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Adaptations in orthodontics for current and future COVID-19 best practices

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Adaptations in orthodontics for current and future COVID-19 best practices

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

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Abstract

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Purpose: To determine what adaptations orthodontists made in their practices during the COVID-19 pandemic in response to safety recommendations and to determine which of these adaptations orthodontists plan to continue to implement after resolution of the COVID-19 pandemic.

Methods: An original 34-question survey was sent by mail to a randomized and geographically proportionate selection of actively practicing orthodontic specialists (N = 1000). Questions asked orthodontists about the changes they made during the pandemic in four overarching categories (infection control, social distancing, appliance use, and tele-orthodontics) and whether they anticipated keeping those changes post-pandemic. The data were compared between categorical responses using chi-squared and Fisher's exact test as appropriate.

Results: 160 orthodontists responded to the survey from 38 states (16% response rate). Use of nearly all forms of personal protective equipment (PPE) were reported to be used at high percentages during the pandemic, with a significant decrease anticipated after the pandemic. 92% of orthodontists modified their aerosol protocol, with the most common modification during the pandemic and predicted after the pandemic being the use of an assistant with high volume suction (61% and 49% respectively). Ninety six percent of orthodontists changed their waiting room protocol during the pandemic to keep patients and parents outside the practice, but few plan to continue that practice (23%). Forty two percent of orthodontists increased the use of clear aligners during the pandemic and the main reason for doing so was due to patient demand (91%). The number of orthodontists who used tele-orthodontics increased from 8% prior to the pandemic to 68% during the pandemic and is expected to decrease significantly post-pandemic. Moving forward, virtual appointments are anticipated to be used for screening and consultations of new patients and monitoring of active patients in clear aligners, but not fixed appliances.

Conclusions: The orthodontic sector utilized many modifications to address the safety and infection control recommendations given during the COVID-19 pandemic. Following the pandemic, use of enhanced PPE is expected to decrease and high-volume suction will likely be continued in many practices for aerosol-producing procedures. Less than half of orthodontists anticipate using tele-orthodontics in the future, but it will likely remain in use for virtual screenings and consultations as well as monitoring of clear aligners.

Introduction

For many decades, dentistry and its multiple specialties have invariably shown a high level of adaptability, a characteristic that has repeatedly put the field at the forefront of progress and safety. One such example was the emergence of the AIDS epidemic in the mid 1980s which illuminated the serious risks of bloodborne pathogens in a dental setting and led dental practitioners to adapt their infection control protocols in response. The routine use of gloves, masks, and protective eyewear were recommended by the Centers for Disease Control and Prevention (CDC) as a set of "Universal Precautions" for all patients in a dental practice and the profession evolved to implement these changes permanently.[1] In times of widespread concern for community health such as an epidemic, current practices in medical and dental settings are often questioned and innovation and change are explored to overcome any challenges being faced. Recently, the COVID-19 pandemic led dental practitioners to once again evaluate the way that they practice and consider the need for any short or long-term adaptations.

Early in 2020, outbreaks of COVID-19 on U.S. soil were confirmed and by March 2020 the World Health Organization (WHO) declared that COVID-19 was characterized as a pandemic[2] and the U.S. government declared a state of national emergency.[3] On a state-by-state basis, stay-at-home orders began to go into effect and non-essential business closed in order to curb the spread of the disease. Around the same time, the American Dental Association (ADA)

recommended that dentists keep their offices closed except for emergency procedures. Orthodontic practices temporarily closed their offices during this time, often for six to ten weeks, and then faced the struggle of safely reopening amid an ongoing pandemic and continuing health concerns by patients and employees. A flood of safety recommendations for the practice of dentistry emerged from various sources such as the WHO and CDC, as well as state and national dental and orthodontic associations, urging orthodontists to implement strict changes to their clinical and practice operations.[4–7]

The recommended adaptations for orthodontic practices during the COVID-19 pandemic fall into four overarching categories: (1) infection control, (2) social distancing, (3) appliance use, and (4) tele-orthodontics.

The CDC guidelines[4] given for dental settings proposed many adaptations during the pandemic to aid in infection control and physical distancing. Recommendations included screening every person entering dental facilities for symptoms of COVID-19 and taking temperature readings to detect fevers, adhering strictly to standard precautions with regard to personal protective equipment (PPE), and avoiding aerosol generating procedures whenever possible. When aerosol generating procedures were necessary, it was recommended to use an N-95 or equivalent facemask, four-handed dentistry with high evacuation suction, individual patient rooms, portable high-efficiency particulate air (HEPA) filtration units, and to consider scheduling patients at different times of the day.[4] Physical distancing was encouraged by limiting visitors to the facility and having patients wait for their appointments in personal vehicles rather than congregating in waiting room areas. While these dental guidelines given by the CDC did not distinguish between dental specialties, other resources were provided to orthodontists with more specific recommendations. Some of those recommendations included closing brushing stations,

removing toys, tablets, and refreshments in reception areas, scheduling non-aerosol appointments at every other chair in the open bay, and limiting aerosol appointments to isolated treatment rooms.[8]

In terms of orthodontic appliance selection, concerns emerged about using orthodontic mechanics during the pandemic that are not self-limiting in nature, such that, if left unattended for extended periods of time, they could create detrimental effects for the patient.[9] Clear aligner therapy was suggested to offer advantages over fixed appliances during the pandemic due to fewer emergencies, shorter chair-time, minimal bonding requirements, fewer recall visits to the office, and ease of remote monitoring.[10,11]

During the initial stages of the pandemic, the CDC urged dental practices to consider the use of teledentistry as an alternative to in-office care whenever possible.[4] Literature emerged suggesting that orthodontic emergencies be managed by first using virtual meetings to perform initial triage so that true urgencies necessitating in-person resolution could be differentiated from remotely manageable situations.[12,13] Rahman et al[14] found that patients who participated in tele-orthodontic meetings during the pandemic were 97% satisfied with their experience and all respondents in their survey agreed th at the tele-orthodontic system was useful in saving time. Another study evaluating patient perspectives on the use of virtual dental monitoring applications found a positive patient perception, with better communication, increased convenience, and reduced number of appointments as perceived benefits.[15] In contrast, Griffeth et al[16] surveyed orthodontic patients and found a preference for seeing the orthodontist face-to-face (86% of adult orthodontic patients and 78% of parents of young patients) compared to virtual alternatives. The same study revealed that the group of patients that was most likely to be interested in utilizing tele-orthodontics was the adult patients receiving clear aligner therapy. It was suggested by

Saccomanno et al. that some types of orthodontic treatment involving aligners, palatal expanders, or functional therapy could be carried out via alternating in-person appointments with tele-orthodontic appointments for many of the follow-ups during the pandemic.[17] While the potential uses and benefits of virtual patient care grew during the pandemic as practitioners looked for ways to limit human contact, its place in orthodontics long-term remains in question.

