ORTHODONTICS

Inaccuracy of clear aligners

BACKGROUND

Invisalign has become an essential part of orthodontic practices based on public demand. However, assessments of the capabilities and limitations of clear aligners have been limited. An initial objective review suggested that Invisalign is not as effective as fixed appliances for expansion, seems to cause more relapse, and is relatively ineffective in controlling buccolingual inclination, occlusal contacts, occlusal relationships, overjet, and overbite. A new aligner material (SmartTrack) was introduced in 2013, which is touted as having properties superior to its predecessor and as being able to exert continuous forces for a longer period of time. Despite advances in the technologies of clear aligners, clinicians still find that a refinement stage is often needed. The accuracy of specific tooth movements with Invisalign was determined to identify possible reasons refinement is required.

METHODS

Twenty adult patients (age 18 to 79 years) completed the study. Each subject was determined to be an appropriate candidate for Invisalign treatment based on a need for correction of mild (0-3 mm), moderate (3-6 mm), or severe crowding (> 6 mm), minor spacing issues, deep overbites, or anterior open bite. Aligners were changed every 2 weeks, and treatment duration averaged 12 months. All Invisalign aligners used the SmartTrack material. Digital models were exported as stereolithography files, with the initial and final models labelled as "initial" and "predicted," respectively. The initial models of the refinement were labelled as "achieved" because they depicted the actual result after the aligners had been worn as initial planned. The initial, predicted, and achieved digital models were imported into SlicerCMF, an open-source software able to superimpose the predicted and achieved models over the initial ones. Measurements were made on the initial versus predicted and the initial versus achieved models to determine the magnitude and direction of the predicted and achieved movement. A total of 398 teeth were measured, with 50 predicted and 50 achieved movements determined for each patient for horizontal movements, vertical movements, rotations, and transverse changes.

RESULTS

Horizontal movements of the incisors seemed accurate, with just small or insignificant differences identified. Incisor extrusion was also accurate, exhibiting no significant differences. The most inaccurate of the linear movements was intrusion of the incisors, with the maxillary central incisors having the largest difference at 1.5 mm.

The horizontal movement of the canines showed significant discrepancy in the maxilla but not the mandible. Similar findings were found for intercanine width change. Vertical canine movement was more predictable in the maxillary arch than the mandibular arch even though the movement planned for the mandibular arch was greater.

Interpremolar expansion was accurate in both arches. The median planned movement for vertical movement of the mandibular first premolars was just 0.2 mm, and no significant discrepancies were found.

All the teeth had significantly smaller rotations than planned. The greatest discrepancies in rotation were 3.05° in the maxillary canines and 2.45° in the mandibular canines. The least discrepancy was 0.9° in maxillary premolar rotation.

DISCUSSION

Significant differences were found for the rotations and vertical movements achieved using clear aligners. The horizontal movements achieved tended to be as predicted. Inaccuracy was greatest for rotations of the canines and intrusions of the incisors. Overcorrection of these movements may decrease the need for refinement.

Clinical Significance

Although further research is needed to validate the findings of this study, it seems apparent that clear aligners have some drawbacks that could lead to extended treatment times to refine the results. Although horizontal movement tended to be as planned, canine rotation and incisor intrusions tended to be less than what was predicted. In addition, the means for measuring the status of the aligner's progress may need to be further refined. Certainly studies should use larger samples with fewer variables to evaluate.

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