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# Appointment impact and orthodontic emergency occurrence during the coronavirus disease 2019 pandemic: A retrospective study

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**Introduction:** This retrospective study aimed to quantify the impact of coronavirus disease 2019 (COVID-19) on the orthodontic appointment and make an analysis of orthodontic emergencies (OEs) that occurred during the pandemic. **Methods:** A total of 628 patients were randomly sampled from 3489 subjects who were undergoing active orthodontic treatment with fixed appliances, and the medical records were reviewed. OE occurrence was analyzed from 617 patients who had explicit return-visit records after the COVID-19 outbreak. Wilcoxon signed rank tests, chi-square tests, and a binary logistic regression were performed. **Results:** The return-visit of 98.6% of the patients was delayed significantly with an increase over  $8.98 \pm 4.76$  weeks ( $P < 0.001$ ). In general, 32.3% of the patients suffered from various OEs while waiting for their first return-visit, and bracket or band debonding was the most frequently reported category. Most OEs did not receive timely treatments because of the lockdown. The incidence was nearly 2 times higher than that of the normal appointment times. No correlation was found between OE occurrence and different demographic and clinical characteristics of patients. The therapeutic progress of patients, especially those in stage 3, was postponed because of the occurrence of OEs. **Conclusions:** Regardless of the limitations, our study suggested that it is highly possible that the COVID-19 pandemic has delayed appointments of fixed orthodontic patients. OEs did bother a minority of patients and could not be settled in time during the lockdown, which had a negative impact on the near-term treatment progress and should have been prevented. Further studies are required to investigate the long-dated influence of COVID-19 on orthodontic practices. (Am J Orthod Dentofacial Orthop 2022;161:e12-9)

The ongoing coronavirus disease 2019 (COVID-19) has disrupted the human society catastrophically since its outbreak, bringing a suspension or stagnation to almost every field throughout the world. Because no effective treatment and safe vaccine is applicable up to now, social distancing measures are still the

most feasible way to control the spreading of this devastating pandemic, which may be necessary until 2022.<sup>1,2</sup>

Because of the distinctive treatment procedures, large quantities of droplets and aerosols could be generated during the implementation of dental and orthodontic services.<sup>3-5</sup> As a consequence, the pathogen, severe acute respiratory syndrome coronavirus 2, may be transmitted potentially in the meanwhile, which exposes dentists, orthodontists and patients to a high risk of infection.<sup>5-8</sup> Therefore, a mandatory suspension of nonemergency dental care, including orthodontic treatment, was conducted in several countries.<sup>9-11</sup>

Unlike other dental therapies, orthodontic treatment requires regular return-visits for active adjustment every 4-6 weeks in a period of nearly 2 years or even longer.<sup>12-14</sup> Thus, the shutdown of dental hospitals and clinics did arouse great challenge to both orthodontists and their patients. Although earlier publications have indicated that the scheduled appointment of patients could be affected before the

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lockdown was relieved, few studies currently report the influence in a quantitative way.<sup>13,15,16</sup>

It is acknowledged that there is a need to close orthodontic practices during the pandemic; however, the treatment of orthodontic emergencies (OEs) should not be completely ignored. An OE may include a problem arising from orthodontic appliances or accessories, in which unavailability of management would be intolerable or detrimental to the patient.<sup>17,18</sup> Scenarios that could result in OEs can be found in previous studies.<sup>17,19-21</sup> Furthermore, the occurrence of some OEs such as bracket debonding probably contributes to a prolonged orthodontic treatment duration.<sup>17,22,23</sup> Consequently, the prevention and timely management of OEs are crucial not only to minimize the burdens of patients but also to avoid a prolonged treatment time by maintaining the efficacy of appliances.

