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Case Report

Allergic contact dermatitis caused by titanium screws and dental implants



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ABSTRACT

Patients: Titanium has been considered to be a non-allergenic material. However, several studies have reported cases of metal allergy caused by titanium-containing materials. We describe a 69-year-old male for whom significant pathologic findings around dental implants had never been observed. He exhibited allergic symptoms (eczema) after orthopedic surgery. The titanium screws used in the orthopedic surgery that he underwent were removed 1 year later, but the eczema remained. After removal of dental implants, the eczema disappeared completely.

Discussion: Titanium is used not only for medical applications such as plastic surgery and/or dental implants, but also for paints, white pigments, photocatalysts, and various types of everyday goods. Most of the usage of titanium is in the form of titanium dioxide. This rapid expansion of titanium-containing products has increased percutaneous and permucosal exposure of titanium to the population.

Conclusions: In general, allergic risk of titanium material is smaller than that of other metal materials. However, we suggest that pre-implant patients should be asked about a history of hypersensitivity reactions to metals, and patch testing should be recommended to patients who have experienced such reactions.

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1. Introduction

An increase in the prevalence of allergic diseases in Japan has been reported recently [1–3]. That is, 3–4% of the population

has the symptoms of asthma, 30% suffer from allergic rhinitis, and 20% junior high school students have atopic dermatitis. In general, allergic disease is benign, but the quality of life can decrease remarkably. It is not an overstatement to say that prevention of allergic disease is a public-health issue.

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Various types of metallic and organic materials have been used for dental prostheses. Some of these materials have been reported to have pro-allergenic properties. Our research team has been engaged in the treatment of patients allergic to dental materials. We have reported on the clinical surveillance of dental allergic hypersensitivity at Tokushima University Dental Hospital (Tokushima, Japan) and evaluated the extent and severity of adverse reactions to dental materials among these patients [4]. Allergic symptoms from these materials are not restricted to the mouth; they are also found on the hands, legs and all the skin on the body [4–7]. Mercury, nickel, chromium, palladium and cobalt are classic allergens [8–12].

Titanium is known to possess good biocompatibility [13,14], so several products containing titanium have been used in plastic surgery and dental implants. However, recent studies have reported cases of allergic symptoms caused by titanium-based materials. The amount of titanium in products has increased with advances in smelting technology, thereby providing more opportunities for humans to be sensitized to this metal. Thomas et al. reported a patient who developed eczema upon titanium-based osteosynthesis [15]. Egusa et al. reported facial eczema in association with a titanium dental implant [16]. In their review, Siddiqi et al. suggested that titanium can induce hypersensitivity in susceptible patients, and could play a critical part in implant failure [17]. Whether dental materials comprising titanium are associated with allergic symptoms is controversial.

Here, we describe a patient who had dental implants and exhibited allergic symptoms after undergoing orthopedic surgery. The dental implant was functioning satisfactorily, but allergic symptoms (eczema) were shown. Moreover, patch tests revealed positive reactions to many reagents (including titanium).

2. Outline of the case

A 69-year-old male who had never experienced allergic symptoms apart from rhinitis and a reaction to leather products is described. He had no history of contact-hypersensitivity reactions to metals. In 2008, he had two dental implants using Fixture MicroThread™ (Astra Tech Dental, Mölndal, Sweden) and had displayed good progress.

In 2010, he had a fracture of a lower limb and underwent open reduction with titanium screws. Six months later, nummular eczema developed over the skin surface. He was prescribed histamine H₁ antagonists, sodium cromoglycate, ascorbic acid, and calcium pantothenate, but the eczema did not improve. A patch test at a dermatology clinic in Osaka University Hospital (Osaka, Japan) revealed an allergy-positive reaction to cobalt, tin, palladium, indium, and iridium, but also demonstrated a false-positive reaction to copper and titanium. Titanium screws were planned to be removed 1-year later, so medication and follow-up of allergic symptoms were applied at that time.

In 2011, the titanium screws were removed from the patient's limb by the plastic surgeon. After then eczema was recovered, but was still remained 50% level of the condition before removing screw. So the dermatologist suspected dental metal allergy and the patient for the previous dentist to



Fig. 1 – Panoramic dental radiograph of the patient at his initial visit.

remove all metal prosthesis. After removing all metal prosthesis except for dental implant and its abutment, the patient's eczema was recovered 30% level before removing it, but still not exhibited complete recovery.

