Case Report

Treatment of a Patient with Metal Hypersensitivity after Orthognathic Surgery

Hideki Kitaura[a]; Yuji Fujimura[b]; Noriko Nakao[a]; Toshiko Eguchi[c]; Noriaki Yoshida[d]

ABSTRACT

In this case report, orthodontic materials may have induced metal allergic reactions in the form of lip swelling and redness after orthognathic surgery. Two months after surgery, the patient suffered continuous lip swelling and redness. She visited a dermatological hospital and was diagnosed with herpes. However, since her symptoms did not improve after 1-month of drug therapy, a metal allergy was subsequently suggested. Patch tests conducted in the dental hospital revealed reactions to chromium, which is not used in prosthetic appliances. For confirmation, the metal composition of all prosthetic appliances was examined using a fluorescent x-ray analyzer, but no chromium was detected (copper, gold, palladium, and silver were detected). However, the orthodontic brackets, wires, and bands do contain chromium and, considering that they may have induced the metal allergic reactions, they were replaced with materials made of polymer with no metals. As a result, the lip swelling and redness improved. For retention, the anterior part of the retainer was bonded on the lingual side of the anterior lower and upper jaws. During retention, no further symptoms of hypersensitivity were observed, suggesting that the nonmetal polymer is useful for treatment of metal allergic patients.

KEY WORDS: Metal allergy; Orthognathic surgery; Mandibular protrusion

INTRODUCTION

Recent years have seen an increase in metal allergies. Allergic reactions in the oral region to metals contained in dental appliances has previously been reported,[1–3] and increased attention has been paid to allergy to orthodontic materials.[4–6] Some metals commonly used in dental practice are known allergens such as nickel, cobalt, and chromium, many of which are contained in various kinds of orthodontic material.[7]

Nickel is the most typical antigen of metal-induced allergic contact dermatitis,[8–10] whereas a chromium allergy is estimated to occur in 10% of male subjects and 3% of female subjects.[11] It is possible that metal ions are eluted from orthodontic materials by the caustic action of saliva, electrolytes in food debris, and acids produced by bacteria. We previously evaluated the release of nickel from orthodontic wires in various acids as a product of oral bacteria.[12] Although not all the wires released nickel in physiological salt solution and sterilized water as control solutions, all did so in hydrochloric and formic acid. Agaoglu et al[13] measured nickel and chromium levels in saliva and serum of patients with fixed orthodontic appliances and showed the release of a measurable amount of nickel and chromium when placed in the mouth. It is therefore possible that orthodontic materials can induce metal allergy.

In this case report, metal allergic reactions in the form of lip swelling and redness were induced after orthognathic surgery. We show that the metal allergic reactions improved by replacing the metal brackets, wire, and bands with an appliance made of polymer, which contained no metals.

[a] Assistant Professor, Divisions of Orthodontic and Dentofacial Orthopedics, Department of Translational Medicine, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan.

[b] Postdoctoral Student, Department of Translational Medicine, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan.

[c] Graduate PhD Student, Department of Translational Medicine, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan.

[d] Professor, Divisions of Orthodontic and Dentofacial Orthopedics, Department of Translational Medicine, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan.

Corresponding author: Dr Hideki Kitaura, Divisions of Orthodontic and Dentofacial Orthopedics, Department of Translational Medicine, Course of Medical and Dental Sciences, Nagasaki University Graduate School of Biomedical Sciences, 1-7-1 Sakamoto, Nagasaki 852-8588, Japan
(e-mail: kitaura@net.nagasaki-u.ac.jp)

Accepted: October 2006. Submitted: August 2006.