This single-center study was aimed at quantifying the impact of the COVID-19 pandemic on the orthodontic appointment of patients. Moreover, the occurrence of OEs was recorded, and the correlation between the occurrence of OEs and different demographic and clinical characteristics was detected. The impact of the occurrence of OEs on the treatment progress in the near term was also analyzed. Although it seems impractical to validate the long-term influence of the pandemic at present, it is still valuable for us to carry out this study because the findings may provide helpful information for orthodontists and patients who are devoting to minimizing the impact of COVID-19 on their treatment.

## MATERIAL AND METHODS

This retrospective study was approved by the ethics committee of West China Hospital of Stomatology (approval no. WCHSIRB-CT-2020-250).

A stratified random sampling (sampling rate = 20%) based on the appointment time was conducted through 3489 patients in West China Hospital of Stomatology, who met the following inclusion criteria: (1) receiving orthodontic treatment of labial fixed appliances in the Department of Orthodontics and (2) having regular appointment records both before and after the outbreak of COVID-19. The recruitment deadline was August 12, 2020. Finally, 628 patients were included in the study after the exclusion of 69 patients who were not under active treatment, and the medical records were reviewed for data extraction independently by 2 researchers (J.X. and Y.L.X.) before integration into the final database used for analysis. Any disagreement was discussed and solved with a third consultant. The patient inclusion procedure is shown in the [Figure](#).

A customized datasheet was used for collecting the medical details of eligible patients. The basic information included sex, age, Angle's classification, extraction protocol (extraction or nonextraction), treatment duration, and the stage division before the outbreak of COVID-19. Notably, the stage division of comprehensive orthodontic treatment was determined by following the introduction of the stages by Raymond Begg: (1) stage 1: alignment and leveling, (2) stage 2: molar relationship correction and space closure, and (3) stage 3: finishing.<sup>24</sup> The scheduled and actual appointment intervals were calculated with the dates of the last visit, planned visit, and the first actual visit spanning the pandemic outbreak. Furthermore, the chief complaint, clinical examination, and treatment details of the first visit after the outbreak of COVID-19 were recorded to evaluate whether patients had experienced OE during their waiting for return-visit and its potential impact on the near-term treatment progress. In addition, to understand whether the shutdown of orthodontic care had increased the risk of OE occurrence, another 617 patients who had appointments during the normal times of 2019 (from 11th, February to 15th, March, a similar period in 2019) were included using the same sampling method, and their OE incidence during a normal appointment interval of this period was analyzed, which was then compared with that of the group during COVID-19 shutdown.

