**Dental Monitoring (Paris, France)**

**Assessment Request:** A request was submitted by an individual member for an assessment by the AAOF Rapid Assessment of Evidence (RAE) Committee to determine the "reliability" of the Dental Monitoring[TM] product (DM).  Specifically, the requestor indicated that the company claims that "*DM is the most innovative help to Aligner treatment in at least 10 years. The true revolution is in finally providing doctors with a measurable way to monitor their patients' aligners.*"  The specific question posed is "*How reliable are dental monitoring devices?*"  The member inquiring does not appear to have a financial interest in this product nor any competing interest.  The potential for this type of product is apparent, particularly when unexpected circumstances make it difficult or impossible to see a patient in person.  However, the product's usefulness depends on its reliability.  This product loosely fits into the "Teledentistry" category of products intended to allow remote monitoring and reduce routine visits.  The product is ideally positioned to complement clear aligner therapy (CAT) because CAT does not require use of elastic modules and other auxiliary appliances.  However, while this assessment of evidence will focus on the Dental Monitoring[TM] system related to CAT progress, it is of note that the Dental Monitoring[TM] devices may be used for monitoring of traditional orthodontic appliances to determine progress (i.e. space closure, impacted canine eruption, compliance, hygiene, etc.).

> **Commented [WA1]:** Not so current anymore.  Oops.

The challenge with determining "reliability," is that this may depend on what the practitioner hopes to accomplish with the product.  If by reliable the requestor means that they want to determine how consistently and reproducibly the product performs, then it is important to establish how the provider will be using the product.  This review assumes that the goal in question is to monitor and guide the sequential use of CAT progress.

**Background:**  Dental Monitoring[TM] (Paris, France) is a software-based program composed of 3 integrated platforms that allows practitioners to remotely monitor patients' treatment progress. The primary functionality is through the use of the patient's mobile phone and mobile app, a patented movement tracking algorithm and a web-based Doctor Dashboard allows receipt of updates from the patient (https://dental-monitoring.com/smilemate/).  There are limited evidence-based publications specifically on the Dental monitoring product, but a summary is as follows:

L.-C. Roisin et al. (J Dentofacial Anom Orthod 2016;19:408: DOI: 10.1051/odfen/2016021) provide a summary of the dental monitoring concept  but no information is provided on reliability or validity.  The article asserts that Dental Monitoring[TM] "provides precise measurements from settings outside the clinic, and in between appointments."  The paper provides the following references in support of the science behind the "precise measurements:"

> 1. Aggarwal J, Vemuri B, Chen Y, Medioni G. Range Image Understanding Object modeling by registration of multiple range images. Image Vis Comput 1992;10(3):145-155.

> 10. Dutagaci H, Cheung CP, Godil A. Evaluation of 3D interest point detection techniques via human-generated ground truth. Vis Comput 2012;28(9):901-917.

> 21. Jia Y, et al. Caffe: Convolutional Architecture for Fast Feature Embedding. ArXiv14085093 Cs [Internet]. 20 juin 2014; Disponible sur: http://arxiv.org/ abs/1408.5093

A manuscript published in *Seminars in Orthodontics* (Vol 24, No 4, 2018: pp 470 - 481) evaluated the application of remote monitoring entitled "Remote monitoring and 'Tele-orthodontics': Concept, scope."  While the study revealed patient-perceived benefits including, "better communication," "increased convenience," and "reduced number of appointments," the findings are based on preliminary results where notably only 3 patients in the experimental group had completed their treatment regime.

In another evidence-based publication in fulfillment of an MS degree, one candidate (Vahe Ohanesian), evaluated 30 patients undergoing orthodontic treatment where the DM system compared to a traditional IO scanner (thesis). The final work, entitled *Reliability and Accuracy of a Novel Photogrammetric Orthodontic Monitoring System,* revealed that the study demonstrated a high level of accuracy when comparing movements tracked by the Dental Monitoring™ system against those of the reference scanner. The report also concluded that there were no macro-level differences detected in the accuracy of the proprietary system when comparing upper versus lower arches or anterior versus posterior sextants. However, the study did find that microlevel differences were noted in that greater deviation were associated with first molars as compared to central incisors and canines, despite these being deemed clinically insignificant. It was concluded that the proprietary system exhibited high levels of both intra-user and inter-user reliability.

Further, two more theses manuscripts from students in the same graduating class assessed the DM system and found it to be no different when comparing models generated from an iTeRO˚Element™ intraoral scanner versus those generated from the DM application in video mode. They also found that the 3D digital dental models produced by DM saw increases in "global deviations," that is, they technology became less accurate over successive exams (i.e. over 300), but these global deviations were deemed *not* clinically significant. Taken together, this study (now published) showed that 3D digital dental models generated by the Dental Monitoring™ smartphone applications in photograph and video modes are accurate enough to be used for clinical applications (AJO-DO;2019:156;3,420-428 https://doi.org/10.1016/j.ajodo.2019.02. 014)

**Assessment:** The DM company purports to offer an innovative system to facilitate a measurable way to monitor the patients' teeth. This claim based on the information provided appears to be reasonable and appropriate for the intended purpose of "monitoring" aligners. However, the evidence-based data is limited at this time and should be expanded to thoroughly vet the applicability of the DM system. Further, the reality that orthodontists and dentists alike may seek novel and creative ways to deliver patient care in a post-COVID reality makes this product just that more relevant. The likelihood of synchronous and asynchronous monitoring increasing is high. The burden of how and when to implement this approach will fall on the licensed provider. It will require an understanding of the Dental Practice Act laws in their respective states and whether these laws align with the product offerings of the DM company.

Invisalign has launched a software product comparable to Dental Monitoring™ that also allows for remote monitoring. Hence, this suggests that similar products will likely become more commonplace soon with reliability being imminent. Ultimately, the onus will be on the orthodontist to enlist the appropriate treatment plan and determine what strategy fits within the limits of the plan execution. Therefore, the major aspect of reliability will be whether this remote monitoring product offers a consistent and useful adjunct to "seeing" the patient in-person. Undoubtedly, this product offers an option for convenience and flexibility and may represent an acceptable adjunctive approach for the future of our profession.