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Editorial

3D-Printed Materials Dentistry

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This editorial focuses on the Special Issue on 3D-printed materials in dentistry. The articles of this Special Issue cover a wide range of applications in the dental field. They range from applications in the clinical workplace to in vitro investigations on the impact of postcuring and storage time on accuracy and precision measurements to the indirect transfer of orthodontic brackets, as well as the application of 3D printing in dental education. Five out of eleven research papers deal with applications of 3D printing in orthodontics, one study presents a 3D-printed fitting system for FFP2 masks which were applied during the COVID-19 pandemic, while the remaining one addresses applications in prosthodontics and restorative dentistry.

In orthodontics, 3D printing is becoming increasingly popular. It allows to create individualized appliances, to perform different treatment tasks at the same time, and much more [1].

The article by Küffer et al. [2] demonstrates a digital workflow for producing highly individualized, skeletally borne 3D-designed appliances for the upper and the lower jaw. As orthodontic mini-implants providing skeletal anchorage are often inserted using templates, the article also presents typical designs for insertion guides. Additionally, it highlights potential sources of errors within the digital workflow that are especially relevant to clinicians in their daily practice.

The article by Kirschner et al. [3] addresses the question of whether steam autoclaving impacts on the biomechanical properties of 3D-printed insertion guides. Autoclaving is necessary as the guides may be in contact with blood during orthodontic implant placements. The study compared two autoclaving cycles and different resin/printer combinations. For the protocol using a lower temperature and a longer autoclaving time, no biomechanical alterations could be observed, whereas in some groups, significant difference were noted for the faster autoclaving protocol at an increased temperature.

The article by Ihssen et al. [4] investigated whether the socket height of 3D-printed casts used to thermoform aligners has an impact on the aligner thickness and homogeneity. Thicker aligners would apply higher forces to the teeth, and varying thickness values might lead to inhomogeneous force applications across the aligners. Indeed, the study demonstrated that increased socket height was associated with thinner and more homogeneous aligners. Additionally, in all groups, the thickness values were highest at the incisal surfaces, and they were the lowest at the facial aspects, especially at the cervical margins. Future clinical studies are needed to assess the impact of local variation in the aligner thickness on the local force application and thus on treatment's success.

The article by Jungbauer et al. [5] compared two 3D-printed bracket transfer trays with different shore hardnesses and assessed whether the crowding of the incisors impacts on the accuracy of indirect bracket transfer. Additionally, the workflow was tested using two different methods, i.e., intraoral scanning and Micro-CT, whereby intraoral scanning was inferior as the shape of the brackets was very different from that of the reference. The study found minor linear deviations for the indirect bracket transfer, whereas angular deviations and deviations in the torque reached values that were above the limits specified by the American Board of Orthodontists. Finally, the deviations were more pronounced for crowded teeth.

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Mieszala et al. [6] proposed the fabrication of Polymer Polyether Ether Ketone (PEEK) transpalatal arches designed in a CAD process. The forces and moments of two transpalatal arch designs were within a range that appears to be clinically useful for expansion or for anchorage purposes. However, their clinical applicability is still limited as the PEEK arches cannot be activated intraorally. Furthermore, there is also a lack of clinical studies proving their applicability in clinical settings.

Vichi et al. [7] focused on infection control during COVID-19 pandemic. They designed a mask fitter to ensure proper fit of FFP2 masks. While no data are available on the efficacy of this device, they reported a high satisfaction of staff members with the novel mask fitting system.

The article focusing on dental education by Lugassy et al. [8] described the fabrication of multi-colored teeth to train students in Class I preparations of molars. The study demonstrated low reliability in evaluations of undergraduate students given by staff for conventional plastic molars, whereas moderate to good reliability was found for the multicolored 3D-printed teeth. Thus, it was concluded that the multicolored teeth can provide a more objective evaluation of the students' performance in cavity preparation.

The article by Lin et al. [9] focused on the dimensional stability of 3D-printed casts obtained using digital light processing (DLP) or stereolithography (SLA). While no shrinkage was noted in the first two weeks for DLP and SLA groups, a significant contraction was noted from two to six weeks.

The article of Doh et al. [10] focused on the dimensional changes during the postcuring of 3D-printed denture bases. They found that the dimensional changes increased with postcuring times of 15–60 min, and that accuracy was higher when no prior removal of support structures had been performed.

The article by Lüchtenborg et al. [11] outlined the potential applications of fused filament fabrication (FFF) printing in dentistry. Despite FFF was reported to exhibit a reduced accuracy compared to that of other 3D printing technologies, this technology was reported to be a promising and cost-efficient alternative for the in-house production of digitally designed models, trays, or prototypes for denture try-ins.

The article by Çakmak et al. [12] investigated the impact of the 3D printing layer thickness on the trueness and margin quality of interim dental crowns in comparison to that of milled PMMA crowns. They demonstrated that milled PMMA crowns had the highest margin quality, while printed crowns with a layer thickness of 20µm and 100µm had the lowest. They also found that the trueness and marginal quality of the 3D-printed interim crowns were influenced by the printing layer thickness. Trueness of milled crowns was reported to be superior compared to 100 µm printed crowns, and margin quality was also highest for milled crowns.

In summary, the publications of this Special Issue reflect the multitude of areas in which 3D printing technologies can be applied to dentistry at present, and they also outline future avenues for novel research projects. As the majority of studies were performed in vitro, this Special Issue might also stimulate future clinical studies and systematic reviews of the existing literature.

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