SCIENTIFIC ARCHIVES OF DENTAL SCIENCES (ISSN: 2642-1623)

Volume 5 Issue 2 February 2022

Case Report

Skeletal Class III Malocclusion Treated with Clear Aligners and Remote Digital Monitoring during the COVID-19 Pandemic. A Case Report.

Linda Sangalli[1,2]* and Laura Laffranchi[1]

[1]*Dental School, Department of Medical and Surgical Specialties, Radiological Sciences and Public Health, University of Brescia, Brescia, Italy*

[2]*Department of Oral Health Science, Division of Orofacial Pain, University of Kentucky, College of Dentistry, Lexington, Kentucky, USA*

***Corresponding Author:** Linda Sangalli, Dental School, Department of Medical and Surgical Specialties, Radiological Sciences and Public Health, University of Brescia, Brescia, Italy.

Received: October 31, 2021; **Published:** January 28, 2022

Abstract

Class III malocclusion is a growth-related dentofacial deformity and one of the most challenging treatments for orthodontists. The ideal management of skeletal Class III malocclusion in non-growing patients is an ortho-surgical approach, aimed at modifying the skeletal deformity. However, not every patient is willing to undergo an orthognathic surgery. Hence, for selected cases, an orthodontic camouflage with clear system, such as Invisalign®, may constitute a feasible treatment option.

The purpose of this case report is to present a 26-year-old Caucasian male with a severe skeletal Class III malocclusion and a negative overjet of 2.9 mm, who dismissed the ortho-surgical option in favor of an orthodontic camouflage with Invisalign®. The management of the case was further complicated by the residence of the patient outside the country and by the national lockdown secondary to the COVID-19 pandemic, which caused the interruption of in-office appointments. To overcome the unexpected obstacle, the retention phase was remotely monitoring with Dental Monitoring®, which allowed the clinician to monthly monitor the dental movements of the patient in absence of chairside visits thought 3D analysis of pictures periodically uploaded by the patient himself. This case suggested that, in selected patients, an orthodontic camouflage with Invisalign® may represent a favorable treatment option, and digital technologies may facilitate a continuity of care, especially in unprecedent times like the current COVID-19 pandemic.

Keywords: *Dental Monitoring®; Skeletal Class III Malocclusion; Invisalign®; Clear Aligners; Remote Monitoring System; COVID-19 Pandemic*

Abbreviations

DM: Dental Monitoring®; OJ: Overjet; OB: Overbite; SNB: Sella-Nasion-B Point Angle; U1-SN: Upper Incisor to Sella-Nasion Angle; L1-MM: Lower Incisor to Mandibular Plane Angle; U1/A-Pog: Upper Incisor to A-Pogonion Line; L1/A-Pog: Lower Incisor to A-Pogonion Line; IPR: Interproximal Reduction; PVS: Polyvinyl Siloxane

Introduction

Class III malocclusion constitutes one of the most challenging treatment management in orthodontics. It can include a mandibular prognathism, a maxillary deficiency or a combination of both [1]. Early orthopedic treatment options are available to influence the residual growth in children and adolescents. However, for those patients with a skeletal discrepancy and no residual growth left, an ortho-surgical approach targeting maxillary and/or mandibular bone is suggested as the ideal treatment plan [1]. Nevertheless, not every patient agrees on undergoing an invasive procedure such as an orthognathic surgery. Therefore, in selected cases, an orthodontic camouflage may be proposed, which includes the dentoalveolar compensation of the underlying maxillary and mandibular skeletal discrepancy by displacing the teeth in relation to the supporting jaws [2], with resulting proclined upper incisors and retroclined lower incisors [3,4]. In cases of orthodontic camouflage, it is important to establish realistic treatment objectives, and to effectively communicate possible aesthetic compromise of the therapy to the patient. For these situations, systems that allow for a careful digital

planning and for a strict control of dental movement and vertical dimension are desirable, such as clear aligners.

In the past 25 years, clear aligners have constituted a revolution for the modern Orthodontics. At first, they were recommended only for the management of mild-to-moderate dental crowding [5]. However, their encouraging advantages in aesthetics, in facilitating oral hygiene performance, in applying controlled forces in compromised periodontal dentition, and in the possibility of fewer in-office visits, allowed this orthodontic system to embrace the treatment of more complex cases [6,7]. In particular, systems of clear aligners, such as Invisalign® (Align Technology©, San José, California, USA), are particularly indicated in some specific malocclusions thanks to their delicate control of each dental movement [8]. Specifically, Invisalign® system may constitute a feasible option for cases of Class III malocclusion with orthodontic camouflage in non-growing patients, where aesthetic demands, a strict control of dental movements of the anterior teeth and of the verticality are often required thorough the entire treatment.

