



SERVIÇO PÚBLICO FEDERAL
MINISTÉRIO DA EDUCAÇÃO
UNIVERSIDADE FEDERAL DE UBERLÂNDIA
FACULDADE DE ODONTOLOGIA
PROGRAMA DE PÓS-GRADUAÇÃO EM ODONTOLOGIA



RODRIGO SILVA MOREIRA

Análise da influência do material dos corpos de escaneamento e da presença de defeitos no seu escaneamento sobre acurácia de modelos digitais: um estudo in vitro

Influence of scanbodies material and the presence of defects in its scan on the accuracy of digital models: an in vitro study

Dissertação apresentada à Faculdade de Odontologia da Universidade Federal de Uberlândia, para obtenção do Título de Mestre em Odontologia na Área de Concentração de Clínica Odontológica Integrada

Uberlândia, 2023

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Uberlândia, 2023



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ATA DE DEFESA - PÓS-GRADUAÇÃO

Programa de Pós-Graduação em:	Odontologia				
Defesa de:	Dissertação de Mestrado Acadêmico; número 419, PPGODONTO				
Data:	Dez de Julho de Dois Mil e Vinte e Três	Hora de início:	09:00	Hora de encerramento:	12:05
Matrícula do Discente:	121222ODO026				
Nome do Discente:	Rodrigo Silva Moreira				
Título do Trabalho:	Análise da influência do material dos corpos de escaneamento e da presença de defeitos no seu escaneamento sobre acurácia de modelos digitais: um estudo in vitro.				
Área de concentração:	Clínica Odontológica Integrada				
Linha de pesquisa:	Implantodontia e Prótese sobre Implantes				
Projeto de Pesquisa de vinculação:	Implantodontia e Prótese sobre Implantes				

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M838 2023	Moreira, Rodrigo Silva, 1998- Análise da influência do material dos corpos de escaneamento e da presença de defeitos no seu escaneamento sobre acurácia de modelos digitais: um estudo in vitro [recurso eletrônico] : Analysis of the influence of scanbodies material and the presence of defects in its scan on the accuracy of digital models: an in vitro study / Rodrigo Silva Moreira. - 2023. Orientador: Flávio Domingues das Neves. Dissertação (Mestrado) - Universidade Federal de Uberlândia, Pós-graduação em Odontologia. Modo de acesso: Internet. Disponível em: http://doi.org/10.14393/ufu.di.2023.355 Inclui bibliografia. 1. Odontologia. I. Neves, Flávio Domingues das, 1965-, (Orient.). II. Universidade Federal de Uberlândia. Pós- graduação em Odontologia. III. Título. CDU: 616.314
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DEDICATÓRIA

À Deus,

Por me abençoar grandemente colocando pessoas iluminadas no meu caminho, como minha família e amigos. Agradeço também por todas as oportunidades concedidas a mim nessa jornada e pela saúde que me permite ir ao encontro delas diariamente. Certamente sem a graça Divina que me protege e ampara constantemente não seria possível concluir mais esta etapa em minha vida.

À toda minha família

Obrigado por todo o suporte e amor incondicional que sempre tiveram comigo, por todos os sacrifícios que fizeram em meu benefício e pelos inúmeros momentos vividos até aqui. Sou muito grato por compartilhar minha convivência diária com pessoas tão extraordinárias quanto minha mãe Vanda, meu pai Antônio e meu irmão Victor Hugo. Agradeço também a todos os familiares falecidos que, mesmo pela passagem, com todo o seu amor continuam zelando por todos nós.

AGRADECIMENTOS ESPECIAIS

Agradeço imensamente ao meu orientador **Prof. Dr. Flávio Domingues das Neves**. Durante todo esse período de convivência tive a oportunidade de conhecer na prática um exemplo de professor e de ser humano. Admiro muito sua trajetória e me impressiono pelo número de grandes profissionais que já passaram pela sua orientação e reconhecem a importância disso. Por todas as oportunidades, pela confiança depositada em mim, pelos inúmeros ensinamentos profissionais, mas principalmente de vida transmitidos, o meu MUITO OBRIGADO!

Agradeço o grupo de pesquisa **NEPRO** que me possibilitou conhecer e aprender com grandes profissionais e pessoas extraordinárias. Certamente poder estar

com vocês me mostrou o quão importante e benéfico pode ser o trabalho em equipe, além de me proporcionarem um significativo suporte diariamente.

A todos os profissionais da **Prado e Neves Odontologia**, agradeço por toda estrutura, suporte e atenção nesse período. O cuidado de vocês teve um papel muito importante para mim.

Muito obrigado toda equipe da **TO Odontologia** e **TO Instituto** que me proporcionaram inúmeras oportunidades e prestação grande apoio. Certamente parte significativa dos trabalhos desenvolvidos foi viabilizada por todos vocês.