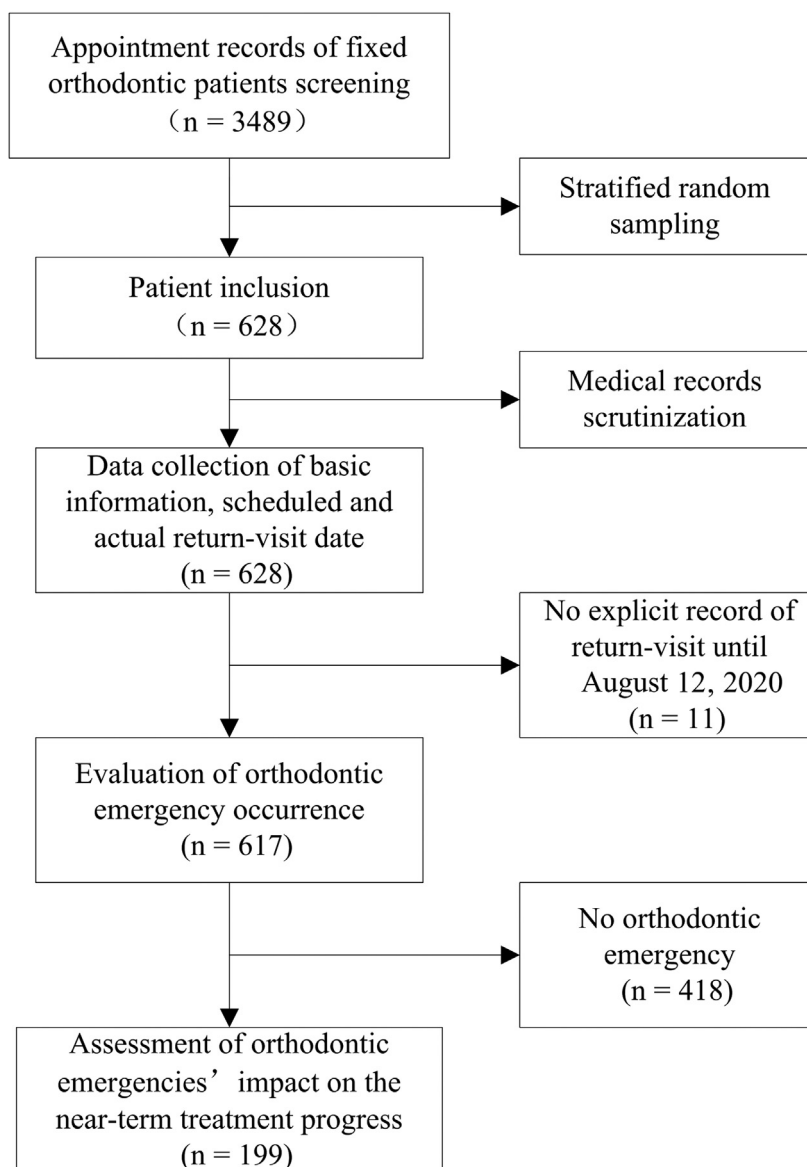
## Statistical analysis

To test the interrater reliability of the 2 reviewers (J.X. and Y.L.X.), kappa coefficients of the stage division and the category of the near-term treatment progress, which may be controversial during the reviewing process, were calculated. The basic information and the occurrence of OEs details of included patients were presented as means  $\pm$  standard deviation, frequencies, or ratios. A Wilcoxon signed rank test was employed to compare the scheduled and actual appointment interval. Chi-square tests were used to compare frequencies or ratios between groups with different demographic and clinical characteristics. Moreover, to explore the correlation between OE occurrence and multiple factors (sex, age, Angle's classification, extraction protocol, treatment duration, and stage division), a binary logistic regression was conducted.

All the aforementioned analyses were performed with SPSS (version 21.0; IBM Corp, Armonk, NY). A *P* value  $<0.05$  was set as statistical significance.

## RESULTS

The kappa coefficients of both stage division and treatment progress categories were excellent (0.924 and 0.922), indicating a good interrater reliability.



**Fig.** Procedure for patient inclusion.

According to the eligibility criteria, 628 fixed orthodontic patients were ultimately included in this study, with a mean age of  $20.54 \pm 7.49$  years. Detailed information about sex, age, Angle's classification, extraction protocol, treatment duration, and stage division of patients before the COVID-19 outbreak is shown in [Table I](#).

The mean interval of scheduled appointments was  $7.26 \pm 1.99$  weeks, which was longer than the recommended return-visit interval for orthodontic patients (ie, 4-6 weeks) because of the New Year's holiday. In contrast, the actual appointment interval was

$16.26 \pm 5.19$  weeks on average. The results of the Wilcoxon signed rank tests showed that the difference was statistically significant ( $P < 0.001$ ). In total, 98.6% of the patients ( $n = 619$ ) could not receive the regular treatment at the appointed time, despite that 0.9% of the patients ( $n = 6$ ) visited their orthodontist on time and 0.5% ( $n = 3$ ) in advance. The increase in return-visit interval was  $8.98 \pm 4.76$  weeks on average, and the distribution trend is summarized in [Table II](#). Notably, 1.8% of the patients ( $n = 11$ ) did not return to visit until August 12, 2020, whose increase in appointment interval was exhibited to be over 20 weeks.

