



A cross-over clinical study on the precision of digital intraoral scanning versus photogrammetry for implant rehabilitation of completely edentulous patients

AUTHORS: W. Negreiros, T. Sun, S. Jain, M. Finkelman, G. Gallucci, A. Hamilton



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William Matthew Negreiros, DMD, MSc

So...why digital?

Clinical Oral Investigations
<https://doi.org/10.1007/s00784-021-04157-3>

REVIEW



Intraoral scanning reduces procedure time and improves patient comfort in fixed prosthodontics and implant dentistry: a systematic review

Rafael Siqueira¹ · Matthew Galli¹ · Zhaozhao Chen¹ · Gustavo Mendonça² · Luiz Melrelles³ · Hom-Lay Wang¹ · Hsun-Liang Chan¹

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Abstract

Objectives The primary aim of this systematic review was to evaluate whether intraoral scanning (IOS) is able to reduce working time and improve patient-reported outcome measures (PROMs) compared to conventional impression (CI) techniques, taking into account the size of the scanned area. The secondary aim was to verify the effectiveness of IOS procedures based on available prosthodontic outcomes.

- Reduced procedure working time
- Improved clinical **efficiency**
- **Better patient experience** during impression procedures

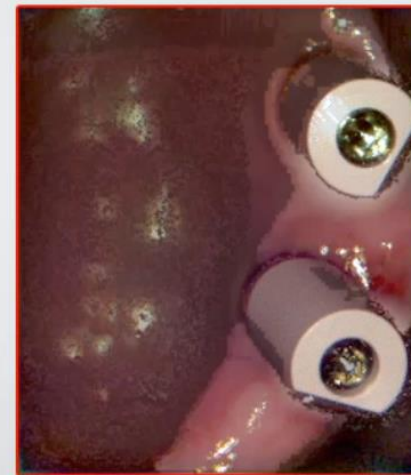
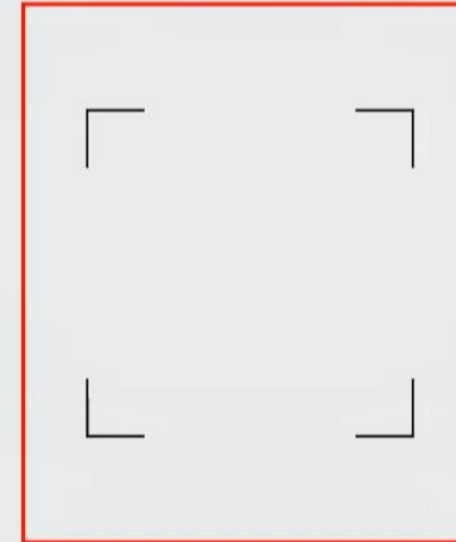
“...IOS are generally preferred by patients over conventional impressions.”

Implant Scanning of the Edentulous arch

00:02

3D images: 0

- Presence of **fixed keratinized mucosa**
- Soft and hard tissues need to be **dry**
- Addition of **unique topographical markers**
- Can be affected by tissue **thickness/implant depth** –
Digital impression copings need to be correct height



Implant Scanning of the Edentulous arch



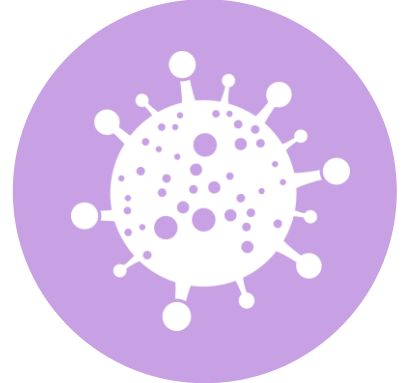
**Bar made for research purposes – Intraoral scanning*



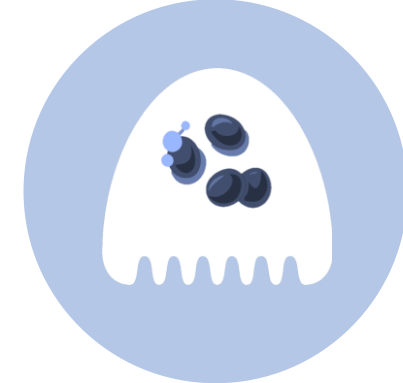
Introduction



Biological



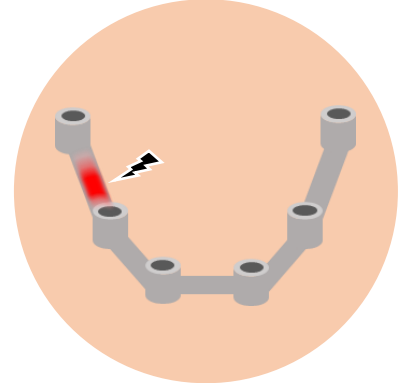
Bacterial accumulation



Bone remodeling



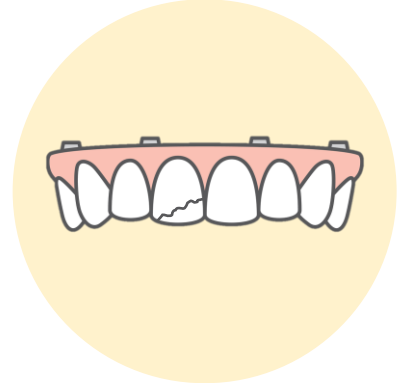
Mechanical



Framework Static stress



Screw loosening
Loss of function
Fracture



Chipping

Implications of implant framework misfit: a systematic review of biomechanical sequelae. Abduo J, Judge RB. Int J Oral Maxillofac Implants. 2014 May-Jun;29(3):608-21. doi: 10.11607/jomi.3418.

Introduction

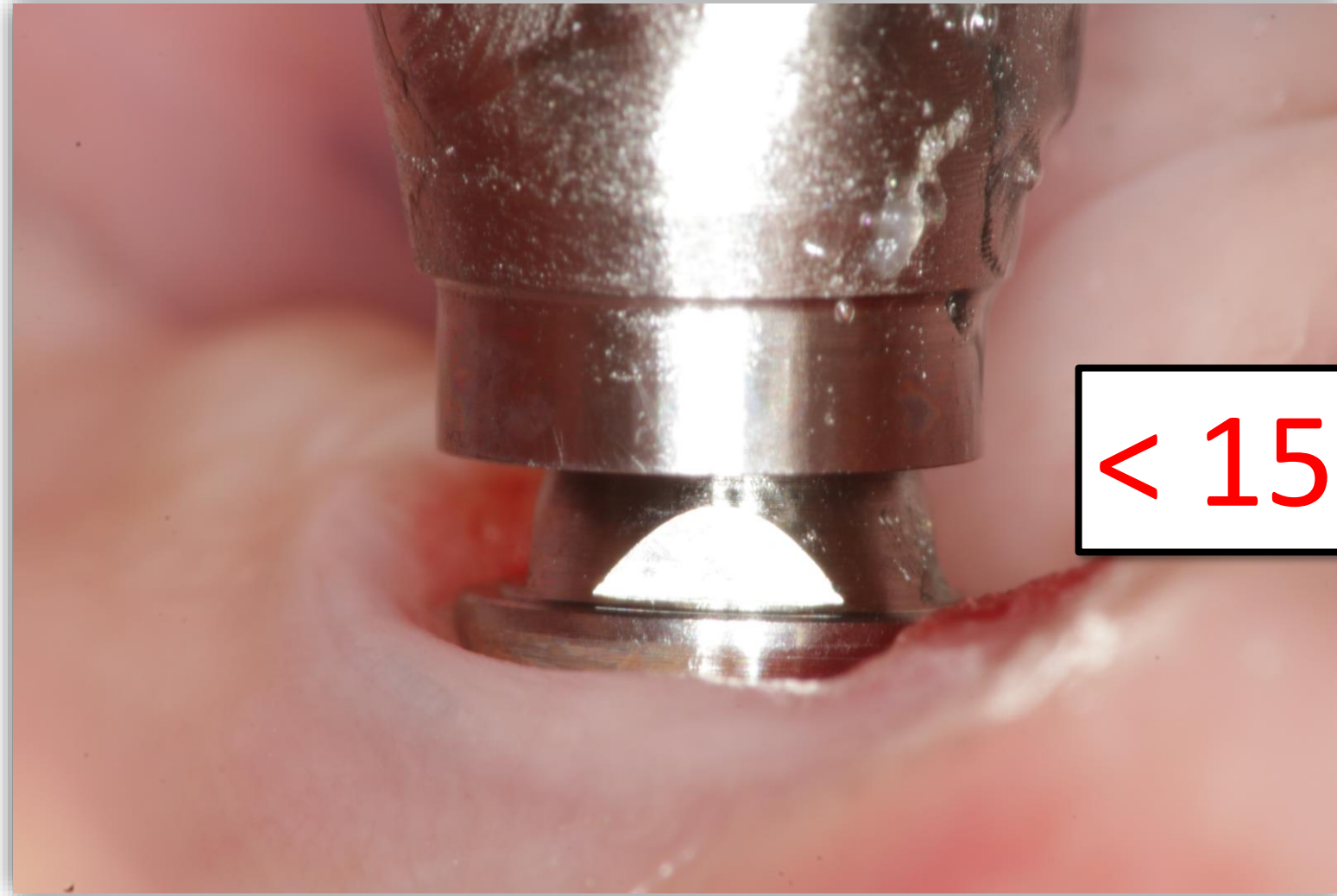


**Bar made for research purposes*

Defined as **simultaneous** and **even** contact of **all** the fitting surfaces, without the development of strains prior to functional loading.



