PHOTOGRAMMETRY
ENSURING PASSIVE FIT IN PROSTHETIC RESTORATIONS

CLINICAL STUDY ON THE USE OF PHOTOGRAMMETRY WITH DYNAMIC ABUTMENT SOLUTIONS

CASE REPORT AND CONCLUSIONS

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Dental Photogrammetry: A High-Precision alternative to Intraoral Scanning in complex implant-supported restorations.

Digital dentistry has revolutionised implant-supported rehabilitation. While the intraoral scanner (IOS) has been the preferred tool in recent years, dental photogrammetry has gained prominence in full-arch restorations due to its exceptional three-dimensional accuracy.

This article offers an in-depth review of the scientific foundations, technological features, advantages, limitations, and clinical applications of photogrammetry, including a comparative analysis with intraoral scanning and an illustrative clinical case.

SECURE PASSIVE FIT THROUGH DIGITAL TECHNOLOGY

In restorations over multiple implants, achieving accurate capture of their three-dimensional position is essential to ensure a passive fit and prevent prosthetic or biomechanical complications.

Dental photogrammetry has emerged as the technique of choice in these cases, enabling high-fidelity records without the cumulative errors inherent to sequential intraoral scanning.

TECHNICAL BASIS OF DENTAL PHOTOGRAMMETRY

Dental photogrammetry uses multiple calibrated images to determine the three-dimensional position of optical markers connected to the implants. Unlike intraoral scanners, which progressively scan surfaces, photogrammetry captures all the data in a single static acquisition, eliminating errors caused by topographic distortions or image stitching.

STANDARD CLINICAL PROCEDURE

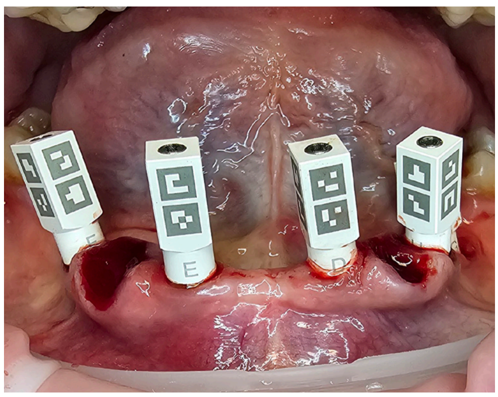
1. Placement of photogrammetry markers (flags with QR-like codes) on multi-unit abutments.

2. Capture of the marker positions using the photogrammetry system.

3. Verification of the generated file and STL export.

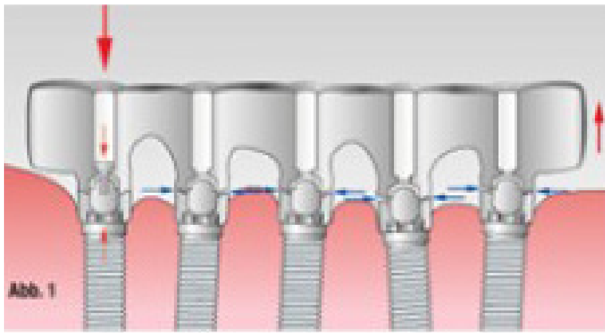
4. Complementary intraoral scan to capture soft tissues, occlusion, and opposing dentition.

5. Integration into CAD/CAM software and prosthetic design (e.g., Exocad).



ARE YOU FAMILIAR WITH THE SHEFFIELD TEST TO VERIFY THE PASSIVITY OF PROSTHETIC FRAMEWORKS?

It's a practical method to assess the prosthesis' passivity directly in the clinic.



Why is the passivity of prosthetic structures so important?

One of the fundamental principles in implant-supported oral rehabilitation is ensuring absolute passivity of the prosthetic framework, meaning the structure must fit precisely to the three-dimensional position of the implants without causing residual forces, deformation, or stress during tightening. Unlike natural teeth, which have a periodontal ligament and can physiologically adapt to small lateral or axial forces, implants are fully integrated into the bone and lack functional mobility. Therefore, any misfit or accumulated stress can lead to detrimental biomechanical consequences.

These complications include repeated screw loosening, abutment fractures, breakage of the prosthetic structure itself, micromovements that can trigger peri-implantitis or marginal bone loss, and, most importantly, early biomechanical failure of the rehabilitation.

From a technical standpoint, prosthetic passivity means that when the structure is screwed onto all implants, there is no need to force its seating, and no micro-gaps are observed at any point.

