Comparing the accuracy of five Intraoral scanners with digital laboratory scanners

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Abstract

Digital impression techniques are computerized methods used to capture 3D images of dental restorations, implants, and orthodontic appliances.

These techniques are revolutionizing the field of restorative dentistry. involve the use of digital scanners to capture images of the patient&#39, s oral structures, which can then be used to create restorations such as crowns, bridges, and veneers.

A maxillary typodont cast was used to simulate the patient's mouth vinylpolysiloxane impression was made of the typodont cast and poured to fabricate stone casts.

The stone. casts were scanned by five IOSs (Medit i500, Medit i600, 3D shining, Carestream 3600, Eightieth Helios600) and one EOS (Optical smart vinyl) to obtain digital casts.

Reference teeth (distance between two centrals, distance between right central and right canine, distance between left central and left canine distance between two canines) dimensions were measured on the digital casts by PTK opera software and compared to measurements of the stone cast done by stereomicroscope[1].

Introduction

Dental impression is a negative replica of the teeth and surrounding oral structures that are created to accurately capture the current state of the patient&#39, s oral cavity. It is an essential step in various dental procedures including the fabrication of crowns, bridges, dentures, and orthodontics appliances, dental professionals provide precise treatment planning and deliver high-quality restoration.Impressions. techniques and materials have gone through many enhancements, to meet the need the dental clinics Polyether and addition silicone have been the impression materials of choice for many years, these materials are very accurate but, technique sensitive[2].

Since the introduction of computer-aided design and computer-aided manufacturing (CAD/CAM) technology, the field of digital dentistry is evolving rapidly fast. Recently, the advancement of chairside (IOSs) Intraoral scanners are providing many clinical advantages compared to conventional impression, namely speed, patient comfort, efficacy, and the reduce costs in the long run. Digital impression techniques are computerized methods used to capture 3D images of dental restorations, implants, and orthodontic appliances. These techniques are revolutionizing the field of restorative dentistry. Involve the use of digital scanners to capture images of the patient' s oral structures, which can then be used to create restorations such as crowns, bridges, and veneers[3].

CAD/CAM technology

CAD/CAM stands for Computer-Aided Design/Computer-Aided Manufacturing. It's a technology that combines the use of computers and software to design and manufacture products quickly and efficiently. In recent years, advancements in CAD/CAM technology have focused on increasing automation and improving connectivity[4].

Figure 2

Intraoral scanners (IOS)

are small handheld devices used for capturing 3D measurement systems as an alternative to traditional impression.They project a light source laser, or structured light onto the object to be scanned such as prepared teeth or implant scanned bodies. The images of these object and soft tissues of the oral cavity captured by imaging sensors are processed by the scanning software, which generates point clouds.These point clouds are then triangulated by the same software, creating a 3D surface model (mesh). The 3D surface models of the teeth and surrounding tissues are the result of the optical impression and are the alternative to traditional plaster models.

The history of intraoral scanner digital impression techniques can be traced back to the early 1980s when the first attempts were made to capture digital images of dental impressions. However, it wasn't until the early 2000s that significant advancements were made in the technology, leading to the development of commercially available intraoral scanners[5]. advantages: offers fast and accurate digital impressions, reducing the need for traditional, mimic dental molds. It allows for better communication between the dentist and the dental laboratory, resulting in more precise restorations. Disadvantages: high cost, which may be a barrier to adoption for some denta practices. Carestream 3600: (figure 3-d) Manufactured in 2014, it's a digital intraoral X-ray imaging system and is a full-size tech. It has an automated sensor positioning system and a hi-res imaging system. Advantages enable quick and comfortable scanning for patients. It provides highly accurate digital impressions, reducing the need for physical dental molds. The scanner is also compact and easy to maneuver, enhancing convenience for dental professionals. However, one of the drawbacks is the requirement for a powered USB port, which may limit its compatibility with certain computer systems or devices. Additionally, cost can be a limiting factor for some dental practices[6].

Figure 3: (a) Medi Figure 3: (a) Medit i500, (b) Medit i600, (c) 3D shining, (d) Carestream 3600, (e) Eighteeth helois600

Material and Methods

Preparation of the model Four identical rectangular plastic pieces were attached to maxillary typodont in four places (figure 4). Distolingual surface of both left and right central incisors, and the distal side of both lift and right canines. An impression of the typodont was made using (Elite HD+ Zhermack, Italy) (figure 5). The impression was poured according to manufacturing structure with type IV dental stone (figure 6) (Elite master, Zhermack, Italy) specially designed by manufacture for scanning (CAD/CAM)[7].

Figure 4: attached rectangular plastic pieces

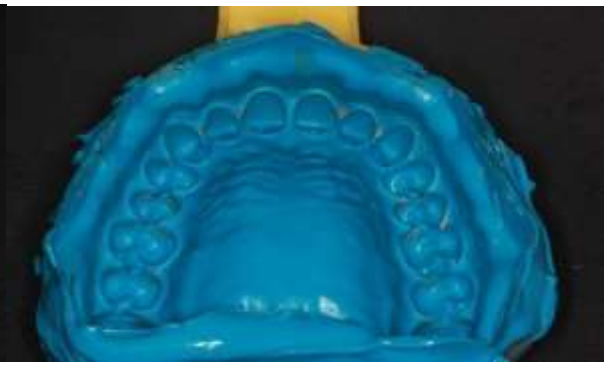


Figure 5: add impression material

Figure 6: Scanned Model

4.2. Laboratory scanners

The stone made was Secured on a holder in the correct position. Moving the scanner tip slowly and evenly across the cast's surface to capture the necessary data. Save the scanned model and associated measurements in the desired file format for further analysis or use.