Introduction



< 150µm



Review Article

Linear Accuracy of Intraoral Scanners for Full-Arch Impressions of Implant-Supported Prostheses: A Systematic Review and Meta-Analysis

Franciele Floriani^{1,2} Guilherme Carpena Lopes³ Alexandre Cabrera⁴ Wagner Duarte⁵
Panagiotis Zoidis⁴ Dayane Oliveira⁶ Mateus Garcia Rocha⁶

¹ Department of Periodontology, University of Florida College of Dentistry, Gainesville, Florida, United States

² Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil

³ Department of Dentistry, Federal University of Santa Catarina, Florianópolis, SC, Brazil

⁴ Division of Prosthodontics, Department of Restorative Dental Science, University of Florida, Gainesville, Florida, United States

⁵ Department of Periodontology, University of Florida, Gainesville, Florida, United States

⁶ Department of Restorative Dental Sciences, Center for Dental Biomaterials, College of Dentistry, Gainesville, Florida, United States

Address for correspondence Mateus Garcia Rocha, DDS, MSc, PhD, 1395 Center Drive, University of Florida College of Dentistry, Gainesville, FL 32610-0415, United States (e-mail: mrocha@dental.ufl.edu).

Eur J Dent

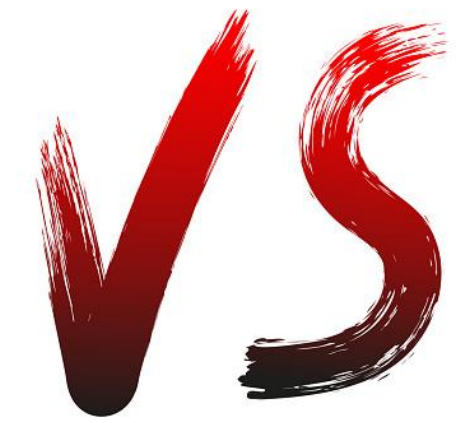
Abstract

This article compares the accuracy of intraoral scanners (IOSs) used in the digital impression of full arches to fabricate implant-supported complete prostheses. This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and was registered in the Open Science Framework (DOI 10.17605/OSF.IO/CPM9K). Six electronic databases, gray literature databases, and a