Especially in those situations where orthodontic treatment alone is not the optimal therapy and incisors are being proclined or retroclined to favor dentoalveolar compensation, a closer monitoring of the stability of the occlusion in the retention period at the end of an active orthodontic treatment appears particularly useful. Unfortunately, from December 2019 the spread of a worldwide pandemic due to SARS-CoV-2 infection imposed lockdowns and restriction in mobility within and among the countries. Dental offices were not immune from such imposition, and non-urgent in-office visits were suspended, in favor of telehealth services [9]. Due to the crucial role of the first months of retention phase at the end of an orthodontic treatment [10], the integration of systems of remote monitoring, such as Dental Monitoring (DM, Dental Monitoring® SAS, Paris, France), to the retention period appears of valuable assistance [11]. DM consists of a digital integrated software, that allows the patients to regularly take pictures of their dentition with a smartphone, patented cheek retractors and a ScanBox®, and upload them on an integrated platform, shared with the clinician [12]. One of the functionalities of DM is three-dimensional (3D) Monitoring Light®, which performs calculation of dental movements and two-dimensional (2D) clinical analysis, by superimposition of the initial virtual dental casts with monthly intraoral scans [13]. Thus, the doctor can regularly evaluate the uploaded pictures to early detect any potential orthodontic relapse. Remote digital technologies such DM appear particularly useful in situations where in-office visits may not be feasible, i.e. in times of the current COVID-19 pandemic, or when the patient lives abroad [14-16].

Case Report

We present the case of a skeletal Class III malocclusion with a negative overjet (OJ) of 2.9 mm, in a healthy 26-year-old male, managed with an orthodontic camouflage using Invisalign®, in-office visits scheduled every 3 months due to the location of the patient outside the country, and monthly follow-ups using DM in the retention period during the lockdown secondary to the COVID-19 pandemic.

Materials and Methods

Appropriate informed consent was obtained from the patient for publication and divulgation of accompanying photographs.

Diagnosis and Etiology

A 26-year-old Caucasian healthy male presented for an orthodontic evaluation for a chief complaint of "dental crowding and reverse bite". He admitted having consulted several other providers to gather information on potential treatments; however, each clinician was concordant in proposing an ortho-surgical approach to treat his malocclusion. Nevertheless, the patient refused to undergo any orthognathic surgery.

General medical history was noncontributory, and dental history revealed a previous trauma to the upper left central incisor. He denied any known familiarity for Class III malocclusion and any previous orthodontic treatment. At the moment of the consultation, the patient expressed another concern: he was living in London (United Kingdom), and he could travel back to Italy for in-office orthodontic appointments approximately every 3 months.

Frontal extraoral examination revealed a pronounced asymmetry of the lower third of the face. On smiling, a midline deviation to the left side by 4 mm and limited exposure of upper incisors were detected. Lateral extraoral examination showed a concave profile, characterized by a marked mandibular prognathism and a flat naso-labial angle. Right and left profiles appeared markedly different (Figure 1A).

Frontal intraoral examination revealed a left unilateral crossbite, a midline discrepancy with a shift of the lower midline to the left, dental crowding in the upper arch, negative bucco-lingual inclination of the lower molars and premolars, an overbite (OB) of 2.3 mm, and an unaesthetic composite restoration on the left upper central incisor, consistent with the reported dental trauma. Lateral intraoral examination revealed molar and canine class III relationships, more severe on the right side, an anterior crossbite, an OJ of -2.9 mm and a flat curve of Spee (Figure 1B and 1C). No signs or symptoms of temporomandibular disorders were reported; swallowing and speech appeared normal and functional. Occlusal contacts were detected on the buccal inclines of the upper and lower posterior teeth and canines (Figure 2). A periodontal evaluation of the patient excluded any sign of gingivitis and periodontal pockets.

