

Photogrammetric Full-Arch Implant Impressions: A Literature Review.

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INTRODUCTION

Making conventional impressions to obtain definitive casts that are used to fabricate full arch implant-supported prostheses can be technique sensitive and time consuming. Recording the accurate implant position and orientation is essential for proper seating and achieving a passive fit that would ensure long-term stability of the implant-supported prosthesis. (Jemt 2012)

After the evolution of digital dentistry, intraoral scanners have been used for impression procedures, including those with multiple implants. However, it has been shown that the reliability of intraoral scanners is still questionable, especially in fully edentulous cases. (Papaspriidakos 2016)

Therefore, a new impression technique called stereophotogrammetry, has been introduced in 1994, by Jemt and Lie, to overcome the challenges faced with the conventional and intraoral scanning techniques.

What is the photogrammetric impression technique? Can we use it as an alternative to the conventional and digital intraoral scanning methods?

This technique was first applied for implant recording in 2005 and has shown to reduce chair-side time during impression making, the possible errors associated with it and increase patient's comfort during this procedure.

What makes this technique special is that it obtains impressions of multiple implant positions and orientations using a stereo camera that recognizes target points on custom scan bodies attached to the implants and automatically captures 350 images in less than 2 minutes with a margin error of 10 microns.

The stereo camera should be held at a 15 to 30 cm distance from the patient's mouth and at an angle of 45° to the scan bodies. The stereo camera then automatically registers the geometrical properties of the custom scan bodies and their interrelated spatial position in a photographic image that could be then converted into an STL file.

Several authors have investigated the accuracy of this method and compared it to the conventional as well as the intraoral scanning methods, however the conclusions were controversial.

METHODS

An electronic search of English language literature between 1994 to 2022 was performed by using PubMed/MEDLINE with the following specific terms "photogrammetry", "full-arch implant", "stereophotogrammetry", "implant-supported prosthesis". The collected data was analyzed and organized further to select articles that provided insight on the subject.

RESULTS

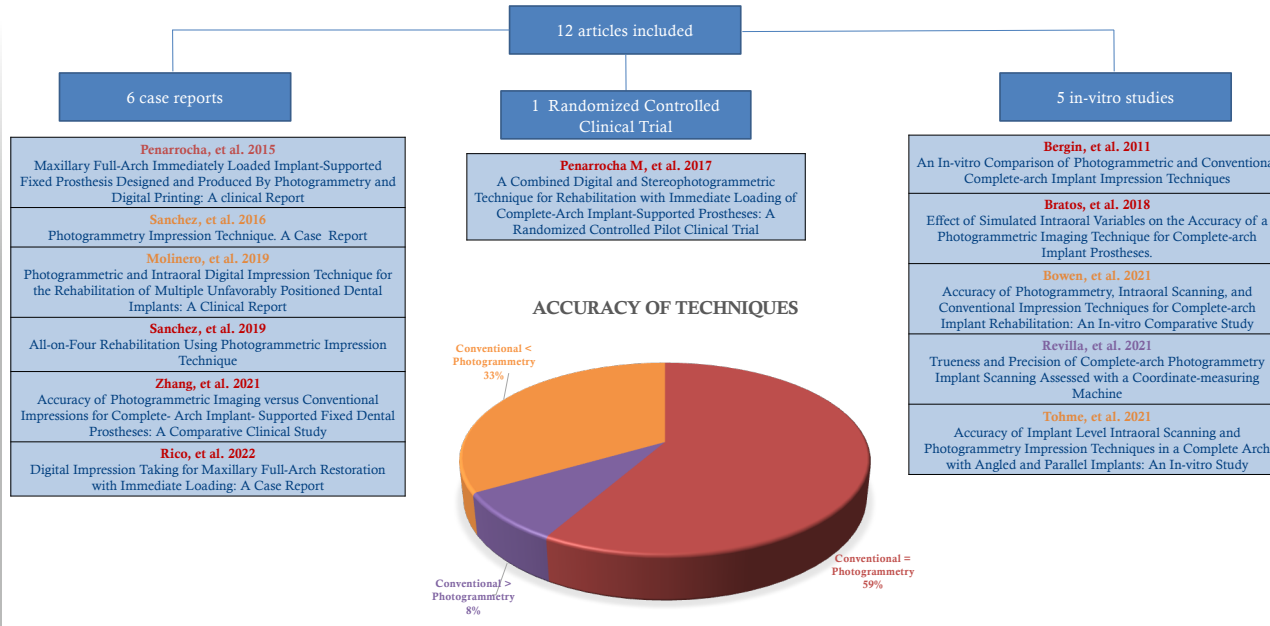


Figure 1 A. Intraoral occlusal view of the multiunit healing caps. 1B. Intraoral frontal view of the custom scan bodies used for the photogrammetric impression. 1C. Intraoral frontal view of the scan bodies used for the digital intraoral scanner. (Courtesy of Dr. Carracho and Dr. Mendonca)

DISCUSSION

Most of the reviewed articles support the conclusion that the photogrammetric impression technique provides similar accuracy in terms of prosthesis fit as the conventional methods.

In order to design a fixed prosthesis with the photogrammetric technique, two scans (STL files) are required:

1. Registering the implant position and angulation; which is achieved by capturing the custom-made scan bodies attached to the implants with the stereo-camera. This technique, unlike intraoral scanning, does not depend on the best-fit algorithm to make up the scan, instead it takes all the measured data from the images captured and generates director vectors of the exact implant position and angulation.
2. Registering the soft tissue; this technique cannot register the patient's soft tissue, therefore an irreversible hydrocolloid impression or an intraoral scan of the soft tissue is necessary.

The two scans are then superimposed and aligned with the designed prosthesis at the correct vertical dimension of occlusion.

In addition to reducing possible chair-side and optimizing the patient's comfort during impression making, the photogrammetry acquisition is not influenced by external factors such as ambient light illuminance conditions (Revilla 2020) or the presence of edentulous area (Lo Russo 2020, Kim 2017) or blood and saliva (Suarez 2018) that might influence the accuracy of intraoral digital scans as well as conventional impressions.

On the other hand, since this technique relies on a camera being held extraorally at a specific distance from the patient's mouth, its ability to record target points situated more posteriorly in the mouth may be compromised, therefore increased inter-implant distance is an important factor that limits the use of this technique. (Zhang 2021)

CONCLUSION

The precision of the photogrammetric impressions may be comparable to the conventional impression techniques; however, it should be used with caution. Their inability to record implants located posterior to the second premolar area may limit their utilization. (Zhang 2021)

On the other hand, their inability to record soft tissue can be easily overcome by using an intraoral digital scanner with designated scan bodies or by scanning the stone cast made from an irreversible hydrocolloid impression material.

Further research focusing on target design and clinical applications with larger sample size is needed.