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Clear aligner vs fixed self-ligating appliances: Orthodontic emergency during the 2020 coronavirus disease 2019 pandemic

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Introduction: The aim was to investigate the type, incidence, and degree of orthodontic-related emergencies in orthodontic patients during the 2020 coronavirus disease 2019 pandemic and compare the different effects of clear aligner (CA) and fixed self-ligating appliances on the orthodontic emergency. **Methods:** The questionnaire was based on emergencies in orthodontics. The responses of 428 patients between the ages of 12 and 38 years (20.4 ± 7.03) in orthodontic treatment during 2020 were examined. **Results:** The gender, age, and the type of orthodontic appliance affect the incidence of orthodontic-related emergencies. Female or adolescent patients treated by self-ligating appliances showed a higher incidence of emergencies. The patients treated by CA exhibited a much lower incidence of emergency. Appliance detachment and mucosa injury were very common in respondents, whereas accidental ingestion and other rare emergencies were less common. The most common reason leading to appliance detachment was chewing hard food. Interestingly, the fixed self-ligating appliances group was also affected by the accidental detachment of appliances to a large extent. The CA and self-ligating groups showed an almost equal incidence of accidental ingestion. The most common foreign body was elastics in both groups. However, the self-ligating group could accidentally ingest dangerous foreign bodies, such as archwires, miniscrews, and welded attachments. **Conclusions:** Orthodontic-related emergencies were very common in patients. The CA could effectively reduce orthodontic-related emergencies. Dentists should raise patients' awareness of proper appliance care. A proper and standard protocol should be developed. (*Am J Orthod Dentofacial Orthop* 2022;161:e400-e406)

It has been reported that emergencies are common in dental practice.¹⁻³ Although less than other oral specialties, orthodontic emergencies should not be overlooked because more and more children, adolescents, and adults seek orthodontic treatment

nowadays.^{1,4} Sometimes, dental practices lead to dental emergencies, prolonged courses, and complicated treatment methods, increasing the medical cost and sometimes leading to medical accidents and disputes. To strengthen dental-medical safety, the design and use of effective methods to prevent dental and medical mistakes should receive attention.

Orthodontic treatment is slightly different from the treatment of other oral diseases. Several appliances have been used in orthodontic treatment.⁵⁻⁷ The types of devices could be one of the most complex appliances among dental therapy. Orthodontic treatment usually lasts for >1 year and the appliances, such as wires, mini-implant, transpalatal arch (TPA), Nance palate pad, and so on, are under patients' control outside the dental clinic. Oral functions such as chewing, swallowing, and speech could also have unavoidable effects on the appliances, leading to damage or detachment of the appliances.⁸⁻¹⁰

It has been reported that the number of patients with a dental emergency has increased annually.⁴ The most

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common cause of dental emergency visits was pain due to caries, pulpitis, periapical periodontitis, and dental injury of either soft tissue, such as oral mucosa, or hard tissue, such as primary or permanent teeth. Though it was not common for an orthodontic emergency to occur, broken or detached orthodontic appliances or attachments could lead to severe adverse events outside the dental clinic or hospital.¹¹

Orthodontic emergencies include mucosal injury because of displaced archwire or protruded orthodontic ligation wire, accidental appliance or attachments ingestion and aspiration, discomfort because of the detachment of appliances or bands, etc.¹² Reasonable and effective decision-making was very important for the prevention, early diagnosis, and appropriate treatment of foreign body inhalation and ingestion in orthodontic practice to avoid severe consequences.¹³

The coronavirus disease 2019 (COVID-19) pandemic altered the visit pattern of the orthodontic patients, and this could cause anxiety and tension in patients and lead to more accidents or emergencies.¹⁴⁻¹⁷ This study aimed to investigate the types and incidence proportion of orthodontic emergencies in orthodontic patients, based on a questionnaire completed by the patients during the pandemic prevention and control period in 2020. This study also compared the different effects of the clear aligner (CA) and fixed self-ligating appliance (FS) on the incidence proportion of orthodontic emergencies. These results might provide orthodontists with appropriate measures to reduce the probability of orthodontic emergencies and patients to avoid potential risks during orthodontic treatment.

