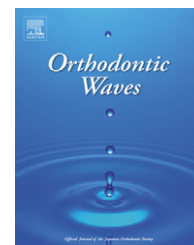


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Case report

A case of severe crowding with nickel allergy, treated using non-nickel-containing orthodontic appliances

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ABSTRACT

Here we report the successful treatment of a patient, aged 19 years 6 months, with Class III malocclusion, severe crowding and nickel allergy; non-nickel-containing orthodontic appliances were used for whole treatment period. As a result of performing a patch test, a positive reaction for nickel sulfate and palladium chloride were noted. Then, we directly bonded composite resin braces and titanium molar tubes on the teeth after extraction of the first premolars in both jaws. Only beta-titanium alloy arch wire was used with a multi bracket appliance. The active treatment period was 25 months. As a result, no symptoms of metal allergy were noted, and good facial appearance and occlusal relationships were seen for 2 years after starting retention.

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1. Introduction

Metal allergy involves contact dermatitis caused by allergens eluted from devices such as accessories and medical metals [1]. Metal-eluting devices in the oral cavity include dental metals and orthodontic appliances. There have been several reports on metal allergy caused by orthodontic appliances [1–7]. Among various metals inducing allergy, nickel (Ni) is the most frequent cause, due to its easy ionization [1–3].

Many orthodontic appliances consist of metal materials, and various metals such as Ni are used for orthodontic treatment [2–6]. Therefore, when patients have Ni allergy,

since the available metal materials for these patients are restricted, treatment frequently becomes difficult [2–4]. There are few orthodontic appliances and materials indicated in Ni-allergy patients [8,9]. Furthermore, there have been few reports on multi-bracket treatment for patients with Ni-allergy [3].

In this study, anterior cross-bite and crowding in a Ni-allergy patient was treated using non-nickel-containing orthodontic appliances. As a result, no symptoms of metal allergy were noted during the active treatment and retention periods, and a good facial appearance and occlusal relationship were obtained.

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Fig. 1 – Pretreatment photographs.

Table 1 – Cephalometric summary^a.

Variable	Mean	S.D.	Pretreatment	Posttreatment	Postretention
Angle (°)					
AHB	2.8	2.44	−4.2	−23	−28
SNA	80.8	3.61	76.7	76.7	76.7
SNB	77.9	4.54	80.9	78.9	79.9
Mp-FH	30.5	3.60	28.8	30.2	30.0
Gonial. A	122.1	5.29	126.0	126.0	126.0
U1-FH	112.1	8.26	120.4	125.8	123.8
U1-NF	115.0	6.99	117.2	122.6	120.6
L1-Mp	93.4	6.77	77.6	87.2	85.2
Interincisal A	123.6	10.64	133.1	116.9	120.9
Occlusal P	16.9	4.40	15.8	18.9	18.9
Linear (mm)					
S-N	67.9	3.65	69.4	69.1	69.1
N-Me	125.8	5.04	125.7	129.3	129.3
Me/NF	68.6	3.71	68.9	71.8	71.8
Go-Me	71.4	4.14	77.1	78.2	76.2
Ar-Me	106.6	5.74	109.1	109.1	109.1
Ar-Go	47.3	3.33	43.0	42.1	42.1
OJ	3.1	1.07	−2.0	2.0	2.3
OB	3.3	1.89	2.0	1.5	1.5
U1/NF	31.0	2.34	30.7	32.7	32.7
U6/NF	24.6	2.00	24.5	24.8	24.8
L1/Mp	44.2	2.68	42.2	43.8	43.8
L6/Mp	32.9	2.50	30.8	34.5	34.5

^a Means and S.D.s from Wada et al. [10].

2. History

The patient was a 19-year and 6-month-old female at the first examination, who visited our university hospital with chief complaints of anterior cross-bite and crowding. Anamnesis showed that the patient had eczema and itching in areas in contact with accessories such as earrings, necklaces, and watches when she was a high-school student. Family history showed that no family members had previous or present allergy. Regarding the history of the present illness, the patient noticed mandibular protrusion when she was an elementary schoolchild, and the symptom deteriorated with age.

