Modern AI-driven acquisition to simplify full-arch cases management

Digital implantology workflows continue to evolve at a rapid pace as technologies such as intra-oral scanners and CAD/CAM systems advance and digital clinical and laboratory processes become more closely integrated.[1–3]

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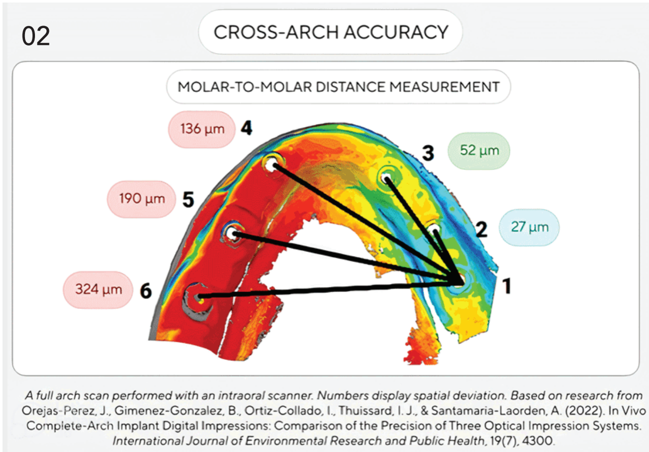


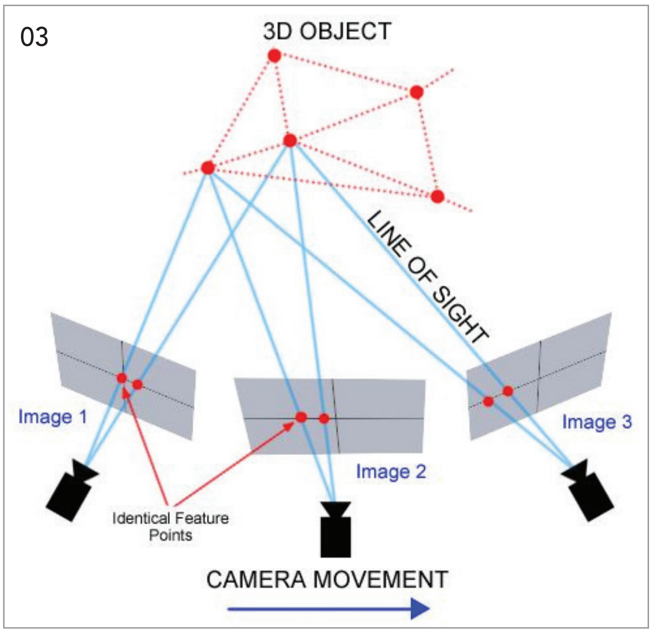
01
Edentulous arch with multi-unit abutments.

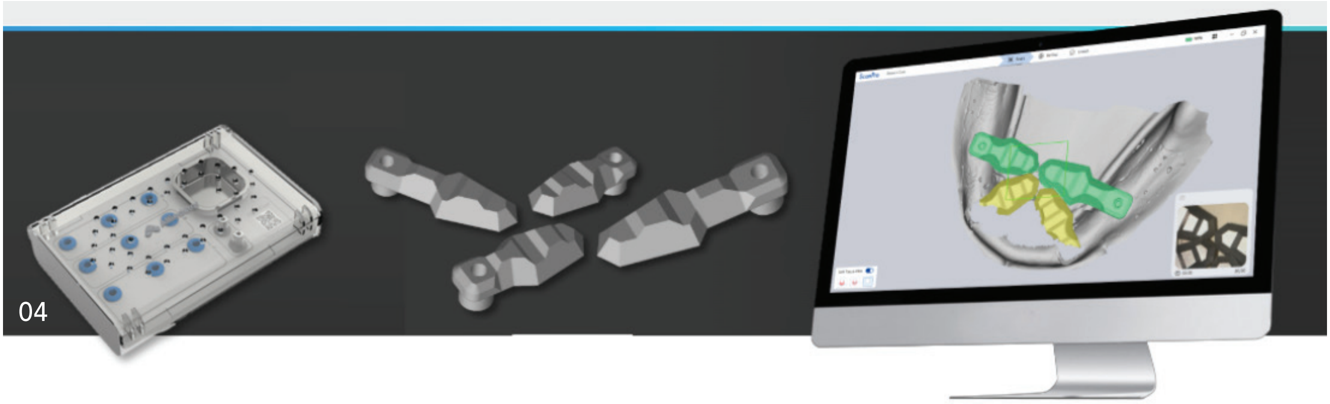
02
Cross-arch deviation in a full-arch intra-oral scan. Molar-to-molar distance measurements illustrate how spatial discrepancies can increase across the arch as a result of cumulative image stitching errors.[26]