A toda equipe do **e.PRO**, agradeço pelas diversas oportunidades proporcionadas e por todos os momentos compartilhados. Em especial ao Lucas, Caio e Karen pelo auxílio e por todo companheirismo vivenciados até aqui. Certamente além de colegas de profissão ganhei verdadeiros amigos e mentores.

Ao professor **Guilherme Faria Moura**, muito obrigado por todos os conselhos e pela disponibilidade de sempre contribuir com ideias e sugestões que foram de extrema importância para a execução dos trabalhos.

Muito obrigado a toda equipe do PPGOUFU pela prestabilidade e agilidade para ajudar da maneira mais eficiente possível, nesse contexto o empenho da **Laís** e **Brenda** fizeram uma enorme diferença.

Agradeço todos os **professores e colegas de turma do PPGO** aos quais tive o enorme prazer de trocar ideias, compartilhar e aprender informações que levarei para toda minha vida.

A todas as pessoas que, de maneira direta ou indireta, tornaram possível a finalização desta etapa. Muito obrigado!

EPÍGRAFE

“Agradeço todas as dificuldades que enfrentei. Não fosse por elas, eu não teria saído do lugar.”

Chico Xavier

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RESUMO

Introdução: Algumas situações clínicas podem dificultar a captura de toda a superfície do corpo de escaneamento. Além disso, diferentes materiais podem oferecer diferentes capacidades óticas de captura de imagem pelos escâneres odontológicos. Porém a influência de tais fatores ainda não é clara. **Objetivo:** O objeto deste estudo in vitro foi avaliar qual a influência do material dos corpos de escaneamento e da presença de defeitos na sua varredura para a acurácia dessas imagens. **Materiais e métodos:** Dois materiais de corpos de escaneamento diferentes (PEEK e Titânio) foram utilizados para gerar modelos com e sem defeitos na face lingual dos dispositivos. Para tal, cada grupo foi escaneado 12 vezes (N=48) com o escâner intraoral Virtuo Vivo. Em seguida os arquivos foram submetidos às análises de reprodutibilidade e veracidade. Sendo que para veracidade os arquivos de cada grupo foram comparados a um arquivo mestre gerado por outro escaneamento do modelo mestre com o escâner de bancada InEos X5. Essas análises foram realizadas no software Geomagic Control, que permite a sobreposição, alinhamento e comparação 3D dos arquivos. Os dados de reprodutibilidade foram submetidos ao teste de Kruskal-Wallis, além das comparações múltiplas realizadas pelo teste de Dwass-Steel-Critchlow-Fligner. Na sequência os dados de veracidade foram submetidos ao teste de ANOVA seguido pelo teste de Tukey. **Resultados:** Com relação à reprodutibilidade houve diferença significativa, sendo que o grupo PEEK com erro apresentou o menor nível de discrepância em relação aos demais grupos ($P = .003$). Com relação à veracidade, houve diferença significativa considerando a presença do erro (grupos com erro apresentaram menor discrepância), enquanto que, segundo a variável material não houve diferença significativa. Nesse contexto os grupos Titânio com erro (5.40) e PEEK com erro (4.81) apresentaram diferença significativa quando comparados aos demais grupos ($P < .001$). **Conclusões:** A acurácia dos arquivos de escaneamento foi significativamente influenciada pela presença de erros na aquisição de imagens dos corpos de escaneamento, nesse contexto arquivos sem erro tiveram menor acurácia. No que diz respeito ao material, não houve influência significativa com uso do PEEK ou Titânio nos parâmetros de acurácia.

PALAVRAS-CHAVE: CAD-CAM, corpo de escaneamento, acurácia.

ABSTRACT

Introduction: Some clinical situations may make it difficult to capture the entire surface of the scanbody. Furthermore, different materials may offer different optical features for image capture by dental scanners. However, the influence of such factors is still unclear. **Objective:** The purpose of this in vitro study was to evaluate the influence of the material of the scanbodies and the presence of defects in the scan on the accuracy of these images. **Material and methods:** Two different scanbody materials (PEEK and Titanium) were used to generate models with and without defects on the lingual surface of the devices. For this, each group was scanned 12 times (N=48) with the Virtuo Vivo intraoral scanner. Then the files were examined for trueness and precision analyses. For trueness, the files of each group were compared to a master file generated by another scan of the master model with the laboratory scanner InEos X5. These analyzes were carried out in the Geomagic Control software, which allows the pairing, overlapping and 3D comparison of the files. Reproducibility data were submitted to the Kruskal-Wallis test, in addition to multiple comparisons performed using the Dwas-Steel-Critchlow-Fligner test. Next, the veracity data were submitted to the ANOVA test followed by the Tukey test. **Results:** Regarding reproducibility, there was a significant difference, with the PEEK group with error having the lowest level of discrepancy in relation to the other groups ($P = .003$). Regarding veracity, there was a significant difference considering the presence of error (groups with error had less discrepancy), while, according to the material variable, there was no significant difference. In this context, the groups Titanium with error (5.40) and PEEK with error (4.81) showed a significant difference when compared to the other groups ($P < .001$). **Conclusions:** The accuracy of the scan files was significantly influenced by the presence of errors in the acquisition of images of the scanbodies, in this context, files without errors had lower accuracy. With regard to the material, there was no significant influence with the use of PEEK or Titanium on the accuracy parameters.