In 2013, the patient was referred to our dental metal allergy clinic. Fig. 1 shows a panoramic dental radiograph of the patient at his first visit. The two dental implants were in the right mandibular molar area. No metallic restoration was found in the mouth apart from the abutments of the dental implants. Significant pathologic findings around the implants were not observed (Fig. 2). These implants did not exhibit any sign of peri-implantitis and/or mechanical problems such as loose screw and superstructure fracture. Radiograph examination did not find any images of bone resorption around the implant fixture. The implants and abutments were made with pure titanium (ASTM F-67, grade 4 ($N \leq 0.05$, $C \leq 0.08$, $H \leq 0.013$, $Fe \leq 0.5$)). A temporary acrylic crown was attached onto the maxillary and mandibular right molars. A temporary acrylic crown was placed on the abutments.

We altered temporary cement from poly carboxylate cement that contains allergy positive zinc components for zinc free glass ionomer cement. After 4-month follow-up with anti-allergic medications by the dermatologist, the eczema remained. Patch testing with 17 patch-test metal reagents (Patch Test Reagents; Torii Pharmaceutical Corporation, Tokyo, Japan) and 11 custom-made reagents was undertaken at our clinic. These reagents were attached to the skin on the back with an adhesive plaster (Patch Tester Torii; Torii Pharmaceutical Corporation). Reactions to the test were read according to criteria set by the International Contact Dermatitis Research Group at D2, D3 and D7 after application.

At that time, he demonstrated an allergy-positive reaction against cobalt, tin, palladium, indium and iridium (the same as in the previous patch test). Moreover, titanium, gold, platinum, zinc and iron also elicited an allergy-positive reaction (Table 1) (Fig. 3).

From these results in April 2014, the abutments were removed. One month after removing implant abutment, the patient did not exhibit remarkable progress. The patient kept medication from the dermatologist during this period. In May 2014, the dental implant fixtures were removed at the Department of Oral Surgery within Tokushima University Hospital. An implant-retrieval tool (Nobel Biocare USA, Yorba



Fig. 2 - (a)-(c) Intraoral photographs at the initial visit.

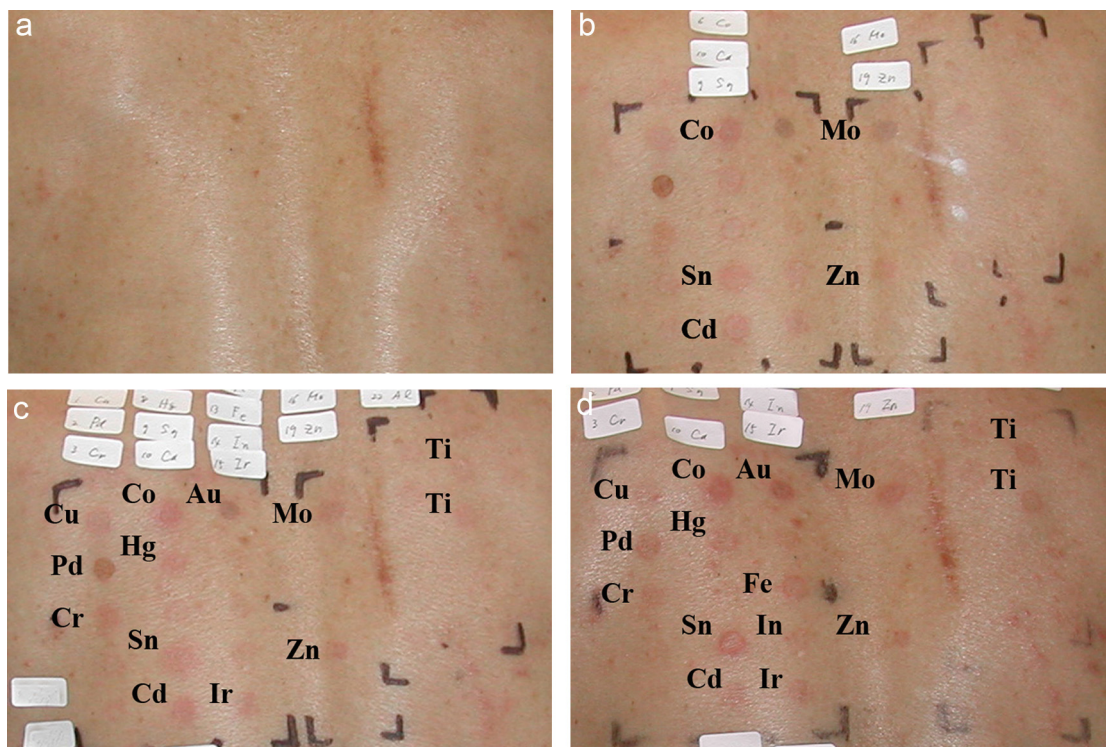


Fig. 3 - Results of patch tests. (a) Upper back before patch testing. (b) Result of patch testing at 48 h. (c) Result of patch testing at 72 h. (d) Result of patch testing at 1 week.

