

Near the end of their letter, Brezniak et al quoted a sentence from our conclusion section and suggested that the conclusion is inappropriate. However, immediately preceding the quoted sentence, we wrote "Based on those findings, we might not be able to make definite predictions on the effect of these differences on the actual tooth movements. However, it is safe to conclude that different force systems produce different types of tooth movement; therefore, we would expect to see more vertical canine movement and less tipping of the adjacent teeth with passive ligation compared with conventional ligation."

Finally, we stated in our conclusion that the force system produced in this in-vitro study by passive self-ligation was more accurate because more consistent vertical extrusion forces (the desired force) and less mesiodistal or buccolingual forces (undesired forces) were generated. We assumed that *AJO-DO* readers would recognize that this is the first of many tests with the orthodontic simulator, and our data provided an example of its capabilities. It has taken 6 years to prepare and validate a 3-dimensional orthodontic force measurement tool that will be used for many tests to better understand a vaguely understood area of orthodontics. We continue to investigate the effects of the ligation method, and we are now gathering data, using a much larger sample size to be able to perform statistical tests. These data will be collected by starting the canine in the displaced position and ligating the teeth from the anterior to the posterior sequentially.

We have been approached by many academics and clinicians with numerous interesting research proposals to use this device, which is giving us a unique view into the world of 3-dimensional orthodontic mechanics. We plan to start an internship program for those interested in using the University of Alberta orthodontic research laboratory to investigate specific orthodontic biomechanic applications as part of a degree program or simply out of curiosity. We thank the doctors for their input and look forward to more discussions as more evidence is published and made available to *AJO-DO* readers.

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Reproducibility of the CVM method: A reply

We read with obvious interest an article published online in October 2009 about the reproducibility of the cervical vertebral maturation (CVM) method (Gabriel DB, Southard KA, Qian F, Marshall SD, Francisus RG, Southard TE. Cervical vertebrae maturation method: poor reproducibility. *Am J Orthod Dentofacial Orthop*

2009;136:478.e1-7). We would like to express a few concerns with regard to the methodology and the interpretation of the results of this study on the reproducibility of the CVM method.

First, in "Material and methods," the authors reported that the training of the orthodontists judging the CVM method consisted of their receiving a hard-copy handout of a schematic representation of the 6 stages of the CVM method and a legend, with no further explanation or training. Therefore, the exposure of the judging orthodontists to the method consisted of an extremely limited self-learning experience.

Also, the schematic representation of the CVM method that was given to the orthodontists (Fig 1 in Baccetti et al¹) never was proposed by the original authors as a guideline for the implementation of the CVM method in a clinical setting. That article described at least 2 examples of the shape of the third and fourth cervical vertebrae for the same CVM stage (more specifically, for stages CS 3, CS 5, and CS 6).

We actually are thankful to the authors for offering us an indirect suggestion to give clinicians and readers more detailed practical tips to perform the CVM method routinely on lateral cephalograms. Any descriptive categorization or staging of a biologic system requires an understanding of the nuances and subtleties of the method, since there is a gradual transition from 1 stage to the next.

Even considering the limited training opportunity of the judging orthodontists in the study, another concern relates to the interpretation of the results. As reported in the title (for us, it is highly unusual to include the study's conclusions in the title), the reproducibility of the CVM method was defined as "poor." In the introduction, the authors recommended the use of a "stringent measure of association . . . for measuring agreement between judges." However, no reference scale for the interpretation of the weighted kappa values for agreement between observers was reported in "Material and methods."

If we look at the results in Table IV, the weighted kappa coefficient for intraobserver agreement for individual cephalograms was between 0.36 and 0.79, with 9 of 10 observers scoring more than 0.41. According to the most widely used scale for the interpretation of weighted kappa in studies on intraobserver agreement (Landis and Koch²), a kappa value greater than 0.41 indicates either moderate (0.41-0.60) or substantial (0.61-0.80) agreement. It is noteworthy that 50% of the observers showed substantial agreement, 40% had moderate agreement, and only 1 observer showed fair agreement. The longitudinal portion of the study reported even better scores. We wonder how the authors were induced to define as "poor" an agreement that typically is considered to be moderate to substantial.

Interestingly, Ballrick et al³ from Ohio State University performed a similar study on both the accuracy and the reproducibility of the CVM method in orthodontic graduate students. Their results showed very good reproducibility (kappa value, 0.82), which would be interpreted as "almost perfect agreement" according to the scale by Landis and

Koch.² Thus, the findings and conclusions of the Iowa and Ohio State studies are in sharp contrast.

