



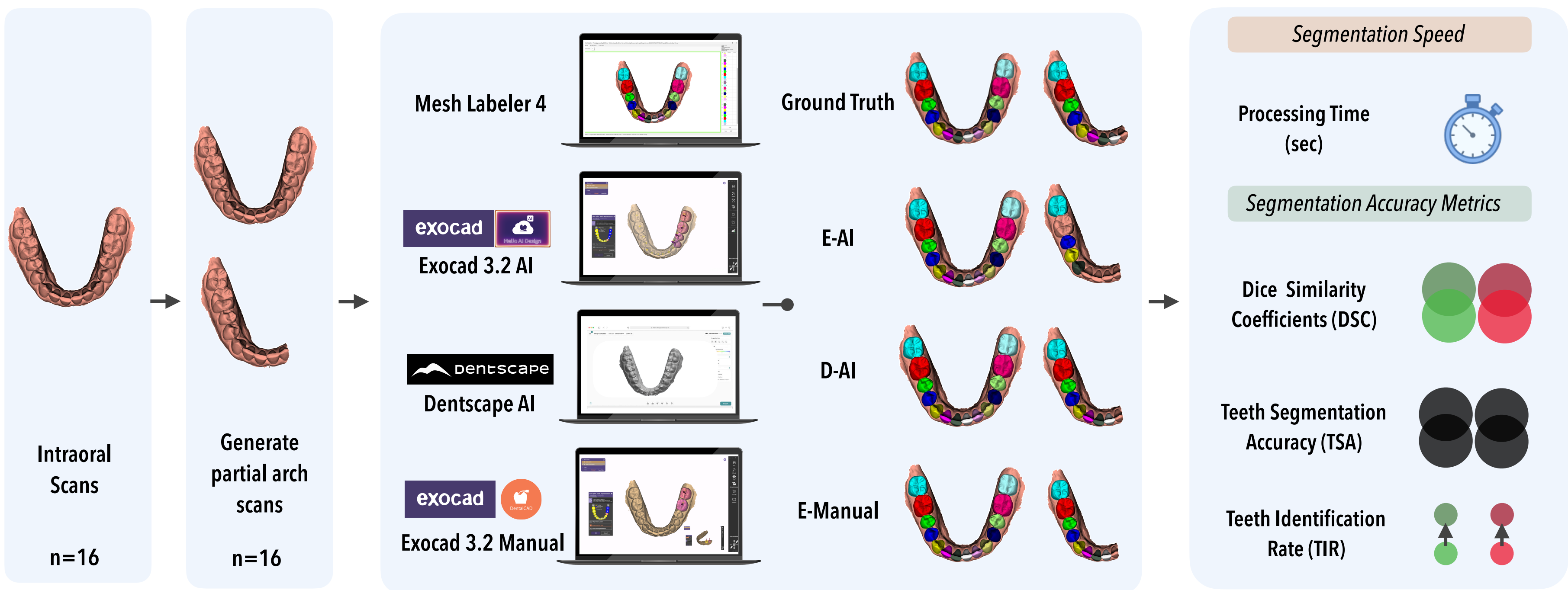
Background

The accuracy and speed of tooth segmentation strongly influence how effectively intraoral scans can be utilized in digital dental workflows.^{12,24,14} Partial-arch intraoral scans are often preferred when fabricating short-span fixed dental prostheses due to their higher accuracy and efficiency.^{1,6,9,11,15,16,21} However, since most deep-learning algorithms are trained on complete-arch orthodontic datasets, their performance on partial-arch intraoral scans remain unclear.¹⁰

Objectives

This study compared the processing time and the accuracy of three segmentation methods on complete- and partial-arch intraoral scans. The null hypothesis is that there are no significant differences between complete- and parital- arch scans, and that there are no differences between each segmentation method.

Materials and Methods



- Sixteen complete-arch scans (13-16 teeth) acquired with intraoral scanners (Trios 3; 3Shape) were randomly cropped with Python/VTK to generate matched partial-arch (5-8 teeth) datasets

- Ground-truth meshes were labelled in MeshLabeler by consensus of two prosthodontic residents.
- Each dataset was segmented using two deep-learning algorithms and one manual method: Exocad-AI (E-AI), a commonly used computer-aided design (CAD) software; DentScape-AI (D-AI), a cloud-based engine; and Exocad-Manual (E-Manual).
- Processing time was measure with a timer, and segmented results were exported for comparison with the ground-truth references.