03
Photogrammetry object acquisition.

Full-arch rehabilitation presents two specific digital workflow challenges: the accurate capture of implant positions to ensure passive seating of the restoration and the registration of the patient's vertical dimension of occlusion. Accurate transfer of the implant positions is essential for achieving passive fit of the restoration, reducing mechanical complications and supporting long-term clinical success.[4–6]

Although intra-oral scanners have become widely used tools for taking digital impressions, various clinical factors can affect scanning accuracy, especially





04
DirectIP geometric scan body overview.

in edentulous cases (Fig. 1) or in restoration cases involving multiple implants. These factors include saliva, bleeding, soft-tissue interference and cumulative errors from the image stitching process (Fig. 2).[7–9]

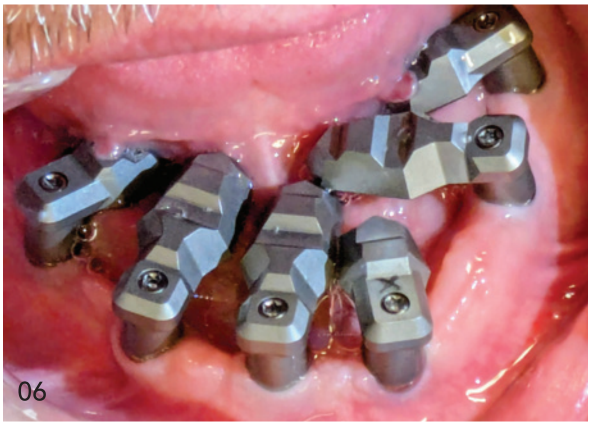
In recent years, photogrammetry systems have emerged as an alternative for improving the accuracy of implant position capture in full-arch cases. These systems employ external cameras and calibrated markers to reconstruct the relative 3D position of the implants with high accuracy (Fig. 3).[10,11] Photogrammetry shows consistent implant capture accuracy of 30–50 µm, but it also has practical limitations. These systems capture only the positions of dedicated scan bodies, so a separate intra-oral scanner is still required to record the soft tissue, opposing arch and occlusal relationship. The resulting datasets must then be matched and aligned in dedicated software. This workflow adds equipment requirements, workflow complexity and cost, making photogrammetry more likely to be employed by more specialised clinics.[12,13]

Several more streamlined intra-oral solutions have been developed to manage full-arch acquisitions with sufficient accuracy to support passive fit. One of these is DirectIP (Alliedstar), which uses software based on artificial intelligence (AI) for high-accuracy identification of scan bodies (Fig. 4). We demonstrate the use of this system in the following case report.[14–16]

Clinical case

A 65-year-old male patient had previously undergone all-on-6 rehabilitation of the maxillary arch and had recently had six implants placed in the mandibular arch and restored with a provisional resin screw-retained restoration. Healing had been uneventful, and the case report begins at the stage of definitive restoration of the mandibular arch.