MATERIAL AND METHODS

This study was approved by the Ethics Committee of Stomatological Hospital of Chongqing Medical University. The screening questionnaire was designed on the basis of emergencies in orthodontics. Besides age, sex, and the types of appliances used, additional questions intended to reveal types and incidence proportion of orthodontic emergency, including bracket, band or attachment detachment, mucosa injury because of orthodontic appliances, accidental appliance or attachment ingestion or aspiration, and other orthodontic emergencies. Although data were obtained through patient self-reports, the follow-up medical records of the patients were checked to complement the results. Recall bias was applied to evaluate the consistency of the self-report. Twenty patients with FS and 20 with clear appliances were randomly selected to finish the questionnaire a second time 1 month later.

Inclusion criteria consisted of people undergoing orthodontic treatment without systemic diseases at the

orthodontic clinic of Stomatological Hospital of Chongqing Medical University during the pandemic prevention and control period in 2020. In the survey, the patients and their parents or guardians were informed about the aim of the study, its privacy policy, and their right to refuse to participate. The patients were asked to complete the questionnaire on the basis of the past 12-month situation in 2020 after giving their informed consent. The ages of respondents between were 12 and 38 years (20.4 ± 7.03).

Statistical analysis

The associations were considered statistically significant if $P < 0.05$. The consistency of the subjects' questionnaire was also analyzed. A regression model was done to compare the effect of appliance type while controlling for potential confounders such as age and gender. All analyses, including descriptive analysis, chi-square test, were performed using the SPSS (version 18.0; SPSS Inc, Chicago, Ill).

RESULTS

This survey received feedback from 428 respondents, including 81 patients treated by CA and 327 patients treated by FS (Table 1). To evaluate the consistency, 40 patients were randomly selected for a second questionnaire survey. The self-reports were consistent. The study consisted of 137 males and 291 females. The male group showed a slightly higher incidence proportion of appliance detachment. The female group showed a higher incidence proportion of mucosa injury. However, both groups showed an equal incidence proportion of accidental ingestion. The adolescents exhibited a higher incidence proportion of emergency than the adults.

This study investigated the incidence proportion and degree of emergency in orthodontic patients in 2020 (Table 1, linear regression analysis in the Supplementary Table). Orthodontic-related emergencies included 4 categories: mucosa injury because of displaced archwire or prolapsed orthodontic ligation wire, detached orthodontic appliances or attachments, ingestion and aspiration of appliances, attachments, or other accidental small accessories, and other emergencies. The incidence proportion of mucosa injury in the CA group was 14.8%, and in the FS group was 57.3%. The incidence proportion of detached clear attachments in the CA group was 21%; however, the incidence proportion of detached orthodontic appliances in the FS group was 60.5%. The incidence proportion of accidental ingestion was 7.4% and 7.8% in the CA and FS groups, respectively. There was no accidental aspiration in both groups. Other emergencies, such as the archwire

Table I. Incidence of orthodontic-related emergency

| Variables | Respondent | Total emergency | Appliance detachment | Mucosa injury | Accidental ingestion | Other emergency |
|-------------------|------------|-----------------|----------------------|---------------|----------------------|-----------------|
| Sex | | | | | | |
| Male | 137 | 96 (70.07%) | 76 (55.47%) | 61 (44.53%) | 9 (6.57%) | 1 (0.73%) |
| Female | 291 | 218 (74.91%) | 151 (51.89%) | 150 (51.55%) | 20 (6.87%) | 6 (2.06%) |
| Age | | | | | | |
| Adolescent | 211 | 166 (78.67%) | 134 (63.51%) | 106 (50.24%) | 9 (4.27%) | 3 (1.42%) |
| Adult | 217 | 148 (68.20%) | 93 (42.86%) | 105 (48.39%) | 20 (9.22%) | 4 (1.84%) |
| Appliances | | | | | | |
| CA | 81 | 29 (35.80%) | 17 (21%) | 12 (14.8%) | 6 (7.4%) | 0 (0.00%) |
| FS | 347 | 285 (82.13%) | 210 (60.5%) | 199 (57.3%) | 27 (7.8%) | 7 (2.0%) |
| Total | 428 | 314 (73.36%) | 227 (53%) | 211 (49.3%) | 29 (6.8%) | 7 (1.6%) |

