



A Comparison of Accuracy of Full Arch Maxillary Digital Impressions with Intraoral Scanners using Two Different Scan Body Systems: An In Vitro Study

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Introduction

With the advancements of intraoral scanners (IOS), it is now possible to obtain a digital impression of a patient’s oral cavity, eliminating the need for conventional impression techniques. For implant restorations, implant scan bodies (ISBs) are used to acquire implant orientation, angulation, and 3D spatial position.¹ A passive fitting restoration depends on an accurate transfer of spatial orientation and angulation of the implants within the clinically acceptable range of errors.² Restorations that do not display passive fit can lead to biological and mechanical complications.² Digital implant impressions offer advantages over conventional impressions, such as reduced risks of distortion during the laboratory phases, improved patient comfort, and reduced chair time.³ Scanning accuracy is shown to be affected by the IOS and geometric features of the ISBs.⁴ The study's null hypothesis is that there are no differences in accuracy between IOS and ISB.

Objectives

Two factors that can cause inaccuracy are IOS type and ISB geometry. This study will examine two scan body types with different geometric features and two intraoral scanners to evaluate accuracy in making full arch digital implant impressions.

Methods

An edentulous maxillary model was 3D printed with six bone-level implant analogs (Straumann USA, Andover, MA). Two ISBs, the Straumann metal scan body (Fig. 1) and the DESS implant scan body (DESS-USA, Coral Gables, FL) (Fig. 2) were tested. Two intraoral scanners (IOS), the Planmeca Emerald S (Planmeca Oy, Helsinki, Finland) and Trios 3 (3Shape, Copenhagen, Denmark) were also tested.

Straumann ISBs, followed by DESS ISB, were tightened onto the model according to the manufacturer's instructions and scanned with a D2000 laboratory desktop scanner (3Shape, Copenhagen, Denmark). The resulting 2 STL files were used as controls. Four test groups were designed. Group 1 – DESS ISB and Planmeca IOS; group 2 – DESS ISB and Trios IOS; group 3 – Strumann ISB and Planmeca IOS; and group 4 - Straumann ISB and Trios IOS. Each group had ten scans, resulting in 40 STLs overall. Using the control STL files; linear deviation was measured using distances from ISB 1-3, 1-4, and 1-6 (Fig. 4), as well as the angular deviation between ISB 3,4 and 6 (Fig. 5) and overall average surface deviation (Fig. 6). Bar charts were made to visualize linear deviation among groups 1-4 (Figs. 7-9).



