The improvement of predictability in Clear Aligner treatment in conjunction with Digital Monitoring

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Abstract

The primary objective of this study is to evaluate the Tpredictability of orthodontic treatment with clear aligners monitored by Dental Monitoring® (DM) and to assess if using the DM system can actually lead to better results and shorter treatment times. A secondary objective is to assess whether the DM system can be more effective in monitoring one type of malocclusion over another, namely: crowding, crossbite and diastema. A total of 55 patients treated consecutively with clear aligners were selected. All patients were asked to use the DM system with scheduled appointments at 7–8-week intervals. Our results show that photos and scans taken in the chair correspond accurately to the photos and scan taken by the patient using the DM system. Results also show that the different malocclusions did not show any difference in predictability when using the DM system. This study concluded that treatment time was indeed reduced in terms of total number of in-office appointments.

Keywords: Dental Monitoring; clear aligners; predictability; treatment plan.

Introduction

Teleorthodontic technology and remote monitoring of patients have become an imminent reality that allows orthodontists to proactively monitor their patients through virtual controls that are an integration with those in the clinic. [2]

Literature suggests that this technology leads to better clinical outcomes and high patient and physician satisfaction by dramatically reducing chair time. [1]. Since orthodontic treatment usually lasts for months, it is essential to guide the patient and follow their compliance in order to obtain the most beneficial results from the treatment. Dental Monitoring (DM) is a recent invention that combines teleodontology with artificial intelligence (AI) and allows orthodontists to monitor their patients' treatment progress remotely using the patient's own smartphone to take photographs or scans. Furthermore, the DM software can build three-dimensional (3D) digital models from these scans. [7] The program consists of three integrated platforms: 1) a phone application for the patient, 2) a patented algorithm that evaluates orthodontic movements and 3) a web platform where professionals receive updates on the evolution of their patients' treatment. When patients take scans, the images are uploaded to the program's servers and verified to ensure that their quality is sufficient to be processed by the Dental Monitoring algorithm, which can calculate tooth movement with high precision. [3]. In orthodontics, the DM system allows the treating doctor to monitor the loss or detachment of brackets, tubes, bands and buttons, injuries from broken hooks or temporary anchoring devices (TAD), broken ligatures, escape of the arch occlusal interference with a tooth or a bracket, oral hygiene, soft tissue inflammation, damage to the teeth, signs of aphthous stomatitis, cleanliness of appliances, gum recessions, and stability of fixed and removable retainers. In particular, during an orthodontic treatment with clear aligners, monitoring can be carried out at each aligner change, according to the protocol chosen by the orthodontist. [9-10]. The DM system notifies the treating doctor of various data: the "tracking" option allows the clinician to remotely follow the treatment at each change of aligners, to evaluate the fit of the aligner. The option "loss of glued auxiliary" allows the doctor to monitor the integrity of the auxiliaries. The "auxiliary device" option can evaluate the presence and maintenance of buttons and elastics. The "damage to aligners" option is essential to ensure proper integrity of the teeth and aligners. The clear aligner system consists of custom-made aligners that perform orthodontic tooth movements by applying compression and traction forces to the periodontium. Optimal tooth movement occurs when continuous orthodontic forces are applied and maintained, hence, making it necessary to change the aligners regularly to counter the effects of aligner force degradation and loss of elasticity with in vivo use. Most clear aligner makers suggest that these changes are needed on average after one to two weeks of wear. Regular replacement of aligners requires a high level of patient compliance [11-12]. In patients with poor compliance, treatment times may also increase due to the need for further refinements which is due, in turn, to

less-than-ideal results.[13-14].In this retrospective study, the primary objective is to evaluate the predictability of orthodontic treatment with clear aligners monitored by DM, and to assess if using the DM system can actually lead to better results and shorter treatment times by monitoring patients closely and more accurately, and following the treatment plan as set up using the Invisalign ClinCheck® **software.**

In our study, the patients were divided into three groups corresponding to three different orthodontic problems: crowding, crossbite and diastema. The secondary objective is to assess whether the DM system can be more effective in monitoring one type of malocclusion over another.