The patient showed a symmetrical frontal facial appearance, and the facial profile exhibited concavity. Lower lip protrusion during lip closing was noted. The maxillo-mandibular bilateral central incisors noted reversed occlusion, and palatoversion in the maxillary bilateral lateral incisors and linguoversion in the mandibular bilateral lateral incisors were noted. The patient could take the edge-to-edge bite position. The occlusal relationship between the maxillo-mandibular first molars was Angle Class III, overjet was -2.0 mm, and overbite was 2.0 mm. Arch length discrepancy (ALD) was -16.5 mm in the maxilla, and -11.5 mm in the mandible (Fig. 1).

Regarding maxillo-oral functional findings, although no pain was present in the bilateral temporomandibular joints, clicking

was detected in the right temporomandibular joint. Sagittal MRI findings of the temporomandibular joints showed the anterior displacement of the articular disc in the right temporomandibular joint, which could be repositioned. Panoramic radiograph showed completely impacted maxillary bilateral third molars. Regarding cephalometric analysis, ANB was -4.2° , compared with cephalographic analytical standard values by Wada et al. [10], showing skeletal Class III. Although the position and size of the mandibular bone were within standard ranges, the size of the maxillary bone was small, exceeding 1 S.D. Although the tooth axis of the maxillary incisors was within the standard ranges, L1-Mp was 77.6° , indicating that the mandibular incisors were lingually inclined (Fig. 2 and Table 1).

Since metal allergy was suspected, a patch test was performed using 18 types of metal allergens, at the Dermatology Department of our university hospital. A positive reaction for 5% nickel sulfate was noted after 48 and 72 h, and 7 days. Although 1% palladium chloride showed a negative reaction after 48 and 72 h, a positive reaction was found after 7 days.

3. Treatment plan

The problem list was as follows. (1) Caries treatment and extraction of the maxillo-mandibular bilateral first premolars

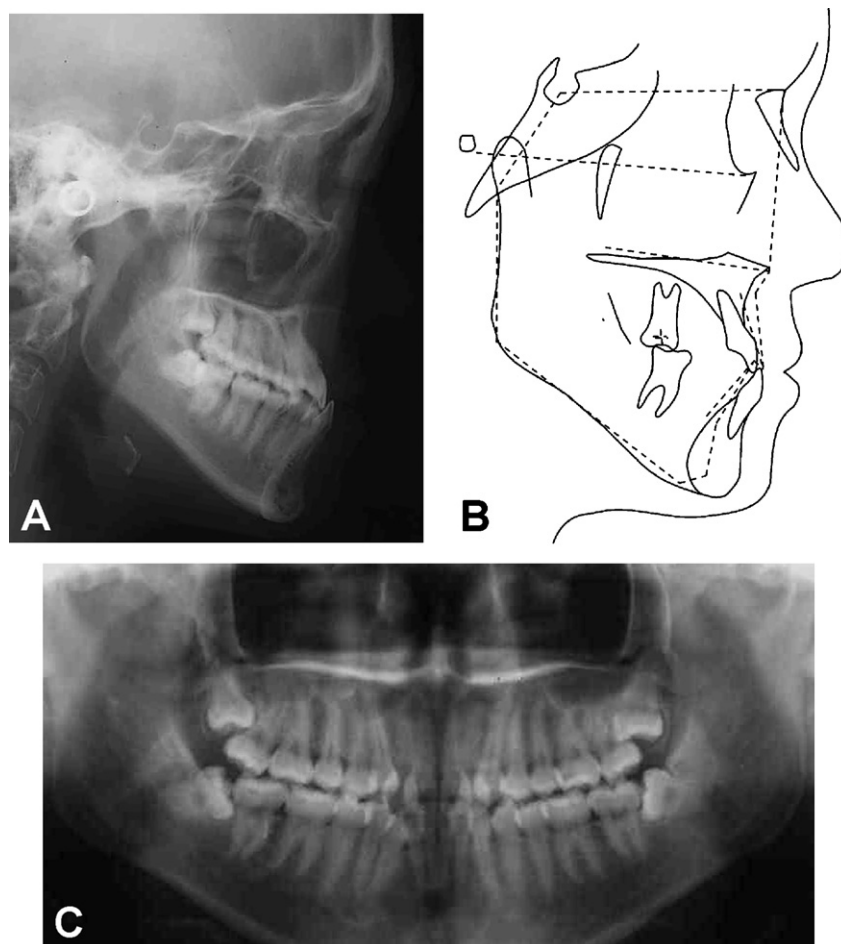


Fig. 2 – (A) Pretreatment cephalometric radiograph; (B) pretreatment cephalometric tracing (solid line) superimposed on mean profilogram (dotted line); (C) panoramic radiograph.



