COMPARATIVE IN VITRO STUDY BETWEEN DIGITAL AND CONVENTIONAL IMPRESSION TECHNIQUES FOR ARTIFICIAL MAXILLECTOMY DEFECTS

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ABSTRACT

Comparative in vitro study between digital and conventional impression techniques for artificial maxillectomy defect

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Background: The trend in using 3D digital dental technology has increased in the past two decades, however, its application in prosthetic rehabilitation of maxillofacial defects is still developing. The aim of this *in vitro* study was to assess the accuracy of utilizing digital technology to record an artificial central maxillofacial defect in comparison to conventional impression methods**.**

Methods: Five casts were fabricated using conventional impression and casting method and five using digital technology from a master model. The casts were assessed in terms of time taken to fabricate each model and the accuracy when compared to the master cast. A digital calibre was used to record the distance using the reference point. Two measurements were recorded: anterior posterior measurement and lateral measurement. Shapiro-Wilk-Smirnov statistical test was used to test the normality of continuous variables. One independent sample t-test was used to compare means between standard and conventional and digital method. Pair t-test was used to compare pairwise between conventional and digital methods.

Results: The data revealed that there was a significant less antero-posterior measure among digital technique comparing with a conventional technique, the difference -0.80 (0.22) with p-value was 0.001. For the lateral measurement, there was less lateral measure within digital technique comparing with the measure among conventional techniques, the difference was -0.73(0.09) and p-value <0.001. Regarding the total time of the process, no statistical significance different was detected between digital techniques and conventional techniques, with difference -18.60 (127.54) and p-value 0.76.

Conclusion: In this study, digital impression technique produced different results in terms of accuracy especially in the lateral measure when compared with master models. The time taken to record the arch and the defect using an intraoral scanner was significantly less when comparing with traditional impression method. There was no statistically significant difference between the two techniques in terms of the total time taken to fabricate a maxillary central defect. Additional research should be conducted to reach more conclusive results.

DEDICATION

This dissertation is dedicated to my father, my mother and my whole family who affection, love, sacrifices, encouragement and prays abled me to succeed. Without them and Allah first I would not be able to achieve it. Thank you for guidance, strength, power of mind, and protection and unlimited support.

DECLARATION

I declare that all the content of this thesis is my own work. There is no conflict of interest with any other entity or organization.

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1. INTRODUCTION

The impression is defined as "a negative likeness or copy in reverse of the surface of an object; an imprint of the teeth and associated structures for use in dentistry," according to the Glossary of Prosthodontic Terms. (2017). For a long time in dentistry, taking impressions has been a key stage in the manufacture of fixed prosthetic restorations such as crowns, bridges, inlays, onlays, and implants, as well as removable dentures (Sailer, Mühlemann et al. 2019) and (Rau, Olafsson et al. 2017). For many years, traditional impression materials like as polyvinyl siloxane and polyether were used in dentistry, but nowadays, elastomeric impression materials, particularly polyvinyl siloxane and polyether, are reliable for accurate impression (Bilir and Ayguzen 2020).

When compared to each other, digital and traditional impression processes have some advantages and disadvantages. Having a larger number of steps in a traditional approach raises the chances of making additional errors (Seelbach, Brueckel et al. 2013). The milling process in the digital impression system is standardized, and there are fewer steps, which reduces the likelihood of errors and enhances adaptability. In terms of duration and clinician choice, digital approaches are preferable (Mehl, Ender et al. 2009).

The likelihood of a problem due to lack of impression details is lower in the digital impression approach than in the traditional method. Even if the digital image has less scanned spots, only the missing parts can be scanned without re-impression. The gag reflex is far less affected by the intraoral device than by the imprint tray. Digital files are easily stored. (Ahlholm, Sipilä et al. 2018, Mühlemann, Benic et al. 2019).

Several limitations of the digital technology include the difficulties of capturing the distal part in the digital impression and the use of titanium oxide powder spray for contrasting (Ahlholm, Sipilä et al. 2018).Other downsides of the digital impression approach include the additional expenses associated and the need for further training to use it due its learning curve.

2. LITERATURE REVIEW

2.1 Maxillary Defects

Maxillectomy deficits are very difficult to repair and may necessitate a multidisciplinary approach (Aramany 1978) . Maxillary defects are caused by surgery for neoplasms, congenital deformities, and trauma (Aramany 1978). Oral function can be affected by communication between the oral and nasal cavities, including phonation problems and the inability to chew and swallow. Patients may be mentally affected as a result of the effects on both quality of life and aesthetics. Depending on the patient's state, tissue grafting, prosthetic reconstruction, or surgical reconstruction may be used to repair such defects. Knowing how to take impressions of maxillectomy flaws is therefore quite useful, since it cuts down on chair time and gives the patient more confidence. The maxillofacial prosthodontist has two goals: to restore mastication, deglutition, and speech function, as well as to create aesthetic results (Beumer, Firtell et al. 1979).

This research should enable the physician to determine which impression technique to use based on the presenting maxillary defect and how to take impressions in a concise and systematic manner. It can be utilized in training for professionals and patients both locally and abroad. There has been no research published on this topic to yet.

Because maxillectomy cases frequently necessitate interdisciplinary treatment, practitioners should be aware with how such anomalies are characterized. The Aramany categorization system, which was developed in 1978 and has six groups 6, is one of the most often used for maxillectomy abnormalities.

