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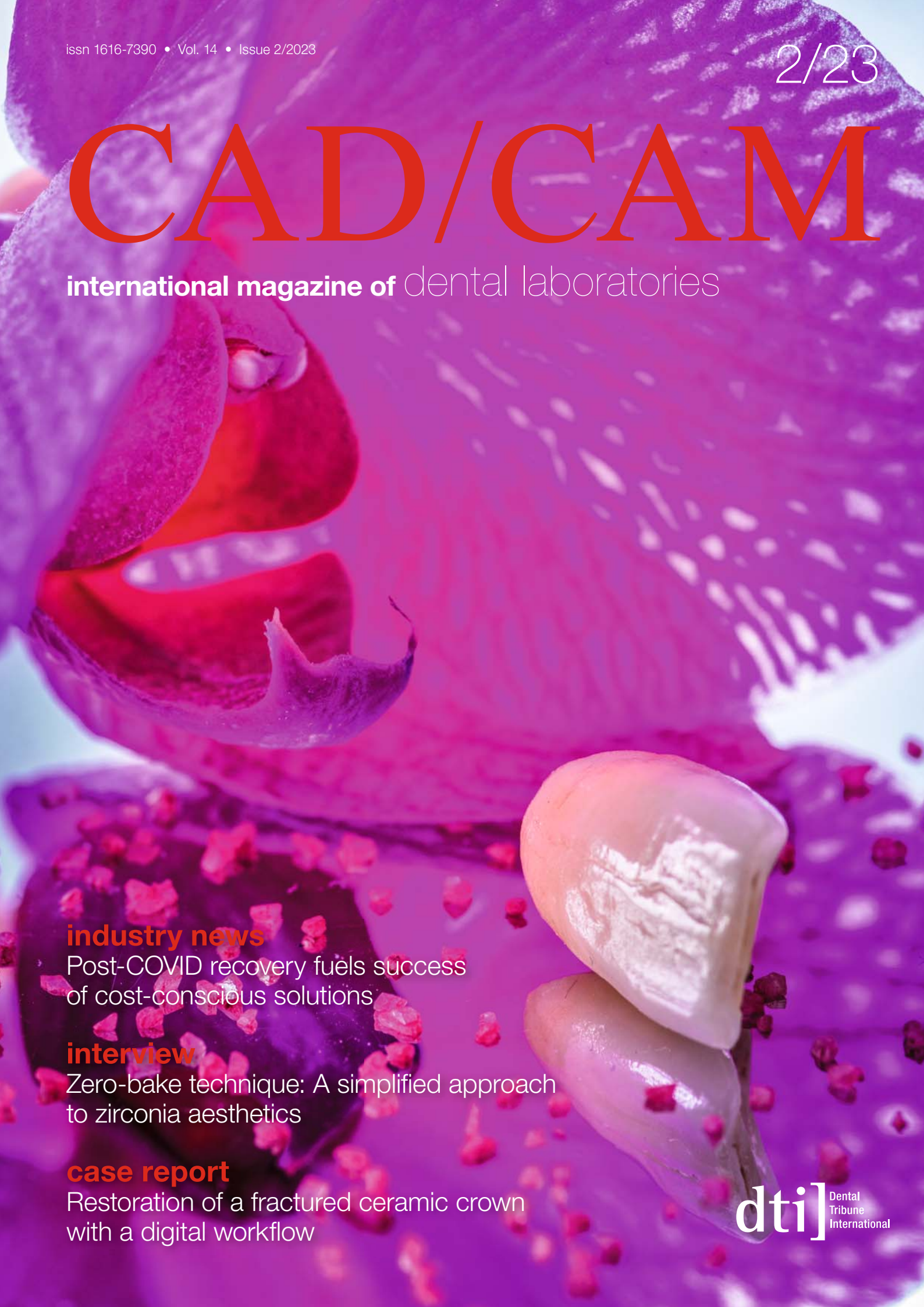
2/23

# CAD/CAM

**international magazine of** dental laboratories



**industry news**
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**Magda Wojtkiewicz**

Managing Editor

# To mill or to print? That is the question

**The introduction** of CAD/CAM milling and 3D-printing technologies to dentistry has significantly reduced the possibility of inaccuracies in the fitting of prosthetic restorations. These new technologies have gained the appreciation of dental professionals as well as patients, who have realised that they no longer have to tolerate the unpleasant aspects of conventional impression taking or attend several appointments for a restoration. Patients enjoy the benefits of receiving a permanent crown in a single visit and dental professionals the shorter, cleaner and more predictable workflow. Many dentists, laboratory owners, dental assistants and dental technicians agree that digital impressions and digital technologies for design and manufacture will soon replace conventional methods of fabricating dentures, splints, bridges, crowns and even veneers. Increasingly, it is not just milling but also 3D-printing technology that is being used to produce CAD/CAM dental restorations. How does a laboratory or dentist know which is better: milling or 3D printing? The answer depends on what do you need the most—speed, exceptional accuracy and aesthetics, or lower costs?