Intra-oral imaging began with acquisition of the maxillary arch, mandibular provisional restoration and occlusal relationship (Fig. 5). The mandibular provisional restoration was then removed, and a 360° scan was performed to capture its intaglio surface. This allowed the relationship between the provisional restoration, the arches and the vertical dimension of occlusion to be preserved in the digital workflow. The scan bodies were screwed on to the multi-unit abutments (Fig. 6), and radiographic verification was performed (Fig. 7).



05
Initial scan.

06
Scan body placement.

The clinical procedure is relatively simple: implant position and soft-tissue data are acquired within a single intra-oral scanning workflow, and no external cameras, reference markers or calibration devices are needed. The DirectIP software analyses the scan using AI-based algorithms that automatically recognise the complex geometry of the scan bodies. During this process, the system is able to filter out any soft-tissue structure that could affect the accuracy of the optical impression

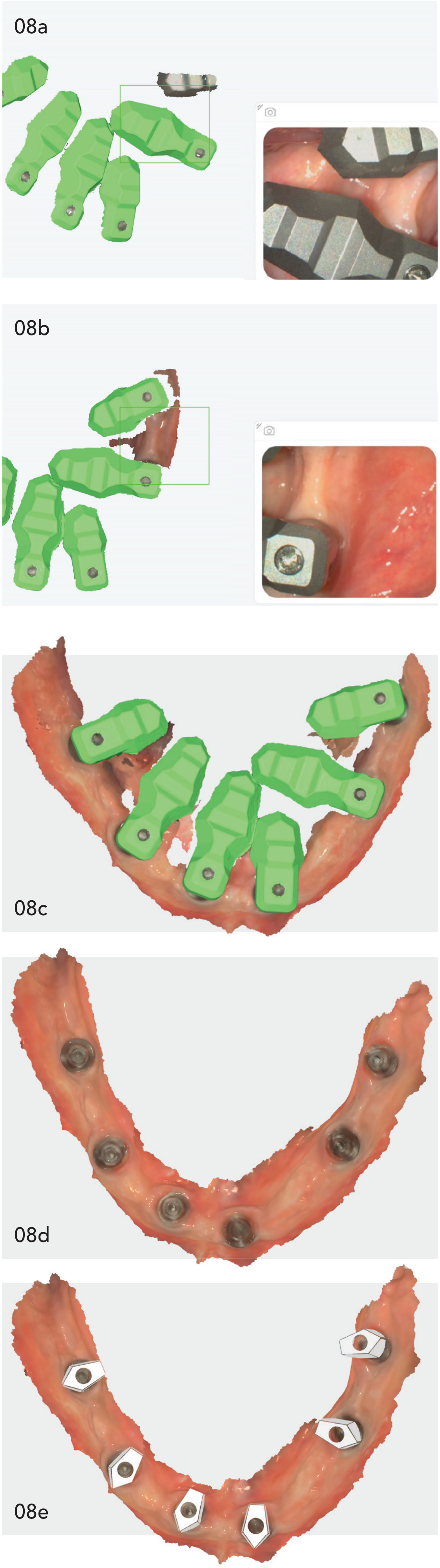
07
Radiographic verification.

(Fig. 8a).[17,18] After the last scan body has been identified, the software then automatically captures the soft tissue, creating a single continuous workflow (Figs. 8b+c). The final step involves scanning the soft tissue after removal of the scan bodies (Fig. 8d).

In this way, the implant positions are accurately identified through geometric recognition of the scan bodies. The software then automatically generates the corresponding manufacturer-specific virtual scan bodies (Fig. 8e), which can be matched directly with the digital libraries in the dental laboratory's CAD/CAM software (Fig. 9).[15,16]

The vertical dimension of occlusion had already been recorded initially. Depending on the clinical situation, this relationship can be recorded from the natural dentition before extractions, from existing complete dentures before implant placement or from the provisional restoration, as in the present case, after the healing period (Fig. 10). This ensures that the implant position data, soft-tissue scan and occlusal relationship are aligned.

