Author’s response to reviews

Title: Deviations in palatal region between indirect and direct digital models: An in vivo study

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Author’s response to reviews:

Paola Cozza (Reviewer 1)

1. Figure 3 is missing
Response: Sorry about it. Figure 3 has been re-uploaded.

2. The sample is not well balanced by gender, too many females than males.
Response: We agree it is better to balance the sex distribution in samples. However, in our study, the balance was broken because of more females in volunteers (9 males: 26 females). And the statistical methods applied in this study were mainly one-way repeated-measures ANOVA and paired t test, which were about self-control, less impacted by sex distribution. We add the possible impact of sex-imbalance on the acquirement of palatal morphology in Discussion section (Manuscript-Discussion-5. Limitations, page 22).

3. Authors are requested to clarify: the exact meaning of Soft tissues, inclusion criteria of premolars extracted for past orthodontic treatment, how many days after they did the second scan, about third molars.
Response:
   i. The exact meaning of Soft tissues: In background, “soft tissue” first mentioned referred to the entire soft tissues in upper jaw model except dental arch, namely palate on palatal side and gingival mucosa on buccal side. However, in this study, palate was the study objective called “palatal soft tissue(s)” unified in Methods and following sections. The definition of study object’s boundary has been already described in Methods section (Manuscript-Methods-3D superimposition measurement, page 9 ).
   ii. Inclusion criteria of premolars extracted for past orthodontic treatment: The supplement was made in Methods section (Manuscript-Methods-Participants, page 7). Those who have had premolars extracted for past orthodontic treatment included in this study were required to have premolars symmetrically extracted and finished retention.
   iii. How many days after they did the second scan: The two intraoral scanning groups (Group Tr1, Group Tr2) were operated in succession. No more scans were made in neither of them. To verify the reproducibility of superimposition methods, the second
measurements of trueness on intraoral palatal scanning were done at least two weeks after
the initial measurements.

iv. About third molars: It was allowed to have third molars. However, third molars were not
included in the process of intraoral scanning and measurements.

4. some references about the topic are too old cite other papers as:

Journal of Clinical and Diagnostic ResearchOpen Access Volume 12, Issue 1, 1 January
2018, Pages ZC14-ZC17

analysis of the palatal morphology in children with impacted incisors: A three-dimensional
Response:
Thanks for your recommendation. We decide to cite the latter research referring to intraoral
scanning (see Methods section-Digital model acquisition-page 8 and the corresponding reference
rearrangement).

Philippe Boitelle, Ph.D (Reviewer 2)

The authors must refer to the ISO 5785 standards, which defines clearly the trueness and
precision.
Response: Thanks for your advice. The terms ‘trueness’ and ‘precision’ mentioned in this study
were referred to the ISO standards. In Background section (page 4, line 4-6), it read “Several
studies have investigated the accuracy of intraoral scans, which encompasses two parameters,
namely ‘trueness’ and ‘precision’ [2-5]”. The definition of ‘trueness’ and ‘precision’ was
clarified in those references according to the International Organization for Standardization
standard 5725-1. To avoid redundancy, specific definition of these two terms was not described
in this study. The screenshot below comes from Wikipedia website.

1. The proposed methodology is composed of two digital measurement chain. Before any
interpretation of the measurements, it is desirable to check the reproducibility of the
superimposition in each region and the reproducibility of each digital measurement chain.
Response: Thanks for your suggestion.

i. the reproducibility of the superimposition in each region: Supplements were made to check
the reproducibility of the other three superimposition methods except the UPRS method by
ICC analyses. Amendments can be viewed at Methods section-Statistical analysis (page 12),
Results section (Page 12) and Discussion section-1. Methodology (page 17).

ii. the reproducibility of each digital measurement chain: The reproducibility of absolute and
signed-value measurements can be represented by the reproducibility of Palatal-level
superimposition method. Amendments can be viewed at Methods section-Statistical analysis
(page 12) and Results section (page 12).
2. Indirect digital models can’t use as reference because the scanning are realized on the plaster model. The conditions for obtaining a reference are very precise. The scans should be realized with the same devices (intraoral scanners).
Response: Thanks for your advice. The reasons why indirect digital models scanned by extraoral scanner were considered as reference are as follows.