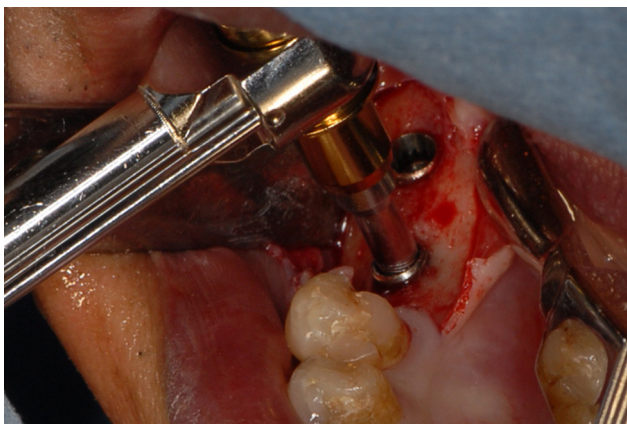
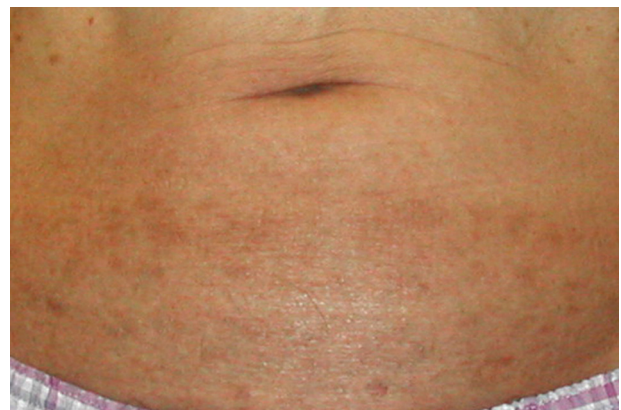
Linda, CA, USA) that enabled a less invasive effect in peripheral bone during removal of the osseointegrated implant was used (Figs. 4 and 5). Implant-retrieval tool was connected inside thread grooves of the implant fixture. Then

oral surgeon applied implant reverse torque with hand wrench. This instrument did not give implant fixture any destructive affect during removing. After removing intra oral metallic restorations, allergic symptoms sometimes develop

Table 1 – Patch testing.

	Metal-based allergen	%	Vehicle	D2	D3	D7
1	CuSO ₄	1	aq	–	?+	+
2	PdCl ₂	1	aq	–	?+	+
3	K ₂ Cr ₂ O ₇	0.5	aq	–	+	+
4	NiSO ₄	5	aq	–	–	–
5 ^a	NiSO ₄	2	aq	–	–	–
6	CoCl ₂	2	aq	+	+	++
7 ^a	HgCl ₂	0.1	aq	–	+	+
8	HgCl ₂	0.05	aq	–	–	–
9	SnCl ₄	1	aq	+	+	+
10 ^a	CdSO ₄	1	aq	?+	?+	?+
11	HAuCl ₄	0.2	aq	–	+	+
12	H ₂ PtCl ₆	0.5	aq	–	–	–
13	FeCl ₃	2	aq	–	–	?+
14	InCl ₃	1	aq	–	–	?+
15	IrCl ₄	1	aq	–	+	+
16 ^a	MoCl ₅	1	aq	?+	+	+
17	AgBr	2	pet	–	–	–
18 ^a	SbCl ₃	1	pet	–	–	–
19	ZnCl ₂	2	pet	?+	+	+
20	MnCl ₂	2	pet	–	–	–
21 ^a	BaCl ₂	0.5	aq	–	–	–
22 ^a	BaCl ₂	0.1	aq	–	–	–
23	CrSO ₄	2	aq	–	–	–
24	Al ₂ O ₃	2	aq	–	–	–
25 ^a	TiO ₂	30	pet	–	–	–
26 ^a	TiO ₂	10	pet	–	–	–
27 ^a	TiCl ₄	0.1	aq	–	?+	+
28 ^a	TiCl ₄	0.05	aq	–	?+	+

aq, aqueous; pet, petroleum.
Patch-test reagents (Torii Pharmaceutical Corporation, Tokyo, Japan).
^a Custom-made reagents.

