Dentistry 3000

Vol 13, No 1 (2025)
ISSN 2167-8677 (online)
DOI 10.5195/d3000/2025.929

Digital Versus Conventional Impressions

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Abstract

Objective: The purpose of this research was to compare, in vivo, the three-dimensional (3D) dental impressions produced by digital and traditional methods. **Material and Methods**: This research was comprised of ten individuals who had full natural teeth. The subjects' molars were digitally imprinted using an intra-oral scanner (Helios 600 3D). The double-mix impression method (SILAXIL BOX & PROTESIL LIGHT) was also used to create a silicone imprint. The Lava COS system exported the stereolithography (STL) data immediately, and a three-dimensional (3D) intra-oral scanner recorded the STL data of a plaster model created from a silicone imprint. The 3D assessment program captured the STL files. It overlaid them using the best-fit-algorithm approach for each impression technique (least-squares method, PolyWorks, InnovMetric program). The Wilcoxon signed-rank test was used to compare the two methods with respect to 3D data. **Results**: Differences between digital impressions were less noticeable when comparing them to silicone impressions, according to a visual analysis of stacked datasets. Using a digital imprint approach yielded more confirmation (0.014± 0.02 mm) compared to a traditional method (0.023 ± 0.01 mm). **Conclusion**: According to this in vivo investigation, digital impression technology outperforms traditional ompression techniques.

Open Access

Citation: Abdulrazzaq MM, et al. (2025) Digital Versus Conventional Impressions. Dentistry 3000. 1:a001 doi:10.5195/d3000.2025.929
Received: May 3, 2025
Accepted: May 31, 2025
Published: June 27, 2025

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Introduction

"Digital Dentistry" is rapidly expanding and represents a major shift in the dental industry that is occurring this century. The use of three-dimensional (3D) intra-oral scanners for digital impressions has recently been trending upward in popularity globally [1]. Dental prostheses may be immediately designed and manufactured using digital pictures of the dental arches and occlusal connections recorded by these intra-oral scanners [2–5]. There are several reasons why intra-oral scanners might eventually replace traditional impression materials [6–10]. For instance, as compared to traditional impression methods, its implementation streamlines processes and increases transparency throughout the impression operation, benefiting patients, dental technicians, and dentists alike [4,5,11,12]. Since dental stone grows due to secondary reactions and silicone impression materials are prone to dimensional changes due to ongoing chemical reactions, this approach also eliminates mistakes associated with the standard impression technique. An ill-fitting dental prosthesis might be the consequence of such alterations in dimensions.

On the other hand, these kinds of alterations should not be expected when teeth are scanned digitally. Several in vitro investigations have shown that digital impressions are far more accurate and precise in terms of dimensions than traditional impressions [11,13–18]. Unfortunately, there are several clinical aspects that might affect the impression's accuracy and precision. The only way to determine accuracy is to compare results, ideally against a gold standard, which is difficult to do in the mouth. There is a dearth of high-quality in vivo research when it comes to accuracy [19,20].

Consequently, the 3D morphological data obtained by digital imprint techniques was the primary focus of this work, which contrasted these data with those obtained in vivo through more traditional methods.

Material and Methods

The ten individuals who were a part of this research were dentistry students at our

institution and had full natural teeth (5 men and 5 females; average age 22.6±2.0 years). An intra-oral scanner and silicone imprint material are the two methods we use. There was a total of twenty impressions.

Digital Impression

Digital impressions were created using an intra-oral scanner (Helios 600 3D). Following the guidelines provided by the manufacturer, a digital optical scan was carried out in a single uninterrupted operation, beginning at the occlusal surface and progressing to the lingual and buccal surfaces. The information retrieved from the digital scanning process was sent straight from the Lava COS system to the lab computer (Figure 1).

Figure 1. Helios 600 3D Device.

Conventional Impression

We used a twofold mix impression method and ordinary metal stock trays to make whole arch conventional impressions using vinylpolysiloxane silicone (SILAXIL BOX & PROTESIL LIGHT). We made sure there was enough room for the impression material. After the appropriate tooth was filled with light-type imprint material using a syringe, the tray was placed in the mouth and pushed against the tooth arch. The imprints were taken out of the mouth after the setting period, cleaned for 10 minutes, and then let sit at room temperature and humidity for 3 hours. After following the manufacturer's instructions (fig. 2&3), dental stone plaster models were scanned using an intra-oral scanner (Helios 600 3D). Data from the scans of the premolar and molar areas were saved on the lab's computer using the STL data format.

