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Review Article

The Effect of Digital Impressions on The Marginal Seal of Full Ceramic Crowns: A systemic Review

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ABSTRACT:

Purpose: A group of three-dimensional imaging techniques have been introduced and these techniques have revolutionized dentistry in general and dental prosthodontics in particular. This has led to an increase in the accuracy of traditional restorations, in addition to providing a virtual framework that includes all treatment strategies, from designing and manufacturing restorations digitally. On the other hand, the challenges related to obtaining oral impressions using traditional methods were highlighted through the use of intraoral scanners (IOSs), as this technology is considered more comfortable and convenient for patients and doctors(1).

Aim: This scientific paper aims to conduct a review of digital impression systems, their advantages, and disadvantages, as well as to evaluate the importance of the marginal seal of full ceramic crowns and to study the impact of digital impressions on them.

Methods and Materials: original scientintific papers on effect of digital impressions on the marginal seal of full ceramic crowns published in the MEDLINE

Conclusion: There is no unison on what nominate a clinically acceptable maximum margin gap width. Furthermore, there is high widely between the systems and methodologies within the different studies which making it difficult to achieve direct comparison between the results of the academicals works. Based on the results of this systematic review all studies appear to indicate a predictable margin gap within or near clinically acceptable thresholds.

Keyword: impression, intra oral scanner, 3Dimaging, all ceramic restoration, marginal seal

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INTRODUCTION

Intraoral scanners (IOS) defined as devices for capturing direct visual impressions in dentistry[2] as they rely on shining a light source (such as a laser) on the object to be scanned, which in this case is Dental arches, including teeth intended for fixed dental prosthetics[3]. Scanning software is used to process images of the gingiva and teeth captured by imaging devices, which generates point clouds, creating three-dimensional models (meshes)[4]. The three-dimensional models of the periodontal tissues are the result of the visual impression and are the "virtual" alternative to traditional plaster models[5].

Intraoral digital scanners are first-class medical electrical devices were each scanner consists of three main components: a wireless portable workstation to support data entry, a computer screen to enter prescriptions - approve scans - review digital files, and a handheld camera to collect scan data from the patient's mouth where energy is projected to collect surface data points with the aid of the laser or any white light from the handpiece onto an object hence it reflected back to a sensor or camera inside the handpiece. Based on algorithms, tens or hundreds of thousands of measurements are made per inch which results in a three-dimensional representation of the object. The technology used by the handle to capture that surface data determines the speed of measurement and the stability and accuracy of the scanner. Currently, four types of imaging techniques are used[6]:

Optical coherence tomography:

Technique seeks to obtain high-resolution images for the anatomical details of living. Optical tomography considered to be similar in technique to ultrasound imaging yet it uses the light first and then sound waves to transfer and project the image. Both of the Scattered radiation and reflected waves technique are invented in 1991 and has emerged as a diagnostic tool for cases where excisional biopsy is undesirable and difficult, and used to generate realistic, microscopic-like images with detailed measurements of the body, each of the technique offers a resolution ranging from 1 to 15 mm, in addition to providing the advantage of penetrating to a depth of 3 mm into living tissue because of their large wavelength. Those technique have been furthermore used in intraoral digital impressions where scanning can accurately replicate the anatomical structure to create a digital model of the prepared tooth[7].

Triangulation:

Useful imaging technique for measuring objects from millimeters to microns. Wet surfaces of flexible objects and small objects can be scanned accurately using the built-in sensors, where direct contact is not suitable. The triangulation imaging system consists of a laser light source, a high-power lens, and a high-sensitivity receiving plate. The light from the source is projected onto a point on the object to be scanned and reflected to the sensitive plate, and the distance is calculated according to specific algorithms [7].