The first aspect to consider is the material from which the final restoration is to be made. Milling uses many different materials (e.g. titanium alloy, cobalt–chromium–molybdenum alloy, PEEK, and other polymers, and PMMA and other resins) but ceramic materials, such as leucite and lithium disilicate glass-ceramics, which are the most natural-looking replacements for missing tooth substance and are available in a wide range of shades and translucencies, give most predictable, durable and highly aesthetic results. 3D printing works with a vast number of different materials too, including non-precious metal alloys (e.g. cobalt–chromium and titanium alloys), composite resins and ceramics—however, these are single-coloured, so the printed restorations may require more finishing than milled restorations.

The second thing to consider is convenience. Nowadays, 3D printing is faster than milling, and according to many dental professionals, 3D printing is easier to use than milling, but this is a very subjective opinion and largely depends on the workflow the user is accustomed to. Many dentists who own chairside milling machines use them only in easier cases where a single crown or inlay is required and send orders for other restoration types to the dental laboratory for more reliable and detailed results.

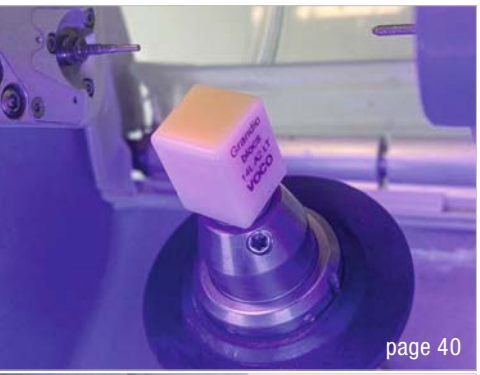
Another important factor is accuracy. In this regard, 3D printers do not have a clear advantage over milling. However, milling tools are limited as milling machines cannot be made smaller than the tools they use. Because milling is a removal process and printing is an additive process, 3D printers are better able to create curves, holes, and very small and complicated shapes than milling machines are.

Cost is usually important for both dental professionals and patients. 3D printers are becoming increasingly affordable, which is great for technology-minded dentists and laboratory owners. Industrial 3D printers are still expensive, but the average cost of each product fabricated is cheaper compared with milling. In addition, 3D printing enables the fabrication of multiple parts at once, and it produces little or no waste.

The possibilities of using 3D-printing technology in dentistry seem endless, but there is still much to discover and learn. Milling is still the most predictable technology to use for permanent fixed restorations, guaranteeing consistency and enabling the highest aesthetics. We can expect that as 3D-printing technology continues to evolve, this method of fabrication will play an ever greater role in transforming the field of dentistry.

Sincerely,

Magda Wojtkiewicz
Managing Editor


page 40

page 46

page 54

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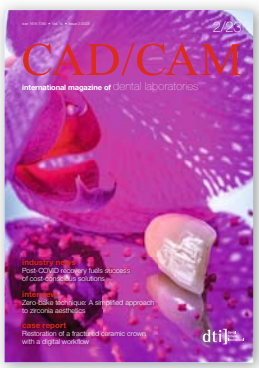



## editorial

To mill or to print? That is the question 03

## news

E-glass fibres need more fine-tuning before they can be useful in CAD/CAM resin composites 06

Intra-oral scans may present more humane option for evaluating clefts in infants 08

Will a scan aid actually help with intra-oral implant scans? 09

## industry news

Post-COVID recovery fuels success of cost-conscious dental implant solutions and digital dentistry 12

Redefining implant therapy with digital planning, guided placement and use of CONNECT abutments 16

## industry report

CEREC or 3D printing: Which technology for in-office manufacturing? 18

## interview

"Digital technologies are fundamentally changing the dynamics of our industry" 22