Fig. 1 Straumann ISB geometric features

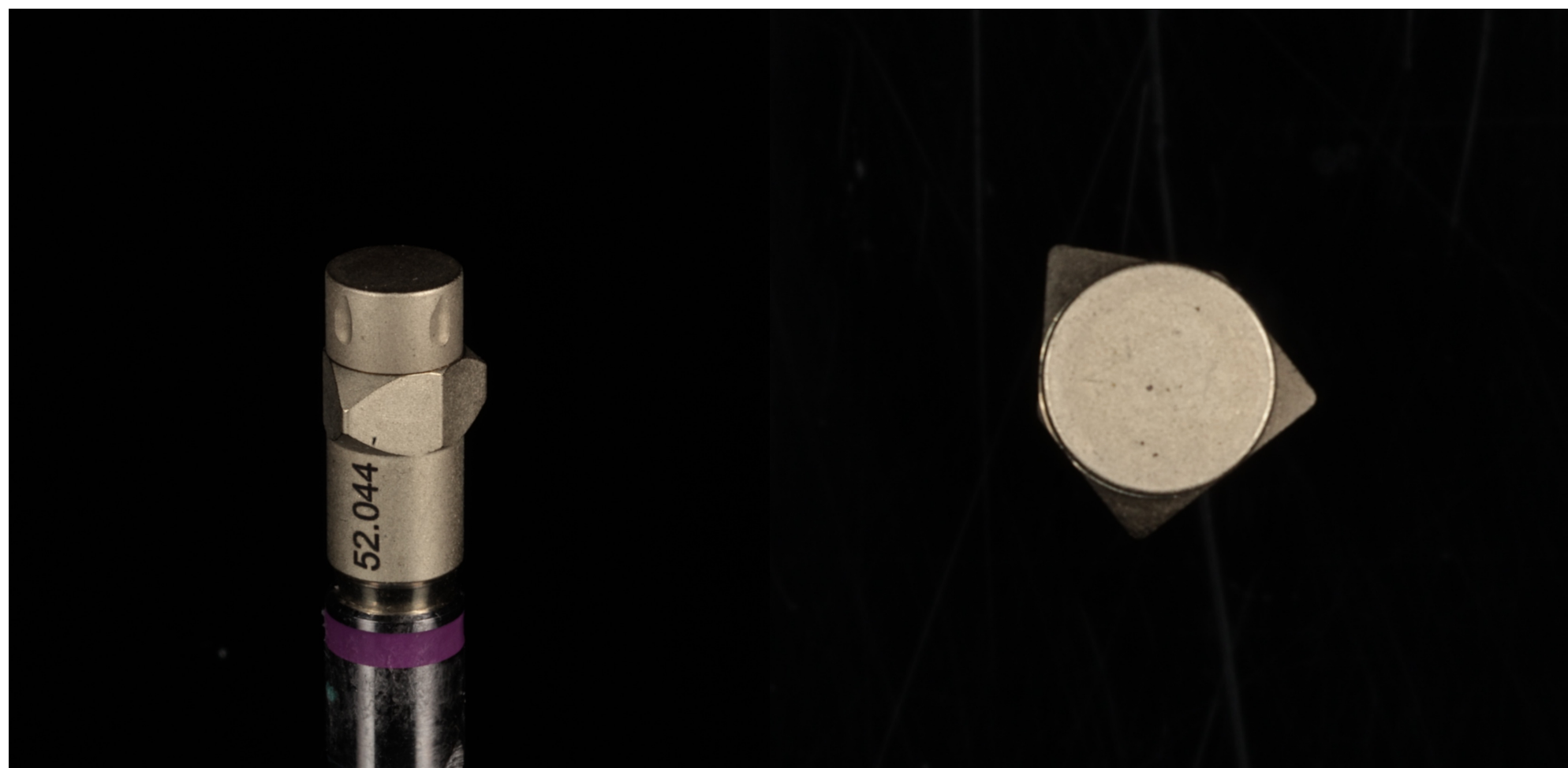


Fig. 2 DESS ISB geometric features