Table II. Analysis of the degree of orthodontic-related emergency

| Respondents | n | No. AD | Average No. AD | No. MJ | Average No. MJ | No. AI | Average No. AI | No. OE | Average No. OE |
|-------------|-----|--------|----------------|--------|----------------|--------|----------------|--------|----------------|
| CA | 81 | 30 | 0.37 | 12 | 0.15 | 11 | 0.14 | 0 | 0 |
| FS | 347 | 525 | 1.51 | 503 | 1.45 | 51 | 0.15 | 7 | 0.02 |
| Total | 428 | 555 | 1.3 | 515 | 1.21 | 62 | 0.14 | 7 | 0.016 |

AD, appliance detachment; MJ, mucosa injury; AI, accidental ingestion; OE, other emergency.

Table III. Analysis of the cause of appliance detachment

| Respondents | Hard food | Occlusion | Injury | Accidental detachment | Other reasons |
|-------------|--------------|------------|-----------|-----------------------|---------------|
| CA | 12 (14.81%) | 4 (4.9%) | 0 (0.0%) | 3 (3.7%) | 0 (0.0%) |
| FS | 169 (48.7%) | 30 (8.6%) | 5 (1.4%) | 44 (12.68%) | 1 (0.3%) |
| Total | 181 (42.28%) | 34 (7.94%) | 5 (1.17%) | 47 (10.98%) | 1 (0.23%) |

Table IV. Analysis of the degree of appliance detachment

| Respondents | Hard food | | Occlusion | | Injury | | Accidental detachment | | Other reasons | |
|-------------|-----------|---------|-----------|---------|--------|---------|-----------------------|---------|---------------|---------|
| | n | Average | n | Average | n | Average | n | Average | n | Average |
| CA | 17 | 0.21 | 6 | 0.074 | 0 | 0 | 6 | 0.074 | 0 | 0 |
| FS | 413 | 1.19 | 43 | 0.124 | 7 | 0.02 | 61 | 0.176 | 1 | 0.003 |
| Total | 430 | 1 | 49 | 0.114 | 7 | 0.164 | 67 | 0.157 | 1 | 0.002 |

breaking, occurred at a low incidence and only in the FS group. According to the above results, the incidence proportion of mucosa injury and orthodontic appliance detachment was much higher in the FS group than in the CA group. Although the 2 groups had a lower probability of appliances or attachments or accessories accidental ingestion, the FS group was slightly higher than those in the CA group.

The degree of orthodontic-related emergency was also analyzed (Table II). On average, mucosa injuries occurred 0.15 times in the CA group and 1.45 times in the FS group within 1 year. In the CA group, 0.37 attachments fell off, whereas 1.51 appliances fell off in the self-ligating group within 1 year. The CA and FS groups had a similar degree of accidental ingestion, respectively

0.14 and 0.15 foreign body. Other emergencies occurred only in the self-ligating bracket, on average, 0.02 times within 1 year.

The causes of the detachment of appliances were divided into 5 categories (Table III), including chewing hard food, occlusal interference, the impact of external forces, accidental detachment, and other reasons. Chewing hard food was the main reason for attachment or appliance detachment, with an incidence of 14.81% in the CA group and 48.7% in the FS group. The incidence of appliance detachment in the FS group was 12.68%, which indicated that accidental detachment was the second important cause of appliance detachment. The incidence proportion of appliance detachment because of other reasons was low.

Table V. Analysis of the position of appliance detachment

| Respondents | Maxillary arch (no. of respondents) | Mandibular arch (no. of respondents) | Maxillary arch (no. of appliances) | Mandibular arch (no. of appliances) |
|-------------|--|---|---------------------------------------|--|
| CA | 12 | 11 | 15 | 15 |
| FS | 121 | 157 | 208 | 317 |
| Total | 133 | 168 | 223 | 332 |

Given the degree of appliance detachment, chewing hard food was still the main cause of the detachment of attachments or appliances (Table IV). In the CA group, 0.21 attachments fell off per person because of hard food, whereas 1.19 appliances fell off in the FS group because of hard food.