2.2 Armany classification

Classification based on partially edentulous maxillectomy dental arches:

Class I: Midline resection

Class II: Unilateral resection

Class III: Central palate resection

Class IV: Bilateral anteroposterior resection

Class V: Posterior resection

Class VI: Anterior resection

The treatment options are either to restore with tissue grafting or by fabrication of a prosthesis. Both treatment modalities have their advantages and disadvantages. Factors such as size and extent of the defect are taken into consideration, but it is ultimately the patients decision. Prosthetic reconstruction is often favoured, not only due to ease of treatment and cost-effectiveness, but also because a prosthesis prevents mucus accumulation and nasal infections and means that the underlying tissue can be monitored for tumour growth (Aramany 1978).

Despite this, many dentists are not trained to the standards of experienced prosthodontists and lack knowledge on treating patients with maxillectomy defects, even though they are widely used in rehabilitating larger maxillary defects. A study done on graduating third year dental students highlighted that only 36% of students had heard the term ‘obturator’ in their final year, and 75% had not come across any patient requiring one. As graduating general dental practitioners, it is crucial to educate students on maxillectomy defects. A reason as to why many clinicians lack knowledge and clinical guidance with an obturator is the fact that there are no standard teaching models designed to teach students at the pre-clinical stage. Additionally, there is a lack of patients requiring obturators. Even if students and general dental practitioners have not come across obturators or patients with maxillectomy defects, it would be beneficial to train them on models which they might need to employ if a patient under their care does require such a prosthesis (Ali, Khalifa et al. 2018).

Therefore, this study will also include models fabricated based on the presenting maxillectomy defect and can be referred to in future training.

For many years prosthodontists have struggled to acquire the necessary level of accuracy and safety in making impressions for these patients, and with a shift in the direction of digital dentistry, it may be beneficial to explore these options in maxillectomy patients. This can increase the ease with which impressions are taken, shorten chairside time and ultimately provide a solution for clinicians with less experience in taking impressions the conventional way for these patients.

With the help of digital dentistry, the complex process of fabricating a prosthesis can be simplified, shortening the time acquired. The development of a digital impression reduces the number of times a patient must endure invasive procedures. It also provides health and safety advantages, as the presence of an oral-nasal fistula can increase the risk of a patient aspirating impression material, which can lead to serious problems. Generally, the conventional impression making process poses a risk to maxillectomy patients and their prosthodontists, so it is not surprising that digital acquisition and digital impressions are being utilized in fixed prosthodontics, with clinicians increasingly using such techniques to make impressions for crowns and fixed partial dentures (Huang, Wang et al. 2015).

2.3 Conventional impression

The contemporary restorative dentist has a host of excellent impression materials available for making impressions in fixed prosthodontics, implant dentistry, and operative dentistry. With proper material selection and manipulation, accurate impressions can be obtained for fabrication of tooth- and implant-supported restorations. However, a majority of im- pressions sent to commercial laboratories for conventional fixed prostheses are deficient in several respects (Donovan and Chee 2004).

Number of ideal properties for impression materials can be identified. These include accuracy, elastic recovery, dimensional stability, flow, flexibility, workability, hydrophilicity, a long shelf-life, patient comfort, and economics. Impression materials vary considerably in relation to these ideal properties, and these differences may provide a basis for the selection of specific materials in specific clinical situations (Donovan and Chee 2004).

2.4 Accuracy

The accuracy of impression materials can be evaluated in many ways. Elastomeric impression materials used to make precision castings must be able to replicate fine detail of fewer than 25 microns, according to an American Dental Association regulation. This level of accuracy is usually met by all currently available impression materials Although, PVS impression materials are the best and reversible hydrocolloid (a water-based impression medium) is the worst (Ragain, Grosko et al. 2000). Because the system's limiting factor is the ability of gypsum die materials to repeat fine detail, differences in detail reproduction are unlikely to be significant clinically.

The capacity of varied viscosities of impression mediums to reproduce fine detail varies significantly. The lower the viscosity of the impression material, the better due to its capability of recording fine details.

When used correctly, majority of today's impression materials provide excellent accuracy. Although PVS materials are expected to be more accurate than other materials, differences in accuracy are unlikely to be clinically significant ,given proper manipulation (Federick and Caputo 1997).

2.5 Elastic recovery

When the set impression is removed from the mouth, the impression material must be able to flow easily into undercut and sets in that condition. The ability to "rebound" back to its original shape that is called an elastic recovery of the impression material. No impression material has a 100 percent elastic recovery. The deeper the undercut, the more permanent the impression material distortion. PVS impression materials has the best elastic recovery, that reaches 99% which plays a great role in its dimensional stability (Klooster, Logan et al. 1991). PVS materials are the most precise material for second pours because of this feature, which is combined with their outstanding dimensional stability (Klooster, Logan et al. 1991).

2.6 Dimensional stability

an ideal feature of an impression material is to be dimensionally stable after setting, which aids in properly reproducing the patient's mouth without any dimensional errors. PVS materials have ideal dimensional stability because its chemical reaction during setting has no by products. They may be poured at the dentist's convenience and are an appropriate material of choice if the impression is to be shipped to a laboratory. PVS impressions can be poured right after they've been removed from the mouth, or hours, days, or even weeks afterwards (Lacy, Fukui et al. 1981).

To achieve optimal precision, other impression materials should be poured within time limitations. Water-based impression materials, such as reversible and irreversible hydrocolloid, contain 80% water and are thus susceptible to the phenomena of imbibition (water absorption) and syneresis (evaporation of water). The impression is affected if either of these events occurs. These imprints should be emptied up within 10 minutes of being removed from the mouth, rather than being covered in a moist paper towel as is commonly done. The moist towel can quickly absorb water from the impression, causing it to deform before pouring (Lacy, Fukui et al. 1981).

