The impact of different CBCT scan-parameters on 3D-model accuracy

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Topic: Basic research

Background and Aim

The CBCT is increasingly available and gains more and more in importance. Not only implant dentistry but also many medical issues (e.g. traumatology and pre-surgical diagnostic) benefit from this development. The conventional MSCT gets substituted more often as the CBCT entails the advantage of lower radiation. Depending on the dimensions of the ROI (region of interest) different parameters can be used for a CBCT scan. It was the aim of this study to evaluate the correlation between the accuracy of 3D-models and the distinct CBCT scan parameters.

Methods and Materials

The macerated mandible which was provided by the Institute of Anatomy (University of Erlangen-Nuremberg) served as a master. Therefore, it was scanned optically with a white light scanner (Atos SO II, GOM mbh, Braunschweig, Germany). Subsequently, the jaw was x-rayed by a CBCT (3D eXam, KaVo dental GmbH, Biberach, Germany) using three different setting (0.2, 0.3 and 0.4 voxel). Per each setting the scan was repeated ten times. The 30 DICOM datasets were converted into STL file format via ImpactView 4.4 (CT Imaging GmbH, Erlangen, Germany). In order to compare the different virtual models to the master model the CAD interactive software GOM Inspect (GOM mbH, Braunschweig, Germany) was used. The deviation was evaluated in 19 measurement points per CBCT scan. The data was analyzed using the statistical software R (version 3.0.2, The R Foundation, Vienna, Austria).

Results

The statistical analysis demonstrated a significant difference concerning the 3D-model accuracy between the CBCT scan-parameters 0.2 and 0.3/0.4 voxel with a p-value of < 0.001 each. There was no statistical significant difference between the parameters 0.3 and 0.4 voxel (p-value = 0.7784).

Conclusions

Within the limitations of this study it was demonstrated that the accuracy of the 3D-model depends directly on the applied scan-parameters. Prospectively, the CBCT setting could be adjusted to the medical purposes to keep the exposure to radiation as low as possible.

References

1. von Wilmowsky C, Bergauer B, Nkenke E, Neukam FW, Neuhuber W, Lell M, Keller A, Eitner S, Matta RE (2015) A new, highly precise measurement technology for the in vitro evaluation of the accuracy of digital imaging data. Journal of cranio-maxillo-facial surgery : official publication of the European Association for Cranio-Maxillo-Facial Surgery. doi:10.1016/j.jcms.2015.06.021.