KEYWORDS: CAD-CAM, scanbody, accuracy

1. INTRODUÇÃO E REFERENCIAL TEÓRICO

Com o surgimento e evolução dos implantes osseointegrados houve a possibilidade de reabilitar pacientes totalmente ou parcialmente edêntulos com uma técnica de alta previsibilidade e altos níveis de sucesso à longo prazo (Barbosa, Bernardes et al. 2016). Para que essas reabilitações consigam desempenhar de maneira satisfatória suas funções biomecânicas, uma importante etapa no processo de confecção das próteses é a moldagem (Barbosa, Bernardes et al. 2016, Flügge, van der Meer et al. 2018). Dentre as inúmeras técnicas que existem para execução desta etapa, seu objetivo em comum é que se faça uma fiel transferência da posição dos implantes ou pilares a fim de propiciar condições favoráveis ao assentamento passivo da prótese (Bhakta, Vere et al. 2011, Bi, Wang et al. 2022).

Contemporaneamente à popularização dos implantes osseointegráveis, ocorreu o desenvolvimento das tecnologias CAI-CAD-CAM (computer aided impressing, comouter aided design e computer aided manufacturing, respectivamente) para Odontologia, que trouxe algumas vantagens relacionadas à maior simplicidade técnica, redução de tempo clínico e mais conforto ao paciente, quando comparadas às técnicas não digitais de confecção de próteses (Bergsjö, Andersson et al. 2014, Mangano, Gandolfi et al. 2017, Suese 2020, Siqueira, Galli et al. 2021). No início, esse sistema era voltado à confecção de próteses fixas sobre dentes, porém sua evolução viabilizou utilizar desses recursos na confecção de modelos impressos, alinhadores ortodônticos, guias cirúrgicos e até mesmo próteses sobre implantes (Miyazaki, Hotta et al. 2009, Fonseca Tavares, Diniz Viana et al. 2018, Hwang, Chou et al. 2018, Khorsandi, Fahimipour et al. 2021).

Nesse contexto de reabilitações com próteses implantadas, o advento de dispositivos denominados corpos de escaneamento permitiu realizar a transferência do posicionamento tridimensional de implantes e pilares (Mizumoto and Yilmaz 2018, Schmidt, Wöstmann et al. 2022). Esses dispositivos possuem três regiões que os compõem: região superior – denominada região de

varredura, responsável pelo alinhamento dos dados de escaneamento ao modelo digital; a região média denominada corpo e a região inferior responsável por reter as demais regiões ao implante ou aos componentes protéticos - denominada base (Mizumoto and Yilmaz 2018). Com isso, tornou-se possível fazer essa transferência com boa fidelidade para inúmeros casos (Michelinakis, Apostolakis et al. 2021). O que segundo a ISO 5725 – 1) é expresso pela acurácia da técnica (digital ou não digital) dada pelos parâmetros de veracidade e reprodutibilidade (Standardization 1994). Ou seja, o quão fiel dimensionalmente o modelo é em relação ao objeto real e qual a capacidade de se reproduzir resultados semelhantes entre si, respectivamente.

O fluxo compreendido para se obter uma prótese sobre implante, por meio de escaneamento intraoral envolve três principais etapas. A primeira etapa (CAI) está associada à aquisição de dados relacionados à estrutura a ser escaneada, na qual o scanner, por mecanismos de emissão de luz e captura de imagens gera um arquivo tridimensional desta estrutura (Bergsjö, Andersson et al. 2014, Richert, Goujat et al. 2017, Hwang, Chou et al. 2018, Mangano, Hauschild et al. 2019). Na segunda etapa (CAD) esse arquivo é processado pelo software. Após o reconhecimento do corpo de escaneamento utilizado, o mesmo é sobreposto ao seu equivalente presente na biblioteca do software e em seguida os análogos digitais são posicionados para que seja obtido o modelo digital propriamente dito (Joda, Zarone et al. 2017, Mizumoto and Yilmaz 2018). Posteriormente o planejamento e execução do desenho é realizado de acordo com a finalidade do projeto. A manufatura (CAM) representa a terceira etapa na qual o desenho é exportado em arquivo tridimensional para a máquina de manufatura aditiva (impressoras 3D) ou subtrativa (fresadoras) realizar a materialização do referido projeto (Kirsch, Ender et al. 2017, Park and Shin 2018, Kessler, Hickel et al. 2020, Khaledi, Farzin et al. 2020, Donmez and Okutan 2022)

