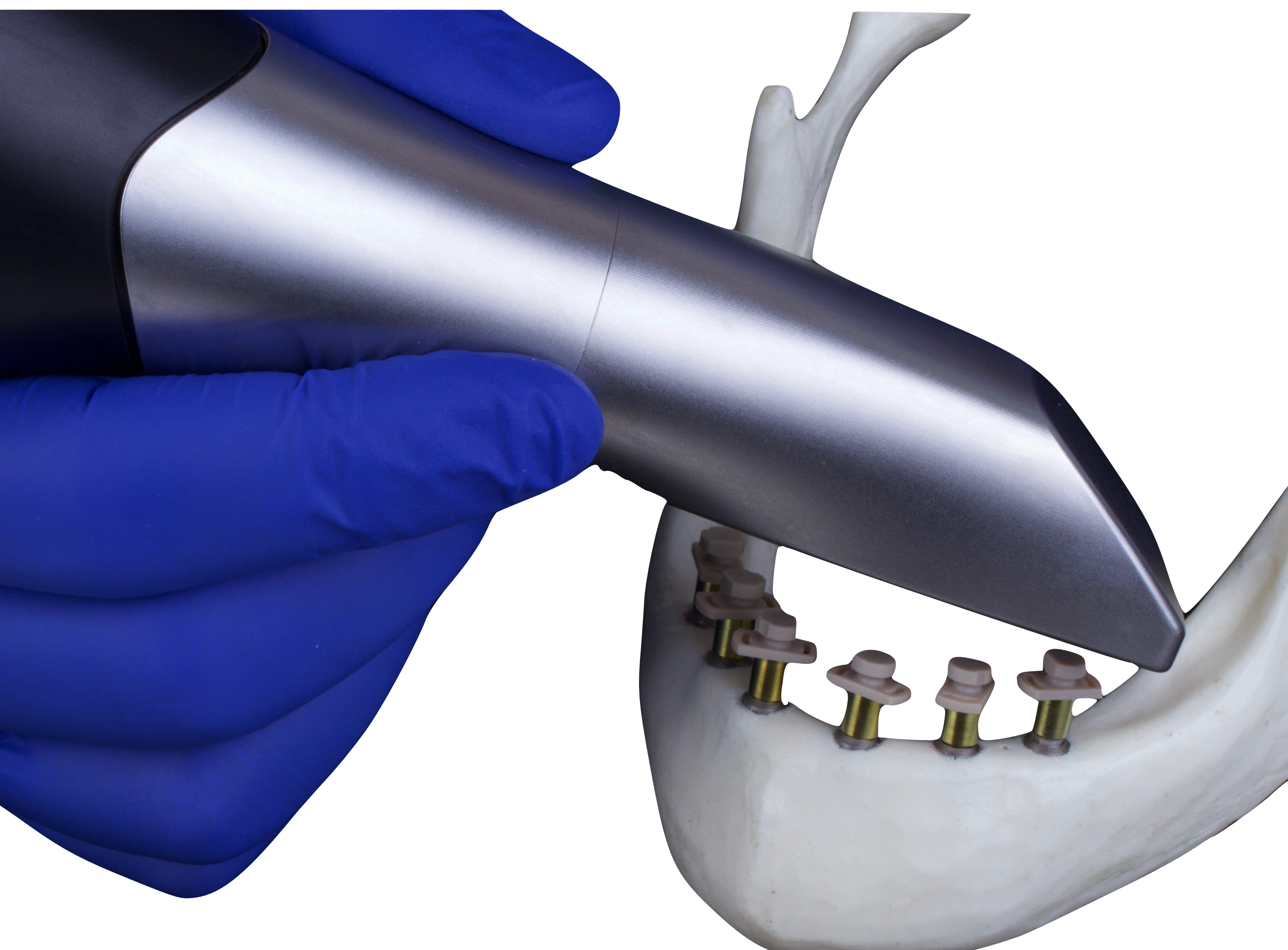


IN VITRO COMPARATIVE STUDY BETWEEN FULL-ARCH CONVENTIONAL IMPLANT IMPRESSIONS AND FULL-ARCH DIGITAL IMPLANT IMPRESSIONS WITH SNAP-ON SCAN BODIES

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Introduction

While advancement in digital technology has increased digitization of restorative workflows in implant dentistry, a definitive cast is still necessary for ceramic application, occlusal, and contact adjustments. As such, more evidence is needed to evaluate the accuracy of 3D printed models. The purpose of the present in vitro study was to measure and compare the accuracy of full-arch conventional implant impressions with open and closed-trays, full-arch digital implant impressions with intraoral scanners (IOS), and 3D printed casts from the full-arch digital implant impressions. Accuracy was defined as mean dimensional difference (Root Mean Square value) between the superimposed digitized control model and digitized models from different impression techniques.