Parallel confocal imaging:

Technique includes a filter with a small hole through with laser beam penetrates the target tissue. Here-In, in the center of the target we note the receiving sensor unit with a small opening placed in front in order to avoid any stray light above and below the specified level, these technique provide a reconstruction mechanism in order to represent the scanned images, where the focused light re-enters the target tissue and removes all focal light, and as a results we obtain a precise and perfect scan of the tissue details after the sectioning and reconstruction method. Even more in this technique we observe an elimination of the unwanted rays which considered the main advantage of this technique [7].

Accordion fringe interferometry:

Imaging technique exploit of the existence of two different light sources to display three different patterns which are called a marginal pattern because it splits and reshapes to take on a new pattern when it falls onto the surface to be scanned,. The new shape is due to the unique curvature of the scanned object were edge curvature defined as a deformation in the original pattern of the scanned object. A high-resolution camera with video capability successfully records a specific point and the fringe curvature features[7].

Three-dimensional in-motion video:

It consists of a three-minute video camera built into the lens. Based on the principle of 3D imaging, a high-resolution video camera with 3D imaging is used to capture the fine details of the scanned object. Light is converted into electrical energy in the form of electrical signals with the help of a metalsemiconductor-based sensor located next to the camera. It captures 3D data to obtain a realistic image. It does not require powder spraying[7].

Digital printing units:

These units consist of two main categories of digital printing systems, one of which allows obtaining digital data only and is called the impression only system, and the other allows obtaining digital impressions in addition to the ability to design restorations digitally and then mill the restorations in the clinic (CAD/CAM systems)[8], as impression-only systems do not have the ability to design or manufacture restorations so the digital information obtained from them must be sent to a qualified online dental laboratory to process the restoration. Hence, a temporary replacement must be placed on the abutments and the patient will need to return for the final restoration. An example of such a device is the True Definition system, 3M, USA. On the other hand, CAD/CAM impression systems allow for single appointment treatment, i.e., the patient receives the final restoration in the same session.

Advantages of digital printing:

Dental impressions, whether digital or conventional, aim to obtain a copy of the prepared tooth or teeth as well as record the occlusal relationship of those teeth. This means that obtaining a good impression is a fundamental criterion for the longevity of the restoration[9].

The digital printing has many advantages, as defined by Suese (2020)[10]:

More acceptable and comfortable for the patient: Traditional impressions require placing materials in the patient's mouth for several minutes until they are completely solidified, while digital impressions do not require these materials. They are more acceptable to patients, especially elderly patients and those who suffer from a severe gag reflex. However, they require some training, and with practice, an impression of the jaws can be obtained in a few minutes.

Reducing the burden on the dentist and the laboratory: Reaching the final restoration requires very precise stages, including taking the impression traditionally, cleaning it, storing it, transporting it to the dental laboratory, pouring it, and following up on laboratory procedures. These stages are exhausting for both the dentist and the laboratory, but the digital impression does not require these complex procedures, as it is sent electronically for follow-up on the laboratory stages.

Reducing the risk of infection transmission: Traditional impressions require sterilization of the trays before use, disinfection of the impression after removing it from the mouth, the possibility of transmitting the infection to the laboratory, cleaning the trays, and removing the residual impression material after completion for re-sterilization. These procedures are time-consuming and expensive as well. Digital scanner heads are sterilizable, and the resulting 3D images from the scanning process can be sent to the laboratory digitally, so there is no need to handle the impression materials or models.

Direct impression error detection: The traditional impression is checked after it is cast in plaster to ensure its accuracy, while the digital impression enables us to detect problems directly on the scanner screen and correct them.

Simple copying and selective scanning: Traditional impressions require a complete redo when they contain errors, whereas the digital impression can only selectively scan questionable areas. Only small areas of the prepared tooth and its adjacent and opposite parts can be scanned without scanning the entire mouth.

Ease of archiving: Digital impressions can be controlled and stored for long periods as digital files can be retrieved at any time, unlike traditional plaster models that require space to store and are difficult to retrieve after a while, and may break if poorly stored.

Disadvantages of digital editions: (Suese, 2020)[10]

The need for training in the use of the intraoral scanner to obtain an accurate digital dental impression.

