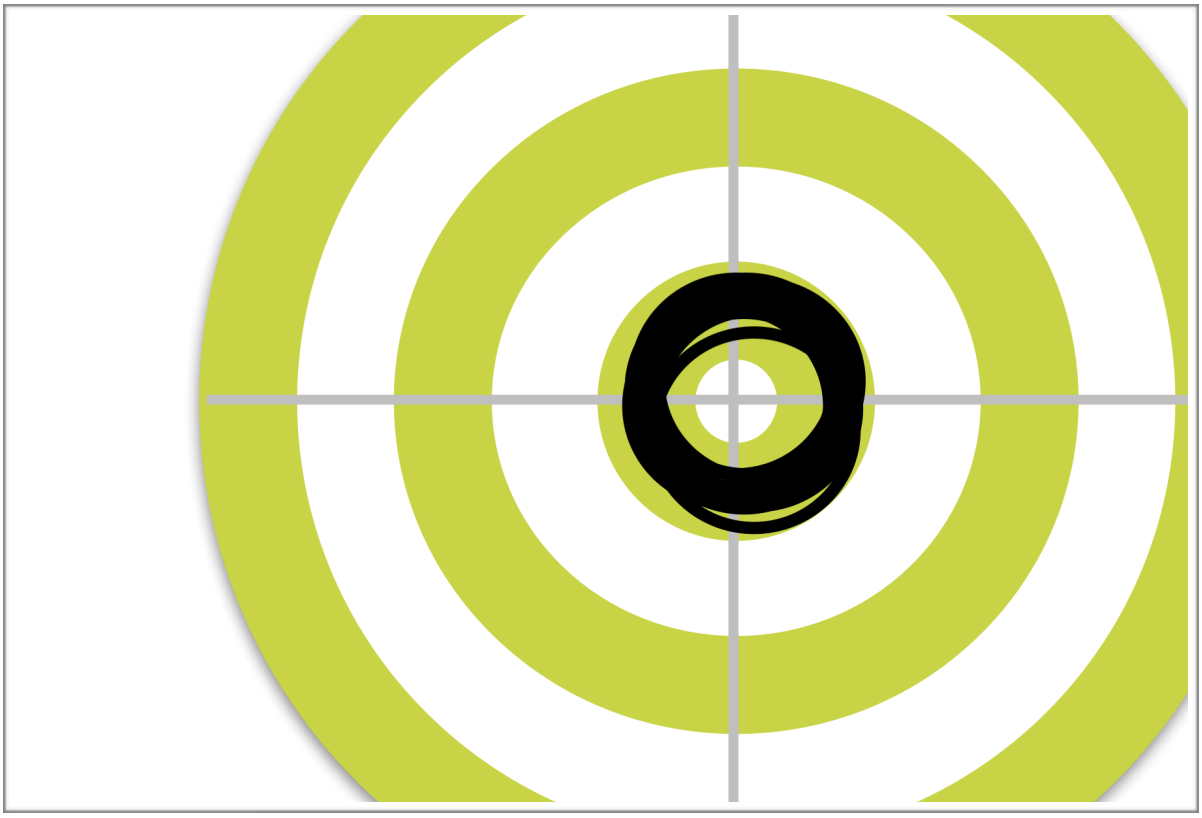
Accuracy of the Versah Guided Surgery System

Assessment of trueness and precision - An in-vitro study



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Introduction

Malpositioning of implants is one of the main factors leading to hard- and soft tissue deficiencies.[1] Guided implant placement aims to increase accuracy and to prevent malpositioning. The International Organization for Standardization (ISO) standard 5725 uses the terms trueness and precision to describe accuracy.[2] Trueness refers to the closeness of the agreement between the arithmetic mean of a large number of test results and the true or accepted reference value. Precision refers to the closeness of the agreement between test results. Figure 1 illustrates the differences between trueness and precision. A method can be considered accurate, when trueness and precision are high.

