Clinical Precision, Operator Experience and Software Accuracy in Guided Endodontics

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Objectives:

It is the aim of guided endodontics to increase the clinical safety by minimal loss of crown and root dentin, minimizing the risk of perforation, and optimizing the obturation of minimal invasive treatment. Therefore, (i) clinical precision, (ii) new software accuracy, and (iii) operator experience of experts vs. novices are decisive for new SICAT ENDO approaches.

Material and Methods:

From a TrueJaw model (DeLabs, Santa Barbara, USA), 3D X-ray images with CBCT Orthophos SL (Dentsply Sirona, Bensheim, Germany) were virtually connected with optical occlusal scans with CEREC Omnicam (Dentsply Sirona).Then the access pathway with 1.2 mm drill diameter was planned with software SICAT ENDO (SICAT, Bonn, Germany), and the template (SICAT ACCESSGUIDE) was produced. Following a briefing of subjects with (n = 12) and without clinical experience (n = 9) in guided treatments with templates, the endodontic access pathways were performed. The clinical simulation was executed on phantom heads with the typodonts in anatomical position, supported by chair assistance for fixation of the template and suction. The access depths were between 15.2 and 24.0 mm. The accuracy of the endodontic channel was determined by a new CBCT measurement system in mesio-distal and bucco-oral direction to the axial layer.

Results:

The accuracy of the planning was reproduced by the second CBCT control recording assessing between 0.03 mm (mesial-distal) and 0.04 mm (buccal-oral) differences. The overall median deviation was 0.045 mm in both groups. There were no statistically significant differences in the accuracy between the group of first-time users and the group with endodontic/ surgical template experience. There was no statistical association between the path depth and the achieved accuracy. All measured deviations allowed the safe finding of the root canal entrance. No perforation of the root was observed.

Conclusions:

The complex endodontic guiding approach is in the limits of in-vitro testing accurate, reproducible with minimal deviations from planning to the treatment outcome.
The finding of different root canal entrances is independent from the performance by experienced operators vs. novices.
The SICAT ENDO concept may contribute to clinical safety.

Sponsored by SICAT GmbH, Bonn, Germany

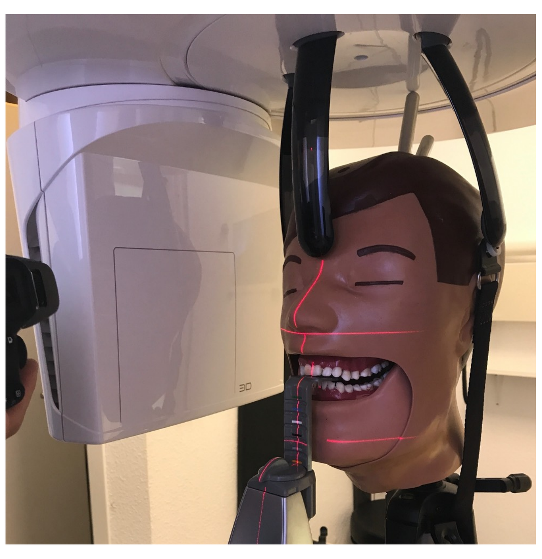

Figure 1 & 2: CBCT assessment of TrueJaw model with Orthophos SL and CEREC Omnicam for optical impression

