

## READER'S FORUM

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Validation of three-dimensional digital model superimpositions based on palatal structures in patients with maximum anterior tooth retraction following premolar extraction.

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I appreciate the authors' great efforts on the article titled "Validation of three-dimensional digital model superimpositions based on palatal structures in patients with maximum anterior tooth retraction following premolar extraction". This timely research topic is thought to be of interest to many orthodontists in line with the digital orthodontic trend.

**Q1.** The authors set the reference area for superimposition as the 3rd or 4th palatal ruga and posterior palatal vault. The palatal vault area was defined based on the tooth position (interdental contact point between the 2nd premolar and the 1st molar for anterior border, and between the 1st molar and the 2nd molar for posterior border). However, this palatal vault area would be changed as the molar moved forward during space closure. Could you elaborate on the reason for the designation of the palatal vault area based on tooth position?

**Q2.** The maxillary superimposition using the ruga area has a weakness that can cause yaw of the maxilla. For example, Figure 3C showed greater rotation of the maxillary arch than Figure 4D. Can we assume that remodeling of the ruga area would occur differ-

ently between the left and right side during retraction of anterior teeth? It would be helpful if the authors comment on further ideas to reduce yaw related errors on superimposition.

**Q3.** The palatal soft tissue remodeling during the retraction of anterior teeth would be an interesting topic to review. In the article, the more posterior movement of the rugae was observed as the anterior teeth were more retracted. Could you give us some insight into the soft tissue remodeling ratio compared to tooth movement? It would be also curious to what extent the palatal ruga returns to its original position depending on the retention period. Please comment on whether the same superimposition results would be expected for both the active retraction period and retention period by this method or not.

*Questioned by*

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Thank you very much for your questions and unique insights. Here is a point-by-point response to the questions and if you would like for further discussion, please feel free to contact us.

**A1.** The reason why we choose this area as part of reference area is based on previous studies in which the researchers used the miniscrews as landmarks for superimposition in extraction cases. The first key research was carried out by Jang et al.,<sup>1</sup> they concluded that the contour of the posterior region of the palatal vault was

not considerably changed during closure of the extraction spaces and a similar area, which was more posterior by a few millimeters but in the same lateral boundary, was selected as a reference in their second experiment. In the second key reference, a stable region of which distal boundary was defined by distal surface of the left and right maxillary first molars was found.<sup>2</sup> Therefore, this area was considered as a stable reference even though the molar moved forward during treatment. However, since this area contains less morphological characteristics, superimposition method using this area only is not recommended in our view.

**A2.** Thank you for bringing this to our attention. We agree with your assumption that the left and right may have a different remodeling pattern during orthodontic treatment. But we consider it as corresponding changes of the adjacent tooth movement and hard tissue remodeling which may have asymmetric changes. Not only yaw error but also pitch and roll error may occur when registering digital models. The yaw of maxilla in Figure 3C is bigger, which means inaccuracy of the superimposition method using the 3rd rugae in maximum retraction case. Meanwhile, Figure 3D is closer to the reality and the small amount of yaw was partially brought by midline correction of the upper arch. For the yaw related error during digital model superimposition, we recommend using symmetric stable reference area.

**A3.** The ratio or the pattern of the ruga area remodeling was not explained in detail yet but valuable points were

found when we did our literature review, and some were listed in this latest review.<sup>3</sup> The lengths, numbers, and positions of the rugae may be affected according to specific tooth movement or arch expansion, but individual characteristics did not change. The reference area we used in this study is stable in maximum retraction group with a median of 8.18 mm retraction. Therefore, we assume that it could be stable during the retention period in which the tooth might have no or only small amount movement due to relapse. In quest of scientific proof, this question calls for future studies that extend this superimposition method to prospective studies with a retention period included.

*Replied by*

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#### References

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