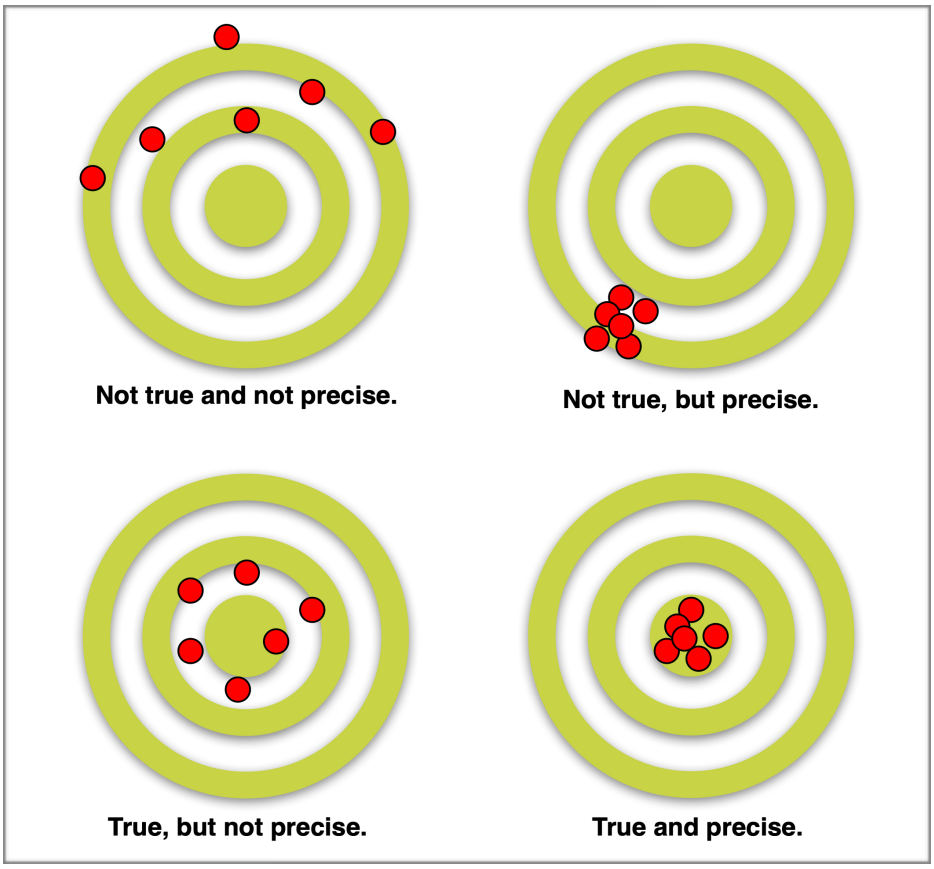

Figure 1. Accuracy is defined by trueness and precision. The closer to the bull's eye, the higher the trueness and the closer the values to each other, the higher the precision.

The aim of this in-vitro study was to assess precision and trueness of the Versah Guided Surgery System.

Material and Methods

N=20 identical replicas of a partially edentulous mandible were 3D-printed (Grey resin V3, Form2 3D printer; both Formlabs, Somerville, MA). A bone level implant (4.1x10 mm Straumann, Basel, Switzerland) for a lower right 1st-molar position was digitally planned (CoDiagnostix, Chemnitz, Germany). A surgical guide including a large C-Guide sleeve (Versah, Jackson, MI) with 2 mm sleeve to bone distance was designed and printed.

The drilling sequence of Densah burs followed the appropriate implant reference guide for Straumann implants. The pilot drill and the VT1828 drill were used with a G-Stop Vertical Gauge Large and 5 mm, 10 mm and 13 mm G-Stop Keys, to allow initially continuous key-sleeve guidance. The remaining drills were used with a G-Stop Vertical Gauge Large and 13 mm G-Stop Keys.

The achieved implant position was digitized using a lab scanner (with an accuracy of 4 µm, E4, 3Shape, Copenhagen, Denmark). Virtually planned (reference) and postoperative implant STL files were superimposed using a best-fit algorithm and compared with the treatment evaluation tool of the planning software. Trueness (planned vs. actual position) and the precision (difference among implants) were determined.[3] The 3D deviation at the crest and apex of the implant (as root mean square between virtual pre-operative planning and post-operative STL-file) as well as the the angular deviation and the mesio-distal, vestibular-oral and coronal-apical deviation at the crest and apex were evaluated (Fig. 2).

