

Digital Dentistry – Digital Impression And CAD/CAM System Applications

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ARTICLE HISTORY

Received: 22 February, 2017
Accepted: 17 March, 2017

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ABSTRACT

Digital imprint and computer-aided design/computer-aided manufacture (CAD/CAM) systems offer several benefits compared to traditional techniques. The use of a CAD/CAM system to scan preparations and generate restorations in-office, removes a second appointment for the patient. The existence of precision benefits in using complete systems and chairside scanning systems, has been proven. CAD/CAM restorations have a good longevity and meet the accepted clinical parameters. New digital impression methods are presently accessible, and before long, the long-awaited goal of sparing patients of one the most unpleasant practices in clinical dentistry, acquiring dental impressions, will be exchanged by intraoral digital scanning. CAD/CAM systems existing nowadays, can feed data through accurate digital scans created from plaster models, straight to manufacturing systems that can shape ceramic or resin restorations with no requirement of a physical copy of the prepared, adjacent, and antagonist teeth.

Keywords: digital dentistry, digital impression, CAD/CAM

INTRODUCTION

Digital impressions represent innovative methods that enable dentists to construct a virtual, computer-generated copy of the hard and soft tissues of the oral cavity, with the use of lasers and other optical scanning machines. The digital method captures impression data with great accuracy, in minutes, without the need for traditional impression resources that some patients find inopportune and messy. Numerous patients consider digital impressions to be an easier and more comfortable method, in comparison with classical impression techniques. The impression information is then moved to a computerized workstation that creates restorations, often without the need for stone models.¹

THE CLASSICAL IMPRESSION – ADVANTAGES AND DISADVANTAGES

The traditional impression, although still used in most cases, has many disadvantages. Despite the development and improvement in quality of the impression

materials, the disadvantages were not eliminated, and still, there is no ideal impression material on the specialized market.

In many studies, an important number of dentists have encountered different problems in the execution of the ideal impression, especially when it comes to restorations. In the execution process, problems regarding the isolation and drying of the prosthetic field, as well as placing the material around the tooth were encountered. When analyzing the impression outside of the oral cavity, problems such as fractures, bubbles, or poorly demarcated preparation margins were found; in all, there are quite a few possible issues in acquiring dental impressions.

An impression can deform or break at certain levels of stress from the moment it is taken since the restoration is finished. All the materials — preliminary model, wax, investment, metal frame, various acrylic materials and ceramics — have certain properties that change through time due to temperature and humidity. There is also the mechanical distortion to be considered.

Despite the impeccable quality of modern impression materials, several inconveniences still appear during the stage of impression, which may jeopardize the final quality of the restorations and their adaptation on the prosthetic field. Other concerns that have been raised by different dentists are that numerous existing impression materials can take up space, can have a difficult mixing process, or they might cause allergic reactions or emesis during the procedure of taking impression. All these errors can easily pass unnoticed by the laboratory technician or the dentist. The result: remaking the steps, lost time and money.

Conventional impressions have also, several advantages:

- the technique is known and accepted by the clinicians;
- most doctors do not want to learn new techniques, since they have become accustomed to the classical ones;
- the equipment is simple; the technique is relatively simple and easily acquired;
- the cost varies from low to moderate;
- the accuracy of impression with silicone and polyether is well known;

The disadvantages of the conventional impression are:

- taking the classical impression makes a lot of “dirt”. Traces of material remain on the skin, mucosa, and teeth of the patients and should be removed. Traces

of material can spread around the cabinet, the gloves on the floor, instruments, etc.

- discomfort for patients (for some, vomiting is accentuated);
- errors due to the incorporation of air bubbles can cause inaccuracies on the model.²

THE IDEAL IMPRESSION AND THE FEATURES OF AN IDEAL MODEL

An ideal impression needed for fixed restorations must be extremely precise and must be stable so as not to deform the impression or to modify its properties before casting a final model. In addition to accuracy and dimensional stability, other properties necessary and desirable for an ideal impression are short acquiring time, biocompatibility, and safety. Currently, the most popular impression materials for fixed restorations are polyvinylsiloxane or polyester. In addition to the above, the ideal impression requires tensile strength, fluidity, hydrophilicity, ease of removal, and elasticity, so that any deformation during removal of the impression from the oral cavity can be rapidly reversed; smell, taste, and texture must be acceptable to patients. Easy storage is also required.³

DIGITAL IMPRESSION

If the impression is not ideal, the software helps to find the lack of adaptation and shows when the impression is ideal. Once the impression is captured, it can be either sent to the laboratory, or to the CAD/CAM application with the help of one click, and in a second, the laboratory or chair-side system receives all the information needed.