While each of the guidelines and recommendations that are applicable to orthodontic practices helped address valid safety concerns during the pandemic, they also carried with them increased business costs and potentially dramatic disruptions to practice flow and efficiency.[18] Orthodontic practitioners faced difficult decisions about which of these recommended changes they would implement during the pandemic, with patient and staff safety, continuity of patient care, and practice costs and revenue all hanging in the balance. Few studies have documented the success of these adaptations and the degree of their implementation. With varying types of orthodontic practice models and sizes, it is also not known if the ability to afford and implement these adaptations was limited to specific orthodontists and/or practice demographics.

It has been suggested that many of the essential adaptations made in orthodontics during the pandemic will likely remain in place due to changes in public perception and a new understanding and expectation of safety measures.[19] García-Camba et al. reasoned that, among many other possible changes, the use of additional personal protective equipment (PPE) may see extended use, aerosol generating procedures may be best carried out in isolated spaces moving forward, clinic spaces may see permanent rearrangements or added barriers to increase physical distance, and patient companions to appointments may be reduced.[19]

There is currently no research evaluating the perspectives of practicing orthodontists on these adaptions as we look forward to the post-pandemic era. The question arises, which of the

changes made during the pandemic proved to be effective and will any of the changes remain a part of the orthodontic practice model moving forward? While some adaptations may have improved the practice of orthodontics, others may have proved to be costly or to decrease clinical efficiency.

The aim of this study was to (1) determine what adaptations orthodontists made in their practices during the COVID-19 pandemic in response to the four categories of recommendations (infection control, social distancing, appliance use, and tele-orthodontics); (2) determine which of these adaptations orthodontists plan to continue to implement after resolution of the COVID-19 pandemic; and (3) evaluate if there was a difference in the utilization of these adaptations among providers with different demographic characteristics. The null hypothesis was that there would be no differences in infection control measures, social distancing, appliance use, or tele-orthodontics during and after the COVID-19 pandemic and there would be no differences in utilization of these adaptations among orthodontic providers with different demographic characteristics. It is critically important for the orthodontic specialty to decide how it will maintain the safety and comfort of patients moving forward with a new understanding of infection risks and the potential benefits of tele-orthodontics and alternative appliances that were illuminated by a global pandemic.

Methods

Sample Selection

Approval to conduct this cross-sectional survey was obtained from the institutional review board at Virginia Commonwealth University (HM20021433). A randomized and geographically proportionate selection of actively practicing orthodontic specialists in the United States (N=1000) who were listed as providers in the American Association of Orthodontists (AAO) online membership directory were selected for participation. For each U.S. state, a proportionate sample of orthodontists were chosen to participate among all orthodontists listed in that state using a random number generator (Microsoft Excel, 2021) to select zip codes and providers. All 50 U.S. states were represented in the sample.

Survey

An original 34-question survey was developed at Virginia Commonwealth University School of Dentistry Department of Orthodontics. The survey was sent by mail using a third party postage service in June 2021 and included an addressed, postage-paid envelope. A second follow-up survey was sent to those who did not return the questionnaire after 6 weeks from the original mailing date.

Survey questions were designed to collect information on the providers' personal demographics and practice characteristics, the adaptations that they implemented during the COVID-19 pandemic, and which of the adaptations they anticipated continuing after resolution

of the pandemic. The COVID-19 pandemic was defined as the period during which the WHO characterized the global outbreak of the virus to be pandemic. At the time respondents completed the survey, COVID-19 was still characterized as pandemic.

All participants were informed that their responses were voluntary and anonymous, and no personal identifiers would be collected. The remainder of the survey was organized into the following five categories: (1) demographic information (11 items), (2) tele-orthodontics (8 items), (3) infection control (8 items), (4) social distancing (4 items), and (5) appliance use (3 items). The demographic section of the study gathered information regarding age, gender, number of years in practice, location, and type of practice. Other background information about the size of the practice was collected including number of days per week worked, patients seen per day, and new starts per year. Respondents were then asked if they closed their practice for any period of time during the COVID-19 pandemic.

For each remaining category of questions, providers were asked to report if they adopted certain changes in their practice at any point during the COVID-19 pandemic and then asked to report their plan to either continue, discontinue, or alter those changes after resolution of the COVID-19 pandemic. The term "during the COVID-19 pandemic" was defined for respondents as the time period beginning in March 2020 and continuing until the present time that respondents were taking the survey, during which the WHO characterized the global outbreak of virus to be a pandemic.

For the "tele-orthodontics" category, questions addressed the extent of virtual patient meeting usage and what types of appointments they were used for. Providers were asked whether they provided a way for new patients to send intra-oral photos for virtual smile assessments or consultations. For the "infection control" category, questions addressed

temperature screenings of patients and staff, high efficiency particulate air (HEPA) filter use, personal protective equipment (PPE) use, and management of aerosol producing procedures. For the "social distancing" category, questions addressed waiting room protocols and limits on patients treated simultaneously. For the "appliance use" category, questions addressed changes in the number of clear aligner treatments being prescribed and the reasons for those changes.

Each section of the survey provided an opportunity for providers to provide free response comments to explain their circumstances, experiences, or opinions regarding the topics of the survey.

Statistical methods

All data collected from returned surveys remained deidentified for analysis. Results were summarized with descriptive statistics including counts and percentages for categorical responses and medians and interquartile range (IQR) for numeric responses due to skewness in the data. Comparisons between categorical responses were tested with chi-squared and Fisher's exact test as appropriate. McNemar's chi-squared tests were used to compare respondents' responses for during the pandemic and their anticipated plans for post-pandemic. Wilcoxon signed-rank test was used to compare average number of virtual visits per week during and after the pandemic. Significance level was set at 0.05. SAS EG v8.2 (SAS Institute, Cary, NC) was used for all analyses.

Results

A total of 160 surveys were returned from 38 states across the U.S. for a 16% response rate. Demographics of the respondents demonstrated a representative sample of practicing orthodontists. The majority of respondents were male (76%) and practicing in private solo orthodontic practices (83%) in suburban settings (55%). About half of respondents had between 11 and 30 years of experience (58%). There was roughly equal representation across the AAO constituencies of United States. The median reported number of new patient starts per year was 300 (IQR: 200-450) and 50 patient visits per day (IQR: 40-70). Complete respondent demographics are presented in Table 1.

Infection Control

Virtually all respondents indicated that temperature screenings were utilized during the COVID-19 pandemic (97%), but significantly less anticipate continuing to do so after resolution of the pandemic (21%, $p<0.0001$). High Efficiency Particulate Air (HEPA) filters were reportedly used by 56% of respondents during the pandemic and 50% anticipated continuing to utilize them in their practice after resolution of the pandemic, indicating a small but statistically significant reduction in use of HEPA filters ($p=0.0027$). Respondents were also asked about individual types of personal protective equipment (PPE) used during the pandemic and anticipated use after. There were significant differences in responses for use during and after

resolution of the pandemic for all types of PPE except for surgical masks (p=0.1336). Nearly all providers indicated using surgical masks during the pandemic (87%) and a slight increased number anticipated using them after resolution of the pandemic (91%). However, N95 and equivalent masks were used by 73% of respondents during the pandemic but only 25% anticipated using them after resolution of the pandemic (p<0.0001). Other forms of PPE that demonstrated clinically meaningful reductions in anticipated use after the resolution of the pandemic were disposable gowns (65% vs 29%, p<0.0001), face shields (89% vs 48%, p<0.0001), and head coverings (27% vs 11%, p<0.0001). There were significant differences in the use of machine-washable lab coats (56% vs 49%, p=0.0116), protective eyewear (92% vs 87%, p=0.0082), and scrubs (81% vs 82%, p=0.0196) but these differences were much smaller. These results are presented in Table 2 and Figure 1.