Diante de tantas etapas e do constante desenvolvimento de novas ferramentas no sistema CAI-CAD-CAM algumas informações sobre quais fatores podem influenciar no sucesso das reabilitações obtidas por esse fluxo ainda não são claras. Porém já se sabe que a experiência do operador pode influenciar nos parâmetros de acurácia, uma vez que operadores mais experientes tendem a

gerar menores níveis de discrepância nos escaneamentos (Resende, Barbosa et al. 2021). Além disso o modelo do escâner utilizado também se associa a diferentes níveis de discrepância dimensional (Emir and Ayyıldız 2019, Natsubori, Fukazawa et al. 2022, Schmidt, Wöstmann et al. 2022, Çakmak, Yilmaz et al. 2022). Outro fator conhecido é o tamanho do arco escaneado, uma vez que escaneamentos de arcos totais geram maiores distorções dimensionais em comparação aos hemi-arcos (Ender, Zimmermann et al. 2019, Resende, Barbosa et al. 2021).

Portanto, faz-se necessário identificar que outros fatores podem prejudicar ou favorecer a acurácia dos escaneamentos e consequentemente das demais etapas do fluxo digital. Nesse contexto um questionamento importante a se fazer é sobre a influência do material do corpo de escaneamento na sua captura de imagem, bem como qual nível aceitável com relação à presença de eventuais regiões na sua superfície que não tenham sido totalmente capturadas pelo escâner.

2. CAPÍTULOS

2.1. CAPÍTULO 1 - Analysis of the influence of scanbodies material and the presence of defects in its scan on the accuracy of digital models: an in vitro study

Abstract

Statement of problem: Some clinical situations may make it difficult to capture the entire surface of the scanbody. Furthermore, different materials may offer different optical features for image capture by dental scanners. However, the influence of such factors is still unclear. **Purpose:** The purpose of this in vitro study was to evaluate the influence of the material of the scanbodies and the presence of defects in the scan on the accuracy of these images. **Material and methods:** Two different scanbody materials (PEEK and Titanium) were used to generate models with and without defects on the lingual surface of the devices. For this, each group was scanned 12 times (N=48) with the Virtuo Vivo intraoral scanner. Then the files were examined for trueness and precision analyses. For trueness, the files of each group were compared to a master file generated by another scan of the master model with the laboratory scanner InEos X5. These analyzes were carried out in the Geomagic Control software, which allows the pairing, overlapping and 3D comparison of the files. Reproducibility data were

submitted to the Kruskal-Wallis test, in addition to multiple comparisons performed using the Dwass-Steel-Critchlow-Fligner test. Next, the veracity data were submitted to the ANOVA test followed by the Tukey test. **Results:** Regarding reproducibility, there was a significant difference, with the PEEK group with error having the lowest level of discrepancy in relation to the other groups ($P = .003$). Regarding veracity, there was a significant difference considering the presence of error (groups with error had less discrepancy), while, according to the material variable, there was no significant difference. In this context, the groups Titanium with error (5.40) and PEEK with error (4.81) showed a significant difference when compared to the other groups ($P < .001$). **Conclusions:** The accuracy of the scan files was significantly influenced by the presence of errors in the acquisition of images of the scanbodies, in this context, files without errors had lower accuracy. With regard to the material, there was no significant influence with the use of PEEK or Titanium on the accuracy parameters.

INTRODUCTION

In obtaining fixed prostheses on implants, an important step for the success of the restorations is the precise transfer of the position of the implants at the moment of molding.¹ With the introduction and development of CAI/CAD/CAM technologies: computer-aided impressioning (CAI), computer-aided design (CAD) and computer-aided manufacturing (CAM) there was the possibility of performing this transfer using devices called scanbodies (SB).¹⁻³ These devices make it possible to generate, through an intraoral or laboratory scan, image data that will be exported to the CAD software. These images are interpreted and from the recognition and alignment of the SB with its corresponding present in the software library, a digital model is obtained that will reproduce the three-dimensional position of the implants or abutments.⁴ For this to be possible, the scanning must be accurate, which according to ISO 5725-1:1994 is evaluated by the parameters of trueness and precision.⁵