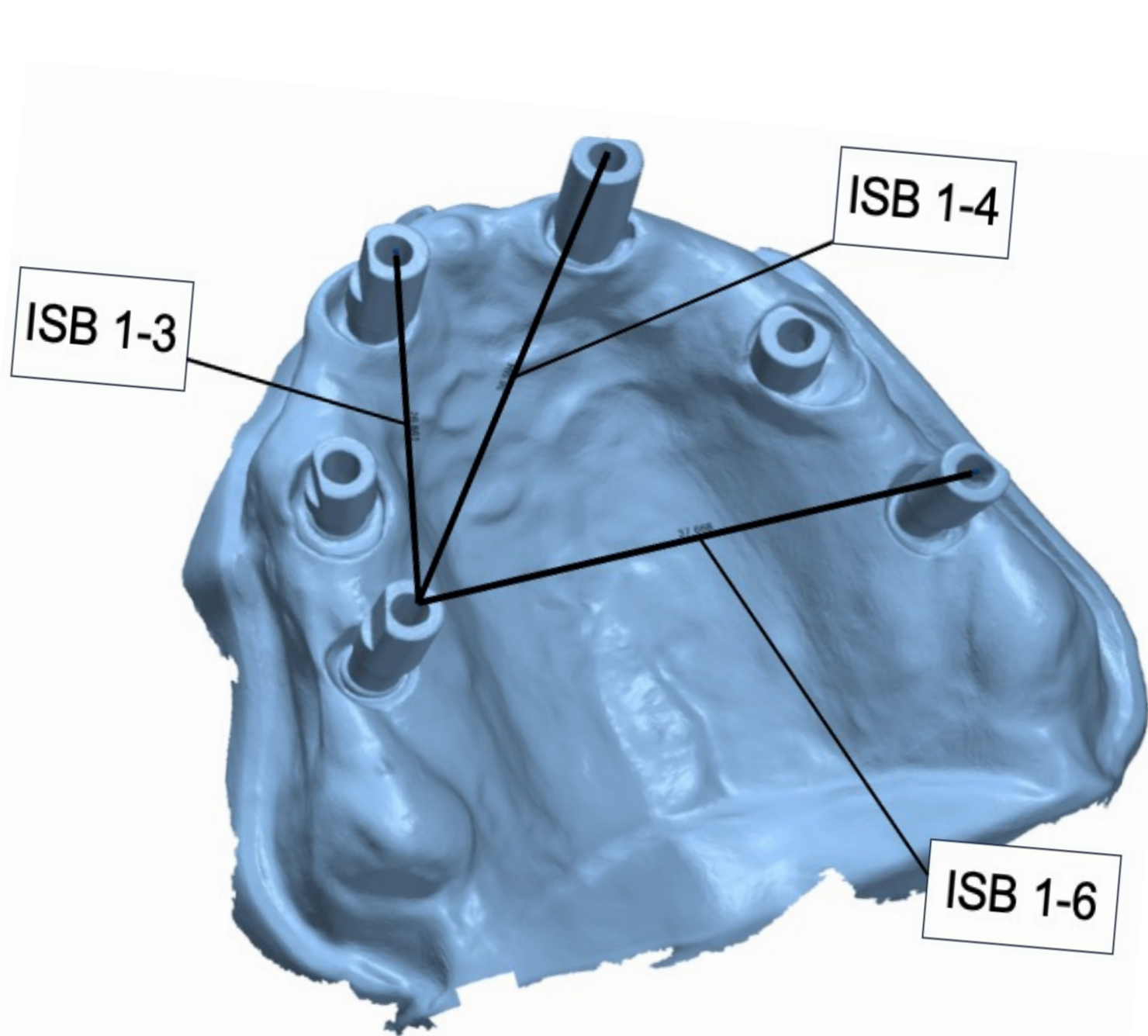


Fig. 4 Straumann/Trios ISB linear distances measured