Introduction

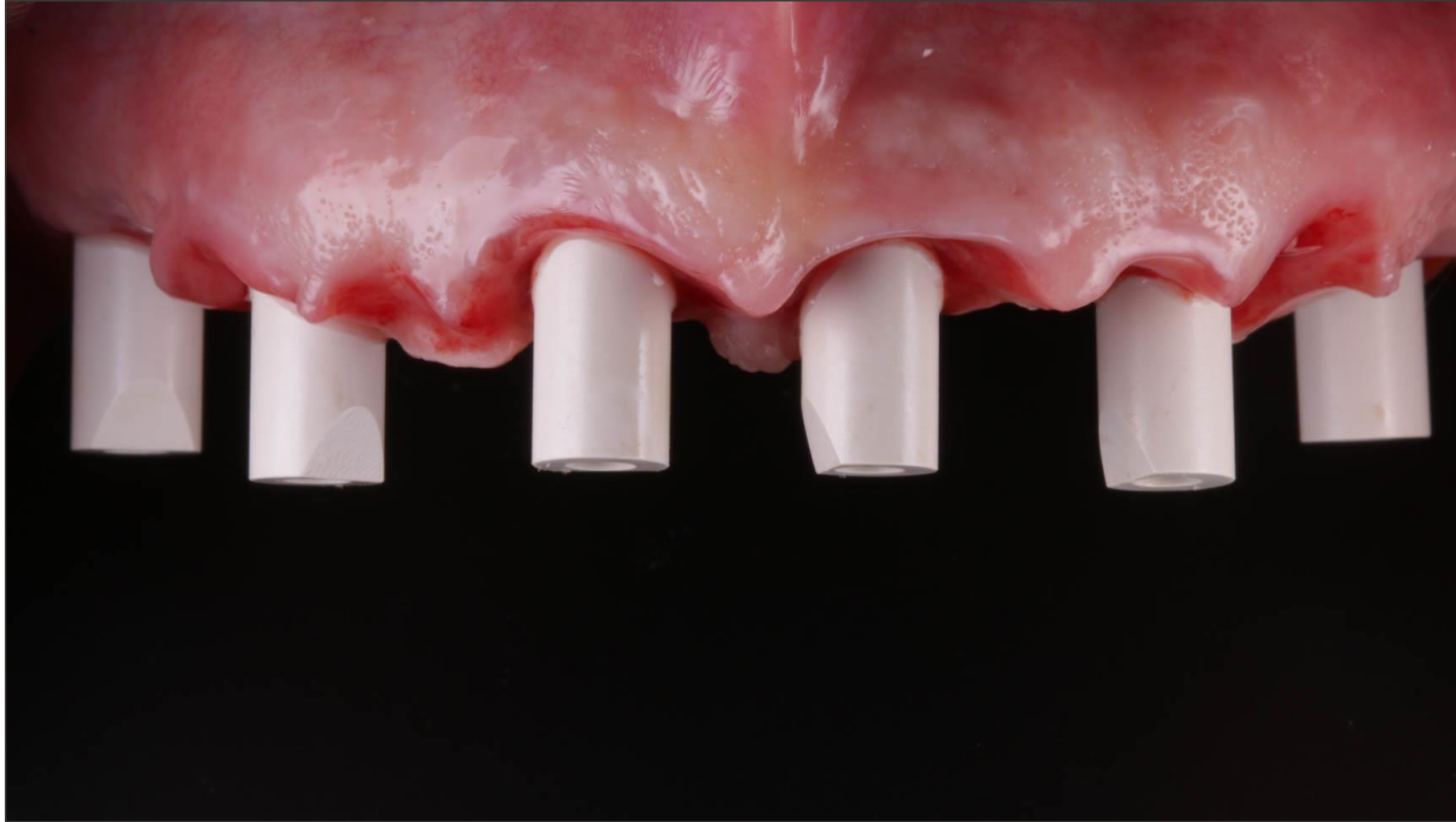


Intraoral Scanner

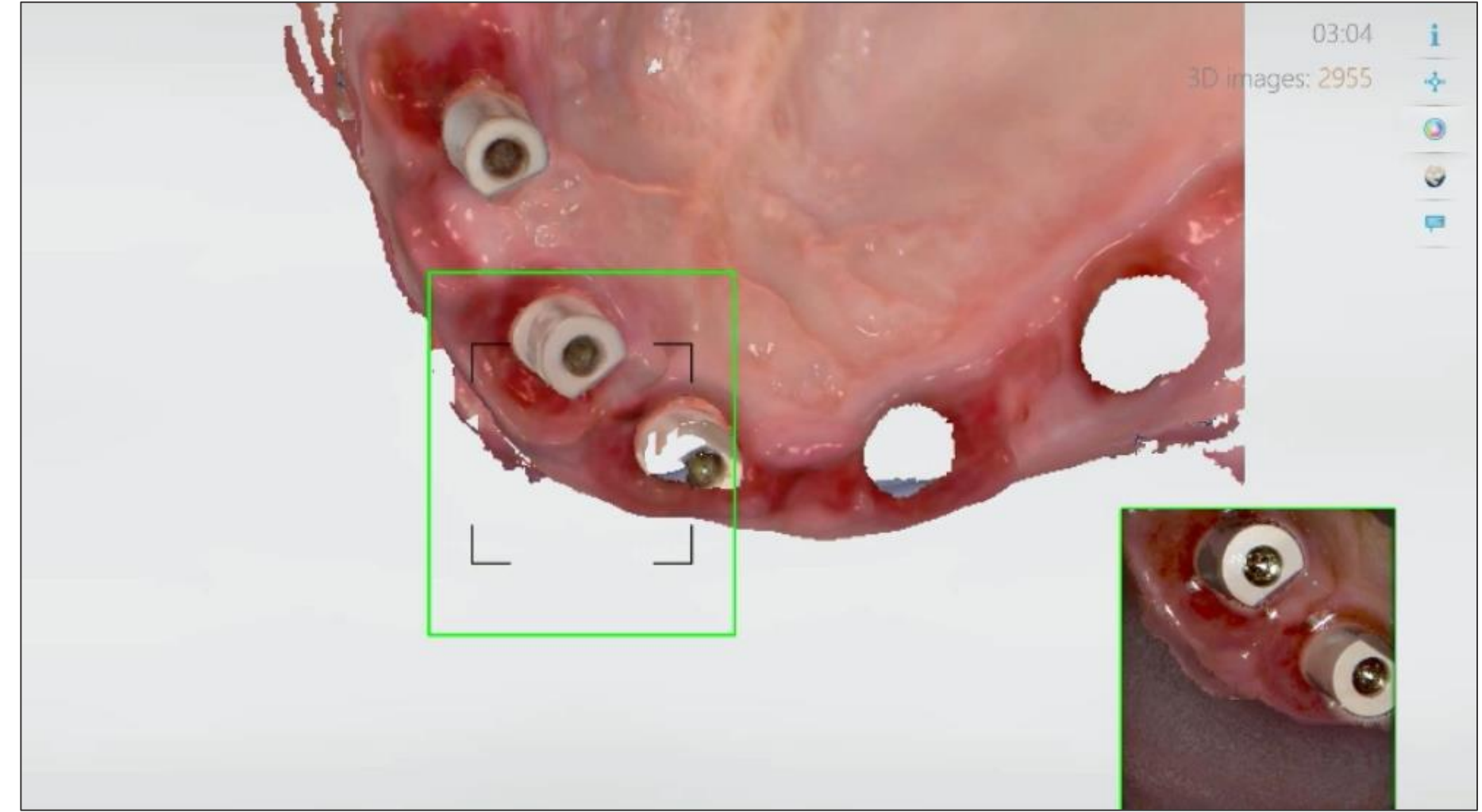


Photogrammetry

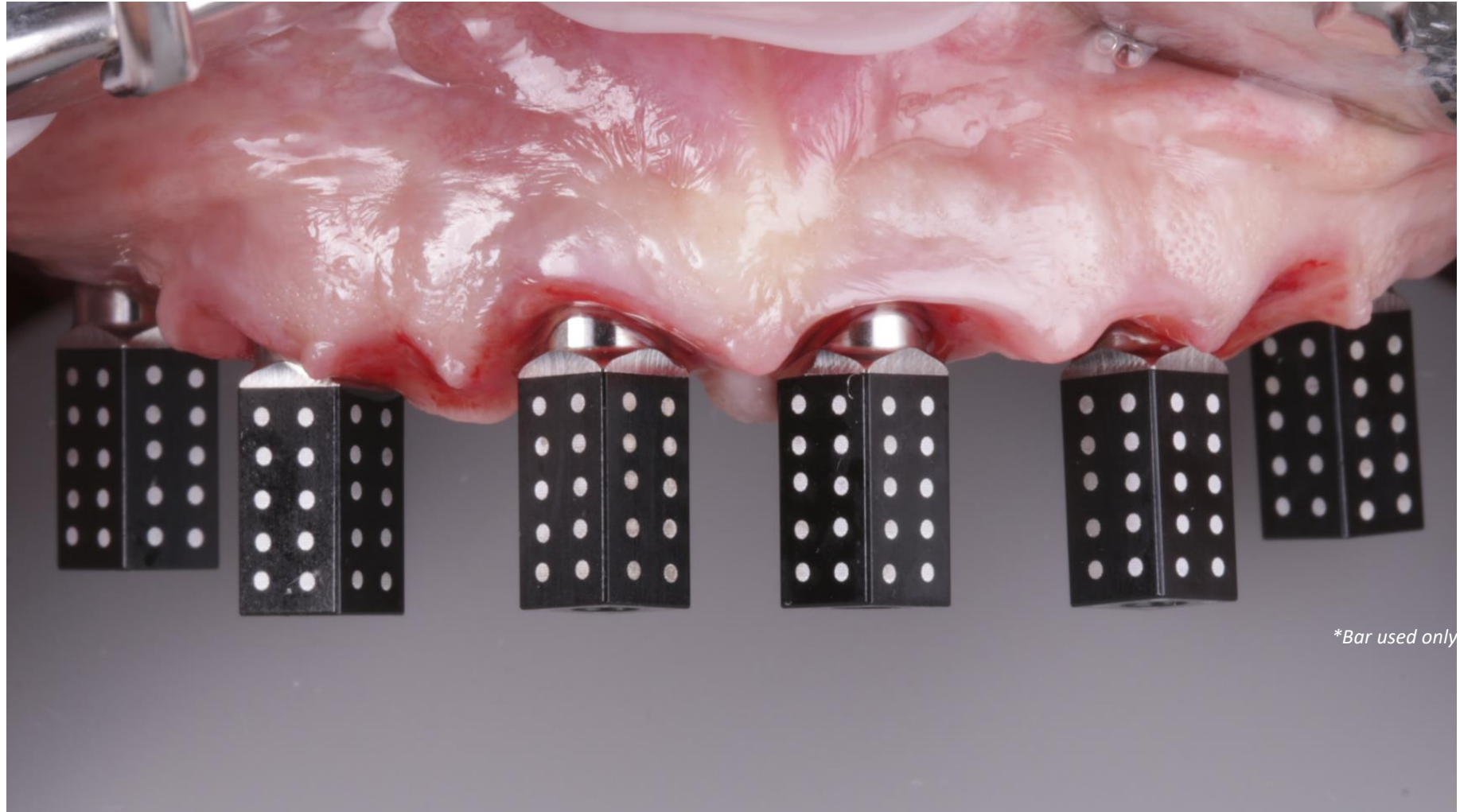
Introduction



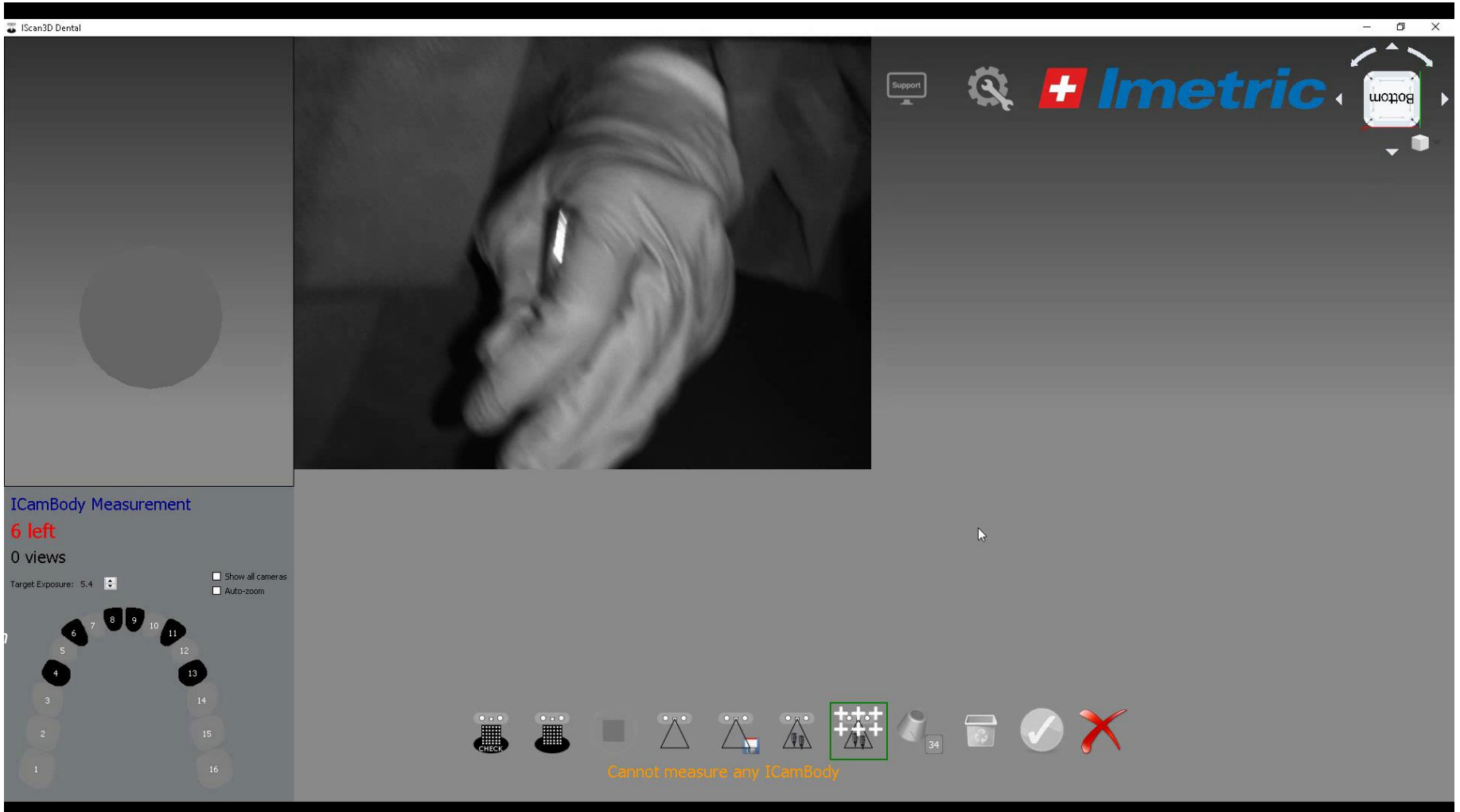
Intraoral Scanning



Introduction



Photogrammetry



Precision

- The closeness of agreement between independent test results obtained under stipulated condition.