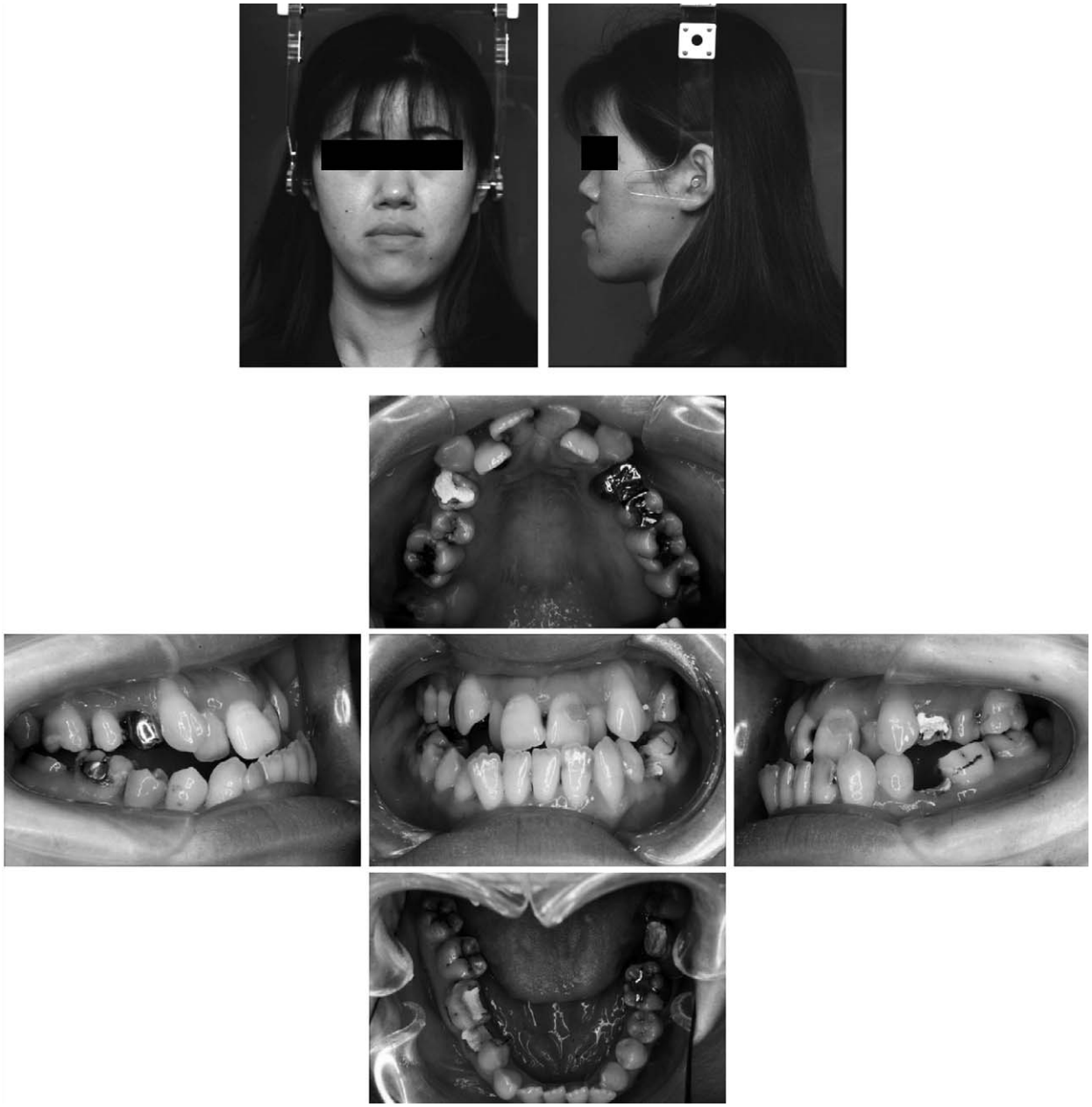

Figure 1. Facial and intraoral photographs taken before treatment (29 years old).

Case Summary

A 29-year-old woman visited Nagasaki University Dental Hospital complaining of an anterior crossbite. Intraoral examination revealed a class III molar relationship and missing upper left second molar, an overjet of −2 mm, overbite of 1 mm, and maxillary midline deviation of 3 mm to the right. The second upper incisors had migrated lingually, and the upper left first premolar, lower left second premolar, lower left first molar, and lower right second molar were under prosthetic treatment. The lower anterior segment showed 3 mm of crowding (Figure 1). Cephalometric analysis indicated SNA 84°, SNB 87°, and ANB −3°. The mandibular plane angle was steep (42°), and the gonial angle was large (145°). The upper incisors were inclined 113° to the labial. However, in contrast, the lower incisors were inclined 71° to the lingual (Table 1).

