

Case
Report

Remission of Palmoplantar Pustulosis after On-Pump Coronary Artery Bypass Grafting in a Patient with Titanium Allergy

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Metal allergy is an uncommon problem during surgery. Among them, titanium allergy is said to be rare, but can lead to serious complications, such as palmoplantar pustulosis (PPP). A 69-year-old woman was admitted to our hospital with a chief complaint of chest pain. Coronary angiography showed severe coronary artery disease that required coronary artery bypass grafting (CABG). The patient had a history of orthopedic surgery for left distal radius fracture 2 years previously, which resulted in inflammation on the left arm and PPP. We suspected titanium allergy based on results of skin patch tests and use of titanium alloy in the previous orthopedic operation. The patient underwent CABG without use of permanent metallic material. As a result, her PPP disappeared. In this rare case, it is difficult to identify the exact cause of the improvement in PPP; thus, further studies are required to clarify the mechanism of remission.

Keywords: metal allergy, titanium, palmoplantar pustulosis, cardiopulmonary bypass

Introduction

Metal allergy is an uncommon but crucial problem during surgery, which can lead to complicated skin diseases, such as palmoplantar pustulosis (PPP).¹⁾ Among metal allergies, titanium allergy is said to be rare.²⁾ Here, we describe the rare case of a woman with titanium allergy

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and PPP who underwent coronary artery bypass grafting (CABG) under cardiopulmonary bypass (CPB) without use of metallic material, except a transient pacing lead for 1 day.

Case Report

A 69-year-old woman was admitted to our hospital with a chief complaint of chest pain. Electrocardiography showed T-wave inversion in leads II, III, aVF, and V4-6. Coronary angiography revealed significant three-vessel coronary artery disease and a small circumflex branch. The patient had a history of orthopedic surgery for left distal radius fracture 2 years previously. Postoperatively, her left forearm swelled due to inflammation and PPP developed. After the titanium plate was removed, swelling of the left forearm normalized, but PPP remained. Until then, metal allergy had never been diagnosed.

PPP remained on the patient's palms and soles at the time of admission to our hospital (**Figs. 1A** and **1B**). The PPP was so refractory that administration of antihistamines and topical steroid therapy was ineffective. Results of preoperative skin patch tests showed a positive reaction



Fig. 1 Skin findings of palmoplantar pustulosis. (A and B) Preoperative skin findings on the palms and soles. (C and D) Postoperative skin findings on the palms and soles; palmoplantar pustulosis was relieved.

to titanium, whereas tests of other metals showed negative reactions. During the investigation, we found that the titanium plate that was implanted in the previous orthopedic surgery was the source of the allergic reaction. She had been a smoker for 43 years, but had quit smoking 6 years previously. Although she had a history of dental treatments, she had no intraoral metals. She was not accustomed to taking any supplements or wearing metal jewelry.

CABG was performed using CPB. The left internal mammary artery conduit was grafted to the left anterior descending artery, and the saphenous vein was grafted to the right coronary artery. We did not use metal hemostatic clips to harvest the left internal mammary artery and saphenous vein. Aortic cross-clamping and CPB times were 83 and 154 minutes, respectively. Intraoperatively, we used a blood concentrator (Aqua Stream; JMS, Tokyo, Japan) and extracorporeal membrane oxygenator (Oxia ACF; JMS). To close the sternum, we used polyester nonabsorbable suturing thread instead of metal sternal wire. A temporary epicardial pacing wire was used, which was removed 1 day postoperatively.

The patient's postoperative course was uneventful; she did not have any allergic symptoms and the PPP disappeared (Figs. 1C and 1D). Three months postoperatively, her allergic symptoms and PPP have not recurred.

Discussion and Conclusion

We performed CABG with CPB in a patient with titanium allergy and PPP without use of metallic material, except a transient pacing lead for 1 day. Postoperatively, allergic symptoms were not observed and, unexpectedly, remission of PPP occurred.

Lately, prevalence of allergy has been increasing in Japan, and frequency of allergic diseases exceeds 30%.³⁾ Although metal allergy is rare, it can be a serious condition. Many cases of metal allergy have been reported in oral and orthopedic surgeries, whereas few metal allergies have been reported in the field of cardiology and cardiac surgery (Table 1).⁴⁻¹⁰⁾

The Japanese Society for Dermatoallergology and Contact Dermatitis reported that a high number of patients have nickel, cobalt, gold, and chrome allergies.¹¹⁾ However, our patient had titanium allergy. Because of the excellent biocompatibility of titanium, titanium alloys have been widely used as alternatives to other metals in invasive medicine, surgery, and dentistry during the last three decades.¹⁾ Most titanium-based biomaterials are made of commercially pure titanium and the alloy Ti-6Al-4V, which includes aluminum and vanadium.¹⁾ Although titanium allergy is rare, recent studies have reported cases of allergic symptoms caused by titanium.²⁾ One report recommends a sternal wire that is made with