The necessity of ensuring a dry and visible workspace, as the area to be scanned must be visible to the doctor. Oral fluids may cause measurement errors due to light reflection, in some cases, so it is necessary to control the humidity.

Establishing a fixed occlusal position; the occlusal position taken by the intraoral scanner cannot be changed or moved to a dynamic occlusion position. However, some CAD/CAM systems have a virtual applicator that supports the modification of jaw movements.

The financial cost, as purchasing an intraoral scanner requires a significant upfront investment.

An overview of the most popular intraoral scanner systems

(iTero) System:

Digital scanning system (iTero, Cadent, USA) introduced in the early 2007 and after 5 years of extensive research and experimental testing based on the “parallel focal light” hypothesis. The scanner emits a beam of light through a small hole in this system were any surface within a certain distance will reflect the light back towards the handpiece[11].

(Lava C.O.S) System:

Method that have been used in Lava Chairside Oral Scanner to obtain 3D impressions which based on taking active wave in front of the samples which allows the 3D imaging technology to be in motion(11) (TRIOS) System:

Intraoral scanning system provide TRIOS Ultrafast optical division and true color technology which produces images that look like real teeth through a system combines hundreds to thousands of 3D images to create the final 3D digital impression. TRIOS is designed to integrate with the clinic management system and work with the required laboratory procedures[6].

(CEREC) and (Apollo) Systems:

Irina, USA, has introduced a complete range of digital impression systems. Thanks to its color flow technology, CEREC allows continuous video capture of the oral cavity. The camera must be moved between 0 and 15 mm above the tooth surface during scanning, and it is not necessary to apply any powder or opacifying agent during scanning. Apollo is known as the approximation of the lines of digital impression systems and is described as an economical entry into the world of digital impressions, including an imaging unit, APOLLO DI software, and an APOLLO DI intraoral camera.

Apollo scans are performed in black and white[11].

(I500) System:

The i500 Media scanner was produced by Medit in 2018. The i500 consists of a 280g handpiece with serializable heads, a desk base to hold the device in place, a USB3 connector, and a power cable. The scanner head is small to simplify the scanning process and has two high-speed cameras and a blue LED light for scanning dental tissues. White light can be used for better scanning of soft tissues[6].

METHODS AND MATERIALS

Search Strategy and selection criteria

Before the initiation of the literature search, a protocol to be followed was agreed upon by the authors. An electronic search through MEDLINE (PubMed) using Boolean operators. The following keywords were combined: impression, intra oral scanner, 3Dimaging, all ceramic restoration, marginal seal, fit gap.no publication year limit was used. The purpose of the search was to obtain all the vitro and in vivo articles on the effect of digital impressions on the marginal seal of full ceramic crowns. The search included articles published in the dental literature up to 2023and was limited to peer-reviewed articles written in English- language, which contained all or part of the key words in their headings. The electronic search was supplemented by manual searching through the following journals: Journal of oral rehabilitation, The Journal of prosthetic dentistry, Journal of Prosthodontic, J Prosthet Dent, Austin Journal of Orthopedics & Rheumatology, Journal of Oral Pathology & Medicine, J Contemp Dent Pract, Dent Mater J, International Journal of Prosthodontics, Int J Comput Dent, J Adv Prosthodont, Journal of Applied Oral Science. Dental Materials Journal, J Clin Med, Australian dental journal, The Journal of Korean Academy of Prosthodontics.in addition, the references of the selected articles were reviewed for *possible inclusion.*