On the hand, the setting reaction of condensation silicone impression material creates ethyl alcohol as a by-product. The setting reaction of polysulfide rubber creates water as a by-product. These volatile by-products tend to evaporate from the set impression's surface, causing deformation. The impression materials should be poured within 30 minutes of the mouth being removed.

Polyether could easily absorb water from the air. Polyether materials swell with time due to water sorption, whereas other materials contract after certain period due to ongoing polymerization and loss by-products (Lacy, Fukui et al. 1981),(Williams, Jackson et al. 1984)

2.7 Flow and flexibility

Impression materials must flow easily into the fine details of oral cavity and capture its details accurately; however, they are different when compared with each other.

In terms of flexibility, these materials differ from one another. Polyether impression materials are more rigid, which might be a difficulty when working with periodontally affected teeth or sever undercuts. Due to the stiffness, fragile gypsum dies frequently fracture.

PVS materials have an acceptable rigidity, and the incidence of die fracture is much lower than polyether. The least rigid of all the materials, reversible hydrocolloid may be the best choice for creating impressions of many periodontally damaged teeth (Donovan and Chee 2004).

2.8 Workability

Depending on the impression material and the manufacturers recommendation, they tend to have different working times, The operator may choose a fast-setting material with a short working time when using taking a single-crown preparation impression. The clinician also may choose a longer-working material when making a complex oral rehabilitation case and/or full-arch impression with several prepared teeth. Manufacture recommendation must be followed for each material that the clinician uses in the dental setting (Chew, Chee et al. 1993).

2.9 Hydrophilicity

Reversible hydrocolloid impression materials are totally hydrophilic, meaning they can generate precise impressions even when wet. Before making the impression, the "wet technique" fills the gingival sulcus with water and then relies on the material's water-loving nature to flow into the sulcus and capture the prepared subgingival margins in the impression.

Polyether is also considered a hydrophilic material, with the ability to absorb moisture from the surrounding atmospheric environment. However, to generate a good impression, polyether materials require a dry field. For making impressions, all rubber-like elastomeric impression materials require a dry surface.

The majority of PVS impression material manufacturers claim that their materials are also hydrophilic. Although it could be technically valid, this statement is deceptive since it implies that excellent impressions may be made in a moist environment, which is not the case.

The contact angle that water makes with a substance can be characterized as "hydrophilic". If that angle is less that a specific point, then the hydrophilicity of the material is true. The initial PVS materials were extremely hydrophobic, resulting in extremely high contact angles. Nonionic surfactants were added to newer PVS material, which enhanced wettability and reduced contact angles. These enhancements made pouring of PVS materials without voids more achievable but didn’t necessarily make acceptable impression material in a wet environment. Dry field is considered as the gold standard for both polyether and PVS impression (Donovan and Chee 2004).

2.10 Shelf-life

Although the exact shelf life of impression materials is unknown, it is not recommended to utilize materials that have passed the manufacturer's expiration date. The physician should familiarize himself or herself with the manufacturer's recommendation for all material to ensure proper usage. It is recommended that no more than six months' supply of impression material be kept in stock (Donovan and Chee 2004).

2.11 Patient comfort

Current materials are significantly more patient-friendly than older polysulfide rubber and reversible hydrocolloid materials, which required the use of large water-cooled trays. Most available materials are colourless, unscented, and tasteless. The rigidity of polyether is an issue, especially if the patient presenting with sever undercuts or fixe prosthesis. It is recommended to utilize a more flexible material in these instances or to block out undercuts using utility wax prior to impression taking.

While some studies indicate that custom trays are more accurate than stock trays, even if both are reasonably accurate, patient comfort is significantly enhanced with custom trays. Additionally, substantially less material is consumed, and it has been suggested that the material savings alone, together with the decreased number of remakes, (Christensen 1994).

2.12 Economic factors

The cost of impression materials can vary significantly. Although reversible hydrocolloid is less expensive than elastomeric materials, it requires conditioning and tempering baths and water-cooled trays. Polyether and PVS materials are comparable in price to rival elastomers. However, it is likely true that differences in the costs of impression materials are insignificant. Practitioners can save money by utilizing auto-mix equipment, utilizing the dual-arch approach when suggested, designing custom trays for full-arch impressions, and minimizing remakes (Christensen 1994).

2.13 Principles of impression material manipulation

Efficient handling of impression materials is arguably more critical than the type of material used in determining the accuracy of an impression. Numerous manipulating factors are required to achieve maximum precision and accuracy. These include providing a homogeneous quantity of material, ensuring that the material sticks effectively to the tray, pouring the impression at the suitable moment, using the appropriate viscosity materials, and mixing and disinfecting the material properly (Rueda, Sy-Muñoz et al. 1996).

2.14 Viscosity control

Elastomeric impression materials are available in a range of viscosities, from extremely low viscosity to extremely high viscosity putty. The primary distinction between the various viscosities is the amount of inert filler contained within the substance. Two principles apply to different viscosity materials: (1) the lower the viscosity, the better the reproduction of fine detail; and (2) the lower the viscosity, the larger the polymerization contraction when the material is setting. Thus, the optimal approach of impression making is to utilize as little low-viscosity material as possible to record the fine detail of the oral condition while forming majority of the impression using high-viscosity material. The heavy-body material aids in the advancement of the light-body material into the gingival sulcus, resulting in minimum deformation from polymerization shrinkage (Donovan and Chee 2004).