Among the elements involved with implant scanning, some factors related to patients, implants, scanners and SB can influence this accuracy. Regarding the patient, the accuracy can be influenced by the presence of saliva due to the refraction of the light emitted by the scanner and the image captured by its camera; movements of the tongue and cheeks that can cause “artifacts” in the meshes; in addition to the substrate to be scanned that offers different optical image capture capabilities of dental scanners.⁶⁻⁸ Regarding the implants – different positions in the arch can generate different levels of discrepancy, in addition, as the inclination and distance between the implants increase, discrepancies can increase and consequently impair the accuracy of the digital models.⁹⁻¹¹ Different scanner models may also have different levels of accuracy, which is generally related to the image capture technologies and depth of focus of each scanner model.¹²⁻¹⁹ In addition, the operator's experience, as well as the scanned area, can also influence accuracy, since more inexperienced operators as well as those scanned from larger areas tend to generate a greater overlap of images, responsible for increasing the weight of the file and mesh density.²⁰ With the increasing popularity of these technologies in implant dentistry, there are several models of SB with specific use in relation to the prosthetic component or

type of implant used. This generates great variability of devices available on the market with regard to shape, size, surface, connection, reusability, cost, compatibility between scanner and software, in addition to material.^{2, 21} In this last factor, some materials have been used for the manufacture of scanbodies. Highlighting the metal Titanium (Ti) and a thermoplastic polymer based on polyether-ether-ketone (PEEK), both materials used in the health area, but capable of generating different mechanical and light reflection characteristics.^{22,23}

Some studies indicate factors that may lead to a reduction in accuracy, but more information is still needed. Faced with such variables, correctly scanning the SB in a clinical setting can become a challenge. In this context, it is common for the surface of the SB not to be fully scanned. However, there is no clear information in the literature about the influence of these “errors” on the accuracy of implant scans. Furthermore, the use of different materials in the composition of the SB raises similar doubts regarding the influence on the accuracy of the scans. In short, it becomes clear that it is necessary to understand more about which materials allow the acquisition of images and how these “errors” influence accuracy.

Therefore, the objective of the present study was to evaluate the influence of the SB material and the presence of defects in its scanning for the accuracy of these images. Therefore, the null hypotheses tested were that there would be no influence on the accuracy of the scans given by the variation in the SB material or the presence of regions in the device that were not scanned

Clinical Implications

Little is known about the influence of different materials on the SB scanning. In addition, something relatively common in clinical practice is the impossibility of capturing the entire surface of the SB during digital impression. However, there is little evidence to indicate the impact of these factors on the accuracy of scans for fixed prostheses on implants.

MATERIAL AND METHODS

The present study is an in vitro laboratory test performed from the design based on the experimental unit of 12 files in Standard Tessellation Language (STL)

format for each group. Which, based on the Cohen test, reached medium magnitude for precision ($f^2 = .06$) and high magnitude for trueness ($f^2 = .81$). Followed by the analysis of two factors under study, namely: presence of errors (two levels - with and without errors) and SB material (two levels - PEEK and TI), to obtain results on the accuracy response variable (N=48) (Figure 1). This variable was evaluated according to the parameters of trueness and precision according to ISO 5725-1 using the Geomagic Control software (3D Systems, Inc.) for each of the four groups: PEEK with error (PWE), PEEK without error (PWOE), titanium with error (TWE), and titanium without error (TWOE).

Creation of the master model

A MOM mannequin (Odontological Mannequins, Marília, Brazil) was used to simulate the absence of elements 44,45,46 (Figure 2). As a treatment possibility, we chose to reproduce two implants installed in regions 44 and 46. This simulates implant-supported rehabilitations of three splinted elements, screwed onto two conical mini-abutments (Neodent Mini Conical Abutment, Curitiba, Brazil) (Figure 3).

Obtaining digital files

For intraoral scanning, a Virtuo Vivo – Straumann scanner (v3.6.2 Dental Wings, Inc.) and compatible SB for mini-conical abutments (Neodent, Curitiba, Brazil) were used.

Twelve partial-arc scans for each group were performed by the same operator. In the groups in which the SB surface was completely scanned, image acquisition was performed according to the manufacturer's recommendations. In the groups with scanning "errors", a very common event in daily clinical practice was simulated for the described rehabilitation situation, which is the impossibility of scanning the entire lingual surface of the SB. These procedures were also repeated for each of the two SB materials used. In addition, the In Eos X5 laboratory scanner (Dendsply Sirona, Germany) was used to allow comparison of the samples with the master file.

Then the files were exported in .STL format for digital analysis of the three-dimensional discrepancies in the Geomagic Control software (3D Systems, Inc.).

Accuracy analysis of digital models

The 48 digital models generated by the scans were submitted to an accuracy analysis according to ISO 5275-1 using the specific software for analysis of volumetric deviations 3D Geomagic Control (3D Systems, Inc.) (Figure 4).

Once imported, each digital model was superimposed on the control using the initial alignment tool. Then, in order to optimize the measurements of trueness and precision, the digital models had irregular regions cut out approximately 2 mm below the gingival margin. Subsequently, these files were submitted to the best fit alignment tool and the entire area around the SBs was cropped to eliminate possible discrepancies in other regions. This process was performed by the same operator with experience in using the software.²⁴ For reproducibility, comparisons were performed within each group, using the 12 samples without referencing them to the master file. Then, the average of maximum and minimum deviations, in addition to the standard deviation generated by the software, were recorded. Trueness followed the same protocol, however the files were superimposed and compared to the master file.