Diagnosis and Treatment Objective

The patient had a skeletal class III relationship with a class III mandibular protrusion and high mandibular plane angle with mandibular and maxillary crowding. The treatment objectives were (1) improvement of the anterior crossbite and mandibular and maxillary rela-

Table 1. Cephalometric Measurements of the Case at Pretreatment and Posttreatment

Cephalometric measure, °	Pretreatment	Posttreatment	Treatment Change
SNA	84.0	85.2	1.2
SNB	87.1	83.0	−4.1
ANB	−3.2	2.1	5.3
SNP	86.6	83.4	−3.2
Gonial angle	145.4	137.8	−7.6
SN-MP	42.4	42.3	−0.1
U1-SN	113.0	114.3	1.3
L1-MP	70.6	72.2	1.6
Interincisal	134.0	131.2	−2.8

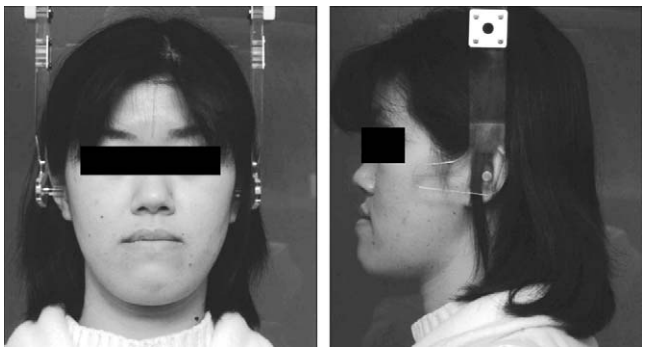

Figure 2. Facial photograph of the presurgical treatment (31 years 1 month of age).

tionship, (2) correction of the upper midline, and (3) correction of crowding.

Treatment Plan

Following orthodontic treatment, orthognathic surgery with sagittal split ramus osteotomy (SSRO) was scheduled. The plan was extraction of the upper first premolars and lower second premolar for treatment of the crowding. The upper right third molar and lower third molars were also extracted. Presurgical orthodontic treatment involved a metal multibracket appliance. SSRO is aimed at improving the skeletal mandibular protrusion and the postsurgical orthodontic treatment at establishing an ideal occlusal relationship. Retention is required to maintain proper occlusion after treatment.

Treatment Progress

A metal edgewise appliance (0.018″ × 0.025″ slot) was applied. Nickel titanium wires were used for leveling and alignment of both arches. Cobalt-chromium wires were used for stabilization before surgery. The total period of presurgical treatment was 21 months (Figure 2). An SSRO was performed to improve mandibular protrusion (Figure 3).

Two months after orthognathic surgery, continuous

Figure 3. Intraoral photograph taken 3 months after orthognathic surgery (31 years 4 months of age).

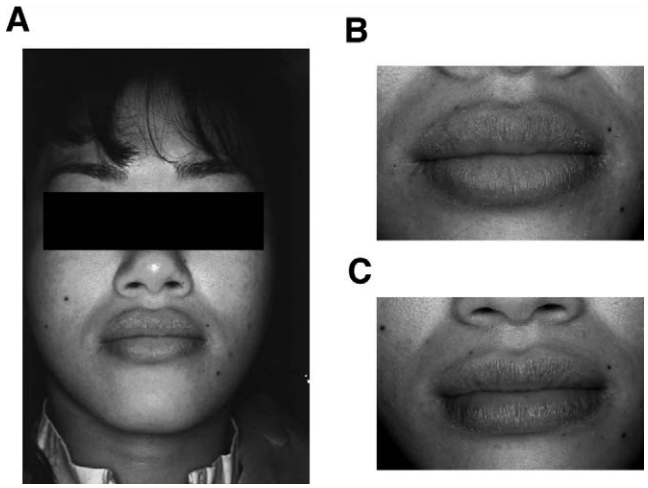

Figure 4. Lip swelling after orthognathic surgery (31 years 4 months of age). (A) Facial photograph taken 3 months after orthognathic surgery. (B) Lip photograph taken 3 months after orthognathic surgery. (C) Lip photograph taken 1 month after drug therapy for herpes.

lip swelling and redness were noted (Figure 4A,B). The patient was diagnosed with herpes infection at a dermatological hospital and given medicine for 1 month, but her symptoms did not improve (Figure 4C). It was then suggested by the dermatological hospital that the patient had a metal allergy, and a reaction to chromium was revealed by patch tests in our dental hospital.