Trueness

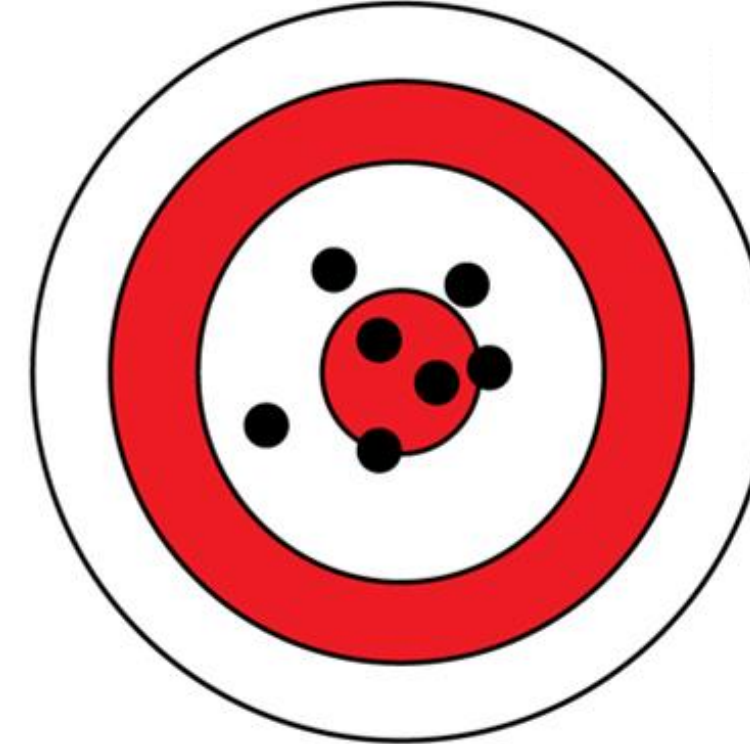
- “The closeness of agreement between the average value obtained from a large series of test results and an accepted reference value”

Accuracy

- “The closeness of agreement between a test result and the accepted reference value”



High Precision
Low Trueness



Low Precision
“Better” Trueness



High Precision
High Trueness

Study Objectives

1. Investigate the precision of **digital intraoral scanning** compared with **photogrammetry** in performing complete-arch digital implant impressions.
2. Investigate the influence of the **arch perimeter** and **jaw type** on the precision of both devices

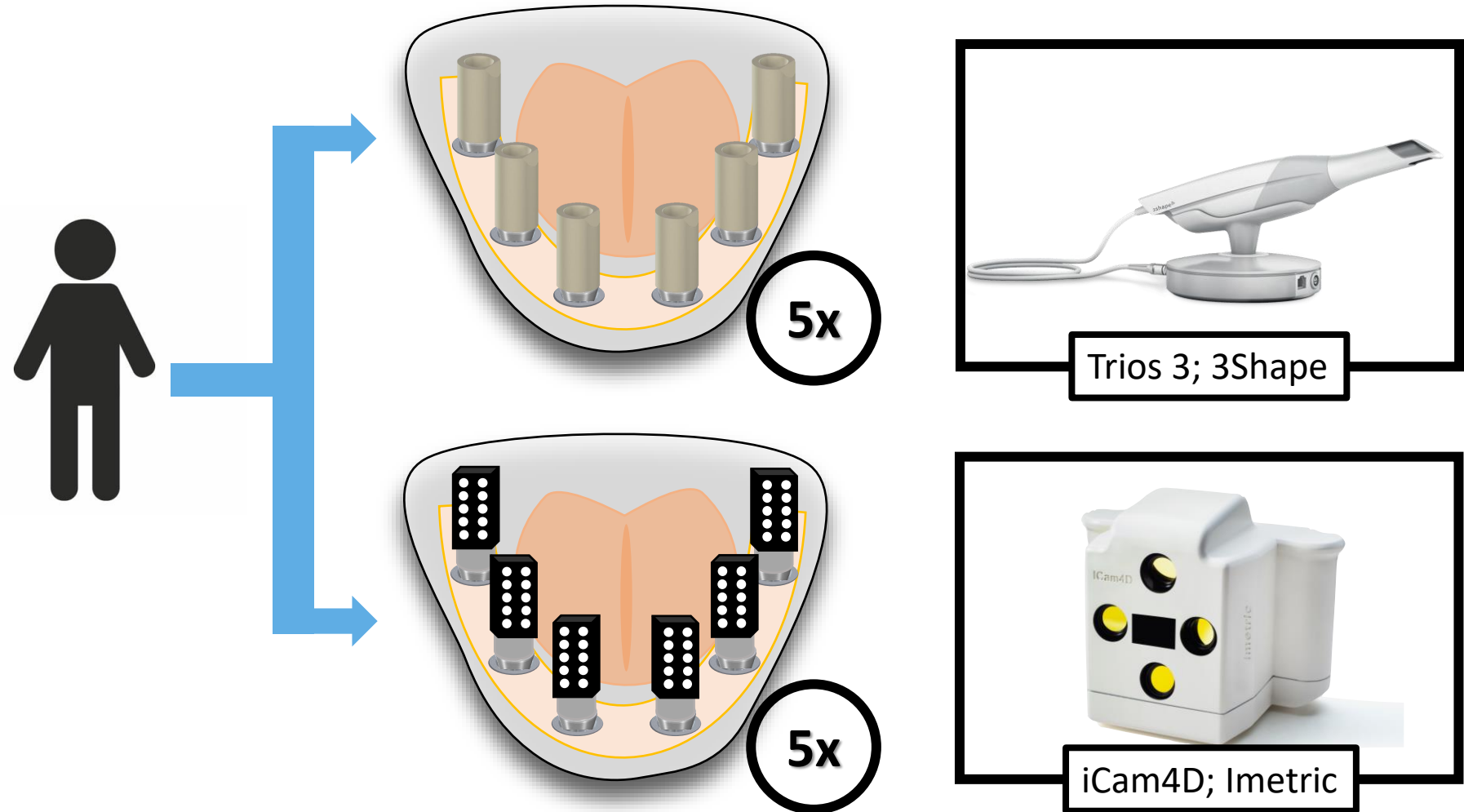
Inclusion Criteria

- Patients over 18-years of age.
- Edentulous spans greater than six teeth with at least four implants in a continuous edentulous site.
- Bone Level[®] implants with SRA abutments.

Exclusion Criteria

- Patients under 18-years of age.
- Edentulous spans shorter than six teeth.
- Unable to tolerate digital scans.
- Implants other than Bone Level[®].