Adaptations were also made during the pandemic in terms of aerosol-producing procedures (Table 2, Figure 2). During the pandemic, the most commonly selected methods for aerosol producing procedures were: in the clinic chair with high volume suction (61%) or in the clinic chair with extra barriers between chairs (50%). After the resolution of the pandemic, the most commonly anticipated practice was in the clinic chair with high volume suction (49%) but was still significantly less common than the percent who reported using it during the pandemic (p=0.0013). Only 8% indicated that they performed these procedures in the clinic chair with no modifications during the pandemic, compared to 33% who anticipated this practice after the resolution of the pandemic (p<0.0001).

Table 1: Respondent Demographics

	n	%
Gender		
Male	118	76%
Female	37	24%
Practice Type		
Private solo orthodontic practice	131	83%
Private group orthodontic practice	24	15%
Corporate orthodontic practice	2	1%
Region		
Northeastern	16	10%
Middle Atlantic	21	13%
Southern	35	22%
Midwestern	18	12%
Great Lakes	11	7%
Southwestern	15	10%
Rocky Mountain	9	6%
Pacific Coast	31	20%
Community Setting		
Rural	6	4%
Small town	37	24%
Suburban/Large town	85	55%
Urban/Metro/City	26	17%
Years in Practice		
< 5 years	6	4%
5 - 10 years	18	11%
11 - 20 years	51	32%
21 - 30 years	40	25%
31 - 40 years	30	19%
> 40 years	12	8%
Practice Size		
Small Practice (<200 Starts per Year)	52	36%
Medium to Large Practice (200+ Starts per Year)	94	64%
	Median	IQR
Starts per Year (median, IQR)	300	200-450
Patients per Day	50	40-70

Table 2: Comparison of Self-Reported and Anticipated Use of Infection Control Measures During and After the COVID-19 Pandemic

	During		Post		P-value
	n	%	n	%	
Temperature Screenings					<0.0001
Yes, to patients only	5	3%	15	9%	
Yes, to staff only	4	3%	1	1%	
Yes, to patients and staff	144	91%	18	11%	
No	5	3%	124	78%	
HEPA Filters	88	56%	79	50%	0.0027
PPE					
Disposable gowns	102	65%	46	29%	<0.0001
Machine-washable lab coats	88	56%	77	49%	0.0116
Face shields	141	89%	76	48%	<0.0001
Protective eyewear	145	92%	138	87%	0.0082
Scrubs	128	81%	129	82%	0.0196
N95 masks (or equivalent)	115	73%	40	25%	<0.0001
Surgical masks (Level 1-3)	138	87%	144	91%	0.1336
Head coverings	42	27%	18	11%	<0.0001
Aerosol-producing procedures					
In the clinic chair with no modifications	12	8%	52	33%	<0.0001
In the clinic chair with extra barriers between chairs	41	26%	29	18%	0.0143
In the clinic chair with extra space between patients	79	50%	31	20%	<0.0001
In the clinic chair with the extra help of an assistant using high volume suction	96	61%	77	49%	0.0013
In an isolated room away from other patients	44	28%	24	15%	<0.0001
At specific times in the schedule	48	30%	17	11%	<0.0001
Not performed	10	6%	3	2%	0.0196
Other	8	5%	6	4%	0.4142

Figure 1: Comparison of Self-Reported and Anticipated Use of Infection Control Measures During and After the COVID-19 Pandemic

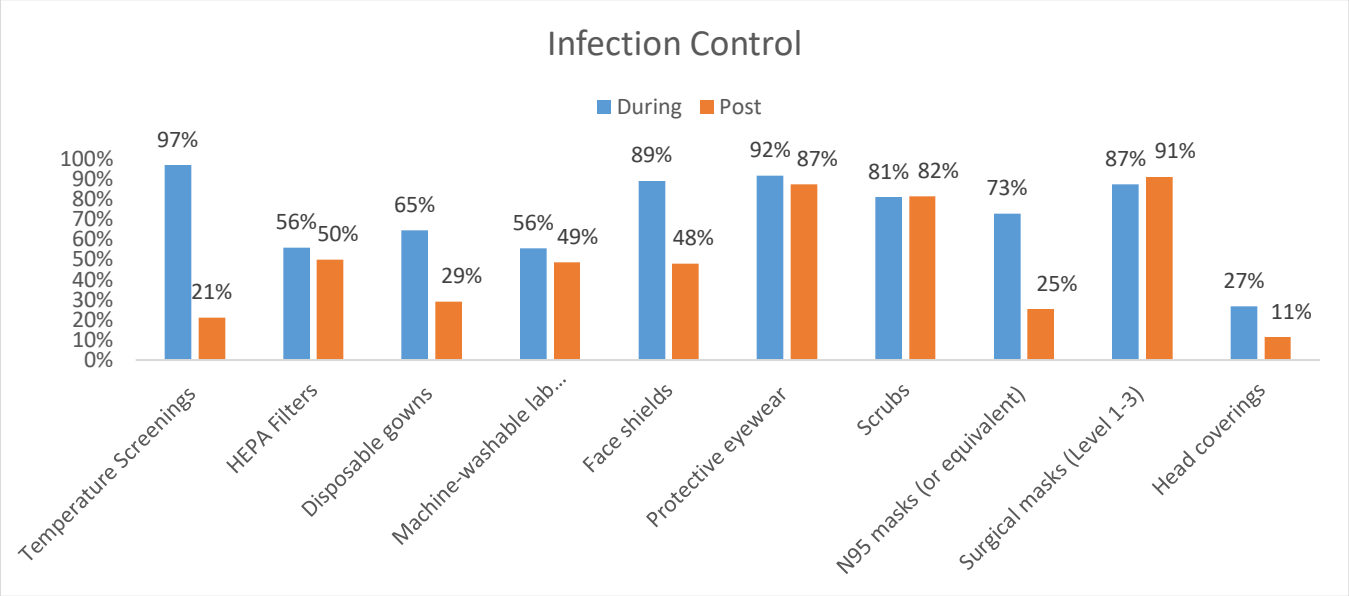
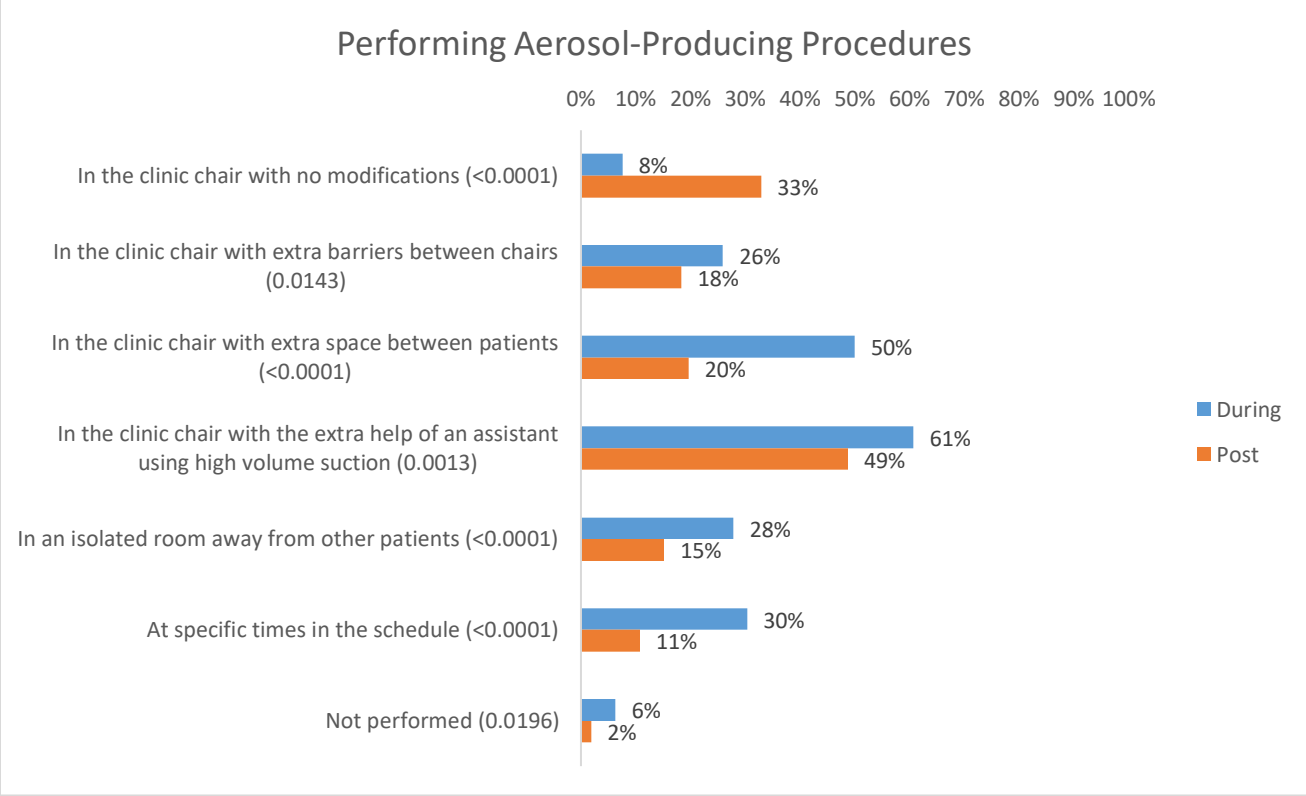