For confirmation, we examined the metal composition of all prosthetic appliances using a fluorescent x-ray analyzer (SEA-2110L; Seiko Instruments Co Ltd, Chiba, Japan); copper, gold, palladium, and silver were detected, but chromium was not (Figure 5). However, the orthodontic brackets, wires, and bands do contain chromium.[7] Considering that these materials may have induced the metal allergic reactions, they were replaced with an appliance made of polymer (Quick Change Methods [QCM]; Chikami Miltec Inc, Kochi, Japan), with no metals[14] (Figure 6). As a result, the lip swelling and redness improved (Figure 7). There is no lip swelling and redness at the time of appliance removal (Figure 8). For retention, the anterior part of the QCM retainer was cut and bonded onto the lingual side of the anterior lower and upper jaws (Figure 9). During retention, no allergenic reactions were observed.

RESULTS

The maxillary dental midline almost coincided with the mandibular midline, and the upper incisors were inclined lingually. Facial mandibular protrusion was also improved. An ideal occlusion with class I molar and canine relationships was also achieved as well as

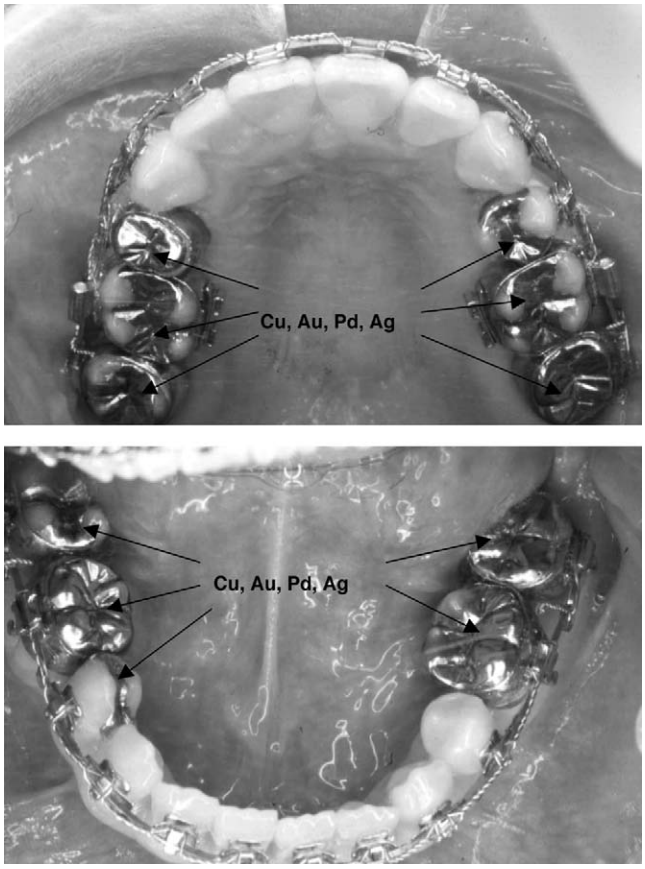

Figure 5. The metal composition of prosthetic appliances.

improvement in the overbite and overjet to 2 mm (Figure 8). The SNB was improved to 83°, and as a result, the ANB was improved to 2° (Table 1). After changing the metal appliance to a nonmetal appliance, no further symptoms of hypersensitivity were observed around the oral region, and this continued to be the case during retention.

DISCUSSION

In general, a small amount of metal can cause metal allergies in daily life. Mercury, nickel, chromium, cobalt, copper, tin, gold, platinum, palladium, antimony, silver, iron, zinc, cadmium, and manganese all have been shown to be causative agents of metallic allergy.[15–17] Metal allergic diseases thought to be related to dental metals have recently become a serious problem.