2.15 Adequate mixing

Majority of elastomeric impression materials are supplied in base/catalyst configurations. Hand mixing is necessary when separate tubes of base and catalyst material are supplied. Typically, the base and catalyst materials are of dissimilar hues, and approximately equal lengths of both components are dispensed onto the mixing pad. After that, the ingredients should be mixed continuously until a homogeneous substance is obtained (Craig 1985). On the other hand, other materials used nowadays are distributed by some form of auto-mix equipment. These techniques ensure optimal material mixing with much fewer inherent voids, increase the material's necessary working duration, and minimize material waste because they are poured straight from the dispenser into the tubes then poured onto the tray (Soh and Chong 1991)

2.16 Disinfection

Microorganisms found in the oral cavity can be transported to the dental laboratory via dental impressions (Leung and Schonfeld 1983). Before casting the model or sending the impressions to the dental laboratory, the practitioner needs to properly disinfect the impressions. Using disinfected die stones as an alternative to disinfecting impressions (Donovan and Chee 1989) .This technique could avoid potential distortions caused by disinfection of the impression

Any disinfection process begins with rinsing the impression in tap water. This procedure eliminates majority of microbes from the impression. Disinfection techniques include spraying disinfectant agents onto the impressions or immersing the impression materials in chemicals such as sodium hypochlorite (Johnson, Drennon et al. 1988).

2.17 3D Printing

Direct 3D Printing is an additive technology that has great potential and application. This additive technology approach can be divided into many forms one of which is Stereolithography (Revilla-León, Meyer et al. 2020). Stereolithography is widely utilized nowadays, and it has progressed to the point where it can now produce more sophisticated ceramic pieces, whilst the other techniques are still in the early stages of research for dental applications. Stereolithography is comparable to 3D printing, all additive processes have the advantage of producing little or no waste material. The rough surface quality and poor fit or limited precision are still drawbacks of all additive technologies to date. Direct 3D Printing stands out among the additive processes discussed since the technology is considerably more approachable and enables for the creation of many dental prothesis (Della Bona, Cantelli et al. 2021) .

3. AIM and Objectives

3.1 Aim

The aim of this *in vitro* study was to assess the accuracy of utilizing digital technology to record an artificial central maxillofacial defect in comparison to conventional impression methods**.**

3.2 Specific Objectives:

The objectives of the study were:

1. To fabricate artificial models of maxillary arch to represent midline defects according to Aramany classification.

2. To record the defect using conventional impression techniques

3. To assess the feasibility of using digital scanners for capturing the defects

4. To compare the dimensional accuracy and the duration of impression taking and fabrication of maxillectomy defect models using conventional impression techniques with those of digitized workflow.

4. MATERIALS AND METHODS

4.1 Study design

4.1 A Master model

In this in vitro study, a maxillary complete denture was copied, and putty was shaped and placed in the palate to duplicate the central defect nasal floor after pouring with cold cure acrylic material (Fig 1). Before processing, boxing of the master model was done to help in the pouring as shown in (Fig 2). Central defect Armany classification was made as master model to aid in evaluating different impression techniques. In the master model, the maxillary central defect size was 24mm in depth and 25 mm in diameter. Master models had four points anterior to the central defect and posterior and two in lateral position. The points in the defect were used to aid in measuring the dimensional accuracy between both techniques.

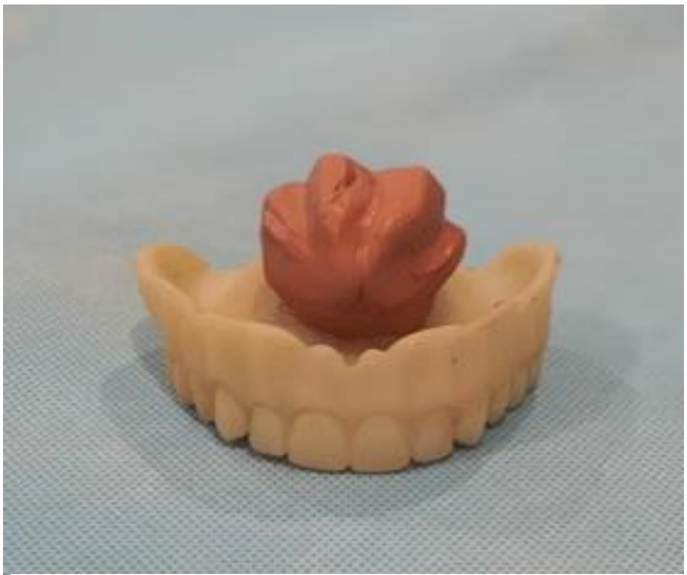

Figure 1 A picture the copied denture and the fabrication of nasal cavity of the central maxillary defect

Figure 2 Figure Master model defect created and boxing was done to aid in casting

Figure 3 Casted maxillary central defect master model.