OE occurrence was analyzed among 617 patients who had explicit return-visit records after the outbreak of COVID-19. In general, 32.3% of the patients ( $n = 199$ ) suffered from different kinds of OEs while waiting for their first return-visit, and 42 out of 199 paid a visit to a dental emergency department to have it managed. The occurrence frequency, management strategy (dental emergency department seeking or not) of OEs, and their relationship with appointment delay are summarized in [Table III](#).

Details about the OEs that occurred were acquired from 199 included patients. In total, 183 out of 199 patients mainly complained about a single OE symptom, whereas 16 patients suffered from 2 kinds of OEs. The specific category of recorded OEs is shown in [Table IV](#). Because bracket or band debonding was the most frequently reported OE, the number and position of loose brackets or bands were analyzed. Whereas 2 out of 145 patients reported at most 6 brackets bonding failure, results showed that 90 out of 149 had only 1 bracket or band that loosened. The position analysis revealed that the debonding of mandibular bracket or band was more recorded than maxillary bracket or band (64.8% vs 35.2%), and posterior bracket or band debonding was more reported than anterior ones (74.5% vs 25.5%), especially those on molars (48.2%).

The intergroup comparability was acceptable because no significant differences were found in the demographic and clinical characteristics. As for the occurrence of OEs, 99 patients in the normal appointment group were recognized with emergencies suffering at a percentage of 16.0%, which was significantly lower than the OE incidence of patients in the COVID-19 shutdown group ( $P < 0.001$ ).

A binary logistic regression was run to explore the correlation between OE occurrence and sex, age, Angle's classification, extraction protocol, treatment duration, and stage division; however, no correlation with statistical significance was detected. Moreover, the incidences of OEs, bracket or band debonding, and poking distal wire among patients with different demographic and clinical characteristics were compared respectively using chi-square tests, but no significant difference was found.

The subsequent treatment during the first return-visit after the COVID-19 outbreak was categorized into 3 kinds: progressing into the next step, retreating to the last step, and maintaining the existing treatment. Results showed that patients who have experienced OEs were less likely to progress into the subsequent treatment than those who did not, and the difference was statistically significant ( $P < 0.001$ ); detailed information is summarized in [Table V](#). Among patients with

**Table I.** Demographic and clinical characteristics of included patients ( $n = 628$ )

Variables	Category	Frequency (n)	Percentage (%)
Sex	Male	205	32.6
	Female	423	67.4
Angle's classification	Class I	163	26.0
	Class II	394	62.7
	Class III	68	10.8
	Class IV*	3	0.5
Extraction protocol	Extraction	441	70.2
	Nonextraction	187	29.8
TD (mo) <sup>†</sup>	TD ≤ 12	290	46.2
	12 < TD ≤ 24	193	30.7
	24 < TD ≤ 36	108	17.2
	36 < TD ≤ 48	26	4.1
	TD > 48	11	1.8
Stage division	Stage 1	319	50.8
	Stage 2	245	39.0
	Stage 3	64	10.2

TD, Treatment duration.

\*Class IV malocclusion indicates a patient with a Class II molar relationship on one side and a Class III molar relationship on the other side; <sup>†</sup>The average treatment duration of included patients was  $15.32 \pm 12.28$  months.

OEs, the possibility of retreating to the last step was higher in the treatment of patients in stage 3 than those in stage 2 and stage 1 (41.2% vs 32.4% vs 0.9%;  $P < 0.001$ ; see [Table VI](#)).

## DISCUSSION

The outbreak of the COVID-19 pandemic has brought huge limitations to dental care, especially to treatments such as orthodontic practice, which requires a regular return-visit for active adjustment.<sup>3</sup> As a consequence, patients are at a greater risk of delaying or missing appointments.

