Author’s response to reviews

Title: Applying intraoral scanner to residual ridge in edentulous regions: in vitro evaluation of inter-operator validity to confirm trueness

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Reviewer reports:

Francesco Mangano, DDS, PhD

(Reviewer 1): Title and Abstract:

From the title and abstract, it looks the authors focus their attention on the precision, at least they say that, but in reality it is an in vitro study (please specify that!) in which they capture reference scans of a plastic model by means of a desktop lab scanner (which one? you must specify all data in the abstract!)

Different desktop scanners give different performance). why? if you just want to evaluate precision, first you can do it in vivo (that is, much better than in vitro!) second, you do not need a reference scan.
I think the authors have no idea of what precision actually is. In metric, precision is repeatability of results and to gather data about precision, you do not need a reference model, you can simply superimpose the different scans taken by the different operators, intraoral. No need to have an in vitro model.

If you capture reference scans, you are evaluating the trueness. so if you calculated the trueness, it makes sense to have in vitro approach (in vivo it is rather impossible), and your study is logic. so please refer to trueness, in your work, instead of precision.

You can refer to precision only if you superimpose the scans taken by the different operators, on each other (without using the reference scans). in that case and only in that case, you can use the term "precision".

Please specify from the abstract the name and manufacturer of the desktop and intraoral scanner used. Devices are very important in digital dentistry.

There is a major bias in this work. the material you selected for your reference model has a completely different behaviour, when compared to the behaviour of human soft tissues. you need to add a limitation statement on your discussion section, highlighting this limitation.

In addition you do not specify, in the abstract, the n° of scans taken by each dentist, nor the level of the experience of these dentists with scanning, nor the scanning strategy. please insert all this info, it is mandatory in the abstract.

You are focusing on the edentulos regions of a partially and totally edentulous model. did you appropriately trim the partially edentulous model, in order to calculate the trueness uniquely in selected areas?

please specify the software used for calculation of deviations after the superimpositions.

Thank you very much for your suggestion.

We have revised the title and abstract.

Title:

Applying intraoral scanner to residual ridge in edentulous regions: in vitro evaluation of inter-operator validity to confirm trueness

Abstract:

As reference data, scanning of two models were performed using a dental laboratory scanner (D900, 3Shape A/S). Five dentists took intraoral scanner data five times and the “zig-zag” scanning technique was used. They hadn’t used intraoral scanners in the clinical treatment. The intraoral scanner data was overlapped with the reference data (TRIOS 2, 3Shape A/S).
Another:

- We have changed precision to trueness in the abstract.
- We have added the limitation of this study in the discussion.

P8L7: The limitation of this study was that the model we selected for the study had a completely different behavior, when compared to the behavior of human soft tissues.

- We have added the trim of data to methods.

P4L21: After scanning, unnecessary information (islands and peninsulas) was trimmed and removed using the tool function.

Introduction:

I like it but you do not mention the real problem with the digital fabrication of dentures (complete removable dentures or overdentures): it is the difficulty of capture the functionalization of tissues and activation of all muscle insertions and frenules by means of an intraoral scanner. the authors should add this limitation in the introduction and most of all, in the discussion section, moreover they should consider that indirect methods may represent the solution for this issue (i.e. normal inversion).

Thank you very much for your suggestion.

We have added this limitation in the introduction and the discussion.

P3L20: It should be mentioned at first that it is difficult to obtain data regarding the amount of tissue displacement of the residual mucous membrane and the functional morphology of mobile tissues such as the oral vestibular, lips, tongue and cheeks with an intraoral scanner.

P8L7: The limitation of this study was that the model we selected for the study had a completely different behavior, when compared to the behavior of human soft tissues.

Methods:

- once again you misuse the term "precision" because here you are evaluating "trueness". Please refer to the following article for the correct definition of trueness and precision:

  Trueness and precision of 5 intraoral scanners in the impressions of single and multiple implants: a comparative in vitro study.


Please change it into "trueness" and never use the term "precision" because you did not superimpose the different scans taken with trios on each other, you just superimposed to the reference models.

You used only 3shape materials and no data are available here on the quality of the superimpositions within the 3shape cad software. please provide this data or a valid certification.