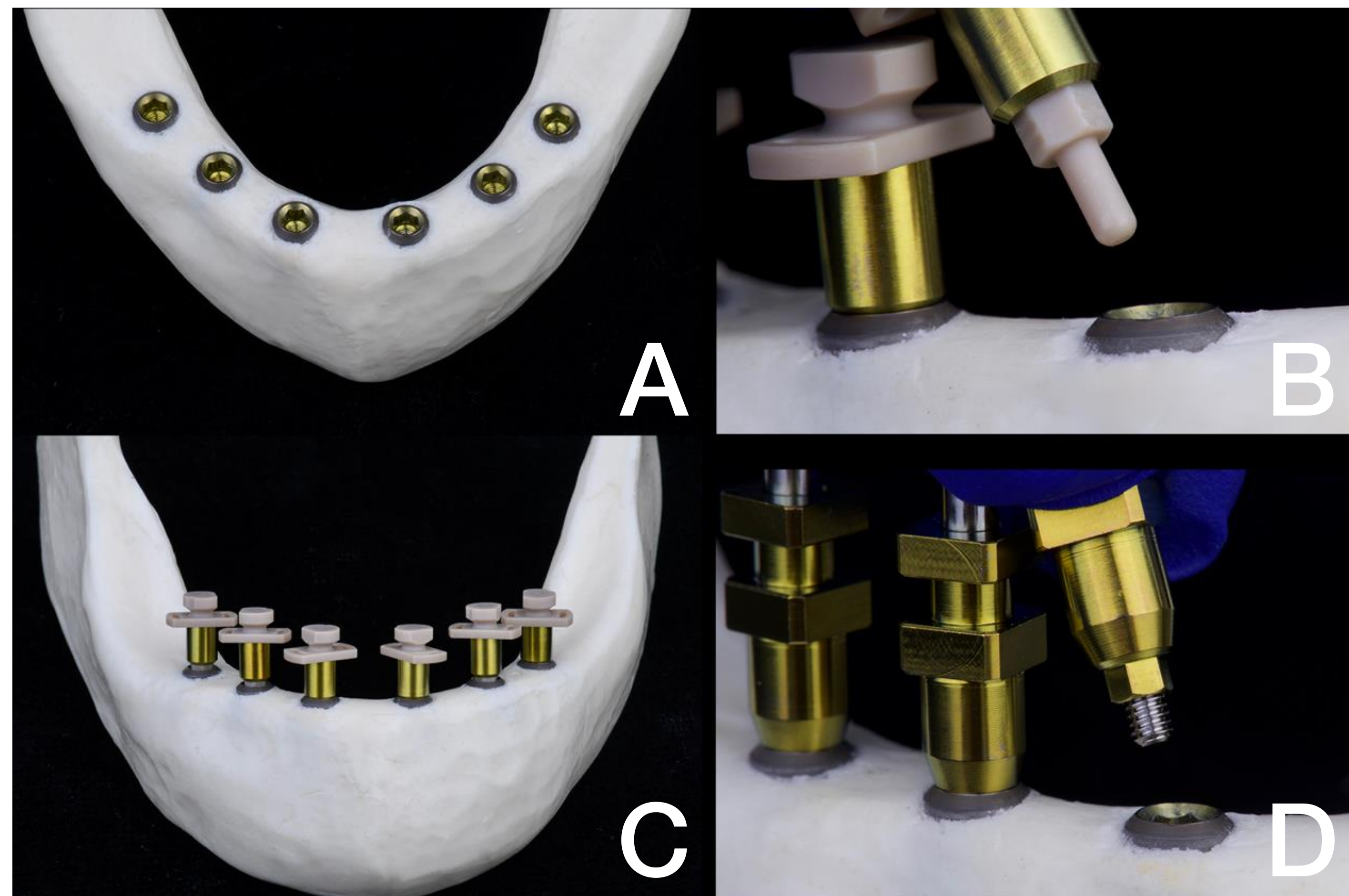


Fig 1A. 6 implants placed into edentulous model

Fig 1B. Snap-on scan bodies inserted into implants

Fig 1C. Reference scanner used to scan and produce .STL

Fig 1D. Open-tray impression copings

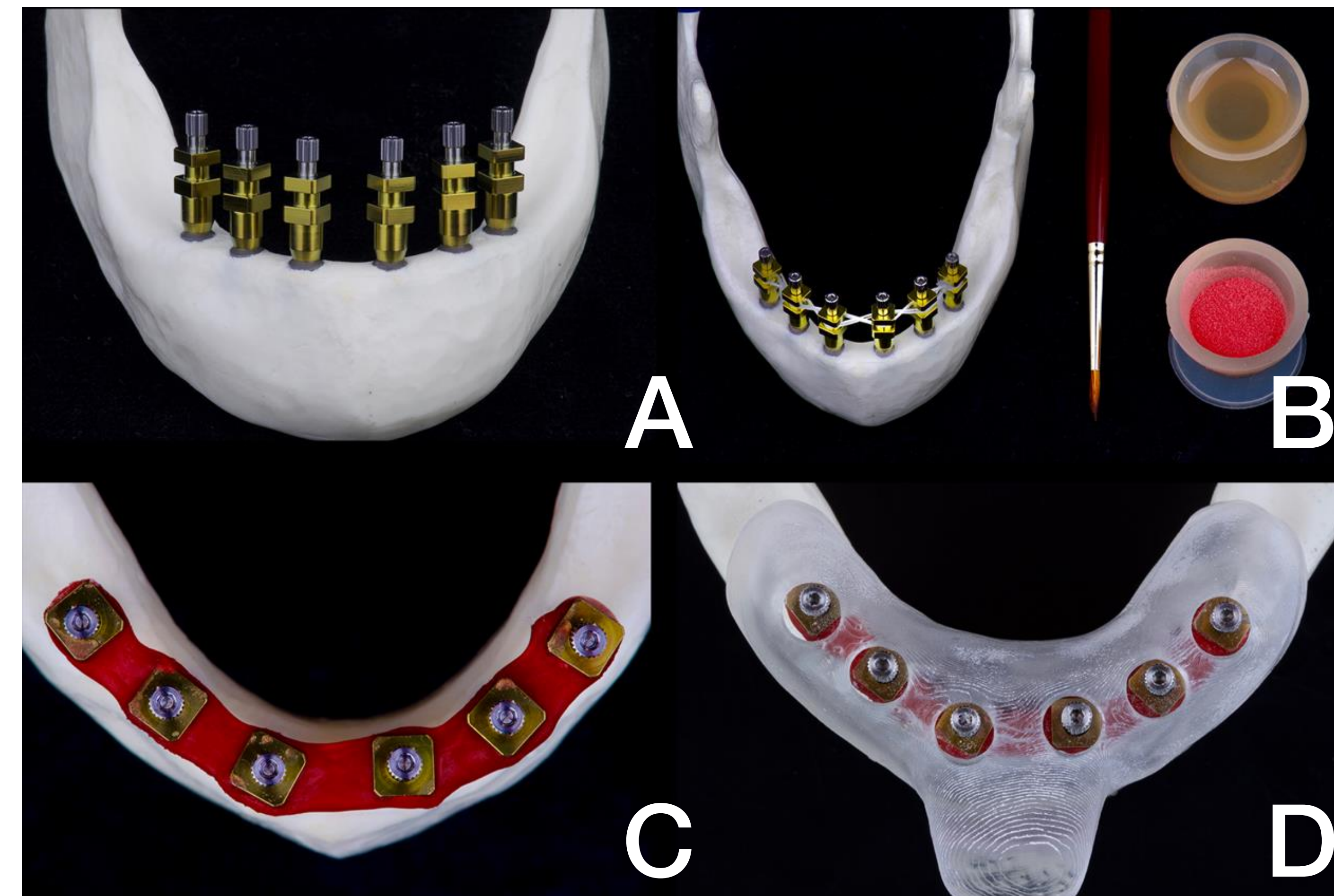


Fig 2A. 6 open-tray impression copings

Fig 2B. Acrylic resin and dental floss used to splint

Fig 2C. Acrylic resin sectioned and reconnected

Fig 2D. Impressions made using printed custom trays

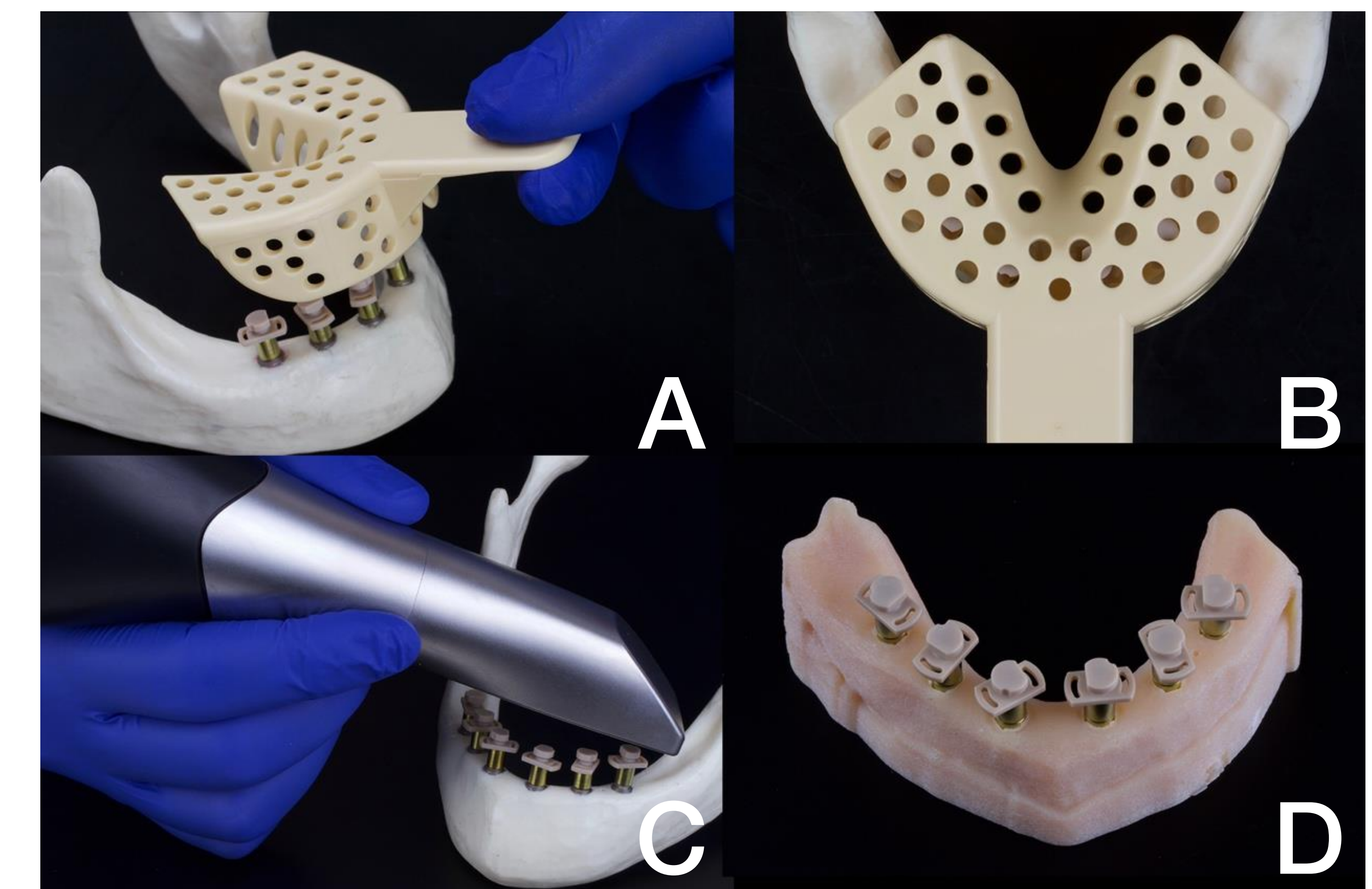


Fig 3A. 6 dual functioning snap-on scan bodies

Fig 3B. Impressions made using pediatric stock trays

Fig 3C. Digital impression made with intraoral scanner

Fig 3D. Printed models rescanned with reference scanner

Materials and Methods

6 implants (Tapered Internal Plus, 3.5 mm Platform Implant, BioHorizons) were placed in edentulous mandibular model (Fig 1A). Dual functioning Snap-on scan