ORIGINAL ARTICLE

HIGHLIGHTING THE MARGINAL PREPARATION ANGLE OF DENTAL ABUTMENT USING DIGITAL METHODS

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Abstract: *Background*: The digitalization of the dental field has highlighted the importance of digital techniques that modify and improve the treatment process of various cases, from diagnosis to execution and maintenance. *Aim*: The study objective was to evaluate the accuracy and practicality of digital technologies, as well as their method of drawing the margin limits of abutment preparations. *Methods*: The following types of virtual models with different impression procedures were included in the study: (1) Plaster models obtained from classical intraoral impression; (2) Virtual models obtained from intraoral scanning; (3) Virtual models obtained from intraoral scanning in addition to classical impression scanning. The marginal line was drawn using the Exocad v3.2 Elefsina design software. *Results*: After applying the study criteria, 25 intraoral impressions of each type of impression (classic, digital and combined) were selected. Scanned images of the impressions were used to outline the particularities of the margin line limits depending on the type of intraoral impression used. *Conclusions*: Digitally highlighting the cervical limit of the coronal abutment preparations can also be done on a plaster model scanned in the dental laboratory, but the existence of an intraoral scan provides more information that helps the dental technician to get closer to clinical reality.

Keywords: CAD/CAM, digital impression, analog impression, accuracy, margin line.

1. Introduction

The evolution of digital technology creates interesting opportunities for improving restorative dentistry. Digital systems now offer the chance to avoid traditional impressions, including conventional impression materials, associated time, and manipulation limitations. Intraoral scanners have the potential to provide excellent accuracy, a more comfortable experience for the patient, and a more efficient data flow for the practice [1].

Using a high-performance intraoral scanner, it is now possible to quickly send a digital impression, made directly in the office by the dentist, electronically to the dental laboratory. The digital technological workflow materializes the virtual reality that begins with the optical impression of the prosthetic field in the office, continues with the use of virtual articulators and the creation of a 3D design of the prosthetic restoration, and ultimately concludes with the manufacturing of real prosthetic work, either through milling or additive technologies guided by dedicated software [2].

One of the important factors in making dental restorations through the digital workflow is the accuracy of intraoral scans. [3-5] If accurate scans are not performed, adjusting the dental restauration can take a long time and, in complex cases, it may need to be remanufactured. The accuracy of intraoral scans can vary depending on various conditions, such as the scanning method [5], the lighting conditions over the scan [6,7], the accuracy of the type of intraoral scanner [3,8] and saliva interference [9,10].

One of the important analyses regarding the accuracy of intraoral scanning is the area of marginal line placement, and studies have shown that the marginal line placed supra-gingivally presented better accuracy, and the marginal line placed sub-gingivally presented inaccurate accuracy [11,12].

For dental restorations whose marginal line must be drawn sub-gingivally, in the case of intraoral scanning impression, gingival retraction is necessary so that the digital impression can be accurate [11,13,14]. The gingival displacement cords dislocate the gingival margin apically and expand the gingival sulcus to increase the surface of the abutment that the IOS light beam can reach. When gingival retraction was used, the accuracy of the impression was found to be increased. This indicates that the presence or absence of gingival retraction can affect the accuracy of impression [11,12].

The digitalization of the dental field has highlighted the importance of digital techniques that modify and improve the treatment process of various cases, from diagnosis to execution and maintenance.

The purpose of this paper is to evaluate the accuracy and practicality of digital technologies, as well as their method of drawing the margin limits of abutment preparations.

The null hypothesis of this study is that the drawing of the marginal line limit depends only on the quality of the intraoral impressions regardless and not on the design software.

2. Materials and method

This study is retrospective and was conducted between 01.02.2025 and 01.05.2025. The techniques for drawing marginal finish lines for dental restorations were analyzed depending on the type of

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intraoral impression and the software application used. Ethics Committee Opinion, 65/29.01.2024.

Dental intraoral impressions

The intraoral impressions used for the study were those taken through the classical procedure and those taken through digital intraoral scanning.

