



Comparison of the Impact of COVID-19 Pandemic on Treatment with Conventional Fixed Orthodontic Appliances Versus Clear Aligners in Saudi Arabia: A Multi-Center Cross-Sectional Study

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Received: 2023 November 06; Revised: 2023 December 14; Accepted: 2024 March 04

Abstract

Aim: This study aimed to compare the treatment progress and complications between patients receiving conventional orthodontic treatment and clear aligners during the coronavirus disease-2019 (COVID-19) pandemic.

Methods: An electronic survey was distributed randomly among orthodontic patients in Saudi Arabia to understand how the global health crisis caused by COVID-19 affected orthodontic patients. The survey questions were structured into four sections, including demographic data, continuation of orthodontic follow-up appointments during the COVID-19, reasons for missed appointments, and problems of orthodontic patients. Data analysis consisted of simple descriptive statistics presented in frequency tables and percentages. Statistical significance was set at $P \leq 0.05$.

Results: A total of 512 electronic responses were received. Sixty-two (12.11%) participants missed no orthodontic follow-up appointment during the COVID-19 lockdown. Hence, the study included 450 (87.89%) participants to evaluate the impact of COVID-19 pandemic on sustained orthodontic treatment.

The proportion of patients in the fixed appliance group (35.2%, 86 patients) who responded that "they had not even once tried to communicate with their orthodontists" was significantly higher than that in the clear aligner group (9.2%, 19 patients) ($P < 0.001$). The proportion of participants who received fixed appliances (62.3%, 152 patients) and disagreed with the lockdown of orthodontic clinics during the COVID-19 was significantly higher than that in clear aligner users (19.4%, 40 patients) ($P < 0.001$).

Conclusion: The results indicated that most issues were reported by patients who had fixed appliances. Thus, tele-orthodontics could provide a solution to continue dental practice during the COVID-19, and clear aligners are preferable to traditional orthodontic treatment methods.

Keywords: COVID-19, Orthodontic Appliances, Fixed, Removable

Background

By the end of 2019, the outbreak of a novel type of coronavirus, known as severe acute respiratory syndrome coronavirus 2, caused a debilitating

disease referred to as the coronavirus disease-2019 (COVID-19) (1,2). COVID-19 was officially proclaimed a worldwide health emergency by the World Health Organization on January 30, 2020 (3). At the onset of the spread of COVID-19 and before



vaccine development, the affected countries demanded new policies and strategies to combat the virus and reduce new cases. These strategies varied from limited to total lockdowns (4,5). Countries banned non-essential activities except for elective non-deferrable and emergency cases. Dentistry is classified as a "very high risk" profession by the Occupational Safety and Health Administration (6) as it deals with tissues with a high viral load and generates considerable amounts of aerosols (7). Thus, thousands of orthodontic patients missed their routine orthodontic appointments, resulting in a significant increase in appointment intervals (8-10). It is important to understand that orthodontic treatment differs from other oral and dental treatments. Among the several appliances used in orthodontic treatment to treat malocclusion (11, 12), the two foremost appliances that are preferred are fixed appliances and clear aligners. Many clinicians claim that the treatment progress in use of fixed appliances is clinically different from that in clear aligner therapy (13). Despite the abundance of information regarding the types of orthodontic appliances offered, a lack of data on the appliances most suitable during the COVID-19 pandemic presently exists (14, 15). Can clear aligner therapy serve as a realistic solution to social distancing throughout the pandemic? To answer this question, the present study aimed to record evidence on recommendations for orthodontic appliance selection during the pandemic. The primary objective was to examine the impact of COVID-19 pandemic on patients under conventional orthodontic fixed appliance therapy versus clear aligner therapy in the Kingdom of Saudi Arabia. The secondary objective of this study was to compare the treatment progress and complications between patients receiving traditional orthodontic treatment and clear aligners during the COVID-19 pandemic. The outcomes of this study may influence the choice of orthodontic appliance systems among dentists and patients following the COVID-19 pandemic.

Methods

The Institutional Review Board approved this study (number: 40/4-103) at Jazan University, Jazan, Kingdom of Saudi Arabia.