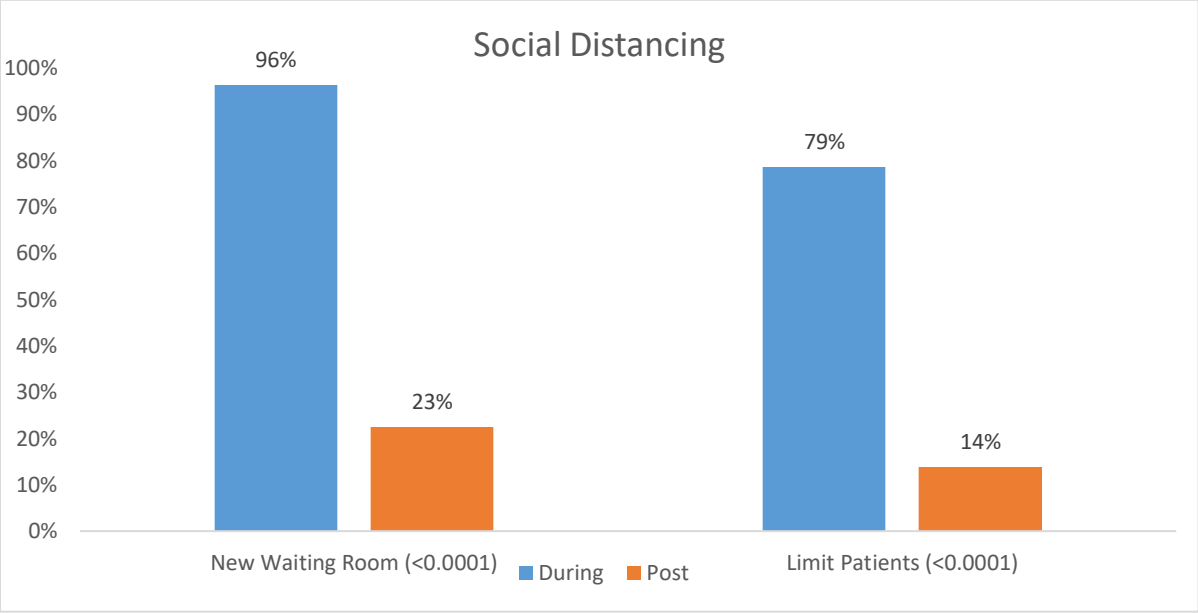
Figure 2: Comparison of Self-Reported and Anticipated Practices for Aerosol-Producing Procedures During and After the COVID-191 Pandemic (P-value)



Social Distancing

During the pandemic, nearly all respondents indicated the use of a new waiting room protocol that kept patients outside the practice until their appointment (n=154, 96%) and most limited the number of patients treated simultaneously (n=125, 79%). The number of orthodontists who anticipated using these social distancing procedures post-pandemic were significantly lower (Figure 3). Only 23% (n=36) anticipated maintaining the new waiting room procedure and only 14% (n=22) planned to continue to limit the number of patients treated simultaneously. Self-reported limiting of patient numbers during the pandemic was not significantly associated with provider gender (p=0.6550), practice type (p=0.0722), AAO region (p=0.3399), community setting (p=0.9127), or number of years in practice (p=0.8561).

Figure 3: Comparison of Self-Reported and Anticipated Use of Social Distancing Measures During and After the COVID-19 Pandemic



Aligner Use

Respondents were also asked if they increased the number of clear aligner treatments prescribed to patients during the pandemic (Table 3). Forty-two percent (n=66) of respondents indicated they perceived an increase in clear aligner use. The most common reason selected by those respondents was patient demand (n=60, 91%) followed by decreasing the number of required in-office visits (n=38, 58%), and decreased emergencies (n=32, 48%). There were no significant differences in those who reported a perceived increase in clear aligner use during the pandemic based on provider gender (p-value=0.3232), practice type (p-value=0.2472), AAO region (p-value=0.5445), community setting (p-value=0.2098), or number of years in practice (p-value=0.2924) (Table 4). These respondents were also asked if they anticipated continuing to increase the amount of clear aligners prescribed to patients after the resolution of the pandemic. Approximately half of respondents indicated they planned to continue to increase clear aligner prescriptions (n=32, 52%). This response was not significantly associated with any of the demographic variables tested (Table 4).