Dental hardware and software applications

The Medit i700 intraoral scanner and Medit Link v.3.3.6 software (Medit, Seoul, Republic of Korea) were used in the dental office workflow (Figure 1).

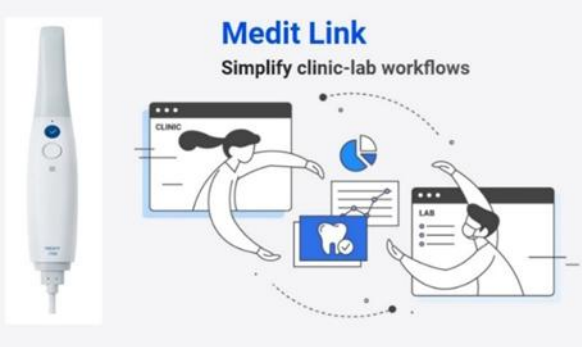

Figure 1. Medit i700 intraoral Scanner and Medit Link software.

The marginal line was drawn using the Exocad v3.2 Elefsina design software (Darmstadt, Germany) (Figure 2).

Study criteria

The following types of virtual models with different impression procedures were included in the study: (1) Plaster models obtained from classical intraoral impression; (2) Virtual models obtained from intraoral scanning; (3) Virtual models obtained from intraoral scanning in addition to classical impression scanning.

The three intraoral impression methods consist of dental office workflow stages, followed by workflow stages specific to the dental laboratory.

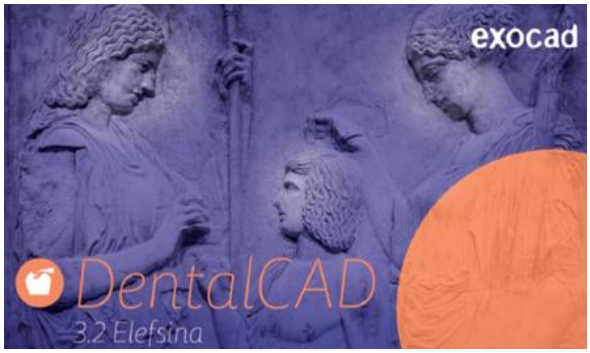

Figure 2. The difference between maxilla or mandible for the implants' placement.

Margin line on scanned Plaster models obtained from classical intraoral impression

Although there are many dental offices that have digital intraoral scanners, in most dental offices, the classic impression remains the main method of intraoral impression. On the other hand, most dental laboratories have implemented digital technology, due to the precision and quality of dental restorations made through this procedure.

Thus, in this situation, the impression is obtained in the classical way in the dental office using conventional impression techniques and materials. After that, in the dental laboratory a plaster model is obtained, then is scanned and the digital stage of creation starting at this moment in the Dental CAD software Exocad Elesfina v3.2 (Figure 3).

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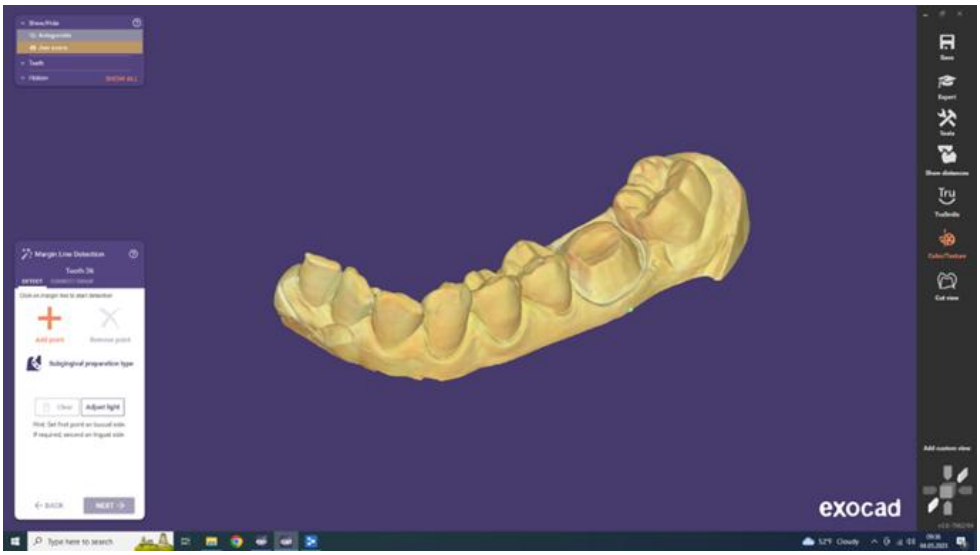