The pre-treatment panoramic radiograph showed a complete permanent dentition, radiopaque intracanal material on the upper left central incisor, consequence of the dental trauma reported by the patient, pronounced antigonial notch, parallelism of the dental roots and normal alveolar bone levels. Only the right condyle was visible on the radiograph, which appeared rounded and regular in morphology, with no sign of osteoarthritic changes and bone erosion (Figure 1D). The lateral cephalogram revealed a skeletal Class III malocclusion (Wits appraisal = -4.85 mm), characterized by a mandibular prognathism (SNB = 84°). The maxillary incisor proclination (U1-SN = 120°, U1/A-Pog = 3.74 mm) confirmed the dento-alveolar compensation of the dentition in the presence of a skeletal malocclusion. Lower incisors did not appear to be retroclined in respect to the supporting mandibular bone (L1-MM = 98°, L1/A-Pog = 8.47 mm) (Figure 1D and Table 1).

Figure 1: *Pre-treatment extra-oral (A) and intra-oral (B) photographs, dental casts (C) and radiographic examination (D) panoramic radiograph and cephalogram*

Figure 2: *Pre-treatment intraoral views from ClinCheck®: frontal, lateral (A) and occlusal views, with occlusal contacts highlighted in green color (B).*

Values	Pre-treatment	Norm values, mean (± SD)
Skeletal measurements		
SNA (°)	82	82 (2)
SNB (°)	84	80 (2)
ANB (°)	2	2 (2)
Wits (mm)	-4.85	2 (2)
SN-MP (°)	22	31.71 (5.19)
FMA (°)	21	25 (5)
MM (°)	22	28 (6)
Dental measurements		
U1-SN (°)	120	103 (5)
L1-MM (°)	98	90 (5)
U1/A-Pog (mm)	3.74	2.7 (1.8)
L1/A-Pog (mm)	8.47	2 (2)

Table 1: *Pre-treatment cephalometric analysis. SNA: Sella-Nasion-A Point Angle; SNB: Sella-Nasion-B Point Angle; ANB: A Point-Nasion-B Point Angle; Wits: Wits Appraisal; SN-MP: Stella-Nasion to Mandibular Plane; FMA: Frankfort Mandibular Plane Angle; MM: Maxilla-Mandibular Plane Angle; U1-SN: Upper Incisor to Sella-Nasion Angle; L1-MM, Lower Incisor to Mandibular Plane Angle; U1/A-Pog: Upper Incisor to A-Pogonion Line; L1/A-Pog: Lower Incisor to A-Pogonion Line.*

Treatment alternatives

The following treatment alternatives were proposed, and risks, advantages and disadvantages of each option were discussed with the patient:

a) Combination of ortho-surgical approach, to address the skeletal nature of the discrepancy and the asymmetry. This was communicated as the ideal treatment plan.

b) Orthodontic camouflage using fixed multibracket orthodontic appliance, with the extraction of one lower incisor and the use of intermaxillary Class III elastics.

c) Orthodontic camouflage using Invisalign®, requesting three ClinCheck® (Align Technology Inc, San José, California, USA) with the following instructions: (1) extraction of lower third molars and one lower incisor, distalization of mandibular molars, and intermaxillary Class III elastics; (2) extraction of lower third molars, extensive interproximal reduction (IPR) on lower anterior teeth, distalization of mandibular molars, and intermaxillary Class III elastics.

As the patient dismissed the ortho-surgical option, the alternative of the orthodontic camouflage with Invisalign® was privileged for aesthetic reason and due to the limited availability of the patient to perform regular chairside visits. Additionally, the patient favored the option of extensive IPR over the extraction of a lower incisor.

Extraction of the upper third molars was also suggested to the patient, although this could have been done during the orthodontic treatment.

Treatment objectives

Treatment goals of the orthodontic therapy were to correct the anterior crossbite by establishing a proper OJ, enhance the smile aesthetics, resolve the dental crowding, avoid harmful occlusal contacts on anterior teeth, and improve the left unilateral crossbite. Establishing molar and canine Class I relationships and achieving coincident dental midlines were not included among the treatment objectives, as not considered realistic within an orthodontic camouflage of a skeletal Class III malocclusion. The patient was informed of the necessity of a long-term retention phase at the end of the active treatment to maintain stable aesthetic outcomes over time.

Treatment progress

The treatment was provided by a specialized Invisalign® provider orthodontist (L.S.). The treatment plan as displayed by the ClinCheck® included an initial set of 27 aligners in the upper arch and 46 aligners in the lower arch (Figure 3A). The ClinCheck® was developed with the following instructions: IPR by 0.3 mm and 0.4 mm between mandibular anterior and posterior teeth, respectively, to be performed before stage 1; mandibular molar distalization by 2 mm; use of intermaxillary Class III elastics; dentoalveolar expansion of upper left premolars; "aesthetic first" on the upper arch, to address the upper dental crowding from the beginning of the treatment. Specific attachments were requested (Table 2).