In this study, the actual interval since the last appointment was proved to be over  $16.26 \pm 5.19$  weeks on average, extremely longer than that of the scheduled appointment. Treatment was delayed in 98.6% of the patients, and the average delay was more than  $8.98 \pm 4.76$  weeks. This might be primarily explained by the suspension of nonemergency dental services, which involved orthodontic treatment and the subjective procrastination of patients. It was universally acknowledged that dental treatments were at an extremely high risk of severe acute respiratory syndrome coronavirus 2 infection because virus-contaminated aerosols could be generated potentially during the operation.<sup>4,5,7</sup> Therefore, dental hospitals and clinics were recommended to shut down temporarily by professionals and authorities, resulting in the unavailability of nonemergency treatment.<sup>25,26</sup> In contrast, the anxiety

**Table II.** Distribution trend of the increase in return-visit interval

Increase (wk)	Frequency (n)	Percentage (%)
1 ≤ 0	9	1.4
0 < 1 ≤ 4	46	7.3
4 < 1 ≤ 8	238	37.9
8 < 1 ≤ 12	221	35.2
12 < 1 ≤ 16	55	8.8
16 < 1 ≤ 20	33	5.3
1 > 20	26	4.1

I, Increase.

and concerns about the pandemic could also act as a hindrance to patients' willingness in attending an orthodontic appointment, as reported by Cotrin et al.<sup>16</sup>

The principal influence of missed or delayed appointment was thought to be the prolongation of orthodontic treatment duration. Beckwith et al<sup>12</sup> claimed that another 1.09 months were increased for each missed return-visit. Except for treatment time, we believe that the therapeutic outcomes should also be taken into consideration if a long-term appointment delay occurred. It was found in our clinical examination that the extraction space of some patients got smaller after a long-term unattendance that resulted from COVID-19, which had a negative impact on the retraction of anterior teeth. Furthermore, Saltaji and Sharaf<sup>19</sup> stated that certain patients could not be left unattended for over 10-12 weeks, such as patients with a reverse-curve nickel-titanium wire. However, the influence on therapeutic outcomes still needs further investigation in the long run.

To date, a unanimous perfect way to balance the regular monitoring and the security of patients during the pandemic lockdown has not been found yet, although teleorthodontics was reported to be a feasible solution.<sup>27,28</sup> Perhaps orthodontists could only make plans on the basis of their own situation to reduce the treatment delay as far as possible.

OE occurrence was analyzed in our study. In total, 32.3% of the patients experienced various OEs during the prolonged appointment interval that resulted from the COVID-19 shutdown. By comparison, only 16.0% of the patients were found to be bothered with OEs during an appointment interval of normal times. The relative risk reached 2.01, suggesting that missed or delayed appointments may increase the risk of OE occurrence. No correlation between OE occurrence and sex, age, Angle's classification, extraction protocol, treatment duration, and stage division was detected by logistic regression, indicating that OE was a common trouble for all patients. In total, 42 out of 199 patients paid a

**Table III.** Occurrence and management of OEs

Increase in return-visit interval (wk)	OE/dental emergency department*			
	N/N <sup>†</sup>	N/Y <sup>‡</sup>	Y/N <sup>‡</sup>	Y/Y <sup>‡</sup>
wk ≤ 0	3 (33.3)	1 (11.1)	3 (33.3)	2 (22.3)
0 < wk ≤ 4	18 (39.1)	2 (4.4)	8 (17.4)	18 (39.1)
4 < wk ≤ 8	172 (72.3)	2 (0.8)	44 (18.5)	20 (8.4)
8 < wk ≤ 12	151 (68.3)	0 (0)	68 (30.8)	2 (0.9)
12 < wk ≤ 16	36 (65.5)	0 (0)	19 (34.5)	0 (0)
16 < wk ≤ 20	22 (66.7)	0 (0)	11 (33.3)	0 (0)
wk > 20	11 (73.3)	0 (0)	4 (26.7)	0 (0)
Total	413 (66.9)	5 (0.8)	157 (25.5)	42 (6.8)

Note. Values are n (%).

N, No; Y, yes.