Figure 3. Overview of the digital model obtained through classic intraoral impression.

Margin line on Virtual models obtained from intraoral scanning

Intraoral scanning currently allows the dentist to draw the marginal line using the Margin Line application integrated into the Medit Link software (Figure 4). Medit Margin Lines option allows to create margin lines automatically or manually. This is an advantage for the dental laboratory to import a margin line already drawn in dental office, thus eliminating any possible error in correctly drawing the marginal line that would only be achieved in the laboratory.

Figure 4. Overview of Margin Line app in Medit Link.

If the marginal boundary is not drawn in the dental office, this will still be done in the dental laboratory to create the dental restoration. In the Exocad software, the first step in the construction is the preparation margin detection (Figure 5). In most cases, the Wizard will prompt you to define the margin line for a specific tooth. Margin line can be detected automatically or drawn manually.

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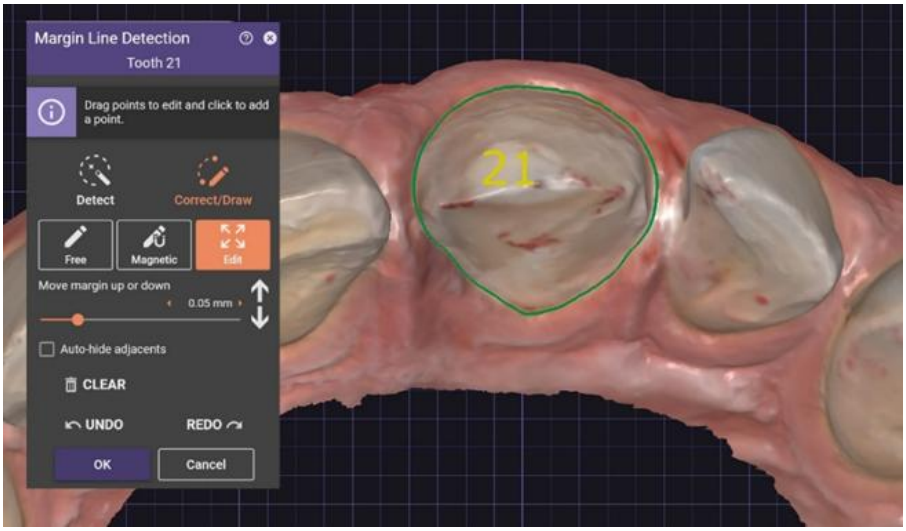

Figure 5. Exocad Margin Line – Detect/Draw.

Virtual models obtained through intraoral scanning combined with classic impression scanning.

The accuracy of intraoral scanning is undeniable, but the way the dental office manages intraoral scanning methods is very important for achieving dental restoration in dental laboratory.

Due to bleeding or saliva, the intraoral scanner cannot scan subgingival, and this type of impression (Figure 6 A) cannot be used for dental restorations that are intended to be inserted subgingival. For this type of subgingival inserted dental restorations, gingival retraction is necessary for the digital impression to be accurate. Gingival displacement cords displace the gingival margin apically and expand the gingival sulcus to increase the abutment surface area that the intraoral scanner light beam can reach (Figure 6 B).