Materials and Methods

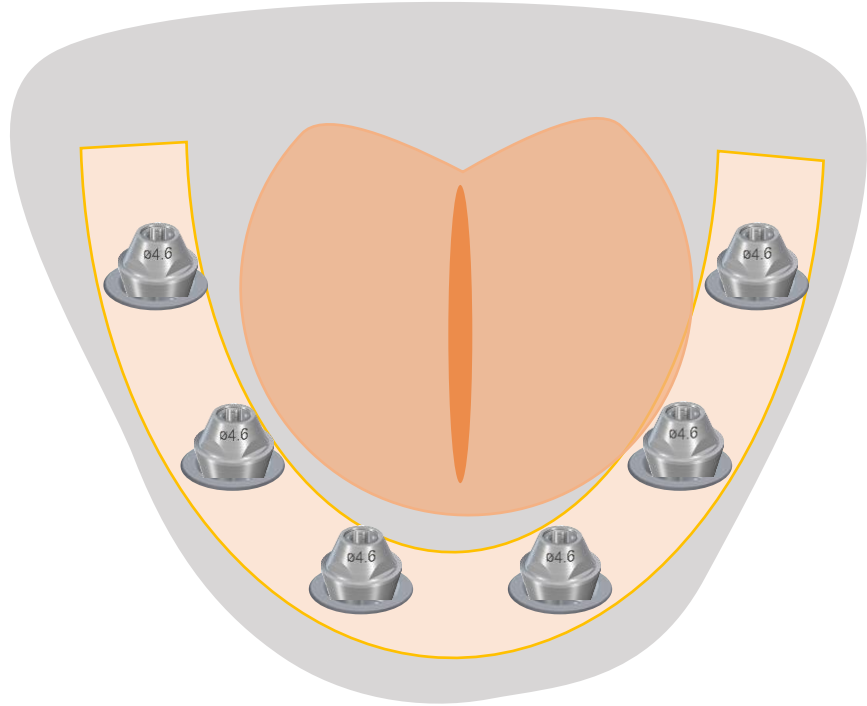


A total of 20 patients and 20 arches were included per group

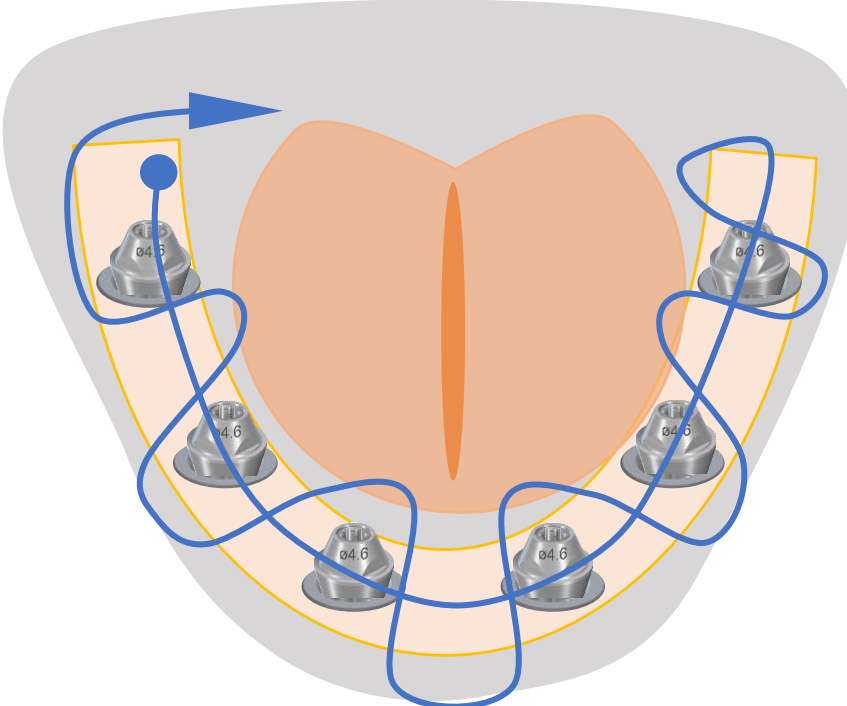
Materials and Methods

Intraoral scanning

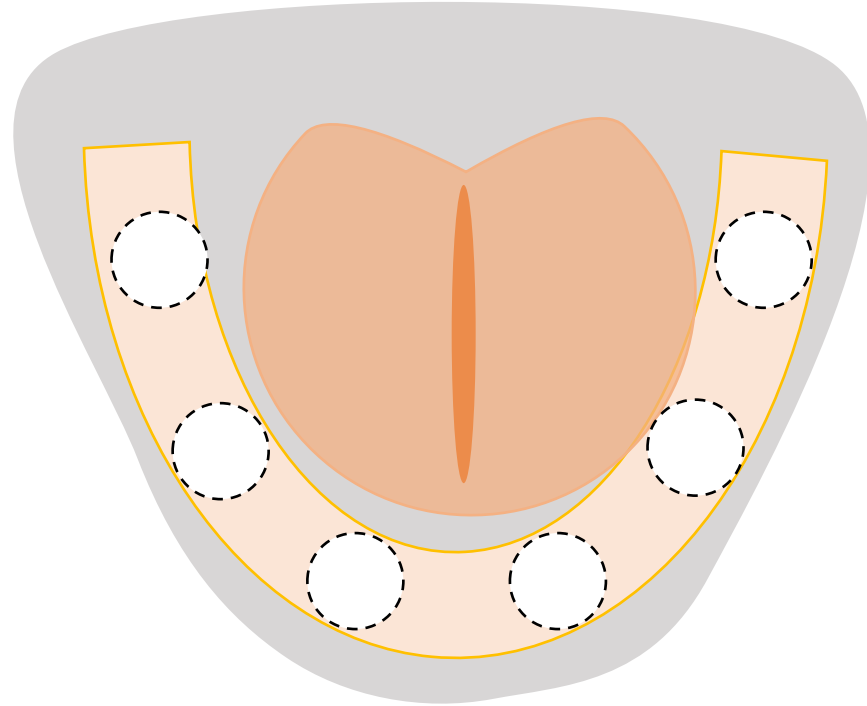
**Scanning pathway suggest by manufacturer*



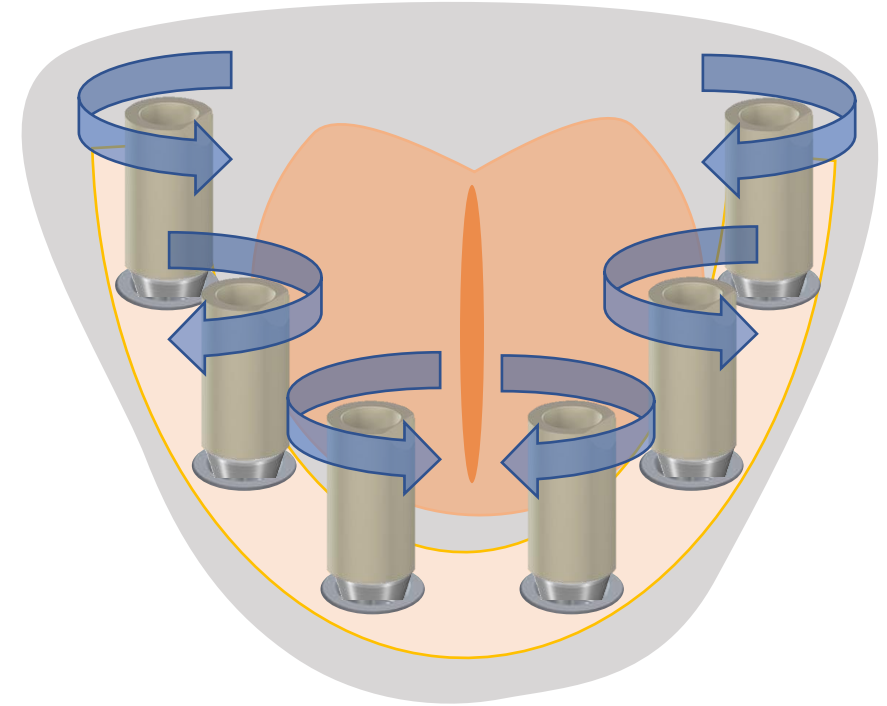
SRA Abutments



Scanning of the crest in a single pass



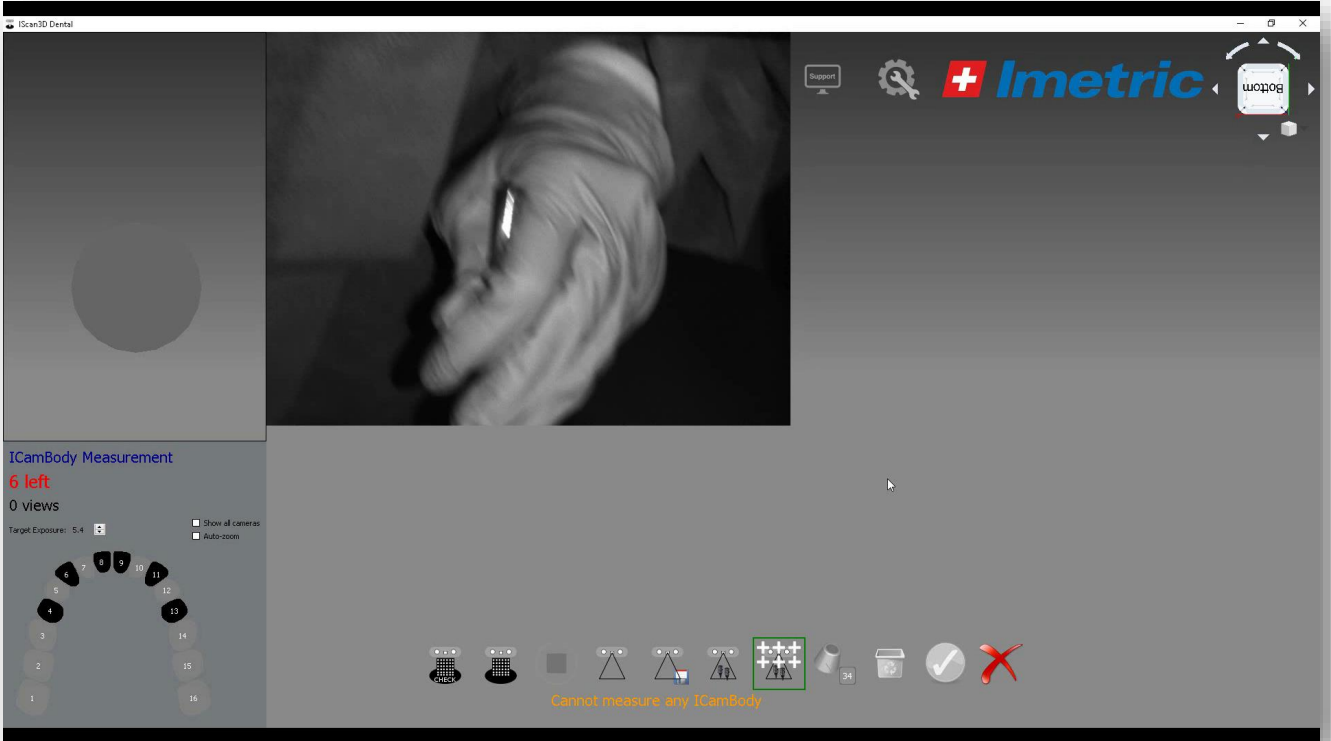
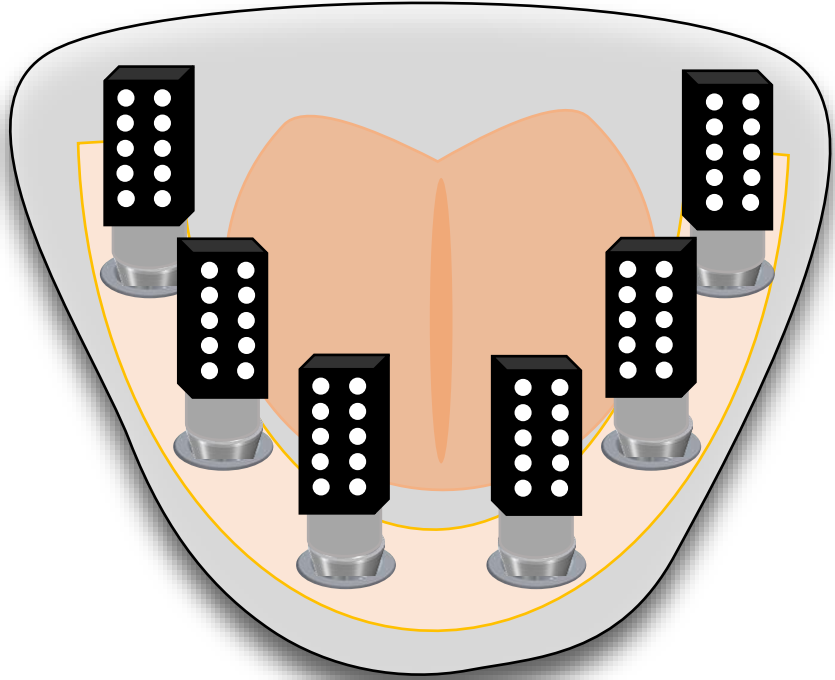
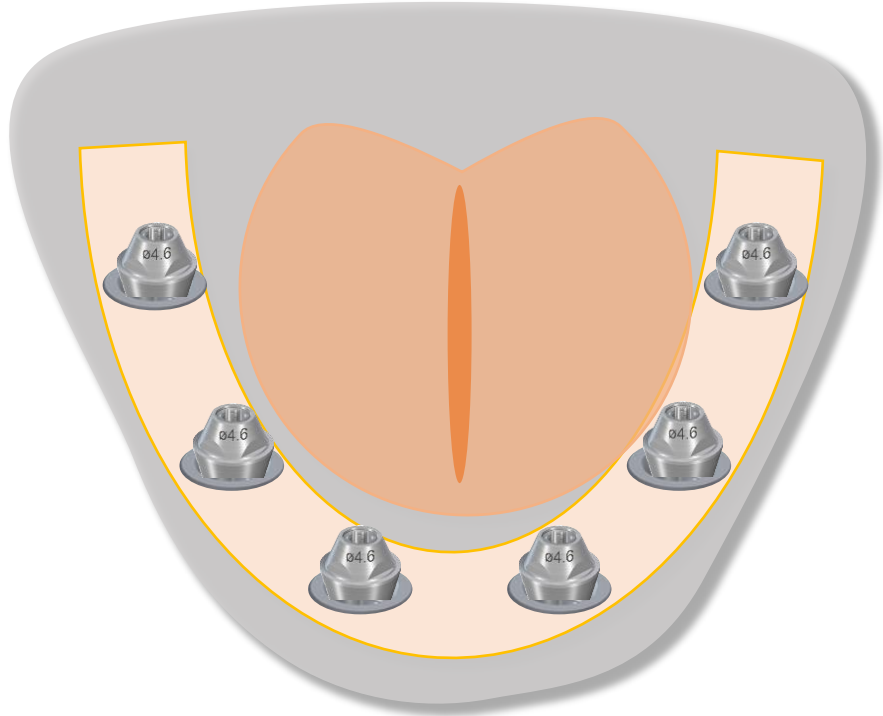
Cropped implant areas