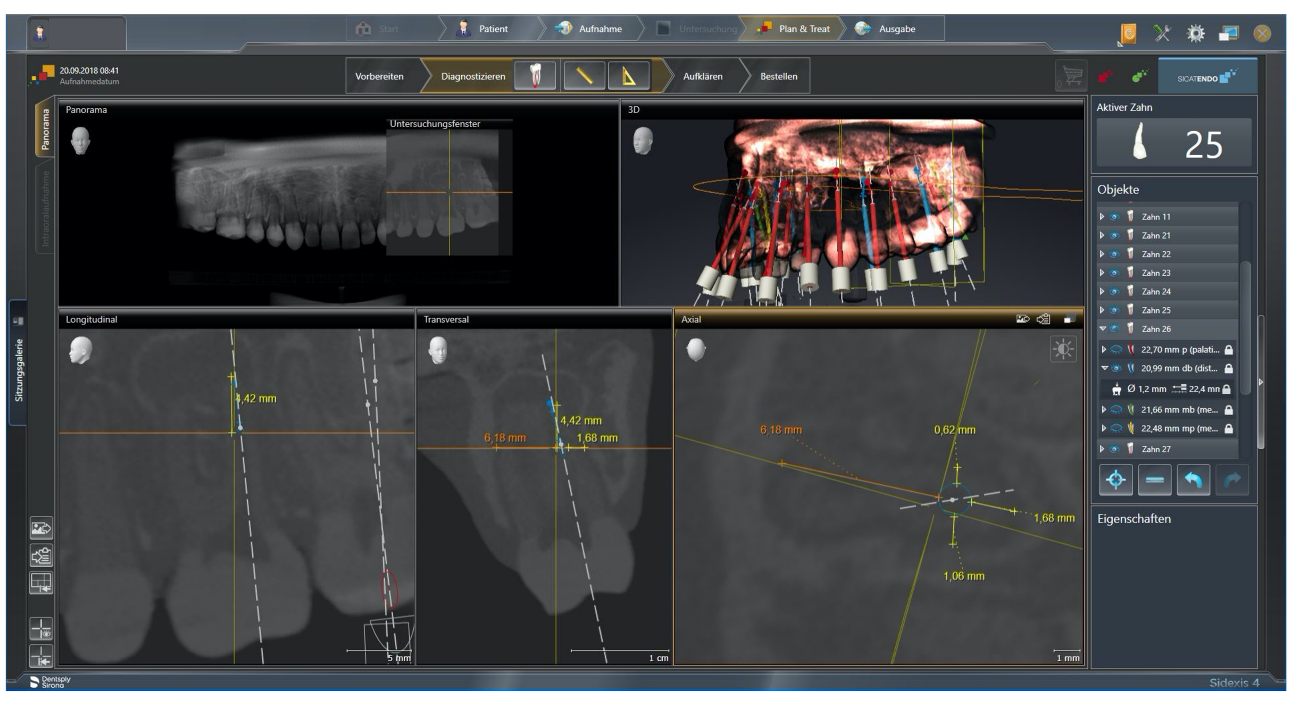

Fig. 3: Root canal access planning with SICAT ENDO software on the buccal root of tooth 25 and measurements of the access path direction from the mesial, distal, buccal and palatal distance to the periodontal ligament space

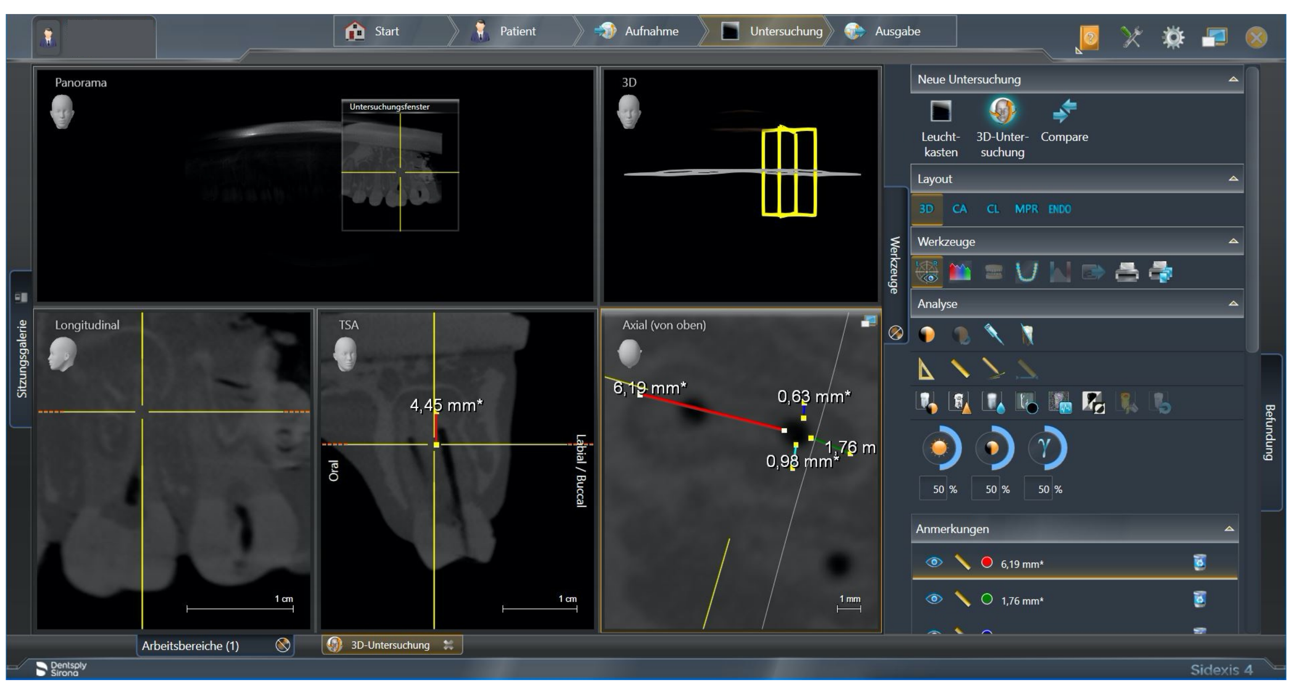

Fig. 4: Second CBCT scan after treatment, images of the buccal root of tooth 25 and measurements of the access path direction from the mesial, distal, buccal and palatal distance to the periodontal ligament space

Measurement Axis (sample size)	t-test				Mann-Whitney-Test	
	t	df	p	differences in (mm)	U	p (exact)
Mesial - Distal (n = 8 vs. n = 4)	0.246	10	0.811	0.005	16.0	1.000
Buccal - Oral (n = 6 vs. n = 5)	0.070	9	0.946	0.002	14.5	0.820
Distal – Mesial (n = 1 vs. n = 8)	-	-	-	-	-	-
Oral – Buccal (n = 3 vs. n = 7)	-0.662	8	0.527	-0.030	9.0	0.883
Total (n = 9 vs. n = 12)	0.020	19	0.984	0.000	53.5	1.000