Only 5 scans per operator? Very few!

How did you calculate "the molar region" or the "premolar region"? did you use a template?

Thank you very much for your suggestion.

We have changed precision to trueness in the methods.

The number of scanners have added to the discussion as a limitation of this study.

P8L8: Moreover, only one type of scanner was used and the operators captured only five times.

We have corrected the description of the calculate.

P5L11: The amount of error between the reference data and intraoral scanner data in each verification region was measured and the vertical maximum distance of the difference and the integral value obtained by integrating the total distance were analyzed using 2D cross section tool of CAD software mentioned above (Fig. 4 and 5).

Discussion and conclusions:

Please do not use the term "precision" but the term "trueness". please introduce and discuss the results of previously published similar studies (Patzelt et al)

please refer to the limits of your study (In vitro, no functionalization that is key with removable dentures, limited samples- only 5 scans per operator, very little, a minimum of 10 would be advisable).

I do not think the head or tip of scanner is the issue, the issue is functionalization, in vivo. of course not with models.

There are many studies on this topic, also published in bmc oral health, you should discuss them thoroughly

Thank you very much for your suggestion.

We have changed precision to trueness in the methods.

We have added the introduction and discussion (Patzelt et al).
Poorly traceable structures and a smooth surface are characteristic on the palatal, suggesting that it would be difficult to stitch the image. [15] We have added the limits of our study in the discussion.

The limitation of this study was that the model we selected for the study had a completely different behavior, when compared to the behavior of human soft tissues. Moreover, only one type of scanner was used and the operators captured only five times. Imburgia et al. reported that the type of scanner affected the scanning accuracy of the missing tooth pattern [36]. For verification of trueness of intraoral scanning on specific region and limited teeth missing pattern, further study is required to investigate with adding other scanners, methods and conditions.

We have deleted the description about head or tip of scanner in discussion. Accordingly, we have corrected the conclusion.

The present study demonstrated satisfactory trueness of intraoral scanning of residual mucous membrane in edentulous regions. However, it was revealed that lack of traceable structures and a smooth surface such as the palatal region or a long free end saddles affected the trueness. If care is taken regarding these issues, the present study shows that optical impressions can be applied to the residual ridge of edentulous regions.

We have added the discussion using the following references in BMC oral health.


Florian Beck (Reviewer 2): Dear Authors,

Your manuscript entitled „Applying intraoral scanner to residual ridge in edentulous patients: verification of inter-operator precision“ is of current relevance in regard to the rise of digital dentistry. It faces some minor limitations which are listed below.

In brief, the authors investigated the precision of one intraoral scanner in a complete edentulous jaw and a partial edentulous jaw, both simulated by a plastic model. Scanning procedure was performed by five dentists. The simulation model was also scanned by a desktop scanner which was defined as verum. Superimposition of the scans was accomplished in the proprietary (intraoral) scanner software.

Copyediting is advised!
Abstract:

Page 2, Line 35: If you conclude "satisfactory inter-operator precision", you should define "satisfactory" and "precision" by referencing the literature within your manuscript

Thank you very much for your suggestion.

We have corrected the discussion as follow.

P7L13 : Therefore, no significant difference was observed in inter-operator, and as the maximum distances (0.04 to 0.60 mm) of the difference between the intraoral scanner data and reference data were the same or lower than the amount of tissue displacement (0.70 to 1.00 mm) [30], with practice operators can bring these errors to within a clinically acceptable range. It is suggested that intraoral scanning of edentulous area could achieve satisfactory capture by the operator.

M&M:

Page 4, Line 25: Please reference a technical data sheet of the scanner or at least a website where it can be found if stating values of the scanner

This is good idea.

We have added the website.

P4L19: Five dentists each used an intraoral scanner (TRIOS 2, 3Shape A/S, Copenhagen, Denmark, 3Shape. com) five times to capture optical impression data.

The way of superimposition of the data sets and especially the way of performing the measurements within the CAD software should be described in more detail.

It should be explained whether methods of data optimization within the CAD software have been applied or not.

Thank you very much for your suggestion.

We have corrected the way and added the explain to the discussion as follow.