Fig. 3 – Treatment progress: (A) the start of leveling and alignment; (B) 5 months later; (C) 10 months later; (D) 18 months later.

and third molars. (2) Improve the maxillo-mandibular bilateral central incisor cross-bite, using multi-bracket appliances. (3) After obtaining appropriate overjet and overbite correction, occlusal adjustment. (4) To avoid metal allergy, perform treatment using orthodontic materials containing no Ni or Pd.

We diagnosed the patient as having Angle Class III, skeletal Class III anterior cross-bite, and crowding with Ni and palladium (Pd) allergy.

4. Treatment progress

After removing caries, resin filling and extraction of the maxillo-mandibular bilateral first premolars and third molars were performed. At the age of 20 years and 1 month, a 0.018-in. slot multi-bracket appliance; composite resin braces (with no Ni in metal slots) (Envision [gold slot], DENTAURUM, Germany) in the anterior teeth, titanium tubes (Rematitan, DENTAURUM, Germany) in the molars and 0.016 in. beta-titanium alloy arch wire (TMA, Ormco, USA) were inserted in the maxillary teeth excluding the bilateral lateral incisors to initiate leveling. Elastic modules were used for ligation. Starting from 1 month after initiating leveling, an open coil spring (TMA coil spring, Ormco, USA) was inserted between the maxillary bilateral central incisors and canines, and the canines were distally moved (Fig. 3). The mandibular canines were distally moved, using sectional arches with closing loops (0.016 in. $\times$ 0.022 in. beta-titanium alloy wire). Three months after starting active treatment, appropriate overlap

of the anterior teeth was achieved. Furthermore, plastic lingual buttons were inserted in the palatal cervical area of the maxillary bilateral lateral incisors to improve palatoversion using orthodontic elastics (Fig. 4). After completing the distal movement of the mandibular canines, a multi-bracket appliance was inserted in the mandibular anterior tooth area, and leveling was performed, using 0.016 in. beta-titanium alloy wire. After the leveling and alignment phase, we used short Class III elastics for 3 months between the lower canines and the upper first premolars for molar uprighting. The elastics were applied between the hooks that originally

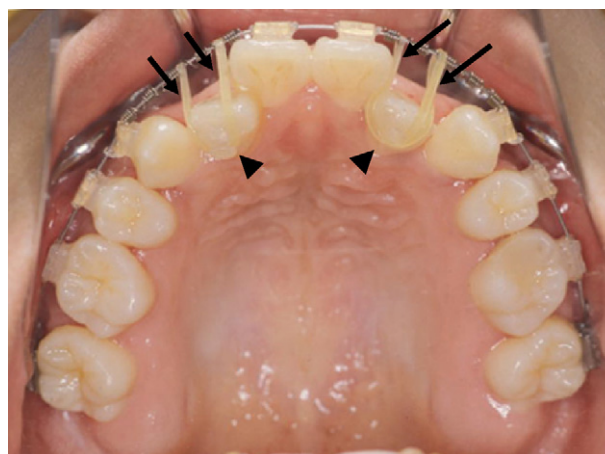


Fig. 4 – Labial movement of lateral incisors: orthodontic elastics (arrow), plastic lingual buttons (arrowheads).



Fig. 5 – Posttreatment photographs.

