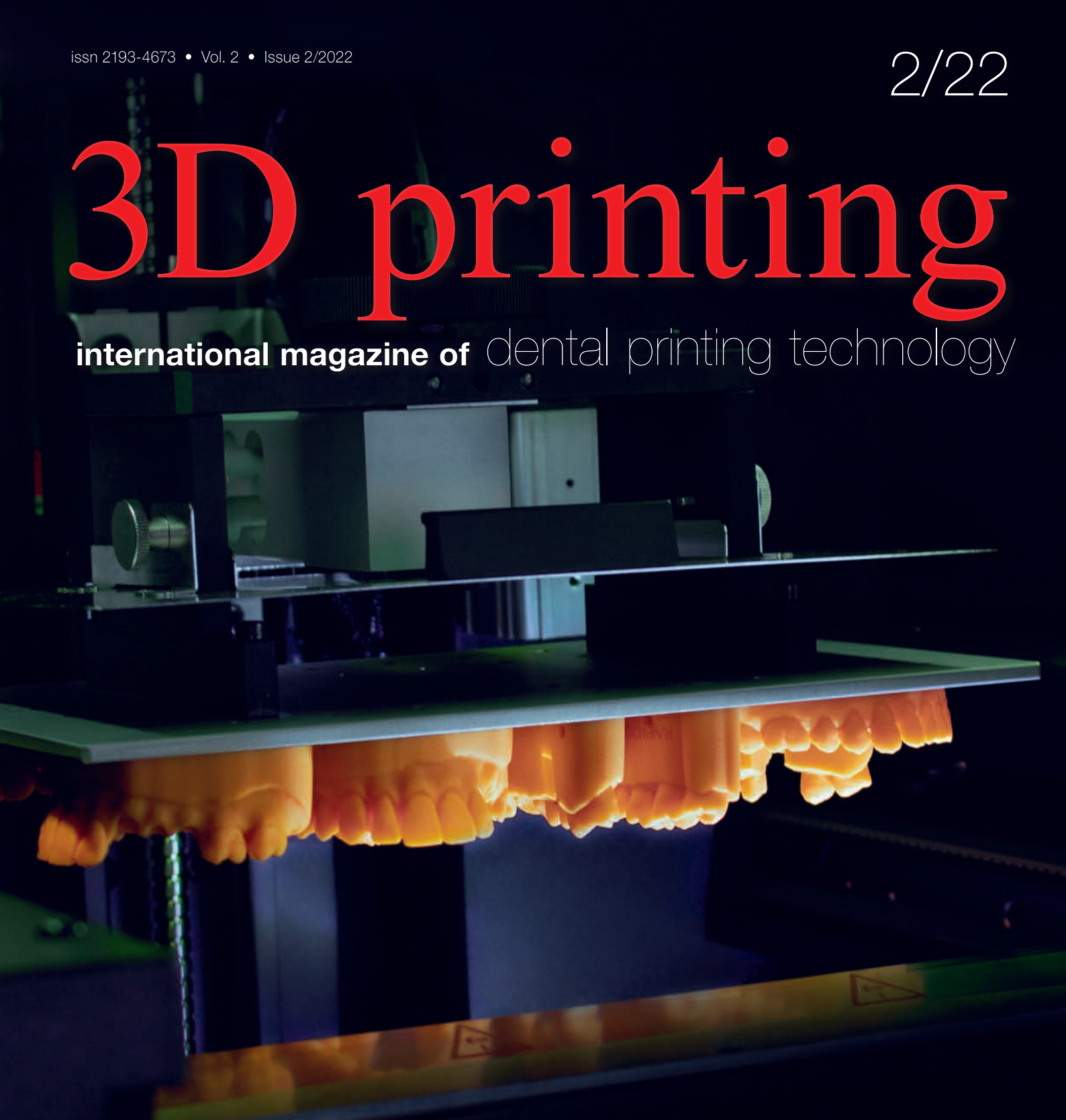
issn 2193-4673 • Vol. 2 • Issue 2/2022

2/22

3D printing

international magazine of dental printing technology



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Dr George Freedman

Editor-in-chief

3D printing in dentistry: The need for leadership

3D dental printing is harmonious with the continuing positive evolution of dentistry. As a field of study and practice, it is clearly distinct from prior dental technologies and techniques yet totally in sync with the arc of dental development. The rapid acceptance and uptake of 3D-printing technologies in a wide range of dental procedures points to the need for an organisational structure to set manufacturing, laboratory and clinical standards and to begin the formulation of a comprehensive educational platform that will serve to train dentists and technicians worldwide.