Scanbody digital scan

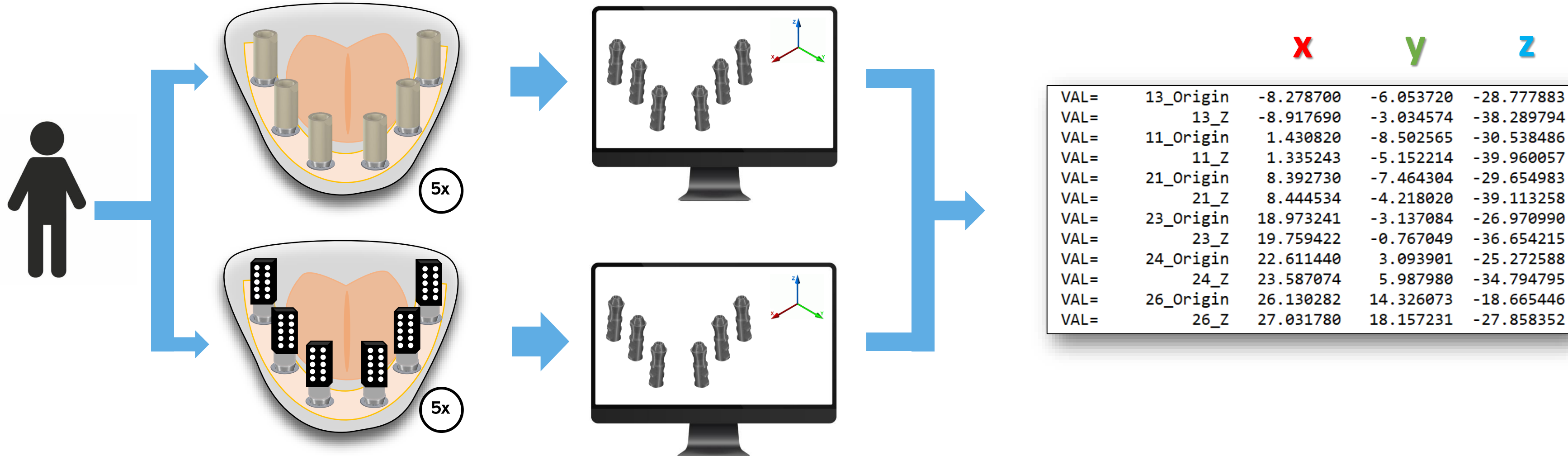
Materials and Methods

Photogrammetry scanning



Materials and Methods

Study Groups

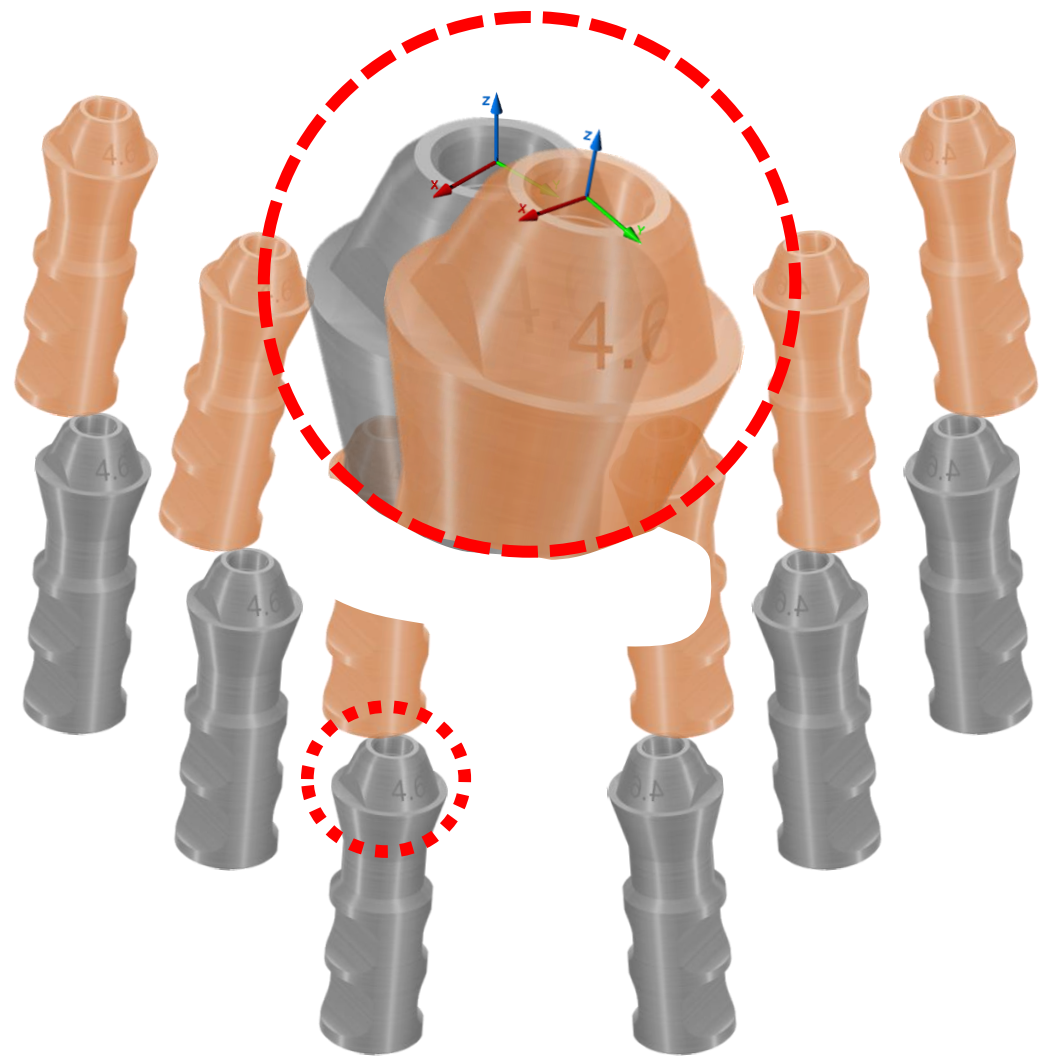


		X	Y	Z
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VAL=	13_Z	-8.917690	-3.034574	-38.289794
VAL=	11_Origin	1.430820	-8.502565	-30.538486
VAL=	11_Z	1.335243	-5.152214	-39.960057
VAL=	21_Origin	8.392730	-7.464304	-29.654983
VAL=	21_Z	8.444534	-4.218020	-39.113258
VAL=	23_Origin	18.973241	-3.137084	-26.970990
VAL=	23_Z	19.759422	-0.767049	-36.654215
VAL=	24_Origin	22.611440	3.093901	-25.272588
VAL=	24_Z	23.587074	5.987980	-34.794795
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VAL=	26_Z	27.031780	18.157231	-27.858352