bodies (Snap Scan Body, BioHorizons) were inserted into the implants, scanned with a high-resolution reference scanner (inEos X5, Dentsply Sirona), and exported as a .STL file (Fig 1C). This file served as the control (Group Control).

Autopolymerizing acrylic resin (Pattern Resin LS, GC Intl) and dental floss were used to splint the impression copings. (Fig 2A-D) 5 open-tray impressions were made using printed custom trays (Group 1). 6 dual functioning Snap-on scan bodies (Snap Scan Body, BioHorizons) were inserted into implants (Fig 3A-B) and 5 closed-tray impressions were made using pediatric stock trays (Group 2). All conventional implant impressions were poured with vacuum mixed type IV dental die stone (Fujirock, GC).

Digital impressions (Group 3, n=5) were made with an intra-oral scanner (Primescan, Dentsply Sirona) (Fig 3C) from the control group and the .STL files were then exported and sent to Vulcan Custom Dental, where the .STL files were printed as resin models (Med690, VeroDentPlus, Group 4, n=5) from a 3D printer (Objet260 Connex3, Stratasys).

All casts were digitized using snap-on scan bodies inserted into the analogs of the casts from conventional and digital impressions (Fig 3D) and scanned with the reference scanner used for Group Control. The .STL files were exported to a 3D inspection software (Geomagic, 3D Systems) (Fig 4), where the .STL files of the digitized models from the different impression techniques were superimposed with the .STL file of the control using the fixed points of the scan bodies (Fig 5). RMS values were calculated from the superimposed files (Fig 5). A final scan of the control model was obtained and was compared with the initial control model. Both .STL files were imported into CloudCompare and were merged by aligning common points between both files. (Fig 6)