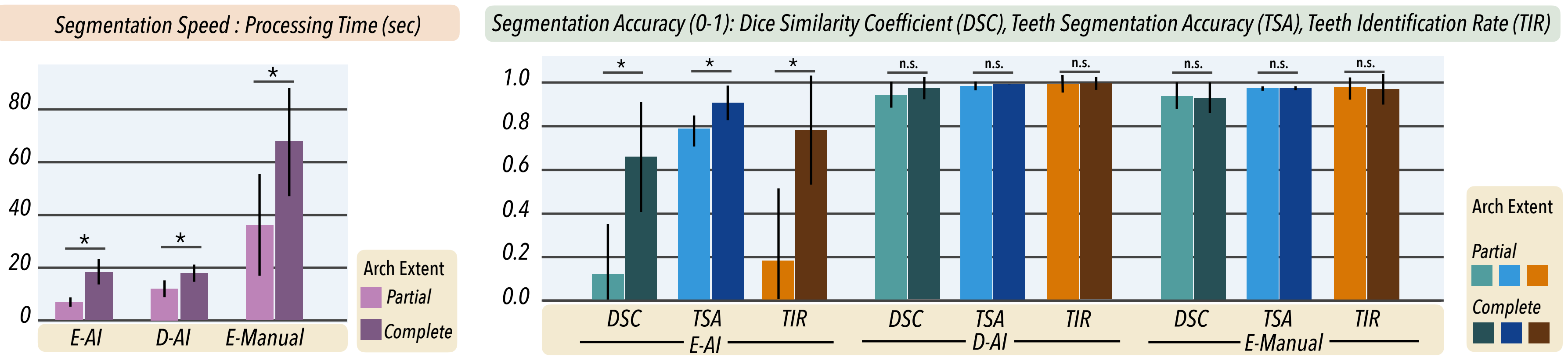
- Segmentation accuracy metrics, including DSC, TSA, and TIR, were computed.^{2,8,20}
- Paired t-tests were used to evaluate the effect of scan extent, and one-way analysis of variance (ANOVA) was used to compare the three methods within each scan type ($\alpha = 0.05$).

Results

Processing time increased significantly from partial- to complete-arch scans for all three methods ($p < 0.05$). Regarding segmentation accuracy, E-AI showed a significant difference in DSC, TSA, and TIR values between scan extents ($p < 0.05$), whereas D-AI and E-Manual did not ($p > 0.05$). Across both scan extents, E-AI yielded significantly lower DSC, TSA, and TIR values than D-AI and E-Manual ($p < 0.05$), but completed segmentation faster than E-manual ($p < 0.05$).

Method	Arch Extent	n	Time (s)	DSC (0-1)	TSA (0-1)	TIR (0-1)
E-AI	Partial	16	6.97 ± 1.79 ^a	0.12 ± 0.23 ^a	0.79 ± 0.07 ^a	0.18 ± 0.33 ^a
	Complete	16	18.4 ± 4.8 ^{a*} ($p < 0.001$)	0.66 ± 0.25 ^{b*} ($p < 0.001$)	0.91 ± 0.08 ^{b*} ($p = 0.001$)	0.78 ± 0.25 ^{b*} ($p = 0.001$)
D- AI	Partial	16	12.3 ± 3.1 ^a	0.94 ± 0.06 ^c	0.98 ± 0.02 ^c	0.99 ± 0.04 ^c
	Complete	16	17.9 ± 3.1 ^{a*} ($p < 0.001$)	0.97 ± 0.05 ^c ($p = 0.180$, NS)	0.99 ± 0.00 ^c ($p = 0.190$, NS)	0.99 ± 0.03 ^c ($p = 0.880$, NS)
E-Manual	Partial	16	36.3 ± 19.3 ^c	0.94 ± 0.06 ^c	0.98 ± 0.01 ^c	0.98 ± 0.05 ^c
	Complete	16	67.8 ± 20.4 ^{c*} ($p < 0.001$)	0.93 ± 0.07 ^c ($p = 0.420$, NS)	0.98 ± 0.01 ^c ($p = 0.770$, NS)	0.97 ± 0.07 ^c ($p = 0.350$, NS)

Asterisks (*) indicates significant difference ($p < 0.05$) under paired t-test (partial vs full). Superscripts (^a,^b,^c) indicates Tukey HSD post-hoc groupings (between different methods).



Discussion

Current deep learning algorithms can achieve manual-level segmentation accuracy with significant reduced processing time. However, their accuracy might differ between complete- and partial-arch scans, and the impact of scan extents on accuracy varies across algorithms. Future work could expand to include more diverse scans and additional AI segmentation tools for broader benchmarking.

Conclusion

Our findings highlight the efficiency of AI segmentation compared to manual methods, while revealing potential accuracy limitations in partial-arch scans. Incorporating partial-arch datasets into AI algorithm training will be critical to ensure reliable clinical application in prosthodontics, and clinicians should be cautious of possible accuracy deficit when segmenting partial-arch intraoral scans.

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References