\*OE/dental emergency department, The situation of orthodontic occurrence and the situation of seeking help from the dental emergency department; <sup>†</sup>N/N indicates patients who did not suffer from an OE and also did not seek help from the dental emergency department. N/Y indicates patients who did not suffer from an OE but did seek help from the dental emergency department. Y/N indicates patients who did suffer from an OE but did not seek help from the dental emergency department. Y/Y indicates patients who did suffer from an OE and also did seek help from the dental emergency department.

**Table IV.** Specific category of recorded OEs

OE	Frequency (n)	Patients with OE (%)	All patients (%)
Bracket/band debonding	149	74.9	24.1
Poking distal wire	37	18.6	6.0
Archwire fracture	6	3.0	1.0
Lingual button looseness	3	1.5	0.5
Power chain/coil spring loss	3	1.5	0.5
Anchorage device looseness*	3	1.5	0.5
Preactivated appliance dysfunction <sup>†</sup>	3	1.5	0.5
Accessory removable appliance dysfunction <sup>‡</sup>	2	1.0	0.3
Metallic ligature loss	1	0.5	0.2
Periodontal symptoms <sup>§</sup>	4	2.0	0.6
Other mucosal symptoms <sup>  </sup>	2	1.0	0.3
Endodontic symptoms <sup>¶</sup>	1	0.5	0.2

\*Including 2 patients with miniscrew looseness and 1 patient with both miniscrew and Nance appliance looseness; <sup>†</sup>Including 2 patients with transpalatal arch looseness and 1 patient with Forsus Fatigue Resistance Devices breakage; <sup>‡</sup>Including 1 patient with flat bite-plate breakage and 1 patient with occlusal splint breakage; <sup>§</sup>Including 1 patient with periodontal abscess and 3 patients with severe gingivitis; <sup>||</sup>Including 1 patient with miniscrew covered by mucosa and 1 patient with mucosal lesion pressed by power chain; <sup>¶</sup>Including 1 patient with periapical periodontitis and fistula.

visit to the dental emergency department to have their OEs solved, revealing that a minority of orthodontic patients also needed emergency dental care, even though orthodontic treatment was regarded as nonessential

**Table V.** Impact of OE occurrence on subsequent treatment in the near term

OEs	Subsequent treatment		
	Progress*	Retreat*	Maintain*
No	415 (99.3)	0 (0.0)	3 (0.7)
Yes	155 (77.9)	31 (15.6)	13 (6.5)
Total	570 (92.4)	31 (5.0)	16 (2.6)

Note. Values are n (%).

\*Progress indicates progressing into next step. Retreat indicates re-treating to the last step. Maintain indicates maintaining the existing treatment.

during the pandemic.<sup>10,29</sup> Therefore, any *one size fits all* recommendation to suspend all orthodontic treatments probably should be avoided.

To deal with OEs, previous publications have promoted a series of advices.<sup>18,20</sup> The first step may be evaluating the severity and urgency of OE; virtual assistance such as photographs, videos, or video calls was also suggested to be used.<sup>20,27,28,30</sup> After the evaluation, orthodontists may decide whether the emergency could be managed by private practice of the patients themselves under specific direction or a visit to dental emergency department was needed. For the former circumstance, detailed solutions could be found in the publications of Caprioglio et al<sup>20</sup> and Dowsing et al,<sup>21</sup> which consequently would not be rediscussed in this study. In contrast, for the latter circumstance, it is believed that a contingency plan must be formulated in advance, and personal protective equipment is needed for both patients and orthodontists.<sup>3,18</sup> Generally speaking, the best way to manage OEs when appointments are inconvenient is to prevent.<sup>20</sup> Therefore, it is quite essential for orthodontists or dental institutions to keep in contact with patients and provide practical tips for avoiding the occurrence of OEs.

Among the specific categories of OEs recorded, bracket or band debonding occurred most frequently, and poking distal wire was the second in terms of occurrence. Position analysis exhibited that mandibular brackets or bands were more likely to loosen than maxillary brackets or bands, and posterior brackets or bands were more reported than anterior brackets or bands, especially those on molars, which was consistent with previous studies.<sup>31-34</sup> These information might be helpful when making decisions on what to be emphasized to patients in terms of OE prevention.