Table 1 Previous reports

Author/year	The contents of the report
Tamenishi et al. (2008) ⁴⁾	Pacemaker-related contact dermatitis that was treated by entirely coating the pacemaker system with polytetrafluoroethylene sheets
Lai et al. (2005) ⁵⁾	Nickel hypersensitivity to the Amplatzer occlude device was associated with pericarditis
Köster et al. (2000) ⁶⁾	Higher frequency of in-stent restenosis in patients with hypersensitivity to metals than those without hypersensitivity
Takazawa et al. (2003) ⁷⁾	A patient had a metal allergy to a stainless steel wire after coronary artery bypass grafting
Lyell et al. (1978) ⁸⁾	Repeated failure of nickel-containing prosthetic heart valves in a patient who was allergic to nickel
Takimoto et al. (2013) ⁹⁾	The metallic components that are included in aortic prosthetic valves
Shomura et al. (2009) ¹⁰⁾	The metallic components that are included in mitral and tricuspid prosthetic valves

Table 2 The metallic components that are included in the medical materials

Medical materials	The name and the company of medical materials	The metallic components
Hemostatic clips	Ligaclip, Ethicon, Inc., Somerville, NJ, USA	Pure titanium
	Premium surgclip II Covidien, Dublin, Ireland	Stainless steel
Sternal wire	The sternal wire, Matsudaika Kogyo Co., Ltd., Tokyo, Japan	Stainless steel
	Yokozuna, Matsudaika Kogyo Co., Ltd., Tokyo, Japan	Pure titanium
Pacing wire	Heart wire, Medtronic Inc., Minneapolis, MN, USA	Stainless steel
Suture needles	Vicryl, Ethicon, Inc., Somerville, NJ, USA	Stainless steel
	Prolene, Ethicon, Inc., Somerville, NJ, USA	Stainless steel
	Nylon, Kono Seisakusho Co., Ltd., Chiba, Japan	Stainless steel
Sternal retractor	Octbase, Medtronic Inc., Minneapolis, MN, USA	None (polycarbonate)
	The sternal retractor, Mizuho Co., Ltd., Tokyo, Japan	Stainless steel
	Jostra, Maquet Cardiopulmonary AG, Hirrlingen, Germany	Stainless steel
Injection needle	BD insight, Becton, Dickinson and Company, Franklin Lakes, NJ, USA	Stainless steel
Surgical instruments	Harmonic synergy, Ethicon, Inc., Somerville, NJ, USA	Titanium alloy
	The electric scalpel, Conmed, Utica, NY, USA	Stainless steel
	The skin stapler, Keisei Medical Industrial, Co., Ltd., Niigata, Japan	Stainless steel

titanium;⁷⁾ however, it is necessary to recognize that titanium allergy exists. In the present case, diagnosis of titanium allergy was obtained preoperatively; therefore, no metallic instruments were used during surgery, except a transient pacing lead for 1 day. We did not use hemostatic clips to harvest the left internal mammary artery and saphenous vein. We also closed the sternum using polyester nonabsorbable suture thread, which has been reported previously,⁹⁾ and there were no wound complications postoperatively.

We investigated the metals comprising the surgical instruments that we were going to use in this operation (**Table 2**). With regard to stainless steel, we were not able to obtain the details of all instruments; however, the stainless-steel wire (Matsudaika Kogyo Co., Ltd, Tokyo, Japan) was reported, which was made of 0.03% carbon, 1.0% silicon, 2.0% manganese, 0.045% phosphorus, 0.03% sulfur, 12%–15% nickel, 16%–18% chromium, and 2%–3% molybdenum.⁷⁾

It is essential to comprehend the medical history of the patient in detail to diagnose metal allergy. When metal

allergy is suspected, a skin patch test is required. Sensitivity and specificity of skin patch tests are reported to be 70% and 80%, respectively.¹²⁾ Skin patch tests do not always reveal metal allergy; however, it is necessary to consider the possibility of false positives and false negatives.

Metal allergy can demonstrate a variety of skin eruptions, such as PPP, lichen planus, maculopapular rash, flexural exanthema, exfoliative erythroderma, and widespread dermatitis.¹⁾ PPP is a chronic, relapsing skin disease characterized by sterile intraepidermal pustules and usually scaly erythematous skin on the palm, soles, or both.¹³⁾ The etiology of PPP has not yet been clarified. In addition to metal allergy, many factors, such as tonsillitis, dental complications, and smoking status, have been reported to cause or exacerbate PPP.¹³⁾ Patients with PPP are usually treated with topical application of steroids and/or vitamin D3 and ultraviolet therapy, and oral administration of cyclosporine, retinoids, methotrexate, colchicine, or diaphenylsulfone.¹³⁾ However, some patients are resistant to these therapies.

