Impression of multiple implants using photogrammetry: Description of technique and case presentation

By David Peñarrocha-Oltra, Rubén Agustín-Panadero, Le-
ticia Bagán, Beatriz Giménez, María Peñarrocha

Abstract

Aim: To describe a techn-ique to record the positions of multiple dental implants using a system based on photogrammetry. A case is presented in which a prosthetic treatment was performed using this technique.

Study Design: Three Euroteknik-
ka® dental implants were placed to rehabilitate a 55-year-old male patient with right posterior maxillary edentulism. Three months later, the positions of the implants were registered using a photogrammetry-based system (PICcamera®).

After processing patient and implant data, special abutments (PICabutments®) were screwed onto each implant. The PICcam-
era® was then used to capture images of the implant positions, automatically taking 150 images in less than 60 seconds. From these images, stereomodels were o-
tained describing the relative positions - angles and distances – of each implant. Information regarding the soft tissues was obtained from an alginate impression which was cast in plaster and scanned. A Cr-Co structure was obtained using this information. The passive fit was verified in the patient’s mouth using the Sheffield test and the screw resistance test.

Results and Conclusions: Twelve months after load-
ing, peri-implant tissues were healthy and no marginal bone loss was observed.

The clinical application of this new system using photogram-
metry was verified in this case; multiple dental implants facil-
tated the rehabilitation of a pa-
tient with posterior maxillary edentulism by using a pros-
thetic prosthesis with optimal fit. The pros-
thetic process was accurate, fast, simple to apply and comfortable for the patient.

Key words: Dental implants, photogrammetry, digital impres-
sion technique, CAD/CAM.

Introduction

Dental implants are one of the most widely used therapies for the rehabilitation of partially or completely edentulous patients. It is scientifically proven that achieving proper passive fit of the implant-supported pros-
hesis improves the long-term pros-
"ness of this therapy (1,2).

The classic system for fabricat-
ing implant-supported pros-
hesis is using conventional im-
pression techniques (3,4). A drawback is after placement of the implant analogues, subsequent casting in plaster to make impres-
sion transfer in order to achieve an accurate fit of the final prosthesis. The passive fit must be obtained. There is a need for a more accurate and reliable technique.

The photogrammetry technique has been used to study the shapes and positions of teeth, dental arches and maxillary and mandi-
dible bones. In orthodontics, it allows the three-dimensional analysis of the variations of the palate while performing rapid palatal expansion techniques and evaluating the achieved dental movement (15-18).

Recently, its application in dental implant surgery planning has also been reported (19).

In the field of implant dentistry, it has been used to check the ac-
curacy of other impression tech-
niques, by analyzing the differ-
ces between images obtained using different techniques and materials (20). As long ago as 1990, Jung and Black (21) pro-
posed photogrammetry as an alternative to conventional im-
pression techniques. However, it was not widely used until then due to the difficulties associated with the development of this applica-
tion has been reported.

The most important quality of this technology - measurement accuracy - is the key to success in implant impressions.

Therefore, its accuracy may be a very useful technique that will improve dental implant therapies.

The aim of this report is to de-
scribe this technique applied to record the position of multiple dental implants using a system based on photogrammetry. A case is presented in which a prosthetic treatment was per-
fomed successfully using this technique.

PICcamera®

The PICcamera® (PICDental, Madrid, Spain) is a stereocom-

era that records implant posi-
tions in the mouth by means of photogrammetry. It comprises two CCD cameras specially de-

signed for three-dimensional geometric use, which accurately determine the position of the implants by the use of specially printed abutments screwed on implants with unique individual coding (PICabutment®, PICdental).

The camera has an infrared flash that constantly illuminates the scanned object while elimi-
nating the shadows that occur with ambient light. The PIC-
camera® uses this technique to capture 50 three-dimensional photographs for every two PICabutments®. To do this, it automatically takes ten extraoral pictures per sec-
ond with an error of less than 10 microdegrees and distances between implants are interrelated and treated as a unit.

System software calculates av-

erage angles and distances between implants from these photographs, obtaining an ac-
curate relative position of each im-
plant. This information is used in the PICfile® (PIC Dental), which contains all the information on implant positions, geometries, connections, healing abutments and screws that are later re-
quired by CAD/CAM software.

Clinical Procedure

A 55-year-old male with no rel-
evant medical history came to the Oral Surgery Unit of the University of Valencia requesting the rehabilitation of bicus-

dental right maxillary poste-
rior region with dental implants. After checking the presence of enough residual alveolar bone height by means of a panoramic radiograph, three Euroteknikka® (Euroteknika Ibiza, Barcelona, Spain) implants were placed of 4.1 mm in diameter (Fig. 1). Three months later, the position of the implants was registered using the PICcamera® (PICDental).

Firstly, the patient’s den-

tition and the scanned data were entered into the system. Then, the positions and the references of the implants (manufac-
turer, model, platform diameter, di-


Fig. 1. A) View at three months after the placement of three implants in the right maxilla. B) Conventional impression taking but since then multiple dental implants were used to place the implants. C) Digitalized plaster model; D) Alignment by means of Best-fit from the PICfile® vector file and digi-
talized plaster model; E) Relative interface positions of the future prosthesis in relation to the gums.

crome-chrome (Cr-Co) by a five-
axis milling machine (Fig. 2). To build a working model, the digital model was processed providing the specific geome-
tries of the implant connections (Fig. 2) and it was manufactured by means of stereolithography using a 3D printer (Objet 2900) by Stratasys, Eden, Israel). The model was processed in a manner that al-

ow the addition of false gum for further work in the labora-
dory (Fig. 2).