Considering the impact of OEs, previous studies have proved that patients may suffer from discomfort owing to certain urgencies such as poking distal wire, and the treatment duration may be prolonged under

**Table VI.** Impact of OE on the subsequent treatment of patients in different stages

Stage division	Category of the subsequent treatment		
	Progress*	Retreat*	Maintain*
Stage 1	103 (92.8)	1 (0.9)	7 (6.3)
Stage 2	44 (62.0)	23 (32.4)	4 (5.6)
Stage 3	8 (47.1)	7 (41.2)	2 (11.8)
Total	155 (77.9)	31 (15.6)	13 (6.5)

Note. Values are n (%).

\*Progress indicates progressing into next step. Retreat indicated re-treating to the last step; Maintain indicates maintaining the existing treatment.

circumstances such as brackets debonding.<sup>17,22,23,35,36</sup>

It could be inferred that these adverse effects were highly likely to be exacerbated during the COVID-19 pandemic because most OEs did not receive timely management as Table III indicates. Although it is difficult to appraise the long-dated therapeutic impact currently, in this study, we analyzed the influence of OE occurrence on the near-term treatment progress and found that patients who experienced OEs were less likely to progress into the subsequent step than those who did not (patients in stage 3 in especial), which may probably contribute to the prolongation of orthodontic treatment time. Accordingly, to minimize the negative influence of COVID-19 on orthodontic treatment duration, the prophylaxis of OEs should be brought to the forefront by both orthodontists and patients, especially patients in stage 3.

In this study, we quantitatively evaluated the return-visit delay of fixed orthodontic patients caused by the COVID-19 pandemic, which confirmed the prediction of earlier studies. Moreover, the incidence, category, and short-term impact on subsequent treatment of OEs were analyzed. The results may provide valuable information for both practitioners and patients who are bothered with a suspension of orthodontic care.

However, some limitations need to be noted. First, our study was conducted in a single center which gradually relieved the lockdown of dental care in early April, thus the results of our investigation may get even worse in other areas where the lockdown was relieved later or remains ongoing. Second, information collected from medical records mainly revealed the objective clinical examinations but could not exhibit the subjective feelings of patients especially those who suffered from OEs, although the chief complaint was also recorded. Therefore, the results of our study should be interpreted in combination with other investigations that focused on

the perspective of patients. In addition, further studies are required. Finally, it is impractical for us to evaluate the impact of COVID-19 on both treatment duration and the final therapeutic outcome of the included patients at the present stage, which motivates us to follow the treatment progress in the coming future.

## CONCLUSIONS

On the basis of the evidence currently available, the findings of this retrospective study are summarized as follows:

1. The COVID-19 pandemic has postponed the appointment of fixed orthodontic patients, which makes it highly possible to experience a return-visit delay.
2. Compared with normal appointment times, the incidence of OE increased almost 2-fold. No correlation was found between the occurrence of OE and different demographic and clinical characteristics of patients.
3. Bracket or band debonding was the OE that occurred most frequently; poking distal wire was the second most frequently occurring OE. Mandibular brackets or bands and posterior brackets or bands were more likely to loosen, particularly those on molars.
4. OE occurrence delayed the therapeutic progress of patients, especially those in stage 3, which may exacerbate the impact of COVID-19 on orthodontic treatment duration and needs to be prevented.

## AUTHOR CREDIT STATEMENT

Jie Xiang contributed to conceptualization, methodology, software, data curation, original and draft preparation, and editing; Yilin Xin contributed data curation and editing; Raokaijuan Wang contributed to data curation and editing; Yiran Zou contributed to data curation; Hongling Zhou contributed to data curation; Sangbeom Shim contributed to data curation; and Lixing Zhao contributed to supervision and funding acquisition.

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