

The Effect of Scanning the Palate with Different Palatal Vault Depths and Implant Numbers on the Accuracy of Complete arch Implant Digital Impressions

Sunee Limmeechokchai DDS MSD ; Kawther Ali BDM B.Med.Sc MS; Roberto Savignano Mac Ph.D

Statement of problem

1. The effect of stitching the palate during maxillary full arch implant digital impressions on the scanning accuracy of jaws with different palatal vault depths is unclear.
2. Whether the number of implants in a maxillary edentulous arch will affect the need to stitch and scan the palate in a full arch maxillary implant digital impression has not been investigated.

Introduction

Scanning edentulous arches is difficult due to the lack of anatomic fixed landmarks and different mucosal and denture border morphology and, thus, may result in intraoral scan inaccuracies.¹⁻⁴ Excluding the palate while scanning maxillary edentulous arches with implants if proved accurate may offer better scan efficiency and may be more comfortable in patients with limited mouth opening and gag reflex.⁵

Therefore, the aim of this study is to investigate the trueness of implant full arch scans with and without stitching the palate with different palatal vault depths and the effect of implant number on the accuracy of palate-less full arch implant digital impression.



Fig. 1; Reference Model.



Fig. 2; ExoCAD modified palatal depth.

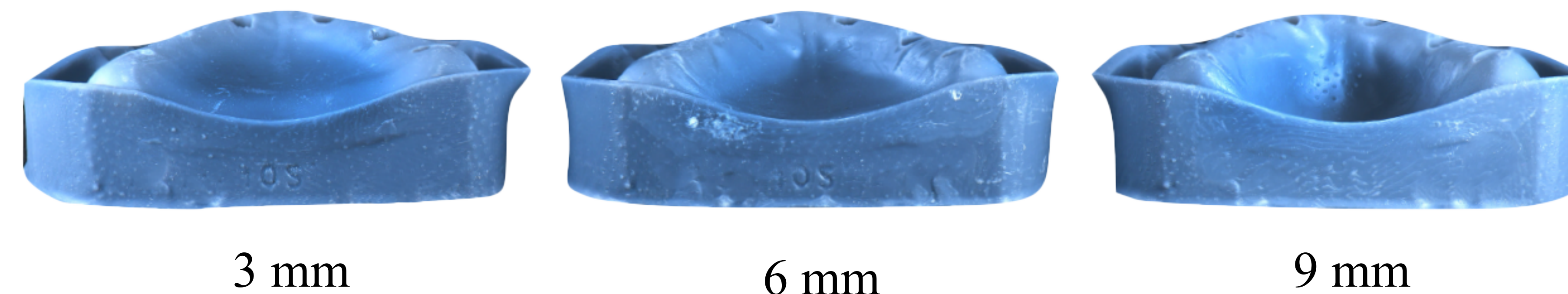


Fig. 3; Modified models with different palatal vault depth.



Fig. 4; Implant analog and ISBs on the model.



Fig. 5; Scan path.

Materials and Methods

An edentulous reference model (Fig. 1) was modified digitally by ExoCAD software (Fig. 2) to introduce variations in three different palatal vault depth: 3mm (shallow), 6mm (medium) and 9mm (deep) (Fig. 3). Afterwards, the three models were duplicated. ExoCAD software was used to insert 4 implants 4.1/10 (Straumann RC) in 3 models. The other 3 models received 6 implants 4.1/10 (Straumann RC) using the same software. Then, the digital models were exported in STL file format and served as the controls for the corresponding experimental groups.

All models were printed into physical models made of resin. Abutment level implant analog were insert into the designated indexed recesses and proprietary intraoral scan bodies (ISBs) were attached to each dental implant analog and torqued according to the manufacturer recommendation (Fig. 4). Each model was scanned with an intraoral scanner (3 shape Trios3) 7 times with and without stitching the palate giving 12 groups of 7 scans. A total of 84 scans were generated and saved in STL file format. A standardized path was followed for all scans (Fig. 5) by the same operator (SL)

Data analysis : Test STL data from each test group were superimposed over the corresponding control using Geomagic software with a best-fit algorithm. The root mean square (RMS) values were calculated to define the trueness. In addition, a color map was created to visualize the displacement between the superimposed digital models within $\pm 100 \mu\text{m}$.