Before fabrication of the definitive restoration, passive fit can be checked using a traditional plaster verification jig (Fig. 11) or a pre-sintered zirconia bar, milled from the implant bar design (Fig. 12). The definitive restoration, consisting of a titanium bar and zirconia superstructure, was then milled (Figs. 13a–d).



08a–e
Artificial intelligence-driven acquisition by the DirectIP software. Recognition of the geometry of the scan bodies, actively filtering out soft tissue (a). Soft-tissue acquisition after the last scan body has been acquired (b). Acquisition completed in a single pass (c). Finalisation of soft-tissue and implant acquisition (d). Automatic generation of manufacturer-specific virtual scan bodies (e).

Sequential scan body capture in limited anatomical spaces

In certain clinical situations, particularly in narrow maxillary arches (Fig. 14), the simultaneous placement of all scan bodies may be physically impossible due to limited inter-implant space, which is a common challenge in full-arch implant rehabilitation. The DirectIP system introduces an innovative solution to this limitation through a sequential capture function that allows clinicians to work without compromising accuracy. Initially, only the scan bodies that can be accommodated within the available space are placed and scanned. The software then preserves those recorded implant positions virtually through a function termed "locking" (Fig. 15a). These scan bodies are then removed, and the remaining scan bodies are placed and a second intra-oral scan is acquired. Through its geometry-based recognition algorithms and advanced data processing, the system integrates both datasets into a single coherent digital model. The previously recorded scan body positions are retained, and the newly captured positions are accurately incorporated (Fig. 15b).

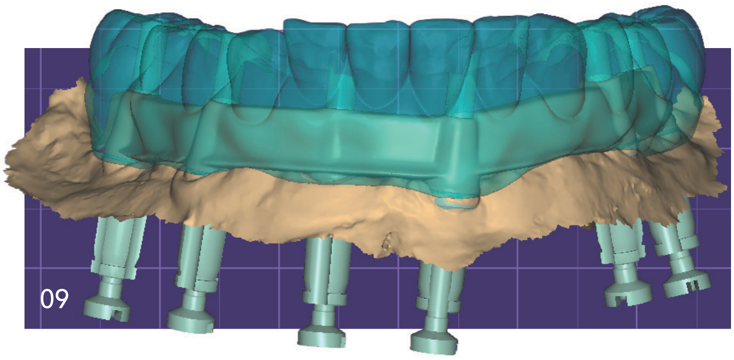
This capability represents a significant clinical advantage, as it allows clinicians to overcome anatomical limitations without resorting to additional techniques or compromising accuracy. Furthermore, it simplifies the clinical workflow and expands the applicability of the system in complex cases that would otherwise be difficult to manage using conventional implant capture methods. Overall, this controlled sequential acquisition function highlights the versatility of DirectIP in digital implantology, demonstrating how AI-assisted geometric recognition can provide precise and practical solutions to real-world clinical challenges. DirectIP is not only limited to full-arch cases, as the system is suitable for any definitive or provisional restoration connected to multi-unit abutments (Figs. 16a–c).

A new technological approach using AI-assisted data processing

The use of AI is a defining component of the DirectIP system. It uses AI-based algorithms not only to recognise the geometry of the scan bodies but also to filter out irrelevant data and isolate stable geometric features. This capability allows the software to distinguish between scan body geometry and surrounding soft-tissue artefacts, ensuring that implant position identification is based on reliable structural information and is less dependent on operator technique.[17,18]