In clinical practice, this passivity can be verified using methods such as the Sheffield test (tightening a single screw and observing distal adaptation) or radiographic assessments of contact.

Achieving this level of passivity is especially important in full-arch rehabilitations involving more than five implants, where the inter-implant distances are greater and the risk of cumulative error increases exponentially if the registration method is not sufficiently precise.

A structure that is not completely passive may be subjected to internal stresses from the moment it is placed.

For this reason, the digital workflow must be aimed at minimizing any source of distortion or error, whether during impression-taking, design, or manufacturing. Dental photogrammetry emerges as a tool that directly addresses this need: capturing the exact three-dimensional position of all implants in a single scan, without relying on interpolations, free of cumulative errors, and with a level of precision that allows the fabrication of structures that fit passively on the very first try.

It's not merely a matter of technological sophistication, but one of biomechanical respect for the achieved osseointegration and long-term clinical predictability.

Therefore, ensuring absolute passivity is not a luxury or an idealistic demand, but an essential requirement in advanced implant prosthetics, whether it's achieved or not, depends directly on the quality of the impression and the digital workflow implemented.

CHARACTERISTICS WHEN USING AN INTRAORAL SCANNER

Both intraoral scanners (IOS) and photogrammetry are digital tools used to register implant positions in prosthetic rehabilitations.
The intraoral scanner works by progressively capturing images of dental surfaces, abutments, or scan bodies, reconstructing the 3D model through the superimposition of multiple photographs. This technique is effective and accurate for single units or short-span bridges, however, as the number of implants and the length of the arch increase, the margin of cumulative error also grows, compromising positional accuracy.

RELIABILITY OF PASSIVE FIT

CONDITIONS

1. Absence of mobile soft tissues around the implants.

2. Implants must be accessible and free of visual obstructions.

3. Exclusive use of multi-unit abutments compatible with photogrammetric markers.

4. Correct and secure installation of the markers (flags).

5. Sufficient interocclusal space to position the photogrammetry camera.

6. Absence of saliva, blood, or shiny reflections on the markers.

7. Neutral and controlled environmental lighting.

8. Patient stability during the capture.

9. Calibrated and up-to-date software.

10. Export in a compatible format (STL or similar) and integration with the CAD/CAM workflow.

WHEN USING PHOTOGRAMMETRY FOR IMPLANT REGISTRATION

Photogrammetry enables the simultaneous registration of all implant positions using a series of calibrated images that capture specific optical markers (flags or abutments). Since it is a spatial reconstruction based on mathematical triangulation, cumulative errors are eliminated, achieving linear accuracy levels below 10 µm and angular precision under 0.01°. This is especially useful in full-arch rehabilitations involving more than five implants, where absolute passive fit is essential.

In terms of efficiency, photogrammetry stands out for its speed: a single capture is enough to register the entire arch, reducing clinical time to under one minute.

On the other hand, the intraoral scanner may require between 3 to 7 minutes to scan a full arch, often necessitating manual adjustments in cases of incomplete scans.

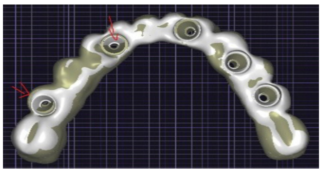
Nevertheless, the IOS has the advantage of capturing soft tissues, mucosa, and opposing dentition, which is essential for completing the prosthetic design.

For this reason, both technologies are considered complementary.

The choice between them should not be mutually exclusive but rather based on case complexity, with an ideal approach being combining both to achieve predictable, high-quality clinical outcomes.

WHEN DO WE USE PHOTOGRAMMETRY?

In rehabilitations involving more than three implants, especially in complex structures such as overdenture bars, long-span bridges, or full arches with five or more implants, achieving an absolute passive fit is essential.

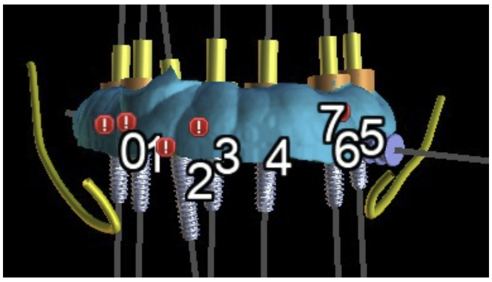


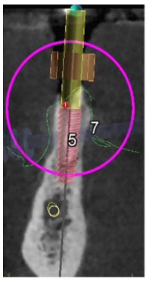
To accomplish this, combining intraoral scanning—which captures soft tissues and occlusal anatomy—with photogrammetry—which provides ultra-precise three-dimensional implant position capture—is indispensable.