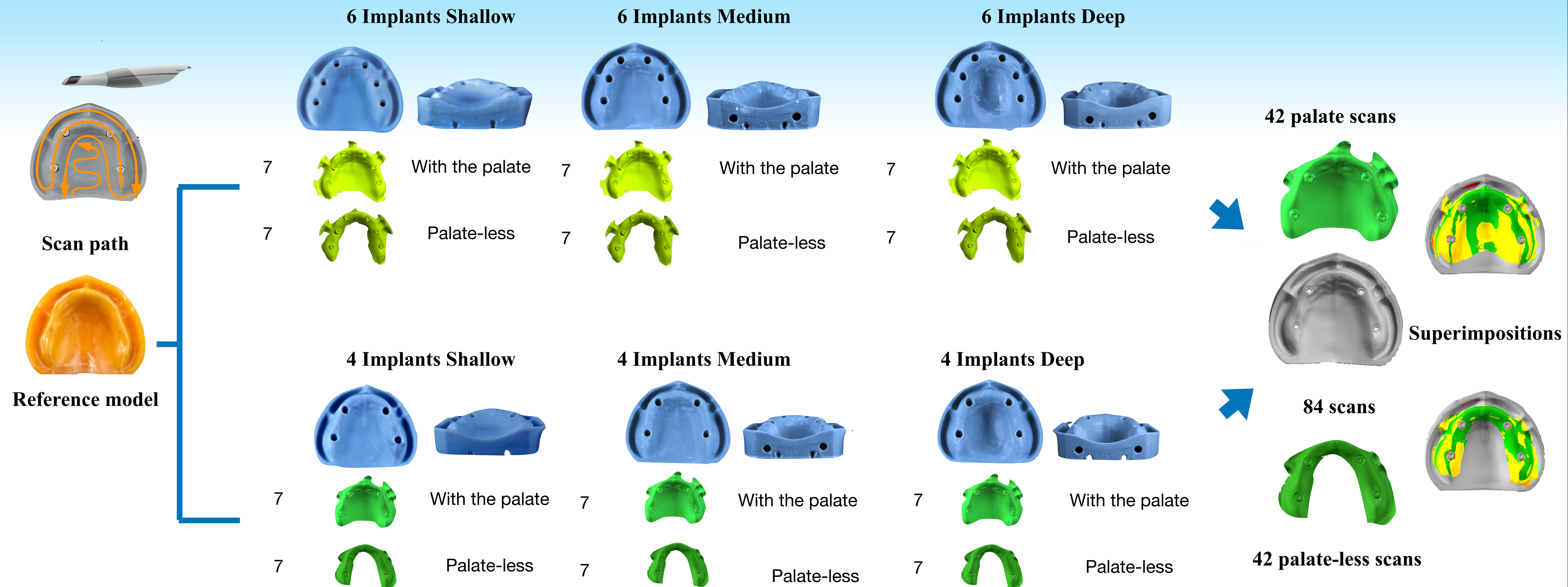


Fig. 6; Diagram display total 84 scans stitching and without stitching the palate in different palatal vault and implant numbers for superimpositions.

Statistical Analysis

Each deviation data set was analyzed using a 2-way ANOVA. Turkey post hoc test was used to completely resolve the significance of pairwise comparisons. The Welch two sample T-test testing the difference of trueness by implant number. One sample t-test was used to compare the mean standard deviation of each 7 scans in to the group with the smallest root mean square difference of the same group (best trueness) to determine the precision.

Results

The trueness of the scan would not be affected whether the palate is completely scanned or not in different palatal vault depths. Effect of palatal vault depth on the trueness of all scans was not significant ($p = .494$). Tukey post-hoc test showed there is no statistically significant difference in trueness of the scans with and without palate ($p = .598$). The precision of the scan would not be affected whether the palate is completely scanned or not in different palatal vault depths. All test groups were deemed not precise as there was a statistically significant difference between the mean standard deviation in that group and the best trueness value from the best scan in the group (Shallow scanned with the Palate (mean = 0.12) of SD), Shallow Palate-less (mean = 0.09), Medium scanned with the Palate (mean = 0.08), Medium Palateless (mean = 0.10), Deep scanned with the Palate (mean = 0.09), Deep Palateless (mean = 0.10). All have $P < .001$.