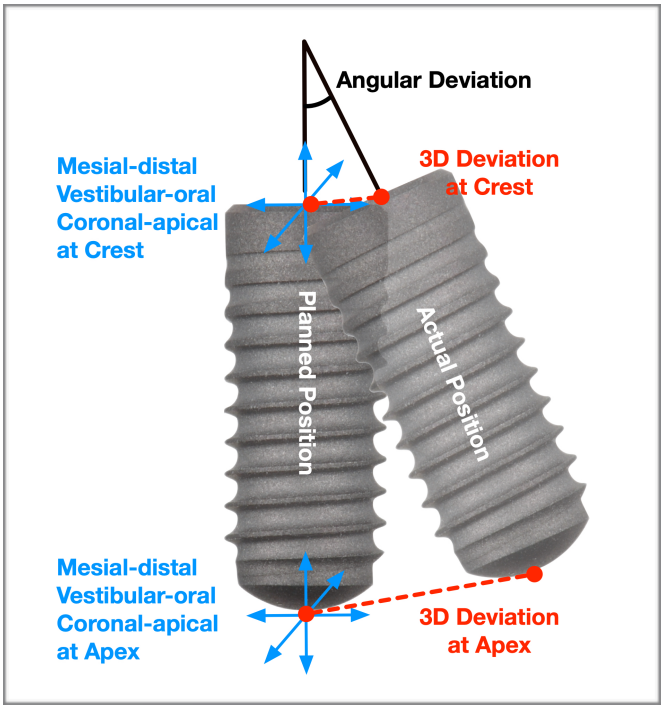

Figure 2. Parameters assessed when comparing planned (reference) and actual implant position

Results

The overlap of the actual position and the planned (reference) position for examples with minimal and maximal angular deviation are illustrated in Figure 3A and 3B.

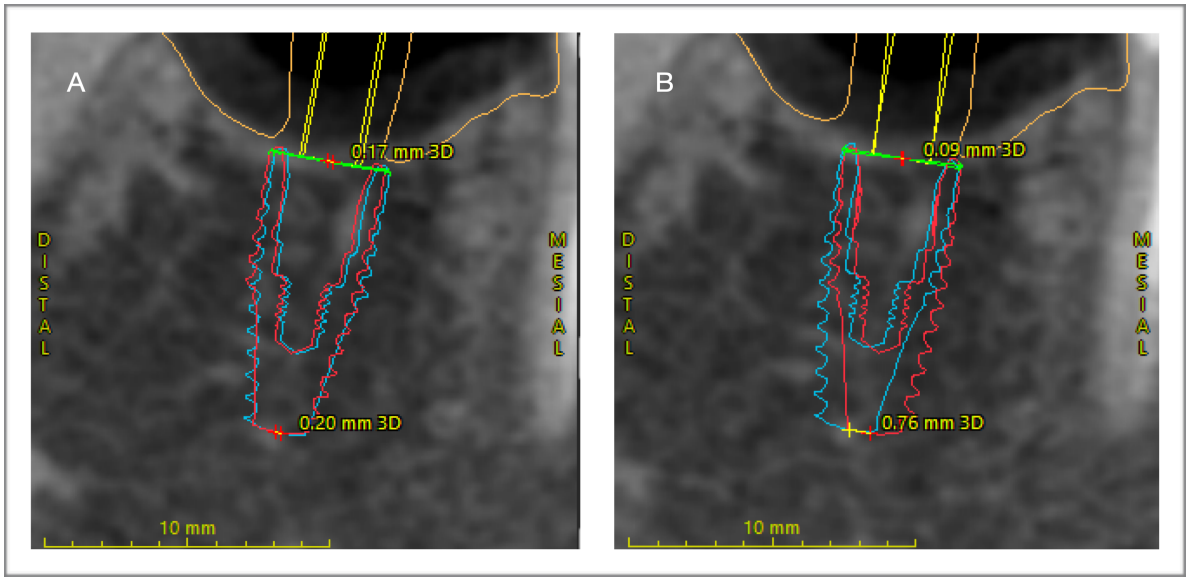

Figure 3: An angular deviation from 0.2 degree (A) in comparison to a 3.9 degree deviation (B).