Tab. 1: t-test and Mann-Whitney-Test of differences in accuracy between experienced and unexperienced operators

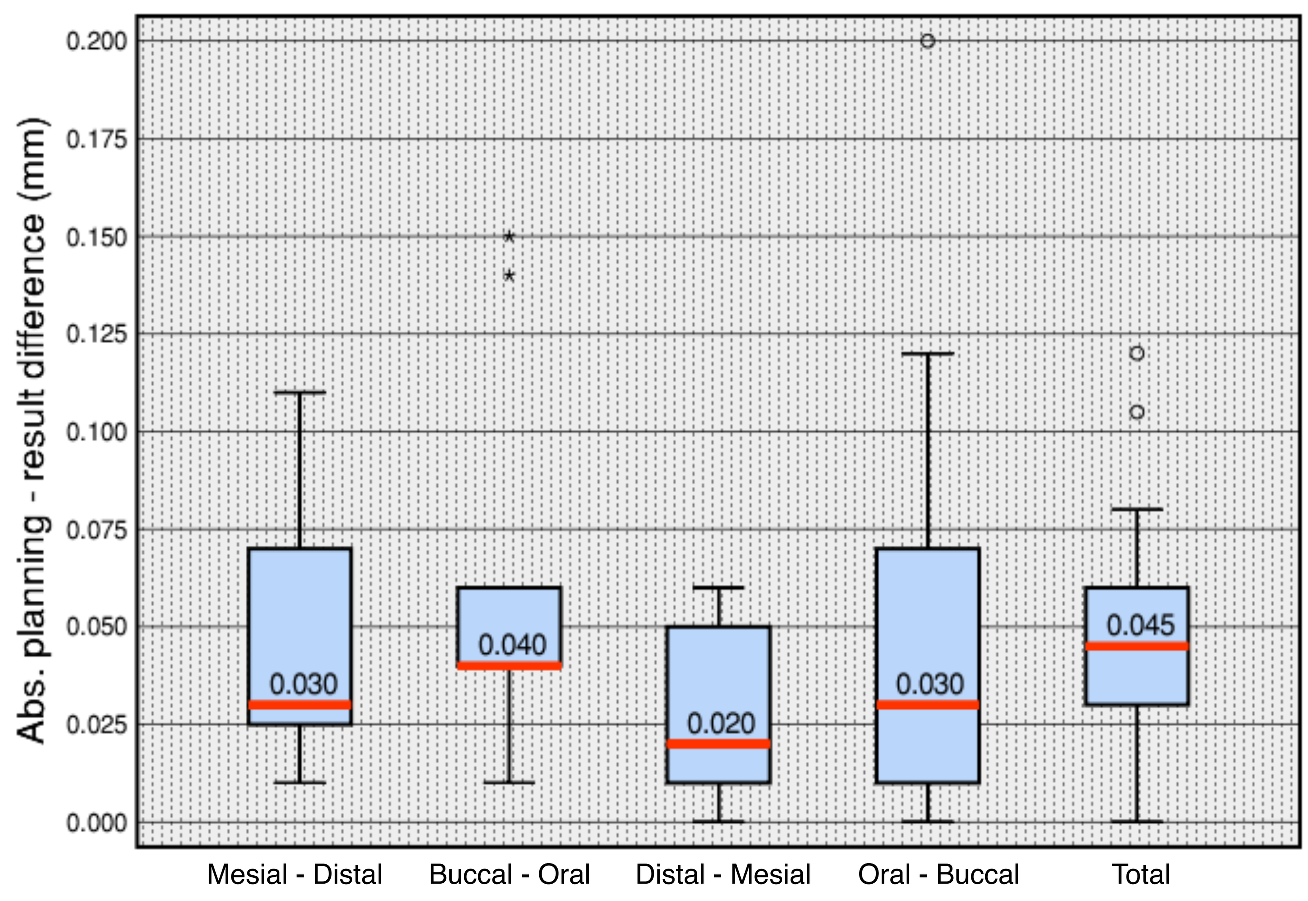

Fig. 5: Box plots of the deviation between treatment and planning in the different measurement axes (mm)

Measurement / Parameter	t-test				Wilcoxon-Test	
	t	df	p	Mean differences (mm)	Z	p (exakt)
Mesial – Distal (n = 12)	5.000***	11	0.000	0.046	-3.072***	0.000
Buccal – Oral (n = 11)	4.394***	10	0.001	0.059	-2.965***	0.001
Distal – Mesial (n = 9)	4.036**	8	0.004	0.029	-2.530**	0.008
Oral – Buccal (n = 10)	2.729*	9	0.023	0.054	-2.670**	0.004
Total Mean (n=21)	7.037***	20	0.000	0.048	-3.923***	0.000

Tab. 2: Statistical analysis of differences between treatment and planning (*: p <= 0.05, **: p <= 0.01; ***: p <= 0.001).