Once the internal structure of the implant-supported fixed par-

tial denture had been fabricated, its passive fit was checked in the patient’s mouth. The Sheffield and one-screw tests were used: a distal screw was placed on the screw at 14 in this case - and a periapical radiograph was ob-
ailed. The model was processed in a manner that al-

ow the addition of false gum for further work in the labora-
dory (Fig. 2).

Once the internal structure of the implant-supported fixed par-

tial denture had been fabricated, its passive fit was checked in the patient’s mouth. The Sheffield and one-screw tests were used: a distal screw was placed on the screw at 14 in this case - and a periapical radiograph was ob-
tained. The model was processed in a manner that al-

ow the addition of false gum for further work in the labora-
dory (Fig. 2).

Once the internal structure of the implant-supported fixed par-

tial denture had been fabricated, its passive fit was checked in the patient’s mouth. The Sheffield and one-screw tests were used: a distal screw was placed on the screw at 14 in this case - and a periapical radiograph was ob-
tained. The model was processed in a manner that al-

ow the addition of false gum for further work in the labora-
dory (Fig. 2).

Once the internal structure of the implant-supported fixed par-

tial denture had been fabricated, its passive fit was checked in the patient’s mouth. The Sheffield and one-screw tests were used: a distal screw was placed on the screw at 14 in this case - and a periapical radiograph was ob-
tained. The model was processed in a manner that al-

ow the addition of false gum for further work in the labora-
dory (Fig. 2).

Once the internal structure of the implant-supported fixed par-

tial denture had been fabricated, its passive fit was checked in the patient’s mouth. The Sheffield and one-screw tests were used: a distal screw was placed on the screw at 14 in this case - and a periapical radiograph was ob-
tained. The model was processed in a manner that al-

ow the addition of false gum for further work in the labora-
dory (Fig. 2).

Once the internal structure of the implant-supported fixed par-

tial denture had been fabricated, its passive fit was checked in the patient’s mouth. The Sheffield and one-screw tests were used: a distal screw was placed on the screw at 14 in this case - and a periapical radiograph was ob-
tained. The model was processed in a manner that al-

ow the addition of false gum for further work in the labora-
dory (Fig. 2).
months after loading, the peri-
implant tissues were healthy and no peri-implant marginal bone loss was observed (Fig. 5). Discussion The provision of ten-
sion-free connections between implants and the prosthetic structures they support is a re-
quirement for medium- and long-term success of implant-
supported rehabilitations. This situation is achieved by carrying out a prosthodontic treatment with good passive fit. Photogrammetry has been applied in various areas of medi-
ca. It has proved to be an efficient clini-
tical test of passive fit, especially in cases with multiple implants and extensive prosthetics. The screw resistance test has the advan-
tage of introducing subjectivity into the evaluation, but is considered a precise way of detecting discrepancies (28).

Registering implant positions with the PICcamera improves patient comfort in comparison with conventional impression techniques. The tech-

nique avoids the introduction of impression materials which must be kept in place in the mouth for an average setting time of 5-6 minutes and can pro-
voking nausea and discomfort. Furthermore, the photograph-
grammetry procedure can be inter-
rupted if necessary and taken up again later on.

The clinical application of this novel photogrammetry system for registering the positions of multiple implants allowed the fabrication of a patient with extreme maxillary free end edentulism with a prosthesis of passive fit, which in contrast with the conventional impression procedure was precise, fast, and simple for the dentist and for the patient.

References
1. Wee MJ, Aquilino SA, Schnei-
der RL. Strategies to achieve fit in implant prosthodontics: a re-
view of the literature. Int J Prostho-
2. Heckmann SM, Karl MJ, Wich-
man MR. Winter W, Gift E, Tay-
3. Windhorn RL, Gunnelin TR. A simple open-tray implant im-
4. Alca K, Cerbeli MC. Accuracy of impression techniques for ITI implants. The Int J Oral Max-
5. Borja A, Levison R. INTRADENT DENTAL LABORATORY
© 2010 ADA CAM-ADON
terrestiar Dent. 2006;26:579-85.
6. Lee HJ, So JS, Haschdorfer JL, Ercoli C. The accuracy of implant impressions: a system-

8. Jen T, Rubenfeld JE, Carl-
son L, Lang BR. Measuring fit at the implant prosthodon-

3) Placement of the finished prosthesis; B) Radiographic check-up after 12 months.

Fig. 3. A)

The photogrammetry method
extends the two-dimensional information provided by pho-
tos into three dimensions, allowing various cameras, the shape of each of the photographic ob-
jects, and the objects in space are reconstructed in relation to an external system of reference points. This is necessary calculations for reconstruction, special cameras are required that are able to identify this sys-
tem of reference. Photogrammetry has been ap-
plied in various areas of medi-
cine (13,14) and dentistry (15-
19). In implant dentistry, it has
been used in vitro research to test the reliability of other im-
pression techniques (20). As ear-
ly as 1999, Jenk and Flack (21) described its use for registering the positions of dental implants in vitro. They compared this technique with a conventional impression technique, concluding that photogrammetry offered a valid alternative. Since then the technical and clinical advances have been considerable but have not been accompanied by any develop-
ment of the application of photon-
ography for the purposes of implant dentistry. The present article describes this new system for registering, simply and pre-
cisely, the positions of multiple implants in the process to a minimum (1,22).

In vitro studies have shown that discrepancies in the super-
structure will be the cause of stress on the implant-supported prosthesis and subsequent fail-
ure. As long ago as 1986, Rubenfeld des-
dcribed mechanical failures which he associated with labo-
ral errors. Since then, the use of impres-
Fig. 3. A) Placement of the finished prosthesis; B) Radiographic check-up after 12 months.

A)

B)