The 2D projection of the achieved implant positions in mesial-distal and vestibular-lingual at the crest level are shown in figure 4.

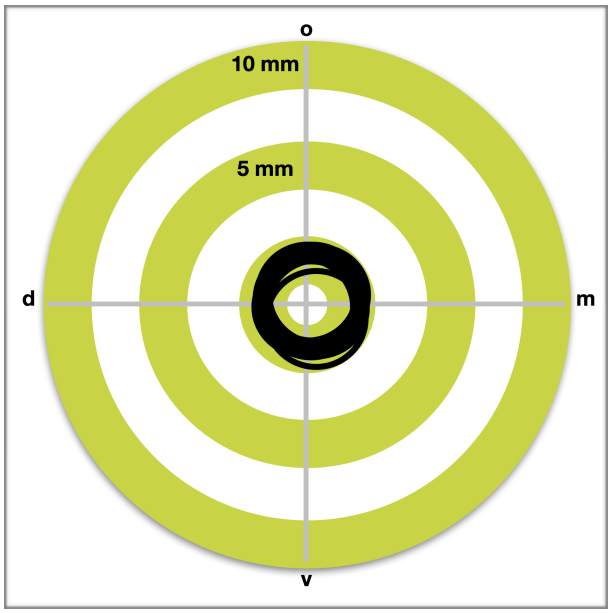

Figure 4: Mesial (m)-distal (d) and vestibular (v)-oral (o) deviation of n=20 implants.

All results of n=20 repeated measurements (n=20 implants in n=20 identical replicas) are summarized in table 1.

Table 1: Trueness and precision (as mean and standard deviation (SD) as well as their 95%-confidence interval (CI)) for the Versah Guided Surgery System

ACCURACY OF VERSAH GUIDED SURGERY (Large C-Guide, Vertical key 13mm, for a 4.1x10 mm bone level implant)		**Trueness** (difference to reference value)		**Precision** (implants among one another)	
		Mean (SD)	**95%-CI**	**Mean** (SD)	**95%-CI**
	Angle in degree	**1.98** (1.11)	1.51 – 2.43	**1.32** (0.90)	1.20 – 1.45
Crest in mm	**Δ3D**	**0.37** (0.19)	0.29 – 0.46	**0.23** (0.16)	0.21 – 0.25
	Mesial-distal	**0.22** (0.16)	0.16 – 0.29	**0.19** (0.13)	0.17 – 0.21
	Vestibular-oral	**0.17** (0.15)	0.11 – 0.24	**0.16** (0.14)	0.14 – 0.18
	Coronal-apical	**0.19** (0.21)	0.11 – 0.28	**0.20** (0.22)	0.17 – 0.24
Apex in mm	**Δ3D**	**0.61** (0.30)	0.49 – 0.74	**0.36** (0.25)	0.32 – 0.39
	Mesial-distal	**0.44** (0.28)	0.32 – 0.56	**0.32** (0.23)	0.29 – 0.36
	Vestibular-oral	**0.32** (0.28)	0.21 – 0.44	**0.30** (0.25)	0.26 – 0.33
	Coronal-apical	**0.15** (0.12)	0.10 – 0.21	**0.13** (0.10)	0.12 – 0.15

Conclusions

The Versah Guided Surgery System showed high trueness and precision.

The digitally planned implant position was accurately translated into the simulated clinical situation.

Clinical recommendation: The G-Stop Keys were used in an ascending order for the initial drills that assured continuous key-sleeve guidance and allowed an accurate implant path preparation.

Limitations of the study: The presented results were achieved in an in-vitro model and not in a clinical trial. However, the advantage of an in-vitro model is that it allows repeated measurements under relatively unchanged, standardized conditions.

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References:

1. Hämmerle CHF & Tarnow D. The etiology of hard-and soft-tissue deficiencies at dental implants: A narrative review. J Periodontol 2018; 89 (Suppl 1): S291-S303
2. ISO-5725. Accuracy (trueness and precision) of measurement methods and results
3. Guentsch A, Sukhtankar L, An H, Luepke PG. Accuracy of implant placement with and without static surgical guides. Journal of Dental Research 2019; 98 A: 0205