Submitted: 01 May, 2025 Accepted: 03 July, 2025 Published: 03 January, 2026 DOI:10.22514/jocpd.2026.025

CASE REPORT

Journal of Clinical Pediatric Dentistry

A case of orthodontic treatment with early tooth extraction and a functional orthodontic appliance in a patient with familial Mediterranean fever

Shunsuke Kako[1], Takeo Sekiya[2], Masako Tabuchi[2,*], Takuma Sato[2], Ken Miyazawa[2], Hiroyuki Nawa[1]

[1]Department of Pediatric Dentistry, School of Dentistry, Aichi Gakuin University, 464-8651 Nagoya, Japan
[2]Department of Orthodontics, School of Dentistry, Aichi Gakuin University, 464-8651 Nagoya, Japan

***Correspondence**
machako@dpc.agu.ac.jp
(Masako Tabuchi)

Abstract

Background: Familial Mediterranean fever (FMF) is a systemic autoinflammatory disease characterized by recurrent attacks of fever, abdominal or chest pain, and joint pain that resolve spontaneously within a short period. There have been few reports of orthodontic treatment in patients with FMF. **Case**: The patient was a girl aged 10 years and 7 months who had been diagnosed with FMF at 1 year old. To improve severe maxillary and mandibular crowding and retruded mandible, orthodontic treatment was performed with early extraction of the bilateral maxillary and mandibular first premolars and the use of a functional orthodontic appliance, which helped improve the skeletal problems characteristic to patients with FMF. No notable attacks were reported during the orthodontic treatment period. **Conclusion**: This case can be a model case of orthodontic treatment for patients with FMF starting from childhood.

Keywords

Familial Mediterranean fever; Autoinflammatory; Orthodontic treatment; Early extraction; Functional appliances

1. Introduction

Familial Mediterranean fever (FMF) is a childhood-onset systemic autoinflammatory disease characterized by recurrent attacks of fever, abdominal or chest pain, and joint pain that resolve spontaneously within a short period [1]. FMF is an autosomal recessive genetic disorder that most commonly affects several ethnic groups in the Eastern Mediterranean region, particularly Jews, Armenians, Turks and Arabs [2]. FMF is the most common monogenic autoinflammatory disease [3], affecting over 100,000 people worldwide [4]. FMF has been linked to mutations in the *Mediterranean fever* (*MEFV*) gene, which is located on the short arm of chromosome 16 [5]. In Japan, several patients presenting with periodic fever were found to have mutations in the *MEFV* gene in 2002 [6], and since then, many patients with FMF have been diagnosed by DNA analysis [7–9]. A nationwide survey conducted in 2009 estimated that there were approximately 300 patients with FMF in Japan [7]. As the number of reported cases has increased, awareness of the disease has also increased in Japan, which may have led to the recent rise in the number of patients with FMF. Known triggers for attacks include stressful events, exposure to cold, and menstrual cycles [10–12]. This autoinflammatory disease has been associated with growth disorders, including impaired bone development [13, 14]. In the head, prolonged inflammation of the mandibular condyle can cause stunted growth of the mandible. Indeed, cephalometric evaluation has statistically demonstrated that small mandibles are a skeletal characteristic of children with FMF [15]. Moreover, a study showed that 45% of patients with FMF had arthritis [16], and another study suggested that active inflammation can reduce the rate of bone formation [17].

To date, there have been few reports of orthodontic treatment in patients with FMF. Here a case is reported in which a patient with FMF underwent successful orthodontic treatment while being monitored for attacks. A treatment plan was developed that took into account the skeletal characteristics of FMF and the duration of wearing a potentially stressful multi-bracket appliance, resulting in a favorable outcome.

2. Case presentation

The patient was a girl aged 10 years and 7 months at initial presentation with a chief complaint of dental irregularity. Her past medical history was notable for FMF that manifested at 1 year of age, with subsequent periodic fever attacks and back pain. There was also a family history of FMF, which was present in a cousin. At presentation, attacks were controlled with colchicine and adalimumab.

Her facial appearance showed rightward deviation of the mandible in the frontal view, and a convex lateral profile without protrusion of the upper and lower lips (Fig. 1A). Oral findings included Hellman's dental age of IIIB and a Class II molar relationship on both sides, with overjet of +4.0 mm

and overbite of +5.0 mm, indicating a deep overbite. The maxillary midline was in line with the facial midline, while the mandibular midline was deviated 0.5 mm to the right of the facial midline. There was severe crowding in both the maxilla and mandible, with labial eruption of the left maxillary canine and prolonged retention of the left mandibular deciduous second molar (Fig. 1B). A mild tongue tie and tongue thrust swallow were observed.

Panoramic radiographs showed no evidence of abnormality in the number of teeth (Fig. 1C). Lateral cephalometric analysis showed that in the skeletal system, the angle between the AN line and NB line (ANB) was 4.0° (norm: 4.7°), indicating a normal anteroposterior relationship. Vertically, FMA was 35.5° (norm: 32.0 ± 2.4°), indicating a high angle case. The total length of the mandible (Gn-Cd) was 99.5 mm (norm: 107.2 ± 5.4 mm) and the height of the mandibular ramus (Cd-Go) was 46.5 mm (norm: 51.9 ± 3.9 mm), indicating a small mandible size. In the dental system, the maxillary anterior teeth were positioned within the normal range anteroposteriorly and were inclined lingually, with the angle formed by the axial inclination of the maxillary incisor and the SN line (U1 to SN) of 89.0° (norm: 102.8 ± 5.5°) and the distance between the tip of the upper incisor and a line from nasion to point A (U1 to NA) of 5.5 mm (norm: 6.2 ± 1.9 mm). Also, the mandibular anterior teeth were positioned within the normal range anteroposteriorly and inclined lingually, with an incisor mandibular plane angle (IMPA) of 82.0° (norm: 93.8 ± 5.9°) and the distance between the tip of the lower incisor and a line from nasion to point B (L1 to NB) of 5.5 mm (norm: 7.8 ± 2.4 mm). The interincisal angle was large at 141.0° (norm: 124.3 ± 6.9°) (Fig. 1D, Table 1). A lateral cephalometric radiograph showed forward head posture. The patient reported that she sometimes experienced headache and neck pain. There was no evidence of bruxism during sleep or during the day. Also, there was mild enlargement of the tonsils and adenoids, but no signs of upper airway restriction, including mouth breathing, narrow nasal passages, and upper pharyngeal narrowing. The patient had a history of temporomandibular joint (TMJ) pain on mouth opening. There was no TMJ noise or pain while eating. The maximal mouth opening was 36.5 mm.

The patient and her parents gave written consent for the publication of this case report.

3. Treatment plan

Because the patient had FMF, a pediatrician was consulted to check her general condition before starting treatment. The first phase of treatment aimed to improve the severe crowding and guide the eruption of permanent teeth by performing early extraction of the maxillary and mandibular first premolars bilaterally. A treatment plan was considered that did not involve tooth extraction, but there was a severe lack of space in both the maxilla and mandible, and lateral and anterior-posterior expansion would be necessary to induce the eruption of permanent teeth. A concern, particularly for the mandible, was that bulky appliances would be required for molar uprighting, and that a long treatment period would be necessary [18]. Treatment with expansion because, if a long time was required in order to gain space, then the timing for using functional orthodontic appliances would be missed and skeletal improvement would not be achieved. In the maxilla, a lip bumper was used to secure space for the eruption of the maxillary canine and guide its eruption. In addition, a functional orthodontic appliance (Bionator) was used in parallel to promote growth of the mandible. In the mandible, a lingual arch was used to secure space for the eruption of permanent teeth. After re-examination at dental age IVA, the second phase of treatment was initiated with the aim to establish a close occlusal relationship using a multi-bracket appliance. The patient was closely monitored for any signs of attacks throughout the course of dynamic treatment.