Study Design and Participants

This cross-sectional multi-center study used an online survey created with Google Docs (docs.google.com/forms) in English and Arabic. It included multiple-choice and check-list questions.

The study used a convenience sample randomly selected from patients who received orthodontic treatment in the orthodontic clinics of the Kingdom of Saudi Arabia during the COVID-19 pandemic. The sample size was calculated using an online calculator (www.raosoft.com) (Raosoft Inc., Seattle, WA, USA). The calculation was based on a population size of 5000 and 95% confidence interval with a margin of error of 5%, which produced a sample size of 357 patients.

The face and content validity of the questionnaire were tested and confirmed by three experienced American Board-certified orthodontists. The selection criteria for the participants were as follows: 1. Age ≥ 18 years and receiving orthodontic treatment during the pandemic period. 2. Orthodontic treatment after the COVID-19 pandemic period. Patients who declined to partake in the study or missed no orthodontic appointment were excluded. Patients who agreed to partake in the study signed a consent form. Privacy was guaranteed, and patient information remained confidential. Responses were divided into two groups:

Group A: Patients who received conventional fixed treatment during the pandemic (n=244).

Group B: Patients who received clear aligners during the same period (n=206).

Questionnaire

The questionnaire was designed (Checklist for Reporting Results of Internet E-Surveys) (16), and the survey was posted on a webpage. A URL was generated and sent to patients. Three public and three private clinics in Saudi Arabia participated via cell phone applications (Messenger Apps) and emails. Responses were collected over one month. The questionnaire was pre-tested on 10 orthodontic patients (5 males and 5 females) from various dental clinics who were not part of the study sample. The Cohen's kappa inter-agreement rate was 0.85 (labeled as "almost perfect").

The survey questionnaire was divided into four sections. The first section focused on age, sex, demographics, and type of orthodontic clinics that conducted patient follow-ups. The second section included a single question on the time frame of delayed or missed orthodontic follow-up appointments during the COVID-19 pandemic. Participants who responded with "did not miss any appointment" were taken to the submission page (as they were not the target patients for this study) and excluded without responding to the question regarding the type of orthodontic appliance used. The survey focused on patients who missed orthodontic follow-up appointments. The

respondents who specified the period could continue to the third section, which included questions on the reasons for missed appointments, communication frequency, method used by the orthodontist, their main dental concern during the lockdown period, the level of agreement with the clinic shutdown, and the type of orthodontic appliance used. Based on the answers, the respondents were chosen for the type of appliance and directed to the fourth and last section of the survey, which asked for the problems faced by patients with each orthodontic appliance and their ways of dealing with the problems during the COVID-19 pandemic.

Data Collection

Research data were obtained from December 2020 to March 2021. We disseminated the questionnaires straightaway after/during the COVID-19 lockdown period and collected them within four days to decrease recall bias and increase authenticity.

Statistical Analysis

Descriptive statistics were reported as frequency distribution and percentages. The differences and the preferences for orthodontic treatment of the fixed appliance and clear aligner groups were compared via the Chi-square test. Statistical significance was set at $P \leq 0.05$. All statistical analyses were performed using SPSS software version 18 (IBM Corp., Armonk, NY, USA).

Results

A total of 512 electronic responses were received. The mean age of the participants was 34.5 ± 4.0 years. Of all, 62 (12.11%) participants who missed no orthodontic follow-up appointment during the COVID-19 lockdown were directed to the submission page.

A total of 450 (87.89%) participants exhibited

the final effect of the COVID-19 pandemic on orthodontic treatment continuation; of which, 215 (47.9%) were males and 235 (52.1%) were females. A significant proportion of male patients (62.9%) received fixed appliances, while a significant proportion of female participants (69.9%) received clear aligners ($p < 0.001$). Significantly higher number of teenagers received fixed appliances than older participants who received clear aligners ($p < 0.001$). The proportion of fixed appliance usage versus clear aligner use was significantly higher in public than private work setups (32.4% vs. 5.3%, respectively) ($P < 0.001$), as shown in Table 1.