References

1. Gimenez-Gonzalez B, Hassan B, Özcan M, Pradies G. An in vitro study of factors influencing the performance of digital intraoral impressions operating on active wavefront sampling technology with multiple implants in the edentulous maxilla. J Prosthodont. 2017;26:650-655.
2. Giménez B, Özcan M, Martínez-Rus F, Pradies G. Accuracy of a digital impression system based on parallel confocal laser technology for implants with consideration of operator experience and implant angulation and depth. Int J Oral Maxillofac Implants. 2014;29:853-862.
3. Goodacre BJ, Goodacre CJ. Using intraoral scanning to fabricate complete dentures: first experiences. Int J Prosthodont. 2018;31:166-170.
4. Goodacre BJ, Goodacre CJ, Baba NZ. Using intraoral scanning to capture complete denture impressions, tooth positions, and centric relation records. Int J Prosthodont. 2018;31:377-381.
5. Lee JH. Improved digital impressions of edentulous areas. J Prosthet Dent 2017;117:448-449.

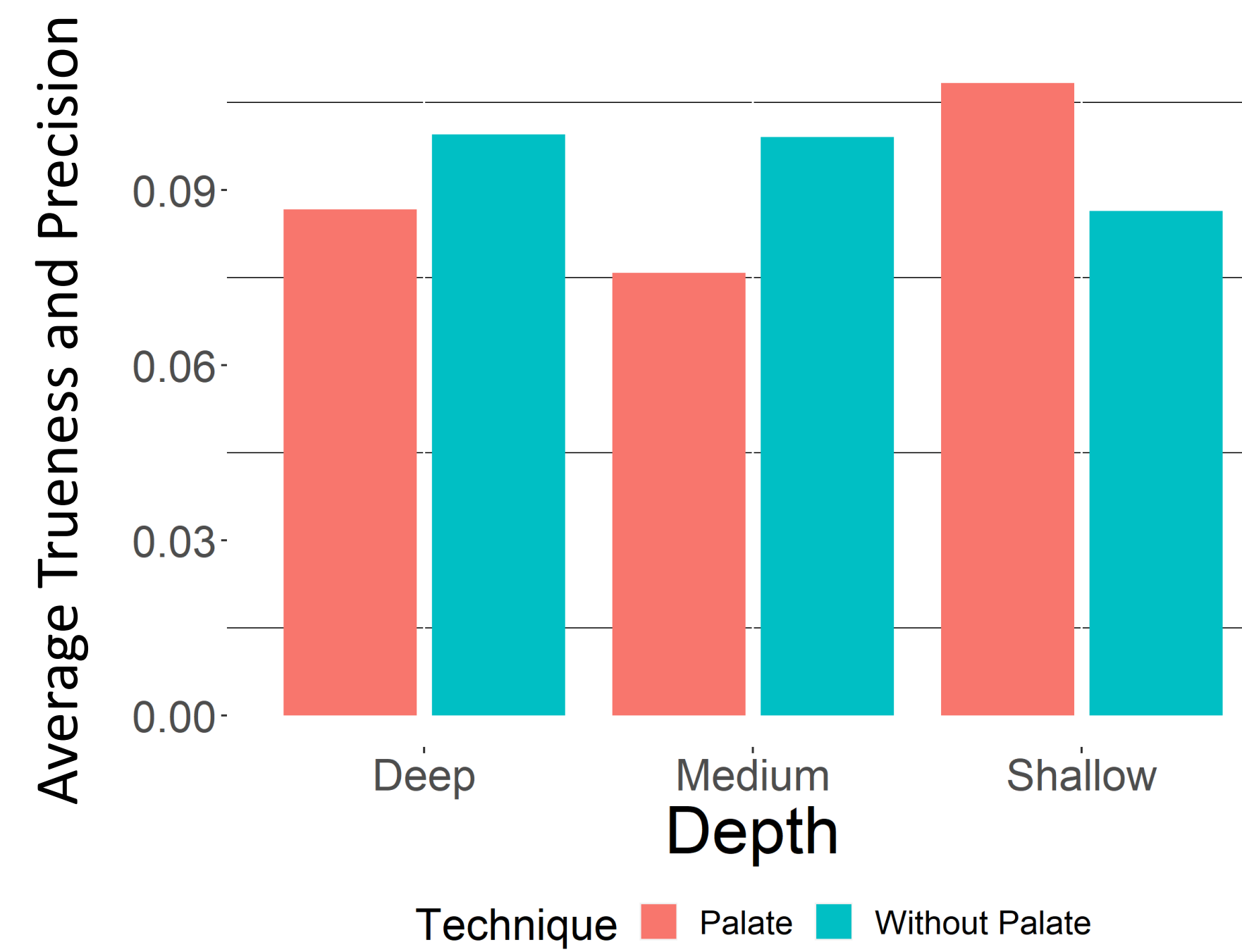


Fig. 7; Boxplot display average trueness and precision between different palatal vault depths.