Before starting the treatment, the lower third molars were extracted. Due to the complexity of the dental movements, the patient was instructed to wear the aligners for 2 weeks (22 hours per day), along with intermaxillary Class III elastics (5/16" 4.5oz, 3/16"

Attachment	Description	Teeth #	Purpose	Additional instructions
Vertical rectangular	Mesial beveled 5-mm vertical rectangular attachment	3.6, 3.7, 4.6, 4.7	Distal translation	Start moving the next tooth once the previous tooth has achieved ½ of the expected distalization (after 8 aligners)
	Distal beveled 5-mm vertical rectangular attachment	3.3, 4.3	Rotation and distal inclination	
Horizontal rectangular	Gingival beveled 4-mm horizontal rectangular attachment	1.4, 1.5, 2.4, 2.5	Buccolingual expansion	- Overcorrection by 2 mm - +3° of buccal root torque for each mm of buccal expansion
	Gingival beveled 5-mm horizontal rectangular attachment	1.6, 1.7, 2.6, 2.7	Buccolingual expansion	- Overcorrection by 2 mm - +3° of buccal root torque for each mm of buccal expansion
Optimized	Optimized extrusion attachment	1.1, 1.2, 2.1, 2.2	Extrusion	

Table 2: *Attachments requested to develop the ClinCheck® of the first se of aligners the first set of aligners.*

4.5oz). During the treatment, in-office check-ups were performed approximately every 10 weeks, coinciding with the travels to Italy of the patient. After 18 months, the treatment was interrupted at lower stage 36 because of poor tracking on lower canines, and new polyvinyl siloxane (PVS) impressions of both arches and bite registration with putty PVS impression material were taken (Bisico®, Bielefelder Dentalsilicone GmbH & Co. KG, Bielefeld, Germany). The patient was already satisfied with the results of this first part of the treatment: OJ and OB were corrected (OJ = 2.4 mm, OB = 1.3 mm), and the left unilateral crossbite was no longer present (Figure 4). The refinement series included a set of 13 additional aligners on upper and lower arches, aimed at establishing bilateral posterior occlusal contacts and detailing the dental alignment (Figure 3B). An additional IPR of 0.3 mm on the lower anterior teeth was prescribed.

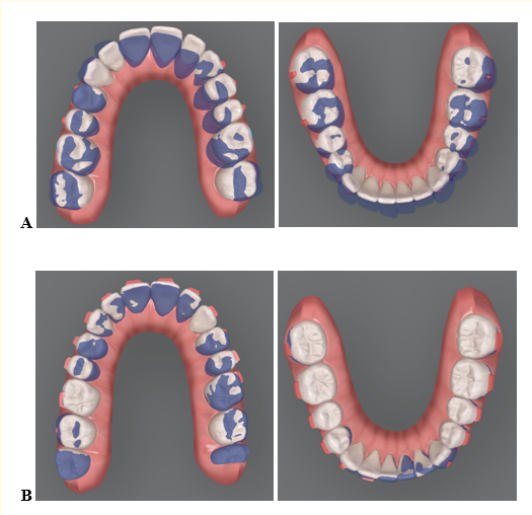

Figure 3: *Superimposition between initial (stage 1, in blue) and final dental position (stage 46, in white) predicted by the ClinCheck® on occlusal view (A); superimposition between initial (stage 1, in blue) and final dental position (stage 13, in white) of the refinement predicted by the ClinCheck® on occlusal view (B).*

Results

After 6½ months from the beginning of the refinement, the case was considered completed with no need of additional aligners. At the appointment of removal of the attachments, removable maxillary and mandibular retainers were delivered to the patient for

Figure 4: *Extraoral (A) and intraoral (B) photographs before the refinement.*

nocturnal use. The treatment objectives were achieved, with great satisfaction of the patient. On extraoral examination, a balanced facial harmony was attained, the pre-treatment facial asymmetry was no longer visible, and the profile was more convex and pleasant (Figure 5). On intraoral examination, a positive OJ was obtained (OJ changed from -2.9 mm to 2.4 mm), bilateral posterior occlusal contacts were established, maxillary and mandibular arches appeared U-shaped, and the dentition resulted well-aligned (Figure 5B). As expected, the Class III molar relationship was maintained. The total time of treatment was 26 months, including 2 months of waiting between the new impression and the delivery of the set of refinement. The patient was encouraged to proceed with the extraction of the remaining upper third molars, still evident at post-treatment panoramic radiograph (Figure 5C).