Table 3: Use of Clear Aligners During and After COVID-19 Pandemic

	n	%
Increase use of Clear Aligners	66	42%
Reasons for Increasing Clear Aligners (n=66)		
Patient Demand	60	91%
Decrease number of required in-office visits	38	58%
Decrease emergencies	32	48%
Easier remote monitoring	21	32%
Other	3	5%
Perceived Change Post Pandemic		
The same as before the pandemic	12	20%
As much as during the pandemic	17	28%
Continue to increase the amount I prescribe	32	52%

Table 4: Association of Respondent Demographics and Perceived Increase in Clear Aligner Use During the COVID-19 Pandemic and Anticipated Increase Ongoing

	Increased During COVID-19 (n=66)		P-value	Continue to Increase (n=61)		P-value
Gender			0.3232			0.8150
Male	49	42%		24	55%	
Female	12	32%		7	58%	
Practice Type			0.2472			0.3184
Private solo orthodontic practice	54	41%		27	54%	
Private group orthodontic practice	10	42%		5	5%	
Corporate orthodontic practice	2	100%		0	0%	
Region			0.5445			0.4149
Northeastern	7	44%		4	67%	
Middle Atlantic	8	38%		6	86%	
Southern	12	34%		4	40%	
Midwestern	8	44%		4	50%	
Great Lakes	4	36%		3	75%	
Southwestern	4	27%		2	50%	
Rocky Mountain	2	22%		0	0%	
Pacific Coast	17	55%		9	56%	
Community Setting			0.2098			0.5582
Small town	16	42%		9	60%	
Suburban/Large town	33	39%		17	59%	
Urban/Metro/City	12	46%		5	42%	
Years in Practice			0.2924			0.9434
< 5 years	3	50%		2	67%	
5 - 10 years	10	56%		5	50%	
11 - 20 years	19	37%		10	59%	
21 - 30 years	21	53%		9	47%	
31 - 40 years	10	33%		5	56%	
> 40 years	3	25%		1	33%	

Tele-orthodontics

A summary of responses related to use of telehealth are presented in Table 5. When asked if virtual patient visits were used at any point during the COVID-19 pandemic, 68% of respondents said yes (n=106). Only thirteen of those (8% of respondents) reported using virtual patient visits prior to the pandemic as well. The most common appointment types that were

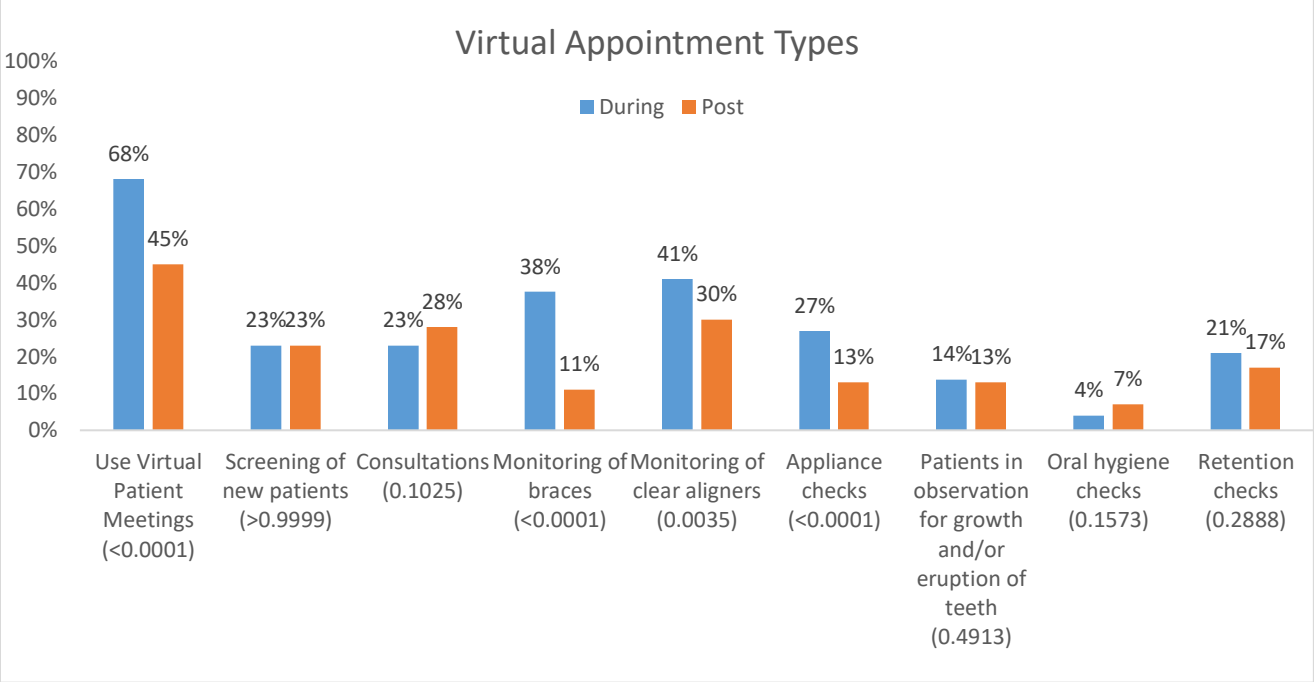
conducted virtually by those who utilized virtual visits were monitoring of clear aligners (62%), monitoring of braces (57%), and appliance checks (41%). Respondents reported that these visits most often took place during time set aside during normal clinic business hours (85%). When asked about the average number of virtual visits per week, the median response was 5 visits (IQR: 3-16). Only 37% of respondents indicated that they provided a method for submitting intra-oral photos to receive a virtual smile assessment or consultation.

The number of respondents who anticipated using virtual visits after the pandemic was significantly lower (45%) than those who reported using it during the pandemic (68%) ($p<0.0001$). Among those who reported they would continue to use virtual visits, there was a significant decrease in the rate using particular types of appointments including monitoring fixed appliance treatment (11% vs 38%, $p<0.0001$), monitoring clear aligners (30% vs 41%, $p=0.0035$), and appliance checks (13% vs 27%). When asked about the average number of virtual visits anticipated per week, the median response was 4.5 (IQR: 2-10). This was not significantly different from the average number of visits during the pandemic for those who planned to continue to use virtual visits ($p=0.1776$). A complete summary is provided in Figure 4.

The self-reported use of tele-health during the pandemic was significantly associated with the provider region ($p=0.0062$) and the practice size ($p=0.0329$). Providers in the Middle Atlantic (80%), Midwestern (88%), and Pacific Coast (87%) reported higher rates of virtual visits than those in Northeastern (63%), Southern (51%), Great Lakes (64%), Southwestern (57%), or Rocky Mountain (33%) regions. Larger practices (200 or more starts per year) had significantly higher self-reported use of virtual visits than smaller practices (74% vs 57%). There was also marginal evidence of a difference in the use of virtual visits based on the provider's years in

practice (p-value=0.0642). Those with <5 years (60%) and those with >40 years (58%) were less likely to report using virtual visits than those with 5-40 years in practice (71-83%). The perceived use of tele-health after the resolution of the COVID-19 pandemic was significantly associated with provider region (p-value=0.0109) but none of the other demographics. Specifically, respondents in Middle Atlantic (n=14, 70%) and Pacific Coast (n=18, 62%) anticipated using virtual visits after the pandemic compared to 20-45% of respondents from the other regions. See Table 6 for complete results.