1) According to the definition, ‘trueness’ reflects the divergences between the golden standard/reference model and the test one. Plaster models (from alginate or PVS impression) were always considered as the gold standards in previous studies on accuracy of intraoral scanning on dental hard tissue. For 3D measurement of trueness on palatal soft tissue, dental arch, whose accuracy is already clinically acceptable, has to be selected for relative stable region in superimposition.
Considering the impact of soft tissue flexibility in impression process, in this study, plaster models were called reference models, not the golden standards. Trying to avoid the impact of flexibility, the distal boundary of the study object was also adjusted mesially.

2) In view of the following reasons, plaster models were scanned by a model scanner (3 Shape R700, Denmark) as reference. 1) This is a common practice to acquire indirect digital models in clinic (see Discussion section-1. Methodology, page 17). 2) The model scanner is provided with high accuracy (20μm) (see Method section, page 8). 3) If the model scanner was replaced by intraoral scanner, it could not determine what scanning strategy should be applied on palatal region as reference at the beginning of the study.
In future, it will be better to employ the combination of anatomical maxillary sample and extraoral scanner with high accuracy as the ideal golden standard for research of palatal accuracy.

3. The impression for the reference model, needed to obtain the plaster model, should be made of alginate in order to avoid as much as possible the flexibility of the palatal mucosa by the impression materials
Response: Thanks for your advice. The reasons for choosing PVS impression are as follows.

1) Although alginate impression is a common practice, it would be prone to choose PVS impression in fields where pretty high accuracy is required on dental arch, such as Prosthodontics and Orthodontics digital planning. It is because PVS impression materials are provided with excellent properties, such as dimensional stability, elastic recovery and better fine detail reproduction compared with alginate impression [1,2]. In this study, dental arch on reference model was required high accuracy to apply for reginal superimposition. Therefore, PVS impression was more suitable.

2) The tray used in impression process were with holes, which were good for relieving pressure [3].

3) Considering the flexibility and anatomical features in palate, the distal boundary of the study object was already adjusted mesially at the level of the mid-gingival margin of second molars. This area can nearly satisfy the need in routine clinical practice.


4. The major limitation of this study is the optical comportment of scanner in function of soft and hard tissue scanning. The optical proprieties are different between enamel and dentine and the palatal mucosa surface. A preliminary study is necessary to know if the difficulty in soft tissue accuracy of intraoral digital scans would be link to these optical proprieties.

Response: Thanks for your opinion. We can't agree more with it. It was consideration of the different features between dental hard tissue and palatal soft tissue, which might induce a distinction in the same optical scanning, that this study paid more attention to the accuracy of intraoral scanning on palate. Since the accuracy on dental arch has been verified to be clinical acceptable, in this study, adjusted-dental-level regional superimposition was applied to measure deviations of intraoral scanning on palate.

Emmanuel NICOLAS, DDS,PhD,HDR (Reviewer 3)

I would suggest to the author to nuance /open their discussion to the fact that only one type of IOS (Trios 3shape) was used, and that image capture could vary according to the type of IOS. For the future, an inter camera comparison using the same evaluation technique could be interesting to look at.

Response: Thanks for your advice. Supplement was made in Limitation (Discussion section-5. Limitations, page 22-23). In future, comparison among different intraoral scanners should be made to explore the divergency in reproducing palatal morphology.

Self-Correction:
Sorry for the error raised in Table 1 (Results section, page 13). The standard deviations of absolute-value deviations on palate were all mistaken by the standard errors. The corresponding corrections were made with red highlighting.