4.2 Sample Fabrication

4.2A Traditional technique

PVS impression (3M ESPE, USA) two steps heavy body and light body wash technique was used to duplicate the master models five times (Figs 3,4,5)

Different timings were recorded such as Putty mixing time, Setting time, Wash time, Boxing time, Casting time. The purpose of recording the time was to assess the duration used to fabricate such a model and use it in the comparison. After boxing of each impression, a stone was poured to duplicate the master cast in a conventional (Fig 6)

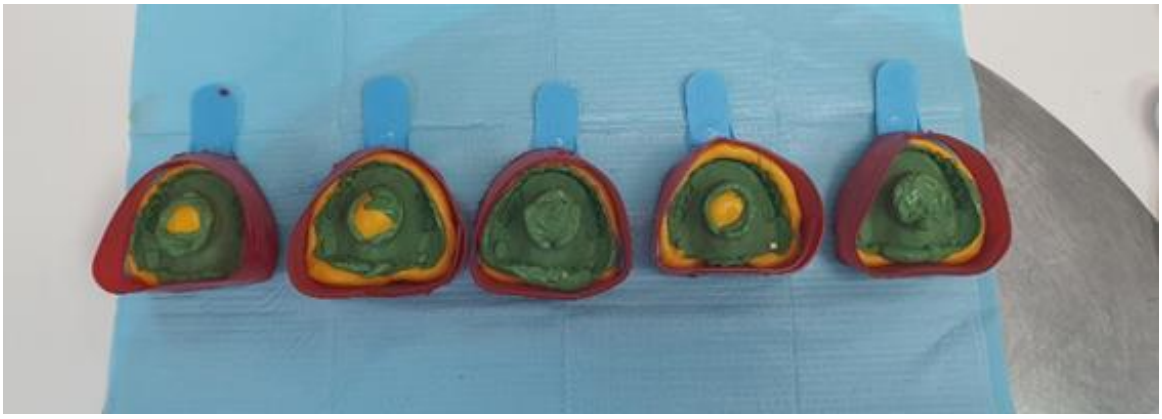

Figure 4 Two Steps Impression were taken using Putyy and Light PVS Impression Technique

Figure 5 PVS Impression Material

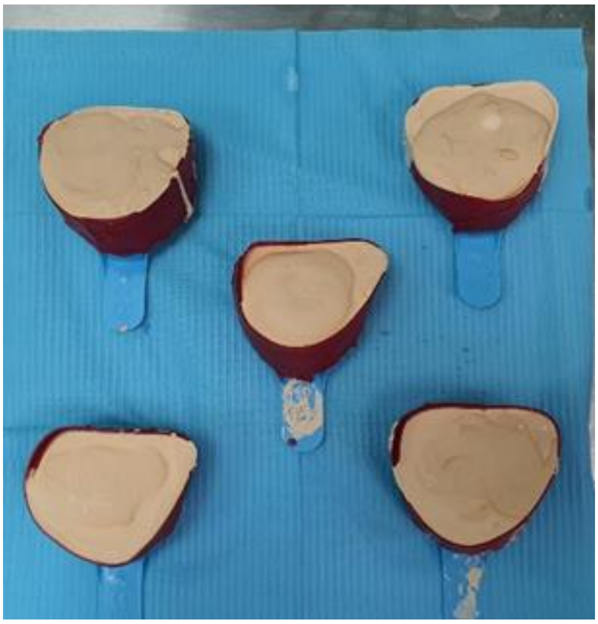

Figure 6 Five Models Were casted and poured to resemble the Master Model

4.2 B Digital Technique

In this part, the same master model was then scanned with an intra-oral scanner five times in a clinical setting. Five different STL files were generated (Fig 7). STL file were sent to 3D scanner software (NEXT Dent) (Fig 8). Each STL file was printed using resin model as shown (Fig 9,10).

After full printing the cast was placed in an alcohol solvent to remove uncured resin (Fig 11) and then placed in light curing machine to get the final duplicated study model.

Digital Scanning Time, Actual Printing Time, Solvent Washing time, Light Curing time was measured to assess the timing took to fabricate each model

Eventually, 5 models were made from conventional impression using PVS putty and light wash technique and 5 models fabricated digitally were compared in terms of accuracy, time taken to fabricated, voids and homogeneity

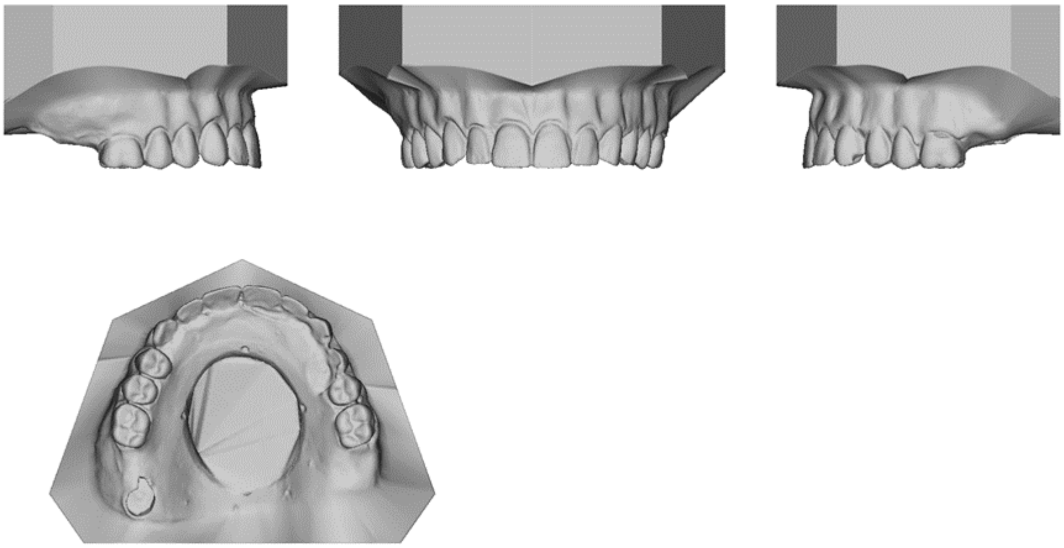

Figure 7 STL File of one of the Digital scans showing the reference points that used in this experiment

