UNIVERSIDADE DE UBERABA

CARLLA MARTINS GUIMARÃES

SIMPLIFICAÇÃO E PRECISÃO EM CIRURGIA GUIADA PARA IMPLANTES OSSOINTEGRADOS

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2016

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Trabalho apresentado à Universidade de Uberaba, como parte das exigências para conclusão do Mestrado Acadêmico em Odontologia.

Orientador: Prof. Dr. Thiago Assunção Valentino

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Trabalho apresentado à Universidade de Uberaba, como parte das exigências para conclusão de Curso de Mestrado Acadêmico em Odontologia.

Área de concentração: Biomateriais

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DEDICATÓRIA

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RESUMO

O objetivo deste estudo clínico foi avaliar a posição tridimensional de implantes osseointegrados instalados no osso mandibular com um nova técnica de cirurgia guiada e com técnica cirúrgica convencional não guiada, além de avaliar o pós-operatório de pacientes submetidos as estas técnicas cirúrgicas. Oito pacientes desdentados parciais com ausência bilaterais posteriores foram selecionados e guias tomográficos embasados no planejamento reverso foram confeccionados. Após a realização das tomografias computadorizadas por feixe cônico, os planejamentos virtuais das posições dos implantes foram realizados em *software* específico (Kea-Tech software, Uberlândia, MG, Brasil) e os guia tomográficos foram convertidos em guias cirúrgicos para que os pacientes recebessem implantes em ambas áreas desdentadas. Para o lado direito (G1), os guias tomográficos foram convertidos em guias cirúrgicos restritivos para cirurgia guiada sem retalho (Pross-Guide System, DabiAtlante, Ribeirão Preto, SP, Brasil) e para o lado esquerdo (G2), os guias tomográficos foram convertidos em guias cirúrgicos convencionais. Um total de 24 implantes de plataforma cone morse (Pross, DabiAtlante, Ribeirão Preto, SP, Brasil) foi instalado e o posicionamento dos implantes foi mensurado por meio de tomografia computadoriza por feixe cônico para conferência. O pós-operatório dos pacientes foi avaliado por meio de um questionário aplicado com 4 e 72 horas após os procedimentos cirúrgicos. Em relação ao posicionamento, o G1 apresentou-se estatisticamente mais preciso que o G2 com valores médios e desvio padrão de 0,74±0,26 e 1,58±0,63 mm para a plataforma, 0,87±0,37 e 2,47±1,32 mm para o ápice, e 1,39±0,82 e 10,56±7,39 graus respectivamente (p <0.0001). O grupo experimental G1 também apresentou melhores resultados na avalição pós-operatória e viabilizou uma transcrição mais exata do planejamento tomográfico digital para a realidade clínica. A realização cotidiana de cirurgia guiada para o posicionamento tridimensional de implantes osseointegrados pode se tornar realidade, devido a simplificação e precisão alcançados pela técnica de cirurgia guiada Pross-Guide.

Palavras-chaves: implante dentário osseointegrado, cirurgia assistida por computador, tomografia computadorizada.

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INTRODUÇÃO

A instalação de implantes osseointegrados como terapêutica reabilitadora oral é considerada como um tratamento seguro e previsível tanto para pacientes edentados parciais como para edentados totais (Muddugangadhar et al., 2015). Para alcançar estes resultados, um minucioso planejamento faz-se necessário, com o conceito de implantes guiados pela correta posição dental e não apenas pelo tecido osso disponível (Becker & Kaiser, 2000).

Para o planejamento em implantodontia, imagens periapicais e panorâmicas convencionais podem ser insuficientes para a obtenção de um bom planejamento pré-cirúrgico. Desta forma, técnicas de imagens tridimensionais adicionam uma dimensão extra para radiografias pré-operatórias rotineiramente disponíveis e fornecem informações mais detalhadas sobre o volume ósseo, qualidade óssea, restrições anatômicas e estruturas nobres (Jacobs R et al., 1999; Geng et al., 2015).

Nas técnicas cirúrgicas convencionais para implantes, as informações a partir da imagem tomográfica não são diretamente transferidas para a cirurgia, neste caso o profissional decide sobre a posição do implante após a elevação do retalho e exposição do osso no momento da cirurgia, com o auxílio do guia cirúrgico apenas como um indicador de posicionamento (Van de Velde et al, 2008) Apesar destes guias de perfuração cirúrgicos não apresentarem a completa integração dos dados do exame tomográfico para o planejamento cirúrgico, ainda se constitui na metodologia mais comumente empregado pelos cirurgiões em geral, auxiliam na escolha da posição dos implantes e fazem parte dos procedimentos clínicos de rotina na implantodontia (Greenberg AM, 2015).

Os guias cirúrgicos oferecem dados para o posicionamento dos implantes e consideram a posição protética para orientação do processo de fresagem do tecido ósseo (Jee-Ho et al., 2013). Devido à aplicação de tecnologias digitais na odontologia, tornou-se possível o planejamento virtual e instalação de implantes com o auxílio da tecnologia assistida por computador (Hammerle et al., 2009). A posição virtual do implante planejado pode ser transferido ao paciente no momento do procedimento cirúrgico, para tanto, o método utilizado deve ser preciso e assegurar um nível elevado de reprodutibilidade (Jan D'haese et al., 2012).

Vários programas de computador são utilizados na implantodontia para planejamento cirúrgico de implantes dentais. As três maneiras mais comuns de aplicar este planejamento cirúrgico em um ambiente clínico, como a cirurgia guiada, são guias de perfuração processadas por prototipagem rápida, guias fabricados por fresadoras e por meio de navegação cirúrgica (Jan D'haese et al.; 2012). No entanto, apesar de precisas, essas técnicas são complexas, caras, demandam experiência do cirurgião e muita tecnologia para serem executadas (Verstreken et al., 1996).

Recentemente, uma nova concepção na realização de cirurgia guiada para implantes que utiliza uma ferramenta chamada Dispositivo Posicionador de Tubos (DPT, Ribeirão Preto, DabiAtlante, SP, Brasil), se mostrou promissora na busca de tornar o sucesso clínico da cirurgia guiada e da prótese uma rotina nos atendimentos (Guimarães, et al., 2014), além de viabilizar a realização da cirurgia sem retalho, promover bem estar ao paciente e diminuir as alterações dos tecidos ósseo e gengival em áreas de necessidade estética (Villaça, Pesqueira & Guimarães, 2015).

Desta forma, com base em análises tomográficas, o objetivo deste estudo clínico foi avaliar a precisão da posição tridimensional de implantes instalados no osso mandibular com um nova técnica de cirurgia guiada e avaliar o pós-operatório de pacientes submetidos as duas técnicas cirúrgicas simultâneas por meio de questionários aplicados 4 e 72 horas após o procedimento cirúrgico. A hipótese nula deste estudo é que a cirurgia guiada por meio de tomografias computadorizadas por feixe cônico e a cirurgia convencional para o posicionamento de implantes dentais não apresentam diferenças significantes no que tange ao posicionamento tridimensional dos implantes e à qualidade pós-operatória após os procedimentos cirúrgicos.

SIMPLIFICATION AND PRECISION IN GUIDE SURGERY TO OSSEOINTEGRATED IMPLANTS

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ABSTRACT

The aim of this clinical study was to evaluate the three-dimensional position of osseointegrated implants placed in the mandibula with a new technique of guided surgery and with conventional surgical unguided technique, as well as evaluate the postoperative patients submitted to these surgical techniques. Eight partially edentulous patients with no bilateral posterior teeth were selected and tomographic guides grounded by reverse planning were made. After the cone beam computed tomographies were made, the virtual planning of the implants positions were carried out in a specific software (Kea-Tech software, Uberlândia, MG, Brazil) and the tomographic guides were converted into surgical guides in order to patients receive implants in edentulous areas. To the right side (G1), the tomographic guides were converted into restrictive surgical guides for the guided surgery without incisions (Pross-Guide System, DabiAtlante, Ribeirão Preto, SP, Brazil), and to the left side (G2), the tomographic guides were converted into conventional surgical guides. The total number of 24 morse taper implants (Pross, DabiAtlante, Ribeirão Preto, SP, Brazil) were placed and the implants positions were measured by Cone Beam Computed Tomographies for verification. The patients' postoperative was evaluated by a questionnaire applied from 4 to 72 hours after the procedures. Regarding the position, G1 was statistically more accurate than G2 with average value and standard deviation of 0,74±0,26 and 1,58±0,63 mm to the plataform, 0,87±0,37 and 2,47±1,32 mm to the apex, and 1,39±0,82 and 10,56±7,39 degrees respectively (p <0.0001). The experimental group G1 also showed better results in postoperative evaluation and enabled a more accurate transition of the digital tomographic planning to the clinical practice. Guided surgery for three-dimensional positioning of osseointegrated implants might become reality, thanks of simplification and precision achieved by guided surgery technique Pross-Guide.

Key-words: osseointegrated dental implant, surgery computer-assisted; tomography computed.

INTRODUCTION

The placement of dental implants as an oral rehabilitative therapy is considered a safe and predictable treatment [1]. However, to achieve accurate results, careful planning is necessary, guided by the concept of implants in the correct dental position and not only by the available bone tissue [2].

For implantology planning, periapical radiographics and conventional panoramics may be insufficient to obtain a good pre-surgical planning. Therefore, three-dimensional imaging techniques add an extra dimension to preoperative radiographs routinely available and provide more detailed information regarding bone volume, bone quality, anatomical restrictions and noble structures [3, 4].

In conventional surgical techniques of dental implants, information from the tomographic image are not directly transferred to the surgery, thus the professional decides about the implant position after lifting the flap and bone exposure at the moment of surgery, using the surgical guide only as a positioning indicator [5].