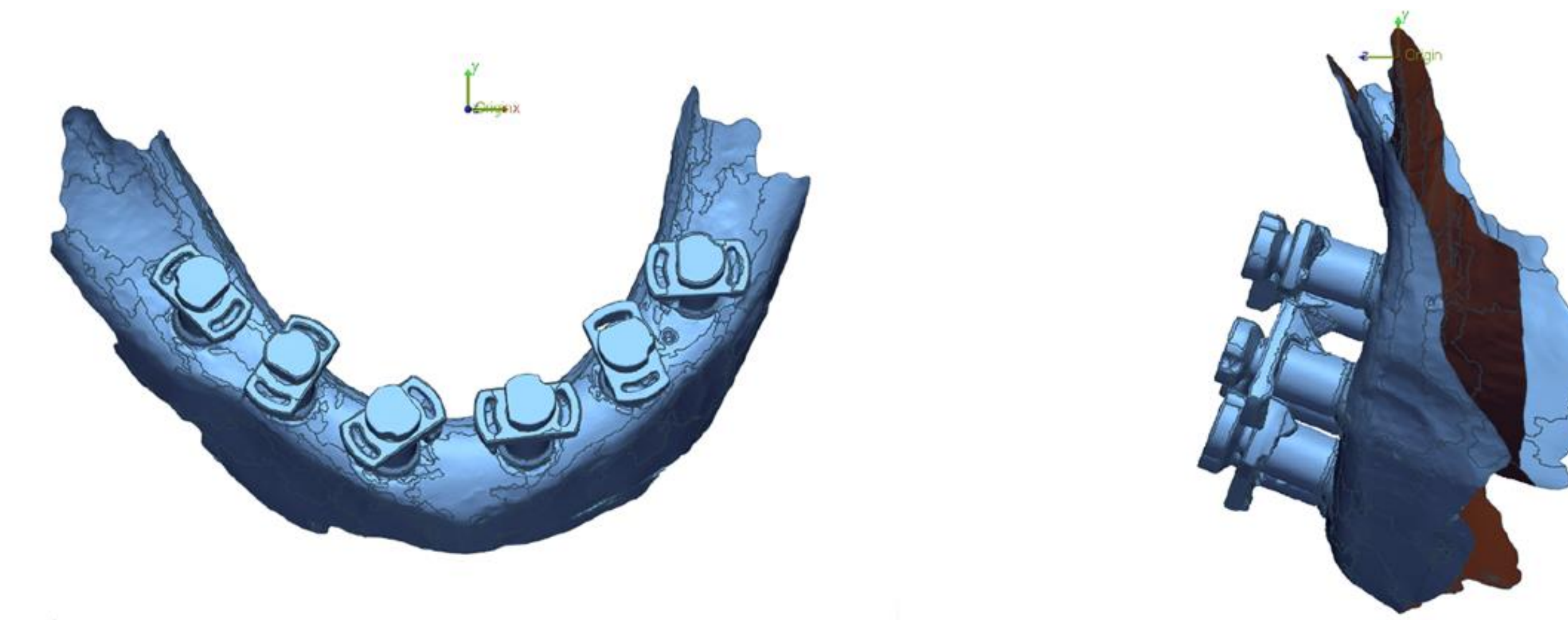


Fig 4. .STL image from control scan

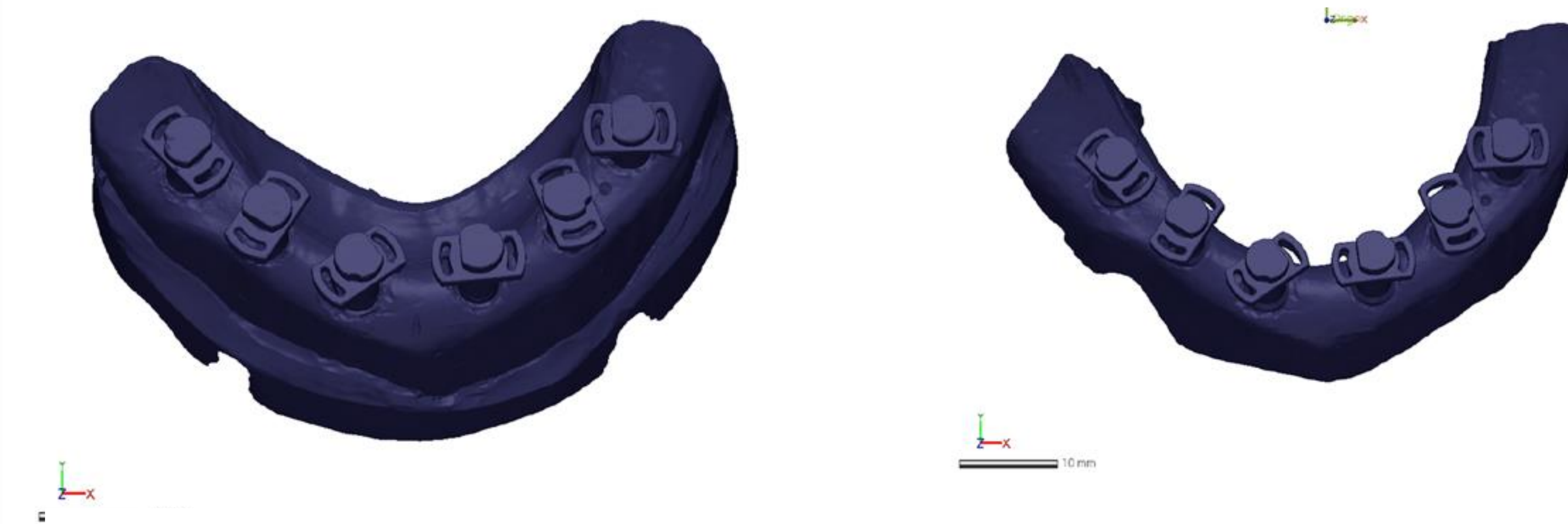


Fig 5. .STL image from test groups

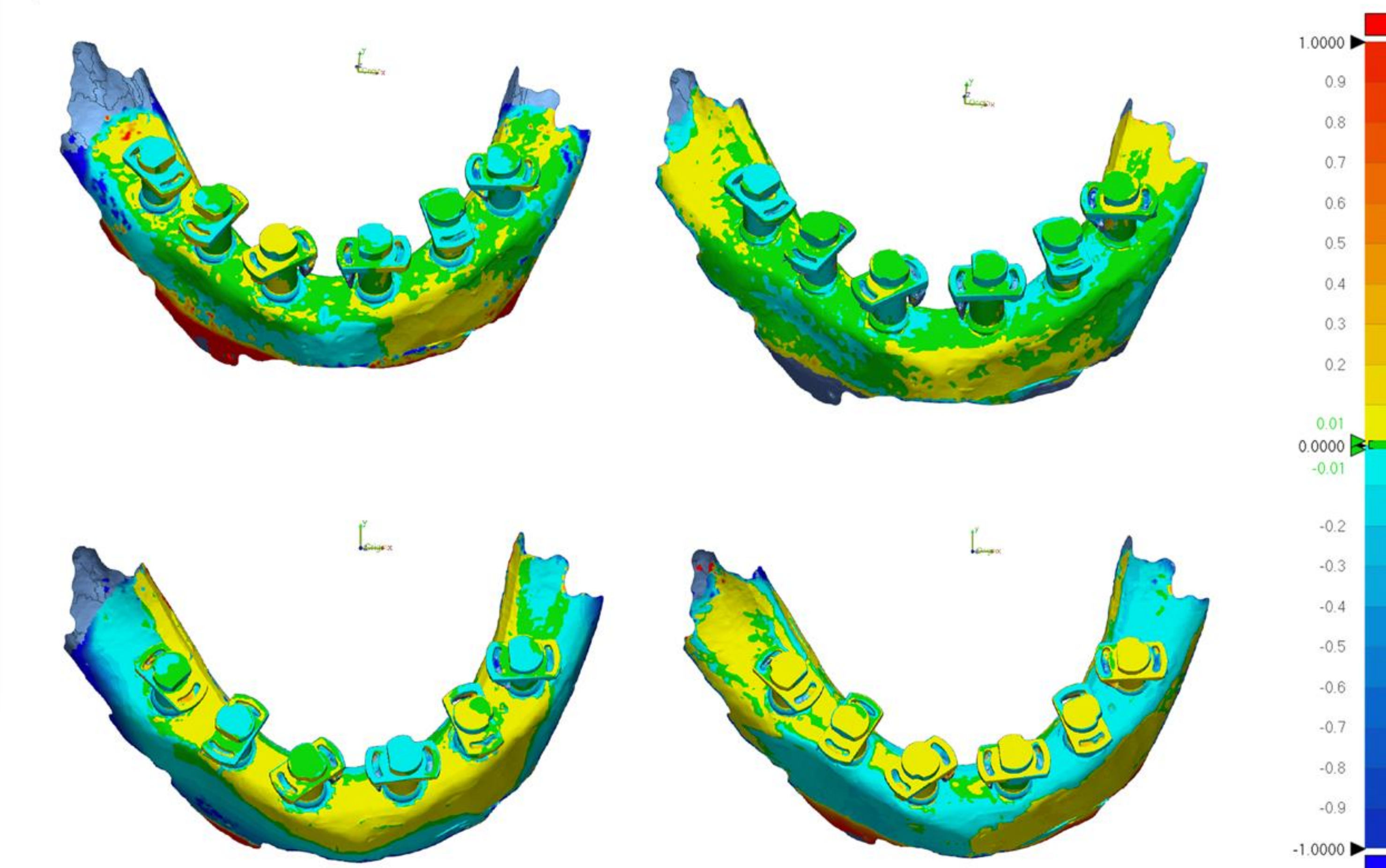


Fig 6. Graphical representation of 3D comparison between control .STL and experimental .STL for each group

Results

The data of the RMS values (means and SD) were calculated and displayed for each test group. (Figure 8) Of the four groups (open-tray, closed-tray, digital impression, printed models from digital impression), superimposed files of the control scan and the closed-tray impressions showed the highest RMS value (Group 2, 0.75268), followed by the open-tray impressions (Group 1, 0.708) and the printed models from digital impressions (Group 4, 0.5749). The superimposed files of the control scan and the digital impressions showed the lowest RMS value (Group 3, 0.2833).