4. Treatment course

Consultation with a pediatrician regarding the patient's general condition revealed that attacks were well controlled with medication, leading to the judgment that the risk of attacks caused by stress from orthodontic treatment would be low. Treatment was initiated after the patient and her parents were informed of the treatment plan and gave their consent. After extraction of the maxillary first premolars, a lip bumper was attached to the maxilla to create space for the eruption of the maxillary canine (Fig. 2A). Then, after confirming the absence of attacks, the use of the Bionator was started to improve the retruded mandible. The lip bumper and Bionator could be used together (Fig. 2B). The period of use of the Bionator was set at 24 months [19]. The daily usage time was set at 12 h [20]. The usage time was generally observed. In addition, to improve the eruption direction of the bilateral maxillary canines, lingual buttons were attached to the bilateral maxillary canines to initiate distal traction (Fig. 3A,B). In the maxilla, after completion of the canine traction, the maxillary anterior teeth were aligned using a sectional arch. In the mandible, after placement of the lingual arch, the bilateral mandibular first premolars were extracted (Fig. 4A,B). The Bionator was used for a total of 25 months. Thereafter, after confirming the eruption of the bilateral maxillary and mandibular second molars, re-examination was performed and it was decided to move on to the second phase of treatment (Fig. 5A–D). Before initiating phase 2 treatment, the patient's general condition was re-examined by a pediatrician, who confirmed that the attacks were well controlled. Also, the patient was taking aripiprazole, ethyl loflazepate, carbamazepine, milnacipran hydrochloride, and diazepam for conversion disorder. Based on the assessment of the patient's stress levels from the first phase of orthodontic treatment, the decision was made to initiate phase 2 treatment using a multi-bracket appliance. The treatment started with leveling of the maxillary arch, and after confirming that the patient was accustomed to the multi-bracket appliance, leveling of the mandibular arch was initiated (Fig. 6A,B). During the mandibular leveling phase, an attempt was made to start using Class II elastics to improve the Class II canine relationship. However, because the patient found the process of attaching and detaching the elastics to be mentally stressful, the use of elastics was abandoned. An alternative plan of using a fixed Class II corrector (Forsus™; 3M Unitek Corp, Monrovia, CA, USA) was explained to the patient and her parents, and after obtaining their consent, the appliance was worn for 1 month. The fixed Class II

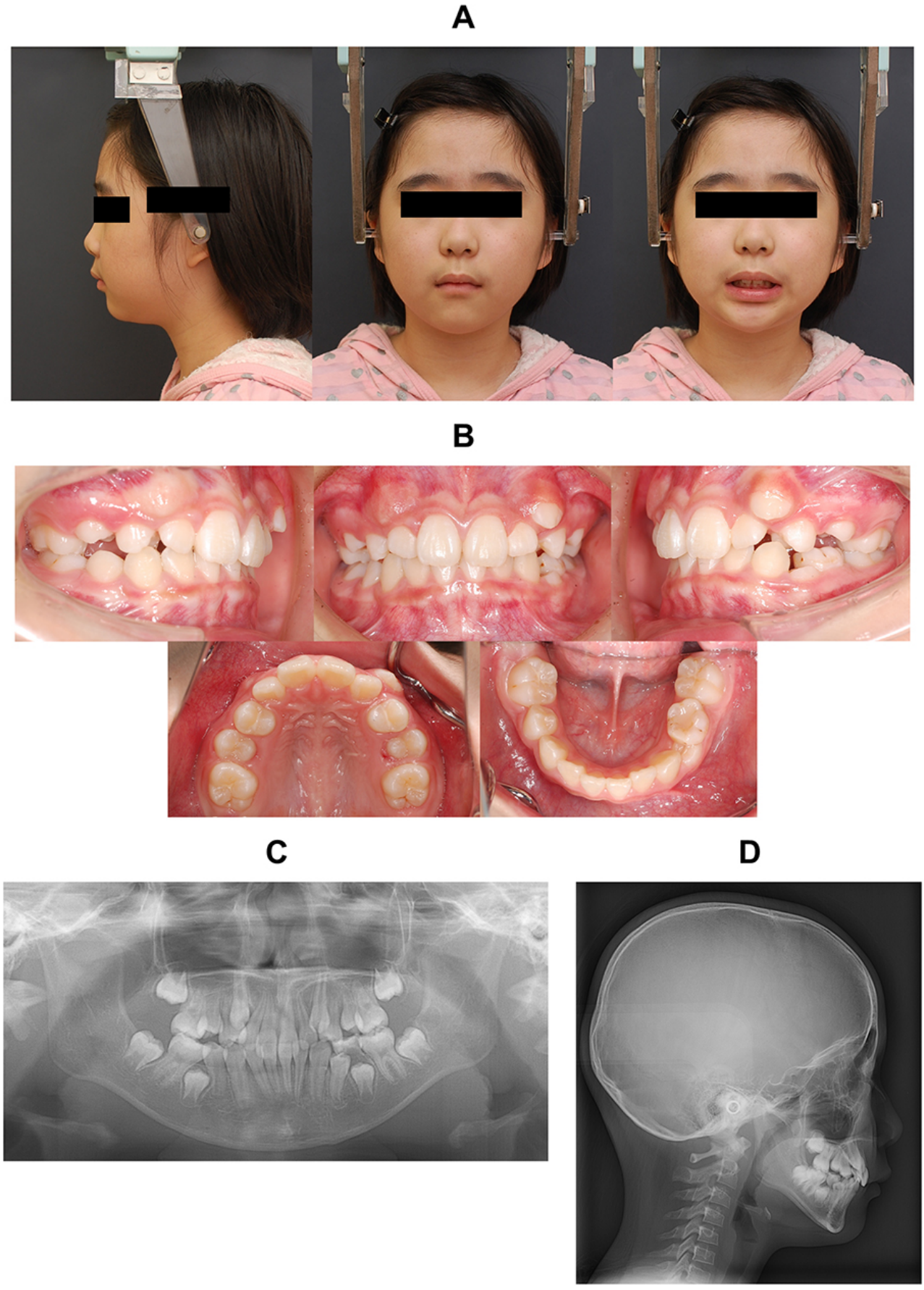

FIGURE 1. Findings at initial presentation. (A) Facial photographs. (B) Intraoral photographs. (C) Panoramic radiograph. (D) Lateral cephalometric radiograph.

TABLE 1. Lateral cephalometric analysis results.