Unfortunately, due to the spike of COVID-19 cases worldwide, a national lockdown was imposed, and non-urgent dental appointments were cancelled. Therefore, the patient was proposed to continue the monitoring of the first months of the retention phase remotely. He was provided with the dedicated cheek® retractor and the ScanBox® by DM (Figure 6) and was instructed on how to perform monthly scans of his dentition. A first set of intraoral pictures was taken together with the orthodontist, to ensure a proper use of the device. The patient was complaint with the instructions and rigorously performed the scans monthly. No major dental movements were detected by DM.

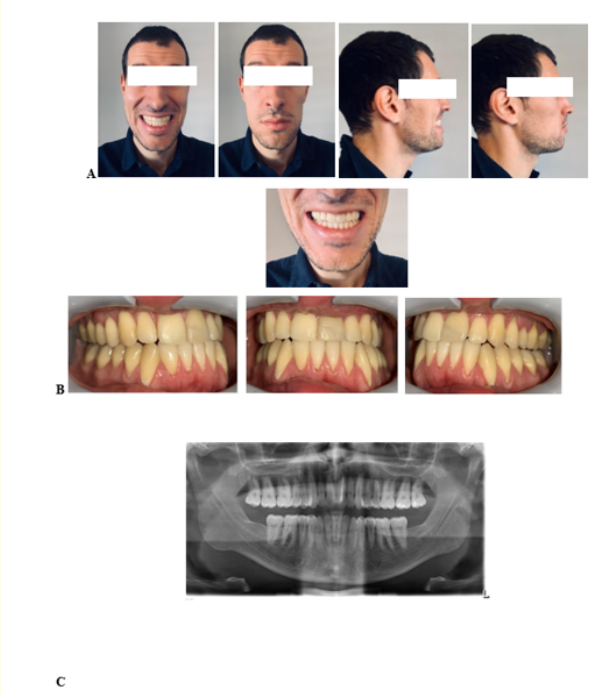

Figure 5: *Post-treatment extraoral (A) and intraoral (B) photographs and radiographic examination (C).*

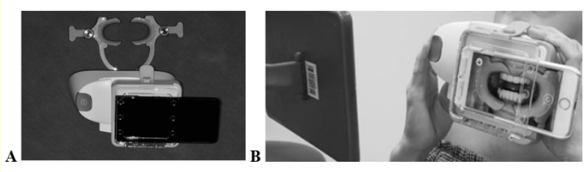

Figure 6: *Dedicated cheek retractor and ScanBox® by Dental Monitoring® (A) and device used by patient (B).*

After 6 months, when travels among European countries were permitted again, the remote monitoring by DM was interrupted and the retention phase was continued with in-office visits every 6 months to monitor the fit of the retainers.

Discussion

This case demonstrated the effectiveness of Invisalign® in managing a severe skeletal Class III malocclusion with an orthodontic camouflage. Offering this system allowed to accomplish the aesthetic and functional expectations of the patient, while also complying with the aesthetic demands and with the limited availability of chairside appointments. Additionally, the case was remotely monitored with Dental Monitoring®, thus allowing a strict control over unfavorable dental movements during the first months of the retention, which the literature suggest being the most critical period for orthodontic relapse [17].

In the present case, the use of digital technologies increased the quality and the accuracy of communication between the clinician and the patient. First of all, the initial virtual ClinCheck®, which provides a virtual simulation of the predicted dental movements [18], permitted to efficiently visualize the different therapeutic options and to set up realistic objectives. During the visualization of the ClinCheck®, it is crucial to educate the patient that this constitutes only a virtual prediction of the dental movements [19,20]. It is responsibility of the clinician to distinguish between predictable movements and unrealistic expectations, based on experience and knowledge of biomechanics, which in turn dictate the choice of the attachments [21].

Moreover, the integration of the remote monitoring by DM permitted to maintain a continuity of care of the patient in times where it would have been otherwise interrupted by the national lockdown imposed by the governments to face the COVID-19 pandemic. The retention period starts at the end of an active orthodontic treatment [3]. Especially during the first months after the removal of the appliance, the teeth are at risk of orthodontic relapse [17]. Hence, monthly chairside appointments in the first three months and every three-six months thereafter are normally recommended, to ensure a proper fit of the retainers and the compliance of the patient in wearing them. A functionality of DM, 3D Monitoring Light®, allows 3D calculation of dental movements to detect early changes in alignment by superimposing the monthly scans to the initial virtual cast (i.e. the .stl file derived from the dental impression taken at the time of debonding of the appliance). The software has a method error of one tenth of millimeters and less than 0.5° of precision for linear and angular movements, respectively [12,22]. Therefore, a monitoring of the retention period with DM may allow for a more precise evaluation of those dental movements that, if undetected, would incur in an unpleasant orthodontic relapse.