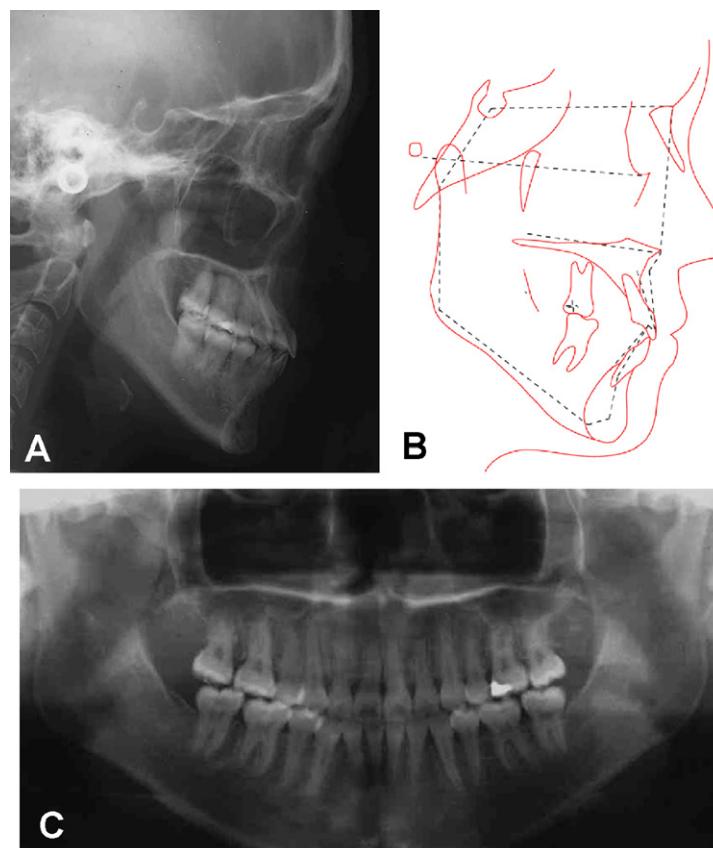


Fig. 6 – (A) Posttreatment cephalometric radiograph; (B) pretreatment cephalometric tracing (solid line) superimposed on mean profilogram (dotted line); (C) panoramic radiograph.

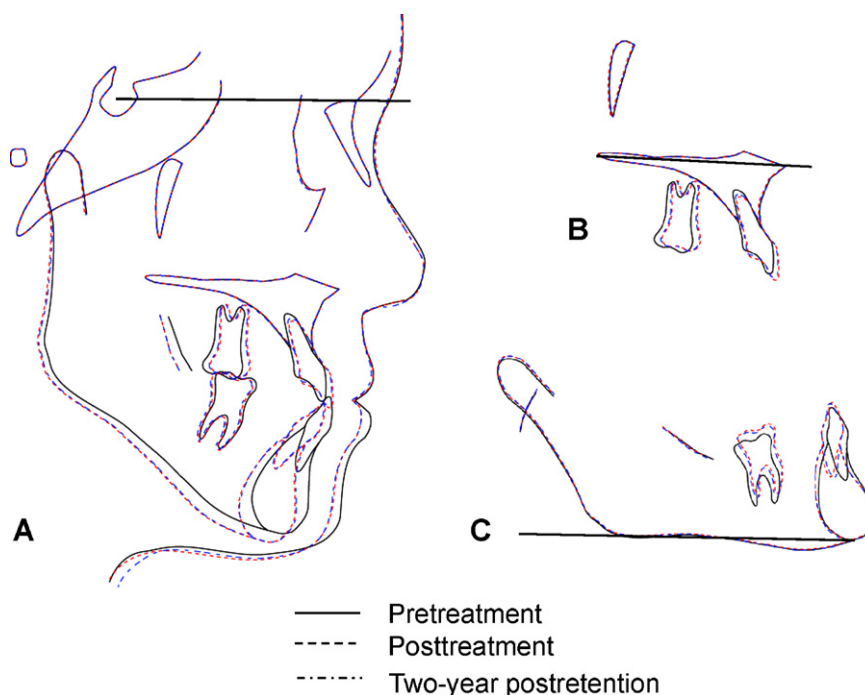


Fig. 7 – Pretreatment, posttreatment and 2-year postretention cephalometric tracings, superimposed on: (A) sella-nasion plate at sella; (B) palatal plane at ANS; (C) mandibular plane at menton.

attached on the braces. Furthermore, detailing and finishing were performed in both the maxilla and mandible, using 0.016 in. $\times$ 0.022 in. and 0.017 in. $\times$ 0.025 in. beta-titanium alloy arch wires (Fig. 3). At 22 years and 2 months, the

edgewise appliance was removed (Figs. 5 and 6), a wrap-around type retainer composed of 0.9 mm labial wire (Noninium, DENTAURUM, Germany) and c-clasp containing almost no nickel was inserted in the maxilla, and a bonded



Fig. 8 – Two-year postretention photographs.