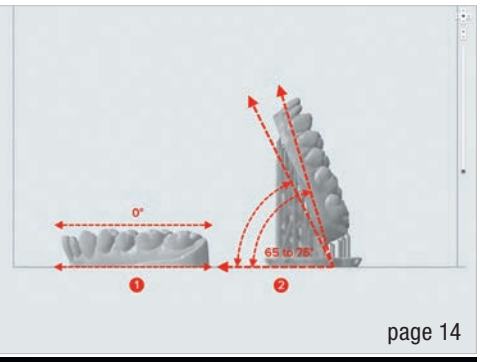
Because 3D dental printing is *so* innovative, *so* promising and *so* disruptive, it is unlikely to find a truly accommodating niche, one that would nurture its growth and progress, within existing, and necessarily competitive, dental organisations. For the very same reasons that cosmetic dentistry could not have flourished as it did within the confines of prosthodontics or traditional restorative dentistry 40 years ago, 3D printing must engage open minds and imaginative spirits and empower science-based risk-takers who will challenge conventional wisdom and established practice. Thus, it is essential that a new organisation dedicated solely and exclusively to 3D dental printing be convened, at the earliest opportunity. Ideally, this will be an organisation that will offer an open forum for free discussions and timely presentations of new ideas (even if they seem far-fetched), an open membership that is affordable and one that will not only attract and collect information and clinical feedback, but effectively disseminate this information around the globe.

What groups of experts are required to lay the foundation for the next major leap in dentistry? They must include:

- hardware experts (who develop the printing technologies and devices);
- software experts (who drive the hardware and link clinicians, laboratory technicians and patients);
- technicians (who use the technology to turn raw materials into restorations etc.); and
- dental professionals (who diagnose, plan treatment and deliver restorations to patients).

And would it not be interesting, and ultimately appropriate, to have this convening meeting at the International Dental Show, where so many of the world's experts in the fields mentioned gather? The show is celebrating its 100th anniversary, and it would be fitting to initiate its second century by inaugurating this most fundamental transformation of the dental profession.

Dr George Freedman
Editor-in-chief



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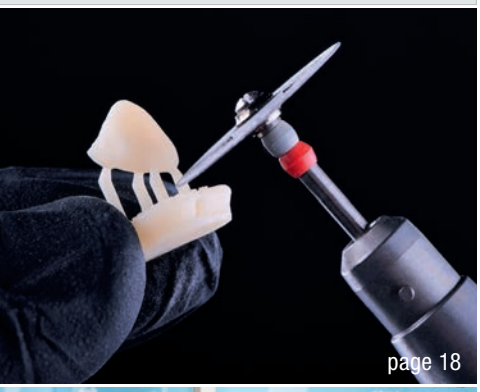
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Study finds 3D printing more accurate than milling when it comes to dental crowns

By Anisha Hall Hoppe, Dental Tribune International

Using the exact same dataset and an industrial 3D digitiser to identify deviations, researchers at Tohoku University Graduate School of Dentistry in Japan found that producing a crown by digital light processing (DLP) 3D printing results in a better-quality product than can be achieved through milling.

CAD/CAM-produced milled crowns have proved a popular alternative to traditional metallic restorations in recent years, thanks to the better wear and aesthetic qualities of resin-composites. However, the new study indicates that advances in DLP printing can offer dentists a far better product in terms of less wastage and higher accuracy than has previously been available.

Compared with the milled crowns created during the study, the DLP-printed crowns were consistently more accurate and had fewer marginal discrepancies. The researchers noted that, particularly at the crown cusps, the milled crowns had a higher rate of dimensional deviations and that, when offset correction was attempted on the internal surfaces of the milled products that had negative deviations, grooves would result.

DLP-based 3D printing achieved a higher level of dimensional fitting accuracy and high trueness, regardless of the abutment shape. When it comes to milling, the trueness is very dependent upon the material properties, and those which are more brittle, such as ceramics and polymer-infiltrated ceramics, are prone to chipping during processing, meaning that too much milling can result in a lower-quality piece.

DLP also provides a broader possible range of fitting accuracy than can be provided by milling.

The researchers noted that future studies could evaluate the fracture resistance and biocompatibility of 3D-printed crowns as permanent prostheses and that additional research utilising different printing parameters and fabrication systems would be useful.

Editorial note: The study, titled "Comparison of the accuracy of resin-composite crowns fabricated by three-dimensional printing and milling methods", was published online on 6 July 2022 in Dental Materials Journal*, ahead of inclusion in an issue.*

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Artificial intelligence may automate design of biomimetic single-tooth protheses

By Franziska Beier, Dental Tribune International

Even with the support of modern CAD/CAM technology, creating a dental prosthesis is still rather time-consuming, resulting in more chair time and high costs for patients. To facilitate the design of molar crowns, researchers from the Faculty of Dentistry at the University of Hong Kong (HKU) and the Department of Computer Science of Chu Hai College of Higher Education in Hong Kong collaborated to develop a novel approach using artificial intelligence (AI).

