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Accuracy and reproducibility of the registration of a digital dental cast or intraoral scan into a 3D-image of the face: protocol for a systematic review

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ADMINISTRATIVE INFORMATION

Support - Funding sources/ sponsors: Department of Orthodontics.

Review Stage at time of this submission - Preliminary searches.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 07 February 2024 and was last updated on 07 February 2024.

INTRODUCTION

Review question / Objective The aim of this systematic review is to investigate the accuracy and reproducibility of the registration of a digital dental cast or intraoral scan into a 3D-image of the face. To this end, the proposed systematic review will address the following question: "What is the accuracy and reproducibility of the registration of a digital dental cast or intraoral scan into a 3D-image of the face?" The following PICO is used for the research question:

P Humans with a 3D-image of the face

I Integration of an intraoral scan or digital dental cast

C The position of the dentition in a CBCT of the head;

O Accuracy and reproducibility.

Rationale Earlier research showed that it is possible to integrate a digital dental cast or intraoral scan in a 3D-image of the face. The accuracy and reproducibility of the integration process is crucial for its clinical application. If the integration is accurate, the 3D-facial image with an integrated digital dental cast or intraoral scan holds the potential to enhance the orthodontic diagnostics and treatment planning and reduce the necessity for X-ray imaging and therefore exposure of a patient to radiation. The next step is to investigate if it is possible to replace the cephalogram with the 3D facial image and integrated intraoral scan for diagnostic purposes to create a patient specific treatment plan. This systematic review addresses the question of the accuracy and reproducibility of the integration process.

Condition being studied The primary objective of orthodontic and orthognathic treatment is to establish a combination of an optimal dental and skeletal relationship in harmony with the soft tissues of the face. To establish an orthodontic diagnosis and treatment plan, accurate documentation of the anatomical structures involved is a prerequisite. In addition, it is preferred to minimize the radiation dose for obtaining the records. Digital technology opens new horizons. The advantages of new digital techniques such as 3D-stereophotogrammetry of the face and intraoral scans are that these scanning methods are radiation-free and can create an accurate 3D-image of the face and the teeth with a short capturing time. Combining these two optical scanning techniques into one augmented model could be an interesting clinical application and raises the question about the accuracy and reproducibility of this integration. Compared to a traditional 2D-cephalogram, the integration of an intraoral scan into a 3D-image of the face provides a radiation-free 3D diagnostic record. CBCT scans provide the actual position of the teeth in the face, the 'gold standard. To investigate the accuracy and reproducibility, this systematic review includes studies using CBCT scans to compare the accuracy and reproducibility.

METHODS

Search strategy The primary objective of orthodontic and orthognathic treatment is to establish a combination of an optimal dental and skeletal relationship in harmony with the soft tissues of the face. To establish an orthodontic diagnosis and treatment plan, accurate documentation of the anatomical structures involved is a prerequisite. In addition, it is preferred to minimize the radiation dose for obtaining the records. Digital technology opens new horizons. The advantages of new digital techniques such as 3D-stereophotogrammetry of the face and intraoral scans are that these scanning methods are radiation-free and can create an accurate 3D-image of the face and the teeth with a short capturing time. Combining these two optical scanning techniques into one augmented model could be an interesting clinical application and raises the question about the accuracy and reproducibility of this integration. Compared to a traditional 2D-cephalogram, the integration of an intraoral scan into a 3D-image of the face provides a radiation-free 3D diagnostic record. CBCT scans provide the actual position of the teeth in the face, the 'gold standard. To investigate the accuracy and reproducibility, this systematic review includes

studies using CBCT scans to compare the accuracy and reproducibility.

Participant or population The systematic review studies healthy growing and non-growing human subjects of any age and sex and with any orthodontic malocclusion whereby dental records are obtained. The dental records need to include a 3D-stereophotogrammetry, a digital dental cast or intraoral scan and a CBCT scan.

Intervention The integration of a digital dental cast or intraoral scan in a 3D-facial image.

Comparator The comparator will be the full face CBCT scan including the area of the upper and lower teeth.

Study designs to be included All study designs except case reports.

Eligibility criteria Inclusion criteria are studies whereby dental records are obtained. The dental records include a digital dental cast or intraoral scan, a 3D-stereophotogrammetry of the face and a CBCT. The CBCT acquisition is with the patient in upright position.

Information sources A comprehensive search will be conducted using PubMed, Embase, the Cochrane Library, and Web of Science.

Main outcome(s) The deviation measurements in millimeters or degrees in the three-dimensional position of the teeth from the digital dental cast or intraoral scan in the 3D-image of the face in comparison to the CBCT or 'gold standard' position of the teeth in the face.

Additional outcome(s) None.

Data management PICO search on MEDLINE using PubMed, EMBASE, Web of Science, Cochrane library.

The search execution will be loaded into EndNote and exported to Covidence for study selection. Title and abstract screening will begin with a calibration exercise on a random sample of five titles/ abstracts. Two reviewers (A.G. and A.K.) will independently review the selected titles/ abstracts. Any disagreements will be resolved with a third reviewer (R.S.) serving as a referee if necessary. After selecting the title/ abstract, subsequent full-text review will be conducted by the same two reviewers. Articles deemed acceptable after full-text review will be included for data extraction and analysis.

Quality assessment / Risk of bias analysis

Quality assessment by two reviewers, independently. Title and abstract screening will begin with a calibration exercise on a random sample of five titles/ abstracts. Any disagreements will be resolved with a third reviewer serving as a referee if necessary. To assess the risk of bias of the included studies, the Cochrane Risk of Bias tool RoB 2 and ROBINS 1, will be performed. The assessment of the quality of the evidence will be performed applying the GRADE system.

Author 5 - HLL Wellens - Article reviewer; interpretation data.

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Strategy of data synthesis Due to the expected heterogeneity, a descriptive synthesis will be carried out. In the unlikely event of homogeneity of the included studies, a quantitative analysis will be carried out.

Subgroup analysis None.

Sensitivity analysis If applicable, sensitivity analysis will be performed.

Language restriction There is no language restriction in this search strategy.

Country(ies) involved The Netherlands, Switzerland, Indonesia, Belgium.

Other relevant information None

Keywords Orthodontics; Face; Dental; Imaging, Three-Dimensional; Accuracy; Reproducibility; Integration; CBCT.

Dissemination plans A manuscript will be prepared and submitted to be considered for publication in a peer-reviewed journal. Presentations of the review's findings at relevant conferences will also be considered.

Contributions of each author

Author 1 - AEHC Go - Designing the review; data collection; data management; article reviewer; analysis of data; interpretation data; writing the protocol or review. Corresponding author.

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