Despite these surgical drill guides do not show complete integration of the CT scan data for surgical planning, they still constitute the most commonly used method by surgeons in general, selecting the position of the implants and are a part of routine clinical procedures in implantology [6].

The surgical guides provide data for positioning implants and consider the prosthetic position to orientate the bone milling process [7]. Due to the application of digital technologies in dentistry, it is possible to conduct virtual plan and implant placement with computer-aided technology [8]. The virtual position of the planned implant may be transferred to the patient during the surgical procedure, therefore, the method used must be accurate and ensure a high level of reproducibility [9].

Several software are used in implantology for surgical planning of dental implants and there are three common ways to apply these surgical planning in a clinical setting, such as keyhole surgery using drill guides processed by rapid prototyping, guides manufactured by milling and through surgical navigation [9]. However, although accurate, these techniques are complex, expensive, require surgeon's experience and several technology [10].

Recently, a new concept in performing guided surgery for dental implants has been claims in the pursuit of making the implant and prosthetic success a clinical routine [11]. This technique also allows flapless surgery, promotes well-being for patients, reduces the alterations of bone and gingival tissues in aesthetic areas, and has a good financial cost-benefit [12].

Considering the importance of better positioning of the implant regarding the prosthesis, the guided techniques and conventional surgery and the search for a treatment for the patient based on tomographic analysis, the aim of this clinical study was to evaluate the accuracy of the three-dimensional position of osseointegrated implants placed in the mandibula with a new guided surgery technique and a conventional the surgical technique, as well as evaluate the patient's postoperative undergoing two simultaneous surgical techniques through questionnaires 4 and 72 hours after surgery. The null hypothesis was that guided surgery by Cone Beam Computed Tomographies and conventional surgery for the placement of dental implants do not show significant differences in terms of three-dimensional positioning of implants and postoperative quality after surgery.

MATERIALS AND METHODS

Experimental Design

For this clinical study approved by the Ethical Research Committee at Uberaba University, number CAAE 56581316.3.0000.5145, the selection criteria was based on patients with no health systemic alterations and bilateral partial posterior inferior edentulous, with the absence of any molars or premolars, not requiring equal number of tooth absence for both sides. After collection of informed consent form, 8 patients were selected, 3 males and 5 females, totaling 24 osseointegrated implants placed with morse taper (Pross DabiAtlante, Ribeirão Preto, SP, Brazil) with patterned platform diameter of 3.5 mm.

Clinical steps performed for all patients were tomographic guide making, CT scan for planning, virtual planning, tomographic guide converted into surgical guide, surgical procedure and tomographic examination for evaluation.

In order to standardize, the experimental groups were defined as Pross-Guide Guided Surgical (Group 1) to the right side, which the tomographic guide was converted into restrictive surgical guide for guided surgery flapless (Pross-Guide, DabiAtlante, Ribeirao Preto, SP, Brazil). The orientation of the implants drilling was performed with a system for targeting of grommets according tomographic virtual planning. On the left side, (Group 2), the tomographic guide was converted in to conventional surgical guide. In this group, the orientation of the implants drilling was performed in open surgical field and only the anatomical reference of dental crowns based on the surgical reverse planning.

Tomographic Guide Preparation

For each patient, functional impression was made with alginate (Jeltrate Plus, Dentsply, EUA) and working casts were made with type IV special stone (Fuji Rock, GC, Belgium). The missing teeth were reproduced through diagnostic waxing and duplicated with a mixture of chemical activated acrylic resin (A3, Pattern, Tokyo, Japan) and silver amalgam alloy (GS 80, Dentsply, Petrópolis, Brazil), in a ratio of 20: 1 to obtain a radiopaque image after the CT scan.

For printing the glycol ethylene terephthalate board (PET G) (Crystal BioArt, São Carlos, SP, Brazil) with 2.0 mm thickness was used, and the retentive regions were eased in the die with clay to model (Faber Castell, São Carlos, SP, Brazil) so that there were no dental fracture during plasticizing, performed with vacuum laminator (P7 BIOART, São Carlos, SP, Brazil), and then the plates were cut in cervical level.

In the occlusal surfaces of PET G board, a specific tomographic support (Tomographic Support Pross, DabiAtlante, Ribeirão Preto, Brazil) was fixed with chemical activated acrylic resin, obtaining the tomographic Guide (Figure 1). For all patients before the CT scan, tomographic guide was positioned in dental arch and the correct fit with no weighbridge were checked, then the patients were submitted to a cone beam tomographic exam.

Virtual Planning of Dental Implants

The images generated in DICOM format by cone beam tomography were imported to Kea-Tech software (Kea-Tech, Uberlândia, MG, Brazil) for virtual planning based on bone anatomy images contained radiopaque teeth in tomographic guides .

For each dental implant, careful planning of the three-dimensional position was virtually performed and then a coordinate report for the placement of drivers' tubes (TPD, DabiAtlante, Ribeirão Preto, Brazil) of the surgical drills was generated.

The Kea-Tech software also generates a report with data about the virtual implant's position. The report is generated and the coordinates were report instantly for each implant planned. So, it was filed for further data analysis.

Guided Surgical Preparation (Group 1)

To make the guided surgical guide (Pross Guide, DabiAtlante, Ribeirão Preto, SP, Brazil), the tomographic support guide was maintained and used to transfer the virtual planning of the standard side for guided surgery using the generated data by the coordinate report.

The tomographic support contains three metal references and five holes to fix the Tubes Positioner Device (TPD, DabiAtlante, Ribeirão Preto, SP, Brazil): four in the vestibular (V) and one in the lingual surface (L).

These references are the link between the real and virtual occlusal planes because as it works as a fixed point, when the tomography board is fitted in the same position in the arch of the patient, these points are connected and aligned by the software generating a new plan. When planning a virtual implant, the software calculates the measurements for the position of the titanium tubes. The tomographic guide was transformed it into Guided Surgical, and the virtual implant positioning data was generated and sended this information by coordinate report that was automatically received after virtual planning.

The coordinate report generated by the software indicates which of the fixing points the TPD should be fixed, and the measurements that the TPD must be calibrated. In millimeters, the linear labiolingual (VL), mesiodistal (MD) and cervico-apical positions (CP), the angular labiolingual (VL) and mesial-distal movements (MD) have to be transferred to the Tube Positioner Device. Each of these measures in the coordinate report has the corresponding color in the TPD, to facilitate calibration. (Figure 3)

For fixing the titanium tubes in the guide, the tomographic guide was drilled in areas to be implemented and the device was set in tomographic support in position with the coordinates generated by the software.

For each intended implant in group 1, a titanium ring on the top of the device was fixed to the surgical guide with chemical activated acrylic resin. This data transferring procedure and washers fixation in the guides were done just to the side regarding the Group 1 to the side of the Group 2. This data as well as all the status reports of the implants in both groups were stored for later analysis.

Conventional Surgical Guide Preparation (Group 2)

For conventional surgical guide (Group 2), the teeth setting-up and printing was made by the laminator for manufacturing the tomographic guide as a reference. The TS was cut from the left side of the tomographic Guide, previously standardized area to group 2, radiopaque teeth were removed and metal references kept.

The preferred area for the dental implants placement was delimited in the central region of each missing tooth, and the PET G boards were drilled a with drill Carbide #8 (KG Sorensen, Barueri, Brazil) engaged in low speed in indicated center position of each tooth. (Figure 4)

Surgical Stage

After the surgical guides manufacture according to the virtual planning, they were cleaned with enzymatic detergent, and then disinfected with chlorhexidine digluconate solution of 2%.

The same implant specialist operator performed all implants. Patients underwent antiseptic mouthwash with 0.12% chlorhexidine solution and extra-oral antisepsis with 2% chlorhexidine digluconate solution. Then the patients received infiltrative terminal anesthesia with the mepivacaine hydrochloride anesthetic salt (DFL Dental products, Rio de Janeiro, RJ, Brazil) with 2% adrenaline as vasoconstrictor.

The surgeries were initiated by the right side of the Group 1, using surgical kit for guided surgery(Figure 5) (Pross Guide System, Dabi Atlante, Ribeirão Preto, Brazil). The soft tissue was incised with a circular scalpel (Figure 5A) and the drilling was carried out using reducing titanium drilling with appropriate measurements to the drills diameters, inserted into the titanium washer from Pross Guide system, ensuring the milling insertion axis and obeying the measurements provided by Kea-Tech software report for each implant.

In the sequence of drilling (Figure 5B), a spherical drill was used, helical drill with 2mm of diameter, followed by a 2.8 mm and finally 3.0 helical drill. The saline solution was used for irrigation during the drillings. The implants were placed with their respective placement limits, initially using the contra-angle, ending with surgical torque rachet (Figure 5C) and healing caps (Pross, Dabi Atlante, Ribeirão Preto, Brazil). For all cases , no suture was performed.

The group 2 was operated at the same time and by the same operator. A linear incision with a scalpel blade number 15C and gingival detachment were performed. Then, the same drilling sequence from the group 1 was performed for the group 2. The central region of each missing tooth in PET G board was taken as drilling reference. After implant placement, the tissue was sutured with nylon 5,0 yarn (Johnson & Johnson, São José dos Campos, SP, Brazil) (Figure 6).

Postoperative Qualitative Analysis

After surgeries, all patients received the same postoperative guidelines and medication by the same professional, and were informed about next surveys that would be applied, explaining each item so that after the time required the patient could answer the questions according to their own perception, with parameters of presence or absence and light, moderate and severe qualification. After 4 hours, enough time for the anesthetic effect completion and beginning of the immediate inflammatory signs, and 72 hours, delayed inflammatory response to the surgical procedure, this questionnaire was applied for qualitative analysis of pain parameters, edema, hematoma and postoperative complications.