From the described processes, adding the trueness and precision evaluations, the data from the 312 analyzes were submitted to statistical tests.

Statistical analysis

For precision, the non-parametric Kruskal-Wallis ANOVA was used, because the variances were not homogeneous and the ANOVA residues did not present a normal distribution ($P > 0.01$). To assess significant differences between groups, the Dwass-Steel-Critchlow-Fligner multiple comparison test was used. As for trueness analysis in the comparison of groups, ANOVA ($P < 0.01$) was used. To assess significant differences between groups, the Tukey test was used.

In both, the significance level used was 5%. The Jamovi software (Jamovi project, v1.6) was used to perform the analyses.

RESULTS

According to the statistical method employed, the descriptive analysis (Table 1) for precision, the PWE group showed the lowest level of discrepancy, followed by the TWOE group (Figure 5). Still regarding precision, according to the analysis of multiple comparisons, there was a significant difference between the PWE and PWOE groups ($P = .007$), as well as between the PWE and TWE groups ($P = .003$).

For trueness, there was a significant difference between the groups regarding the presence of the defect (figure 6). The PWE and TWE groups presented significantly lower results than the other groups (Table 2). Regarding the material of the SB, there was no significant difference between the groups in the present study (Table 2).

DISCUSSION

Based on the purpose, as well as on the results obtained in the present study, the null hypothesis that there would be no influence on the accuracy of the scans given by the variation in the SB material was accepted. On the other hand, the second null hypothesis (there is no influence on the accuracy of the scans due to the presence of defects in the image capture) was rejected.

Accuracy is a factor that, according to ISO 5725-1, must be performed based on the parameters of trueness and precision.⁵ Regarding trueness, it is important that the .stl files are compared to a master file that has good dimensional reproduction in relation to the real object, which can be obtained by laboratory scanning of the mouth model, in the in vitro study model.¹⁵

Among the various laboratory scanner models available on the market, the InEos X5 was chosen due to the good optical characteristic of blue light, added to the good trueness and precision indices to generate the master file.^{14,17,18} Regarding intraoral scanners, the Virtuo Vivo model was recently incorporated into the market, but recent studies show good performance when compared to other models of intraoral scanners.^{19,25} Therefore, it becomes important to develop more studies that demonstrate its accuracy in scanning.

In general, some studies evaluated factors that may influence the accuracy of scans, such as: substrate, operator experience and scanner used.^{7,20} In implant prostheses, in vitro studies present in the literature used different SB models for

accuracy analysis.^{11,15,21} However, there are few studies that evaluated the influence of the SB material on this factor.¹⁰ The presence of scanning errors resulting from the impossibility of capturing the entire surface of the SB is another factor that is rarely addressed.²⁶ This can occur due to the sum of factors such as: the difficulty of accessing the scanner due to the anatomical conditions of the region, the possibility of generating distortions or even the weight of the file, since all these factors impair the fidelity of the scan.^{20,26}

In view of the entire context addressed, the research group opted to reproduce a scenario with great similarity to the clinical scenario on the mannequin, including the common difficulties during the procedure, even in the case of an *in vitro* study.

As for the presence of error, the data obtained in this study showed that the groups with errors had lower discrepancy values when compared to groups without errors. This fact is contrary to what is found in the literature.²⁶ This can be explained by the different way in which the errors were created, considering that studies that simulated the error by erasing part of the mesh found different results, correlating the presence of the error to higher discrepancy values.²⁶ In addition, the development of the error in the chamfer region, which is important for the alignment of the CAD software, may also be another factor that explains the difference in the findings.²⁶ As the present study sought a scenario close to the clinical reality, the lingual error without affecting the chamfer region would be more common and less harmful to the alignment of the software. In this context, not scanning the face opposite to the position of the chamfers can speed up the scanning process, in addition to making it simpler and with less chance of discrepancies. As the present study sought a scenario close to the clinical reality, the lingual error without affecting the chamfer region would be more common and less harmful to the alignment of the software. Therefore, not scanning the face opposite to the position of the chamfers can speed up the scanning process, in addition to making it simpler and with less chance of discrepancies, since the files tend to be lighter and with lower levels of image overlap.

Considering the SB material, monolithic samples of different materials were used. In this context, the findings of the present study did not show a significant

difference between the materials. These results are contrary to those found in the literature.¹⁰ This fact may be related to methodological differences due to the scanning of total and partial arches, in addition to the difference between dentate and edentulous arches. Therefore, with regard to the material, the use of Titanium SB presents additional advantages related to their use due to the possibility, according to the manufacturer, of reusing them through sterilization. In addition to the possibility of being radiographically identified, which currently does not happen with PEEK SB.