**Fig. 4 – An implant-retrieval tool with the implant body is shown.****Fig. 5 – Intraoral photograph 2 months after removal of implants.****Fig. 6 – Symptomatic progress. Before removal of implants.****Fig. 7 – Symptomatic progress. Two months after removal of implants (no medication).**

more severe before removing. This counter allergic reaction seems to be caused by cutting dust of metallic restoration. Since chance of additional titanium contamination was minimum during this removing procedure, allergic symptoms of this patient did not exhibit such immediate reaction. The extent of the eczema reduced rapidly. One month later, he stopped taking medication and the eczema disappeared

completely. Figs. 6 and 7 show a hypogastric skin condition before and 2 months after removal of the dental implant fixtures. After 2-months follow-up, the patients underwent final prosthetic treatment with zirconia full veneer crown and metal free removable denture. Fig. 8 shows intra oral photographs of the patient after prosthetic treatment. Fig. 9 shows the



Fig. 8 - (a)-(c) Intraoral photographs of the patient after prosthetic treatment.



Fig. 9 - Symptomatic progress. One year after removal of implants (no medication).

hypogastric skin condition 1 year after removal of the implants. Severe recurrence of eczema has not been observed.

3. Discussion

We report a patient with allergic contact dermatitis who had dental implant prostheses and who exhibited allergic symptoms after orthopedic surgery. Dental implant prostheses and screw fixation did not result in specific problems in a local area of the body. Allergic symptoms appeared on the general skin

surface, and removal of titanium screws did not reduce the extent of skin eruptions. He clearly exhibited an allergy-positive reaction for a titanium reagent, and these symptoms disappeared after removal of dental implant fixtures.

Our patient may have become sensitized to titanium because of the titanium screws used in orthopedic surgery, and presented symptoms simultaneously. Alternatively, he might have presented allergic symptoms for the dental implants that he had received previously. Another option is that he became sensitized to titanium upon dental implantation and subsequently developed allergic symptoms because of the titanium screws used in orthopedic surgery.

His symptoms remained while he had dental implants and after the removal of titanium screws. This patient developed eczema 1 year after orthopedic surgery, so the primary cause of allergic symptoms seemed to be titanium screws in the lower limb. Nevertheless, the titanium component in the dental implant was the most suspicious cause of allergic symptoms.

Some medical studies and dental studies have reported cases of titanium allergy, and our research team, in dental metal allergy clinics, has documented suspicious cases of titanium allergy. Studies have shown that most instances of titanium allergy appear as contact dermatitis around titanium products [15,16,18]. However, our patient developed dermatitis symptoms on the general skin surface.

Osseointegrated dental implants work well, but removal of such implants is not considered easy or free of risk. If an osseointegrated implant must be removed, then an implant-retrieval tool is very useful because it enables a less invasive effect in peripheral bone.

In the 1980s, dental implants became one of the major choices for the treatment of missing teeth. Titanium was used as a material for dental implants at a very early stage of the development of dental implants [19,20]. The high biocompatibility of this metal suggested that titanium was an allergy-free material, and several reports supported the safety of titanium [21–24]. Today, titanium is used for medical applications such as plastic surgery, but also for paints, white pigments, photocatalysts, and various types of everyday goods [25]. Most of the usage of titanium is as titanium dioxide. This rapid expansion of titanium-containing products has increased the percutaneous and permucosal exposure of titanium to the population.

However, the patch-test reagent for titanium has not been standardized worldwide. Nakajima examined the form and density of patch-test reagents for titanium [26]. He reported that reagents composed of pure titanium powder and the petroleum jelly Vaseline (Unilever, Rotterdam, the Netherlands) was not preferable because it was a stimulant in this form. He suggested that titanium tetrachloride (0.1%) is preferable as a patch-test reagent for titanium, and we followed his advice.

Prevalence of allergy-positive reactions against titanium reagents is far lower than that for “risky” materials such as chromium, mercury, palladium and nickel. No patient has exhibited an allergy-positive reaction only for a titanium reagent. Hence, one could conclude that titanium is a relatively safe material that causes allergic symptoms rarely. The detailed mechanism of action of allergy and hypersensitivity with metal materials is not known, but we speculate that the total amount of exposure to specific metallic ions is an important parameter. The extent of exposure to titanium-based materials in everyday life and medical applications is increasing, so the number of the titanium-allergic patients will probably increase in the near future.

4. Conclusions

We report a patient with allergic contact dermatitis who had dental implant prostheses and who exhibited allergic symptoms after orthopedic surgery. The allergic risk for titanium was lower than that for other metal materials. However, we suggest that pre-implant patients should be asked about a history of hypersensitivity reactions to metals, and patch testing should be recommended to patients who have experienced such reactions.

Ethical approval

This experimental protocol was approved by the Ethics Committee of Tokushima Clinical Trial Center for Developmental Therapeutics (number 1036).

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Conflicts of interest

The authors declare that they have no conflicts of interest.

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