Implants Position Analysis and Conference

The analysis of the 3D position of osseointegrated implants, as well as regarding this position in the virtual planning and final execution were carried out by means of CT scans for postoperative cone beam.

For the second scan, the surgical guide is placed in the same position of the first one, and how the tomographic support was maintained with three metal references, it was possible to maintain the same alignment results in both tests, ensuring that the conference methodology to be reliable, comparing and using the virtual implant placement report.

After the examination and conversion of images in DICOM format for the software (Kea-Teach Software, Uberlândia, MG, Brazil), virtual implants were overlapping to radiopaque images of the placed implants, and a new report was generated for all implants from both groups. (Figure 7)

The virtual implant placement report was calculated from the alignment of the three metal references by the software, which generates a new plane. And from this plane, in one of the metal references, an axis of three-dimensional coordinates (x, y, z) is created where x is the distance from the occlusal plane, y is the distance from the buccolingual plane, and z the mesial-distal plane and are given to the cervical region (platform) and apical of each virtual implant generated by the software. The angles are also calculated by the buccolingual and mesiodistal planes.

Data from status reports generated by the software were plotted and compared with the initial data for all implants in this study.

The generated distances contained in the placement report are: Head to reference plane, which were call Platform or x c '; Head to lobby lingual plane, V-L Cervical or y c '; Head to mesial distal plane, M-D Cervical or z c '; Tail to reference plane, the x 'or Summit; Tail to lobby lingual plane, the y 'or V-L Apical, tail plane distal to mesial, the z' or M-D Apical, lingual Lobby angle by angle V-L; and distal Mesio angle by angle M-D. With these measurements, it was possible to calculate the overall positioning and the deviations that occurred between the planning and execution by the distance between the three-dimensional coronal center (or apical) of the planned implants and corresponding ones.

The overall deviation was defined as a three-dimensional distance between the coronal center (or apical) of the planned implants and corresponding placed ones. The angular deviation was calculated as a three-dimensional angle between the longitudinal axis of the implant and the planned placed. The method used to calculate the overall linear deviations to the platform and summit Euclidean Distance, by the formula:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

For the angular difference, the vector direction of planned and executed implants were calculated. And from this, the angular difference between them was calculated by the formula:

$$\theta = \text{arcos} \left(\frac{\vec{u}.\vec{v}}{|\bar{u}||\bar{v}|} \right)$$

Where $\underset{u}{\rightarrow}$ is ecqual to (x c'- x a', y c'- y a', z c'- z a') to the planned implants and $\underset{v}{\rightarrow}$ (x c'- x a', y c'- y a', z c'- z a') to the implants performed.

Statistical analysis

The values corresponding to the three-dimensional positioning of the placed implants were subjected to non-parametric Mann-Whitney analysis with 5% significance level.

RESULTS

After performing the calculation and plotting of data on tridimensional position of implants placed, the results were subjected to statistical analysis nonparametric Mann-Whitney test, as shown in Table 1, which shows the average and standard deviation of the differences between the results reports of planning and execution in millimeters for linear and angular degrees for the virtual planning for each of the eight distances generated by the software for groups 1 and 2.

The results of this study in relation to the positioning, virtual planning inclination and implant placement, group 1 showed significantly lower difference values from group 2 ($p < 0.0001$). In relation to postoperative parameters, for presence of pain, swelling, palpation pain and hematoma, for the evaluated periods of 4 and 72 hours after the surgical stage, the group 1 also showed better results as shown in Table 2.

DISCUSSION

The guided surgery technique used in this study showed, besides being easy to perform, more precision regarding the three-dimensional positioning of dental implants compared to conventional guide employed in the control group (group 2) in a tomographic analysis cone beam ($p < 0.0001$). Moreover, regarding to postoperative qualitative analysis, guided surgery technique showed lower postoperative pain, edema formation, hematoma and pain on palpation over the group 2, for time periods of 4 and 72 hours elapsed from surgery (Table 2). Thus, the null hypothesis of this study that guided surgery by computed tomography cone beam and conventional surgery for the placement of dental implants do not show significant differences with respect to the three-dimensional positioning of the implant and post-operative quality after surgical procedures was rejected.

The evaluation of the three-dimensional position of dental implants placed through guided surgery aims to reconcile security, accuracy and practicality in the surgical time [13,14,15,16]. These questions were observed in present methodology with global linear values of 0.74 mm for the platform and 0.84 mm for the height of the implants to the group using guided surgery.

These values were similar to other studies using different guided surgery techniques for dental implants, for example, 1.07 mm in the coronal center and 1.63 mm at the apical center [17], 0 99 mm in the coronal center and 1.24 mm at the apical center [18] and 1.09 mm in the coronal center and 1.56 mm at the apical center [7]. Likewise, the precision regarding the angular deviation observed in guided surgery with Kea-Tech system was 1.39°, and it was lower than other studies with guided surgery, for example, an axis deviation 5.26° [17], 3.81° [18] and 3.80° [7]. In comparison to group using conventional surgical guide, the observed value was 10.56°, showing that Pross-Guide guided surgical technique was statistically more accurate.

Digital technological advances applied to the planning and placement of dental implants have made implantology highly reliable and predictable [19]. With the advent of guided surgery for dental implants placement, techniques that use digital technology for planning the dental implants have advantages due to the determination inclination and selection of dental implants be performed in software that enables three-dimensional view of better positioning of implants [20, 21, 22] and due to the this position transfer to the surgical field, including the inclusion of surgeries without gingival flap [9].

Although there is no consensus on the precise placement of dental implants placed through tomographic virtual planning of the data transfer to the surgical time [23], linear and angular deviations are inherent in the information transfer chain for planning in guided surgery and must respect the virtual planning, anatomical limitations and prosthetic position to ensure a predictable and safe treatment [24, 25]. Like other techniques of guided surgery computer-assisted, discrepancies may result from the sum of each stage in the execution of a surgical guide and tomographic, from molding, obtaining work models, CT scan, prototyping employed software and even the conference methodology itself [26, 27].

Another crucial factor for precision guided surgery is the inherent stability and the support from the guide, which must be hard, stable and be able to reproduce its position in all the surgical steps [23]. When using laboratory or double scanning methods for acquiring surgical guides, it is necessary that the dental model is needed to ensure the production of a radiographic guide and adapted to ensure a correct laying during the CT scan of the patient [6].

The guided surgical used in this study has a tomographic guide and then is converted into a surgical guide, ensuring the precise reproducibility position at the surgical time. It enables precise transfer of the placement of dental implants carried out virtually in Kea-Tech software for surgery. According to Bottino at al. 2006, [28] the possibility of using the same device tests for diagnosis and surgery for implant placement is a big advantage compared to those that provide only a purpose.

The guided surgery performed with the use of flapless surgical technique favors the blood supply of the peri-implant gingival area, provides less pain and postoperative bleeding and reduces edema formation as demonstrated in Table 2. These findings are in accordance with some studies still related to maintenance of the gingival tissue and bone architecture, reduced surgical time and it allows patients to return to their normal oral hygiene habits [29, 30]. Although conventional surgery where mucosa and periosteum are manipulated and displaced from the bone tissue for obtaining surgical flap shown to be effective [31, 32], it may lead to some inconveniences, as loss of alveolar bone crest, gingival recession, decreased blood supply due to handling and elevation of the surgical flap, bleeding and postoperative discomfort [33, 34].

According to the Toronto Symposium in 1998, a consensus that the subjective assessment of patient satisfaction about the treatment was included as one of the important factors to measure the success of implants treatment [35]. The techniques that advocates retail without guided surgery has less emotional discomfort during surgery and increased postoperative satisfaction, but the economic cost has been listed as a discontent [36]. Surgical techniques using surgical prototyping and navigation are expensive and require time for guide planning and construction, which makes many clinicians prefer not routinely use guided surgery [13]. Thus, the transformation of a tomographic guide into a surgical guide-tomographic enabled the production of a guide to good cost-benefit and highly accurate positioning of implants, simplifying guided surgery and may be routinely indicated in implantology.

Despite continuous scientific and technological improvements, there are still limitations in guided surgery for dental implants placement, for example mouth opening of patients in this study. Drills used in guided surgery are bigger than conventional drilling and require attention in the clinical examination and planning to reconcile the mouth opening of the patients with the size of the surgical drill. Another limitation is the application of sophisticated imaging techniques in clinical practice that are difficult to acceptance by the professional who is familiar with the processing of tomographic images, as the radiologist [37, 6].

Based on the these considerations, the routine use of the guided surgery for three-dimensional positioning of dental implants could become reality due to the duet between simplification and precision achieved by guided surgery technique tested, combining also the advantages of this type of technique when patient comfort is an important requirement for successful rehabilitation with osseointegrated implants.

CONCLUSION

Within the limitations of this clinical study, the authors could conclude that:

1. Pross-Guide guided surgery technique combines simplicity and precision in three-dimensional positioning of osseointegrated implants.

2. The tested guided surgical technique demonstrates that could reproduce the virtual planning for surgery with high reliability.

3. Flapless Pross-Guide surgical technique demonstrated better postoperative reduced edema formation, pain, and hematoma formation in relation of the gingival detachment surgical technique.

4. The routine use in implantology of a guided surgical technique could be achieved by using a simple technique, high precision, and good cost benefit compared to comventional surgical technique.

