Letter to the editor

Observations on the effect of Invisalign correction

Invisalign is now widely used in daily clinical practice because of its aesthetics and effectiveness, which has been gradually recognized by dental professionals and patients. According to its producer, from its release till now, it has continuously undergone significant development. This is why we read the article by Haouili et al with great interest (Haouili N, Kravitz ND, Vaid NR, Ferguson DJ, Makki L. Has Invisalign improved? A prospective follow-up study on the efficacy of tooth movement with Invisalign. Am J Orthod Dentofacial Orthop 2020;158:420-5). This article reported that the mean accuracy of Invisalign for all tooth movements was 50%, which is a significant improvement from a 2009 study, but the strengths and weaknesses remained relatively the same. From our aspect, we still have several questions.

First, the authors described in the Material and Methods section that the samples consisted of adult and adolescent patients diagnosed with Class I, Class II, or Class III malocclusion, but nothing was mentioned about the facial pattern (hypodivergent, normodivergent, or hyperdivergent). From classic orthodontic theory, the facial pattern may have a significant effect on tooth movement. We wonder whether facial patterns might have had some influence on the conclusion of the research.

Second, this study used the best-fit algorithm, which superimposed the individual teeth from the initial model over the equivalent teeth of the final model. If an Invisalign treatment protocol involves movement of the entire arch, as an example, the treatment protocol in Figure *A* of the original article, the position of all teeth may have undergone corresponding changes. Under this circumstance, no position can be used as the reference; hence, the best-fit algorithm may no longer be applicable. We believe that superimposition on the basis of x-ray or cone-beam computed tomography is a better way to solve this problem.[1,2] The authors also mentioned that a best-fit analysis might underestimate the product's overall clinical efficacy in their conclusion, which we think is a lack of evidence. There is no superimposition on the basis of cone-beam computed tomography, how can we tell whether best-fit analysis underestimates or overestimates the overall clinical efficacy?

Finally, we believe that there are some flaws in this study. Although the authors mentioned that the American Board of Orthodontics cast evaluation system was used for model scoring, there was no mention of how much the American Board of Orthodontics score changed after treatment. Moreover, from an average treatment time of 8.5 months and the mean number of aligners (21 maxillary and 20 mandibular) per arch, these cases are relatively simple. As a result, to what extent can Invisalign do when targeted at a wide range, long-distance tooth movement? Evidence is still lacking.

Yimeng Cai
Jialing Liu
Wen Liao
Chengdu, Sichuan, China

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2. Liao W, Pan F, Yao Y. Three-dimensional observations of the effects of third molars on orthodontic treatment. Am J Orthod Dentofacial Orthop 2019;155:613-4.

Authors' response

We thank the readers for their interest in our paper. A few points were raised that we will try to answer.

The first point was that the sample did not take into consideration the growth pattern of the patients. The author is absolutely correct. Certainly, a hypodivergent patient would struggle greater with overbite correction. In our study, mandibular incisor intrusion was one of the least predictable movements, which is consistent with other Invisalign studies that also did not factor in the patient's growth pattern.

The second point was regarding whether cone-beam computed tomography would have been better for model superimposition. Our study used a best-fit algorithm that has been used many times in the literature. This registration does not depend on stable structures but rather uses the whole surface during the computation of the

registration parameters. Nonetheless, you are ultimately correct in stating that a best-fit algorithm is an imperfect method. Simply, it appears to underestimate the product's efficacy. After all, it would be ludicrous to take away from this paper that Invisalign is only 50% effective. Perhaps a resident could expand on the research by Grauer et al.[1] and devise a master's thesis on a more accurate method for superimposing predicted and achieved digital models for future Invisalign research.

Finally, we agree with the third point, in that the malocclusions treated were relatively moderate. Perhaps, this was also a function of choosing appropriate Invisalign patients during the consultation. Still, we were testing individual tooth movements and not malocclusions. For example, we all have Invisalign patients with simple malocclusions who ultimately had unsuccessful treatment because of an inability to extrude a maxillary lateral incisor or rotate a mandibular canine.

We hope that we have shown that the Invisalign system is clearly improving but still struggles with certain types of tooth movements, notably rotations of rounded teeth and mandibular incisor intrusion in nongrowing patients. We will be certain to include all of the suggestions for improvements for future follow-up studies.

Neal Kravitz
South Riding, Va

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Lip profile changes in extraction patients

An article in the November 2020 issue by Mishra et al compared posttreatment lip profile changes in patients with Class II Division 1 malocclusion and skeletal Class I malocclusion (Mishra D, Natarajan M, Urala AS. Lip profile changes in patients with Class II Division 1 malocclusion of varied growth patterns treated with maxillary premolar extractions: a pilot study. Am J Orthod Dentofacial Orthop 2020;158:684-93). We noted some errors in the article. In the Abstract, it is mentioned that significant differences in SNA for groups 2-4 were observed, but Table III mentions a nonsignificant difference for SNA.

In the Material and Methods section, the standard exposure parameters and film size were given as 65 mA, 7 kVp, and 8 × 10 cm. However, the standard exposure parameters and film size are 10 mA, 70 kVp, and 8 × 10 inches.

In Table I, under the heading "Linear soft tissue measurements," the contours of the soft and hard tissue are reportedly denoted by a *red dotted line* and a *blue line* in Figure 2. However, Figure 2 does not include *red dotted* or *blue lines*.

In Table II, the linear measurements for L1 to NB for pretreatment and posttreatment are given as 7.48 ± 2.29 and 7.48 ± 2.29, but in Figure 4, the linear measurements for L1 to NB for pretreatment and posttreatment are 7.48 and 6.76.

In the Results section, the description for Table III is mentioned in terms of significant correlation between different groups. We believe an analysis of variance with post-hoc Dunnett test was used in Table III, so results should be mentioned in terms of significant difference instead of significant correlation. The Results section also mentions significant increases in lower lip length and nasolabial angle posttreatment. In contrast, the first Conclusion reports significant decreases in lower lip length and nasolabial angle posttreatment.

The Discussion section mentions that significant increases in the mandibular incisor to NB (degrees and millimeters) were observed in group 2 followed by group 3 compared with group 1. However, Table III shows that there is no significant difference for mandibular incisor to NB (millimeters). The Discussion section also reports that increase in Mp-SN angle and reduction of facial height ratio in group 3 (intermediate angle) followed by group 4 (high angle) and significant difference between skeletal parameters such as SNA ($P = 0.003$) and ANB angles ($P < 0.001$) for Class II Division 1 malocclusion is shown in Table I. We believe the wrong Table was cited.

Ekta Yadav
Mukesh Kumar
Manish Goyal
Prateek Bhushan
Uttar Pradesh, India

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Authors' response

Thank you for your careful reading of our article reporting changes in lip profiles. We take this opportunity to improve our choice of words and correct several of our errors.

In the Abstract and the Discussion section, the choice of the word "significant" was incorrect. In the Abstract,