It is observed that such findings should be considered with parsimony in relation to clinical applicability, since this is an in vitro study carried out with specific models of scanners and SB. In addition, the manufacture of prostheses would also be influenced by other steps within the CAI/CAD/CAM flow. In this scenario, little is known about the real influence of the factors addressed in this study on the final result of rehabilitation. Since only the scanning factor was addressed, there is still a need to better understand the interaction between the other stages of the digital workflow. Therefore, future studies should seek to evaluate the relationship between mesh analyzes performed in 3D discrepancy software and the other stages of the flow, mainly by conducting clinical studies that identify the real relevance of such findings in the long-term success of rehabilitations on implants made by the CAI/CAD/CAM system.

CONCLUSIONS

Due to the limitations and findings inherent to the present study, it is concluded that:

- The accuracy of SB partial arch scans was influenced by the presence of errors, and the presence of errors generated less discrepancy in the evaluated files when compared to groups without errors.
- There was no significant difference in relation to the SB material used.

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Figure 1 - Scheme representing the workflow. (A) Master model with the abutments in place. (B) PEEK scanbody. (C) TI scan body. (D) InEos X5 laboratory scanner. (E) master file. (F) Virtuo Vivo intraoral scanner. (G) scan file without error. (H) Scan file with error. (I) Analysis in Geomagic Control

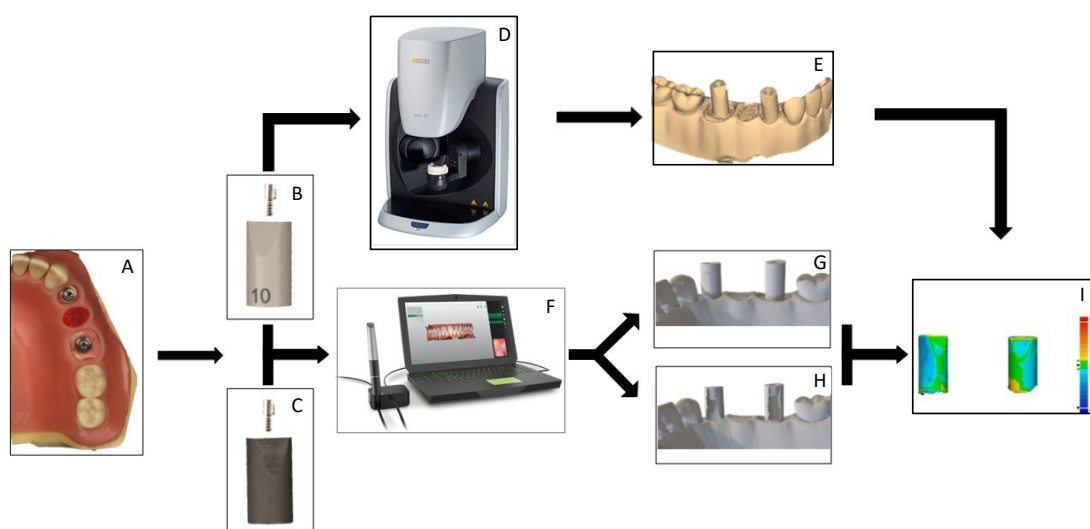


Figure 2 – Master model with missing teeth in the region of elements 44, 45 and 46



Figure 3 – Master model with pillars positioned in the region of elements 44 and 46 simulating a splinted prosthesis rehabilitation.



Figure 4 – Representative image of analysis of three-dimensional discrepancies in Geomagic Control software.

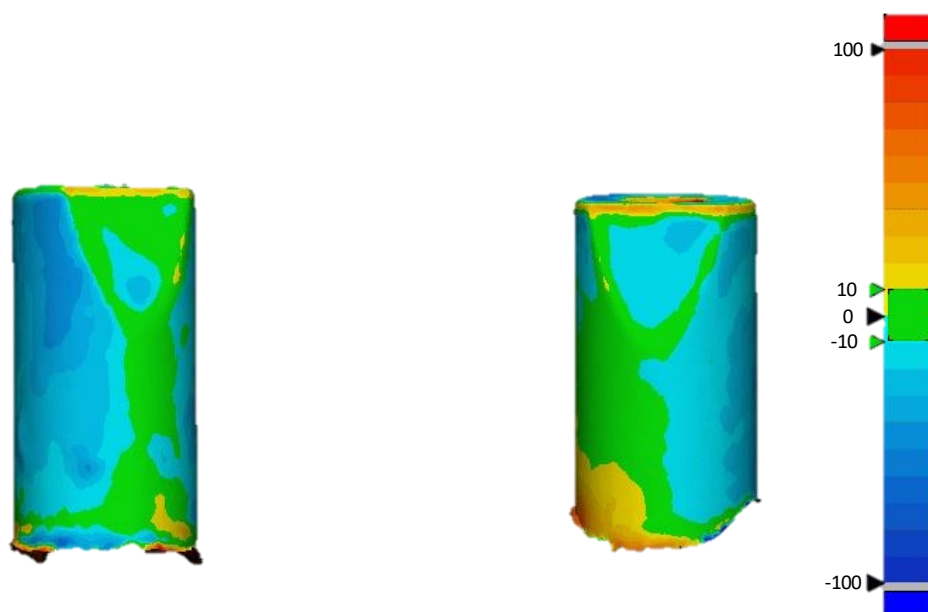


Figure 5 – Distribution of data related to the precision parameter.