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REFERENCES

1. Baccetti T, Franchi L, McNamara J. The cervical vertebral maturation method for the assessment of optimal treatment timing in dentofacial orthopedics. *Semin Orthod* 2005;11:119-29.
2. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159-74.
3. Ballrick J, Fields H, Vig KWL, Beck F, Germack J, Baccetti T, et al. Reliability and validity of cervical vertebral maturation and hand-wrist radiographs. Proceedings of the 83rd General Session of the IADR/AADR/CADR; 2005 Mar 9-12; Baltimore, MD. Available at: http://iadr.confex.com/iadr/2005Balt/techprogram/abstract_62129.htm. Accessed December 16, 2009.

Authors' response

A clinically useful measurement must be reproducible. Drs McNamara, Baccetti, and Franchi claim that the CVM method has high reproducibility. They claim interoperator (between each other) agreement of 98.6% and intraoperator (between themselves) agreement of 100%.¹

The results of our study demonstrate that the CVM method has poor reproducibility. On average, CVM staging agreement among seasoned practicing orthodontists was below 50%, and the orthodontists agreed with their own CVM staging only 62% of the time. In a study at Ohio State University, the residents agreed with themselves 63% of the time for the CVM method.²

In a follow-up study, we discovered why the CVM method has such poor reproducibility.³ The weakness arises, in part, from difficulty in classifying the vertebral bodies of C3 and C4 as trapezoidal, rectangular horizontal, square, or rectangular vertical.

Drs McNamara, Baccetti, and Franchi criticized our teaching of the CVM method to orthodontists because their diagram "never was proposed by the original authors as a guideline for the implementation of the CVM method in a clinical setting." We trained our orthodontists using their method in a research setting, not a clinical setting.⁴ Our observers were experienced orthodontists. They received a cover letter explaining the procedure, and the exact reference material, diagrams, and descriptors accompanying the diagrams. They were allowed to use these reference materials freely during the judging with no time limit.

Our orthodontists looked at exactly the same radiographic images twice and used exactly the same logic to stage the vertebrae both times. Plainly speaking, if

the CVM method works, then our orthodontists should have easily staged the images the same both times. They did not.

Instead, we discovered a key point: a few of our randomly chosen subjects were easily staged repeatedly, but most were not. This implies that, if researchers dramatically reduce their subject sample size from a large sample to a much smaller sample, then they run the risk of selecting for the more easily staged radiographs. This could be a major source of error for Drs McNamara, Baccetti, and Franchi, who reduced their sample size dramatically.⁵

Additionally, the dentitions could give an observer clues as to the CVM stage. For this reason, we masked the dentitions in our sample. Drs McNamara, Baccetti, and Franchi did not.

Does the CVM method have merit? Some morphologic changes do occur with maturation. However, reliable and usable assessments must be reproducible in all subjects in a random population. Our study demonstrates that this is not true for the CVM method.

For 40 years, various methods of radiographic interpretation has surfaced purporting to accurately predict individual jaw growth. None has survived.

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REFERENCES

1. Franchi L, Baccetti T, McNamara J. Mandibular growth as related to cervical vertebral maturation and body height. *Am J Orthod Dentofacial Orthop* 2000;118:335-40.
2. Ballrick J, Fields H, Vig KWL, Beck F, Germack J, Baccetti T, et al. Reliability and validity of cervical vertebral maturation and hand-wrist radiographs. Proceedings of 83rd General Session of the IADR/AADR/CADR; 2005 March 9-12; Baltimore, MD. Available at: http://iadr.confex.com/iadr/2005Balt/techprogram/abstract_62129.htm. Accessed January 25, 2010.
3. Nestman T, Marshall S, Qian F, Holton N, Franciscus R, Southard T. CVM method morphologic criteria: poor reproducibility. *Am J Orthod Dentofacial Orthop*; 2010 (in press).
4. Baccetti T, Franchi L, McNamara J. The cervical vertebral maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. *Semin Orthod* 2005;11:119-29.
5. Baccetti T, Franchi L, McNamara J. An improved version of the cervical vertebral maturation (CVM) method for the assessment of mandibular growth. *Angle Orthod* 2002;72:316-23.

Soft-tissue considerations in mandibular setback

In the September issue, "Surgical orthodontic treatment for a patient with advanced periodontal disease: Evaluation with electromyography and 3-dimensional cone-beam computed tomography" (Nakajima K, Yamaguchi T, Maki K.