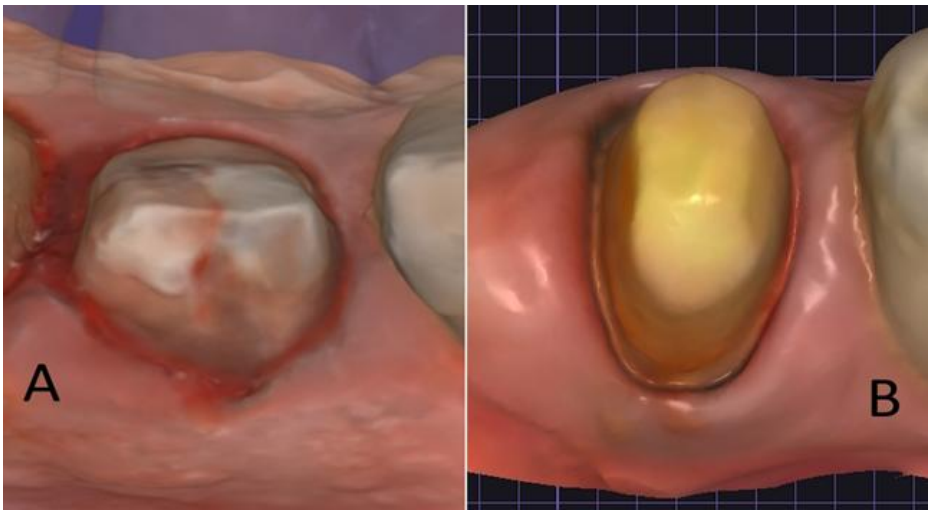

Figure 6. Intraoral impression with saliva (a); Intraoral impression with subgingival cord (B).

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When multiple teeth are prepared, it is possible, but difficult, to obtain a subgingival digital impression. The alternative is to scan a classic impression that perfectly fits the digital impression, thus resulting in a subgingival digital impression (Figure 7).

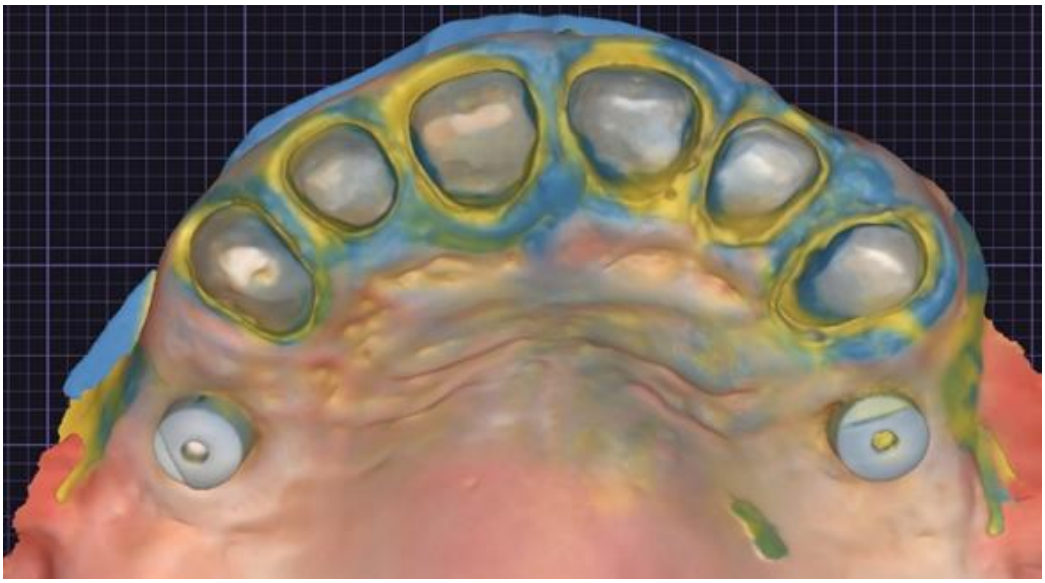

Figure 7. Digital impression scan combined with analog impression.