In Orthodontics, systems of remote monitoring like DM are advocated for several other uses, such as monitoring of the oral

hygiene [23,24] and of the fit of clear aligners [25] during orthodontic treatments, evaluation of the expansion with rapid palatal expander [26] and of the compliance of patients in wearing retainers [27,29], and follow-up of surgical-orthodontic approaches [28] and during retention period [29]. Instead, integration of DM during the orthodontic therapy was not performed, based on a recent study that did not find any significant difference in terms of accuracy of predicted dental movements between the group with DM and the group without DM [30]. For the above-mentioned advantages, remote digital technologies may be suggested as part of standard orthodontic care [31,32].

Despite the ideal management being ortho-surgical, Invisalign® achieved the established treatment objectives thanks to specific advantages of the system. First of all, the expected molar distalization was efficiently accomplished by the aligners, as predicted by the ClinCheck®. At this regard, studies reported high predictability of Invisalign® in molar distalization within 2.6 mm, when attachments and intermaxillary elastics are utilized [33-35]. On the contrary, fixed multibracket appliances may rely on complex mechanics to achieve the same degree of mandibular molar distalization [36-39]. In the present case, the OJ changed by 5.3 mm at the end of the therapy, which is in line with what reported by the literature in cases of non-growing non-surgical treatments of severe skeletal class III malocclusion [40]. Beside the 2 mm of molar distalization, the rest of the OJ correction was achieved by IPR and significant dental compensation. However, studies have suggested a negligible difference between non-surgical and surgical skeletal class III cases, especially when a lack of optimal dental decompensation in the pre-surgical phase is attained, thus compromising the quantity of the orthognathic surgical correction [41,42].

In the literature, cases of orthodontic camouflage of severe non-growing skeletal Class III malocclusion treated with clear aligners are increasing [43,44]. These are frequently associated with additional procedures or technologies to either accelerate or improve the accuracy of the treatment, such as high frequency vibration devices [45], surgical corticotomy [27], or supportive myofunctional therapy [46]. To the best of our knowledge, this is the first study that reported of a non-growing skeletal Class III case treated with Invisalign®, with a first period of retention phase remotely monitored with DM. The implementation of DM was reassuring for both the patient and the clinician, especially because relying on an imminent reopening from the lockdown to allow for in-office checkups was not predictable.

Conclusion

Although orthodontic therapy alone was considered as second-line option, Invisalign® system was effective in achieving the treatment objectives in a healthy adult with severe skeletal class III malocclusion. The results suggest that, for selected patients, an orthodontic camouflage may be a feasible choice. The inconvenience of the lockdown due to the COVID-19 pandemic was overcome by the integration of a remote monitoring by DM. Implementing traditional orthodontic therapies with digital technologies may maintain a continuity of care for orthodontic patients during unprecedent times, like the present COVID-19 pandemic.

Conflict of Interest

The authors declare no conflict of interest.

Bibliography

1. Proffit WR, White RP, Sarver DM. Contemporary treatment of dentofacial deformity. Mosby, St Louis. 2003.

2. Ishikawa H, Nakamura S, Iwasaki H, Kitazawa S, Tsukada H, Chu S. Dentoalveolar compensation in negative overjet cases. Angle Orthod. 2000;70(2):145-148.

3. Proffitt WR. Contemporary Orthodontics. 3rd Edition, St Louis, Mosby, 2001.

4. Ellis E, McNamara JA. Components of adult Class III malocclusion. J Oral Maxillofac Surg. 1984;42(5):295-305.

5. Needham R, Waring DT, Malik OH. Invisalign treatment of Class III malocclusion with lower-incisor extraction. JCO. 2015;49(7):429-441.

6. Lagravère MO, Flores Mir C. The treatment effects of Invisalign orthodontic aligners: A systematic review. J Am Dent Assoc. 2005;136(12):1724-1729.

7. Boyd RL. Esthetic orthodontic treatment using the invisalign appliance for moderate to complex malocclusions. J Dent Educat. 2008;72(8):948-967.