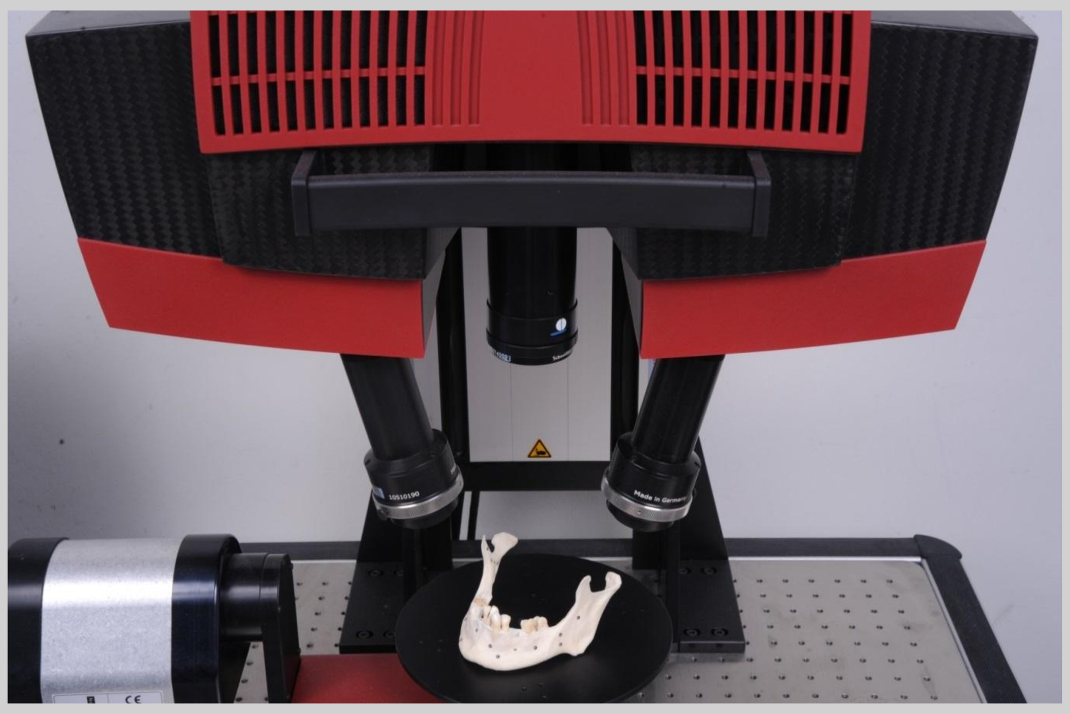

Fig. 1: ATOS II with macerated mandible

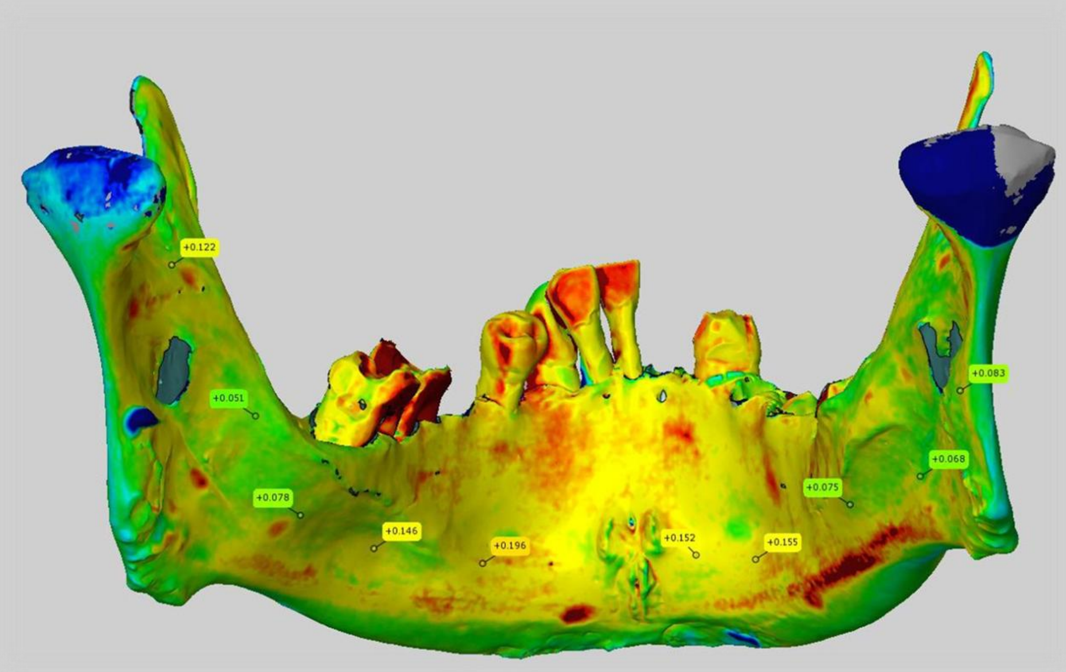

Fig. 2: lingual view of CBCT 0.2 voxel deviation

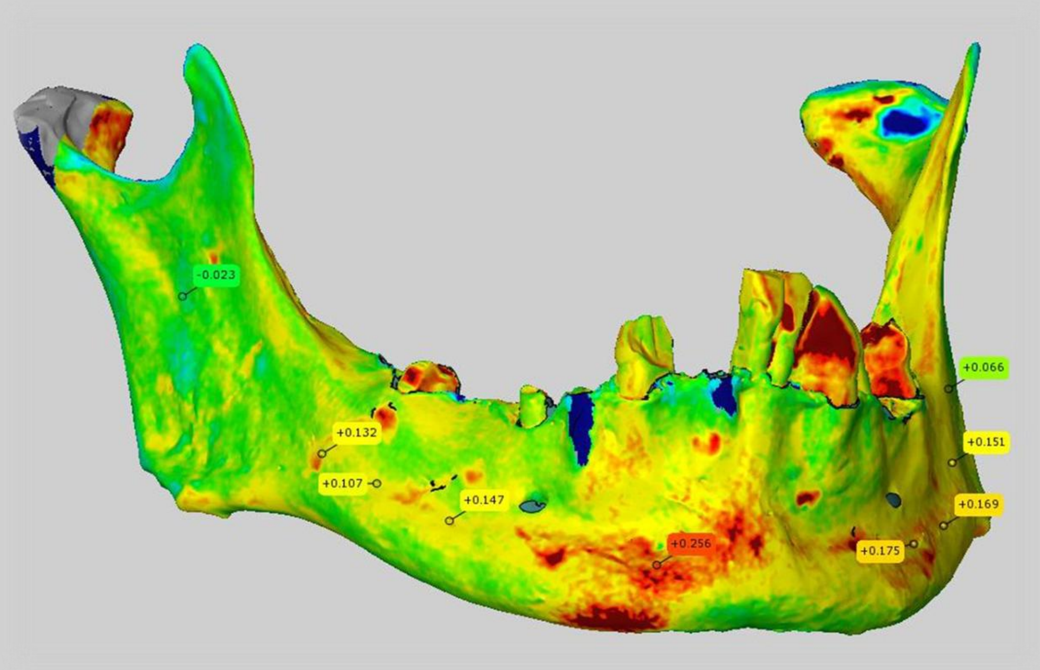

Fig. 3: vestibular view of CBCT 0.2 voxel deviation

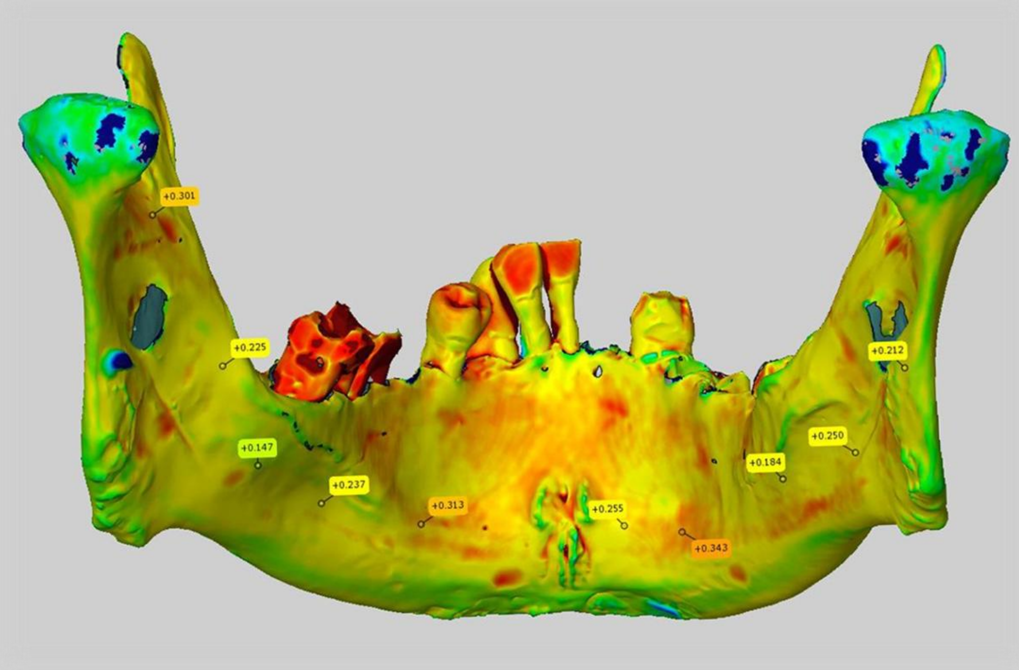

Fig. 4: lingual view of CBCT 0.3 voxel deviation