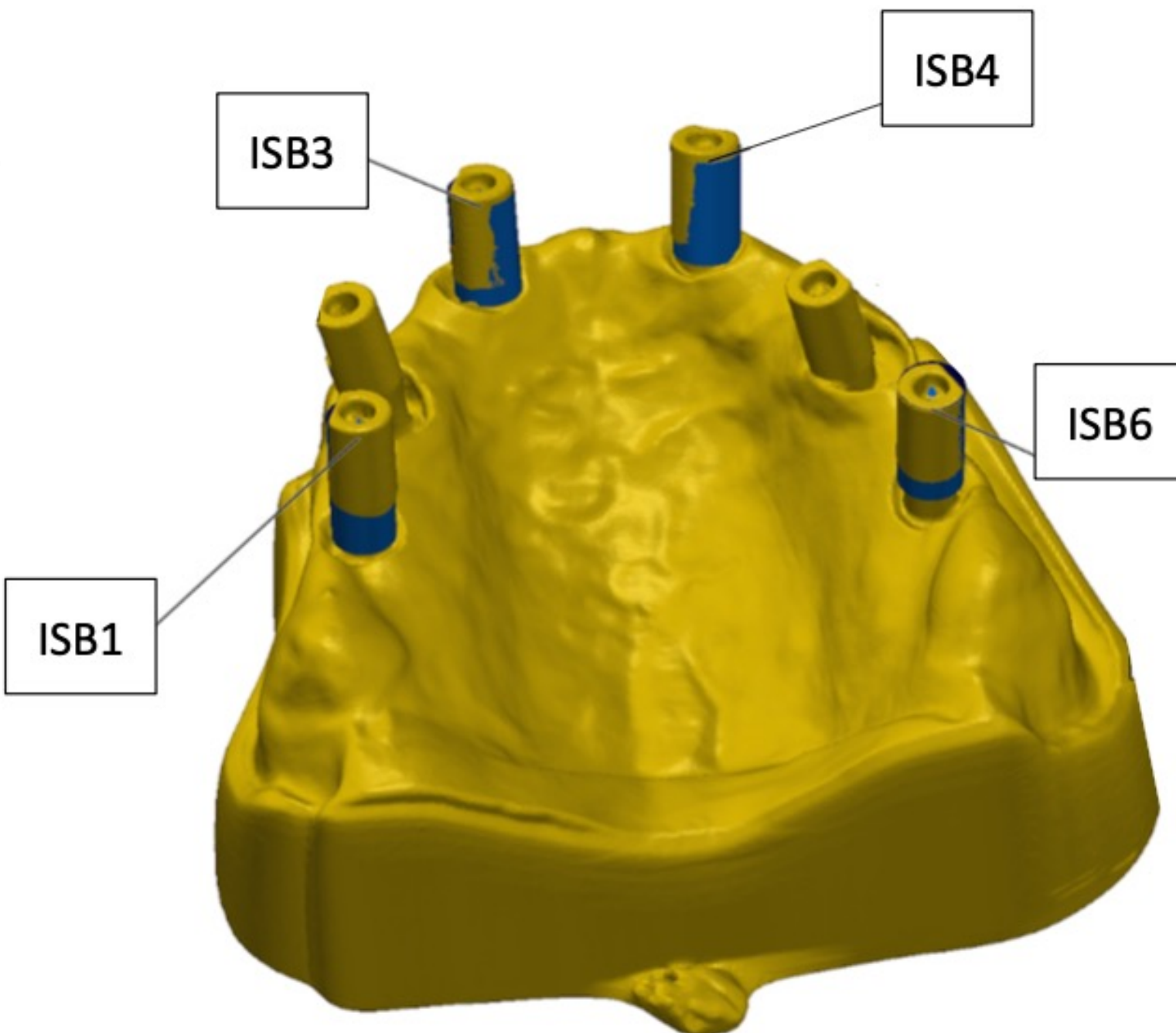


Fig. 5 Straumann/Trios ISB angular deviation color map (p = 0.155)