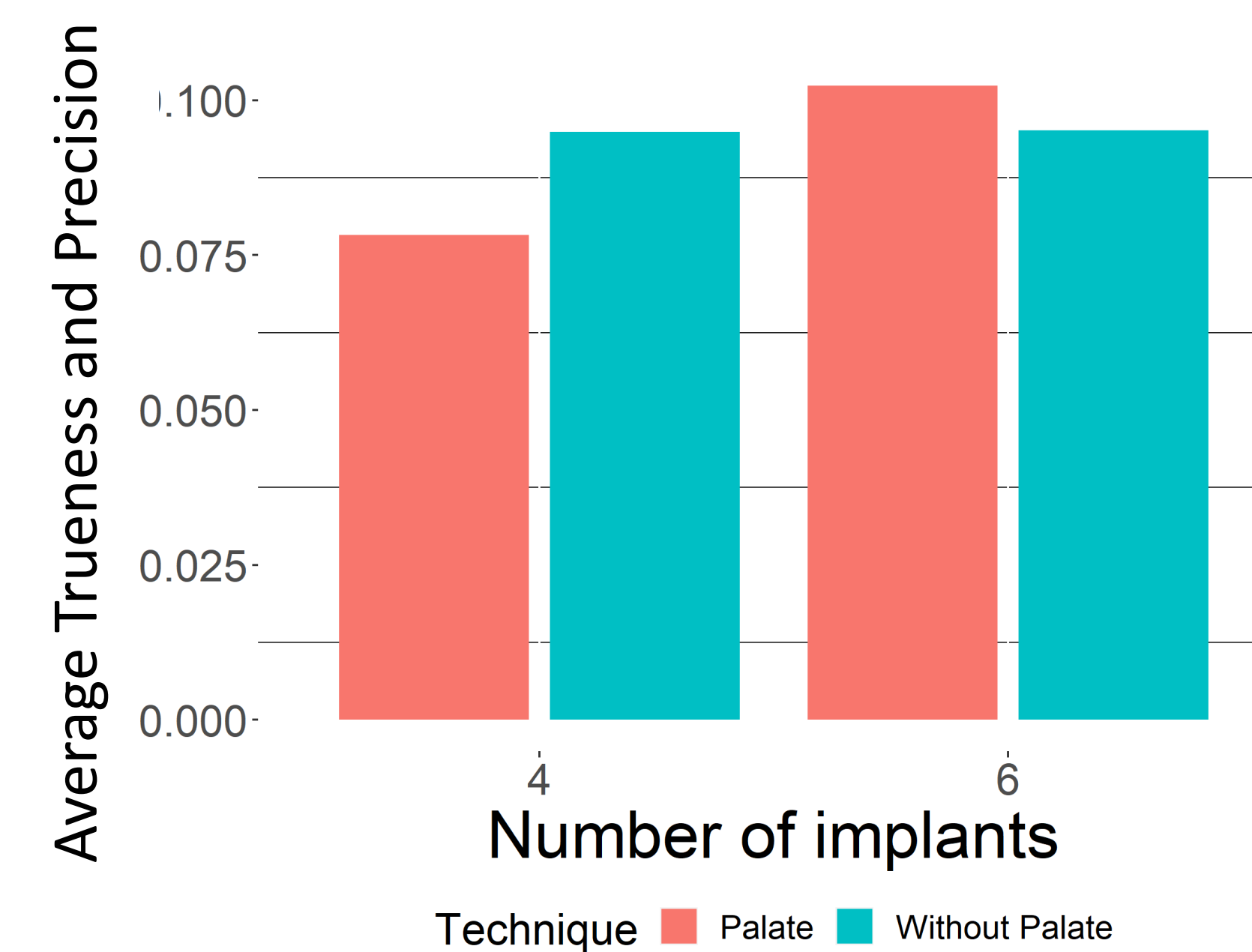


Fig. 8; Boxplot display average trueness and precision in between two different implant numbers.

The scan body number would not affect the trueness of palate-less implant full arch digital impressions. According to ANOVA test There was no statistically significant interaction between the implant number and technique (with palate or palateless) $p = .038$. or depth $p = .086$.

The effect of palatal vault depth on the trueness of all scans was not significant ($p = .494$). However, it is interesting to note that there is a statistically