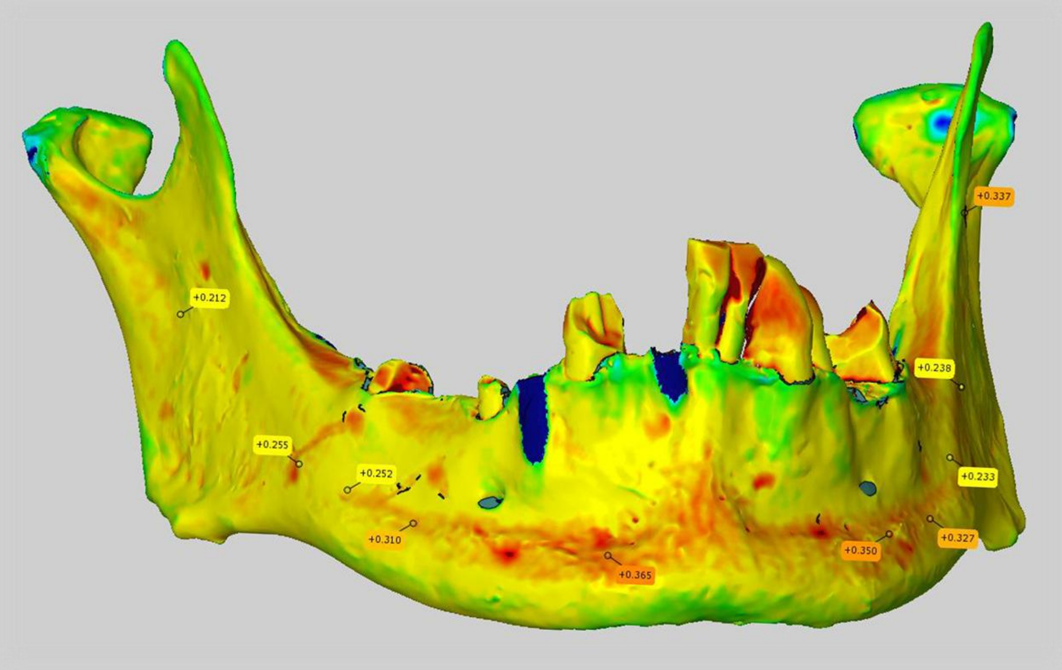

Fig. 5: vestibular view of CBCT 0.3 voxel deviation

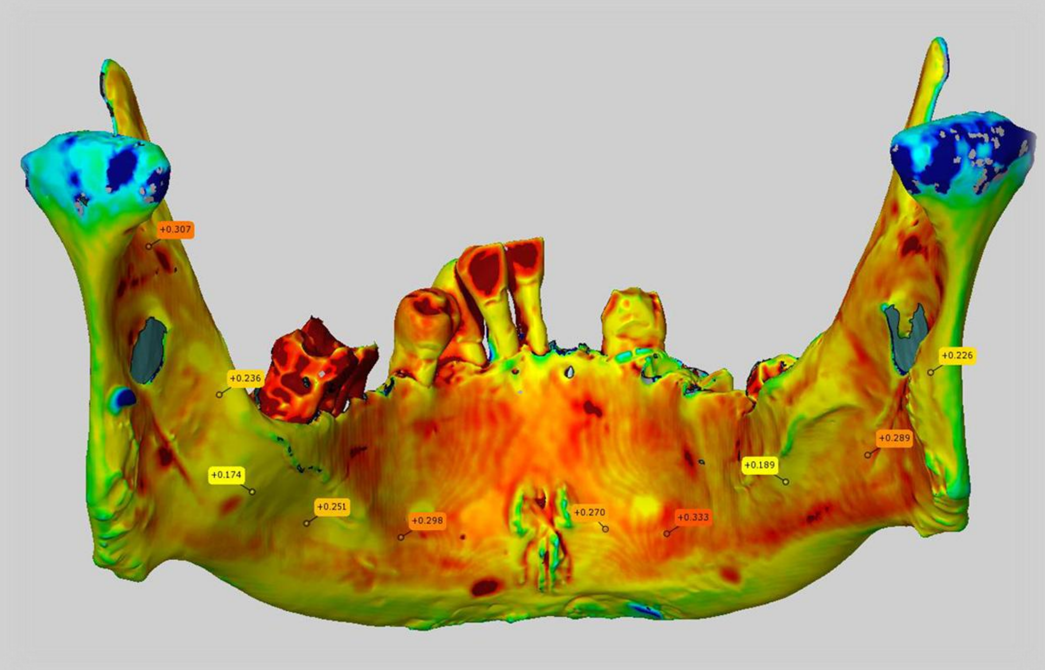

Fig. 6: lingual view of CBCT 0.4 voxel deviation

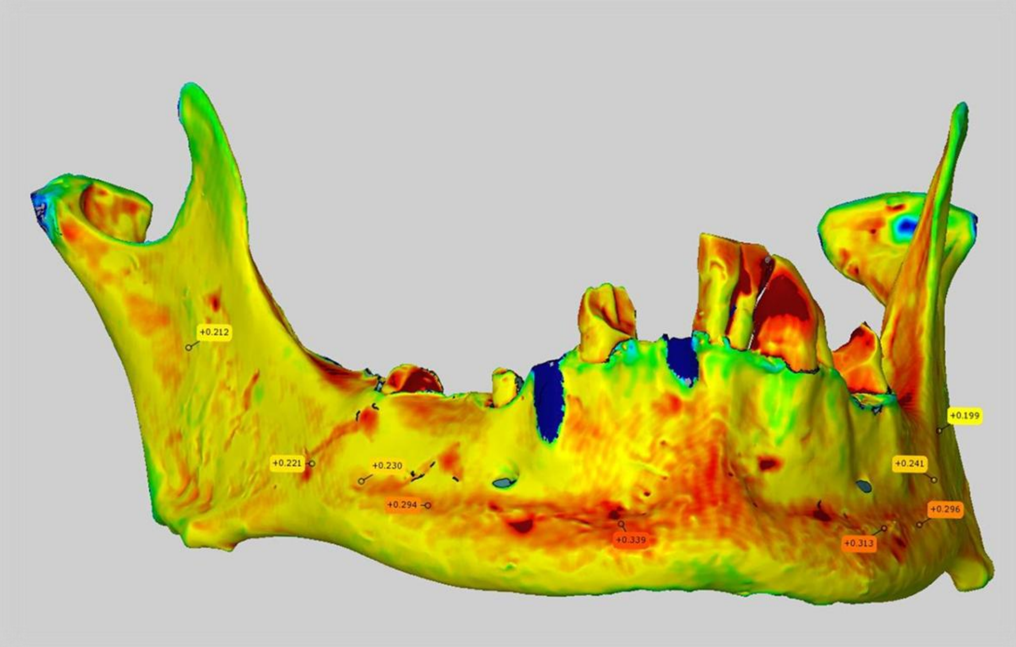

Fig. 7: vestibular view of CBCT 0.4 voxel deviation

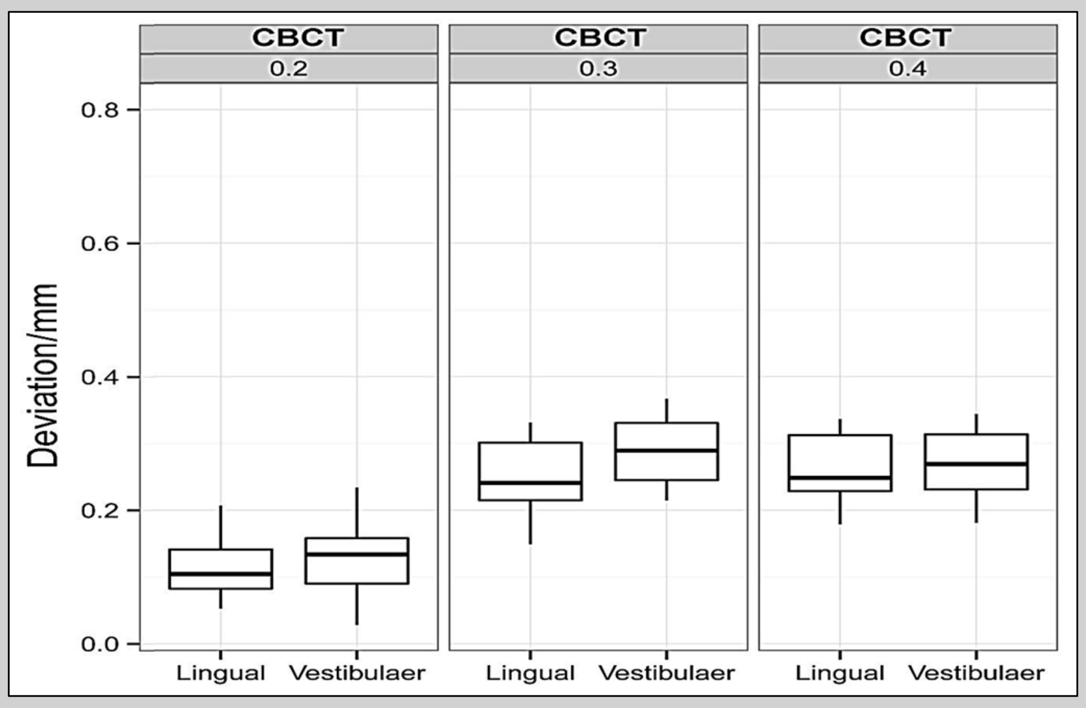

Fig. 8: boxplots of the deviation from master model

Variable	Levels	N	Min	Max	Mean
CBCT 0.2	Lingual	90	0.026	0.254	0.111
CBCT 0.2	Vestibular	100	0.001	0.257	0.124
CBCT 0.3	Lingual	90	0.129	0.372	0.236
CBCT 0.3	Vestibular	100	0.178	0.384	0.288
CBCT 0.4	Lingual	90	0.155	0.361	0.256
CBCT 0.4	Vestibular	100	0.146	0.373	0.266

Tab. 1: deviation of CBCT scans lingual/vestibular

Variable	N	Min	Max	Mean
CBCT 0.2 voxel	190	0.027	0.234	0.118
CBCT 0.3 voxel	190	0.178	0.344	0.262
CBCT 0.4 voxel	190	0.148	0.367	0.268

Tab. 2: overall deviation of CBCT scans

	Standard deviation	p-Value
CBCT 0.3 - CBCT 0.2	0.0043	< 0.001
CBCT 0.4 - CBCT 0.2	0.0043	< 0.001
CBCT 0.4 - CBCT 0.3	0.0043	0.78

Tab. 3: comparison between different CBCT settings

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