Figure 4: Comparison of Self-Reported and Anticipated Use of Virtual Patient Visits During and After the COVID-19 Pandemic (P-value*)



*P-value from McNemar's Chi-Squared test for change in use of virtual appointments

Table 5: Self-Reported and Anticipated Use of Virtual Patient Visits During and After the COVID-19 Pandemic

	n	%
During Pandemic		
At any point during the COVID-19 pandemic did you use virtual patient meetings to continue care of patients in your practice?		
Yes, and I also used virtual patient meetings prior to the pandemic	13	8%
Yes, I began using virtual patient meetings for the first time during the pandemic	93	60%
No	50	32%
What type of appointments were virtual during pandemic? (n=106)		
Screening of new patients	37	35%
Consultations	36	34%
Monitoring of braces	60	57%
Monitoring of clear aligners	66	62%
Appliance checks	43	41%
Patients in observation for growth and/or eruption of teeth	23	22%
Oral hygiene checks	7	7%
Retention checks	33	31%
Other	13	12%
When do the majority of virtual patient meetings take place?		
Time set aside during normal clinical business hours	87	85%
Time set aside outside of normal clinical business hours	15	15%
Have you provided a way via your practice website or another clinical application for potential new patients to send your office intra-oral photos in order to receive a virtual smile assessment and/or consultation?		
Yes	58	37%
No	99	63%
	Median	**IQR**
Average number of virtual patient meetings per week during the COVID-19 Pandemic (n=102)	5	3-16
After Pandemic		
Do you plan to continue to use virtual patient meetings in your practice?		
Yes	71	45%
No	88	55%
What type of appointments? (n=71)		
Screening of new patients	37	52%
Consultations	44	62%
Monitoring of braces	18	25%
Monitoring of clear aligners	48	68%
Appliance checks	20	28%
Patients in observation for growth and/or eruption of teeth	20	28%
Oral hygiene checks	11	15%
Retention checks	27	38%
Other	4	6%
	Median	**IQR**
Average number of virtual patient meetings you plan to use per week in your practice after resolution of the COVID-19 pandemic? (n=71)	4.5	2-10

Table 6: Association of Respondent Demographics and Use of Virtual Patient Visits During and After the COVID-19 Pandemic

	During	P-value	After Resolution	p-value
Gender		0.0727		0.5578
Male	74, 64%		51, 45%	
Female	28, 80%		13, 38%	
Practice Type		0.6006		0.2504
Private solo orthodontic practice	88, 68%		58, 46%	
Private group orthodontic practice	15, 65%		7, 32%	
Corporate orthodontic practice	2, 100%		0, 0%	
Region		0.0062		0.0109
Northeastern	10, 63%		6, 40%	
Middle Atlantic	16, 80%		14, 70%	
Southern	18, 51%		13, 37%	
Midwestern	15, 88%		3, 20%	
Great Lakes	7, 64%		5, 45%	
Southwestern	8, 57%		3, 21%	
Rocky Mountain	3, 33%		2, 22%	
Pacific Coast	26, 87%		18, 62%	
Community Setting		0.5992		0.8616
Rural	3, 50%		2, 33%	
Small town	27, 75%		15, 42%	
Suburban/Large town	55, 66%		34, 43%	
Urban/Metro/City	17, 65%		13, 50%	
Years in Practice		0.0642		0.2452
< 5 years	3, 60%		2, 40%	
5 - 10 years	15, 83%		10, 63%	
11 - 20 years	36, 71%		16, 33%	
21 - 30 years	30, 77%		19, 49%	
31 - 40 years	14, 47%		11, 38%	
> 40 years	7, 58%		7, 58%	
Practice Size		0.0329		0.8638
Small Practice (<200 Starts per Year)	29, 57%		23, 45%	
Large Practice (200+ Starts per Year)	69, 74%		41, 44%	

Discussion

The results of this cross-sectional survey show that orthodontic practices followed the enhanced safety protocols that were issued during the COVID-19 pandemic. There was a nearly universal use of temperature screenings of patients and staff, and very high reported use of enhanced PPE such as face shields, disposable gowns, protective eyewear, scrubs, N95 masks, and surgical masks. Reports from other studies have documented extremely low infection rates in dental offices compared to other front-line health professionals, such as nurses and physicians, and the population as a whole. The results of a study by Araujo et al,[20] based on the number of dentists with confirmed or probable COVID-19 infections over more than 6 months, found a cumulative infection rate of only 2.6%. By comparison, the reported prevalence rates of other U.S. health professionals ranges from 4.8% in Chicago hospitals[21] to 31.6% in U.S. based emergency medicine services[22]. Our results reinforce that the dental and orthodontic sector remain extremely safe for patients and staff during the COVID-19 pandemic.

Orthodontists varied widely in the way that they chose to address aerosol procedures in their practices, with the vast majority of orthodontists making some modifications to their pre-pandemic protocol. There was a clear trend toward using the extra help of an assistant providing high volume suction and creating additional space between patients undergoing aerosol procedures. Other common methods of separating aerosol procedures from other patients were using extra barriers between chairs, an isolated room, and specific times in the schedule, which were almost equally distributed among responses (26%, 28%, and 30% respectively). All of the

above-mentioned modifications were recommended for reducing aerosol transmission of COVID-19 but, on average, orthodontists responded that they only implemented one or two of these aerosol modifications in their practices. Variations in practice size, the number of equipped patient chairs, and availability of isolated treatment rooms likely limited the options available to many orthodontists. However, using the help of an assistant with high volume suction required no change to space or barriers within the practice and, therefore, was adopted by many as being the most feasible and the least cost-prohibitive change. Despite possible interruptions to practice flow and efficiency, 2 out of 3 orthodontists anticipated maintaining modifications to their aerosol protocols after resolution of the pandemic with a clear preference for doing so with the extra help of an assistant with high volume suction. The anticipated continuation of other aerosol modifications were all reported to be low. These responses suggest that a large percentage of orthodontists were not consistently using the help of an assistant for suction during aerosol-producing procedures prior to the pandemic but adopted that practice during the pandemic and anticipate maintaining that practice permanently moving forward.

The new waiting room protocol that kept patients and parents outside of the practice, most often waiting in their cars, was found by orthodontists to be both helpful and hurtful. Some orthodontists commented on the increased efficiency of having patients check-in to their appointments using mobile apps and having fewer crowds in the practice. Others expressed concern about the difficulty of being able to communicate treatment progress, hygiene, and other needs with guardians without seeing them face-to-face. Despite these apparent difficulties with proper communication, nearly 1 in 4 orthodontists answered that they plan to keep the new outside waiting room post-pandemic. As a compromise, many orthodontists commented that they plan to keep the option open to each family with organized methods of conveying important

information to guardians waiting in cars such as using running assistants and patient report cards. With the high demand for face-to-face doctor interaction reported by patients in other studies,[16] keeping such a protocol may require added efforts by doctors and staff to maintain proper lines of communication and interaction with guardians.