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FIGURES

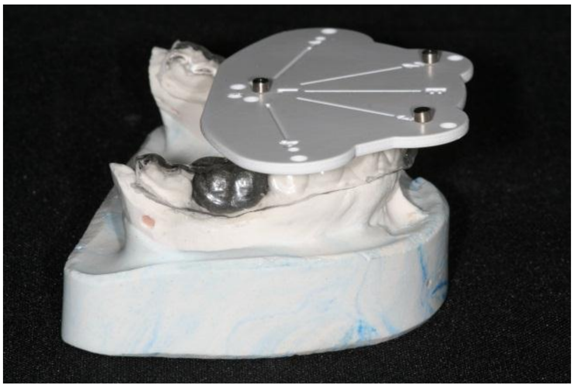


Figure 1 – Tomographic Guide

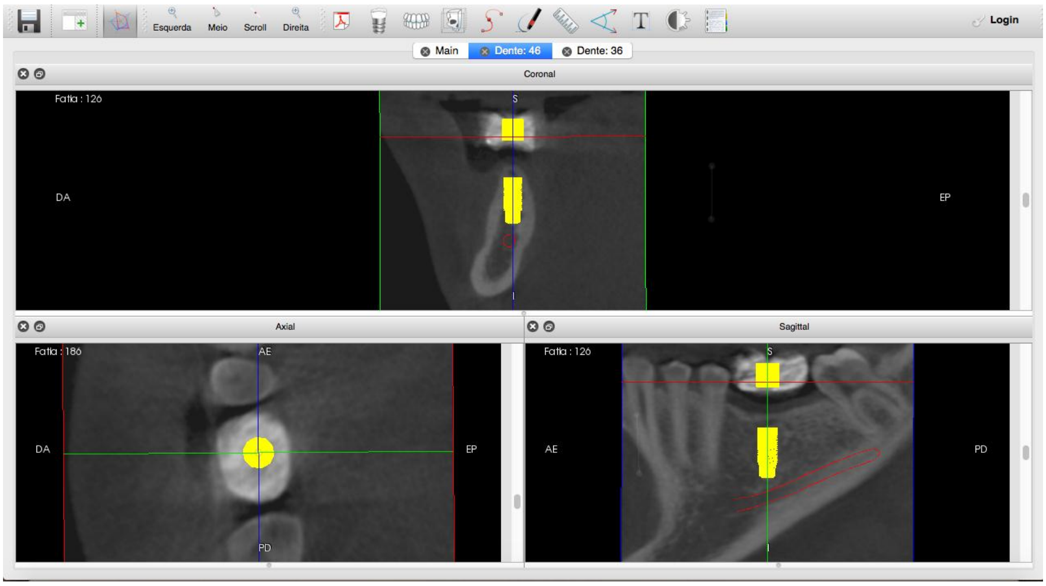
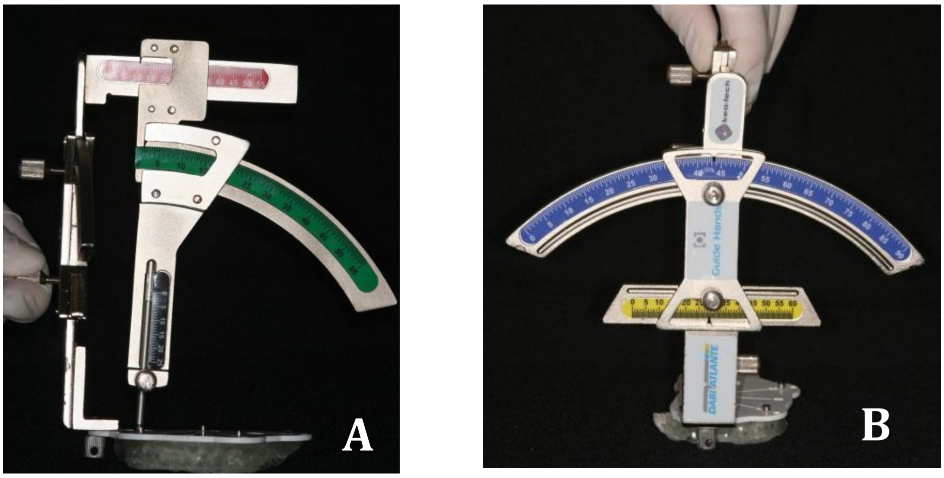


Figure 2 - Virtual planning Kea-Tech software.



Figures 3 (A and B) - Linear and angular measurements transfer for the TPD set in TS.

Figure 4 - Surgical guide with TS and references maintained for subsequent conference tomography. Right: washer transferred by TPD in the 46 region (Pross-Guide Guide); Left: Drilling in central tooth 36 (Surgical Guide Conventional).

Figure 5 (A-D) - Sequence keyhole surgery group KEA

Figure 6 - Immediate postoperative.

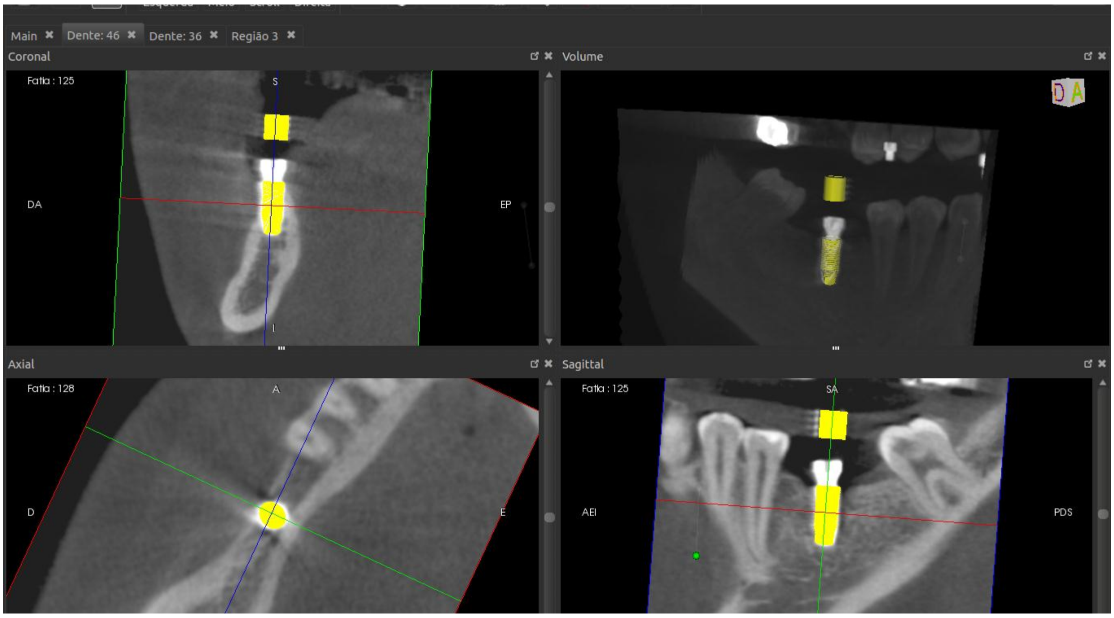


Figure 7 - Overlap of the virtual implant on the placed implant.

TABLES

Table 1. Average linear and angular values of the differences between planned and executed implants for the Pross-Guide surgical guide and conventional surgical guide.

	Pross-Guide Surgical Guide	**Convencional Surgical Guide**
Plataform	0,74 mm (0,26) A	1,58 mm (0,63) B
Apex	0,87 mm (0,37) A	2,47 mm (1,32) B
Angle	1,39° (0,82) A	10,56° (7,39) B

Different capital letters in the row show statistically significant difference according to the non-parametric Mann-Whitney test, with 5% significance level.

Table 2. Qualitative analysis of postoperative parameters of the 8 patients submitted simultaneously to both surgical techniques with Pross-Guide and Conventional surgical guides, for time periods of 4 and 72 hours after surgery.

	Spontaneous Pain				Edema				Touch Pain				Hematoma			
	Group 1		Group 2		Group 1		Group 2		Group 1		Group 2		Group 1		Group 2	
	4h	72h	4h	72h	4h	72h	4h	72h	4h	72h	4h	72h	4h	72h	4h	72h
No Pain	6	7	3	1	4	7	4	0	7	8	4	2	8	8	8	5
Mild Pain	1	1	3	3	4	1	2	5	1	0	4	6	0	0	0	3
Moderate Pain	1	0	1	3	0	0	2	3	0	0	0	0	0	0	0	0
Severe Pain	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0

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ANEXO 1 - GUIA PARA PUBLICAÇÃO

JOMI

The International Journal of ORAL & MAXILLOFACIAL IMPLANTS

GUIDELINES FOR AUTHORS

Acceptable material. Original articles are considered for publication on the condition they have not been published or submitted for publication elsewhere (except at the dis- cretion of the editors). Articles on implant or tissue engineering (TE) basic or clinical research, clinical applications of implant/TE research and technology, proceedings of pertinent symposia or conferences, quality review papers, and matters of education related to the implant/TE field are invited.

Number of authors. Authors listed in the byline should be limited to four. Secondary contributors may be acknowledged at the end of the article. (Special circum- stances will be considered by the editorial chairman.)

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Ann Intern Med 1997;126:36–47). See http://www.icmje.org

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for the corresponding author, who will
be assumed to be the first-listed author unless otherwise noted. If the paper was presented before an organized group, the name of the organization, location, and date should be included.

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and clinical research articles must be structured with the following four sec- tions: Purpose, Materials and Methods, Results, and Conclusions. Abstracts of short communications should also be structured but should be a maximum of 250 words. For all other types of articles (ie, literature reviews, technical and case reports), abstracts should not exceed 250 words and need not be structured.

• Article text. Currently there is no article page limit (within reason).

• Acknowledgments. Persons who have made substantive contributions to the study may be acknowledged at the end of the article. Also specify grant or other financial support, citing the name of

the supporting organization and grant

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• Legends. Figure legends should be typed

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• Avoid using abstracts as references.
• Provide complete information for each

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1. Waasdorp J, Reynolds MA. Allogeneic bone onlay grafts for alveolar ridge aug- mentation: A systematic review. Int J Oral Maxillofac Implants 2010;25:525–531.