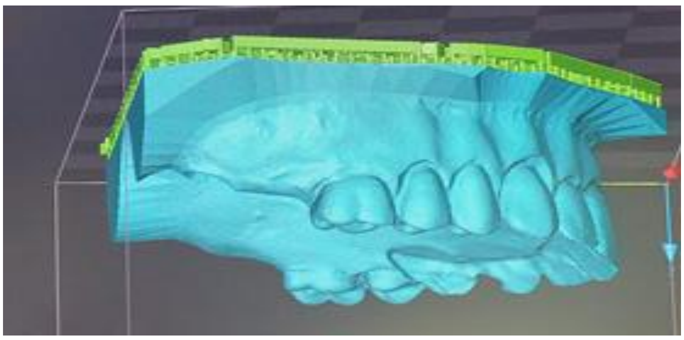

Figure 7 Picture of the digital cast before washing it with alcohol or curing it.

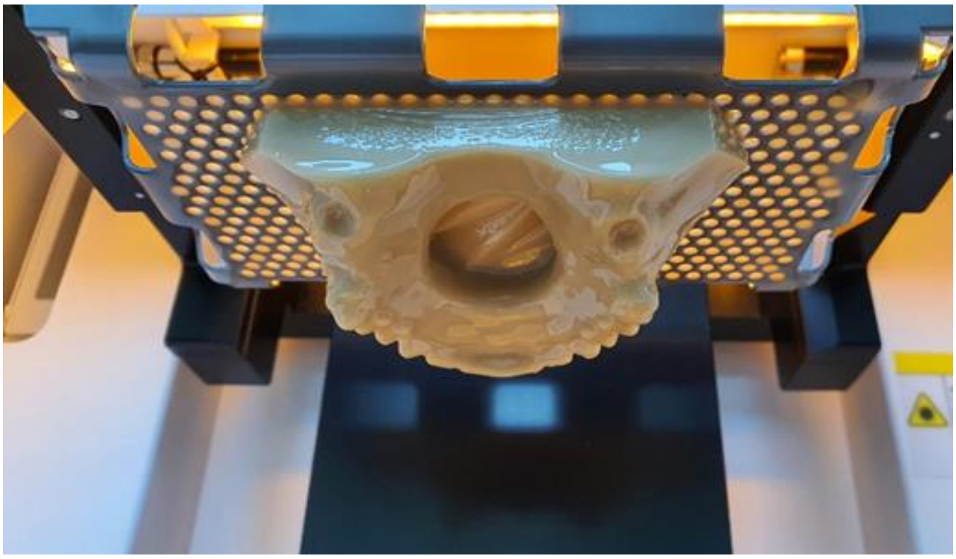

Figure 8 Picture of the digital cast before washing it with alcohol or curing it

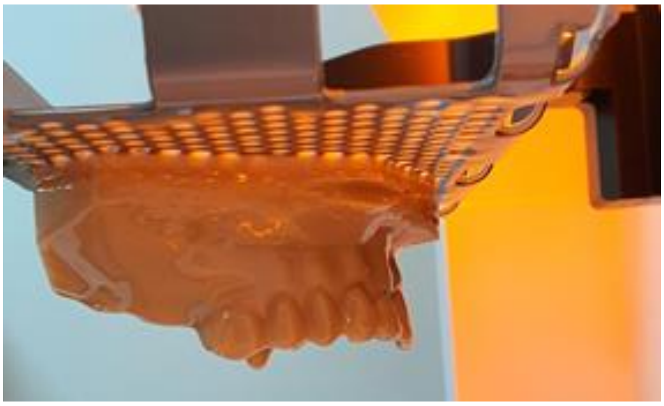

Figure 9 Another View

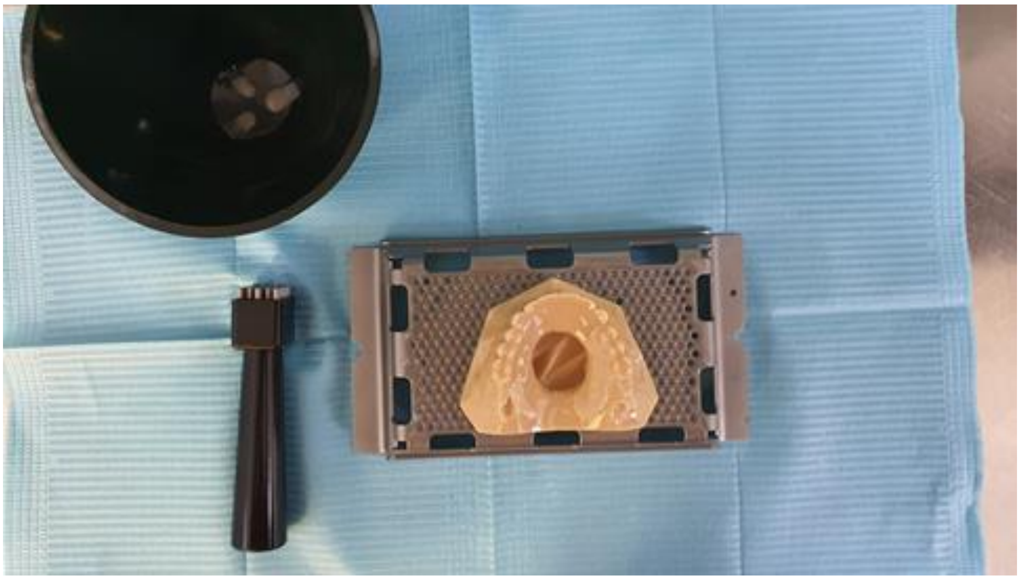

Figure 10 Metal try was retrieved, and the cast were separated in order to place it in an alcohol wash