Aspen Dental's digital denture transformation 24

Zero-bake technique: A simplified approach to zirconia aesthetics 28

## case report

Extremely minimally invasive mock-up-guided veneer preparations in the aesthetic area 32

Restoration of a fractured ceramic crown with a digital workflow 38

Endocrowns milled from CAD/CAM composites for high strength and flexibility 40

The copyCAD 3: Crown legacy 46

Treatment of severe oral pathology in pre-geriatric patients: A proposal for a clinical protocol for same-day dentistry 50

## practice management

"Alone we can do so little, together we can do so much" 54

## manufacturer news 58

## meetings

All about the patient: The 2024 ITI World Symposium 61

Long-awaited Digital Dentistry Show to premiere in Berlin in June 2024 62

International events 64

## about the publisher

submission guidelines 65

international imprint 66

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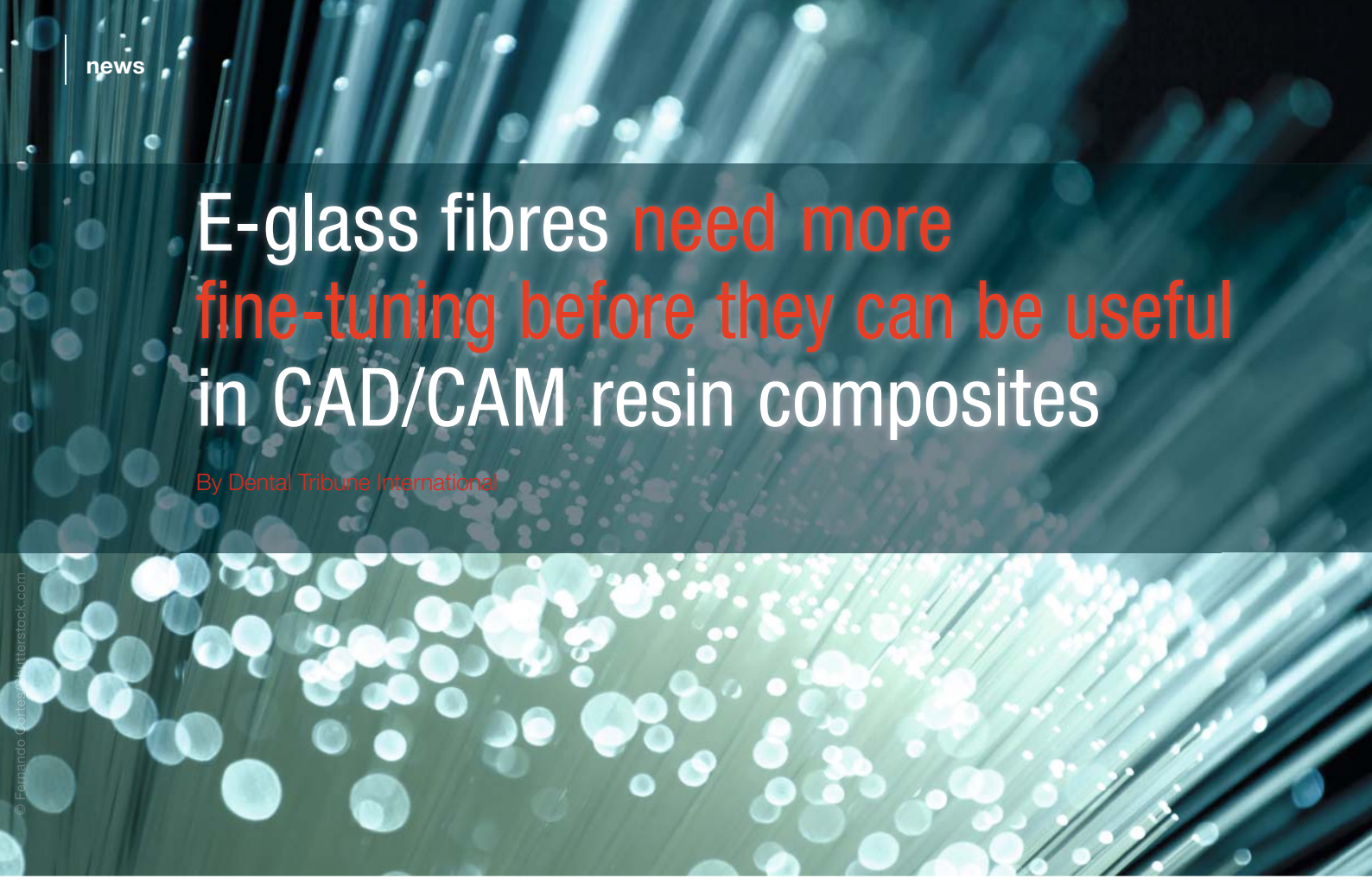