When asked what inspired the research, lead author Dr Walter Yu Hang Lam, clinical assistant professor in prosthodontics at the Division of Restorative Dental Sciences at HKU, told Dental Tribune International: "Some patients sense a very subtle hair-thin high spot on their dental prosthesis. Therefore, in the dental curriculum, a significant proportion of time is dedicated to occlusion theory and clinical training to provide a dental prosthesis that fits the patient's mouth. My colleagues and I hoped to figure out a solution for improved treatment efficiency and patient experience."

In order to restore the patient's original appearance, masticatory function and general oral health, dental protheses should have the same occlusal morphology and 3D position of the natural teeth. These can be deduced for a missing tooth from those of the surrounding dentition because the teeth of an individual are all controlled by the same set of genes and exposed to the same oral environment. The researchers hypothesised that AI could thus generate the design for a single-tooth prothesis based on the characteristics of the remaining dentition.

The research team used a machine learning approach called a generative adversarial network (GAN) to train and validate their AI system and have tested it on 175 participants. The system was able to reconstruct the shape of a natural tooth and automate the process of dental protheses design based only on the digital model of the patient's dentition.

"The 3D GAN algorithm was selected due to its superior performance on 3D object reconstruction compared with other AI algorithms. In the preliminary study, 3D GAN was able to rebuild similar shapes to the original teeth for 60% of the cases. It is expected to mature with more AI training data," commented co-author Dr Reinhard Chun Wang Chau, research assistant in the Division of Restorative Dental Sciences and of Applied Oral Sciences and Community Dental Care at HKU, in a press release. For future research, the team proposes to investigate whether the presence of opposing teeth will help the AI to generate a more natural tooth.

Asked about the advantages of this method for dental professionals and patients, Dr Lam said: "It's less time-consuming for both of them. Dentists will spend less time on registering jaw relationships and chairside adjustment, greatly facilitating the entire treatment process and enabling them to take on more cases."

He continued: "Patients will spend less time and money on the treatment. In addition, the dental prostheses they receive will fit better to their remaining dentition and are thus less likely to cause jaw problems."

According to Dr Lam, the research group hopes to make the AI technology available for dental professionals within the next five years, after having tested its accuracy further in simulated and clinical scenarios. Moreover, the researchers believe that the method may be applied to the fabrication of crowns for other teeth and of multi-unit restorations in the future.

Editorial note: The study, titled "Artificial intelligence-designed single molar dental prostheses: A protocol of prospective experimental study", was published online on 2 June 2022 in PLOS ONE.

In a recent experimental study, Hong Kong researchers demonstrated that their AI system could generate the design of a molar (red) based on the features of the remaining dentition (dark grey). *(Image: © HKU)*

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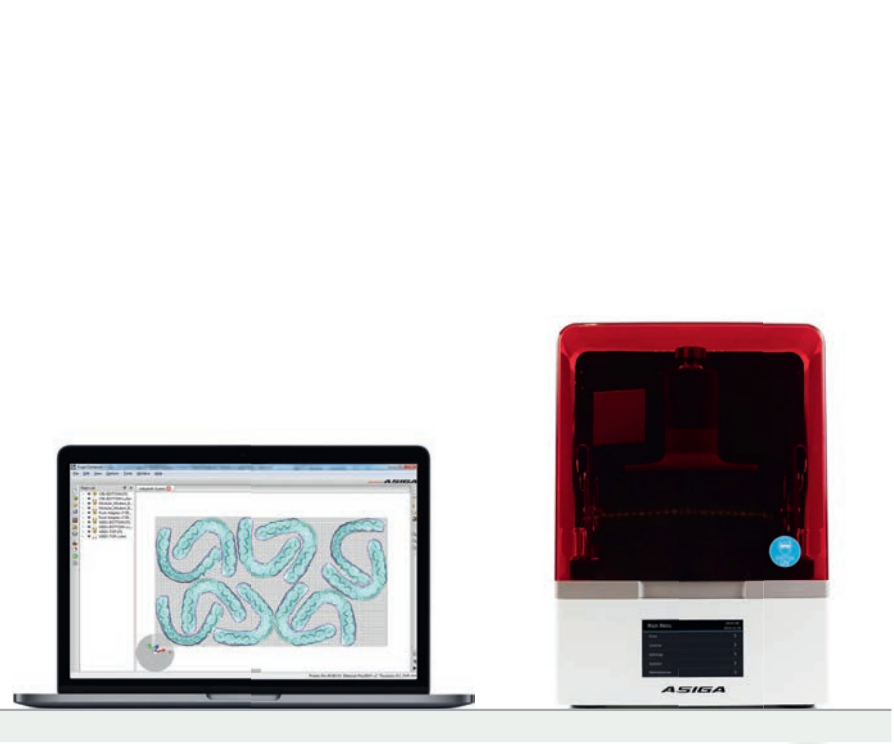

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