In this case, allergic hypersensitivity in the form of lip swelling and redness was induced after orthognathic surgery. In clinical cases, allergic contact hypersensitivity to nickel develops much more readily in inflamed skin than in normal skin. In this way, sensitization to nickel develops much more easily in the presence of strong inflammation. At the inflammation site, reactive oxygen species such as hydrogen per-

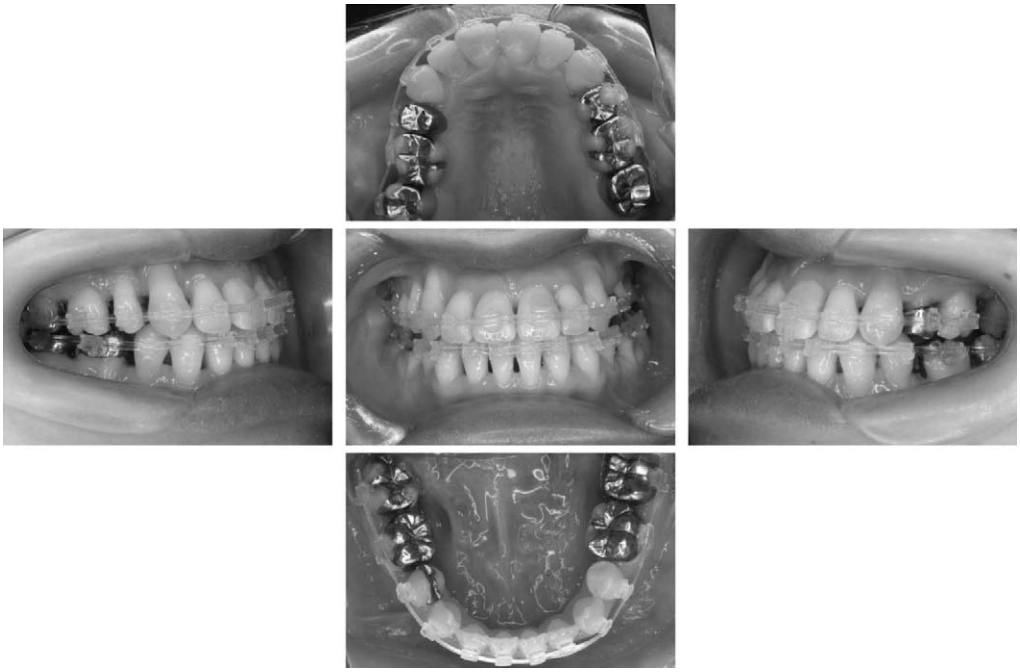

Figure 6. Intraoral photograph taken after replacement with the Quick Change Methods (31 years 6 months of age).

oxide (H_2O_2) and hypochlorite $(OCL^-)_4$ are produced by phagocytes.[18] In the case of nickel hypersensitivity, these powerful oxidants can oxidize Ni^{2+} to the higher oxidation states of Ni^{3+} and Ni^{4+}, respectively,[19] which have a far greater chemical reactivity than Ni^{2+}. It has also been reported that sensitization is achieved by injecting Ni^{2+} or by administering nickel as Ni^{3+} and Ni^{4+}.[20] The results showed that Ni^{3+} and Ni^{4+}, but not Ni^{2+} alone, were able to sensitize native T cells. These findings might explain why hypersensitivity against nickel in humans develops much more easily in inflamed skin than in normal skin, since both Ni^{3+} and Ni^{4+} can be generated from Ni^{2+} by reactive oxygen species released during inflammation. In fact, we previously established a nickel-hypersensitized animal model by injecting nickel at the inflammation site.[21]

Cr^{4+} species are strong oxidants that act as carcinogens, mutagens, and teratogens in biological systems.[22] The high solubility, bioavailability, and toxicity of Cr^{4+} make it a particular environmental concern. In contrast, Cr^{3+} species have low toxicity, in part because their bioavailability is limited by their low solubility and their tendency to form strong complexes with organics and hydroxo complexes.[23] Higher chromium oxidation states also possess a far greater chemical reactivity.

In this case, we did not check for allergic reactions before the orthognathic surgery, and therefore, we do not know whether the patient had the chromium allergy before or developed it after the surgery. However, it is possible that the allergenic symptom was triggered by the surgery. That is, it is possible that higher chromium oxidation states were induced, generating hypersensitivity through inflammation resulting from the orthognathic surgery. Many studies have suggested a rare intraoral sensitization in contrast to epicutan/intracutan sensitization,[24,25] even a desensitization of patients treated with brackets/wires.[5,26] However, with inflammation during surgery, a risk of development or induction of allergic reactions does exist.