The occlusion of any fixed prosthesis is determined by the occlusion of its margins at the cervical borders of the abutment, its internal occlusion at the abutment walls and its occlusal surface [12]. The gap between the margins of the prosthesis and the edges of the preparation acts as a point of contact with the oral environment once the prosthesis is placed in the mouth[13]. Therefore, malalignment of the margins results in the dissolution of the bonding cement, and thus increased microscopic infiltration of bacteria and their products[14]. As a result, the tooth becomes more susceptible to secondary caries and margin discoloration[15], and the chance of pulpitis and dental sensitivity in living teeth increases[16]. The presence of a large margin gap favors the accumulation of bacterial plaque, which is a cause of gingivitis and the development of periodontal diseases[17]. Thus, it can be said that the lack of marginal occlusion can lead to negative results that may cause the failure of the restoration[15], as studies have shown that vital failure is the most common reason for crown replacement[18]. In addition, the internal malocclusion of fixed restorations leads to an increase in the thickness of the cement layer, which negatively affects the mechanical properties of these restorations in terms of their resistance and stability, and causes a significant increase in stresses within them[19]. Studies differed in determining the reference points for measuring occlusion and used different terms to describe similar measurements. On the contrary, the same term was used to describe different measurement locations. Uniformity in this review, the margin occlusion of dental prosthesis terminology proposed by (Holmes, 1989)[20] was used to discrepancy from the reviewed studies as (table1).

Table 1: Reference points for measuring the marginal occlusion of fixed prostheses according to (Holmes, 1989)

The term	The definition
Internal gap	Vertical measurement from the inner surface of the restoration to the axial wall of the prepared tooth.
Marginal gap	Vertical measurement from the inner surface of the restoration to the prepared tooth at the finish line.
Vertical marginal discrepancy	Vertical marginal malocclusion which is measured parallel to the restoration insertion line.
Horizontal marginal discrepancy	Horizontal marginal malocclusion and is measured perpendicular to the restoration insertion line.
Hyperextended margin	The vertical distance from the edge gap to the edge of the repair.
Hypoextended margin	The distance from the marginal gap to the angle of the prepared tooth.
Absolute marginal discrepancy	The line that connecting the outer edge of the restoration with the edge of the prepared tooth in both cases of lack or increase in extension, and it is specifically the hypotenuse of the right triangle formed by two right sides, one of which is the vertical marginal contrast and the other is the horizontal marginal contrast.

Methods used in the study of marginal applicability: A number of methods have been used in the published medical literature to study marginal occlusion. The simplest is the direct visualization method, which is easy, does not damage the specimen, and relies on measuring the marginal gap at predetermined points using a light microscope or scanning electron microscope. However, it can cause wear on the edges of the master specimen due to repeated use, in addition to the difficulty of determining the excessive horizontal extension of the studied edge[21].

***Cross sections*:** Specimens fixed to their twins or natural teeth embedded in resin or plaster are cut to obtain longitudinal sections through which the marginal occlusion or internal occlusion of a fixed prosthesis can be studied. This method is characterized by the possibility of determining the horizontal extension of the rim and determining repeatable measurement points. However, it is time-consuming, and the specimen is damaged by cutting, so the occlusion cannot be measured during the different stages of making the prosthesis, in addition to the possibility of the edges being distorted during cutting, and the number of measurements is limited to specific places for a single prosthesis[21].

***Replica technique*: There are two methods for measuring fit using a replica; the first method is based on an impression of the prosthetic edges using additional rubber and a special stamp. This impression is cast in epoxy resin to obtain an exact replica of the edges. Measurements are made on this replica using a scanning electron microscope or a light microscope, but the results of these measurements lack the required accuracy[22]. The second most common method is to inject additional liquid rubber into the inner surface of the prosthesis, and then return it to the model or natural tooth until it is completely hardened to represent the inner space (cement thickness) between the prosthesis and the abutment. This thin layer of liquid rubber is supported by a dense or medium-viscosity rubber of a different color. Then this mass of rubber is cut to obtain longitudinal sections through which the marginal or internal fit is studied using a microscope. This technique is reliable and non-destructive and its results can be relied upon. It is also characterized by the possibility of its application to study fit clinically, and it is non-destructive to samples and allows measurements to be made during different stages of manufacturing the prosthesis[23]. However, it may be difficult to measure the thickness of the rubber in the margin area if it is deformed [24]. It may be difficult to distinguish between the boundaries of the termination line and the edge of the prosthesis, in addition to the possibility of tearing the rubber during the removal of the prosthesis from the model [25]. Additionally, it is possible that an error in estimating the fit may occur due to an error in the rubber shear level [26].

