

Evidence for use of intraoral scanners under clinical conditions for obtaining full-arch digital impressions is insufficient

Abstracted from

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Accuracy, reliability, and efficiency of intraoral scanners for full-arch impressions: a systematic review of the clinical evidence. *Eur J Orthod* 2016; **38**: 422-428.

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Question: Have the current scanning systems for complete arch digital impressions been tested under clinical conditions for their reliability, accuracy and reproducibility?

Data sources PubMed, Scopus, Cochrane Library, Web of Science, Embase. Relevant papers were also searched from the reference lists of selected studies. A web search of current manufacturers of intraoral scanners.

Study selection Studies with full-arch digital impressions recorded intraorally that tested any of the following outcomes; validity, repeatability, reproducibility, time efficiency. Patient acceptance of digital impressions were considered for the review.

Data extraction and synthesis Initially, only titles of the papers identified from the databases were screened, then further screening of the abstracts of the selected titles was carried out. Then finally, full text articles of the selected abstracts were read and only relevant articles were included in the review. Two examiners assessed the quality of the chosen articles using the QUADAS checklist. Any disagreement was resolved by discussion between the two examiners.

Results Only eight studies were found that carried out full-arch intraoral scanning. Four studies reported on validity, repeatability and reproducibility of digital measurements. These studies were included in the qualitative assessment. Two intraoral scanners were tested, Lava COS and iTero. In assessing scanning times and patient perception, six and four studies were included, respectively. A decrease in the scanning time was noted as the operator gained experience.

Conclusions The literature lacks sufficient evidence to comment on the use of intraoral scanners under clinical conditions. Further studies are needed to properly assess the reliability, accuracy, reproducibility and scanning times of intraoral scans.

Commentary

The use of intraoral scanners in fabricating digitalised impressions is a recent technological advance. A number of problems could arise with the use of conventional impression techniques that could be eliminated by digital scanning including 'pull', tears, bubbles, voids and material shrinkage.¹ In addition, data storage is made more efficient, with the use of digital models eliminating the need for physical storage space while also avoiding storage issues of plaster chipping or breakage.² Within orthodontics, electronic transfer of digital study models establishes an efficient communication between clinicians and laboratories.²

While intraoral scanners offer a number of advantages over conventional impression techniques, their use in clinical practice depends on their accuracy, reliability, repeatability and time efficiency under clinical conditions. The aim of this systematic review is to assess whether there is sufficient evidence to support the use of intraoral scanners for obtaining full-arch digital impressions in a clinical setting on the basis of the aforementioned parameters or outcomes.

The review question was formulated in accordance with the PRISMA guidelines, but no criteria were placed on the type of participants involved in any of the studies. A wide search of the literature was conducted using multiple major databases such as the Cochrane Library and PubMed; the search strategy was clearly described and illustrated using a Consort flow diagram. However, it is not clear how many examiners were involved in the search and data collection process. It is not known for example whether this search was conducted independently by two examiners or by just one examiner. Reassuringly however a similar systematic review with comparable inclusion and exclusion criteria yielded similar final search results, with the exact same four studies included in the qualitative analysis.³

Nevertheless, various limitations were noted in the selected studies. Analogous to the Cochrane risk of bias tool, the QUADAS-2 tool provides a domain-based evaluation where critical assessment is carried out on various areas of research, but the former provides visual presentation of bias assessment in the form of graphs. The Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) revealed that none of them had adequate sample size (1-30) and no overall quantitative assessment was given to each of the studies.

Goracci's risk assessment of the reviewed papers differed from another similar systematic review by Aragón who, although he reviewed the same studies, classified them differently, with Wiranto *et al.*, Naidu and Freer categorised as low risk, Grunheid *et al.* as

medium risk, and Flugge *et al.* as high risk.³ Nevertheless, Aragón's review reached the same conclusion as Goracci's; that none of Aragón's studies provided adequate evidence to recommend the use of intraoral scanning.

Aragón highlighted the fact that the samples in the studies are not necessarily representative of the patients who would undergo intraoral scanning in practice; the participants of all studies had permanent dentition, and all excluded children from their research. In addition, Wiranto *et al.* excluded patients with severely crowded dentition. One could assume that the presence of severe crowding could possibly hinder obtaining accurate measurements, but it also raises the question of whether or not accurate and reliable digital impressions can be obtained from scanning arches with severe crowding.

Wiranto *et al.* and Naidu and Freer used digital calipers to carry out measurements (tooth widths and Bolton ratios) on the stone casts and contrasted these with measurements of digital impressions obtained using computer software. It's important in studies like this that the benchmark that is used as a comparator is of high quality or consistent. A 2012 study for example found out that the accuracy of digital calipers is less than that of computer software.⁴ Without a standardised method for taking measurements it is difficult to know how accurate the comparison is. Grunheid and Flugge adopted different methods of measurements in their studies. Grunheid used computed tomography to produce stereolithographic models and compared them to the digital models while Flugge analysed digital images obtained from chairside scanning comparing them to plaster model scanning, however, these methods have also not been independently assessed for accuracy.

The authors summarised the findings of six studies in regards to assessment of scanning times. Risk of bias relating to scanning times was evaluated in only two of these studies; (Wiranto *et al.* and Grunheid *et al.*). Each paper had different methods of measuring

scanning times, which would be one factor in understanding the variation in times recorded. Similarly to the measurement issue the inclusion of information on scanning times highlighted the need to establish a standardised protocol in measuring scanning times for fair comparison between digital and conventional impression techniques.

The need for research including patient and public involvement is an important part of ensuring research outcomes are relevant for the population that we serve. Patient preference was not investigated in sufficient detail. Three of the studies reported patients preferring intraoral scans to conventional impressions. However, these studies were considered to be of poor quality and as such this area remains 'largely unexplored' as the authors put it, particularly among children.

Given the evidence presented in hand, the literature lacks sufficient evidence needed to recommend the use of intraoral scanners in clinical practice. Various important clinical factors such as patient preference and time efficiency have not been properly or adequately addressed in the previous studies. Despite the lack of evidence, intraoral scanners are growing in popularity. The need for future research of high quality is vital.

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