Book reference style:

1. Wikesjo UME, Hanisch O, Sigurdsson TJ, Caplanis N. Application of rhBMP-2 to alveolar and periodontal defects. In: Lynch SE, Genco RJ, Marx RE (eds). Tissue Engineering: Applications in Maxillofacial Surgery and Periodontics. Chicago: Quintessence, 1999:269–286.

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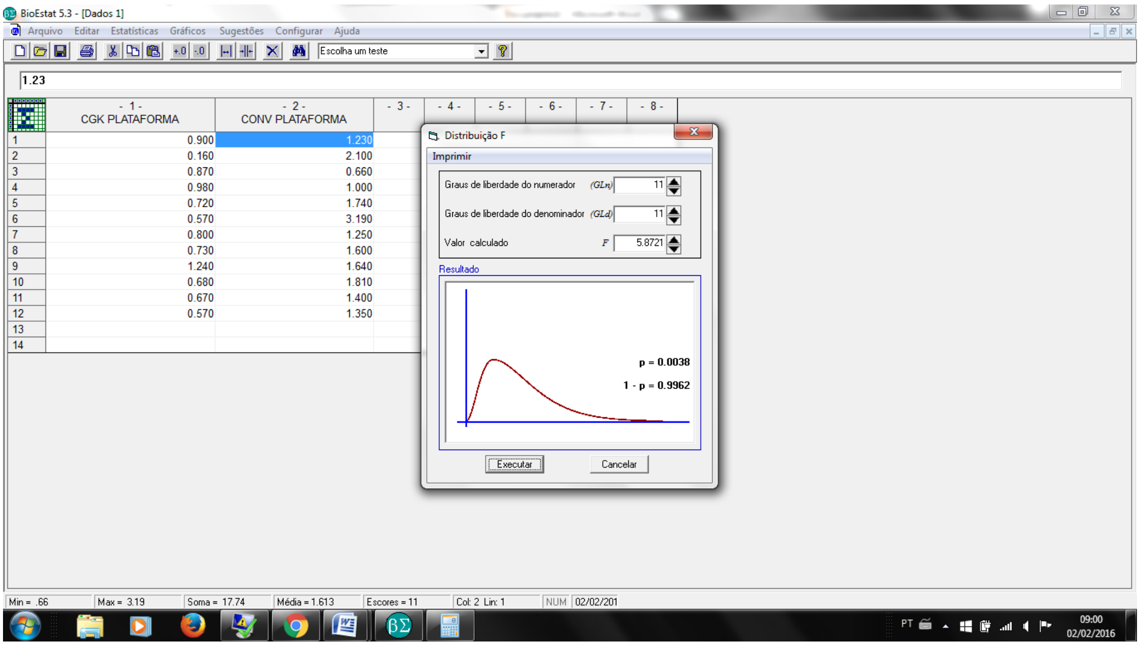
APÊNDICE 1 - ANÁLISE ESTATÍSTICA

STATISTICAL ANALYSIS OF NON-PARAMETRIC MANN-WHITNEY

Normality Platform Shapiro-Wilk
Results - 1 - - 2 -
Sample Size = 12 12
Average = 0.7408 1.5808
Standard inclination = 0.2623 0.6356
W = 0.9504 0.8978
p = 0.5992 0.1987
The value of p> 0.05 indicates normal.
F (Fisher) Test



Mann-Whitney test
Results Sample 1 Sample 2
Sample size 12 12
Sum of posts (Ri) 89.0 211.0
Median = 0.73 1:50

U = 11:00
Z (u) = 3.5218
p-value (one-sided) = 0.0002
p-value (bilateral) = 0.0004

comparison summit
Shapiro-Wilk
Results - 3 - - 4 –
Size of sample = 12 12
Average = 0.8758 2.4725
standard deviation = 0.3728 1.3234

W = 0.9344 0.8078
p = 0.4427 0.0112
Not normal
Test man-whitney
Results Sample 1 Sample 2
Sample size 12 12
Sum of posts (Ri) 84.0 216.0
Median = 0.81 2:13

U = 6.00
Z (u) = 3.8105
p-value (one-sided) = <0.0001
p-value (bilateral) = 0.0001

Normality angle
Results - 5 - - 6 -
Sample Size = 12 12
Average = 1.3950 10.5658
Standard deviation = 0.8221 7.3947
W = 0.9642 0.7931
p = 0.7827 0.0099

Man-Whitney
Results Sample 1 Sample 2
Sample size 12 12
Sum of posts (Ri) 78.0 222.0
Median = 1.50 9:00

U = 00:00
Z (u) = 4.1569
p-value (one-sided) = <0.0001
p-value (bilateral) = <0.0001

APÊNDICE 2 - FIGURAS

FIGURES

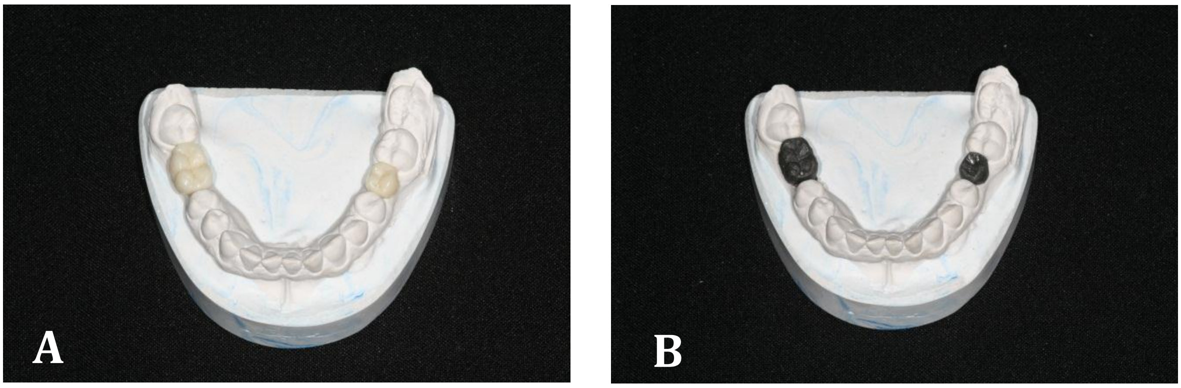


Figure 1 - A- Diagnosis Closure. B - Reverse planning with radiopaque teeth.

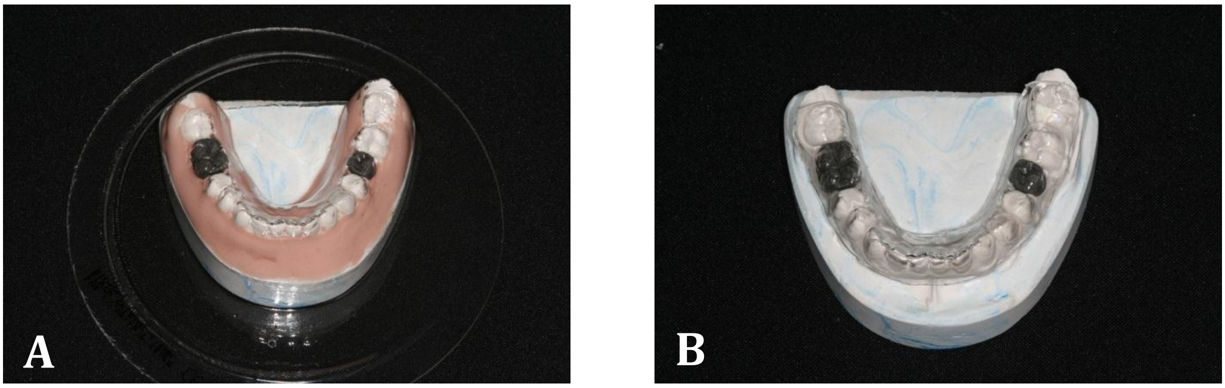


Figure 2 - A- Model relief and lamination of plate PETG. B- Cervical level plate cut.

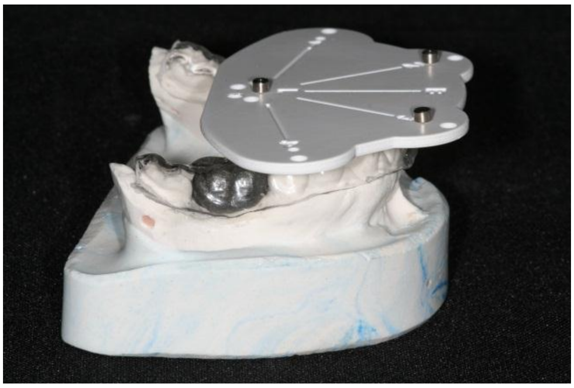


Figure 3 – Tomographic Guide.

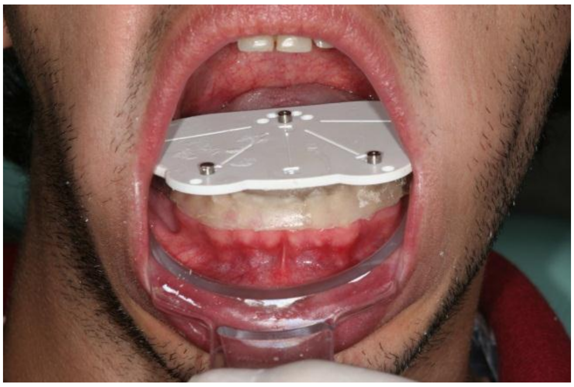


Figure 4 - Tomographic Guide Position.