# E-glass fibres need more fine-tuning before they can be useful in CAD/CAM resin composites

By Dental Tribune International

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**Dental restorations** often rely on CAD/CAM resin composites for their precision and reliability. However, ensuring the longevity and durability of these restorations remains a challenge. The integration of bidirectional E-glass fibres beneath the composites offers potential benefits in enhancing fracture resistance and directing crack propagation, thus potentially minimising catastrophic failures. A recent study has delved into understanding these dynamics further, finding that the exact placement of fibre layers under the composites needs consideration in order to balance resistance and risk of catastrophic failure.

Endodontically treated teeth are more prone to fractures and often have a reduced lifespan compared with non-treated teeth. The main challenge is preventing fractures below the cemento-enamel junction, which can cause unrepairable root fractures. While endocrowns and overlays have emerged as alternatives to traditional restorations, concerns remain. A promising approach to reinforcing restorations is the use of composites reinforced with fibre, especially glass fibre, and such reinforced composites possess superior mechanical properties compared with particulate-filled resins.

The researchers in the study sought to determine whether the presence and position of E-glass fibre reinforcement affects the restoration's load-bearing capacity, fatigue resistance and fracture pattern. To do so, they created 90 specimens composed of a bidirectional fibre-reinforced composite layer between a superficial layer of a CAD/CAM resin composite of different thicknesses and a particulate-filled resin substructure of different thicknesses, the CAD/CAM layer simulating the coronal restoration and the particulate-filled resin simulating the resin composite core build-up of an endodontically treated tooth. They used 30 specimens of unreinforced CAD/CAM resin composite as control.

Half of the samples underwent compressive loading and the other half cyclic loading. The former showed that the control samples had the highest load at failure and that breaking force decreased with reducing CAD/CAM resin composite thickness. Under compressive loading, the CAD/CAM resin composite displayed high resistance, especially when integrated with a fibre layer, which directed crack propagation laterally. The cyclic loading showed that the fractures typically occurred at lower stress levels than those defined by maximum strength. Notably, the layer thickness of the CAD/CAM resin composite played a significant role in fatigue resistance. Thicker layers had higher resistance, but the positioning of the fibre layer had implications for stress distribution. Specimens with balanced tensile and compressive stresses showed that the fibre layer deviated the crack, indicating the potential for reducing non-restorable tooth fractures. Analysis of the fracture surfaces, using stereomicroscopy and scanning electron microscopy, elucidated fracture origins and directions.

*Editorial note: The study, titled "Exploring the influence of placing bi-directional E-glass fibers as protective layer under a CAD-CAM resin composite on the fracture pattern", was published online on 19 September 2023 in* Dental Materials*, ahead of inclusion in an issue.*

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Techniques for taking impressions of clefts in infants have not changed in over 70 years. New research has probed the advantages and acceptability of the use of intra-oral scanners.

# Intra-oral scans may present more humane option for evaluating clefts in infants

By Anisha Hall Hoppe, Dental Tribune International

Clefts of the lip and/or palate and alveolar bone are the most common congenital anomalies of the head and neck and result in feeding, psychological, craniofacial and speech challenges. In infants, care may involve preoperative appliances, for which impressions of their clefts are required. Conventional impression taking techniques pose risks like ingestion and suffocation. A study at Alexandria University has assessed the reliability of digital versus conventional impressions in reproducing unilateral cleft lip and palate in newborns and found digital impressions to be as accurate but more acceptable for guardians.

The study involved seven infants aged 0–28 days diagnosed with complete unilateral cleft lip and palate. Impressions of their clefts were taken with the conventional method using an irreversible hydrocolloid impression material and with an intra-oral scanner. Stone models of the conventional impressions were scanned, creating virtual 3D models, and the intra-oral scans were saved as virtual 3D models and 3D-printed.

The virtual models from both methods were superimposed to compare the alveolar arch width and alveolar cleft defect. The maximum alveolar arch width and maximum distance between the premaxillary segments were measured on the physical models from both techniques using vernier callipers. The superimposed 3D scans of the conventional and digital impressions showed significant differences in three of the cases. However, the calliper measurements showed no significant variation between the conventional and digital impressions.