***Visual examination*: The dentist's clinical assessment of marginal occlusion usually relies on visual examination of the margins using a probe, where a sharp probe is passed between the crown edge and the tooth edge to detect the presence of a marginal gap. This method depends largely on the sharpness of the probe tip, which decreases with repeated use, and the skill of the dentist [27]. According to Dedmon (1982)[28], a dental probe cannot accurately determine the marginal gap when it is less than 95 microns.

Other methods of measurement: Two-dimensional radiography may be used, but it lacks the required accuracy, and marginal malalignment is observed only in the adjacent areas[27]. Some researchers have also used a profilometer to measure marginal malalignment, where a fine needle tip is used that moves vertically up and down to draw the space schematically, giving an idea of the amount of marginal gap[29]. Despite the accuracy of this method, it cannot detect excessive vertical extension of the crown edges. Micro-computed tomography (MCT) has also been used in some in-vitro studies to investigate the marginal and internal fit of zirconia bridges[30]. It is one of the latest methods used to investigate the fit of dental restorations, where X-rays are projected from several angles over the entire perimeter of the sample, and then processed by a computer to obtain high-resolution three-dimensional images that are cut into very small sections. The disadvantages of this method include the difficulty of distinguishing between the internal prosthetic surface and the abutment wall, in addition to the possibility of distortion of the radiographic image[31].

Perfect occlusion for fixed compensation:

A complete fit of the restoration to the abutment without any gap is clinically inappropriate because of the need for a space to be filled with bonding cement[32]. The thickness of the cement between the inner surface of the crown and the outer surface of the prepared tooth should be uniform on all inner surfaces of the restoration, which facilitates bonding without affecting the stability and strength of the restoration[33]. A review of the literature reveals considerable controversy regarding the ideal value of this gap and its effect on success: According to the American Dental Association Specification No. 8, the thickness of the cement gap when using zinc phosphate

cement should be less than 40 µm. Others have suggested that an acceptable cement space could be 200-300 µm [34].
Regarding the controversy over the effect of the type of bonding cement on the amount of acceptable void, a study by Rossetti, Valle et al. (2008) [35]demonstrated that there were no significant differences in the value of this void when comparing zinc phosphate cement, resin cement, and resin-modified glass ionomer cement, and they concluded that the minimum value of the cement distance is independent of the type of cement studied. In general, the internal gap in the grinding surface area is considered the largest distance and ranges between 100-160 microns [36].
Referring to the results of in-vivo and in-vitro studies regarding the success of fixed prostheses, it was found that there is no absolute consensus on the clinically acceptable value for marginal occlusion. The proposed values varied greatly, and this topic has been studied extensively and has been the subject of much controversy. The value ranged between 500 - 10 microns according to Sailer,Fehér, et al. (2007). Boeckler et al. (2005) [37]indicated the diversity of the results of studies on the amount of clinically acceptable marginal gap, which ranged between 30 - 200 microns. As for Zinelis (2009), he found that the clinically acceptable marginal occlusion according to the studies he reviewed ranged between 313 - 7.5 microns. The reason for this difference may be due to the lack of standardization of the definition of the term marginal occlusion between different studies and the method of measuring this occlusion [38]. In conclusion, most researchers have now agreed on a clinically acceptable marginal gap value of 100-120 microns [39]. Most recent studies have relied on this value.

Factors affecting the applicability of fixed prosthodontics:

In this context, researchers have addressed a group of factors that play an important role in marginal and internal fit. The topics of these studies varied, with some related to preparation and impressions, some to the manufacturing method or materials used, and others to various laboratory procedures. Additionally, some studies focused on adhesiveness, its materials, and techniques. These factors are summarized in Table 2.