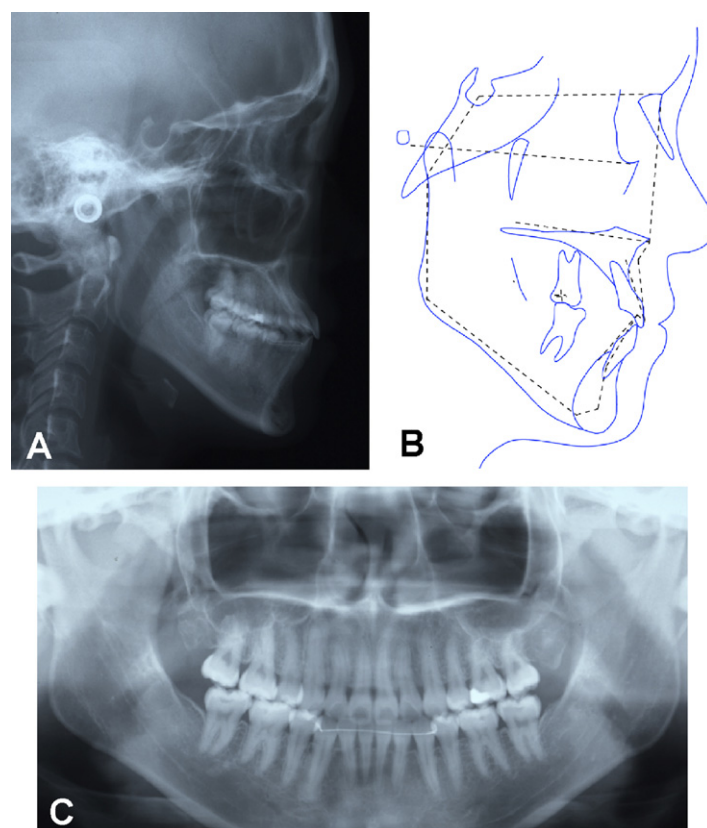


Fig. 9 – (A) Two-year postretention cephalometric radiograph; (B) pretreatment cephalometric tracing (solid line) superimposed on mean profilogram (dotted line); (C) panoramic radiograph.

type retainer using 0.016 in. beta-titanium alloy wire was inserted in the mandible. The total active orthodontic treatment period was 25 months. The patient has shown a good clinical course for 2 years after starting retention (Figs. 7–9).

5. Treatment results

The facial profile, which showed concavity at the first examination, became straight after active treatment, showing improvement in the protrusion of the lower lip (Fig. 5). Overjet was 2.0 mm, and overbite was 1.5 mm, indicating a good overlap relationship in the anterior area, and crowding also improved. Although no changes in SNA were noted, SNB decreased due to the clockwise rotation of the mandible, and ANB increased from -4.2° to -2.4° . Furthermore, the mandibular anterior tooth axis (IMPA) increased from 77.6 to 87.2° , and FMIA decreased from 73.6 to 62.7° . These parameters were changed within the normal range (Fig. 7 and Table 1). Panoramic radiograph showed that the tooth roots were well parallel with each other (Fig. 6). No symptoms of temporomandibular disorder were noted during the active treatment and retention periods. The over-corrected uprighting molars were adequately seated during retention phase (Fig. 9). Both the facial appearance and occlusal condition were stable for 2 years after retention (Figs. 7–9). No metal allergy symptoms

were present during the active treatment and retention periods.