Additionally, the infants' guardians completed a questionnaire on their acceptance of both impression techniques, and their answers revealed a distinct preference for the digital method. Two significant findings were that the guardians felt that the conventional method was more invasive and that they believed their infant had suffered during its application.

The study indicates a shift away from traditional impressions owing to associated risks and the stress it places on both patients and guardians. Digital impressions emerged as safer and preferred because they minimised risks to infants as well as eased guardians' concerns. The study also showed that digital impressions are accurate and efficient. Digital impression taking also offers the advantage of creating reliable models for future treatment planning and provides visual aids to parents that showcase the potential improvements in their infant's condition.

*Editorial note: The study, titled "Diagnostic evaluation and guardian assessment of using digital impression in neonates versus the conventional techniques", was published online on 30 August 2023 in the* Alexandria Dental Journal*, ahead of inclusion in an issue.*

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# Will a scan aid actually help with intra-oral implant scans?

## New research suggests using scan aids has both pros and cons

By Dental Tribune International

**The use of intra-oral scanners** for full-arch digitisation of edentulous arches with multiple implants has not been recommended, owing to significant errors. A study by researchers in Freiburg and Berlin in Germany compared the accuracy of intra-oral scans for multiple implants with and without the use of a scan aid. The goal was to understand the potential improvements the scan aid could provide in the context of edentulous arch scans, assessing parameters such as linear deviation, precision and software recognition of scan bodies. The findings highlight the role of scan aids in improving registration of scan bodies and reducing linear deviation in intra-oral scans.

Having less distinct anatomical surface morphology, the edentulous jaw makes it difficult to stitch intra-oral scan images accurately to form a complete virtual model, and the intra-oral environment can introduce additional inaccuracies. Efforts to overcome these issues have included devices that create an optical bridge or increase the scannable surface, aiming to minimise stitching errors, but require additional time-consuming steps that add complexity to the process. Nonetheless, these devices have been shown to improve scanning accuracy.

A prior study introduced an optical bridge for universal use that can be adjusted chairside and is easy to handle. It tested three different designs and materials for trueness, precision and clinical applicability. The most user-friendly and accurate scan aid had an irregular design and a grey colour. The aim of the current study was to evaluate the accuracy of this universal 3D-printed scan aid *in vivo*.

The study used a case–control format, scanning implants in the edentulous jaw with and without the universal scan aid. Twenty-two participants with an edentulous arch and at least three implants were selected. The patients had received CAMLOG SCREW-LINE, SICace (SIC invent) or Straumann Standard Plus implants, and system-specific scan bodies were used. Two types of intra-oral scanners, the CS 3600 from Carestream Dental (CS) and TRIOS 3 from 3Shape (TR), were employed. The scans were capped at 9 minutes, because it has been found that repeated scanning does not increase accuracy in areas with minimal surface morphology.

Failure to register the scan body during scanning was reported for 25% of Straumann, 20% of Camlog and 8% of SIC scan bodies. For the CS scanner, 83% of scan bodies were successfully scanned with the scan aid and 70% without, compared with 96% and 86%, respectively, for the TR scanner.

The scan aid statistically significantly minimised the total mean linear deviation when using the CS scanner. However, for the TR scanner, there was no difference.

As for precision, statistically significant differences were found between the two scanners when the scan aid was not used. The scan aid decreased precision significantly for the TR scanner. Other parameters showed increased variability, particularly regarding precision within each group of scan bodies, suggesting that the scan aid's usefulness might be influenced by the specific scanning technology used.

For instance, the CS scanner uses active triangulation, which may be more prone to errors in edentulous arch scans and could benefit more from the scan aid than the TR scanner, which uses confocal microscopy. The use of the scan aid also improved the software's recognition of scan bodies for both scanners.

The authors cautioned about the interpretation of accuracy regarding the results, owing to inherent errors in extra-oral reference models and potential deviations related to scan body height. They concluded that, while the scan aid can significantly improve linear deviation with the CS scanner and enhance software recognition of scan bodies, it may also lead to increased variability in precision.

*Editorial note: The study, titled "Enhancing intraoral scanner accuracy using scan aid for multiple implants in the edentulous arch: An in vivo study", was published in the August 2023 issue of* Clinical Oral Implants Research.

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