Figure 2. Convensional impression (mandibular cast).

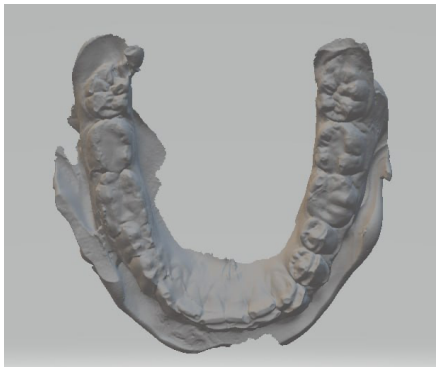

Figure 3. Conventional impression (maxillary cast).

Analysis of 3D Data

The tooth form and gingival margin were adjusted in the 3D images created from STL data using the right software (PolyWorks, InnovMetric Software). Before being overlaid utilizing the best-fit-algorithm approach (least-squares method) to match 2 surfaces, these trimmed STL data were put into a 3D assessment software platform [17,20]. The STL dataset was designated as the standard. With the help of the reference data set's triangular surfaces and the test data set's polygons, the program determines the orientation and nearest distance of each vertex. The industrial sector makes frequent use of this verification approach [21–23].

For two methods, we averaged the absolute value disparities in overall measurement locations. On top of that, we determined the mean difference across all 10 individuals.

Evaluation of the Casts Scanner and Intraoral Scanner in vitro

The accuracy of the scanner, which might affect the accuracy of the scanned data, was tested by scanning a cast model five times and comparing the resulting ten data set pairings using the best-fit algorithm, as mentioned before. The oral scanner underwent the same tests in a controlled environment to ensure accuracy.

Statistical Analysis

We used the Mann-Whitney U test to compare the two methods by calculating the average disparities of all measurement points. A 0.05 threshold of significance was used. Because the data did not follow a normal distribution, non-parametric Mann-Whitney U tests were used to determine if there was a statistically significant difference between the digital and traditional imprint methods. An analysis was conducted using SPSS version 22 (SPSS Inc., Chicago, IL, USA) for statistical purposes.

Results

To compare the two methods, this research used digital and conventional imprint techniques for dental work. For both methods, precise readings were taken for several parameters (ten in all). Parameters like "a," "b," and "c" have much lower mean values and variability metrics for the Digital Impression Technique compared to the Conventional Impression Technique, indicating improved accuracy.

A statistically significant difference in measurement accuracy between the digital impression method and the traditional impression technique is shown by the substantially higher mean value of parameter "a" in the former (p=0.000) compared to the latter. With a p-value of 0.000, there is a difference in the results for parameter "b," as the traditional imprint method has a much lower mean value than the digital impression approach. With a p-value of 0.000, parameter "c" shows that the traditional impression approach tends to provide larger measurements than the digital impression technique, with the former showing a higher mean value. Parameters "j" and "i", on the other hand, do not change significantly between methods (p=0.917 and p=0.117) (Figure 4).

Most cases of generalized aggressive disease were observed in patients with the condition (60%), compared to 30% of people who have chronic or localized severe periodontitis. The case group tended to have higher levels of bleeding, plaque, and gingivitis. This disparity did not, however, reach statistical significance. In comparison to non-users, case women had mean probing depths that were deeper (3.3–1.0 versus 2.7–0.5 mm) (P = 0.04) (Table 2 and Figure 2).

Discussion

These findings imply that digital impressions have less disparity than traditional impressions.

In contrast to more traditional imprint methods, digital direct scanning has several established advantages, as mentioned in the introduction. Despite claims to the contrary, digital impressions are prone to errors because of factors including saliva, jaw movement,

and the merging of many digital pictures. The fact that digital impressions are not susceptible to the inevitable mistakes caused by the dimensional changes of dental stones and impression materials, which may result in the misfitting of dental prostheses, is one of the most significant advantages from a clinical standpoint.

Digital impressions outperform traditional impressions in vitro in terms of dimensional correctness and precision, according to many studies [11, 13–17]. It is crucial to conduct in vivo clinical assessments to prove the translation of in vitro findings to clinical importance in vivo because several clinical circumstances affect the accuracy and precision of an impression. Unfortunately, the gold standard (ISO 5725-1) [24]—accuracy, which stands for truthfulness—cannot be readily tested in patients' mouth cavities, making it impossible to assess in vivo. It is common practice to measure the fit of final restorations as a means of conducting in vivo accuracy assessments [3,7,20,25,26]. Comparing restorations made using digital impressions to those made using traditional impressions, studies have shown that the former provides a more clinically acceptable fit [6,27-30]. It should be mentioned that these assessments of accuracy include the complete restoration manufacturing process, not only the imprint operation. Consequently, it is necessary to compare the imprint processes.