Most participants in the clear aligner group did not see an orthodontist for 1-2 months due to the COVID-19 pandemic; whereas, most participants who received fixed appliances did not see an orthodontist for >2 months ($P < 0.001$). The reasons for not seeing an orthodontist were significantly different for orthodontic devices, as most (62.3%) participants who received fixed appliances could not get an appointment due to closure or limited number of operational clinics during the COVID-19 pandemic. Most (68%) participants who received clear aligners did not see an orthodontist due to fear of COVID-19 infection ($P < 0.001$). The proportion of participants who did not even once try to communicate with their orthodontist was significantly higher in the fixed appliance group than in the clear aligner group (35.2% vs. 9.2%, respectively) ($P < 0.001$). The proportion of phone/Zoom calls as the source of communication was significantly higher in the clear aligner group than in the fixed appliance group ($P < 0.001$). Both groups showed significant differences in their main concern. Most participants using fixed appliances were primarily concerned that their treatment would be extended (52%). In comparison, most participants who received clear aligners were worried about a relapse (80.1%) due to orthodontic treatment discontinuation during the COVID-19 pandemic (Table 2).

Table 1. Comparison of demographic features of patients using fixed appliances versus clear aligners

Variables	Total (n=450) Frequency (%)	Orthodontic appliance		P-value
		Fixed appliance (n=244) Frequency (%)	Clear aligner (n=206) Frequency (%)	
Gender				
o Male	215 (47.9)	153 (62.9)*	62 (30.1)	<0.001
o Female	235 (52.1)	91 (37.1)	144 (69.9)	
Age (years)				
o <20	61 (13.6)	56 (23.0)*	5 (2.4)	<0.001
o 20 – 29	70 (15.6)	43 (17.6)	27 (13.1)	
o 30 – 39	258 (57.3)	118 (48.4)	140 (68.0)	
o 40 – 49	61 (13.6)	27 (11.1)	34 (16.5)	
Primary work setup				
o Public	90 (20.0)	79 (32.4)*	11 (5.3)	<0.001
o Private	360 (80.0)	165 (67.6)	195 (94.7)	

*Shows a significant difference at P<0.05

Table 2. Effects of COVID-19 pandemic on patients undergoing conventional fixed appliance therapy versus clear aligner therapy

Variables	Total (n=450) Frequency (%)	Orthodontic appliance		P-value
		Fixed appliance (n=244) Frequency (%)	Clear aligner (n=206) Frequency (%)	
Not seen an orthodontist				
o 1-2 months	251 (55.8)	90 (36.9)	161 (78.1)*	<0.001
o > 2 months	176 (39.1)	133 (54.5)*	43 (20.9)	
o Still not visiting	23 (5.1)	21 (8.6)	2 (1.0)	
Reason for not seeing an orthodontist				
o No appointment/clinic closed	192 (42.6)	152 (62.3)*	40 (19.4)	<0.001
o Fear of COVID-19 infection	219 (48.6)	79 (32.4)	140 (68.0)*	
o Out of city/ country	35 (7.8)	12 (4.9)	23 (11.2)	
o Others	4 (1.0)	1 (0.8)	3 (1.5)	
Frequency of communicating with orthodontist				
o Not even once	105 (23.3)	86 (35.2)*	19 (9.2)	<0.001
o Once or twice	294 (65.3)	148 (60.7)	146 (70.9)	
o 3 – 4 times	43 (9.6)	4 (1.6)	39 (18.9)	
o >4 times	8 (1.8)	6 (2.5)	2 (1.0)	
Source of communication				
o I did not communicate	64 (14.2)	50 (20.5)	14 (6.8)	<0.001
o Visited	4 (0.9)	4 (1.6)	0 (0)	
o Phone/ Zoom call	284 (63.1)	138 (56.6)	146 (70.9)*	
o SMS/ Email/ Instagram	98 (21.8)	52 (21.3)	46 (22.3)	
What was the main concern?				
o My teeth would relapse	280 (62.2)	115 (47.2)	165 (80.1)*	<0.001
o Treatment would be extended	166 (36.9)	127 (52.0)*	39 (18.9)	
o None	4 (0.9)	2 (0.8)	2 (1.0)	

*Shows a significant difference at P<0.05

Table 3. Orthodontic appliance-related problems faced during the COVID-19 pandemic