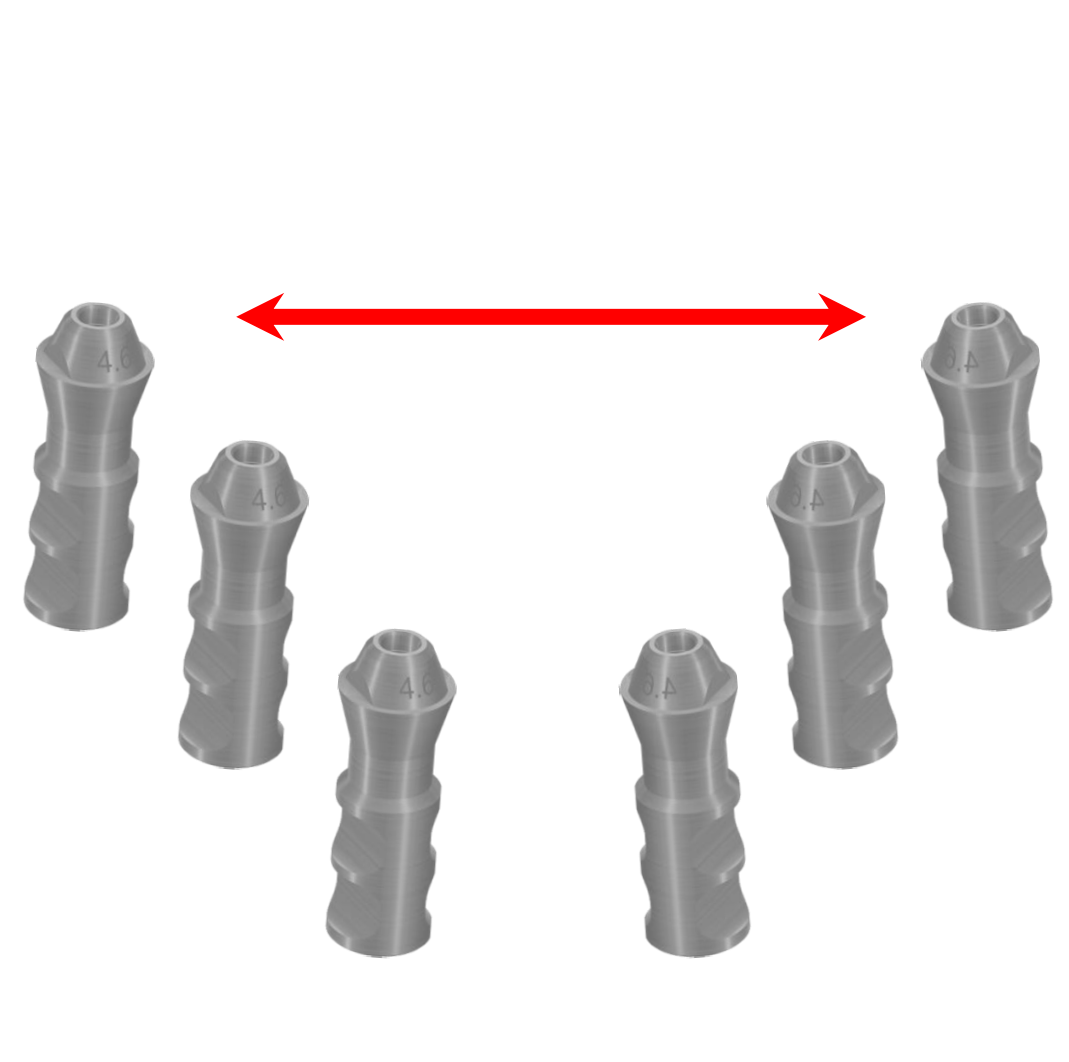
Materials and Methods

Transforming set
Reference set (Fixed)

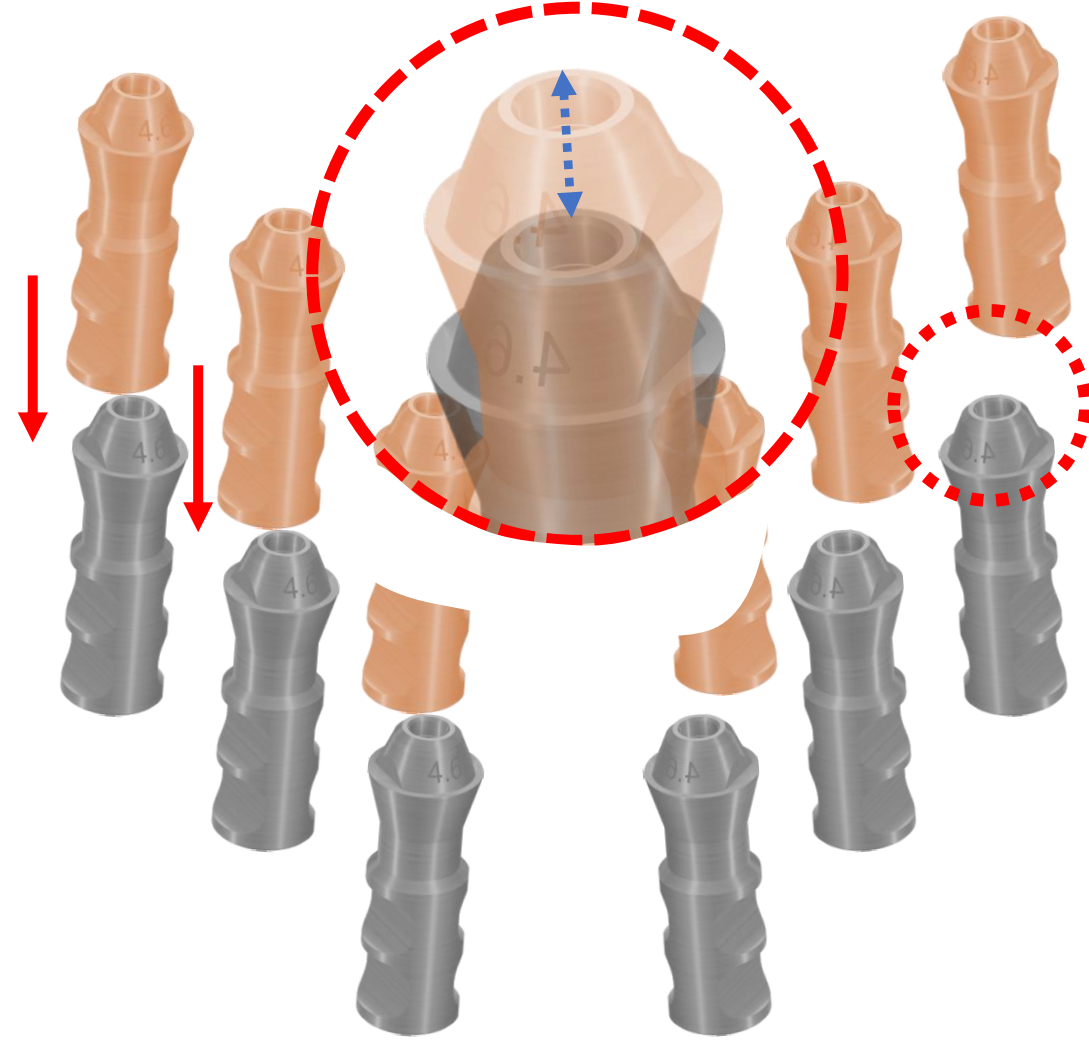
Spatial Fit



Cross-arch Distance





Virtual Sheffield Test



Materials and Methods

- A generalized estimating equation (GEE) analysis was used to evaluate the association between scanner and 3D distance.
- GEE was also used to analyze the association between jaw type, arch perimeter and average deviation.
- The significance level was set at $\alpha = 0.05$.

