In vitro comparative study between full-arch abutment level Implant impressions with intraoral scanning and photogrammetry systems - a pilot study.

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INTRODUCTION

Digital impression techniques are widely used in implant dentistry. The purpose of this in vitro study was to measure and compare the accuracy of full-arch digital implant impressions with intraoral scanning and photogrammetry systems.

METHODS & MATERIAL

A reference mandibular model was used to place 4 implants (Tapered Internal Plus Dental Implant, BioHorizons) and multi-unit abutments were inserted into the implants and torqued to 30 N/Cm (Fig.1). Specimens were divided into different groups according to the impression technique used:

Group Control: Intraoral scan bodies (Elos Accurate multi-unit scan body) were positioned and tightened by hand on each implant abutment replica. The reference model was scanned with a high-resolution reference scanner (inEos X5, DentsplySirona) and a Standard Tessellation Language (.STL) file was obtained (Fig.2).

Group 1: Intraoral scan bodies (Elos Accurate multi-unit scan body) were positioned and tightened by hand on each implant abutment replica. Two intraoral scans (Primescan, DenstplySirona) were made at the abutment level (3.5mm multi-unit abutment, straight) and exported as .STL files (Fig.3).

Group 2: Optical markers (IcamBody; Imetric4D Imaging Sarl) were positioned on each implant abutment replica and a photogrammetry system (Imetric 4D Imaging Sarl) was used to make two scans at the abutment level (3.5mm multi-unit abutment, straight) and exported as .STL files (Fig.4).

Group 3: Optical markers (PiC transfers; PIC Dental) were positioned on each implant abutment replica and a photogrammetry system (PIC Camera, PIC Dental) was used to make two scans at the abutment level (3.5mm multi-unit abutment, straight) and exported as .STL files (Fig.5).
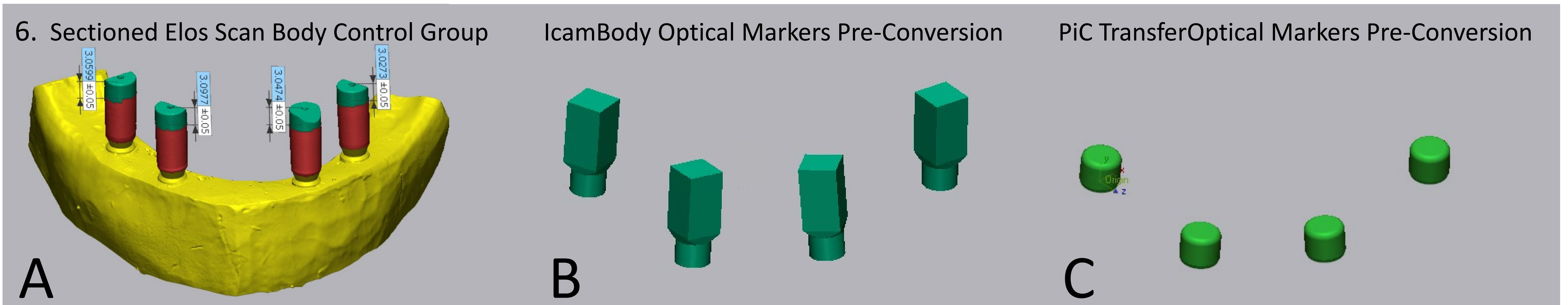

Figure 6. During scanning , digital impression systems use different scanning landmarks to track anatomic positions. Primescan (DentsplySirona) used Elos Acurrate multi-unit scan bodies (A). Imetric 4D Imaging Sarl used IcamBody optic makers(B). PiC used PiC tranfer optic markers (C). To compare scans, Icambody and PiC transfer optical markers were converted to Elos multi-unit scan bodies (E&F). To minimize the variability of the non-engaging scan bodies, the scans were exclusively analyzed at the cylindrical portion of the scan body, 3mm from the top (A). The region of comparison can be visualized in the highlighted red region (A).
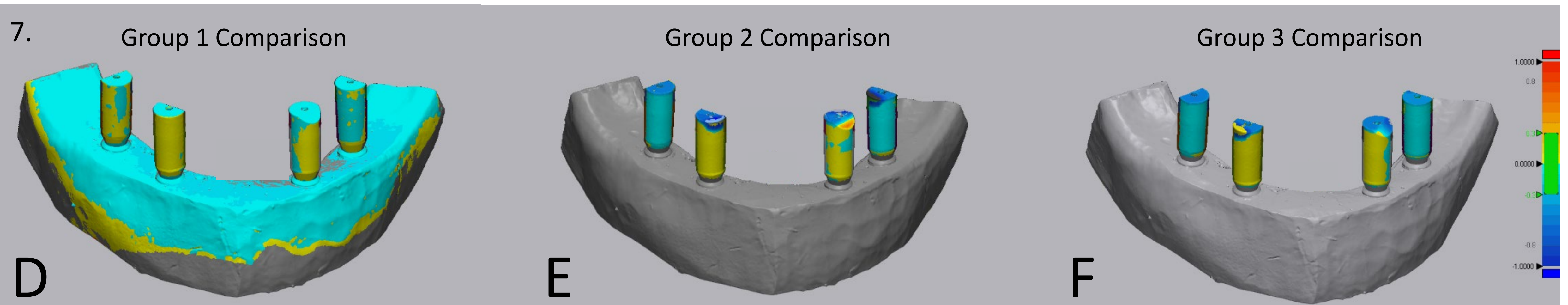
Using Geomagic Control X, all scanned groups were compared and superimposed to the control scan (A). Group 1 looked at the Primescan scan (D). Group 2 looked at the Imetric 4D scan (E). Group 3 looked at the PiC camera scan (F). A duplicate compare scan was performed for each group, but they are not shown. Measurements that appear bluer suggest a smaller value compared to the control. Measurements that appear more yellowish red suggest a larger value than the control. Measurements that are between yellow and teal are within 300 microns of the control.

Results

Root mean squared (RMS) values were calculated from superimposed control and digital scans. Group 1 showed the lowest RMS value, followed by Group 3, and the highest, Group 2.
After one-way ANOVA analysis, a significant difference was found between the different impression techniques (P<0.05). Using a Tukey's Honest Significant difference test, Group 1 was significantly different from Groups 2 and 3 (P<0.05). No significant difference was found between Groups 2 and 3 (P>0.05).

Conclusions

- The digital impression created using the Primescan intraoral scanner seems to be more accurate than the digital impression created by either the ICAM or PiC photogrammetry system
- The digital impression created using the ICAM and PiC photogrammetry system seem to demonstrate a similar level of accuracy.
- Future studies should investigate the accuracy of milled frameworks made from full-arch digital implant impressions with intraoral scanning and photogrammetry systems
- The optical marker conversion to Elos scan bodies may have led to an inaccurate comparison

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