To determine the accuracy of an imprint technique, it is recommended to repeatedly superimpose full scanned pictures taken in the same way [16,17,20,31]. Using the calculated 3D distances, this process finds the discrepancies between the impression pictures taken at each surface point. The clinical feasibility of such a comparison is high. However, the number of investigations assessing the accuracy of the imprint method in vivo is low [19,32].

Previous work [19] that the digital imprint systems had adequate precision in vivo. There is broad consensus among our research findings. Because silicone impressions are so sensitive to the clinician's competence and experience level, the latter is especially crucial from a clinical standpoint [10,12]. Our research found that 3D data from direct oral digital scanning is far more consistent than data from silicone impressions, which is an important finding. Given the scanner's proven accuracy and precision in previous studies, it stands to reason that dimensional variations in the materials used to make stone models from silicone imprints might be a contributing factor to their inconsistency [20,33–37].

Please be aware that the focus of our research was not on accuracy but on precision as applied to individual clinical cases. Table 1 shows that digital impressions were consistently and independently more reproducible than silicone impressions, regardless of participant. This suggests that the inherent dimensional changes associated with the silicone impression technique may be the main factor influencing this finding.

Finally, our results indicate that the digital impression approach provides higher accuracy, even if the average variation between the two methods was just 0.009 mm, which is not deemed clinically important.

Conclusions

Based on the findings of this in vivo investigation, digital impressions seem to be more reproducible than traditional impressions.

Clinical Relevance

Our research shows that the digital impression method is superior to the traditional impression technique; hence, we suggest using it.

Acknowledgements

The authors appreciate the students who participated in the work and our college team that made this research possible.

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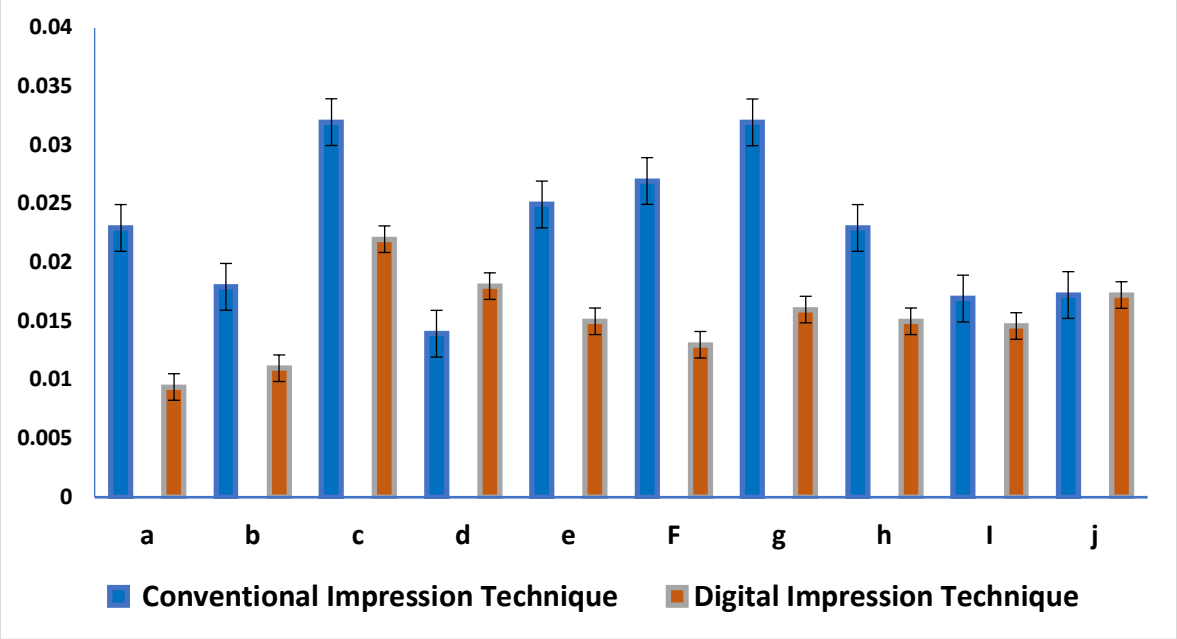

Figure 4. Conventional and digital imprint method mean values.