4.3 Measurement collection

After fabricating 5 traditional cast and 5 digital casts that were duplicate of the master models, a digital calibre was used to record the distance using the reference point. Two measurements were recorded: Anterior Posterior measurement (AP) (Fig12) and Lateral Measurement (Fig13)

Figure 12 Digital caliber was used to measure the AP distance

Figure 11 Digital caliber was used to measure the Lateral distance

4.4 Statistical analysis

Data was entered in computer using IBM-SPSS for windows version 28.0.0.0 (190) IBM (SPSS Inc., Chicago, IL). The measurements of AP. Lateral and total time were described by measures of tendency and measure of dispersion. Shapiro-Wilk-Smirnov was used to test the normality of continuous variables. One independent sample t-test was used to compare means between standard and conventional and digital method. Pair t-test was used to compare pairwise between conventional and digital method for total time, AP, and lateral measurements. Coefficient of variation was calculated to shows the extent of variability in relation to the mean of the population and to measure the accuracy of digital and conventional techniques. A P-value of less than 0.05 will be considered significant in all statistical analysis.

In this study the analysis of the fabricated cast evaluated the following parameters:

Dimensional accuracy using reference points in both AP measure and Lateral Measure and the duration of impression taking and production of maxillectomy defect models using conventional impression techniques and digitized workflow.

5. RESULTS

Table 1: Descriptive of measurements

	Conventional	Digital
items	Mean (SD)	Mean (SD)
Time per second	3688.6 (37.85)	3707 (139.48)
AP measure	32.03 (0.24)	32.83(0.11)
Lateral measure	25.85 (0.09)	26.58 (0.11)

The descriptive statistics are shown in Table 1. The mean and standard deviation for each group and the measurement points are shown. For the conventional techniques the mean of the time per second is 3688.6 (37.85) second, while it is 3707 (139.48) second among digital technique. For AP (After process measure) the average among conventional technique is 32.03 (0.24) while it is 32.83 (0.11). Lateral measure has an average 25.85 (0.09) among conventional and 26.58 (0.11) among digital technique.

Analysis of the accuracy of the techniques was performed using the coefficients of variation. The descriptive statistics indicated that G2, G5, and G6 had higher coefficients of variation

	Shapiro-Wilk		
Variables	Statistic	df	P-value
Ap measures	0.81	5	0.098
Lateral measures	0.945	5	0.703

Digital AP measures	0.936	5	0.637
Digital lateral measures	0.894	5	0.38
Total time with conventional	0.992	5	0.987
Total time with digital	0.99	5	0.98

Shapiro -Wilk test shows that all the measurements are following the normal distribution. Although the number of measurements is small, parametric statistics will be used for the analysis.

Table 3: The mean, standard deviation (SD) of different time, and coefficient of variation (CV) per case

		Conventional		Digital	
Case	N	Mean (SD)	CV	Mean (SD)	CV
C1	5	741.8 (1102.24)	1.49	1119.4 (934.55)	1.04
C2	5	738.4 (1103.19)	1.49	1138.6 (982.13)	1.08
C3	5	747 (1099.89)	1.47	1160 (955.09)	1.00
C4	5	727 (1108.54)	1.52	1134 (925.25)	.99
C5	5	734.4 (1104.35)	1.50	1089.2 (856.70)	.94

Table 3 shows the mean and standard deviation per case with conventional and digital techniques. Analysis of the accuracy of the techniques is performed using the coefficients of variation. The descriptive statistics indicated that cases C4 and C5 among digital techniques have smallest coefficients of variation that indicates the extent of variability in relation to the mean of the population. The accuracy with digital techniques is better tendency wise.

Table 4: Comparisons measurements between conventional and digital methods with the standard measurements

Measurement	Standard	Conventional		Digital	
		Mean (SD)	p-value	Mean (SD)	P-value
AP measure	32.55	32.03 (0.24)	0.008	32.83(0.11)	0.005

Lateral measure	26.54	25.85 (0.09)	<0.001	26.58 (0.11)	0.435

Table 4 shows the comparison of AP measure and lateral measure between standard and conventional form one side and between digital and standard from other side. The result reveals that for Ap measure the conventional is higher 32.03 (0.24) against32.55 in the standard p-value is 0.008, the same result is found between digital 32.83(0.11) and standard p-value 0.005. For the lateral measure conventional techniques yield a significant less measure on average compared with the standard 25.85 (0.09) and 26.54 respectively p-value <0.001. No significant is detected between digital techniques and standard for the lateral measurements p-value is 0.435.