The way each model is molded, adjusted, and fitted, has a huge impact on the outcome of the final restoration. Laboratory uncertainties disappear using this innovative method. Unfortunately, often when clinicians are faced with a completely new technology, such as digital printing, the typical response is to minimize it, to pretend it is not accurate enough, though evidence-based data has proved otherwise.

The first impression systems were simplistic compared to today's standards, but they were more accurate. Impression scanners have similar accuracy and are easy to use. Even older models have proved to be more accurate than traditional materials, and they do certainly not raise as many problems.⁴

Reducing problems such as digital transferring without a model means reducing the cost of the laboratory, for the dentist and patient as well. In fact, this is the reason why many laboratories receive less money compared to a traditional impression.

The digital impression is a noninvasive method, which involves the use of an intraoral scanner of small dimensions that does not create discomfort for the patient. The scanner records a series of snapshots of the oral cavity of the patient, which are transferred onto a computer where they will be processed and a virtual model will be obtained.

The digital impression eliminates the drawbacks of the conventional one. In the case of digital impressions, the information is saved on a computerized workstation, it does not change its fidelity through time, and data stored on a computer occupy a small space in the cabinet. Also, the process of taking the impressions takes very little time. The digital impression offers the patient greater comfort for many reasons. The small size intraoral scanner eliminates the inconvenience of holding a spoon in the mouth loaded with voluminous material that generates a vagal reflex in many patients. It is also much easier to clean.

This type of impression is still unknown and less applied in our country, especially due to significantly higher costs.

Even if the digital impression technique proves to be superior in many aspects, it has a weakness: in the registration of subgingival preparations, the gingival sulcus may compromise the marginal adaptation of the restoration, hence the treatment will fail. The scanner records the same images the doctor sees; to recreate the gingival limit, visibility is mandatory, and it can be obtained through better isolation, using retraction wires or a rubber dam.

Patients like to see the technology in action and often inquire about scanning and how the restorations will be made. Also, different dentists are wondering about how a digital scanning system works. The most common questions are related to its low cost and its ease of use. The price is not reflected on a faulty system, which is extraordinarily accurate. Scanning the dental field is an original technique, as it requires the doctor to look on a screen while using devices in the oral cavity of the patient. The learning process of this technique is like when the doctor learns to move his hands by looking in a mirror. The clinician's brain requires time to get used to using mirror images, as it takes time and experience to take an ideal impression. The laboratory also needs some adjustments to allow work with the new equipment.

When taking a digital impression, all the risks of a conventional impression are eliminated. The result is superior, and more restorations are viable without major rectifications. Studies show a rectification rate of 0.3% on digital impressions versus 4–5% in traditional methods.⁵

One thing is certain: taking a digital impression is simple, practical, accurate, and easily accepted by patients,

it eliminates many of the traditional impression inconveniences, but on the result, the exceptional contribution is made by the doctor. Hence, even if future research will continue and dentistry will be based on modern instruments, the human factor is indispensable and cannot be substituted.

ADVANTAGES AND DISADVANTAGES OF DIGITAL IMPRESSIONS

The disadvantages of the method include the lack of familiarity among dentists. It is not a known concept and mastered by all. The equipment is sophisticated, although lately it has been greatly simplified, and it takes training and practice to acquire the technique. The cost of equipment is high, but after depreciation it becomes cheaper than the conventional technique. Comparative studies between conventional and digital impression in terms of accuracy suggest that there is a small similarity. However, it requires long-term clinical studies to highlight that these systems are superior in terms of accuracy for the restorations.

The advantages of digital impression include simplicity, the elimination of the “dirty” cabinet and patient discomfort. The method has no issues of incorporating air bubbles. However, a close attention should be directed towards not acquiring artifacts due to saliva, gum margins, and the sites in the oral cavity. There is no need for storage space or the purchase of spoons and impression materials. The risk of contamination is reduced, and disinfection needed by the classical impressions is not a must for the digital impression technique.