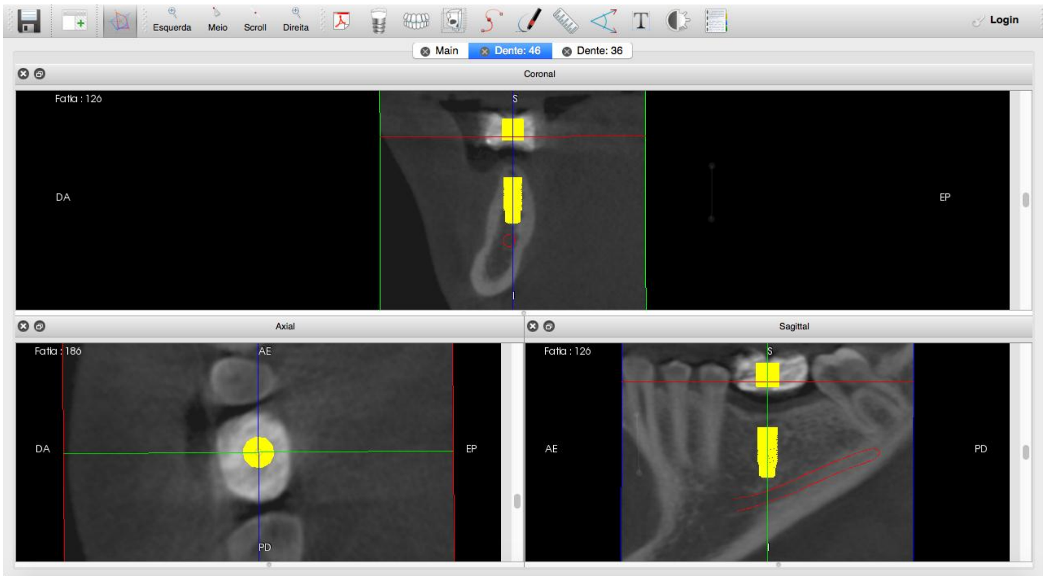


Figure 5 - Kea-Tech software virtual planning.

kea·tech

Relatório de Coordenadas

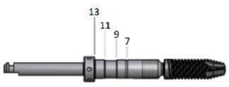
Dados Cadastrais			
Dentista:	Carlla		
Paciente:	[redacted]		
Série Tomografia:	1.2.826.0.1.3680043.9.1938.1614503250606063.23939.20316.1		
Data/Hora:	14:0:8 2015-11-17 GMT-3.0		
Serial Suporte:	12345678		
Coordenadas DPT			
Número do dente:	46	Eixo de trabalho/Lado de Fixação:	4 / Vestibular
Movimento Vestíbulo Lingual:	11.00 mm	Ângulo Vestíbulo Lingual:	1.75 º
Movimento Mesiodistal:	28.75 mm	Ângulo Mesiodistal:	43.25 º
Movimento Cérvico Apical (Haste):	3.25 mm	Implante (Altura/Diâmetro):	8.50 mm/3.50 mm
Tubo	Distância: 11.00 mm	Diâmetro: 4.00 mm	
Pilar Protético	Altura:	Diâmetro:	Ângulo:
Transmucoso	Altura:	Diâmetro:	
Marca/Modelo:	PROSS/3,5 X 8,5		
Dados Cirúrgicos			
Limite de Fressagem	21.50 mm		
Limite de Instalação	11.00 mm		
Observações:			

Figure 6 – Coordenate Report.

Head to Reference Plane	14.15 mm
Head to Vestibulo Lingual Plane	1.77 mm
Head to Mesio Distal Plane	10.67 mm
Tail to Reference Plane	22.64 mm
Tail to Vestibulo Lingual Plane	2.04 mm
Tail to Mesio Distal Plane	10.41 mm
Vestibulo Ligual Angle	1.73 mm
Medio Distal Angle	1.84 mm

Figure 7 – Report of Virtual Implant Position.

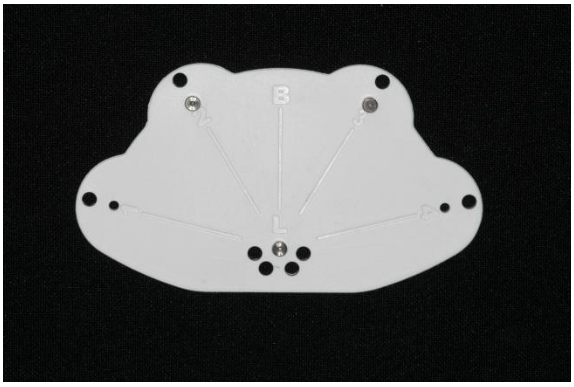
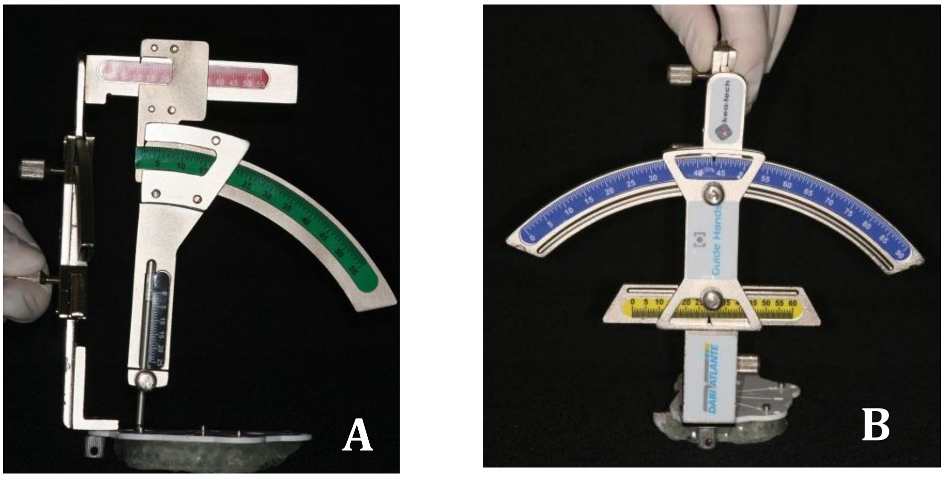
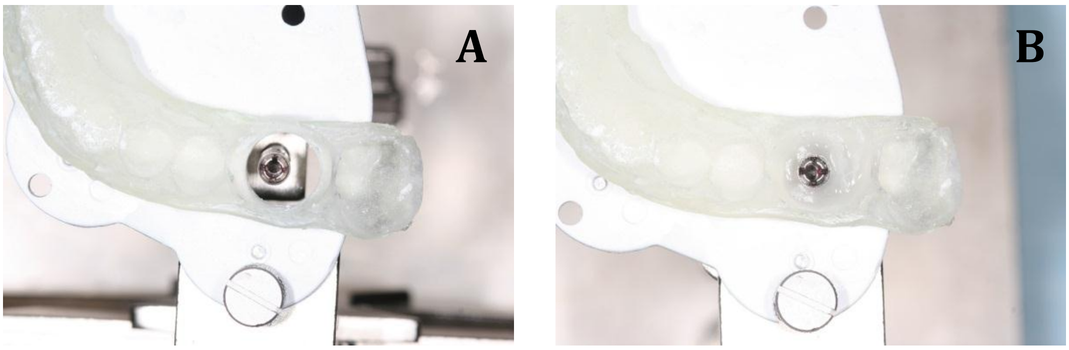


Figure 8 – Tomographic Support (ST).

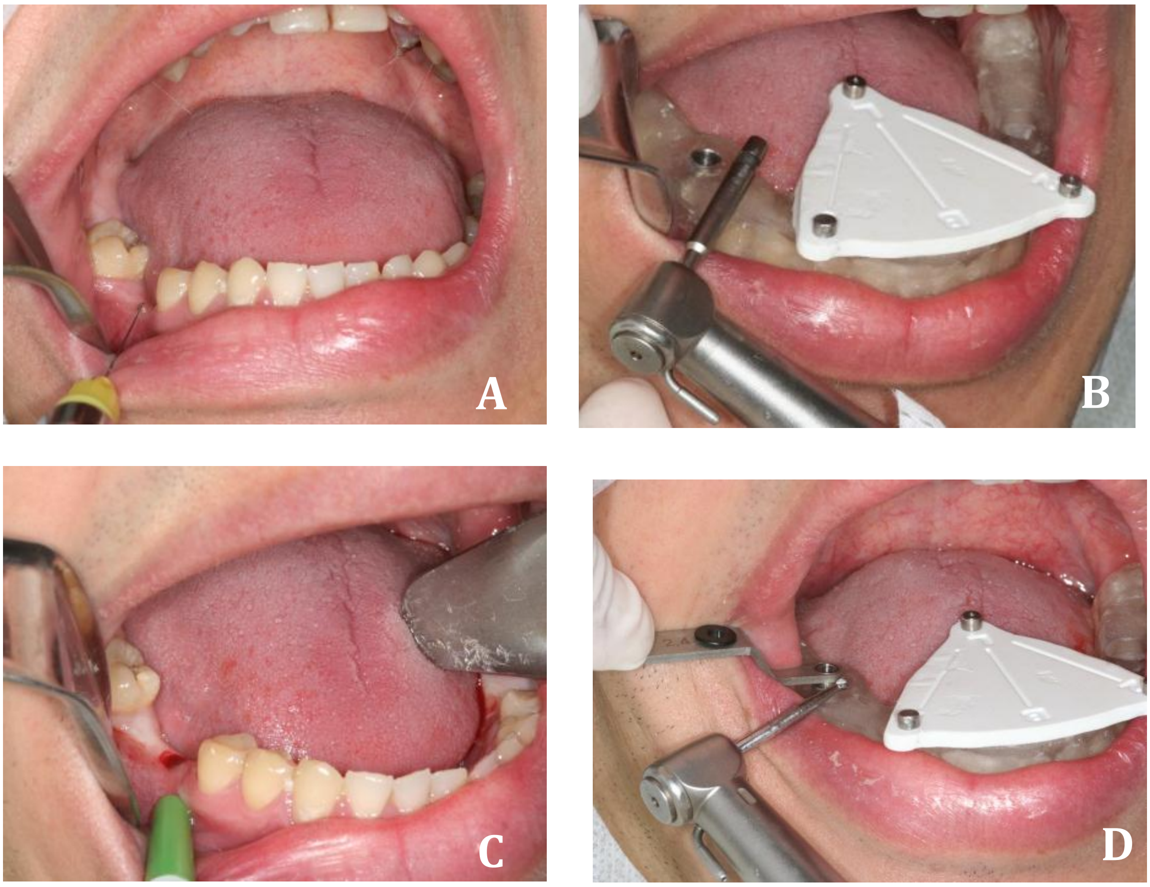


Figures 9 - A and B. Linear and angular measurements transfer for the DPT set in ST.