4.3. Intraoral scanners

Five IOS (Medit i500, Medit i600, 3D shining, Carestream 3600, Eighteenth Helios 600) (figure 3), were used to scan the model (figure 5), and four scans were taken from the same model[3].

Figure 7: Lab scanner (Optical smart vinyl)

4.5. Measurements

The distance was measured in three places ((w) distance between two centrals, (x) the distance between right central and right canine, (y) the distance between left central and left canines, (z) the distance between right and lift canines (figure 6).

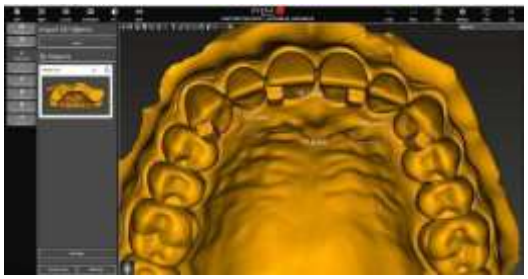


Figure 8: (w) distance between two centrals, (x) the distance between right central and right canine, (y) the distance between left central and left canines, (z) the distance between right and lift canines

*** The measurements were measured from the PTK opera software (Italy; 3D IEMME).**

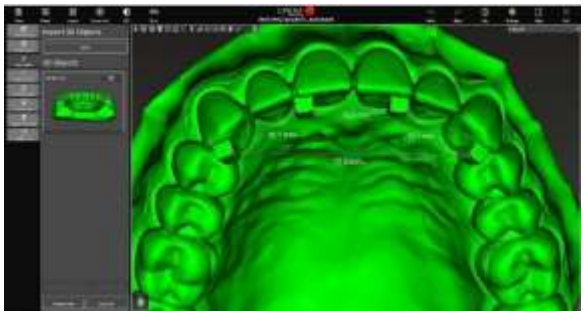
RESULTS

The measurement shows that was no significant difference between the groups W and Z. The p value wasW0.000, p value Z0.036 with no statistical different, null hypothesis was rejected. X and Y was statistical different, the p value X was0.200, p value Y0.0285, and the null hypothesis was not rejected[8].

Scanner type	Lab scanner (smart optic)	Carestream 3600	3D shining	Eighteenth helois600	Medit i500	Medit i600
Distance between two centrals	10.3mm	10.3mm	10.3mm	10.3mm	10.3mm	10.3mm
Distance between Right central and right canine	10.1mm	10.0mm	10.1mm	10.0mm	10.2mm	10.1mm
Distance between left central and left canine	10.1mm	10.0mm	10.3mm	10.0mm	10.0mm	10.2mm
Distance between two canines	31.6mm	31.6mm	31.6mm	31.5mm	31.6mm	31.7mm

Table 4: Result of measurement from various scanner

The following picture is showing the image was taken by different IOS used in this study:



Discussion

This study evaluated and compared the accuracy of IOSs with EOS, and the findings of the study showed that there were. little variation across scanners for the mean of each measuremen, except in distance(z), shows significance value below than the others indicating it was not normally distributed. The deviation was variable with no in (w), slightly higher in (y), and low in(z), and null

hypothesis of normality and normally distributed for all distance except in (z), data measurement was not normally distributed and suggesting a rejection of the null hypothesis of normality. Carestream 3600, Mediti i500 showed the highest accuracy for all tests, while eighteenth helios had lower accuracy with significantly higher deviation. Since all 5 scanners were similarly accurate, any of them can be selected depending on other factors such as cost, ease of use, office space, convenience and dentist preference. According to Adam B. Nulty The study results showed that the Primes can produced a very low amount of overall deviation and recorded the most accurate results, which were statistically like all lab scanners except the Ineous X5. The Primescan was followed closely by the Trios 4, Medit i500, CS3600, and Trios 3 as the second most accurate data set of intra-oral scanners with no statistical difference between the overall results of the current range of scanners: Primescan, Trios 3 and 4, i500, and 3600[9]. Using the tested powder-free intraoral scanner, higher translucency objects (greater translucency than S1-M/ A1C) resulted in lower scanning accuracy and larger morphological changes. Therefore, more suitable methods of measurement are still required.In previous studies assessing that there are differences in results When Scan with powder spraying and without it, depending on the environment and the method Using.According to panelAnna S.K. El.at The precision of the measuring method, presented as the repeatability coefficient, ranged between 7 and 16 µm (entire surface), whereas the analysis of the stone replicas revealed a precision (repeatability coefficient) ranging from 19 to 26 µm. The accuracy of the replica to master (the mean discrepancy) ranged from 0.5 to 2.0 µm (95% confidence interval 1.5–2.9 mm). In this study, premolars measurements were underestimated. Previous research showed that positive deviations in concave-ties and convexities in the occlusal surfaces resulted in digital casts larger than the reference cast. Greater discrepancies might be attributed to the presence of several grooves and irregularities in the molar shape than the premolar. Therefore, preparations must have smooth, uniform surfaces without sharp areas or undercuts to achieve optimum CAD/CAM scanning. Several limitations related to this study should be noted. First, digital casts obtained from the IOSs were done in vitro outside the oral environment[10].

CONCLUSION

Within the limitations of this study, the following conclusions can be drawn:

- Regarding dentate complete- arch, found that all scanners produced accurate measurements with minimal variability.
- The scanner Medit I 500, CS 3600 were similar in performance, with some differences in results.
- The loss CS 3600 gives a better result, therefore it's preferred to be used in similar clinical sittings[11].
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