Variables measured	Start of phase 1 treatment (age 10 y 7 m)	Start of phase 2 treatment (age 15 y 1 m)	End of phase 2 treatment (age 16 y 6 m)	Postretention (age 18 y 6 m)
Skeletal system				
SNA (°)	73.5	75.0	75.0	75.0
SNB (°)	69.5	72.0	72.0	72.0
ANB (°)	4.0	3.0	3.0	3.0
Facial angle (°)	81.0	82.0	82.0	82.5
Y-Axis (°)	66.5	67.5	67.5	67.5
FMA (°)	35.5	35.0	35.5	35.0
SN-MP (°)	47.5	46.0	46.5	46.0
Gonial angle (°)	129.5	127.5	127.5	127.5
Gn-Cd (mm)	99.5	110.5	111.5	111.5
Pog'-Go (mm)	67.5	72.5	72.5	73.5
Cd-Go (mm)	46.5	54.0	54.0	54.0
Dental system				
Occusal plane to SN (°)	15.5	12.5	14.5	14.0
U1 to SN (°)	89.0	98.5	100.0	101.5
IMPA (L1 to MP) (°)	82.0	88.5	92.5	93.0
FMIA (°)	62.5	56.5	52.0	52.0
Interincisal angle (°)	141.0	127.5	121.0	119.0
U1 to A-Pog (mm)	8.0	9.0	9.0	9.0
L1 to A-Pog (mm)	3.5	6.0	6.5	6.0
U1 to NA (mm)	5.5	6.5	7.0	7.0
L1 to NB (mm)	5.5	6.0	8.0	8.0
Soft tissue				
E-line: Upper (mm)	3.0	2.0	2.0	0.5
E-line: Lower (mm)	2.0	2.0	2.5	1.0
Nasolabial angle (°)	105.0	100.0	100.0	100.0
Dental cast				
Overjet (mm)	+4.0	+3.0	+2.0	+2.0
Overbite (mm)	+5.0	+2.5	+2.0	+2.0

y: year; m: month; SNA: angle between the sella (S), nasion (N), and subspinale point A (A); SNB: angle between the SN line and supramentale point B (B); ANB: angle between the AN line and NB line; FMA: Frankfort-mandibular plane angle; SN-MP: SN plane to the mandibular plane angle; Gn-Cd: the total length of the mandible; Pog'-Go: the length of body of mandible; Cd-Go: the height of the mandibular ramus; IMPA: the incisor mandibular plane angle; FMIA: Frankfort-Mandibular incisor angle; NA: the line from nasion to point A; NB: the line from nasion to point B.

corrector affects the jaw through the following mechanisms: remodeling of the condyle, remodeling of the glenoid cavity, repositioning of the condyle in the glenoid cavity, and rotation of the mandible [21]. Therefore, due to concerns about the effect on the TMJ, the fixed Class II corrector was used for only 1 month. After completion of the dynamic treatment, lingual fixed retainers were attached to both the maxilla and mandible, and the brackets were removed. In addition, as retention devices, a Begg retainer was used for the maxilla and a Hawley retainer was used in the mandible. The multi-bracket appliance was worn for 11 months. No attacks attributable to orthodontic treatment were reported during the dynamic treatment phase. Extraction of the mandibular third molars bilaterally was recommended in order to prevent relapse, and the patient and her parents agreed to have them extracted in the future. The total treatment duration was 71 months.

5. Treatment results

After the completion of dynamic treatment, the appropriate overjet and overbite were achieved. The molars were in a Class I occlusal relationship on both the left and right sides,

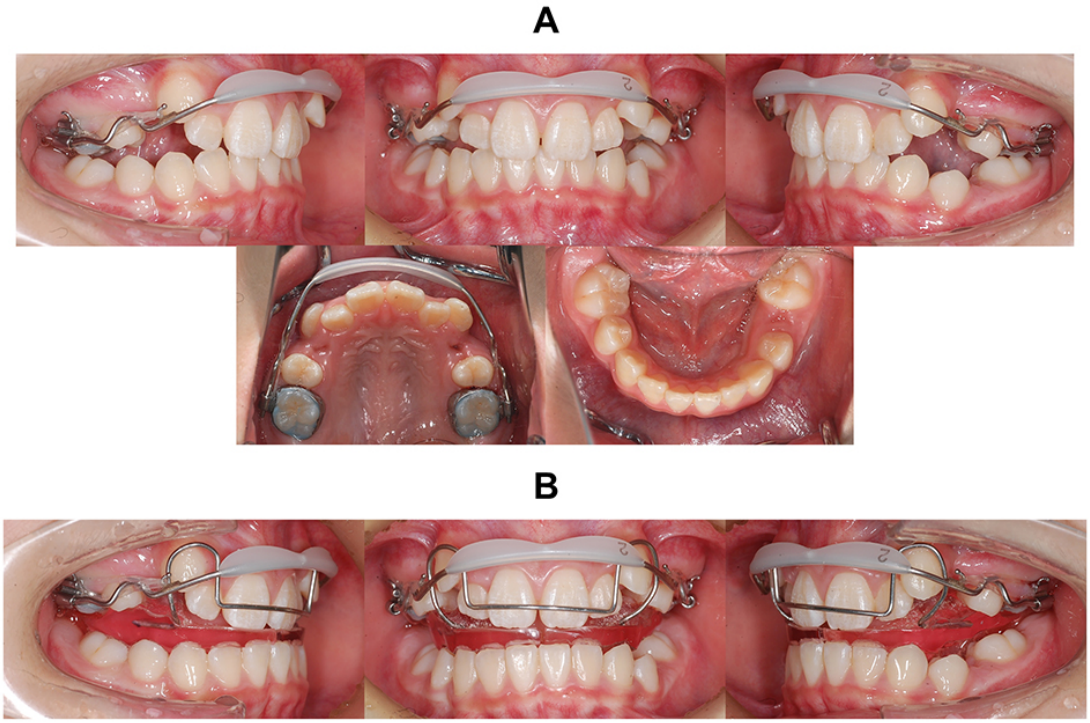

FIGURE 2. Intraoral photographs with appliances. (A) Lip bumper. (B) Bionator.