3. Results

After applying the study criteria, 25 intraoral impressions of each type of impression (classic, digital and combined) were selected. For this article, we will exemplify through images the particularities of the margin line limits depending on the type of intraoral impression used.

For plaster models obtained from classical intraoral impressions, we chose to evaluate this standard method of digital recording of the cervical limit of the preparation using the case presenting a standardized preparation at the level of the lower left 1st molar 3.6 to create a monolithic zirconia crown.

Exocad offers the possibility to draw the marginal line automatically (Figure 8 A), trying to detect it, but on plaster models, I drew the marginal line manually point by point (Figure 8 B). Automatic detection was only possible when the plaster model had a movable abutment.

For intraoral scans, the marginal line is drawn by detection when the tooth preparation is highlighted supragingival. When the tooth preparation is subgingival, then the marginal line is usually drawn manually.

For virtual models obtained from digital intraoral scanning, we choose to present a case with supragingival preparation on mandibular tooth 4.5 (Figure 9A) and a case with subgingival preparation on mandibular tooth 4.5 (Figure 9B). Exocad offers the possibility to detect the subgingival marginal line, but every time we had to make manual corrections.

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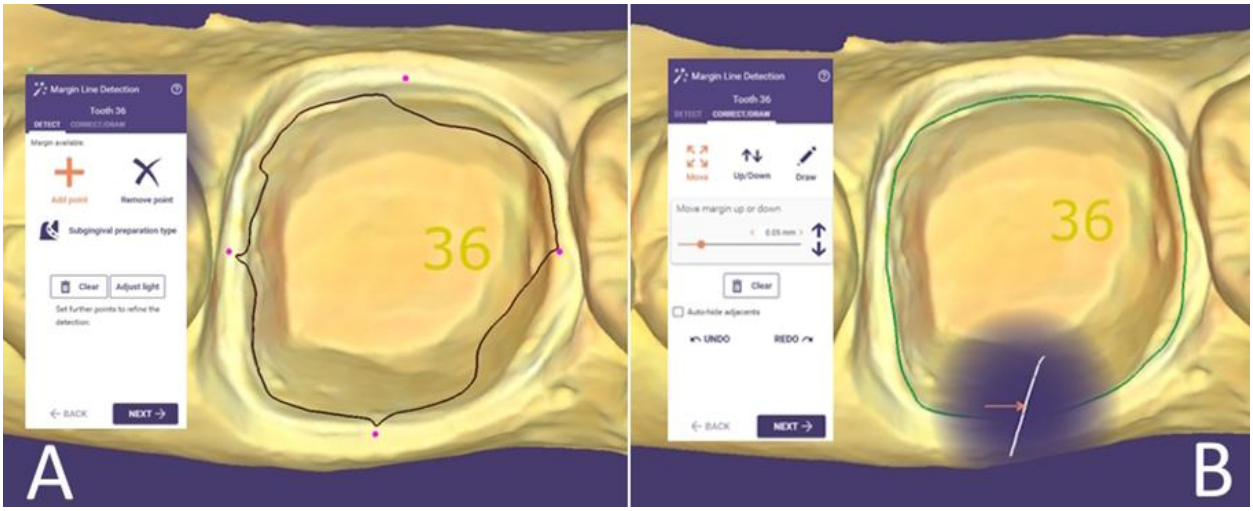

Figure 8. Margin line Detect (A); Margin line Draw (B).