Materials and Methods

A total of 55 patients treated consecutively with clear aligners were selected by the University of L'Aquila of which, 32 belonging to group A: patients with dental crowding in both arches, 15 to group B: patients with multiple diastemas, 8 belonging to group C: patients with anterior crossbite, unilateral or bilateral. Patients were followed up with Dental Monitoring (DM) during the approximately 12-month course of treatment and have the following inclusion criteria:

- treatment with at least 20 clear aligners in the first treatment phase
- non-extraction treatment
- patients with full permanent dentition
- patients who did not have agenesis or other dental anomalies.

The exclusion criteria were as follows:

- need for orthognathic treatment
- anomalies of enamel and dentin.

Patients were treated by a single orthodontist provider (S.C.) and all patients were asked to use the DM system at the start of their treatment with scheduled appointments at approximately 7-8week intervals. Each group changed aligners approximately every 10 days with an average wear of 22h per day. However, this aligner change protocol could vary based on how the DM software instructed the patient as to whether to proceed to the next aligner or continue wearing the same aligner one or several days longer. Frontal and lateral DM scans were processed and compared at time T0 (before treatment) and at time T1 (after approximately 12 months of treatment). The DM software highlights at each aligner change both the degree of gingival inflammation present and the location of the various dental misalignments. (Fig.1-2).

These measurements were verified by two doctors: MEDF and SA.C.

Results

The scans obtained using the DM application at time T0 and T1 were then compared. We found excellent correlation in the first year of therapy between clinical teeth alignment and the planned alignment in the ClinCheck® treatment plan. (Fig.3-8). During the course of treatment, the "negative" comments provided by the DM system, which indicated poor oral hygiene or a lack of aligner tracking, made it possible to immediately identify the

Figure 1. Platform of DM of the first case

Figure 2. Platform of DM of the second case

Figure 3. Pre-treatment of crossbite case

Figure 5. Pre treatment of diastema case

Figure 4. Post treatment of crossbite case

Figure 6. Post treatment of diastema case

Figure 7. Pre treatment of crowding case

Figure 8. Post treatment of crowding case

problem and make corrective measures. In addition, the proper wear of the aligners, and the correspondence of the photos taken in the dental chair with those of the application were compared at each appointment, detecting an almost total correspondence between both sets of photographs. Our study evaluated whether there were differences in the predictability of treatment based on the different malocclusions. The results showed that the malocclusions did not show any difference in predictability over the first year of therapy.

Discussion

Treatment with clear aligners requires careful and thoughtful digital planning in order to achieve successful dental movements throughout treatment until the finishing stage and make this technique more predictable. In our study, the patients recruited and subjected to orthodontic treatment with clear aligners were monitored using the DM system where a sequence of scans were generated that corresponded to the various treatment phases. The primary objective was to evaluate the predictability of orthodontic treatment with clear aligners monitored by DM and to assess if using the DM system can actually lead to better results and shorter treatment times by following patients closely and more accurately, and following the treatment plan as setup using the ClinCheck® **software**. The results obtained in our study are in agreement with the literature [8,3] as they demonstrated excellent therapy control and a correspondence between the scans performed through the application and the office visits with intervals of 7-8 weeks. Furthermore, the study showed that after about 12 months, the scans obtained using the DM application showed excellent results for all three monitored malocclusions. [4,5,6]. The study by

Hansa et. al, measuring the effect of treatment monitoring with DM, recorded a reduction in treatment time of 1.8 months for patient using the DM system. In addition, a reduction in appointments of 33.1% over the total duration of treatment was recorded in the study. Patients with crowded dentitions showed a prevalence of negative comments regarding poor oral hygiene. The first set of aligners was completed without the need to interrupt the treatment and perform a refinement ahead of schedule.

Conclusions

This study showed that therapy time was reduced in terms of the number of appointments and this indicates that there is also a reduction in material costs and number of visits. In addition, there is an increase in the frequency of patient monitoring, resulting in a more accurate assessment of the treatment by the orthodontist. Furthermore, these results reveal an important precision in terms of the development of the DM system that allowed the doctor to follow the patients remotely, achieving the pre-established objectives. The limit of the study refers to the lack of occlusal scans of the dental arches and therefore to a lack of overlap with the digital models processed by the 3D scanner.

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