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

By David Peñarrocha-Oltra, Raquel Martínez-Fernández, Le- ticia Bagán, Beatriz Giménez, María Peñarrocha

Abstract

Aim: To describe a technique for registering 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 Euroteknikak® 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 (PICabutment®). After processing patient and implant data, special abutments (PICabutments®) were screwed onto each implant. The PICcameras® were then used to capture images of the implant positions, automatically taking 150 images in less than 60 seconds. From these images, the software system extracted 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 cerametal® and an anchor fit was verified in the patient's mouth using the Sheffield test and the screw resistance test.

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

The clinical application of this new system using photogrammetry for registering the positions of multiple dental implants facilitated the rehabilitation of a patient with posterior maxillary edentulism by using a prosthetic treatment with optimal fit. The prosthetic process was accurate, fast, simple to apply and comfortable for the patient.

Key words: Dental implants, photogrammetry, digital impression 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 osseous fit of the implant-supported prosthe- sis improves the long-term prognosis of this therapy (1-3).

The classic system for fabricating implant-supported prostheses involves the impression, analysis of the variations of the palate while performing rapid palatal expansion techniques and evaluating the achieved dental movement (15-18). Rec- ently, 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- ences between models obtained using different techniques and materials (20). As long as 1990, Ernst and Black (21) pro- posed photogrammetry as an alternative to conventional im- pression techniques and stated that “the future of conventional impression techniques must be examined further if no 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 application may be a very useful technique that will improve dental implant therapy.

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

PICabutment®

The PICcameras® (PICdental, Madrid, Spain) is a stereocam- era that records implant posi- tions in the mouth by means of photogrammetry. It comprises two CCD cameras specially de- signed for the registration of implant positions with impression mate- rials and plaster modelbase so avoids the slight dimensional differences between the materials that cause unwanted errors during processing (1). This technique avoids the use of anda digitizing system. It is used to check the accuracy of the relative position between implants (2). To this end, it automatically takes ten extraoral photographs per sec- ond with an error of less than 10 microns in angle and 3 microns in distance between implants are interrelated and treated as a unit.

The system software calculates av- erage angles and distances between implants from these photographs, obtaining an ac- curate relative position of each implant. This information is sent to the PICfile® (PICdental), which contains all the information on 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 a lateral maxillary edentulous region with dental implants. After checking the presence of enough residual alveolar bone height by means of a panoramic radiograph, three Euroteknika® (Euroteknika® Iberia, Barcelona, Spain) implants were placed of 4.5 mm in diameter (Fig. 1).

Three months later, the position of the implants was registered using the PICcameras® (PICdental).

Firstly, the patient’s den- tures and dental impressions were made including the positions and the references for the future implant installation. Once the information was automatically captured using this system, 150 photographs were taken in less than 60 seconds to obtain the relative pos- ition of each implant (angle and distance) in vector format. This information was automatically compiled into a vector PICfile® (PICdental).

The healing abutments were placed and an alginate im- pression was taken and cast in plaster. The plaster model was scanned with a 3D scanner in open STL format to obtain infor- mation regarding the patient’s soft tissues (Fig. 1). This infor- mation was then introduced in the CAD software together with the PICfile®.

The PICfile® and the digitized plaster model were aligned with the Exocad® software (Exocad GmbH, Darmstadt, Germany) using three-point registration and subsequently improved alignment by Best-fit® (Fig. 1). This process transferred the relative position between im- plants to the digital model which provided the shape of the soft tis- sues, thus leaving the interfaces of the future prosthesis in rela- tion to the patient’s gingiva (Fig. 1).

A model of the antagonist arch was also scanned and centered in the CAD software to provide occlusal re- ferences, and the prosthetic structure was designed using Exocad® (Exocad GmbH) in STL format (Fig. 2). The design was sent to be machined in chrome-cobalt (Cr-Co) by a five- axis milling machine (Fig. 2).

To build a working model, the digital model was processed providing the specific geome- teries of the implant connections (Fig. 2) and it was manufactured by means of stereolithography using a 3D printer (Objet 2500® Eden, Israel). The model was processed in a manner that al- lowed the addition of false gum for further work in the labora- tory (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 at the screw at 4 in this case - and a peripical radiograph was ob- tained to check the correct pros- thetic settlement on the other two implant connections (Fig. 2).

The screw resistance tech- nique was used as a subjective complementary test of the pas- sive fit. Distal screws (Fig. 1 and 17) were screwed with a torque of 10 Ncm and then a medial screw was introduced verifying that the tactile sensation was soft and presented no resistance to screwing. After these verifica- tions, the Cr-Co structure was sent to the laboratory to have the ceramic loaded.

The prosthesis finished, was screwed onto the implants (Fig. 3), with 25 Ncm torque. Occlusal adjustments were performed and the correct set- tlement on the implant con- nections was verified with a radiograph (Fig. 3). A follow-up plan was established and twelve
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, or connections between implants and the prosthesis structures they support is a re-
quiring a profound and long-term success of implant-
supported rehabilitations. This situation is achieved by carrying out a prosthodontic treatment with good passive fit. Previously, establishing a fit between prosthesis and abutment is a key parameter for avoiding overloading of the supporting screws which leads to prosthetic failure. For this reason, the taking of im-
pressions is the most reliable.

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 as 1988, Shillingburg described mechanical failures which he associated with labo-
ratory procedures and clinical procedures using un-
impressive working models. Jent et al. (8) and Ruhé et al. all showed a difference between the fit between prosthesis and abutment is a key parameter for avoiding overloading of the supporting screws which leads to prosthetic failure. For this reason, the taking of im-
pressions is the most reliable.

Bearing in mind that conventional impression techniques often lead to prosthetic failure, the present article presents this new system to make as many points as possible to calculate the posi-
tion of dental implants. The Sheffield novel photogrammetry system can be used to identify this sys-
tem of reference points. To make the necessary calculations for reconstruction, the x-ray images of the patient’s mouth to a computer file. This is achieved by using a digital X-ray scanner, which digitizes dental stone replicas of impression abutments, implant body analogues, trays and im-
pression materials. The PIC-camera measures angles and distances between prosthetic attachments placed on the im-
plants, allowing the patient to achieve a precise fit and the presence of blood, saliva or any other organic or inorganic residue does not affect measure-
ment accuracy. Avoiding so many procedures and materials and the possibility of errors saves time – both the number of visits to the clinic and their dura-
tion – and the comfort of the patient. The technique avoids the introduction of impression materials which may be kept in place in the mouth for an average setting time of 8-9 minutes and can pro-
voke nausea and discomfort. Furthermore, the photogram-
metry procedure can be interrupted if necessary and taken up again later on.

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jectivity into the evaluation, but is considered a precise way of detecting discrepancies (28). Registering implant positions with the PIC-camera improves patient comfort in comparison with conventional impression taking procedures.

About the Authors

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David Perallosa-Oltra

Full Lecturer in Oral Surgery and Im-
plant Dentistry. Department of Den-
mal Medicine, University of Valencia, Spain

Rubén Agustín-Panadero

Associate Lecturer in Prosthetic. De-
partment of Dental Medicine, University of Valencia, Spain

Letizia Bagán

Collaborating Lecturer in Oral Surgery. De-
partment of Dental Medicine, University of Valencia, Spain

Beatriz Gutiérrez

Basics in Prosthetics. PhD stu-
dent. Department of Prosthetics. Complutense University of Ma-
ibrí, Spain

María Perallosa

Full Lecturer in Oral Surgery. Department of Dental Medicine, University of Valencia, Spain

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