Statistical analysis revealed normal variance and power value of 1.0. There was a significant difference found in the RMS values from the superimposed control model and digitized models between different impression techniques ($P < 0.05$). Post Hoc (Tukey) test revealed that Group 3, the superimposed files of the control scan and digital impressions, was significantly different from other groups ($P < 0.001$). There was no significant difference found for Groups 1, 2, and 4 ($P > 0.001$).

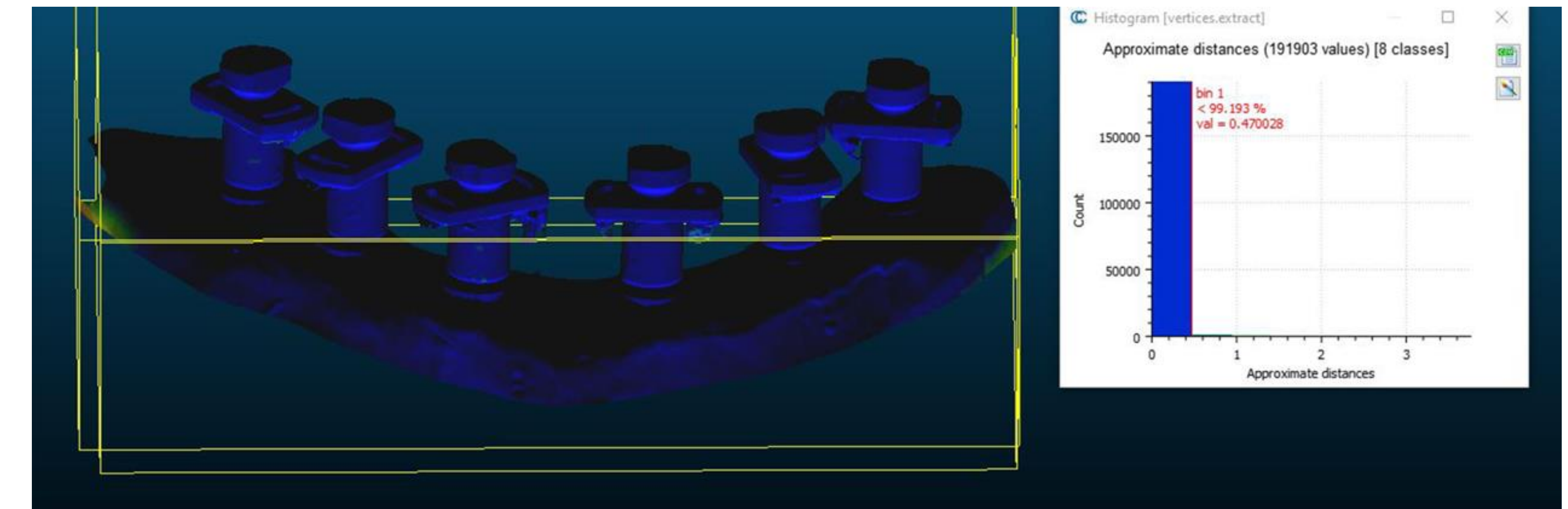


Fig 7. Comparison between the initial and final control .STL files

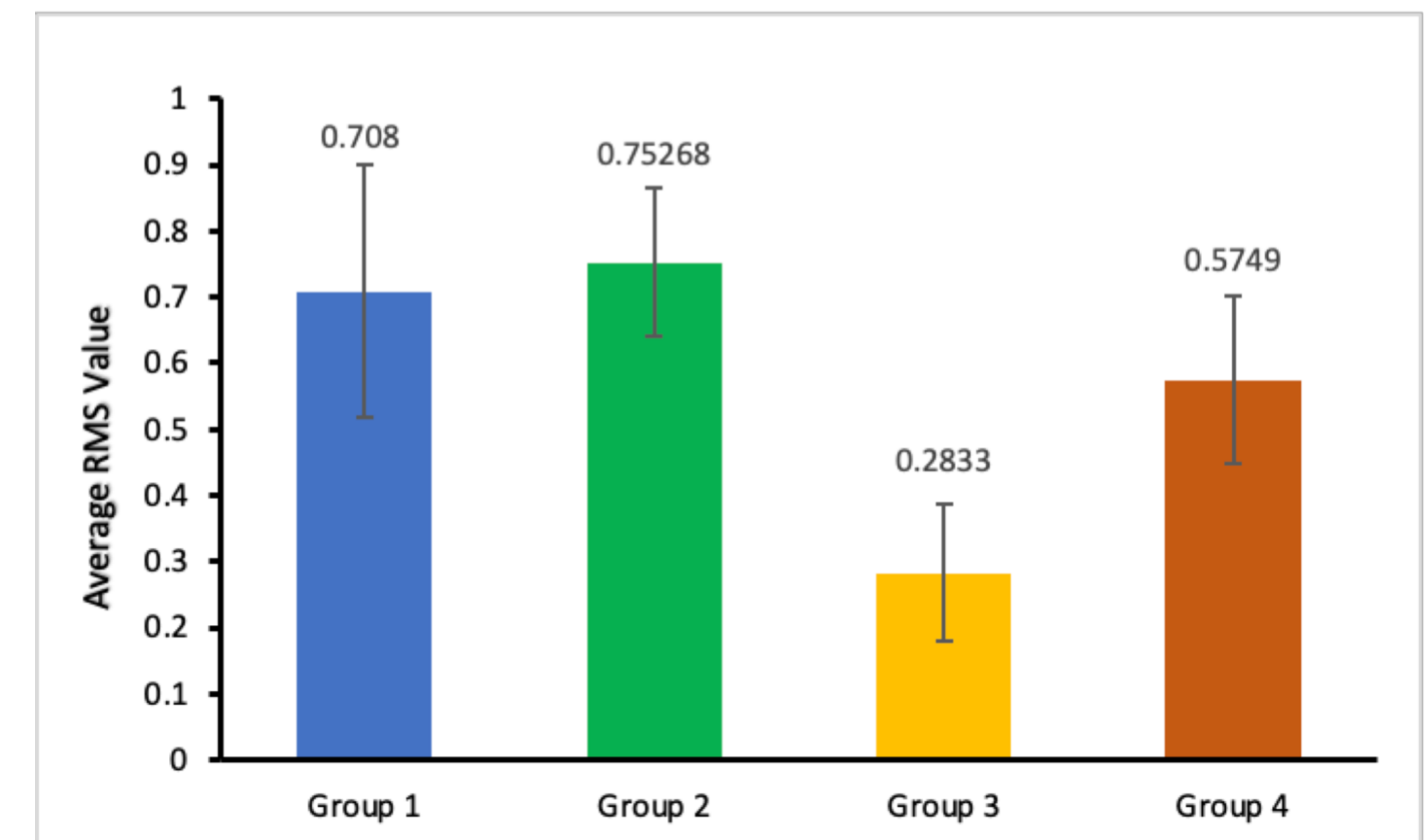
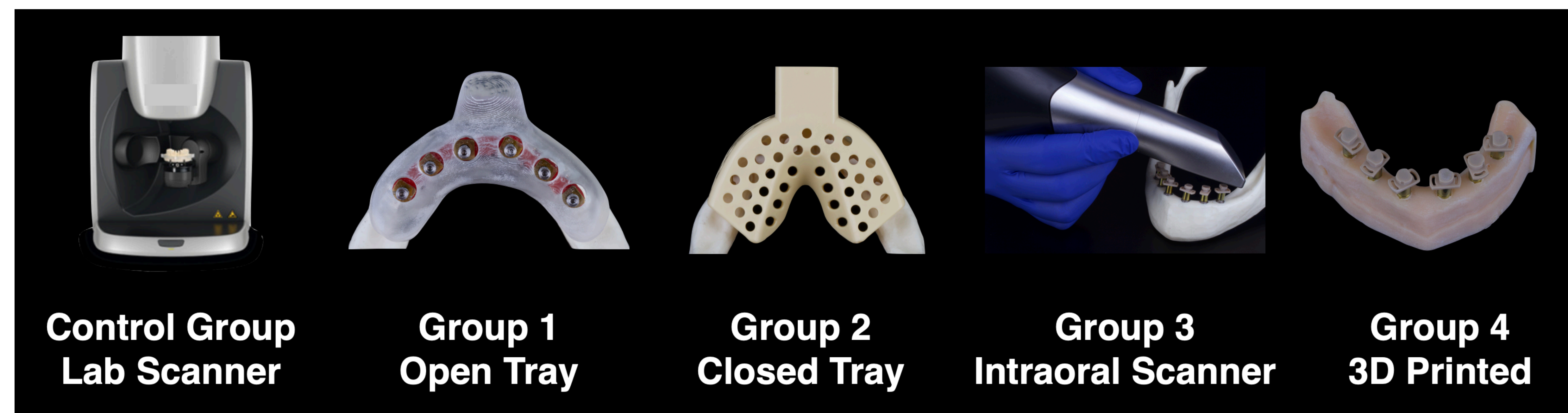


Fig 8. Mean RMS values for each group



Conclusion

While a fully digital workflow for edentulous patients may not be clinically viable, **the combination of conventional and digital workflow** may be an alternative to fully conventional workflow for rehabilitating edentulous patients with implant supported FDPs with ceramic application.

Closed-tray impression may be a clinically acceptable alternative to splinted-open-tray impression when dual functioning snap-on scan bodies are used.

The use of dual functioning snap-on scan bodies would negate the need to splint impression copings and provide more comfort to the patients.

For full-arch implant-supported prosthetic workflow requiring a definitive cast, there is still a need to use verification jigs to ensure the accuracy of the model, whether printed or poured, before proceeding to the definitive prosthesis.

Fabrication of an implant framework or verification jig on the edentulous mandibular model and assessment of the actual fit of the framework or verification jig on printed casts could further validate the clinical acceptance and integration of the printed models in digital workflow