Table 2: Factors affecting the applicability of fixed compensation

The study	The factor that was taken up	The Result
(Boening *et al*., 2000) **(Grenade *et al*., 2011)(40)**	Tooth type (Ant/Post)	The type of tooth affects the marginal occlusion, and the reason for the effect may be due to the difficulty of preparing and obtaining an accurate impression of the posterior teeth.
(Ayad, 2009) (41)	Roughness of the preparation surface	Diamond finishing burs are superior to carbide burs in providing smoothness to the prepared surface and thus achieving less marginal variation.
(Han *et al*., 2011) (42)	Finish line shape	The shoulder finish and semi-shoulder finish achieved better edge occlusion than the simple finish.
(Song, 2000) (43)	Preparation angle	The smaller the angle of preparation, the more accurate the occlusion. When preparing at an angle of 6 degrees, the occlusion was better than when preparing at an angle of 10 degrees.
(Yüksel, 2011) (44)	Adhesion	The type of cement has no role in increasing the marginal gap, and the bonding process has no significant effect on increasing the marginal gap.

(Kaleli, 2017) (45)	Manufacturing method	Direct human intervention in crown fabrication can play a role, depending on the skill of the dental technician. The number of laboratory steps is of relative importance in marginal occlusion because the probability of error increases with each additional step required.

Comparison of the accuracy of intraoral scanners and conventional impressions:

All-ceramic restorations require certain features such as shoulder or semi-shoulder finish lines[46] and rounded linear angles[47]. The impression must accurately convey these features to ensure the durability of the restoration. Published studies indicate that some of the steps required to obtain traditional rubber impressions and cast them in plaster can cause distortion, thus reducing the possibility of obtaining a crown with well-adjusted edges[48]. Scanning relies on reading the tooth surface within the mouth using a set of scanning instruments to obtain digital data.

Studies have evaluated single abutments [49], as well as short-span bridges[50], and some studies have compared the results of a typical full-arch scans using different intraoral scanners[51]. Due to differences in methodologies, it is difficult to compare these studies individually to draw a general conclusion about the accuracy of the intraoral scanner. Syrec et al. 2010 [52] reported in their clinical study a mean marginal gap size of 49 µm for digital impressions and 71 µm for conventional impressions with no significant differences between them.

This superiority of conventional impressions was attributed to the use of metal stamps, as flexible plastic stamps would affect the accuracy of the measurements[53][54] measured the misfit of two intraoral scanners without a control group. They intended to compare the misfit found with two different intraoral digital scanners. Their results for the LAVA C.O.S. and CEREC scanners were, respectively: marginal gap 51 µm/83 µm, occlusal centrality 178 µm/230 µm and occlusal centrality 181 µm/297 µm. On the other hand, the average marginal gap width of CAD/CAM zirconia crowns in Zarauz (2016)[53] was slightly higher than the results of Syrec et al., (2010). The sample consisted of crowns with zirconia cores and feldspar-compatible porcelain, while Syrec et al. (2010) [52]used only porcelain crowns to measure the fit. This may have some effect in marginal fitness[55].

It should be noted that the accuracy of the digital impression is affected by the patient's compliance with the instructions, the location of the termination line, the gingiva health, gingival sulcus bleeding, saliva flow rate, and the ability of the scanner wand to reach the intended tooth. This ability is reduced in posterior teeth or when there is a limitation in the mouth opening[56].

Comparison of the accuracy of intraoral and extraoral scanners:

The marginal gap resulting from intraoral and extraoral scanning ranged between 16 and 80 µm and 19 and 112 µm, respectively according to the previously published academicals works and study. Even more the marginal gap of restorations made using intraoral scanners was significantly lower than the marginal gap of restorations made using extraoral scanners in some studies [57][58]. However, in one study, the marginal gap of restorations in either group showed no significant difference[59]. In another study, scanning teeth with the Lava True Definition resulted in a smaller marginal gap than scanning impressions and models using the 3Shape extraoral scanner. Furthermore, the use of the Cadent iTero intraoral scanner resulted in a smaller marginal gap compared to impression scanning but a larger marginal gap than model scanning using the 3Shape scanner[60].