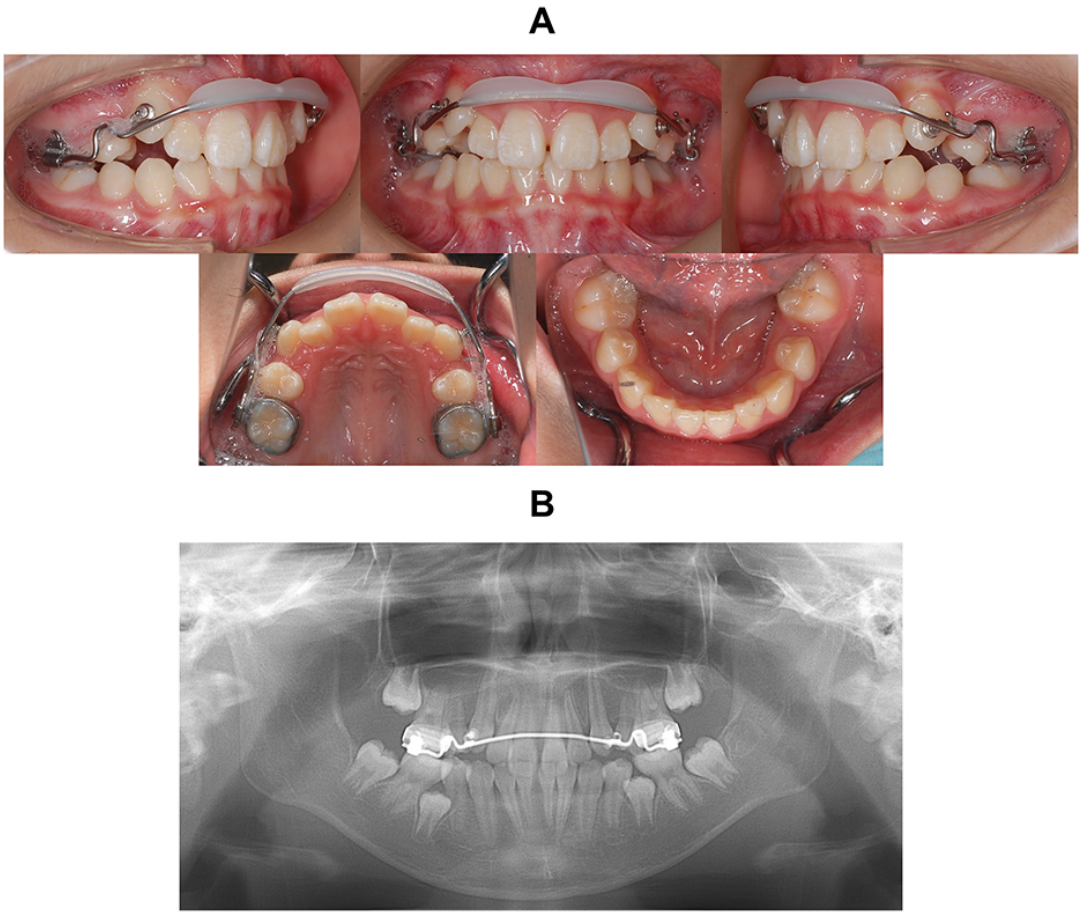

FIGURE 3. Intraoral photographs with appliances. (A) Traction of the maxillary bilateral canines were started. (B) Panoramic radiograph.

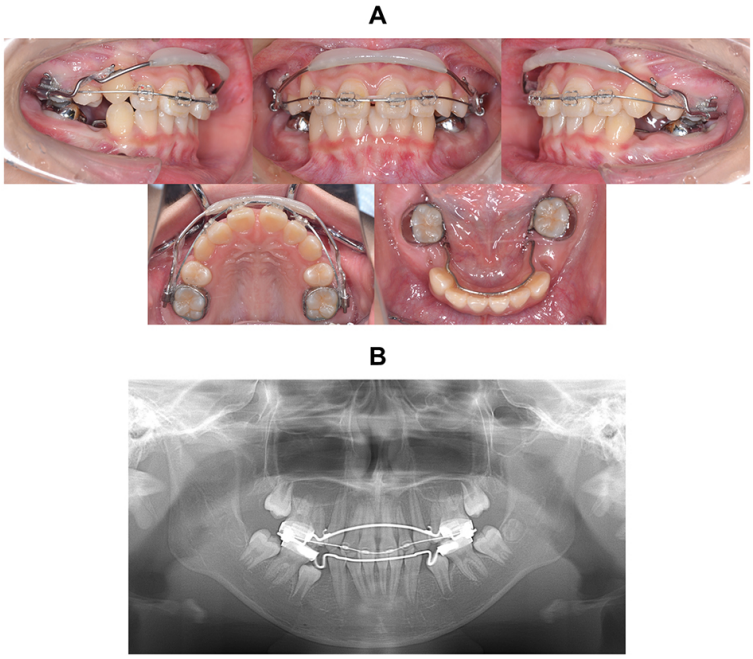

FIGURE 4. Intraoral photographs with appliances. (A) Maxillary, sectional arch and lip bumper; mandibular, lingual arch. (B) Panoramic radiograph.

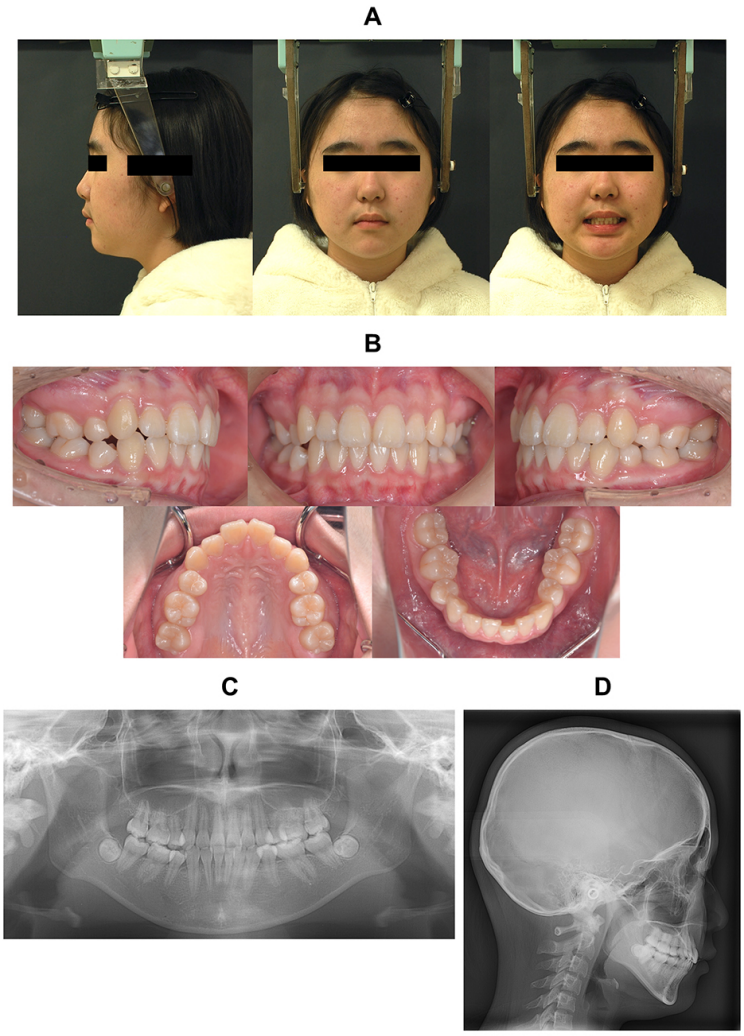

FIGURE 5. Findings at the end of phase 1 treatment (at the beginning of phase 2 treatment). (A) Facial photographs. (B) Intraoral photographs. (C) Panoramic radiograph. (D) Lateral cephalometric radiograph.