The position of attachments or appliance detachment was also analyzed (Table V). The CA group showed a similar degree of detachment in the maxillary and mandibular dental arch. In contrast, the self-ligating group showed much higher detachment of appliances in the mandibular dental arch.

Linear regression analysis was done. It was found that female patients were more likely to be uncomfortable because of mucosal injury than male patients ($P = 0.010$ and $P < 0.05$), and young patients were more likely to encounter appliance detachment than older ones ($P < 0.001$) (Supplementary Table).

Because no patients had accidental aspiration, we only show the data of accidental ingestion in Tables VI-VIII. Combined with the literature, the accidental aspiration caused by orthodontic treatment was rare. The CA and FS groups had a similar amount of accidental ingestion, 0.135 and 0.147 foreign bodies. The main foreign body by ingested in both groups was elastics, which are relatively safe. The self-ligating group could ingest broken metal archwire, miniscrews, and welding accessories. Although the probability was not high, these might cause more serious consequences.

DISCUSSION

Patients with CA and with FS were investigated in our study. During 2020, because of the COVID-19 pandemic, the interval and procedure of revisits for orthodontic patients were slightly different from before, which might add to their anxiety and lead to increased incidence of an emergency.^{4,18-21}

Orthodontic patients with CA were more because of invisibility. Although no appliances were used in these patients, the attachments, including lingual buttons, mini-implants, auxiliary arches, and so on, were inevitable sometimes to achieve ideal treatment results.^{15,22} In our survey, the CA and FS groups were found to encounter an orthodontic-related emergency in 2020 35.80% and 82.13%, respectively. It was reported that

Table VI. Analysis of accidental ingestion

| Respondents | n | Respondents with accidental ingestion | | Accidental ingestion appliances | |
|-------------|-----|--|-------|------------------------------------|-------|
| | | n | IAI | n | ANAI |
| CA | 81 | 6 | 7.4% | 11 | 0.135 |
| FS | 347 | 27 | 7.8% | 51 | 0.147 |
| Total | 428 | 33 | 7.71% | 62 | 0.145 |

IAI, incidence of accidental ingestion; ANAI, average number of accidental ingestion.

the most frequent orthodontic urgencies during the COVID-19 were bracket, molar tubes, molar bands, and archwire breakage.²¹ Although it was found besides appliance breakage, mucosa injury and accidental ingestion in orthodontic patients also need to be paid attention to in our survey.

Pain because of mucosal injury is another common dental emergency.² In our survey, orthodontic mucosal injury emergency was found mostly because of displaced archwire, protruded orthodontic ligation wire, and the sharp margin of the CAs. In addition, orthodontic mini-implants could cause mucosal injury related to their angle and position in the oral cavity. It was also noticed that female patients were more likely to be uncomfortable because of mucosal injury than male patients. It might be related to women being more sensitive to pain. It relied on the effective methods applied by the orthodontists to decrease mucosa injury, which included wire and CA rechecking, limiting wire slip ability, adding a mini-implant protective cap, etc. In addition, female patients should be given more attention during COVID-19 to alleviate their anxiety.

Appliance detachment was more likely to arise in patients with FS than those with CA in our survey. It was the same situation for mucosa injury. It might be connected with appliances and archwires mostly used in fixed orthodontic treatment.²³ It was also noticed that young patients were more likely to encounter appliance detachment than older ones. It might be related to young patients' lack of resistance to food temptation and carelessness. Yavan et al²⁴ reported the incidence of bracket bonding failure was significantly higher in men than in women during COVID-19, whereas there was no statistically significant detachment or accidental

Table VII. Type of appliance in accidental ingestion

| Respondents | Archwire | Bracket | Miniscrew | Welded attachment | Band | Spring | Elastic | Other appliance | Total |
|-------------|-----------|-----------|-----------|-------------------|----------|----------|------------|-----------------|-----------|
| CA | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 4 (4.94%) | 2 (2.47%) | 6 (7.4%) |
| FS | 6 (1.73%) | 2 (0.58%) | 1 (0.29%) | 1 (0.29%) | 0 (0.0%) | 0 (0.0%) | 15 (4.32%) | 2 (0.58%) | 27 (7.8%) |
| Total | 6 | 2 | 1 | 1 | 0 | 0 | 19 | 4 | 33 |