Figures 10 - A. Washer Position B. Fixation with chemical activated acrylic resin.

Figure 11 - Surgical guide with ST and references maintained for subsequent conference tomography. Right: washer transferred by DPT in the 46 region (Pross-Guide Guide); Left: Drilling in central tooth 36 (Surgical Guide Conventional).



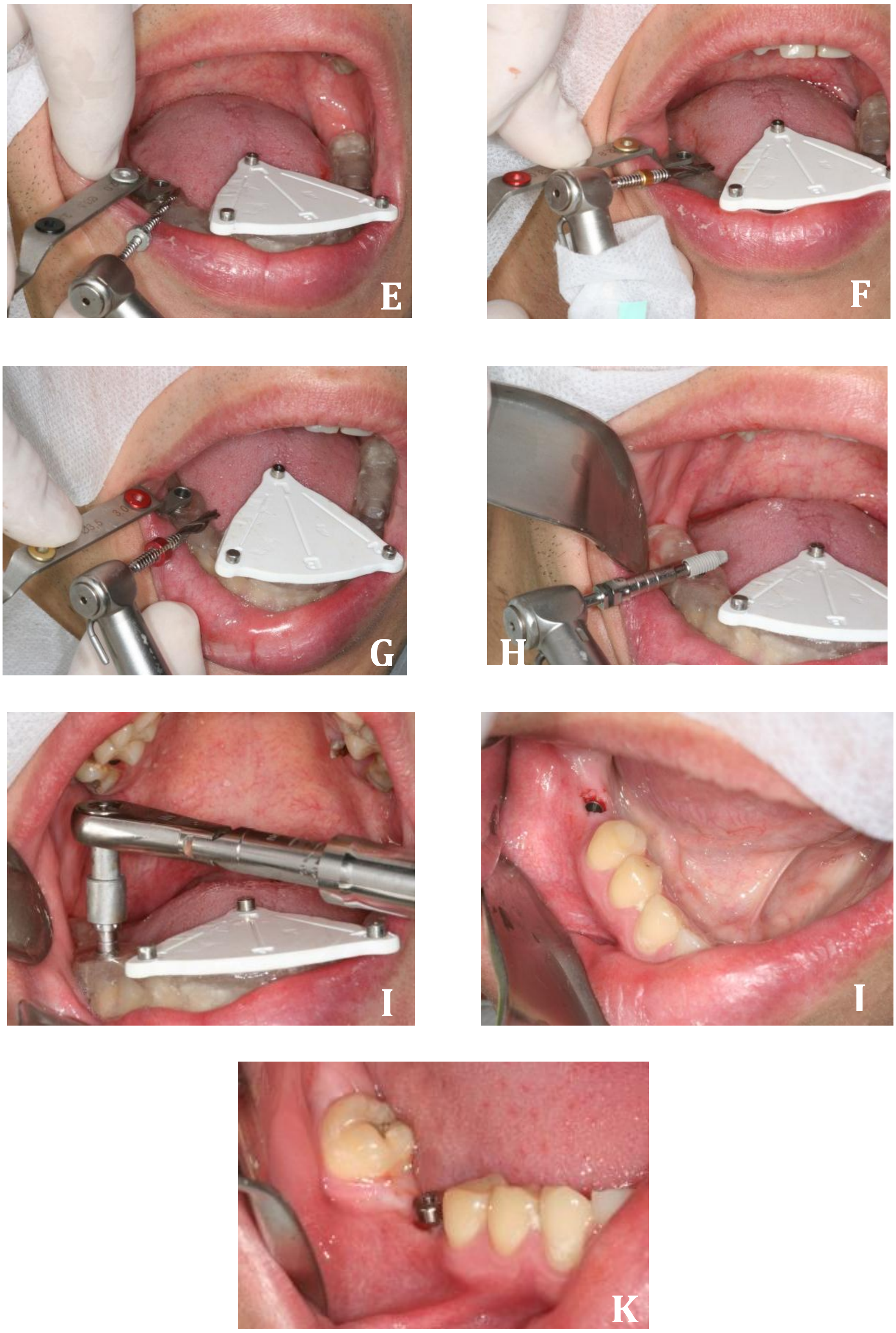
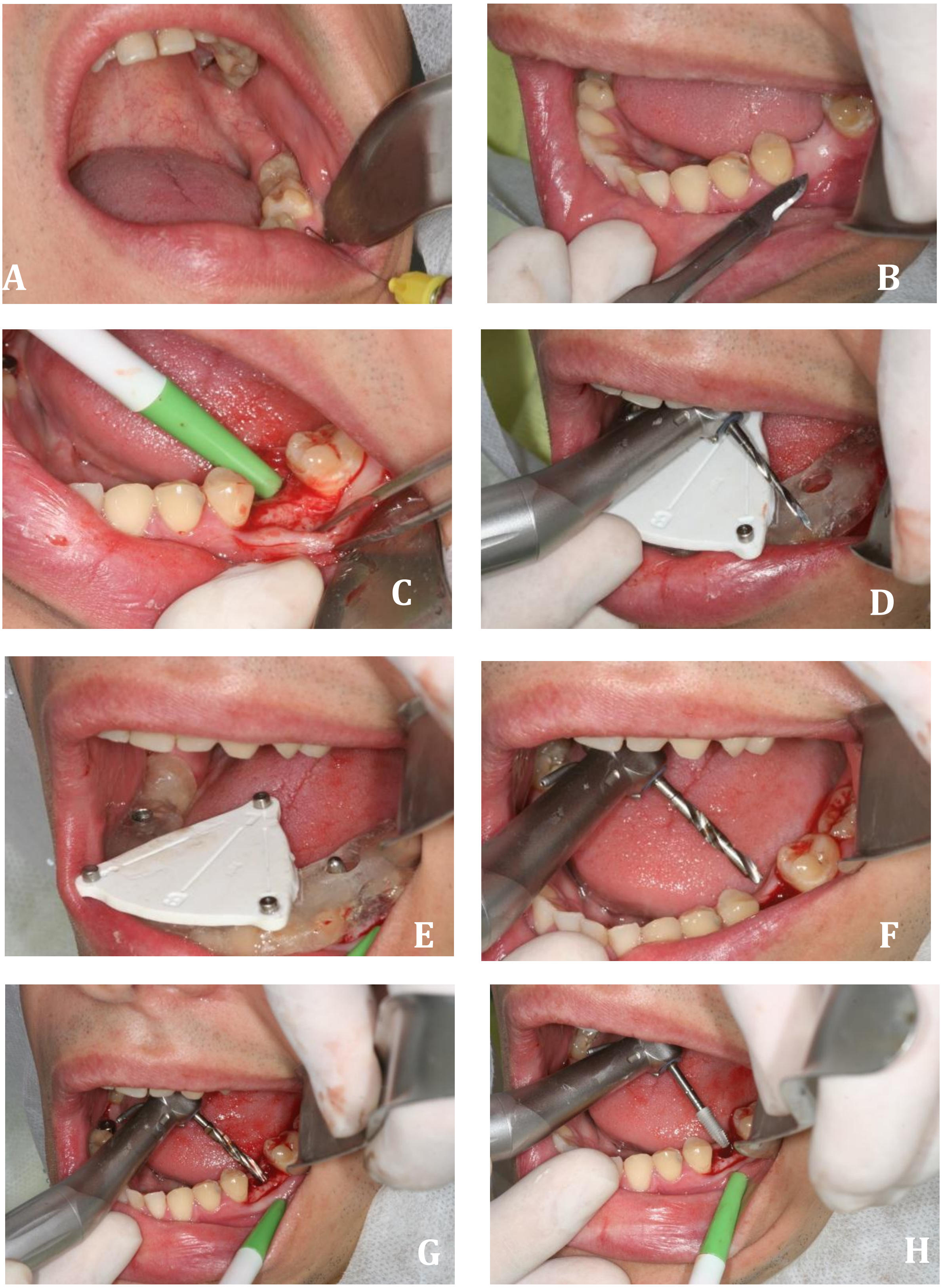
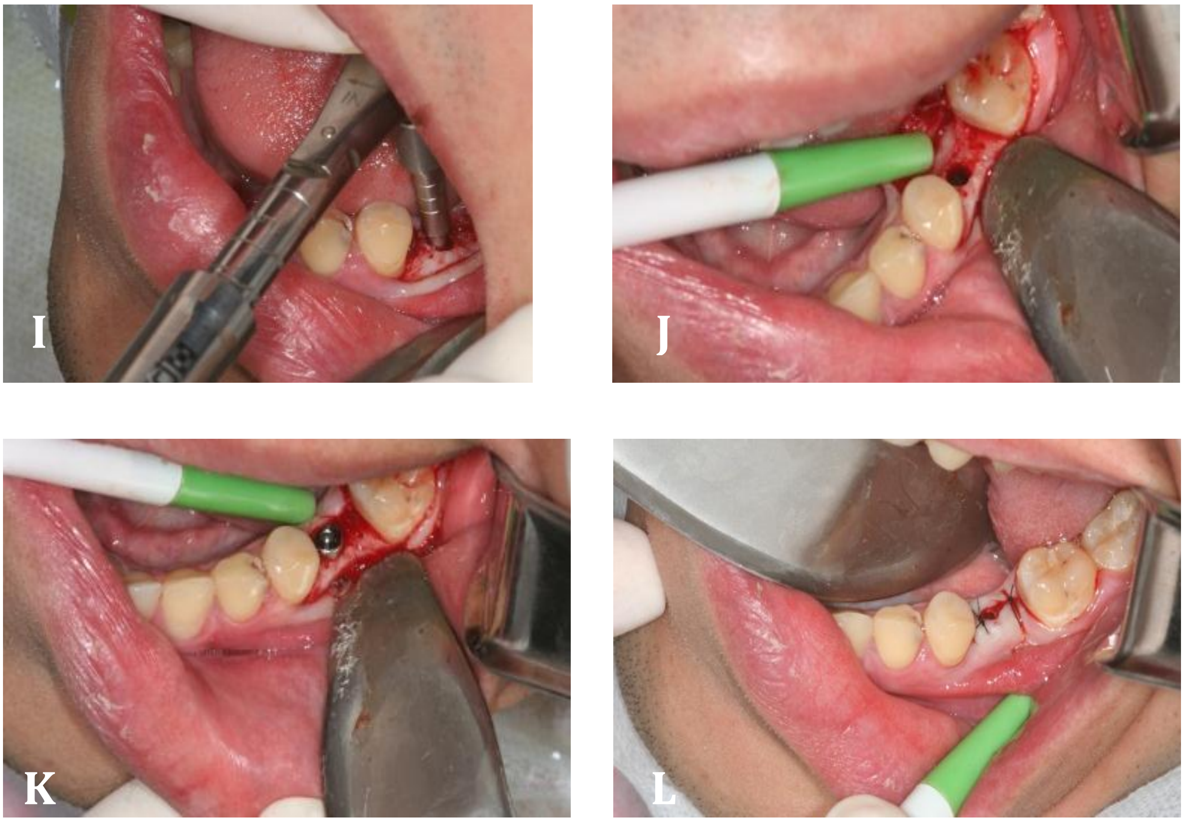