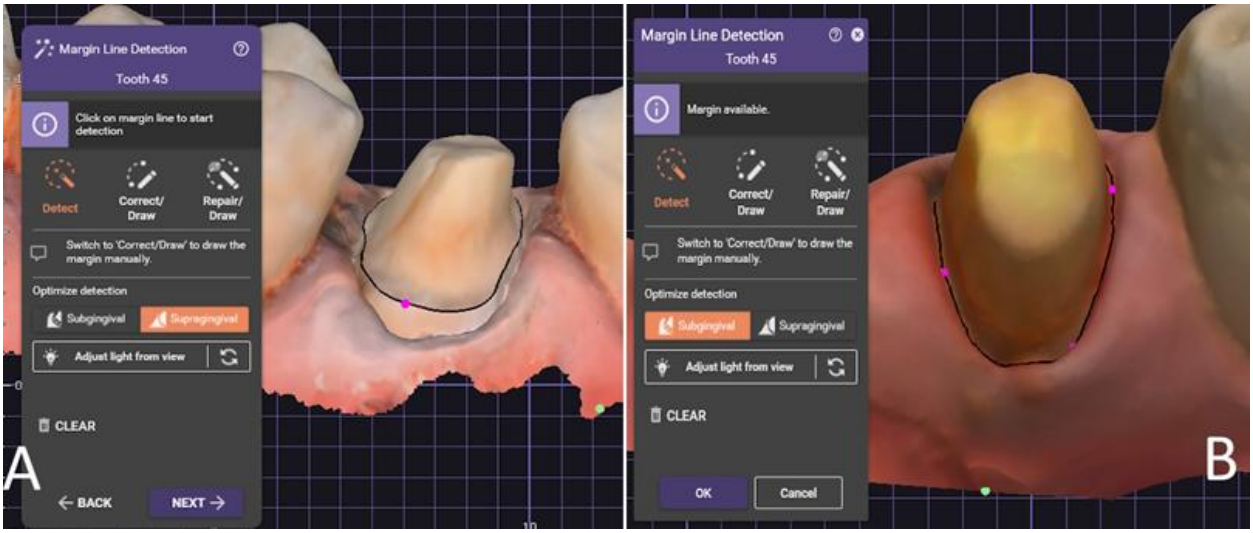

Figure 9. Supragingival Margin Line Detect (A); Subgingival Marginal Line Detect/Correct (B).

For virtual models obtained through intraoral scanning combined with classical impression scanning we chose to present a case in frontal area 1.3 – 2.3 where it was desired that the marginal line be drawn subgingival. Retraction cords were inserted in all 6 prepared teeth (Figure 10A). Although it was possible to scan subgingival tooth by tooth after removing each cord, it was decided to take a classical impression and then scan it to highlight the boundary delimitation for the marginal line (Figure 10B). The Exocad workflow consisted of automatically detecting marginal lines, then correcting them.

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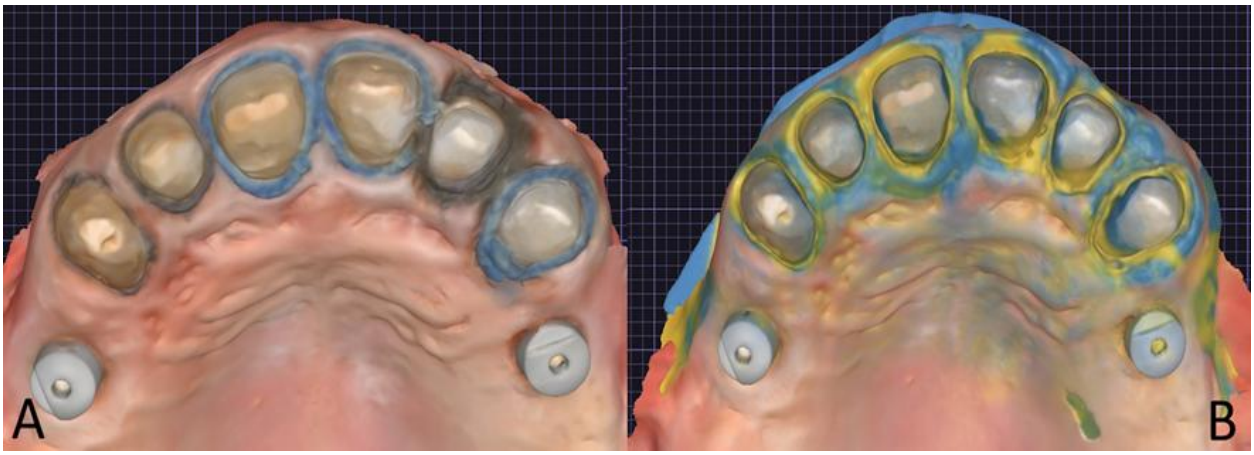