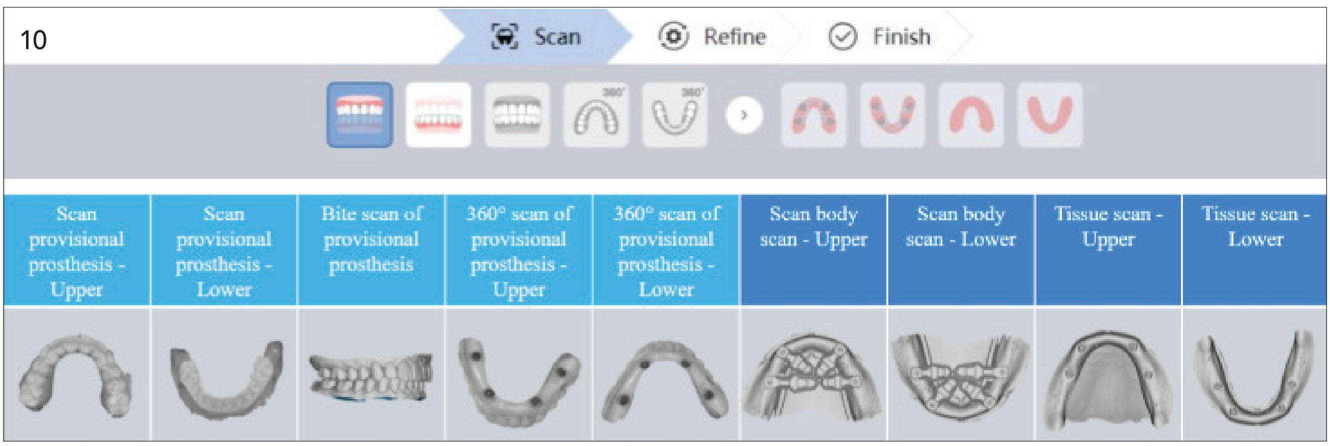
Recent research has demonstrated that AI-assisted workflows can significantly improve the accuracy and reliability of intra-oral scanning, particularly under clinical conditions that are not ideal.[19–21] This is especially relevant in surgical and immediate loading protocols, where ideal scanning conditions are difficult to achieve.

In full-arch implant acquisition, the primary clinical objective is not necessarily an exhaustive digital reconstruction