8. Boyd RL. Complex orthodontic treatment using a new protocol for the Invisalign appliance. J Clin Orthod. 2007;41(9):523-547.

9. Golinelli D, Boetto E, Carullo G, Landini MP, Fantini MP. How the COVID-19 pandemic is favoring the adoption of digital technologies in healthcare: a rapid literature review. medRxiv, 2020.

10. Littlewood SJ, Millett DT, Doubleday B, Bearn DR, Worthington HV. Retention procedures for stabilising tooth position after treatment with orthodontic braces. Cochrane Database Syst Rev. 2016;2016(1):CD002283.

11. Caruso S, Caruso S, Pellegrino M, Skafi R, Nota A, Tecco S. A knowledge-based algorithm for automatic monitoring of orthodontic treatment: the dental monitoring system. Two cases. Sensors. 2021;21(5):1856.

12. Roisin LC, Brézulier D, Sorel O. Remotely-controlled orthodontics: fundamentals and description of the Dental Monitoring system. J Dentofacial Anom Orthod. 2016;19(4):1-12.

13. Morris RS, Hoye NL, Elnagar MH, Atsawasuwan P, Galang-Boquiren MT, Caplin J, et al. Accuracy of Dental Monitoring 3D digital dental models using photograph and video mode. Am J Orthod Dentofac Orthop. 2019;156(3):420-428.

14. Giudice A, Barone S, Muraca D, Averta F, Diodati F, Antonelli A, et al. Can teledentistry improve the monitoring of patients during the Covid-19 dissemination? A descriptive pilot study. Int J Environ Res Public Health. 2020;17(10):3399.

15. Suri S, VanderSluis YR, Kochhar AS, Bhasin R, Abdallah MN. Clinical orthodontic management during the COVID-19 pandemic. Angle Orthod. 2020;90(4):473-484.

16. Malekshoar M, Malekshoar M, Javanshir B. Challenges, limitations, and solutions for orthodontists during the coronavirus pandemic: A review. Am J Orthod Dentofac Orthop. 2021;159(1):e59-e71.

17. Torkan S, Firth F, Fleming PS, Kravitz ND, Farella M, Huang GJ. Retention: taking a more active role. Br Dent J. 2021;230(11):731-738.

18. Haouili N, Kravitz ND, Vaid RN, Ferguson DJ, Makki L. Has Invisalign improved? A prospective follow-up study on the efficacy of tooth movement with Invisalign. Am J Orthod Dentofac Orthop. 2020;158(3):420-425.

19. Houle JP, Piedade L, Todescan R Jr, Pinheiro FHSL. The predictability of transverse changes with Invisalign. Angle Orthod. 2017;87(1):19-24.

20. Vidal-Bernárdez ML, Vilches-Arenas A, Sonnemberg B, Solano-Reina E, Solano-Mendoza B. Efficacy and predictability of maxillary and mandibular expansion with the Invisalign® system. J Clin Exp Dent. 2021;13(7):e669-e677.

21. Sangalli L, Dalessandri D, Bonetti S, Mandelli G, Visconti L, Savoldi F. Proposed optimal position of central incisors: a systematic review. Korean J Orthod. 2021.

22. Moylan HB, Carrico CK, Lindauer SJ, Tufekci E. Accuracy of a smartphone-based orthodontic treatment-monitoring application: a pilot study. Angle Orthod. 2019;89(5):727-733.

23. Sangalli L, Savoldi F, Dalessandri D, Bonetti S, Min G, Signoroni A, Paganelli C. Effects of remote digital monitoring on oral hygiene of orthodontic patients: a prospective study. BMC Oral Health. 2021;21(1):435.

24. Zotti F, Dalessandri D, Salgarello S, et al. Usefulness of an app in improving oral hygiene compliance in adolescent orthodontic patients. Angle Orthod. 2016;86(1):101-107.

25. Hansa I, Semaan SJ, Vaid NR. Clinical outcomes and patient perspectives of Dental Monitoring® GoLive® with Invisalign®-a retrospective cohort study. Prog Orthod 2020;21(1):16.

26. Kuriakose P, Greenlee GM, Heaton LJ, Khosrave R, Tressel W, Bollen AM. The assessment of rapid palatal expansion using a remote monitoring software. J World Fed Orthod. 2019;8(4):165-170.