Figure 10. Intraoral scan with cords (A); Intraoral combined digital and classic impression (B)

4. Discussion

In our study in which we had to analyze the marginal line limit on different types of virtual models, we observed that digital technology offers concrete possibilities for each of these - virtual models obtained through classical impression taking, virtual models obtained through digital impression taking through intraoral scanning, and virtual models obtained by combining the two types of impression, classical and digital.

Previous studies have confirmed the results of the accuracy of virtual models obtained by intraoral scanning compared to virtual models obtained by classical intraoral impression [15,16], but studies on the evaluation of the fidelity of intraoral scans in the dental office or laboratory scans of plaster models depending on the location of the marginal line are still insufficient [17].

In a study by Chochlidakis et al., it was shown that the mean marginal adjustment using digital and conventional impressions did not show a significant difference, and both methods were within the clinically acceptable range [18].

In a meta-analysis conducted by Tsirogiannis et al the mean marginal gaps in digital and conventional methods were 63.3 and 58.9 μm, respectively, but the difference between the two groups was not statistically significant [19]. Regarding classic intraoral impressions, they can indeed record subgingival boundaries, but they may have certain volumetric limits, additionally creating discomfort for patients [15,20].

On the other hand, regardless of the type of intraoral scanner and the surface evaluated, subgingival scanning presented lower accuracy in contrast to the precision of supragingival scanning [8,21].

Similar findings have been reported previously, and the authors correlated the subgingival finish line with poor scanning accuracy and recommended gingival displacement to improve accuracy [11]. The scanning performance of an intraoral scanner is directly affected by an unrestricted viewing angle and an appropriate angle of incidence of the light source. Improved dental restauration fit has also been reported when preparations with easily detectable margin lines, which do not have deep and subgingival finish lines, were digitized using intraoral scanners [22-24]. As shown in the other studies, the dental restorations with a supragingival finish line

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could be more accurate than the others because the direct line of sight to the intraoral scanners could ensure the accuracy of the scan [25-28].

Studies on marginal line drawing are limited because intraoral impression methods, materials used, and intraoral scanners are different. Therefore, any comparative studies must take these variables into account [29,30].

Taking into account all these aspects presented in various studies, the drawing of the marginal line depends on the accuracy of the intraoral impression regardless of the impression-taking method, and not on the CAD design software, which leads to the acceptance of the null hypothesis.

5. Conclusions

Digital methods have already entered the daily workflow of dentistry, especially in the case of fixed dental prostheses, both in the dental laboratory and in the dental office.

Although dental restorations are performed by the dental technician, the dentist must be aware of the technical possibilities of implementation and be able to collaborate directly in this important stage for the success of the prosthetic treatment.

Correctly highlighting the cervical limits of the coronal abutment preparations is the basis for obtaining an optimal marginal adaptation that will ensure the success of the prosthetic restoration.

Digitally highlighting the cervical limit of the coronal abutment preparations can also be done on a plaster model scanned in the dental laboratory, but the existence of an intraoral scan provides more information that helps the dental technician to get closer to clinical reality.

The software used for intraoral scanning has functions that facilitate the drawing of the cervical limit of the preparations of the coronal abutments by the dentist in the dental office on the obtained image.

Digital methods facilitate the drawing of a cervical limit of the preparation both in the dental laboratory and even in the dental office and their use improves the communication between the dentist and the dental technician to achieve the common goal of obtaining an optimal dental restoration.

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Author contributions

All authors have read and approved the final manuscript. All authors have equally contributed to this work.

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Conflict of interest statement

The authors declare no conflicts of interest concerning this study.

Data availability statement

Will be provided on request.

Ethics statement

Approved by the Scientific Ethics and Deontology Commission of UMF Craiova (no. 65/29.01.2024).

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