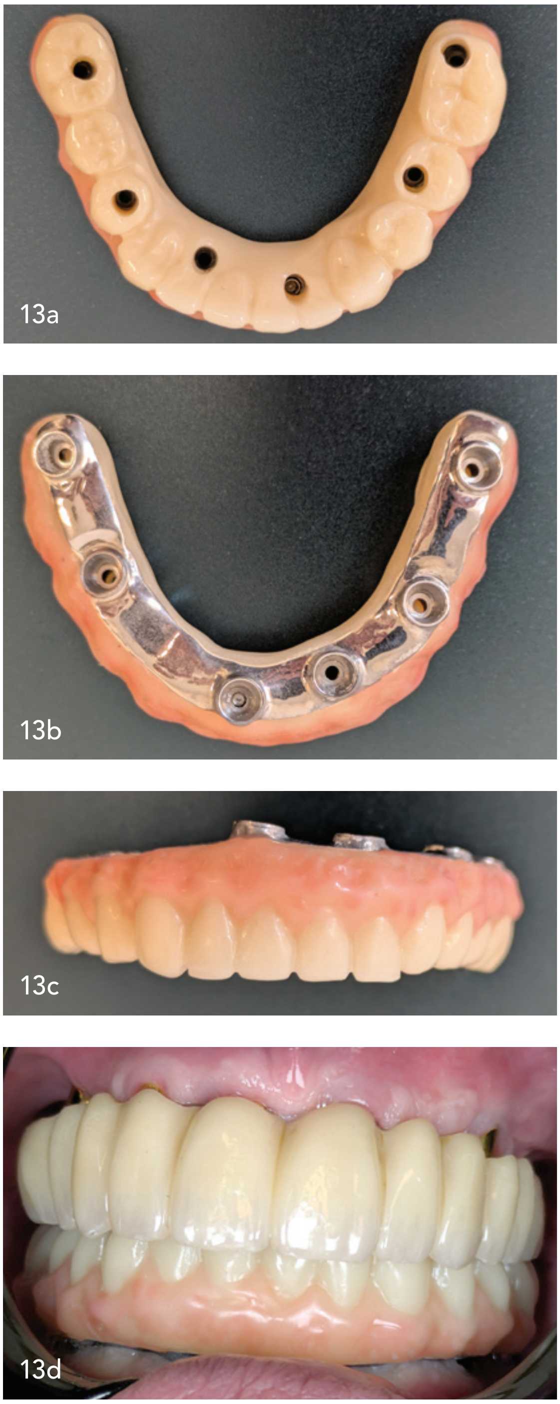


09
CAD starting directly from the acquisition files.

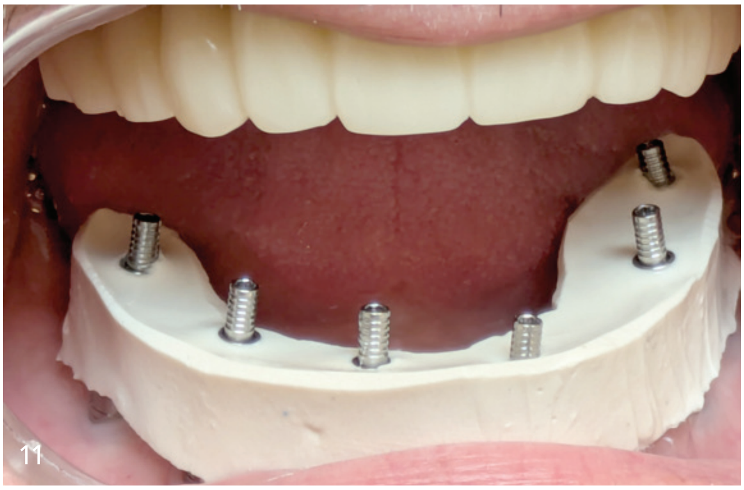
10
One integrated workflow to capture the provisional restoration, occlusal relationship, soft tissue and implant positions.



13a–d
Definitive restoration consisting of a titanium bar and zirconia superstructure: occlusal surface (a), intaglio surface (b), frontal view (c) and *in situ* (d).



