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Editorial

Digital versus Conventional Workflow in Oral Rehabilitations: Current Status

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In recent years, computer-aided design and computer-aided manufacturing (CAD-CAM) technology has developed along with its applications in dentistry, including several new techniques that are used in oral rehabilitation applications [1–8]. These techniques usually differ from conventional analog techniques regarding the way in which impressions are obtained (e.g., conventional impressions vs. intraoral scanning) or the way restorations are designed and produced (e.g., conventional waxing and casting vs. CAD-CAM). The general advantages that digital workflow involving CAD-CAM has over conventional workflow include faster treatment times, shorter appointments, reduced patient discomfort, no need to use plaster models and better predictability [9,10]. Another key feature of digital workflow is the ability to merge and superimpose three-dimensional (3D) meshes from different imaging examinations to create a virtual patient, which enhances virtual treatment planning and communication with patients [11]. The general disadvantages of digital workflow that have been described include purchasing and managing costs, as well as a learning curve [9]. Nevertheless, it is also important to understand differences in quantitative outcomes such as trueness and precision between digital and conventional workflows.

One of the most commonly investigated quantitative comparisons in digital dentistry is between conventional impressions and intraoral scans. In comparison to conventional impressions, intraoral scanning (IOS) has been considered to be more accurate in regard to the outcomes of resulting CAD-CAM crowns and short-span fixed partial dentures [12–14]. Several articles have found marginal gap values lower than 60 µm for CAD-CAM dental crowns produced using IOS, whereas gap values up to 183 µm were found for crowns produced using conventional impressions [12]. One finding that is found across multiple studies is that ensuring the accuracy of intraoral scans of long-span and completely edentulous arches it is still challenging [15].

Conventional impressions can also be digitalized to enable the execution of digital workflows by using CBCT or desktop optical scanners. The latter, however, has been found to offer significantly lower gaps for CAD-CAM crowns (reported to be around 50–60 µm), as compared to the former (reported to be higher than 100 µm) [16–18]. The acquisition parameters of CBCT also seem to have an influence on the results, as one study found that a voxel size of 0.125 mm led to better results in comparison to other values [16].

In addition to the differences between conventional and digital impressions, CAD studies have also focused on assessing and comparing different software programs and methods for use in the digital design of dental prosthesis [19,20]. Virtual waxing was found to be affected not only by subgingival finish lines of the scanned preparations and the IOS device used [19], but also by the operator's clinical experience and educational background, as prosthodontists with basic CAD training were shown to outperform dental professionals who had CAD certificates but less clinical experience [20].

In terms of production, studies assessing conventional and CAD-CAM methods in the manufacture of dental prosthesis have compared CAD-CAM with pressed ceramic restorations [21–25]. While for dental crowns, CAD-CAM was found to have significantly better adaptation than pressed ceramics [21,22], most of the studies concerning laminate

Citation: Cortes, A.R.G. Digital versus Conventional Workflow in Oral Rehabilitations: Current Status. *Appl. Sci.* **2022**, *12*, 3710. https://doi.org/10.3390/app12083710

Received: 24 March 2022
Accepted: 28 March 2022
Published: 7 April 2022

veneers found a different pattern, with similar [23,24] or worse adaptation using CAD-CAM [25].

Regarding resin restorations, previous studies have concluded that CAD-CAM (i.e., milled and 3D-printed) outperform conventional (i.e., manually constructed) interim resin crowns in terms of adaptation [26] and mechanical resistance [27]. On the other hand, there is controversy in the literature regarding comparisons between 3D-printed and milled resin restorations. A recent study found that a five-axis milling device is more accurate and faster but has a lower production rate and higher costs compared to a low-cost LCD 3D-printer to produce CAD-CAM dental crowns [28]. Nevertheless, another study on dental implants that compared a high-end DLP 3D-printer and a four-axis milling device found better adaptation for 3D-printed resin crowns compared to the milled and conventional crowns produced in the study [29]. Other previous in vitro studies found similar results between milling and 3D printing [26,27]. Significant differences in the marginal gaps of CAD-CAM crowns have also been found between milling devices with different numbers of axes [30].

In conclusion, the interpretation of research assessing CAD-CAM methods and comparing them to conventional methods should be performed carefully, as the materials and methodologies used vary considerably among the studies. It is important to understand that several variables can affect the outcomes of CAD-CAM restorations and prostheses during either image acquisition (e.g., IOS device, operator, technique, or anatomy), CAD (e.g., software or operator) or CAM phases (e.g., device, manufacturing material, CAM protocol, or finishing). It has also been suggested that digital dentistry has the potential to play important roles in preventive dentistry, public health, and even dental education [31]. Despite this evidence and several other upcoming clinical trends [31,32], the lack of clinical, prospective, long-term comparative studies on digital dentistry is a sign that the train of digital dentistry research still has its first wagon.

Funding: This editorial work received no special funding.

Acknowledgments: The Guest Editor wishes to acknowledge all of the authors and the anonymous reviewers.

Conflicts of Interest: The author declares no conflict of interest.

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