significant difference in trueness of the scan ($p = .004$) between Shallow $M = 0.11$, $SD = 0.109$ and Medium Depth $M = 0.08$, $SD = 0.021$ when palate is scanned.

Conclusion

In conclusion, the accuracy of implant edentulous full arch scans was not affected whether the palate was scanned or not in shallow, medium, or deep palatal vaults. The implant number did not affect the accuracy of full arch edentulous maxillary implant scans or affect the need to scan the palate.

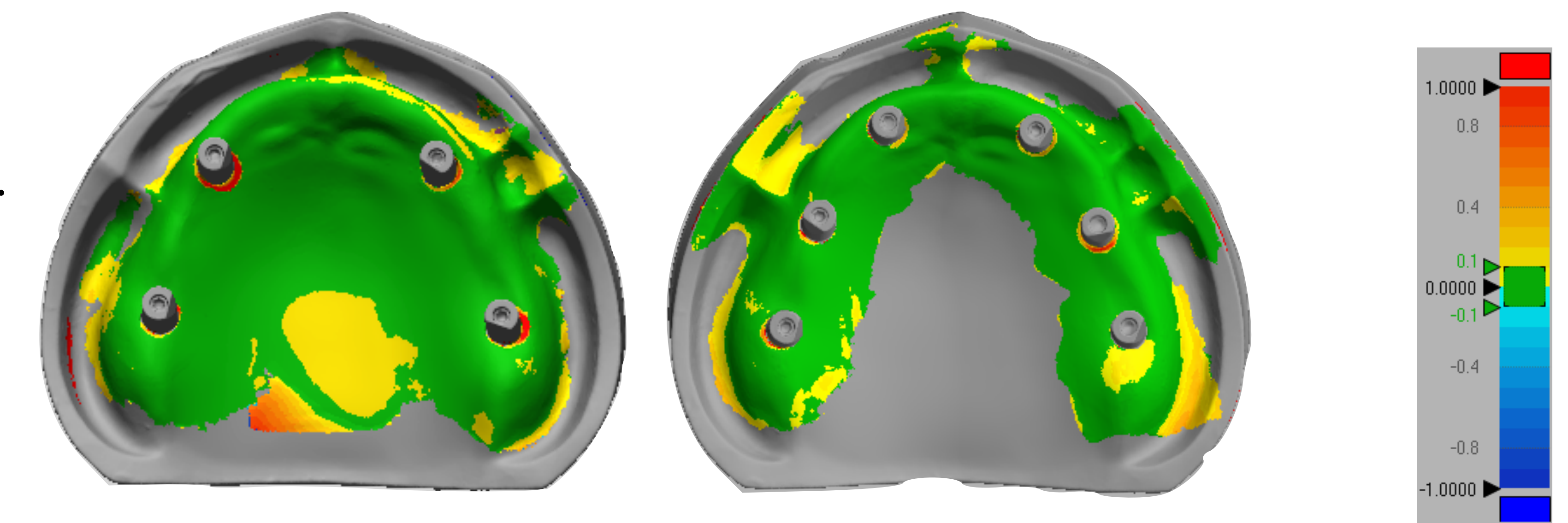


Fig. 11; The color maps after superimposed with palate and palateless.