The choice of material is important in the orthodontic treatment of patients with metal allergies, and it is necessary to understand the metallic composition of such orthodontic materials. We previously examined the elements of metal materials using an x-ray fluorescence spectroscope[7] and found that substantial amounts of

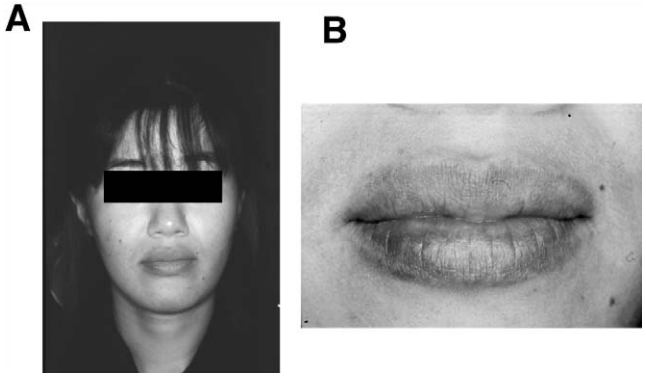

Figure 7. Improvement of lip swelling after placement of the Quick Change Methods (31 years 7 months of age). (A) Facial photograph. (B) Lip photograph.

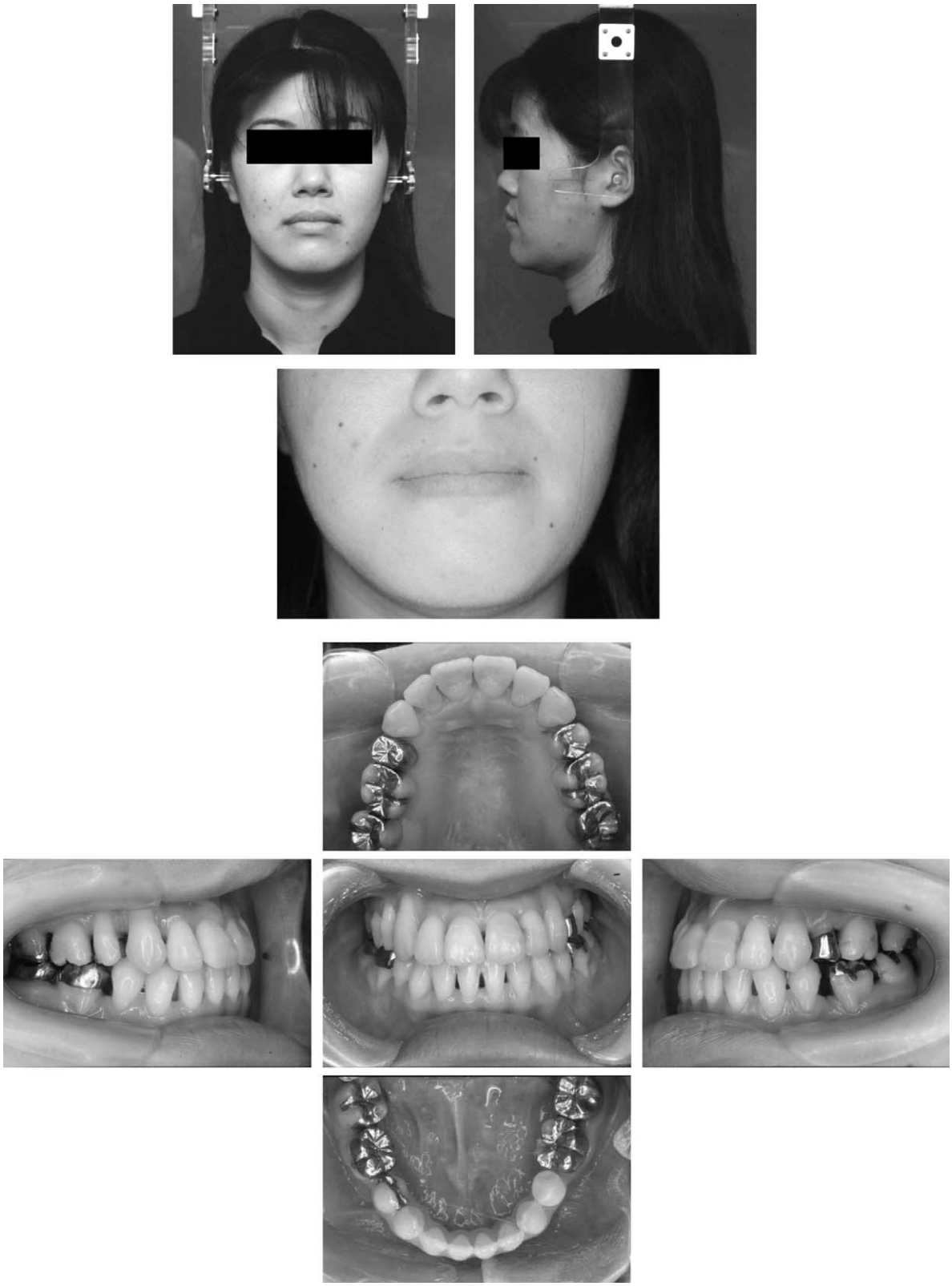

Figure 8. Facial, lip, and intraoral photograph taken after treatment (31 years 11 months old).

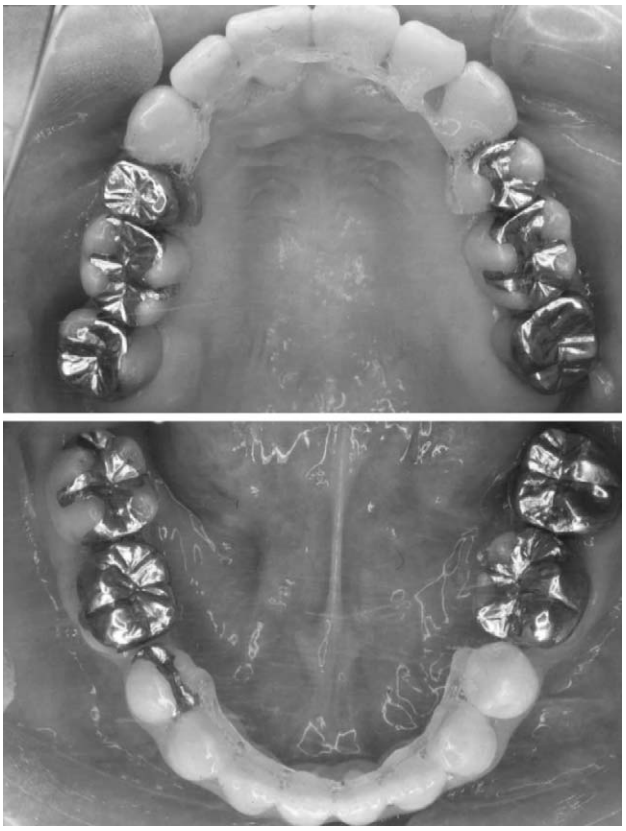

Figure 9. Intraoral photograph of the Quick Change Methods (QCM) retainer (31 years 11 months of age). The QCM retainer was cut and bonded onto the lingual side of the anterior lower and upper jaws.

nickel, chromium, and iron are contained in orthodontic metal materials. It is thought that the various metal elements elute from the materials, become antigens, and cause an allergic reaction. When allergic-like symptoms occur, we should therefore verify hypersensitivity to each of these metals to help determine whether the symptoms are an allergic reaction. We should first find out whether there is an allergen in the oral region and, second, whether the patient is hypersensitive to any metals and, if so, which elements. Accordingly, if the orthodontic materials include the metal elements, we should use an alternative material not containing the allergen.

In the present case, the patient had allergenic hypersensitivity to chromium, which is included in metal brackets and many kinds of wire and band, and we therefore chose to employ a nonmetallic appliance made of organic polymer.[14] For retention, the anterior part of the QCM retainer was cut and bonded onto the lingual side of the anterior lower and upper jaws. This treatment resulted in a disappearance of the hypersensitivity symptoms, suggesting that nonmetal orthodontic material is useful for treatment of metal allergenic patients.