27. Al-Moghrabi D, Pandis N, McLaughlin K, Johal A, Donos N, Fleming P. Evaluation of the effectiveness of a tailored mobile application in increasing the duration of wear of thermoplastic retainers: a randomized controlled trial. Eur J Orthod. 2020;42(5):571-579.

28. Hannequin R, Ouadi E, Racy E, Moreau N. Clinical follow-up of corticotomy-accelerated Invisalign orthodontic treatment with Dental Monitoring. Am J Orthod Dentofac Orthop. 2020;158(6):878-888.

29. Sangalli L, Savoldi F, Dalessandri D, Visconti L, Massetti F, Bonetti S. Use of remote digital monitoring during the retention phase after orthodontic treatment. A prospective feasibility study. Korean J Orthod. 2021.

30. Hansa I, Katyal V, Ferguson DJ, Vaid NR. Outcomes of clear aligner treatment with and without Dental Monitoring: a retrospective cohort study. Am J Orthod Dentofac Orthop. 2021;159(4):453-459.

31. Dalessandri D, Sangalli L, Tonni I, Laffranchi L, Bonetti S, Visconti L, Signoroni A, Paganelli C. Attitude towards Telemonitoring in Orthodontists and Orthodontic Patients. Dent J 2021;9(5):47.

32. Sangalli L, Fernandez-Vial D, Moreno-Hay I, Boggero I. Telehealth Increases Access to Brief Behavioral Interventions in Orofacial Pain Clinic during COVID-19 Pandemic: A Retrospective Study. Pain Med. 2021.

33. Simon M, Keiling L, Schwarze J, Jung BA, Bourauel C. Treatment outcome and efficacy of an eligner technique: regarding incisor torque premolar derotation and molar distalization. BMC Oral Health. 2014;11:68.

34. Ravera S, Castroflorio T, Garino F, Daher S, Cugliari G, Deregibus A. A maxillary molar distalization with aligners in adult patients: a multicenter retrospective study. Prog Orthod. 2016;17:12.

35. Garino F, Castroflorio T, Daher Sm et al. Effectiveness of composite attachments in controlling upper-molar movement with aligners. J Clin Orthod. 2016;50(6):314-317.

36. Safavi SM, Younessian F, Kohli S. Miniscrew-assisted mandibular molar distalization in a patient with skeletal class-III malocclusion: A clinical case report. APOS Trends in Orthod. 2013;3(3):83-88.

37. Saito I, Yamaki M, Hanada K. Nonsurgical treatment of adult open bite using edgewise appliance combined with high-pull headgear and class III elastics. Angle Orthod. 2005;75(2):277-283.

38. Kuroda Y, Kuroda S, Alexander RG, Tanaka E. Adult Class III treatment using a J-hook headgear to the mandibular arch. Angle Orthod. 2010;80(2):336-343.

39. Sugawara J, Daimaruya T, Umemori M, Nagasaka H, Takahashi I, Kawamura H, et al. Distal movement of mandibular molars in adult patients with the skeletal anchorage system. Am J Orthod Dentofac Orthop. 2004;125(2):130-138.

40. Lin J, Gu Y. Preliminary investigation of nonsurgical treatment of severe skeletal class III malocclusion in permanent dentition. Angle Orthod. 2003;73(4):401-410.

41. Johnston C, Burden D, Kennedy D, Harradine N, Stevenson M. Class III surgical-orthodontic treatment: a cephalometric study. Am J Orthod Dentofacial Orthop. 2006;130(3):300-309.

42. Troy BA, Shanker S, Fields HW, Vig K, Johnston W. Comparison of incisor inclination in patients with Class III malocclusion treated with orthognathic surgery or orthodontic camouflage. Am J Orthod Dentofac Orthop. 2009;135(2):146.e1-e9.

43. Malekian K, Parrini S, Garino F, Deregibus A, Castroflorio T. Mandibular molar distlization with clear aligners in Class III patients. J Aligner Orthod. 2019;3(1):7-14.

44. Park JH, Kim TW. Anterior crossbite correction with a series of clear removable appliances: a case report. J Esthet Restor Dent. 2009;21(3):149-160.

45. El-Biraly T. The use of high frequency vibration and clear aligners in a management of an adult patient with class III skeletal malocclusion with open bite and sever bimaxillary protrusion: case report. Dent J. 2020;8(3):75.

46. Staderini E, Meuli S, Gallenzi P. Orthodontic treatment of class three malocclusion using clear aligners: a case report. J Oral Biol Craniofac Res. 2019;9(4):360-362.

Volume 5 Issue 2 February 2022