Results		<i>Overall Precision – Average deviations</i>					
		<u>Spatial Fit</u>		<u>Cross-arch Distance</u>		<u>Virtual Sheffield Test</u>	
	<p>Mean: 7µm</p> <p>Max: 18µm</p>						
	<p>Mean: 61µm</p> <p>Max: 371µm</p>						

Spatial Fit

Cross-arch Distance

Virtual Sheffield Test

Mean: 7µm

Max: 18µm

P<.0001

Mean: 61µm

Max: 371µm

Mean: 10µm

Max: 68µm

P<.0001

Mean: 89µm

Max: 416µm

Mean: 38µm

Max: 173µm

P<.0001

Mean: 447µm

Max: 2963µm

Results

Effect of *arch type* – Average deviations

Spatial Fit

Cross-arch Distance

Virtual Sheffield Test



Mandible

Mean: 8 μ m

Max: 39 μ m

Maxilla

Mean: 6 μ m

Max: 43 μ m

P=0.1675

Mandible

Mean: 14 μ m

Max: 68 μ m

Maxilla

Mean: 8 μ m

Max: 35 μ m

P=0.1385

Mandible

Mean: 42 μ m

Max: 136 μ m

Maxilla

Mean: 36 μ m

Max: 173 μ m

P=0.6177



Mandible

Mean: 95 μ m

Max: 312 μ m

Maxilla

Mean: 51 μ m

Max: 371 μ m

P=0.0408

Mandible

Mean: 122 μ m

Max: 323 μ m

Maxilla

Mean: 77 μ m

Max: 416 μ m

P=0.0264

Mandible

Mean: 722 μ m

Max: 2963 μ m

Maxilla

Mean: 349 μ m

Max: 1562 μ m

P=0.019

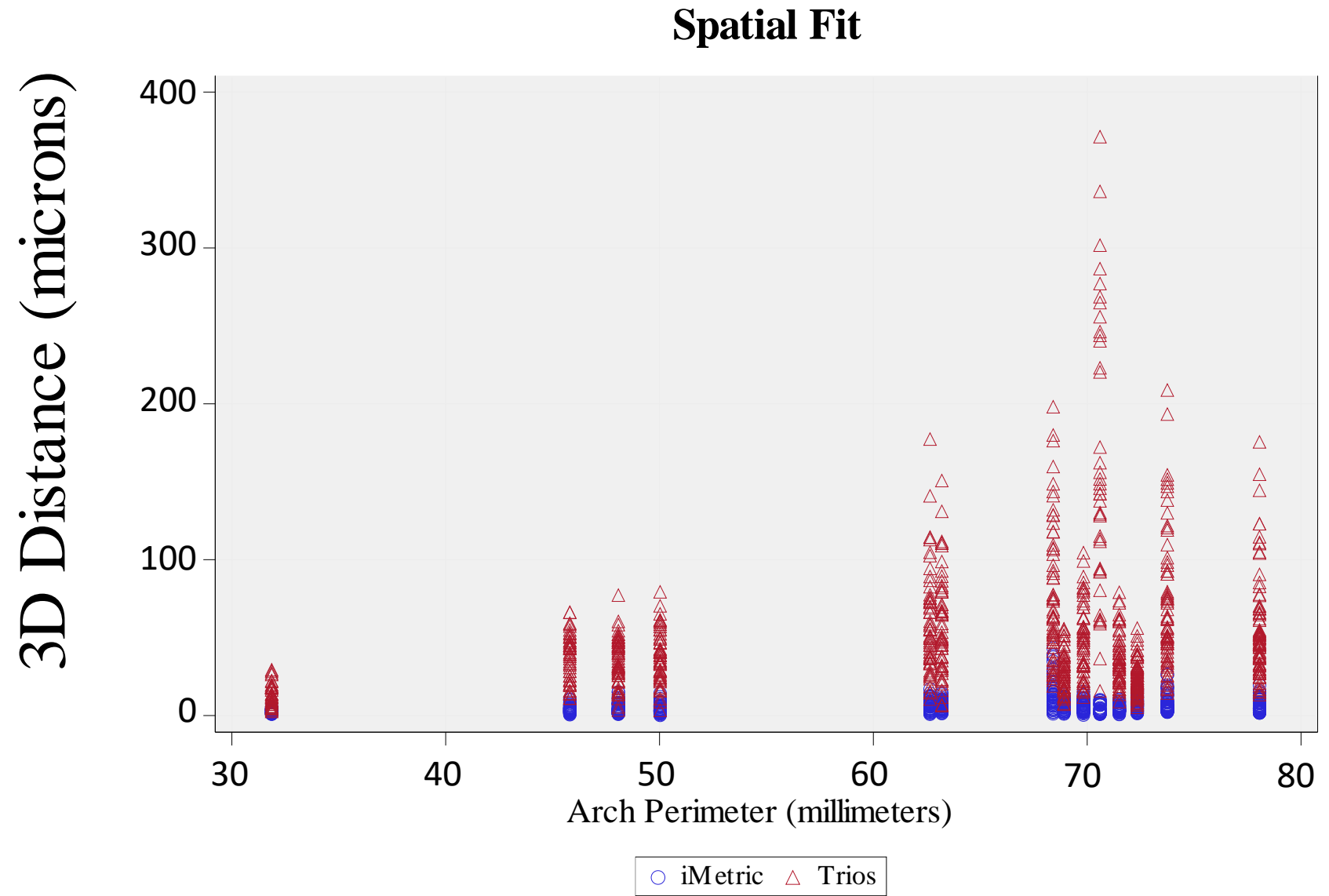


Table 1. Generalized Estimating Equations (GEE) to assess the association of 'Arch Perimeter' with spatial fit 'average 3D distance' for Imetric and Trios groups.

Analysis of GEE Parameter estimates						
Empirical Standard Error Estimates						
Scanner	Estimate	Standard Error	95% Confidence Limits		P-Value ¶	P-Value ¥
iMetric	0.0192	0.0023	0.0147	0.024	<.0001	<.0001
Trios	0.0257	0.0033	0.0192	0.032	<.0001	<.0001

¶: The P-Value is a comparison within groups (same row)

¥: The P-Value is a comparison between groups

Results

Effect of Arch Perimeter – 3D deviations

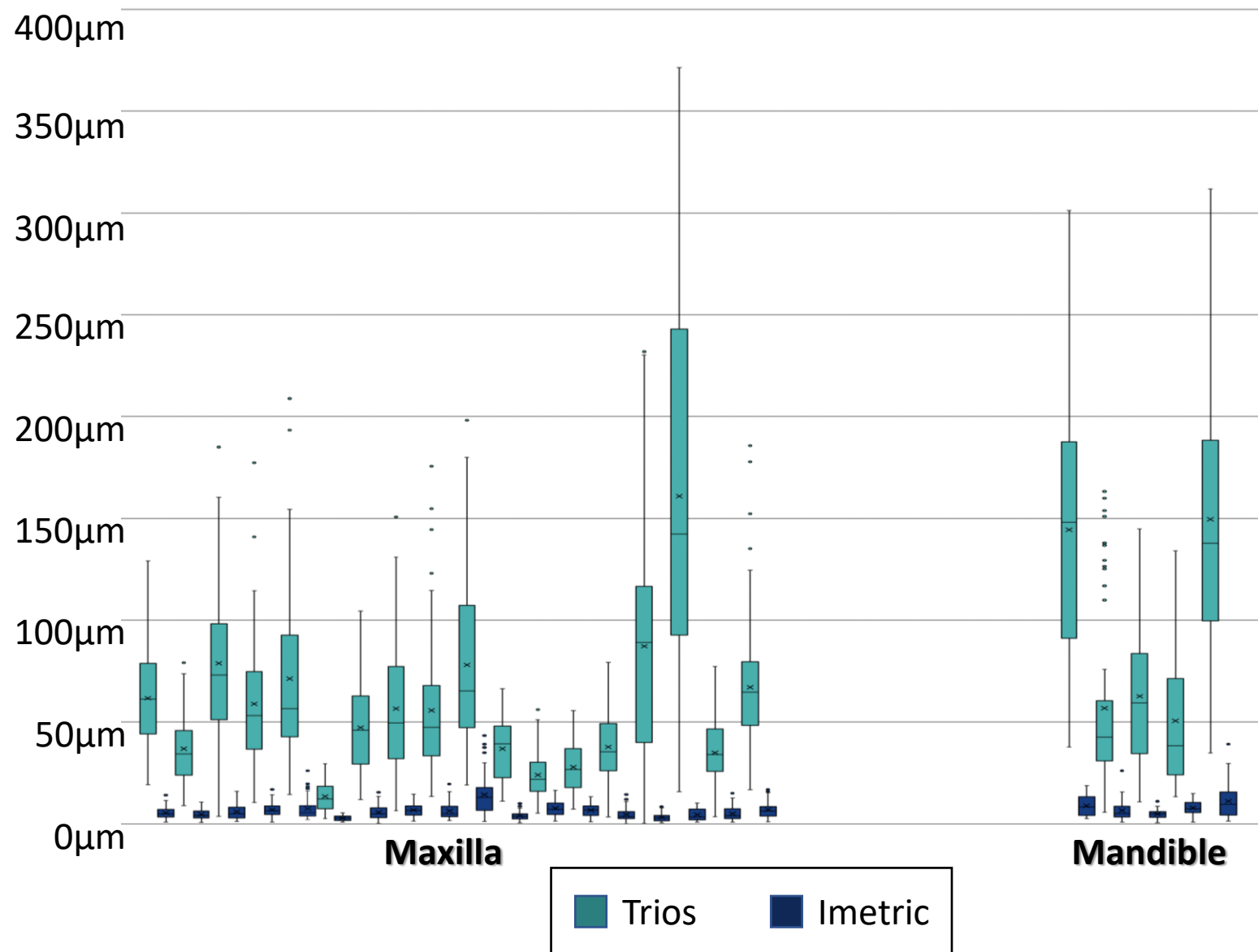


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Conclusion

Within the limitations of this clinical study, the following can be concluded:

- 1 – **Photogrammetry** demonstrated higher precision compared to intraoral scanning.
- 2 – When evaluating mean and maximum deviations, only photogrammetry demonstrated clinically acceptable precision.
- 3 – Maxillary scans are associate with better precision. However, statistical significance was only found in the intraoral scanning group.
- 4 – Precision was negatively affected as the arch perimeter increased, regardless of the device used.



Thank you



William Negreiros