Our results suggest that during the COVID-19 pandemic orthodontists and patients saw increasing indications for using clear aligners as a treatment modality. Not only did a significant percentage of orthodontists report an increase in clear aligner use in their practices during the pandemic, the number one reported reason for that increase was patient demand. Corporate aligner companies, such as Align Technology, saw continued growth of sales in the year 2020 despite the period of shutdown, which is evidence of that increasing demand.[23] The "Zoom Effect" has been hypothesized to be a contributing factor, reasoning that the millions of people conducting their work and schooling in front of a camera have become more conscious of their teeth and appearance, thus creating a higher demand in the market for esthetic treatments like orthodontics.[24,25]

An increase in clear aligner treatment during the pandemic does not, however, indicate that the pandemic was the primary cause of this increase, nor did orthodontists suggest that to be the case. Many respondents commented that they had seen a marked increase in the demand for clear aligners prior to the pandemic, in large part due to increases in adult patients, and saw that trend only continue during the pandemic rather than slow down or plateau. Furthermore, there is evidence that not all patients believe that clear aligners offer a better solution during the pandemic compared to braces. A cross-sectional study by Arqub et al[26] evaluated patient perceptions during the pandemic and found that almost twice as many patients still preferred braces over clear aligners (55% vs 29%).

Other reasons indicated by orthodontists for increasing clear aligners in their practices during the pandemic were a decreased need for in-office visits and decreased emergencies, both of which have been validated by previous studies.[27,28] Buschang et al.[28] reported that, when comparing matched groups of patients with non-extraction treatment goals, conventional edgewise braces required an average of 4 additional office visits and involved 1 additional emergency. Clear aligner treatment also finished treatment 5.5 months earlier and required 93.4 fewer minutes of total chair time compared to braces. Clear aligners unquestionably offer some advantages during pandemic times, especially for patients with on-going concerns about infection in a dental office due to personal health risks or for patients who prefer to see their orthodontist less frequently. However, preference by patients for decreased in-office visits has not been substantiated in research. Arqub[26] showed that when patients were asked how often they would prefer to see their orthodontist during the pandemic, 73.4% preferred monthly rather than the option for 6, 8, 10, or 12 week intervals.

Although our study did not ask about the use of in-house aligners, another possible explanation for the increase in overall aligner use during the pandemic could have been a higher number of practices implementing in-house aligner systems due to their cost-effectiveness relative to corporate aligner systems at a time when practice finances were getting squeezed.[29,30] Further studies are needed to investigate if this is the case. Overall, there is no causal relationship that can be drawn between the COVID-19 pandemic and the rising demand for clear aligners despite a number of theories surrounding a connection between the two. Nevertheless, the increase in demand is being felt by orthodontic practitioners and at least half of orthodontists are planning to follow that demand with intentional increase of clear aligner use in the post-pandemic era.

One of the most discernable changes to come out of the COVID-19 pandemic in orthodontics was elevated use of virtual patient appointments. Our survey showed a near 9-fold increase in orthodontists using virtual appointments during the pandemic from pre-pandemic numbers. Out of necessity for continuity of care during the period of shutdown and the slow reopening of practices, 2 out of 3 orthodontists turned to technology to maintain patient contact. During the pandemic, virtual tools were used the most for monitoring patients in active treatment with fixed appliances and clear aligners and less so for screening and consulting new patients, and monitoring appliances or retention. In addition to the options provided on our survey, a significant number of orthodontists shared that they used virtual meetings to address emergencies and walk patients through at-home fixes to get them out of pain. Orthodontists expressed concerns about its limited usefulness for screening new patients due to nondiagnostic photographs, a lack of radiographic records, inability to check for shifting and posturing in patient bites, inability to palpate for impacted teeth, and a hindered ability to foster relationships and share practice culture.

While it may seem that virtual meetings might be more useful for patients that travel far distances for appointments, such as in rural areas, our survey did not indicate that this was the case. There was no statistically significant difference in the number of orthodontists utilizing virtual appointments or the number of virtual appointments per week between rural and urban areas. Orthodontists even suggested the opposite in our survey, with many who practice in rural areas reporting that the virtual appointment option was not well received by their patient pool. The region of the country where orthodontists practice did seem to play a significant role in the degree that virtual meetings were utilized. The reason behind higher use in the Middle Atlantic and Pacific Coast regions is not clear but may be related to practice trends that vary

geographically. Teledentistry is regulated at the state level and some states had not passed laws allowing its use in the early stages of the pandemic, thereby restricting many practitioners from using virtual appointments during the time it may have been most useful. For example, Texas restricted the use of teledentistry until new laws were passed in mid-2021. Variation in state regulations certainly played a role in the rates of utilization among some regions.

The number of orthodontists that anticipated using virtual appointments post-pandemic fell significantly from the number that had tried using them during the pandemic, suggesting a moderate level of dissatisfaction by many. Our results indicate that orthodontists saw little value in monitoring fixed appliance treatment virtually, whereas monitoring treatment with clear aligners was more useful. This is not surprising considering that clear aligners can be given to patients for extended periods of time without adjustment and with only the need to monitor proper seating of the aligners and tracking of the teeth, which can be accomplished virtually. There appears to be a cohort of orthodontists that feel that virtual screening and consultation appointments are worth keeping long-term, perhaps because they feel that this option allows for greater convenience for patients or attracts a wider group of prospective patients to the practice. There is no doubt that virtual appointments and monitoring are here to stay in orthodontics, but the extent of the role that it will play long-term is yet to be seen. The results of this survey suggest that its primary role may be in new patient screenings and consultations as well as monitoring of clear aligners.

The COVID-19 pandemic created unique challenges for orthodontic practitioners, but the specialty adapted quickly and carefully to continue the care of patients without compromising safety. The results of our survey demonstrate wide variation in pandemic adaptations among orthodontic practices across the U.S. and that a number of these changes exhibited sufficient

benefit to support their long-term use. As we move forward beyond the COVID-19 pandemic, we can expect that the practice of orthodontics will look a little bit different. The profession took a step forward with a new understanding of infection risks and the potential benefits of tele-orthodontics and alternative appliances.

Conclusions

1. The orthodontic sector utilized many modifications to address the safety and infection control recommendations given during the COVID-19 pandemic.
2. During the pandemic, the vast majority of orthodontists followed the guidance to increase PPE in their practice, including but not limited to N95 masks, face shields, and disposable gowns. After resolution of the pandemic, use of enhanced PPE is expected to decrease.
3. A variety of modifications were utilized during the pandemic to prevent COVID-19 transmission via aerosols, with the predominant method being the additional use of an assistant using high volume suction. More than any other aerosol modification, consistent use of high-volume suction is likely to be continued even after resolution of the pandemic.
4. Clear aligner treatments saw increased use during the pandemic primarily due to patient demand and that trend is expected to continue after the pandemic. There were no indications that this increase was related to pandemic.
5. Tele-orthodontics increased dramatically during the pandemic, but less than half of orthodontists anticipate using virtual meetings in the future. Those who desire to continue using tele-orthodontics in their practice see its usefulness primarily for new patient screenings and consultations as well as monitoring of clear aligners.