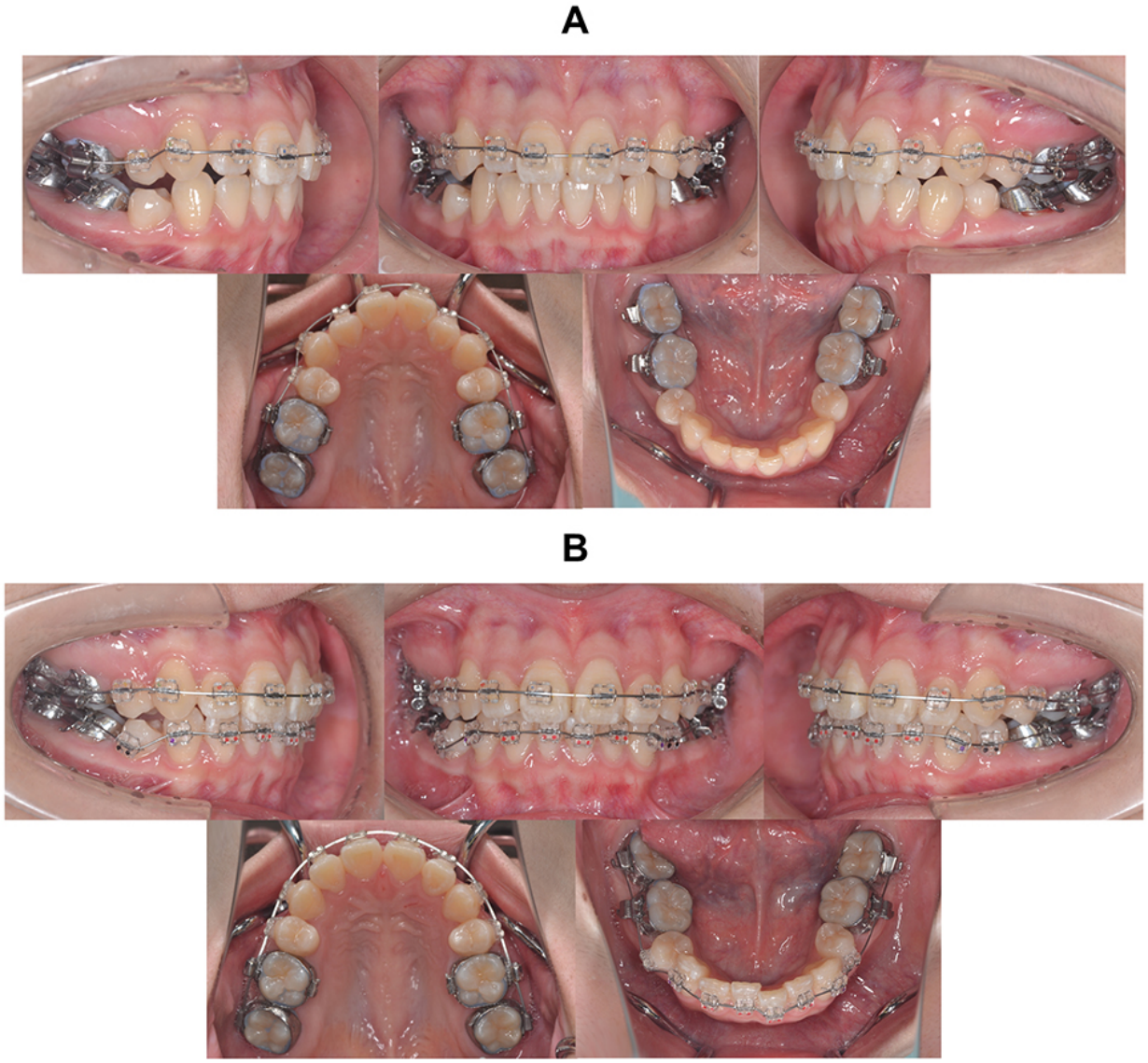

FIGURE 6. Intraoral photographs with appliances. (A) Multi-bracket appliance applied to the maxillary arch. (B) Multi-bracket appliance applied to the mandibular arch.

with the establishment of "one-to-two" occlusion (Fig. 7A–D). On lateral cephalometry after completion of phase 1 treatment, changes in the skeletal system measurements from first presentation included increases in the SNA angle from 73.5° to 75.0° (norm: 81.5 ± 4.2°) and the SNB angle from 69.5° to 72.0° (norm: 77.1 ± 3.8°) which resulted in a 1.0° decrease in the ANB angle from 4.0° to 3.0° (Norm: 4.4°). The Gn-Cd and Cd-Go distances increased from 99.5 mm and 46.5 mm to 110.5 mm (norm: 114.5 ± 4.3 mm) and 54.0 mm (norm: 57.5 ± 3.6 mm), respectively, which were within the normal range. After completion of phase 2 treatment, there were no changes in skeletal system measurements of the SNA and SNB angles compared with the start of phase 2 treatment. In the dental system, the U1 to NA distance increased from 6.5 to 7.0 mm (norm: 6.2 ± 1.9 mm) and the U1 to SN angle increased from 98.5° to 100.0° (norm: 105.4 ± 5.2°), indicating slight labial inclination of the maxillary anterior teeth. Similarly, the L1 to NB distance increased from 6.0 to 8.0 mm (norm: 7.8 ± 2.4 mm) and the IMPA increased from 88.5° to 92.5° (norm: 95.4 ± 6.3°), indicating a slight labial inclination of the mandibular anterior teeth. Consequently, the interincisal angle changed from 127.5° to 121.0° (norm: 118.7 ± 7.5°). The measurements of the maxillary and mandibular anterior teeth were within the normal range in terms of tooth axis and anteroposterior relationship (Fig. 8A,B, Table 1). Data at 2 years after the end of dynamic treatment showed good occlusal conditions (Fig. 9A–D).

6. Discussion

In the present case, FMF attacks also well controlled by colchicine, which allowed the patient to undergo orthodontic treatment. The mainstay of treatment for FMF is oral colchicine, which has been reported to be safe and effective in reducing the frequency of fever attacks in most patients with FMF [22]. With very few reports of orthodontic treatment in patients with FMF available to date, the effect of orthodontic treatment on FMF was not known. Therefore, it was necessary