Table 5: Comparison of AP, total time, and lateral measurements between conventional and digital method

	Means of	SD of	95% CI of difference		p-value
Pairs	difference	difference	Lower	Upper	
AP-conventional - AP-digital	-0.80	0.22	-1.08	-0.52	0.001
Lateral-conventional - Lateral-digital	-0.73	0.09	-0.84	-0.62	<.001
Total time conventional - Total time digital	-18.60	127.54	-176.96	139.76	0.761

Table 5 shows the pairwise comparison for the AP measure, lateral measure, and the overall time. The data reveals that there is a significant less AP measure among digital technique comparing with a conventional technique, the difference -0.80 (0.22) with p-value is 0.001. For the lateral measurement there is less lateral measure within digital technique comparing with the measure among conventional techniques, the difference is -0.73(0.09) and p-value <0.001. To that concern the total time of the process no statistical significance different was detected between digital techniques and conventional techniques, difference -18.60 (127.54) and p-value 0.76.

6. DISCUSSION

The trend of using the digital technology has spread to most dental clinics, hospital and laboratory. Digital technology has proven to be a very viable option in order to take impression or fabricate prosthesis. However, research must be conducted to determine its true effectiveness using an evidence-based methodology. This in vitro study is considered as a first to determine the accuracy of conventional vs digital in a central maxillary defect.

At this Present study 10 models were fabricated using both conventional and digital methods. Each clinical step' timing was recorded. Conventional method recorded Putty mixing time, setting time, wash time, boxing time, and casting time while the 3D printing method recorded Digital Scanning Time, Actual Printing Time, Solvent Washing time, Light Curing time. Time comparison revealed that both techniques were not superior on one and another with a mean time of 1h 1m 26s for the conventional technique and 1h 1m 47s for the digital technique. Within the limitation of this study. 3D additive technology did not give any additional advantage in terms of time taken to fabricate a central defect in the maxilla.

However, there was a significant difference for the impression timing between both methodologies. It was recorded that a mean of 10 minutes, 41 seconds needed in the laboratory setting for impression taking while in the digital methods a mean digital scanning time is 3 minutes and 23 seconds. These results are consistent with findings of (Lee, Jamjoom et al. 2021) as they stated that the time of digital impression method was shorter than the conventional impression method. However, training must be provided to the dentist in order to achieve optimum outcomes. According to (Marti, Harris et al. 2017) giving training before taking digital impression will result in shorter duration of digital impression and therefore better time efficacy in comparison with the conventional methods.

In this study another comparison was used to determine the accuracy of both techniques. Four reference point were placed in the master models to aid in the measurements. One anterior and one posterior and two lateral to the central defect. Two readings were recorded from the reference points. The AP distance and Lateral distance. Digital caliber was used to record the distance for all models. The standard distance in the master models were 32.55mm and 26.54 for the AP distance and lateral distance respectively. Conventional models had a mean of 32.03 mm in AP distance and 25.85 mm in the lateral distance. The conventional model AP distance was 0.52 mm in difference with the control cast while the lateral measurement was 0.69 mm in difference.

The mean digital cast measurements were 32.83 mm in the anterior posterior measurements and 26.58 mm in the lateral measurements. The change in measure in comparison with the fabricated master models was 0.28mm and 0.04 mm in AP measurement and Lateral measurement respectively.

According to table 5 in the results, the comparison in both anterior posterior measurements and lateral measurement place in the cast indicates that the data collected is not significant in the AP measure while it is significant in the lateral measure. The measurement taken in the lateral ends favored the digital cast over the conventional cast. However, these results slight differ from the systematic review of (Giachetti, Sarti et al. 2020)) when he compared the accuracy of conventional versus digital and aimed in this study to prove that prosthesis using digital technology can be an alternative to conventional technique. He included six studies in his systematic review to determine which technique is more accurate on another. The study concluded that conventional technique had a higher precision and accuracy in comparison with digital. Yet the study also supported that additional research should be conducted to have more conclusive date and assess the accuracy in different clinical setting.(Giachetti, Sarti et al. 2020)

Another factor that may play a role in the accuracy in the digital technique was the intra oral scanner. Scanning the palate appeared to be more technique sensitive as there are no landmark the intra oral scanner can use to easily orient itself. Repeated scanning movement towards the tissue was necessary to capture the defect and its surrounding. Given the size of the intra oral scanner and the size of the defect it was not possible to insert the scanner sleeve any further and fair distance needed all time. The literature has looked at the scanning the edentulous area and denture bearing area. A systematic review by (Rasaie, Abduo et al. 2021) was conducted to assess the accuracy of intraoral scanners for recording the denture bearing areas in both clinical and laboratory setting. (Rasaie, Abduo et al. 2021) looked at 18 studies. Eight of which were clinical. The study found the accuracy result were different when using different intraoral scanner especially when try to capture denture supporting area and peripheral mobile tissue which has similar appearance to central maxillary defect. The study pointed that there were factors that can improve and aid in the ability of capturing better impressions such as some of artificial markers, scanner head size, scanning strategy, and the operator's experience. (Rasaie, Abduo et al. 2021) also concluded that they were not capable of accurately registering the mobile tissues. This can serve as a precaution to not consider that digital is superior to conventional without any proper pre-operative assessment to the defect as intra oral scanning palatal defect with mobile peripheral tissues may results in suboptimum impression and subsequently fabricating an ill-fitting obturator or prosthesis

7. CONCLUSION

Within the limitation of this study and sample size we conclude that:

1 Digital workflow to fabricate a central maxillary defect produced a different result in terms of accuracy especially in the lateral measure when compared with master models.

2- The time taken to record the arch and the defect using an intraoral scanner was significantly less when comparing with traditional impression method

3- There was no statistically significant difference between the two techniques in terms of the total time taken to fabricate a maxillary central defect.

4- Additional research should be conducted to reach more conclusive results.

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