It is necessary to make very precise preparations (for both techniques), and digital impressions do not support approximations. Gingival sulcus preparation is as important as for conventional impressions.

Data-capturing systems differ considerably among the currently available systems.

Intraoral scanners (chairside systems) include a 3D intraoral digital scanner (Components CEREC 3D system), a 4D Evolution of the D4D company (Technologies). The scanning procedure requires an optical scan or a mechanical technique. The machines must map the entire surface of the tooth preparation. The optical laser is sensitive to any movement — if the patient is not perfectly still, it can compromise the data capturing process.

Current research has led to the development of sophisticated methods to capture images, called “active wavefront sampling”. This revolutionary system method uses 3D video to capture images in the mouth.

ADVANTAGES OF USING CAD/CAM SYSTEMS WITH CHAIRSIDE

The advantages of using CAD/CAM technology for crowns and fixed partial denture manufacturing are the following: application of new materials, reduced labor, cost-effectiveness, and quality control.

In the last years, the materials and the processing technology have been closely related to the manufacturing of dental prosthetic devices and reconstructive dentistry. However, high-strength ceramic, which was expected to be a novel material for fixed partial dentures, was difficult to work with using conventional technologies in the dental laboratory. This has led to the application of CAD/CAM processing, especially in a large machining center facility. CAD/CAM technology has been useful and effective for compensating for changes in dimensions that come with chalky material processing.⁶

Conventional dental technologies require traditionally hard work. The application of CAD/CAM technology should reduce the total work effort and time involved. When a molar ceramic crown was produced by DECSY®, for example, it took 4 minutes for the measurement, 1 minute for the design, 2 minutes for the conversion processing and 90 minutes for the ceramics processing. The total processing time was much shorter than conventional construction dust/powder and firing pottery. In addition, the operator assisted for only 5–6 minutes, and most of the process was carried out automatically by CAD/CAM. Therefore, efforts are greatly reduced by using this technique. In addition, system outsourcing for specialized techniques in the processing center by using network connections allow additional decrease in the work time.⁷

CONCLUSIONS

There is no doubt that therapeutic tools and resources in medicine have gradually advanced over the past 50 years,

especially in the field of dentistry and prosthetic reconstruction. The dentist must provide a high quality dental care for all patients, in order to maintain and restore oral functions. Therefore, applying novel methods and materials, such as digital impressions (using CAD/CAM system), is of utmost importance for future oral health protocols. The application of new materials and technologies is essential for dental services in the future. The digital technique of acquiring tooth impressions leads to a shorter time of treatment and recovery in the field of restorative dental medicine.

ACKNOWLEDGEMENT

This research was partially supported by the research grant of the PhD grant of the Victor Babes University of Medicine and Pharmacy Timisoara – 3637/01.10.2015 (contract no. 11522/01.10.2015).

CONFLICT OF INTEREST

Nothing to declare.

REFERENCES

1. Digital Impressions: Virtually Perfect. Available at: <http://www.yourdentistryguide.com/digital-impressions/>
2. Bratu D, Nussbaum R. Bazele clinice si tehnice ale protezarii fixe. Bucharest: Editura Medicala, 2009.
3. Bratu D, Rominu M, Leretter M, Uram-Tuculescu S. Materiale dentare in cabinetul de stomatologie. Bucharest: Editura Helicon, 2008.
4. Miyazaki T, Hotta Y, Kunii J, Kuriyama S, Tamaki Y. A review of dental CAD/CAM: current status and future perspectives from 20 years of experience. *Dent Mater J.* 2009;28:44-56.
5. Klim J, Corrales E. Innovation in Dentistry: CAD/CAM Restorative Procedures. A Peer-Reviewed Publication. *Dent Mater J.* 2009;28:44-56.
6. Digital Impression Systems and the Importance of Interoperability. Available at: <http://glidewell dental.com/education/inclusive-dental-implant-magazine/volume-5-issue-1/digital-impression-systems-and-the-importance-of-interoperability/>
7. Innovation in Dentistry: CAD/CAM Restorative Procedures. Available at: <https://www.dentalacademyofce.com/courses/1586/pdf/innovationcad.pdf>.