Problem	Orthodontic appliance		Problem	Frequency (%)
	Fixed appliance (n=244) Frequency (%)	Clear aligner (n=206) Frequency (%)		
Exposed sharp wire end	84 (34.4)		Loose aligner	26 (12.6)
Broken bracket/metal bands	110 (45.1)		Broken aligner	3 (1.5)
Ran out of intermaxillary elastic bands	136 (55.7)		Ran out of aligner	195 (94.7)
Gingival swelling	169 (69.3)		Gingival swelling	102 (49.5)
Orthodontic pain	44 (18.0)		Orthodontic pain	95 (46.1)
Spacing	50 (20.5)		Spacing	16 (7.8)
Other	1 (0.4)		Other	1 (0.5)

The nature of the problems was relatively different for each orthodontic appliance. Gingival swelling was a significant concern (69.3%) among those who received fixed appliances; whereas, running out of clear aligners was a greater problem for participants (94.7%) who received clear aligners (Table 3).

Most participants (58.6%) using fixed appliances tried to manage orthodontic appliance-related issues by searching the Internet for solutions. Among those who received clear aligners, most

participants requested an emergency appointment (58.7%) in addition to visiting a nearby dentist or calling the orthodontist, as presented in Table 4.

A significantly higher proportion of the participants who received fixed appliances disagreed with the lockdown of orthodontic clinics during the COVID-19 pandemic than those who received clear aligners ($p < 0.001$), as illustrated in Figure 1.

Table 4. Comparison of management of problems related to orthodontic appliances during the COVID-19 pandemic

How did you manage the problem?	Orthodontic appliance	
	Fixed appliance (n=244) Frequency (%)	Clear aligner (n=206) Frequency (%)
Calling my orthodontist	139 (57.0)	104 (50.5)
Sending a picture to my orthodontist	98 (40.2)	51 (24.8)
Visiting a nearby dentist	109 (44.7)	81 (39.3)
Requested an emergency appointment	59 (24.2)	121 (58.7)
Orthodontic wax	65 (26.6)	0 (0)
Searching for a solution over the internet	143 (58.6)	95 (46.1)
Ignoring the problem	11 (4.5)	14 (6.8)
Others	2 (1.0)	5 (2.4)

There may be more than one option tried by the participants to solve the problem.

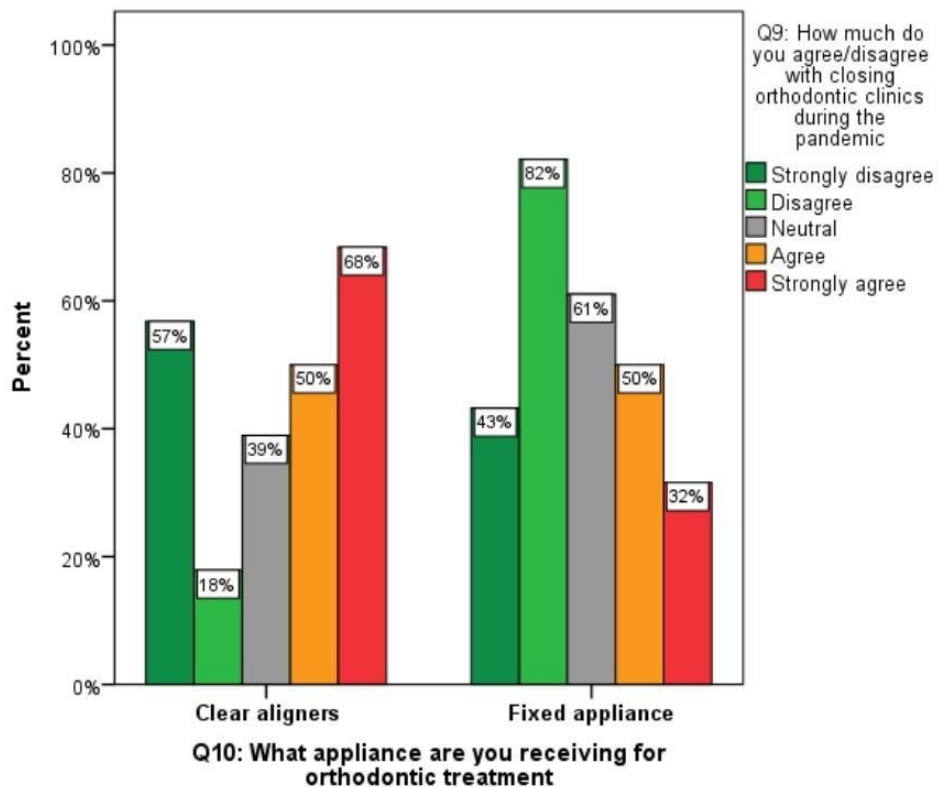


Figure 1. Comparison of patients' perception about closing orthodontic clinics during the pandemic in relation to their orthodontic appliance