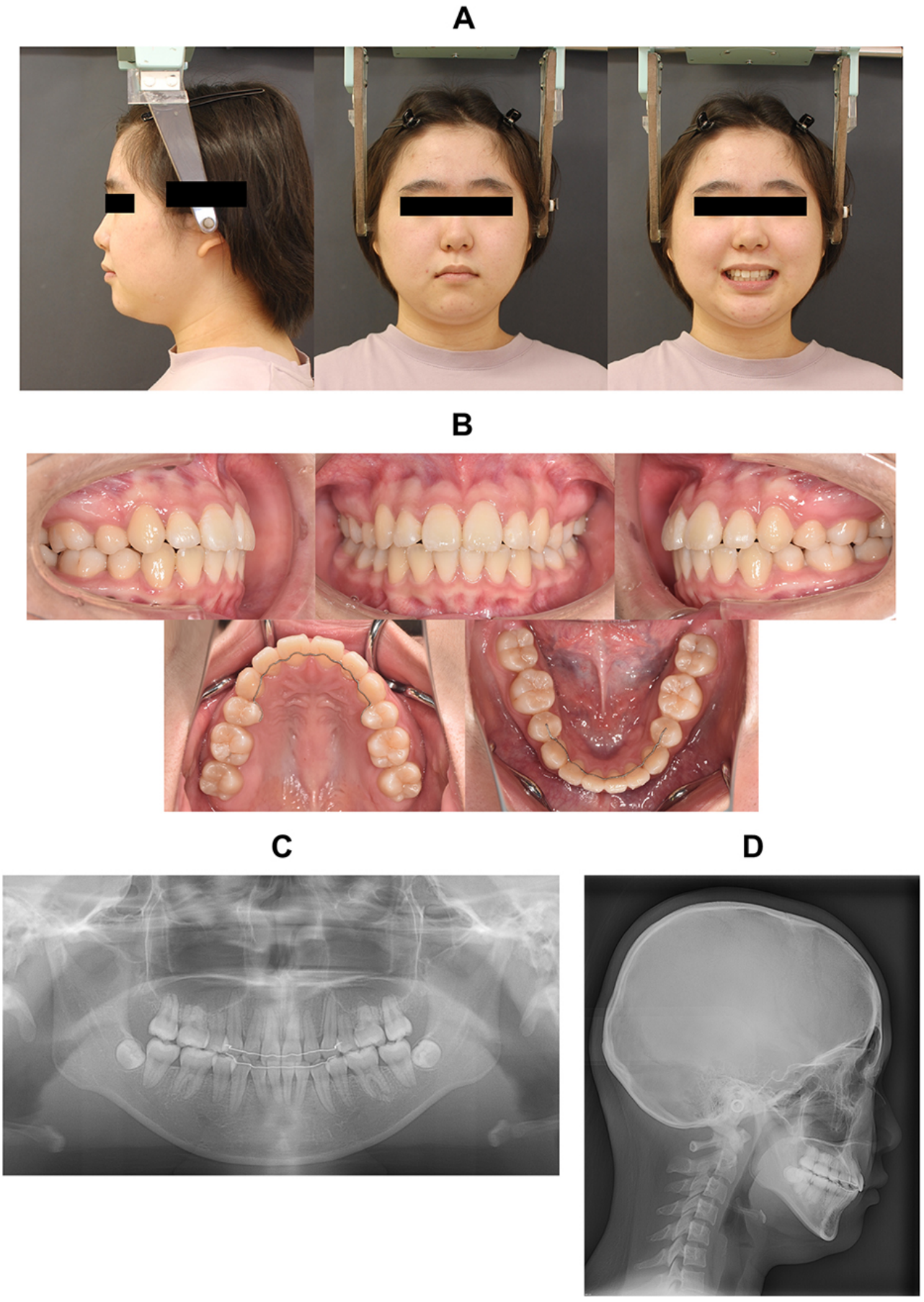

FIGURE 7. Findings at the end of dynamic treatment. (A) Facial photographs. (B) Intraoral photographs. (C) Panoramic radiograph. (D) Lateral cephalometric radiograph.

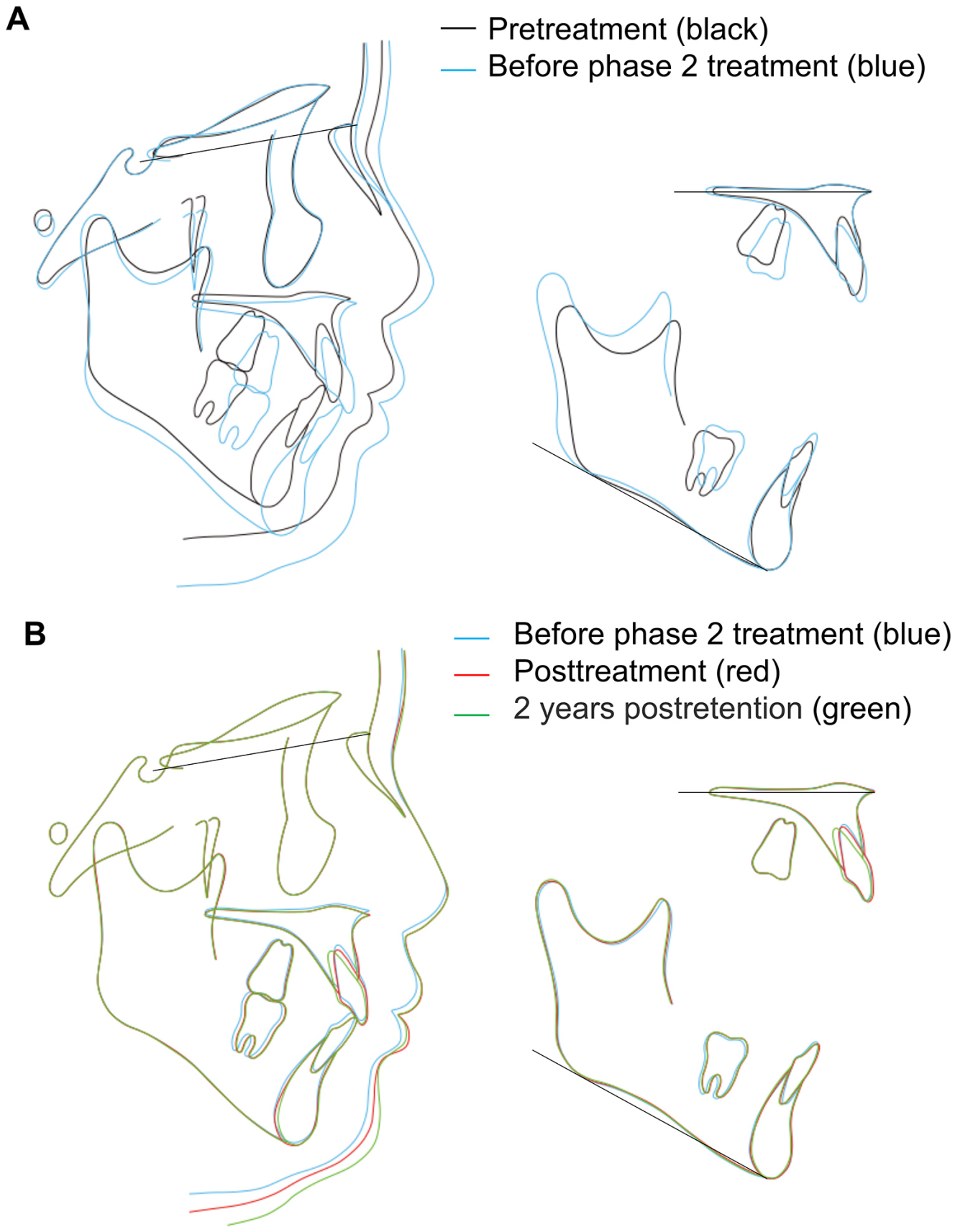

FIGURE 8. Cephalometric superimposition. (A) Pretreatment (10 y 7 m) and before phase 2 treatment (15 y 1 m). (B) Before phase 2 treatment (15 y 1 m), posttreatment (16 y 6 m) and postretention (18 y 6 m).