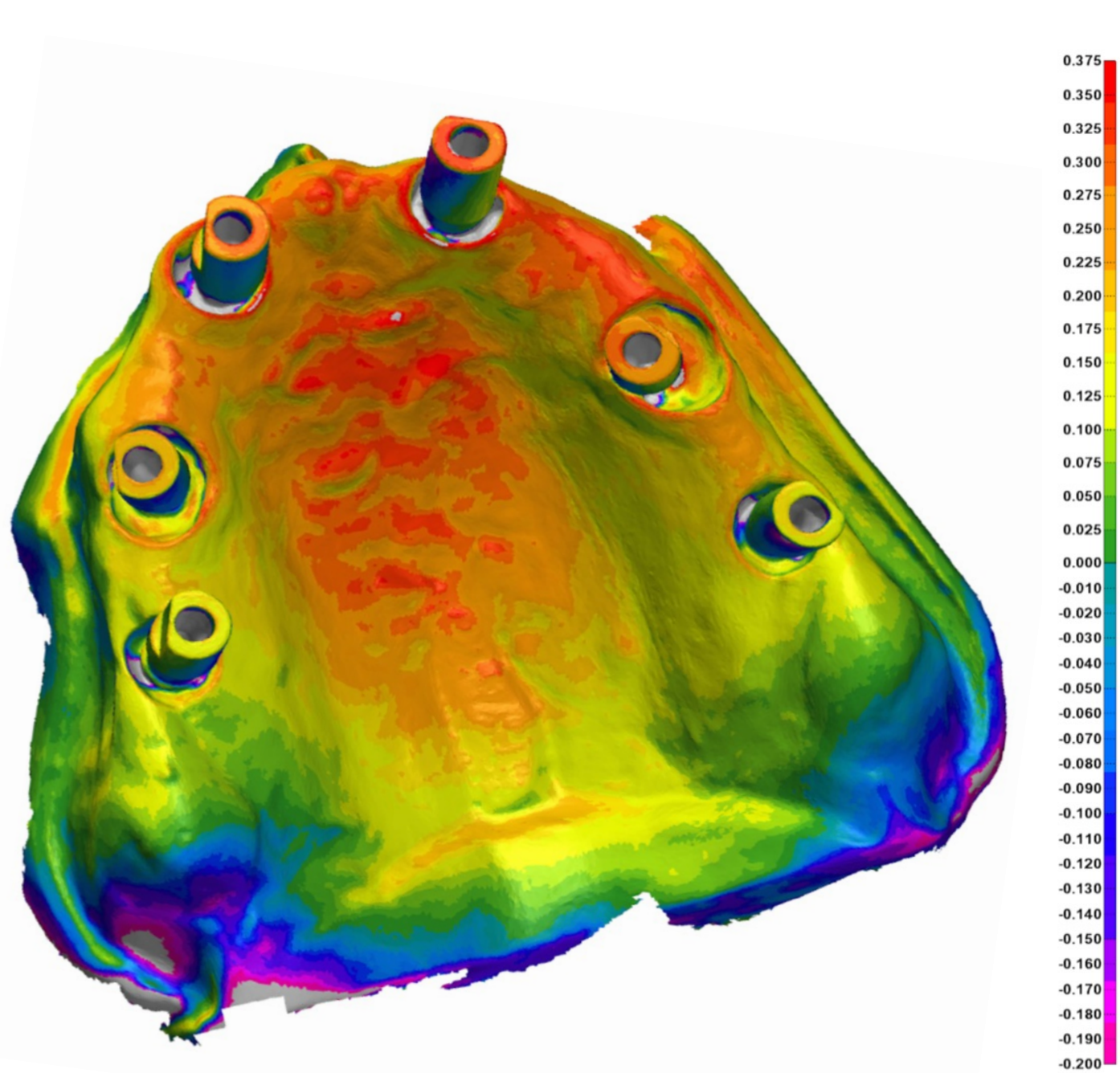


Fig. 6 Overall surface deviation heat map for Straumann/Trios map

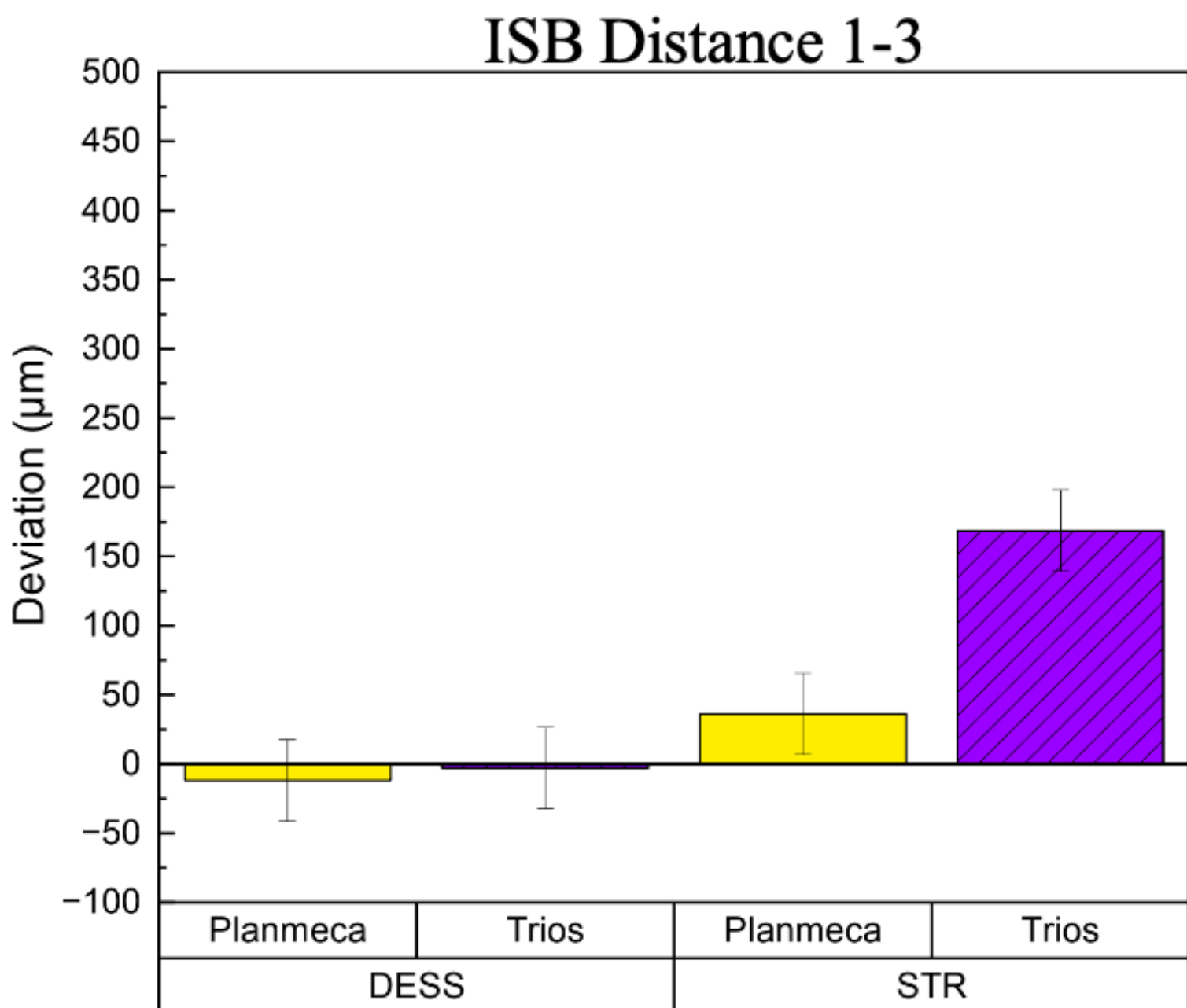


Fig. 7 ISB 1-3 linear deviation comparison

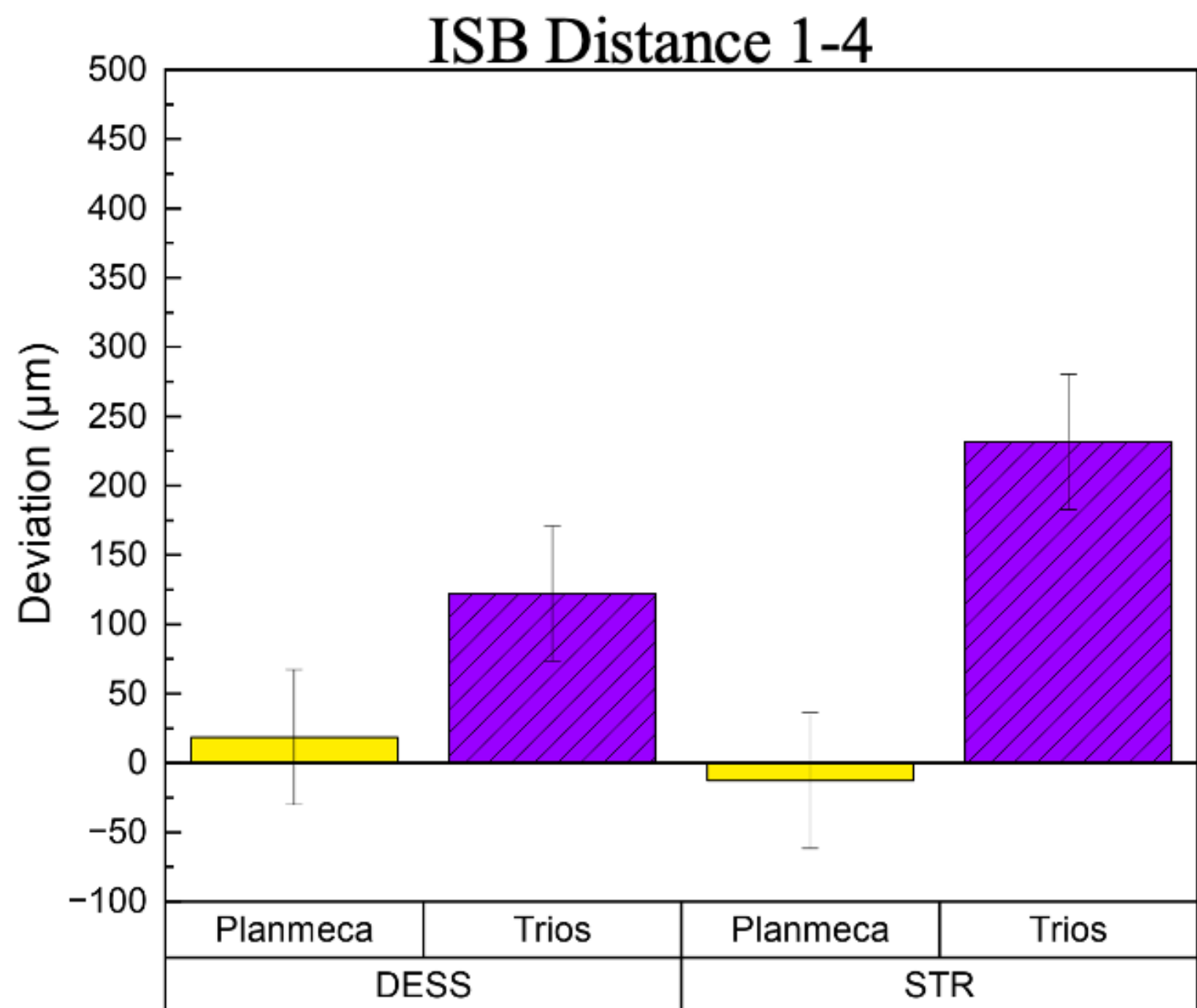


Fig. 8 ISB 1-4 linear deviation comparison

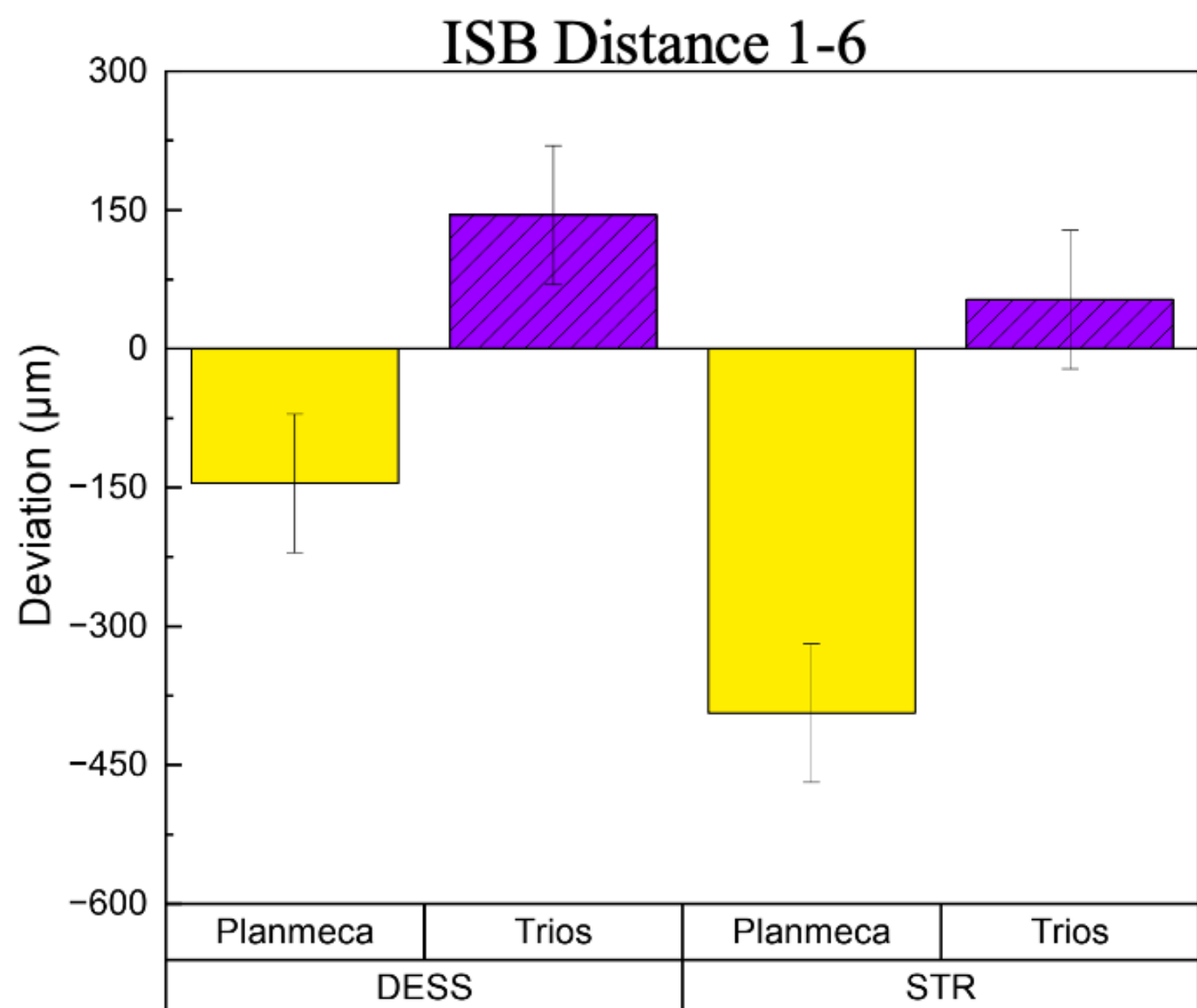


Fig. 9 ISB 1-6 linear deviation comparison

Table 1. Statistical Significance Levels of Deviation Comparisons by IOSs with Different ISBs

IOS	ISB 1-3	ISB 1-4	ISB 1-6
Planmeca	DESS (Less than STR) (p = 0.024)	p = 0.361	DESS (Less than STR) (p < 0.001)