6. Discussion

Metal allergy usually involves local contact dermatitis, and occurs in areas in direct contact with metal allergens [1]. Dermal lesions consist of local erythema with eczema and itching, occasionally with accompanying papules and vesicles [11]. As another clinical type, contact dermatitis occurs in areas apart from that in direct contact with allergens, in which dental metals in the oral cavity can be eluting allergens, in particular [4,5]. Therefore, it is important to obtain anamnesis and family history regarding metal allergy during dental treatment [2].

In this study, no metal restorations were present in the oral cavity at the first examination. Furthermore, no family members had previous allergy, according to the patient's interview. However, since the patient presented symptoms such as eczema and itching in areas in contact with accessories in the past, metal allergy was suspected, and as a result of the patch test, Ni and Pd were identified as metal allergens. Although Pd is widely used for dental restoration as gold–silver–palladium alloy in Japan [7], almost no Pd is used for orthodontic appliances [6]. However, Ni is contained in stainless steel, ultra-elastic nickel–titanium alloy wires, and

cobalt-chromium alloy wires, which are frequently used as orthodontic materials such as braces, bands, and arch wires. Although Ni is the main component metal of orthodontic appliances, it has the characteristic of readily becoming an allergen; therefore, it is necessary to pay attention to the occurrence of allergic symptoms [1-7,10,11]. In this study, orthodontic treatment was performed using non-nickel-containing appliances.

In this case, direct bonding of composite resin braces (with no Ni in metal slots) in the anterior teeth, and titanium tubes in the molars, was performed. Only beta-titanium wires were used as arch wire, and ligature was performed using elastic modules. Therefore, compared with cases in which ultra-elastic Ni-Ti wires were used, it took time to improve the torsion of the teeth in this case. On the other hand, since labial inclination of the tooth axis of the maxillary incisors in the patient with skeletal Class III, and Angle Class III anterior cross-bite, was planned in this study, a titanium open coil spring was inserted in the maxillary bilateral lateral incisors, and the bilateral canines were distally moved for 7 months to obtain alignment space for the lateral incisors. Since Ni-Ti wire could not be used in the palatally displaced maxillary lateral incisors, plastic lingual buttons were placed in the palatal cervical area, and the patient used orthodontic rubber rings to achieve labial movement [12]. Since the patient's cooperation was good, the palatal displacement improved in a short period, and this method was very useful in this case. However, since maxillo-mandibular anterior tooth crowding was severe, and available materials were restricted, the time required for leveling was longer (11 months) than that in usual cases.

Since only beta-titanium alloy arch wire was used for detailing, it took 14 months to achieve torque control in the maxillary anterior teeth and maxillo-mandibular molars, vertical control of the occlusal plane, and harmonization of the maxillo-mandibular dental arch forms. The elastic modulus of beta-titanium alloy is smaller than that of stainless steel. Therefore, sufficient orthodontic force could not be achieved for large distance adjustment [13]. In the present study, detailing should have been performed using 0.22 slot braces, and inserting 0.019 in. $\times$ 0.025 in. and 0.021 in. $\times$ 0.025 in. arch wires to generate the sufficient orthodontic force of torque control.

In recent years, there have been reports on orthodontic treatment using thin resin appliances [8,9], and polymer tooth movement appliances [14] have been developed. In cases of slight malocclusion, these non-metal appliances are considered useful for orthodontic treatment for patients with metal allergy. However, in cases of severe crowding cases requiring tooth extraction, as in the present case, treatment with multi-bracket is considered appropriate. Since materials of reinforced anchorage such as headgear [2] and the trans-palatal arch [3] are stainless steel and cobalt chromium alloy, these are not applicable to patients with Ni-allergy. Therefore, in cases requiring reinforced anchorage, we consider that implant anchorage, which has recently been used, is indicated [15,16].

In this study, the available materials were restricted due to Ni-allergy, and the treatment period was 25 months, which

was slightly longer than that in patients without metal allergy. However, this active treatment period was considered to be acceptable, considering the severity of crowding in this case. Even in patients with metal allergy such as the present case, good treatment results can be obtained by selecting appropriate treatment materials. The number of patients with metal allergy is increasing [1,3]. Therefore, opportunities to use these orthodontic appliances will increase in the future.

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