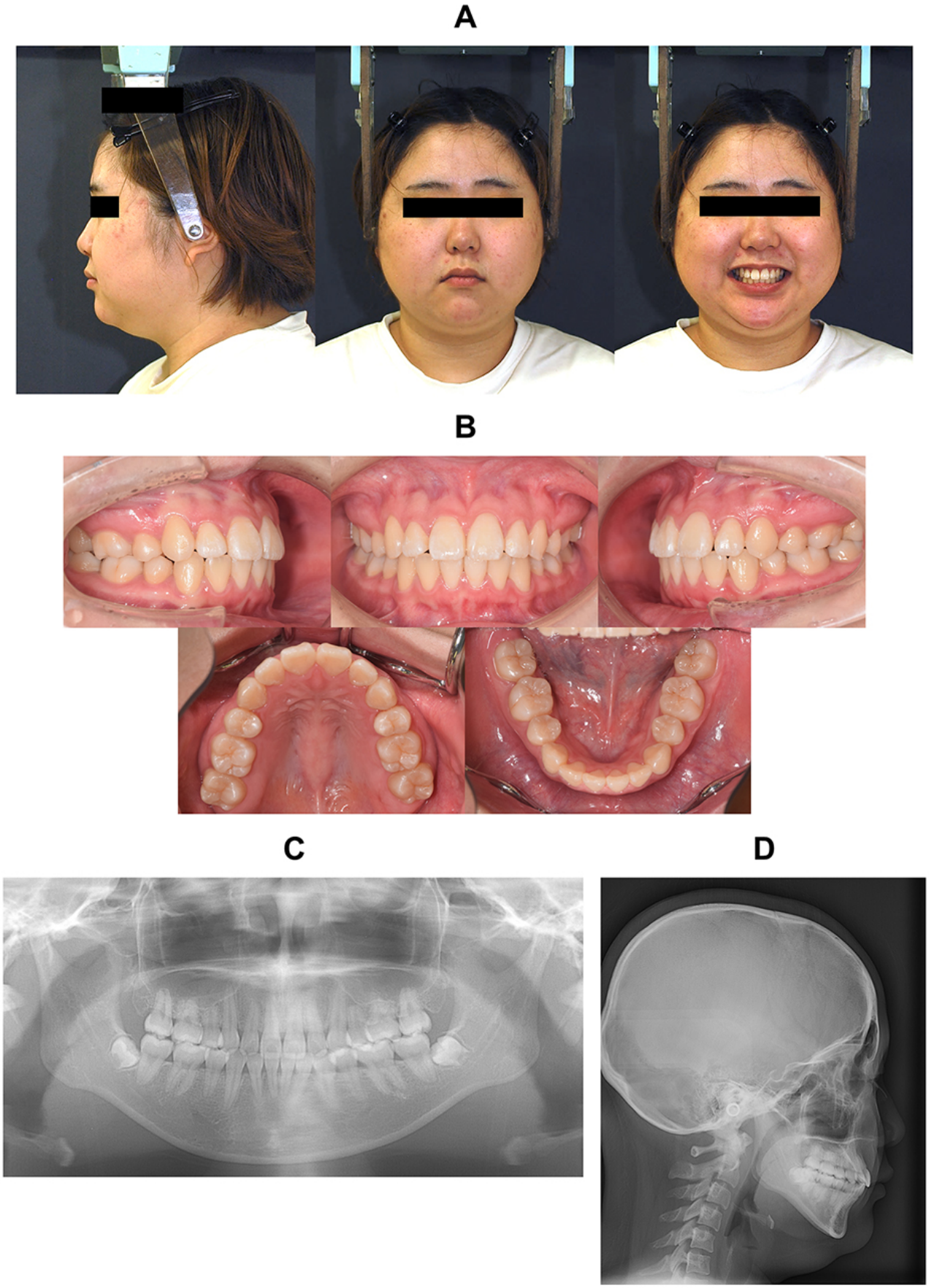

FIGURE 9. Findings at the end of postretention. (A) Facial photographs. (B) Intraoral photographs. (C) Panoramic radiograph. (D) Lateral cephalometric radiograph.

to develop a treatment plan for the present case that took into account the characteristics of FMF. Firstly, consideration needed to be given to attacks. Stressful events have been suggested to be a trigger for attacks [10–12]. Multi-bracket appliances are associated with pain due to tooth movement, difficulty in eating, and aesthetic problems, which can affect patients' quality of life [23, 24]. Therefore, it was considered necessary to shorten the duration of wearing the appliance, as this could be a stressor during orthodontic treatment. Orthodontic treatment involving early extraction of the first premolars during the mixed dentition period has been reported to be superior to treatment with extraction after complete eruption of the permanent teeth, in terms of shorter treatment time and lower risk of relapse [25]. In the present case, early extraction of the maxillary and mandibular first premolars was performed during phase 1 treatment, which shortened the period of wearing the multi-bracket appliance during phase 2 treatment to 11 months, which would normally be expected to last 2.5 to 3 years. It is thought that this led to a reduction in the stress associated with wearing the appliance. Furthermore, while the multi-bracket appliance was worn, the patient needed to wear elastics to improve the Class II premolar relation, but she found the process of attaching and detaching the elastics herself to be mentally stressful, and it was decided not to use them. Instead, she wore a fixed Class II corrector for 1 month. In a questionnaire survey on the use of fixed Class II correctors, these appliances were rated positively as they "do not need to be removed and provide constant orthodontic force" in comparison to removable Class II correctors such as headgear [26]. In the present case, the appliance not needing to be removed was a factor in the patient's acceptance of the appliance. Fixed Class II corrector are fixed and have a greater volume compared with elastics and thus can cause discomfort; however, for this patient, avoiding the process of attaching and detaching the elastics provided the greatest psychological benefit [27]. Since stress-inducing factors differ from patient to patient, it is important to take into account the patient's personality and living environment when selecting an appliance. Although tooth extraction is also a stressor, extraction of the bilateral maxillary and mandibular first premolars was considered necessary to improve the severe crowding. Fortunately, tooth extraction did not cause an attack in the present case, but it is important to determine the necessity of tooth extraction and decide the treatment strategy based on the understanding that the stress from tooth extraction could trigger an attack.

Secondly, the skeletal characteristics in FMF needed to be taken into consideration, one of which is a small mandible [8]. These findings suggest that persistent inflammation of the mandibular condyle may lead to stunted growth of the mandible, meaning that the characteristics of patients with FMF need to be taken into account when using a functional orthodontic appliance [15]. There are various types of functional orthodontic appliances, with different configurations and effects [28, 29]. Among the most common functional orthodontic appliances is the Bionator [30], the use of which has been shown to increase anterior mandibular growth, total mandibular length, and mandibular body length [31]. The present patient was found to have a small mandibular length and small mandibular ramus height at the initial examination, prompting consideration of the use of a functional orthodontic appliance. The Bionator was selected as it is designed to be usable with a lip bumper, which was planned for phase 1 treatment to secure space for the eruption of the maxillary canines and to guide their eruption. After 25 months with the Bionator, at the end of phase 1 treatment, the total mandibular length and mandibular ramus height were both within the normal range. Including the adolescent growth period in the treatment period with a functional orthodontic appliance is considered to be important for effectively promoting mandibular growth [19]. In the present case, the fact that the functional orthodontic appliance was used between the ages of 11 and 13, during the adolescent growth period, may have led to the efficient promotion of mandibular growth. These results suggest that functional orthodontic appliances should be used at the appropriate time, with due consideration given to the purpose of use and other appliances used in combination. In addition, these appliances should be used with caution as they may affect the TMJ. This study has some potential limitations. There are very few reports of orthodontic treatment in FMF patients, and it is unclear whether the treatment plan for this case can be applied to FMF patients in general. Moreover, although no significant TMJ symptoms were observed during or after the use of the appliance in the present case, further investigation is needed to determine the effects of functional orthodontic appliances on the TMJ of patients with FMF. The teaching point of this case is that it clarifies points that should be considered when performing orthodontic treatment in FMF patients.

7. Conclusion

With few reports of orthodontic treatment in patients with FMF, the effect of orthodontic treatment on FMF was unknown. In the present case, orthodontic treatment was successfully completed without any notable problems, as treatment was carried out while monitoring for signs of attacks. The use of a functional orthodontic appliance during the growth period also helped stimulate vigorous growth of the mandible, thus addressing the issue of the small mandible size, which is a skeletal characteristic of FMF. The present case can be a model case of orthodontic treatment for patients with FMF starting from childhood.

AVAILABILITY OF DATA AND MATERIALS

Data sharing is not applicable to this article, as no datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTIONS

SK and MT—performed the treatment and conceptualization. TSe, TSa and HN—provided help and advice on the manuscript. KM—managed the project. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The need for ethical approval was waived by the ethics committee of Aichi Gakuin University School of Dentistry since this was a case report. Written consent for presentation of this case was obtained from the patient and her parents.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Rigante D, La Torraca I, Ansuini V, Compagnone A, Sallì A, Stabile A. The multi-face expression of familial Mediterranean fever in the child. European Review for Medical and Pharmacological Sciences. 2006; 10: 163–171.