REFERENCES

1. Gaul JE. Development of allergic nickel dermatitis from earrings. *JAMA.* 1967;200:176–178.
2. Watt TL, Baumann RR. Nickel earlobe dermatitis. *Arch Dermatol.* 1968;98:155–158.
3. Barranco VP, Soloman H. Eczematous dermatitis from nickel. *JAMA.* 1972;220:1244.
4. Grimsdottir MR, Gjerdet NR, Hensten PA. Composition and in vitro corrosion of orthodontic appliances. *Am J Orthod Dentofacial Orthop.* 1992;101:525–532.
5. Kerosuo H, Kullaa A, Kerosuo E, Kanerva L, Hensten PA. Nickel allergy in adolescents in relation to orthodontic treatment and piercing of ears. *Am J Orthod Dentofacial Orthop.* 1996;109:148–154.
6. Thilander BL. Complications of orthodontic treatment. *Curr Opin Dent.* 1992;2:28–37.
7. Adachi N, Kitaura H, Ikeda M, Kobayashi K. Quantitative analysis of the surface elements of orthodontic metal materials using an x-ray fluorescence spectroscope. *Orthod Waves.* 2000;59:128–137.
8. Meding B. Differences between the sexes with regard to work-related skin disease. *Contact Dermatitis.* 2000;43:65–71.
9. Kanerva L, Rantanen T, Aalto-Korte K, et al. A multicenter study of patch test reactions with dental screening series. *Am J Contact Dermatitis.* 2001;12:83–87.
10. Mattila L, Kilpelainen M, Terho E, Koskenvuo M, Helenius H, Kalimo K. Prevalence of nickel allergy among Finnish university students in 1995. *Contact Dermatitis.* 2001;44: 218–223.
11. Norseth T. The carcinogenicity of chromium. *Environ Health Perspect.* 1981;40:121–130.
12. Nakao N, Kitaura H, Yoshida N. Analysis of orthodontic wires for nickel release using dimethylglyoxime spot test in vitro and in vivo. *Orthod Waves.* 2002;61:478–481.
13. Agaoglu G, Arun T, Izgi B, Yarat A. Nickel and chromium levels in the saliva and serum of patients with fixed orthodontic appliances. *Angle Orthod.* 2001;71:375–379.
14. Morishita T, Sa'do B, Nakata S, Nakasima A. An organic polymer orthodontic appliance. *J Clin Orthod.* 2001;35:632–640.
15. Brendlinger DL, Tarsitano JJ. Generalized dermatitis due to sensitivity to a chrome cobalt removable partial denture. *J Am Dent Assoc.* 1970;81:392–394.
16. Duxbury AJ, Ead RD, McMurrough S, Watts DC. Allergy to mercury in dental amalgam. *Br Dent J.* 1982;152:47–48.
17. Namikoshi T, Yoshimatsu T, Suga K, Fujii H, Yasuda K. The prevalence of sensitivity to constituents of dental alloys. *J Oral Rehabil.* 1990;17:377–381.
18. Moller H. Attempts to induce contact allergy to nickel in the mouse. *Contact Dermatitis.* 1984;10:65–68.
19. Oller AR, Costa M, Oberdorster G. Carcinogenicity assessment of selected nickel compounds. *Toxicol Appl Pharmacol.* 1997;143:152–166.
20. Artik S, von VC, Gleichmann E, Schwarz T, Griem P. Nickel allergy in mice: enhanced sensitization capacity of nickel at higher oxidation states. *J Immunol.* 1999;163:1143–1152.
21. Kitaura H, Nakao N, Yoshida N, Yamada T. Induced sensitization to nickel in guinea pigs immunized with mycobacteria by injection of purified protein derivative (PPD) with nickel. *Microbiologica.* 2003;26:101–108.
22. Cieslak-Golonka M. Toxic and mutagenic effects of chromium (VI). *Polyhedron.* 1995;15:3667–3689.
23. Fendorf S, Wielinga BW, Hansel CM. Chromium transformations in natural environments: the role of biological and abiological processes in chromium (VI) reduction. *Internat Geol Rev.* 2000;42:691–701.

24. Janson GR, Dainesi EA, Consolaro A, Woodside DG, de Freitas MR. Nickel hypersensitivity reaction before, during, and after orthodontic therapy. *Am J Orthod Dentofacial Orthop.* 1998;113:655–660.
25. Staerkjaer L, Menne T. Nickel allergy and orthodontic treatment. *Eur J Orthod.* 1990;12:284–289.
26. Mortz CG, Lauritsen JM, Bindslev JC, Andersen KE. Nickel sensitization in adolescents and association with ear piercing, use of dental braces and hand eczema. The Odense Adolescence Cohort Study on Atopic Diseases and Dermatitis (TOACS). *Acta Derm Venereol.* 2002;82: 359–364.