file to be printed or milled. All guides were printed on the Anycubic 3D printer (Anycubic Photon Mono X, Hongkong Anycubic Technology, China).

Then, the surgical planning was exported to DentalCAD-ExoCAD software and fabrication performed using CAM-Magics software, prosthesis design software. At this stage, the anatomy was drawn in order to verify proximal contacts and occlusal contacts of the indexed tooth to be installed on the implant.

The tooth design was exported in the STL file. In all clinical cases, the teeth were milled. The STL file was imported into the InLab Cam 20 software (Dentsply Sirona®, Hessen, Germany®) and milled on the MC XL milling machine (Dentsply Sirona, Hessen, Germany).

Surgical procedure

With the printed guide, milling was performed to install the implant. The implants installed were flash Vulcano (Conexão Sistema de Prothesis, São Paulo, Brazil), with a diameter of 3.5 mm and height variation according to each case since the size of the implant installed is irrelevant for the indexing (Figure 2 and 3).

The guided procedure was performed with the Speed Guide® System (Prosthesis System Connection, São Paulo, Brazil). After surgery, atraumatic extraction without flap elevation to preserve the integrity of the remaining buccal and lingual boards, the tooth, planned in the software, was installed, proving the efficiency of the indexing of this system.

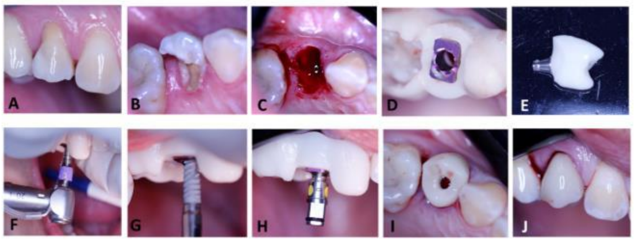

Fig. 2: Clinical example illustrating the protocol for installing and indexing the single prosthesis. A-B) Unit 14 with extensive tooth loss and indication for immediate implant; C) Atraumatic extraction; D) Proof of sensitive guide; E) Fabrication of the dental crown cemented in 0.8 (small) tibase; F) Milling; G) Installation of the planned implant; H) Index sensitive insertion key; I-J) Indexed provisional.

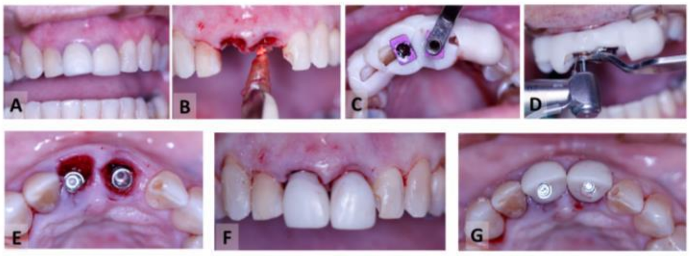

Fig. 3: Clinical example illustrating the protocol for installing and indexing two prostheses. A) Unit 11 and 21 signs of pulp necrosis and movement with indication for immediate implant; B) Atraumatic extraction; C) Positioning the guide with the Sensitive washers; D) Milling; E) Implants positioned as planning in the exoplan; F-G) Case ended with confirmation that the system works with correct indexing.

III. DISCUSSION

The digital fabrication of fixed dental prostheses supported by implants is becoming a clinical reality. With the advancement of digital technologies and application protocols, 3D planning has increased the accuracy of implant fixation and prosthesis making through the CAD/CAM system. Thus, the surgical act became faster, simpler and with greater precision, reducing pain and patient recovery time (ALTEMIMI; RODRIGUEZ; NAHON, 2022; CHEN; NIKOYAN, 2021; KIVOVICS; TAKÁCS; PÉNZES; NÉMETH et al., 2022).

In this sense, Index Sensitive® Technology came up with a new, faster and more accurate proposal for implant/prosthesis installation, where the prosthesis is indexed by the abutment to the implant from the virtual planning. In the current work, the validation of this new technology was documented and proven in the installation of dental implants of immediate loading in single units using the prosthesis indexed in the Sensitive® System in 7 patients with a mean age of 48 ± 9 years of age.