[2] Yuksel S, Samli H, Colbay M, Dundar U, Acarturk G, Demir S, *et al*. Increased serum osteoprotegerin levels associated with decreased bone mineral density in familial Mediterranean fever. Tohoku Journal of Experimental Medicine. 2009; 217: 321–327.

[3] Schwartz DM, Kitakule MM, Dizon BLP, Gutierrez-Huerta C, Blackstone SA, Burma AM, *et al*. Systematic evaluation of nine monogenic autoinflammatory diseases reveals common and disease-specific correlations with allergy-associated features. Annals of the Rheumatic Diseases. 2021; 80: 788–795.

[4] Onen F. Familial Mediterranean fever. Rheumatology International. 2006; 26: 489–496.

[5] The French FMF Consortium. A candidate gene for familial Mediterranean fever. Nature Genetics. 1997; 17: 25–31.

[6] Shinozaki K, Agematsu K, Yasui K, Nagumo H, Naitoh H, Naganuma K, *et al*. Familial Mediterranean fever in 2 Japanese families. Journal of Rheumatology. 2002; 29: 1324–1325.

[7] Migita K, Uehara R, Nakamura Y, Yasunami M, Tsuchiya-Suzuki A, Yazaki M, *et al*. Familial Mediterranean fever in Japan. Medicine. 2012; 91: 337–343.

[8] Inoue K, Torii K, Yoda A, Kadota K, Nakamichi S, Obata Y, *et al*. Familial Mediterranean fever with onset at 66 years of age. Internal Medicine. 2012; 51: 2649–2653.

[9] Oshima K, Yamazaki K, Nakajima Y, Kobayashi A, Kato T, Ohara O, *et al*. A case of familial Mediterranean fever associated with compound heterozygosity for the pyrin variant L110P-E148Q/M680I in Japan. Modern Rheumatology. 2010; 20: 193–195.

[10] Yenokyan G, Armenian HK. Triggers for attacks in familial Mediterranean fever: application of the case-crossover design. American Journal of Epidemiology. 2012; 175: 1054–1061.

[11] Karadag O, Tufan A, Yazisiz V, Ureten K, Yilmaz S, Cinar M, *et al*. The factors considered as trigger for the attacks in patients with familial Mediterranean fever. Rheumatology International. 2013; 33: 893–897.

[12] Ben-Chetrit E, Ben-Chetrit A. Familial Mediterranean fever and menstruation. BJOG. 2001; 108: 403–407.

[13] Duzova A, Ozaltin F, Ozon A, Besbas N, Topaloglu R, Ozen S, *et al*. Bone mineral density in children with familial Mediterranean fever. Clinical Rheumatology. 2004; 23: 230–234.

[14] Górska A, Urban M, Bartnicka M, Zelazowska-Rutkowska B, Wysocka J. Bone mineral metabolism in children with juvenile idiopathic arthritis—preliminary report. Ortopedia Traumatologia Rehabilitacja. 2008; 10: 54–62.

[15] Gungor AY, Arica V, Gungor O, Tutanc M. Cephalometric evaluation of children with familial Mediterranean fever. The Angle Orthodontist. 2012; 82: 552–555.

[16] Bakkaloglu A. Familial Mediterranean fever. Pediatric Nephrology. 2003; 18: 853–859.

[17] Reed A, Haugen M, Pachman LM, Langman CB. 25-Hydroxy vitamin D therapy in children with active juvenile idiopathic arthritis: short term effects on serum osteocalsin levels and bone mineral density. Journal of Pediatrics. 1991; 119: 657–660.

[18] Magkavali-Trikka P, Emmanouilidis G, Papadopoulos MA. Mandibular molar uprighting using orthodontic miniscrew implants: a systematic review. Progress in Orthodontics. 2018; 19: 1.

[19] Cozza P, Baccetti T, Franchi L, De Toffol L, McNamara JA Jr. Mandibular changes produced by functional appliances in Class II malocclusion: a systematic review. American Journal of Orthodontics and Dentofacial Orthopedics. 2006; 129: 559.E1–599.E12.

[20] Abbing A, Koretsi V, Kalavritinos M, Schröder T, Eliades T, Papageorgiou SN. Comparative assessment of two-phase class II treatment with Activator or Bionator followed by fixed appliances: a retrospective controlled before-and-after study. International Orthodontics. 2024; 22: 100863.

[21] Arici S, Akan H, Yakubov K, Arici N. Effects of fixed functional appliance treatment on the temporomandibular joint. American Journal of Orthodontics and Dentofacial Orthopedics. 2008; 133: 809–814.

[22] Goldstein RC, Schwabe AD. Prophylactic colchicine therapy in familial Mediterranean fever. A controlled, double-blind study. Annals of Internal Medicine. 1974; 81: 792–794.

[23] Scheurer PA, Firestone AR, Bürgin WB. Perception of pain as a result of orthodontic treatment with fixed appliances. European Journal of Orthodontics. 1996; 18: 349–357.

[24] Oliver RG, Knapman YM. Attitudes to orthodontic treatment. British Journal of Orthodontics. 1985; 12: 179–188.

[25] Lopes Filho H, Maia LH, Lau TC, de Souza MMG, Maia LC. Early *vs* late orthodontic treatment of tooth crowding by first premolar extraction: a systematic review. The Angle Orthodontist. 2015; 85: 510–517.

[26] Miyazawa K, Sakai N, Asano Y, Sekiya T, Tabuchi M, Sato T, *et al*. A questionnaire survey on the usability of fixed class II corrector and headgear. Aichi-Gakuin Journal of Dental Science. 2022; 60: 272–282.

[27] Matthaios S, Tsolakis AI, Haidich AB, Galanis I, Tsolakis IA. Dental and skeletal effects of herbst appliance, forsus fatigue resistance device, and class II elastics—a systematic review and meta-analysis. Journal of Clinical Medicine. 2022; 11: 6995.

[28] Jena AK, Duggal R, Parkash H. Skeletal and dentoalveolar effects of Twin-block and bionator appliances in the treatment of Class II malocclusion: a comparative study. American Journal of Orthodontics and Dentofacial Orthopedics. 2006; 130: 594–602.

[29] Burhan AS, Nawaya FR. Dentoskeletal effects of the Bite-Jumping Appliance and the Twin-Block Appliance in the treatment of skeletal Class II malocclusion: a randomized controlled trial. European Journal of Orthodontics. 2015; 37: 330–337.

[30] Sidiropoulou-Hatziyianni S. Bionator basic functional appliance. Orthodontike Epitheorese. 1989; 1: 147–152. (In Greek)

[31] Almeida MR, Henriques JF, Almeida RR, Almeida-Pedrin RR, Ursi W. Treatment effects produced by the Bionator appliance. Comparison with an untreated Class II sample. European Journal of Orthodontics. 2004; 26: 65–72.

How to cite this article: Shunsuke Kako, Takeo Sekiya, Masako Tabuchi, Takuma Sato, Ken Miyazawa, Hiroyuki Nawa. A case of orthodontic treatment with early tooth extraction and a functional orthodontic appliance in a patient with familial Mediterranean fever. Journal of Clinical Pediatric Dentistry. 2026; 50(1): 276-287. doi: 10.22514/jocpd.2026.025.