Comparison of the accuracy of different intraoral scanning devices:

Reliability of intraoral scanners are effected by many factors including the scanning technology, data processing algorithm, and image acquisition method. Active triangulation which are commonly used conventional scanning technology featured by providing the highest degree of resolution. In comparison, parallel confocal microscopy does not require a specific distance for image resolution, thus ensuring accurate images regardless of whether the scanner tip is in contact with the teeth when scanning the oral cavity. Meanwhile, optical coherence tomography provides high resolution of the exact shape of the abutment by combining optical interference phenomenon and confocal microscopy technology [61]. Studies that compared similar restoration materials, abutment placement, and preparation design, but differed only in the type of scanner, were reviewed. Several studies measured the marginal gap in posterior zirconia restorations made using digital impressions[60][59]. Reported marginal gaps included 41 and 48 µm by the iTero and Lava systems, respectively (using a conventional rubber impression with 33 and 60 µm for comparing in respectively) (Seelbach et al., 2013)[57], 80 µm by the iTero scanner (compared to a conventional impression with a marginal gap of 133 µm) [53], and 195 and 176 µm by the iTero and Lava scanners, respectively (compared to 187 µm by using a conventional impression)[62]. Two studies measured the marginal gap in posterior zirconia crowns using digital impressions. The reported marginal gaps included 59 µm for the 3Shape system (compared to 71 µm using conventional impressions)[63], and 97 µm for the Lava COS system (compared to 95 µm using conventional impressions)[64]. Comparing these figures to clinically acceptable limits, it can be concluded that although there are differences in marginal fit accuracy between different types of intraoral scanners, all intraoral scanners tested fall within an acceptable range[65]. This result cannot be generalized as previous comparative studies suffer from a lack of methodological consistency, as differences in observed results can often be explained by the use of non-comparable technology and/or differences in crown preparation specifications.

CONCLUSION

Respecting Impact of software updates on intraoral scanner accuracy: Only a little information in the literature about the influence of hardware and software components on IOS performance are available[66]. Manufacturers constantly developing new generations of intraoral scanners with updated hardware, new software versions and software updates (the same generations of intraoral scanners with a new software version) aiming within their update to improve the overall performance of the intraoral scanner and its ability to capture the intraoral position in more reliably, more stably and more quickly to make digitization easier for the clinician and more comfortable for the patient[67]. A study by Schmalzl (2023)[68]evaluated two different generations of intraoral scanners: the 3Shape Trios 3 and 3Shape Trios 4 on the marginal fit of fixed prostheses. A generation change occurs when the manufacturer upgrades an existing scanner (previous generation) in terms of both hardware and software, creating a new version (new generation model). The study concluded that new generations of intraoral scanner hardware and software can significantly increase the accuracy of the devices when it comes to scanning an entire dental arch, while all versions produce a clinically acceptable digital impression of a single abutment.

At present, there is no unison on what nominate a clinically acceptable maximum margin gap width. Furthermore, there is high widely between the systems and methodologies within the different studies which making it difficult to achieve direct comparison between the results of the academicals works. However, all studies appear to indicate a predictable margin gap within or near clinically acceptable thresholds. There were several limitations to the current studies: measurements were made without crown fixation which makes the increase in marginal gap width caused by fixation not taken into account. Furthermore, the conventional impression procedure could not be repeated without significantly increasing patient burden and discomfort, and was therefore considered an unsuitable procedure for clinical practice. Finally, as mentioned earlier, the use of flexible plastic tray can affect the accuracy of conventional impressions. Further clinical studies are needed to determine the accuracy of digital impressions in more extensive treatments in fixed prosthetic dentistry, as well as for implant impressions.

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