11
Passivity verification jig.

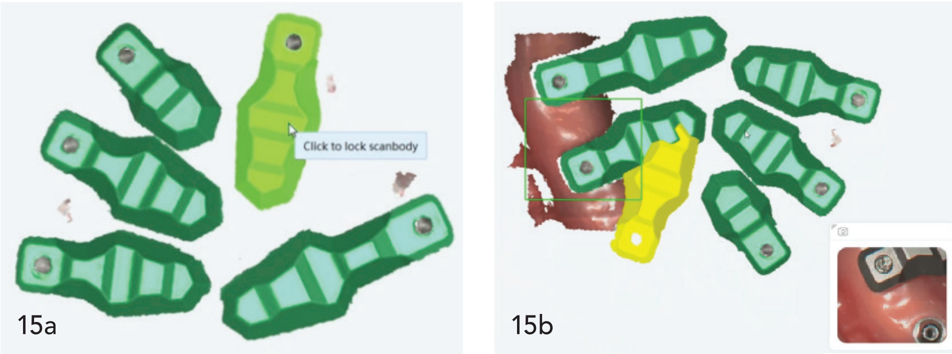


12
Zirconia verification bar.

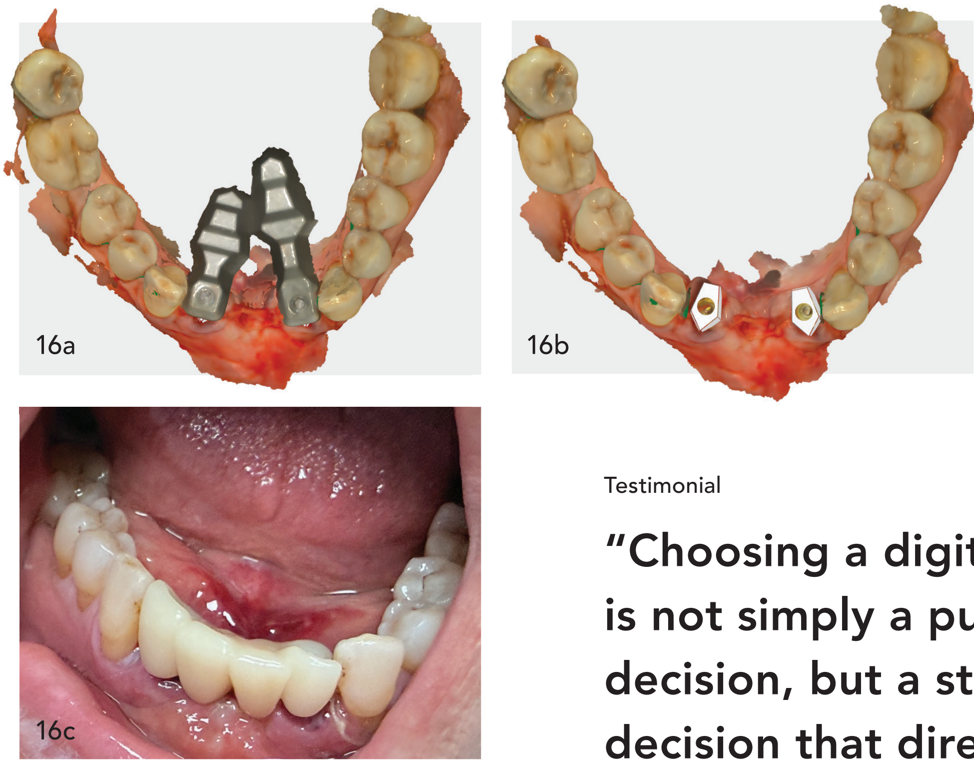
of all intra-oral surfaces, but rather the accurate transfer of the relative positions of the implants to allow for the fabrication of a prosthesis with passive fit.[22,23] From this perspective, DirectIP introduces a different approach: rather than relying on the point triangulation characteristic of photogrammetry, the system is based on the geometric recognition of calibrated scan bodies using data acquired with an intra-oral scanner.

This eliminates elements of the photogrammetry workflow such as external cameras, calibration devices or complex acquisition protocols, reducing potential sources of error and facilitating the integration of the system into daily clinical practice.[14,16,24] By reducing the number of clinical and technical steps required for full-arch implant acquisition, this approach may improve workflow efficiency[25] and reduce the likelihood of cumulative errors, accieving more reliable treatments and more consistent outcomes.

14
DirectIP scan body placement in narrow spaces.



15a+b
DirectIP locking function: locking of recorded implant positions by the software (a) and retention of those positions during capture of newly placed scan bodies (b).



16a–c
Use of DirectIP for short-span cases. Acquisition of two scan bodies (a). Automatic generation of manufacturer-specific virtual scan bodies (b). Immediate loading of the provisional restoration (c).

Conclusion

DirectIP enables accurate implant positioning using an intra-oral scanner, allowing full-arch implant scanning to be integrated into established digital workflows. By eliminating the need for additional equipment, calibration steps or separate data alignment procedures, it significantly reduces the number of clinical steps, decreases chair time and technical complexity, and simplifies the workflow. Furthermore, its ability to operate under realistic clinical conditions helps improve the stability of implant position capture and reduce variability among operators. This system demonstrates that the evolution of digital dentistry is not about adding more technology or more steps to the clinical workflow, but rather about developing solutions that simplify processes without compromising accuracy, enabling more predictable results under real-world conditions.

Testimonial

"Choosing a digital technology is not simply a purchasing decision, but a strategic clinical decision that directly impacts the quality of treatments, workflow efficiency and the sustainability of the practice model."

—Mathieu Mausservey, CEO of the dental lab Axis Dental in Mâcon in France.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References