References

1. Recommended Infection-Control Practices for Dentistry. Centers for Disease Control and Prevention. Published April 18, 1986. Accessed February 17, 2022. https://www.cdc.gov/mmwr/preview/mmwrhtml/00033634.htm
2. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. Accessed January 24, 2021. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020
3. President of the United States of America. *Proclamation 9994 of March 13, 2020: Declaring a National Emergency Concerning the Novel Coronavirus Disease (COVID-19) Outbreak.* Vol 85.; 2020:15337-15338.
4. Guidance for Dental Settings. Centers for Disease Control and Prevention. Published 2022. Accessed October 3, 2022. https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html
5. Return to Work Interim Guidance Toolkit. *American Dental Association*. Published online 2020. Accessed April 9, 2022. ada.org
6. Considerations for the provision of essential oral health services in the context of COVID-19. *World Health Organization*. Published online August 3, 2020:1-5.
7. Interim Orthodontic PPE Summary Based on Current CDC and OSHA Guidelines. American Association of Orthodontists. Published 2021. Accessed January 23, 2021. https://www2.aaoinfo.org/library/covid-19-resource-center/
8. Dorst J. Back-to-Work Coronavirus Infection Control. Journal of Clinical Orthodontics. Published May 2020. Accessed April 9, 2022. https://www.jco-online.com/archive/2020/05/268-back-to-work-coronavirus-infection-control/
9. Srirengalakshmi M, Venugopal A, Pangilinan PJP, et al. Orthodontics in the COVID-19 Era: The way forward Part 2 orthodontic treatment considerations. *J Clin Orthod*. 2020;54(6):341-349.
10. Kaur H, Kochhar AS, Gupta H, Singh G, Kubavat A. Appropriate orthodontic appliances during the COVID-19 pandemic: A scoping review. *Journal of Oral Biology and Craniofacial Research*. 2020;10(4):782-787. doi:10.1016/j.jobcr.2020.10.014

11. Gou Y, Ungvijanpunya N, Chen L, et al. Clear aligner vs fixed self-ligating appliances: Orthodontic emergency during the 2020 coronavirus disease 2019 pandemic. *Am J Orthod Dentofacial Orthop.* 2022 Apr;161(4):e400-e406. doi:10.1016/j.ajodo.2021.12.009

12. Caprioglio A, Pizzetti GB, Zecca PA, Fastuca R, Maino G, Nanda R. Management of orthodontic emergencies during 2019-NCOV. *Progress in Orthodontics*. 2020;21(1). doi:10.1186/s40510-020-00310-y

13. 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. doi:10.2319/033120-236.1

14. Rahman N, Nathwani S, Kandiah T. Teledentistry from a patient perspective during the coronavirus pandemic. *British Dental Journal*. 2020;229(3):1-4. doi:10.1038/s41415-020-1919-6

15. Hansa I, Semaan SJ, Vaid NR, Ferguson DJ. Remote monitoring and "Tele-orthodontics": Concept, scope and applications. *Seminars in Orthodontics*. 2018;24(4):470-481. doi:10.1053/j.sodo.2018.10.011

16. Griffeth J, Shroff B, Carrico C, Cook P. Patient perspectives on teledentistry and face-to-face doctor interaction during orthodontic treatment. *VCU Theses and Dissertations*. Published online January 1, 2021. Accessed January 3, 2022. https://scholarscompass.vcu.edu/etd/6577

17. Saccomanno S, Quinzi V, Sarhan S, Laganà D, Marzo G. Perspectives of tele-orthodontics in the COVID-19 emergency and as a future tool in daily practice. *European Journal of Paediatric Dentistry*. 2020;21(2):157-162. doi:10.23804/EJPD.2020.21.02.12

18. Park JH, Kim JH, Kai A, Rogowski L, Liu A. Post-COVID-19 Management Guidelines for Orthodontic Practices. *Journal of Clinical Orthodontics*. Published online 2020:351-355.

19. García-Camba P, Marcianes M, Varela Morales M. Changes in orthodontics during the COVID-19 pandemic that have come to stay. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2020;158(4):e1-e3. doi:10.1016/j.ajodo.2020.07.014

20. Araujo MW, Estrich CG, Mikkelsen M, Morrissey R, Harrison B. COVID-2019 among dentists in the United States: A 6-month longitudinal report of accumulative prevalence and incidence. *Journal of the American Dental Association*. 2021;152(8):588. doi:10.1016/j.adaj.2021.03.021

21. Wilkins JT, Gray EL, Wallia A, et al. Seroprevalence and Correlates of SARS-CoV-2 Antibodies in Health Care Workers in Chicago. *Open Forum Infectious Diseases*. 2021;8(1):1-9. doi:10.1093/OFID/OFAA582

22. Firew T, Sano ED, Lee JW, et al. Protecting the front line: a cross-sectional survey analysis of the occupational factors contributing to healthcare workers' infection and

psychological distress during the COVID-19 pandemic in the USA. *BMJ Open*. 2020;10. doi:10.1136/bmjopen-2020-042752

23. Booth J. Pandemic-proof? Align Technology sold a record number of clear aligner in 2020. Dental Tribune International. Published 2021. Accessed March 7, 2022. https://coronavirus.dental-tribune.com/news/pandemic-proof-align-technology-sold-a-record-number-of-clear-aligners-in-2020/

24. Zoom Drives Boom in Orthodontic Services. Dentistry Today. Published 2021. Accessed March 7, 2022. https://www.dentistrytoday.com/zoom-drives-boom-in-orthodontic-services/

25. Pikoos TD, Buzwell S, Sharp G, Rossell SL. The Zoom Effect: Exploring the Impact of Video Calling on Appearance Dissatisfaction and Interest in Aesthetic Treatment During the COVID-19 Pandemic. *Aesthetic Surgery Journal*. 2021;41(12):NP2066-NP2075. doi:10.1093/asj/sjab257

26. Arqub SA, Voldman R, Ahmida A, et al. Patients' perceptions of orthodontic treatment experiences during COVID-19: a cross-sectional study. *Progress in Orthodontics*. 2021;22(1). doi:10.1186/S40510-021-00363-7

27. Gu J, Tang JS, Skulski B, et al. Evaluation of Invisalign treatment effectiveness and efficiency compared with conventional fixed appliances using the Peer Assessment Rating index. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2017;151(2):259-266. doi:10.1016/j.ajodo.2016.06.041

28. Buschang PH, Shaw SG, Ross M, Crosby D, Campbell PM. Comparative time efficiency of aligner therapy and conventional edgewise braces. *Angle Orthodontist*. 2014;84(3):391-396. doi:10.2319/062113-466

29. Nisco PM. Integration of In-House Aligner Therapy in Private Practice. *Journal of Clinical Orthodontics*. Published online January 2021:450-459.

30. Marya A, Venugopal E. In-house Aligners Helping Answer the Distress Call During the Pandemic! *Journal of International Oral Health*. 2021;13:197-198.