P4L23: The captured intraoral scanner data were imported into CAD software (Dental System, 3Shape A/S, Copenhagen, Denmark). Using the double scan technique of CAD software, intraoral scanner data were superimposed onto the reference data on the basis of the incisive papilla (1 point) and the top of the bilateral maxillary tubercles (2 points) for the edentulous maxillary model and of the incisal point (1 point) and the centers of the bilateral retromolar pads (2 points) for the free end missing mandibular model (Fig. 1).

P6L18 : The method of superimposition in this study was feature based. Using the double scan technique of CAD software, the data were aligned by 3 points. The choice of points was for the operator to decide. Three points of the characteristic anatomical structures of the edentulous maxillary (incisive papilla and top of the bilateral maxillary tubercles) and the
free end missing mandibular model (incisal papilla and centers of the bilateral retromolar pads) were selected. In addition, it was also considered that the plane connecting each point is approximately the entire dentition.

Discussion:

Page 5, Line 55: I would avoid mentioning brand names within the text (except M&M) and instead use "intraoral scanner"

Thank you very much for your suggestion.

We have corrected it.

Page 6, Line 6: please indicate values/references for the precision of the intraoral scanner

Thank you very much for your suggestion.

However, the value could not be described because the manufacturer has not announced it. There is study comparing the RMS values of TRIOS2 and Laboratory scanner in recent studies, so this data is added for reference.

P6L12: Park et al. reported that the RMS value of the laboratory scanner (47.5±1.6 μm) is smaller than the intraoral scanner (343.4±56.4 μm) in fully-dented people.

Page 6, Line 29: The limitation of the study in regard to clinical relevance should be extended as major problems observed in-vivo (e.g. saliva, tongue, movement of the floor of the mouth, frenulum) are not simulated in this study design

Thank you very much for your suggestion.

We have added this limitation in the discussion.

P3L20: It should be mentioned at first that it is difficult to obtain data regarding the amount of tissue displacement of the residual mucous membrane and the functional morphology of mobile tissues such as the oral vestibular, lips, tongue and cheeks with an intraoral scanner.

P8L7: The limitation of this study was that the model we selected for the study had a completely different behavior, when compared to the behavior of human soft tissues.

Page 6, Line 37: the IQR is not provided in the manuscript

Thank you very much for your suggestion.

We have added the IQR.

P7L5: However, the interquartile range (IQR) for the maximum values of the difference and the integral values tended to be larger on the left side (IQR of the maximum value: 0.01 to 0.35mm, IQR of the integral value: 0.3 to 2.7mm) than on the right side (IQR of the maximum value: 0.00 to 0.10mm, IQR of the integral value: 0.2 to 0.9mm) of the free end saddles on mandibular model.
with practice…": it would be of interest whether the precision of scan no. 5 was closer to the reference scan compared to scan no. 1 of one dentist

Nice point of your view.

We have checked it.

Some dentists showed a tendency closer to the reference, but that did not necessarily follow.

Page 6, Line 51: please define "clinically acceptable range"

Thank you very much for your suggestion.

We considered that the maximum distance was within the tissue displacement range and was within the clinically acceptable range.

Therefore, we have corrected the discussion as follow.

P7L13 : Therefore, no significant difference was observed in inter-operator trueness, and as the maximum distances (0.04 to 0.60 mm) of the difference between the intraoral scanner data and reference data were the same or lower than the amount of tissue displacement (0.70 to 1.00 mm) [30], with practice operators can bring these errors to within a clinically acceptable range. It is suggested that intraoral scanning of edentulous area could achieve satisfactory capture by the operator.

Conclusion:

Page 7, Line 41: satisfactory precision should be explained by referencing literature

Thank you very much for your suggestion.

We considered that the clinical acceptable range is the satisfactory precision.

We have explained using result of this study and literature [30] in the discussion as follow.

P7L13 : Therefore, no significant difference was observed in inter-operator trueness, and as the maximum distances (0.04 to 0.60 mm) of the difference between the intraoral scanner data and reference data were the same or lower than the amount of tissue displacement (0.70 to 1.00 mm) [30], with practice operators can bring these errors to within a clinically acceptable range. It is suggested that intraoral scanning of edentulous area could achieve satisfactory capture by the operator.