Discussion

The COVID-19 pandemic contributed to increased levels of anxiety and distress in the personal and professional lives of orthodontists and orthodontic patients. Patients seeking treatment were additionally concerned about the risk of COVID-19 infection, and several patients undergoing orthodontic treatment missed their regular orthodontic check-ups. Thus, the appropriate selection of orthodontic appliance systems is important to maximize comfort and safety. This study investigated the influence of the COVID-19 pandemic on patients receiving conventional fixed appliances versus clear aligner therapy in Saudi Arabia.

A study conducted in 2020 included 388 orthodontic patients with 2 months of follow-up (17). The results showed that 106 (27.3%) participants could not attend their visits, and 244 (69%) stated that the clinic's closure was their primary reason for missing appointments. Patients encountered various challenges and sought multiple solutions based on their appliance type. Most participants (84%, 327 patients) had fixed appliances, and only 21% (n=64) said they had no problems, compared to 8 (36%) and 11 (39%) participants in the clear aligner and removable appliance groups, respectively (17).

Due to the COVID-19 pandemic in 2020, the intervals and procedures of orthodontic revisits changed slightly from those used in the past. The present findings showed that most (62.3%) participants who received fixed appliances could not set appointments due to closure or limited number of operational clinics. In comparison, most (68%) participants who received clear aligners did not see an orthodontist due to fear of contracting COVID-19. This outcome was in agreement with a prior study by Bustati and Rajeh (17). According to the present findings, several patients in both groups reported that they overlooked their problems and probably chose not to visit any clinic due to concerns of becoming infected with COVID-19, and this outcome was similar to the findings of Bustati and Rajeh (17).

Anxiety and the risk of an emergency could increase (18-20) due to pain, discomfort, exposed wire ends, brackets or bands coming off, and loss of aligners (21,22). Also, besides age, sex, and demographics could influence the perception of attractiveness (23). Older and female patients have a stronger preference for more esthetic appliances. A significant proportion of teenagers receive fixed appliances versus older participants who receive clear aligners (23).

Furthermore, technological advancements in secure video communication, which enable capturing and sharing high-quality images on patients' smartphones, facilitate clinical practice and promote patient reassurance (24). These approaches have been helpful, especially in addressing orthodontic emergencies. A comparison of clear aligners with other appliances showed that clear aligners coupled with tele-dentistry were a suitable treatment modality during the epidemic. Most clear aligner participants maintained closer contact with their orthodontist by phone/Zoom calls as a source of communication compared to the fixed appliance group. A 2018 study by Hansa et al. (25) showed that smartphones and their applications offered quick and clear access to emailed digital images, and liberated professionals from the constraints of a desktop computer (25). Another study in 2020 (26) demonstrated the importance of tele-orthodontics (particularly during this era) in avoiding unnecessary visits while monitoring patients from a distance. Therefore, online consultation using images instead of words could continue to be the primary mode of communication to address patient challenges. It may be more convenient at the beginning of work resumption and during in-patient triage throughout this busy period (26).

Higher number of patients with fixed appliances were worried about the extended period of treatment. In addition, it was improbable that clear aligner patients would need exacting follow-up visits every month, their chair time was relatively shorter, and they required less time for bonding than fixed appliance patients (27). This finding agrees with a prior study questioning the patients regarding the duration of treatment time before starting orthodontic treatment (28). However, the main concern among clear aligner patients was treatment relapse, consistent with a study by Kuncio et al (29). They compared conventional fixed appliances with Invisalign treatment and found that Invisalign treatment was associated with less pain but a higher relapse rate (29).