Table VIII. The degree of accidental ingestion

| Appliances | Archwire | Bracket | Miniscrew | Welded attachment | Band | Spring | Elastic | Other appliance | Total |
|------------|----------|---------|-----------|-------------------|------|--------|---------|-----------------|-------|
| CA | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 3 | 11 |
| FS | 7 | 3 | 1 | 1 | 0 | 0 | 37 | 2 | 51 |
| Total | 7 | 3 | 1 | 1 | 0 | 0 | 45 | 5 | 62 |

ingestion between males and females in our investigation. Reasons for appliance detachment were chewing hard food, occlusal interference, the impact of the external forces, accidental detachment, etc. The most common reason was chewing hard food in both CA and FS groups, which most patients could avoid if they were instructed to change their improper chewing habits, thus decreasing the orthodontic-related emergency incidence proportion.

The incidence proportion of injury was most common in oral and maxillofacial emergencies, especially soft tissue injuries. Because of obvious pain, most patients with pulpitis, acute periapical periodontitis, or other oral inflammation would seek medical treatment in time.³

Inhalation and ingestion of foreign bodies might occur in dental treatment, including orthodontic treatment. Extracted teeth, root canal instruments, prostheses, and parts of orthodontic appliances could be inhaled and ingested by the patient. In treating oral diseases, foreign body inhalation was usually much less than accidental ingestion.²⁵ In the orthodontic treatment, orthodontists used many small parts, which might lead to accidental inhalation or ingestion in the patient. However, accidental ingestion or inhalation in orthodontic treatment is likely to be ignored by the patients.

Orthodontic patients, especially children and adolescents, were at increased risk of inhaling and swallowing foreign bodies if they failed to comply with treatment, which might cause a problem. For the foreign body inhalation and ingestion, it was reported more commonly in children than in adults,²⁵ whereas, in our survey, the incidence proportion of accidental ingestion was higher in adults than in adolescents. Inhaling and swallowing foreign bodies might cause complications, especially when the foreign bodies are sharp, thin, or long, such as orthodontic wire, mini-implant, TPA, and so on.²⁶⁻²⁸

Elastics were the most accidentally ingested object in our survey. Although it might not be harmful to the patients, they should be instructed to avoid accidental elastic ingestion. Fracture of TPA, broken short archwire, and mini-implant were accidentally ingested in our survey. Although the patients were instructed to treat the accidental ingestion in time and no complications were caused, orthodontists should be aware of the potential risk during orthodontic treatment.

It could effectively avoid accidental foreign body inhalation or ingestion in orthodontic treatment through the training for skilled operation techniques.^{11,29} The use of a rubber dam was the most effective prevention method in the dental clinic; however, there was no suitable rubber dam available for orthodontic treatment for now. It relied not only on orthodontists but also patients to reduce accidental inhalation or ingestion and avoid complications.

CONCLUSIONS

The CA could effectively reduce orthodontic-related emergencies. Dentists should raise patients' awareness of proper appliance care. To strengthen orthodontic medical safety and decrease orthodontic-related emergencies, it should focus on designing and using effective methods to prevent orthodontic medical-related emergencies and their potential adverse consequences.

AUTHOR CREDIT STATEMENT

Yongchao Gou contributed to study design, data curation, and original draft preparation; Nicha Ungvijanpunya contributed manuscript review and editing; Liuting Chen contributed to software and validation; Yushan Zeng contributed to software and validation; Huayu Ye contributed manuscript review and editing; and Li Cao contributed to study design, data curation, and original draft preparation.

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Supplementary Table. Linear regression analysis

| <i>Respondents</i> | <i>Detachment</i> | | <i>Mucosa injury</i> | | <i>Accidental ingestion</i> | |
|--------------------|-------------------|----------------|----------------------|----------------|-----------------------------|----------------|
| | <i>F</i> | <i>P value</i> | <i>F</i> | <i>P value</i> | <i>F</i> | <i>P value</i> |
| Sex | 1.015 | 0.314 | 6.703 | 0.010* | 0.015 | 0.902 |
| Age | 16.645 | 0.000** | 0.044 | 0.835 | 0.257 | 0.612 |

P* <0.05; *P* <0.01.