Trios	DESS (Less than STR) (p < 0.001)	DESS (Less than STR) (p = 0.003)	p = 0.089

Table 2. Statistical Significance Levels of Deviation Comparisons by ISBs with Different IOSs

ISB	ISB 1-3	ISB 1-4	ISB 1-6
DESS	p = 0.659	Planmeca (Less than Trios, p < 0.001)	Trios (Less than Planmeca, p < 0.001)
Straumann	Planmeca (Less than Trios, p < 0.001)	Planmeca (Less than Trios, p < 0.001)	Trios (Less than Planmeca, p < 0.001)

Results

- At ISB distance 1-3, all groups produced clinically acceptable average deviations except Straumann ISB and the Trios IOS pair (Fig. 7).
- At ISB distance 1-4, regardless of ISB types, the Trios IOS produced greater linear deviations outside the clinically acceptable range (Fig. 8, Table 2).
- At ISB distance 1-6, All groups displayed linear deviations outside the clinically acceptable range, except for the Straumann ISB and Trios pair (Fig. 9).
- With the DESS ISB, the absolute linear deviation increased as the distance increased. The DESS ISB and Planmeca pair showed less deviation than the Straumann ISB with statistical significance (Table 1).
- There were no statistically significant differences in ISB angular deviations in all groups (Fig. 5).

Conclusions

Within the limitations of the study, the null hypothesis that there is no difference in accuracy with the ISB and IOS types is rejected. This study suggests that increasing the geometrical features of an ISB can improve the accuracy of the full-arch digital implant impression. DESS ISB performed better with both IOS types.

The accuracy of full-arch digital implant impressions can be influenced by the choice of intraoral scanner and the geometrical design of the implant scan body.

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References