The nature of the problems was relatively different for each orthodontic appliance. The incidence of mucosal injury and orthodontic appliance detachment was much higher in fixed appliance patients than in clear aligner patients. Gingival swelling was the most significant problem in participants with fixed appliances (69.3%). In addition, running out of intermaxillary elastics (55.7%) was a popular response in this group. However, a previous study by Turkistani (30) showed that a poking wire was the main reported problem, which could be due to archwire pricks

causing discomfort in the inner cheek or tongue. Several fixed appliance issues could result from the breakage of components (31). Many such problems were most commonly mentioned by the participants in the fixed appliance group and were significant compared to the outcomes of the latest related research (30, 32). In contrast, the greatest concern of aligner users was lack of aligners (94.7%), which was more manageable throughout the lockdown. Patients were instructed to wear each available aligner for an extended period with utmost care to avoid breakage, return to work afterwards without an appointment, and obtain the remaining aligners on delivery (9).

Furthermore, participants differed in their approaches to problem-solving across groups. Fixed appliance users who participated in the survey used orthodontic wax to conceal pointed ends, while the other group did not have the option to do so. Most participants (58.6%) who received fixed appliances chose to manage orthodontic appliance-related challenges during the COVID-19 pandemic by searching the Internet for solutions. The Internet enabled some patients to gain knowledge and learn from the experiences of others in their condition. However, most clear aligner participants requested an emergency appointment (58.7%) besides visiting a nearby dentist or calling the orthodontist.

Several individuals in both groups showed a disregard for their issues, which could be explained by the fear of contracting the disease and their refusal to visit clinics. Thus, the needs of orthodontic patients and their lengthy treatment journey require careful attention. In addition, the type of appliance used could play a significant role in simplifying the treatment. Clear aligners are more pleasant, easy to use, and esthetic than fixed appliances (33). Although removable appliances, for example, aligners, have the lowest COVID-19 transmission rate compared to fixed labial/lingual appliances, it is not possible to use them in every case. Compared to fixed appliances, clear aligner therapy has numerous advantages, such as reduced chair time, minimal bonding requirements, limited office recall visits, remote monitoring with virtual devices, greater accuracy of treatment planning with digital scans, and fewer iatrogenic effects (34, 35). An awareness of emergency guidelines such as the British Orthodontic Society COVID-19 Orthodontic Emergency Guidelines (36) can help avoid several problems, and patient education can address many concerns. Furthermore, numerous recommendations and standards proposed in the literature can help orthodontists provide appropriate patient care while safeguarding themselves (36). Therefore, to reach substantiated

conclusions, more clinical research and surveys are needed to understand feasible appliance options utilized in clinical practice.

The main limitation of this study was that the proportion of fixed appliance usage versus clear aligner use was significantly higher in public than private work setups. This drawback could be due to some public and private work setups using one orthodontic appliance type only, the cost of orthodontic treatment, appointment times for patients and dental professionals, and clinical experience of orthodontists. Unequal number of patients in the two groups (fixed appliance group vs. clear aligner appliance group) was another limitation. Sex distribution was not equal in the two groups either. Furthermore, the appointment suspension lasted barely 2 months, followed by lockdown removal. There is a possibility that recall bias may have resulted from the survey questionnaire design.

This study had several strengths. It presented comprehensive knowledge about the effect of COVID-19 on two treatment groups in public and private work setups. In addition, this study focused on orthodontic patients more than dental professionals regarding the issues of orthodontic follow-up appointments in detail as a new trend in this type of study design. Finally, it provided suggestions for future research. Longitudinal clinical studies on different orthodontic appliance systems followed by an assessment of the follow-up orthodontic appointments during the previous COVID-19 period would be helpful.

Conclusion

The results indicated that more issues were reported by patients who received fixed appliances than those with clear aligners. Therefore, tele-dentistry will continue to provide solutions to dental practice during the pandemic and beyond. Health education imparted by orthodontists may help patients to resolve their problems whenever possible. When in-person orthodontic appointments were suspended during the COVID-19 pandemic, clear aligners in conjunction with tele-dentistry were shown to be the orthodontic appliance of choice because of their potential to weather the challenges imposed by the epidemic and to reduce virus transmission.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Funding

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of Interest: None to declare.

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