Both techniques are not mutually exclusive but rather complementary within an advanced digital workflow aimed at biomechanical precision and clinical predictability.

Extraction of multiple teeth for implant placement and semi-immediate loading, as well as for the future placement of a milled internal bar prosthesis that will be screwed onto the multi-unit abutments.

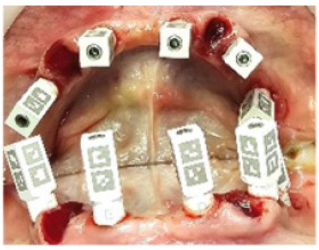
The decision was made to extract the teeth and design a 3D-printed surgical guide for the placement of multiple implants.

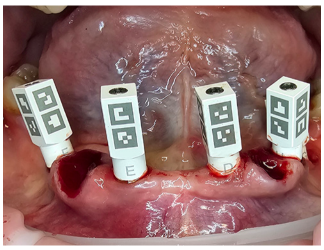




A careful digital preparation is carried out to plan implant placement in accordance with the future prosthesis and the biological widths presented by the various anatomies of the maxillary bone.

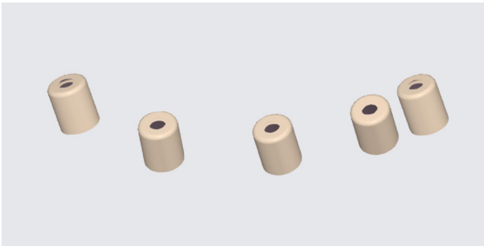
The implants are placed using the surgical guide, distributed in a way that allows for a fixed screw-retained prosthesis to be placed from day one until full osseointegration is achieved.



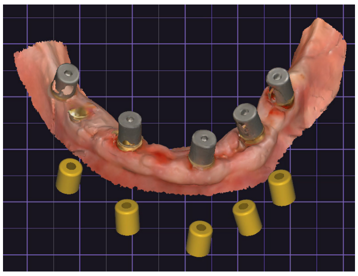


Once the implants are in place and the multi-unit abutments are adapted to each implant, the flags are screwed onto the multi-units for detection by the photogrammetry camera.

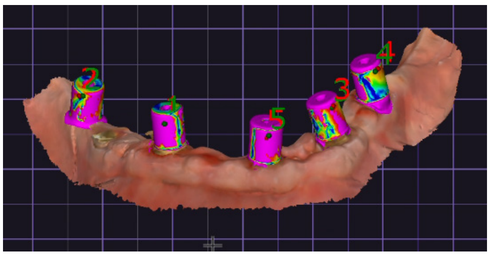
By positioning the camera at the correct distance, the system's lens captures the shape of each flag, allowing it to accurately detect their position.
Through red, yellow, and green indicators, the software confirms whether the system is correctly detecting and capturing the position of each implant within the optical triangulation process.



This information is transmitted to the scanning software, in this case, Medit, and is combined with the routine scan of the patient's anatomy, along with the special scan bodies screwed onto the multi-unit abutments.

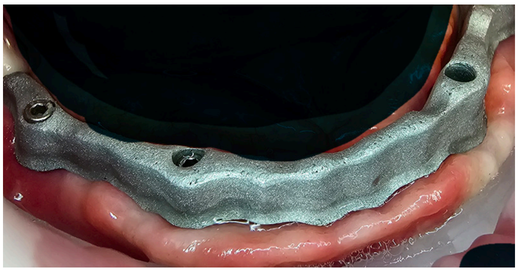


Once the triangular and spatial position of the photogrammetry flags have been captured, the area is scanned as usual and scan bodies are then placed onto each implant's multi-unit abutment, allowing the photogrammetry data to be aligned and overlaid with the scan using the Exocad software.



In this way, the exact three-dimensional position is achieved, **with a total fit deviation not exceeding 30 µm linearly and 0.15° angularly**—even in configurations involving six implants and wide arches.

Finally, we receive a printed dental structure adapted to the implants, with such stability that it can be screwed directly onto the multi-units with complete passivity, improving both the anatomical fit and occlusion.



Subsequently, we send the design with these parameters to be milled or sintered as a metal structure that will be screwed onto the multi-units, over which a high-strength printed structure with a ceramic component will be cemented.

Milled Structure and Printed Structure.

Both cemented structures prepared for screwing.

CLINICAL CASE

Extraction of several lower teeth is performed to replace them with implants that will support a 3D-printed structure (Sprintray / Onx) over a milled or sintered bar.