The patients were from a private clinic and the procedures were performed by an experienced surgeon using the same equipment and software. The static guided surgery of dental implants, single or multiple, consisted of the virtual planning of each case, in Exocam. For this, two exams were essential, dental computed tomography and intraoral scanning of the patient's dental arch. Captures of radiographic examinations provide crucial information to determine the position of the sensory nerves, the position of the sinus jaw, and other anatomical landmarks (CICCIÙ; FIORILLO; D'AMICO; GAMBINO et al., 2020).

The combination of the 3D rendering of the digital scanner with the 3D model of the CBCT provides high accuracy in determining the best implant placement along with the correct size and shape of the crown (ELKHADEM; OSMAN, 2022; HAMILTON; OBERMAIER; DOLIVEUX; NEGREIROS et al., 2022; JAMJOOM; KIM; MCGLUMPHY; LEE et al., 2018). Thus, in the Exoplan program, surgical planning was carried out for the installation of the implant together with the prosthetic component, Ti-Base S NP virtually indexed to the implant, generating the surgical guide that was exported in an STL file to be printed. In all cases the surgical guide was produced with the Index Sensitive Ring with a lock in a single position that integrates with the Index Sensitive insertion key, allowing an easy and safe insertion and the locking of the implant in the position, direction and height/depth as planned in Exoplan.

The surgical planning was exported to a design software (CAD), allowing the operator/prosthetist, in a virtual way, to study, apply and improve the design of the prosthesis according to the desired and required particularities. Advanced digital workflows increasingly enable the creation of prosthetic structures with optimal smile esthetics that are precisely adapted to the anatomic preconditions of the patient-individually (BEDROSSIAN; SULLIVAN; FORTIN; MALO et al., 2008; COACHMAN; CALAMITA; COACHMAN; COACHMAN et al., 2017; POZZI; ARCURI; MOY, 2018).

It is important to emphasize that the professional must have good familiarity with the CAD software so that the tooth comes out without occlusal/proximal interferences. If the professional is not skilled in handling the software, it is recommended that he use the resource of a Planning Center (surgical planning center) or hire the services of a laboratory that uses digital resources and aims at excellence in results so that he can perform the tooth design relying on the talent of qualified professionals and the application of cutting-edge technology.

It is worth mentioning that the determination of implant location, position, angulation in relation to the definitive prosthesis provides a better treatment result for function, aesthetics and also implant longevity (RAIKAR; TALUKDAR; KUMARI; PANDA et al., 2017). A compromised final prosthesis can have an adverse effect on long-term implant success with unfavorable biomechanics and poor esthetics. Therefore, prosthetic planning before implantation surgery has been considered an important factor for succes. (SKJERVEN; RIIS; HERLOFSSON; ELLINGSEN, 2019).

The long-term clinical success of a fixed dental restoration depends on how well it fits (GUREL; TOKSAVUL; TOMAN; TAMAC, 2019; KALELI; URAL; US, 2020). Marginal poor fit increases the gap between restoration and abutment in different ways as it leads to microleakage, plaque buildup, bacterial adhesion and changes in microflora resulting in inflammation in the surrounding tissues (KALELI; URAL; ÖZKÖYLÜ; DURAN, 2019). Furthermore, the success of a single dental implant in the esthetic area does not only depend on the restored function, but also on the harmonious integration of the restoration with the patient's overall appearance (STEFANINI; FELICE; MAZZOTTI; MOUNSSIF et al., 2018). In prostheses produced using Index Sensitive® Technology, the abutment is indexed to the implant, allowing positioning as planned virtually. Easy to install, in all cases, the esthetic and occlusal aspects of the single prosthesis on implant proved to be excellent, confirming the perfect reproduction of the indexed planning.

IV. CONCLUSION

Clinically, the Index Sensitive technology proved to be efficient in the virtual planning, fabrication and installation of single-unit prostheses indexed to the post-extraction implant.

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