In this case, an unsolved problem is why PPP remained after the titanium plate was removed. Despite the numerous

reported causes of PPP, the patient did not have any inciting cause except titanium allergy. In other words, it is worth considering that PPP caused by metal allergy may remain after removal of the cause. Kouno et al. reported that two-thirds of patients with PPP associated with dental metal showed no improvement of skin lesions after removal of the dental metal.¹⁴⁾ Thus, although metal allergy can be a cause of PPP, the condition of a patient with PPP may have a more complicated mechanism.

There has been no report of PPP that was relieved after CPB. To the best of our knowledge, this is the first case report of PPP remission after surgery with CPB. Fujisawa et al. reported the efficacy of granulocyte and monocyte adsorption apheresis (GMA) to treat PPP.¹⁵⁾ GMA selectively adsorbs Mac-1-expressing neutrophils and reduces serum levels of proinflammatory cytokines.¹⁵⁾ Although inflammatory cytokines are increased after CPB,¹⁶⁾ there has been no report that an extracorporeal membrane oxygenator removes cytokines. Rather, CPB promotes inflammatory responses. Theoretically, hemocytes cannot pass through the extracorporeal membrane oxygenator. Meanwhile, blood plasma can pass through the membrane, and, therefore, some substances in the blood plasma might be removed. It is difficult to identify the cause of improvement in PPP in this case, which might be due to other reasons; further studies are mandatory to clarify the mechanism of remission. PPP has been reported to exacerbate and go into remission repetitively; thus, follow-up observation of these patients is necessary.

Consent for Publication

Consent was obtained from the patient to use her medical information in this manuscript.

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Disclosure Statement

The authors declare that they have no conflict of interest.

References

- 1) Fage SW, Muris J, Jakobsen SS, et al. Titanium: a review on exposure, release, penetration, allergy,

epidemiology, and clinical reactivity. *Contact Derm* 2016; **74**: 323-45.

- 2) Sakamoto K, Ando K, Noma D. Metal allergy to titanium bars after the Nuss procedure for pectus excavatum. *Ann Thorac Surg* 2014; **98**: 708-10.
- 3) Dobashi K, Akiyama K, Usami A, et al. Japanese guidelines for occupational allergic diseases 2017. *Allergol Int* 2017; **66**: 265-80.
- 4) Tamenishi A, Usui A, Oshima H, et al. Entirely polytetrafluoroethylene coating for pacemaker system contact dermatitis. *Interact Cardiovasc Thorac Surg* 2008; **7**: 275-7.
- 5) Lai DW, Saver JL, Araujo JA, et al. Pericarditis associated with nickel hypersensitivity to the Amplatzer occluder device: a case report. *Catheter Cardiovasc Interv* 2005; **66**: 424-6.
- 6) Köster R, Vieluf D, Kiehn M, et al. Nickel and molybdenum contact allergies in patients with coronary in-stent restenosis. *Lancet* 2000; **356**: 1895-7.
- 7) Takazawa K, Ishikawa N, Miyagawa H, et al. Metal allergy to stainless steel wire after coronary artery bypass grafting. *J Artif Organs* 2003; **6**: 71-2.
- 8) Lyell A, Bain WH, Thomson RM. Repeated failure of nickel-containing prosthetic heart valves in a patient allergic to nickel. *Lancet* 1978; **2**: 657-9.
- 9) Takimoto S, Hanyu M, Arai Y, et al. A case of aortic regurgitation accompanied by multiple metal allergy treated with aortic valve replacement under median sternotomy. *Jpn J Cardiovasc Surg* 2013; **42**: 466-70. (in Japanese)
- 10) Shomura Y, Okada Y, Nasu M, et al. A case of mitral valve stenosis and tricuspid valve regurgitation accompanied by metal allergy treated with mitral valve replacement and tricuspid valve annuloplasty. *Jpn J Cardiovasc Surg* 2009; **38**: 385-8. (in Japanese)
- 11) Suzuki K, Matsunaga K, Yagami A, et al. Positive rates in 2013 and 2014 of Japanese standard allergens 2008. *J Environ Dermatol Cutan Allergol* 2017; **11**: 234-47. (in Japanese)
- 12) Bourke J, Coulson I, English J. Guidelines for care of contact dermatitis. *Brit J Dermatol* 2001; **145**: 877-85.
- 13) Farley E, Masrour S, McKey J, et al. Palmoplantar psoriasis: a phenotypical and clinical review with introduction of a new quality-of-life assessment tool. *J Am Acad Dermatol* 2009; **60**: 1024-31.
- 14) Kouno M, Nishiyama A, Minabe M, et al. Retrospective analysis of the clinical response of palmoplantar pustulosis after dental infection control and dental metal removal. *J Dermatol* 2017; **44**: 695-8.
- 15) Fujisawa T, Tawada C, Mizutani Y, et al. Efficacy of granulocyte and monocyte adsorption apheresis for treatment of palmoplantar pustulosis. *Ther Apher Dial* 2014; **18**: 238-43.
- 16) Hirtleman E, Larson DF. Cardiopulmonary bypass and edema: physiology and pathophysiology. *Perfusion* 2008; **23**: 311-22.