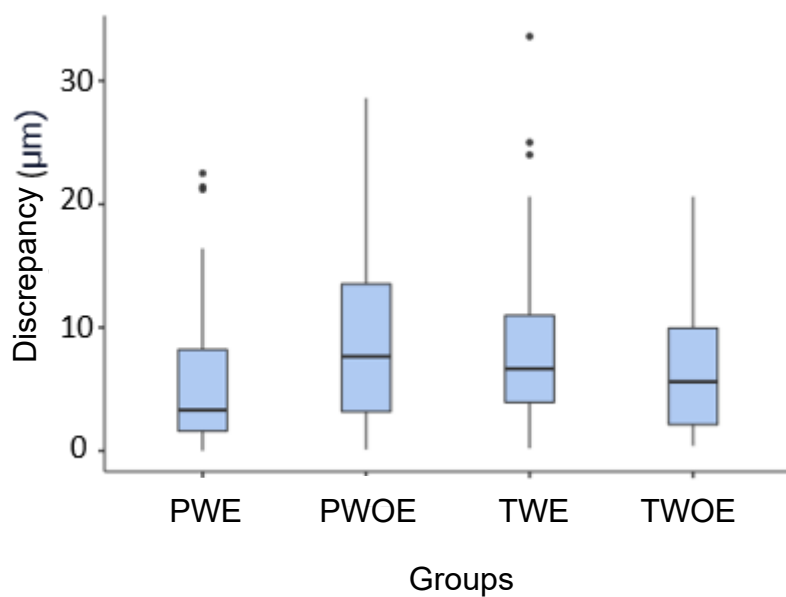


Figure 6 – Distribution of data related to the trueness parameter.

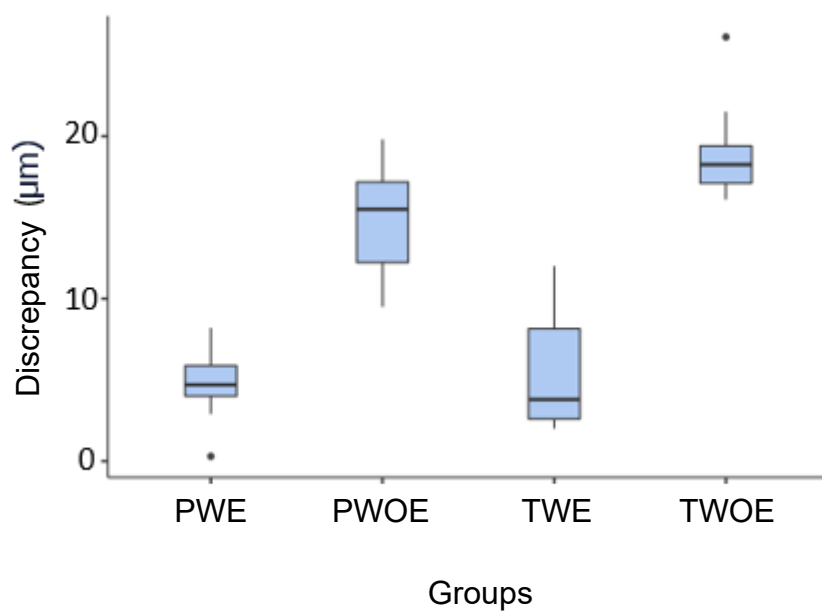


Table 1 – Precision data estimated in μm .

GRUPO	Média	Mediana	Desvio padrão	Limite inferior	Limite superior	25th	75th
PSE ^a	8.73	7.65	6.63	7.30	10.17	3.17	13.52
TCE ^a	8.40	6.65	6.46	6.97	9.84	3.92	10.98
TSE ^{ab}	6.36	5.60	4.75	4.92	7.80	2.13	9.95
PCE ^b	5.52	3.30	5.70	4.08	6.96	1.60	8.20

Table 2 – Trueness data estimated in μm .

GRUPO	Média	Desvio padrão	Limite inferior	Limite superior
TSE ^a	19.04	2.93	17.08	21.00
PSE ^a	14.95	3.33	12.99	16.91
TCE ^b	5.40	3.53	3.44	7.36
PCE ^b	4.81	2.30	2.85	6.77

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