Figure 12 - A-K – Sequel Keyhole Surgery KEA Group.


A
B
C
D
E
F
G
H



Figures 13 - A-L. Conventional Surgical Guide Surgery

Figure 14 – Immediate postoperative

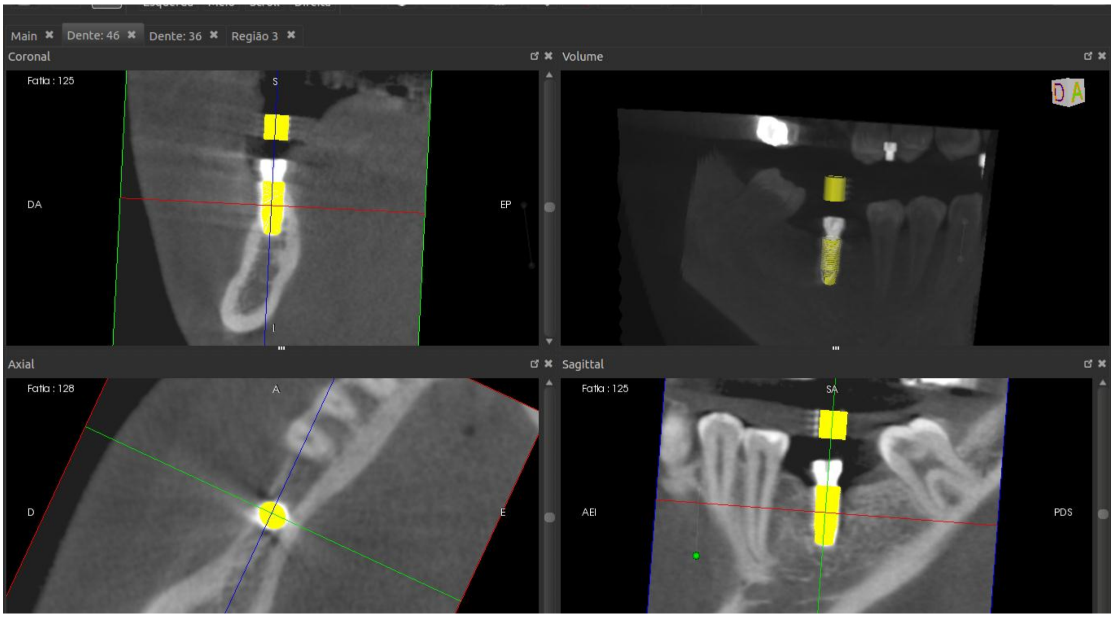


Figure 15 - Virtual implant overlap on the placed implant.

PLANEJAMENTO		EXECUÇÃO	
Head to Reference Plane	14.15 mm	Head to Reference Plane	14.41 mm
Head to Vestibulo Lingual Plane	1.77 mm	Head to Vestibulo Lingual Plane	2.20 mm
Head to Mesio Distal Plane	10.67 mm	Head to Mesio Distal Plane	10.16 mm
Tail to Reference Plane	22.64 mm	Tail to Reference Plane	22.91 mm
Tail to Vestibulo Lingual Plane	2.04 mm	Tail to Vestibulo Lingual Plane	2.47 mm
Tail to Mesio Distal Plane	10.41 mm	Tail to Mesio Distal Plane	10.14 mm
Vestibulo Ligual Angle	1.73 mm	Vestibulo Ligual Angle	0.13 mm
Medio Distal Angle	1.84 mm	Medio Distal Angle	1.77 mm

Figure 16 – Planning of virtual implant position report to the left side, and after that, the overlap on the right.

APÊNDICE 3 - TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

UNIUBE
Educação e Responsabilidade Social

Local e data

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Nome do paciente/sujeito da pesquisa
Identificação (RG) do paciente/sujeito da pesquisa
Nome do responsável (quando aplicável):
Identificação (RG) do responsável:

Título do projeto: **SIMPLIFICAÇÃO E PRECISÃO EM CIRURGIA GUIADA PARA IMPLANTES OSSEOINTEGRADOS**

Instituição onde será realizado: Universidade de Uberaba - Uniube
Pesquisador Responsável: Prof. Dr. Thiago Assunção Valentino
Identificação (conselho), telefone e e-mail: CRO MG 35.720, (34) 9 9165-3699/ (34) 3319-8884, thiago.valentino@uniube.br
CEP-UNIUBE: Av. Nenê Sabino, 1801 – Bairro: Universitário – CEP: 38055-500-Uberaba/MG, tel: 34-3319-8959 e-mail: cep@uniube.br

Eu, ____

(colocar o nome e grau de parentesco do paciente/sujeito, no caso de menores) está sendo convidado para participar do projeto **SIMPLIFICAÇÃO E PRECISÃO EM CIRURGIA GUIADA PARA IMPLANTES OSSEOINTEGRÁVEIS**, de responsabilidade do Prof. Dr. Thiago Assunção Valentino, CRO MG 35.720, a ser desenvolvida na Universidade de Uberaba – UNIUBE. Este projeto tem como objetivos avaliar a precisão de dois guias cirúrgico, um guia realizado de forma convencional e outro com técnica KEA realizado a partir dos dados tomográficos do paciente e planejamento virtual dos implantes em software.

Este projeto se justifica por trazer melhora ao Guia convencional que é utilizado atualmente, tendo maior precisão na transferência do planejamento virtual para a situação real durante a cirurgia e pode trazer como benefícios uma melhor posição tridimensional dos implantes, melhor pós operatório e maior satisfação com o resultado final obtido.

Se aceitar participar desse projeto, você será submetido a cirurgia de implantes, de um lado com a maneira que é realizada atualmente com guia e técnica convencional utilizando todos os artifícios possíveis para ser realizado da melhor maneira possível, do outro lado serão realizados implantes utilizando técnica com Guia Kea, que é um Guia feito e acordo com a posição que queremos instalar o implante, e é um guia restritivo, que possibilita que a cirurgia seja feita sem cortes. Após a instalação serão realizadas tomografias para medir a posição que foram instalados e conferir com o planejamento realizado antes da cirurgia. Não haverá nenhum risco com a participação no estudo , pois estaremos utilizando as técnicas que já existem, apenas serão comparadas.

Os seus dados serão mantidos em sigilo e serão utilizados apenas com fins científicos, tais como apresentações em congressos e publicação de artigos científicos. Seu nome ou qualquer identificação sua (voz, foto, etc) jamais aparecerá.

Pela sua participação no estudo, você não receberá nenhum pagamento, e também não terá nenhum custo. Você pode parar de participar a qualquer momento, sem nenhum tipo de prejuízo para você ou para seu tratamento/atendimento. Sinta-se à vontade para solicitar, a qualquer momento, os esclarecimentos que você julgar necessários. Caso decida-se por não participar, ou por não ser submetido a algum procedimento que lhe for solicitado, nenhuma penalidade será imposta a você, nem seu tratamento ou atendimento será alterado ou prejudicado.

Você receberá uma cópia desse termo, assinada pela equipe, onde consta a identificação (nome e número de registro – se houver-) e os telefones da equipe de pesquisadores, caso você queira entrar em contato com eles.

____

Nome do paciente (ou sujeito) ou responsável e assinatura

____

Prof. Dr. Thiago Assunção Valentino
CROMG 35.720
(34) 9 9165-3699/ (34) 3319-8884
thiago.valentino@uniube.br