

Applicability of Zirconia Dental Prostheses for Metal Allergy Patients

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The aim of this study was to investigate the applicability of zirconium dioxide (zirconia) as a substitute for metal alloys in a group of metal allergy patients. Fourteen patients (eight women, six men) who had been restored with porcelain-fused-to-metal fixed partial dentures (FPDs) and had exhibited hypersensitivity lesions to dental alloys were enrolled in this study. Patients were previously patch-tested using standard testing substances authorized by the International Contact Dermatitis Research Group. Patients received FPDs with zirconia frameworks and occurrences of oral symptoms were evaluated. No hypersensitivity lesions in the mouth or on the skin were encountered during the follow-up period of 3 years. Zirconia FPDs may be an alternative to porcelain-fused-to-metal FPDs in patients with metal allergies. *Int J Prosthodont* 2010;23:562–565.

The clinical applications of dental prostheses are expanding, and allergies related to the metal alloys commonly used in dentistry have become a serious problem.¹ The oral cavity is frequently exposed to sensitizing and irritating substances, and the spectrum of signs and symptoms of oral disease related to dental materials is broad.

Because of corrosion and mechanical abrasion over time, almost every element can be released from the alloys.² Furthermore, nearly every alloy used in prosthodontics releases ions. In the presence of saliva, dental alloys act as electrolytes, causing electrochemical corrosion, and the released elements can initiate reactions of hypersensitivity. Many reports exist concerning allergies that arise from dental alloys containing nickel, chromium, or cobalt.

The fabrication of all-ceramic fixed partial dentures (FPDs) is a popular option for patients allergic to metal. Although such restorations have excellent esthetics, chemical stability, and biocompatibility, their inadequate mechanical properties limit their use. Zirconia (ZrO₂) fulfills the standards for posterior restorations, being a bioinert nonresorbable metal oxide with a remarkably high strength and toughness, as well as having good chemical and dimensional stability.

Zirconia has been used in dentistry with no reported allergic reactions and has proven to be non-toxic and nonirritating. But to the authors' knowledge, there are no short- or long-term clinical studies investigating the adverse reactions of zirconium in metal allergy patients. Therefore, the aim of this preliminary report was to investigate the applicability of zirconia as a framework substitute in a group of metal allergy patients. The null hypothesis tested was that zirconia would lead to reactions of hypersensitivity when used as a framework substitute.

Materials and Methods

Fourteen patients (eight women, six men; mean age: 48 years, range: 20 to 66 years) that had been restored with porcelain-fused-to-metal FPDs in private clinics in the Marmara region between 2000 and 2002 were included in this study. According to the patients' medical records, allergic reactions had been found in the mouth within 3 to 6 weeks of delivering the FPDs. Base metal alloys (Remanium CS, Dentaurem) and

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Table 1 Patient Demographics and Type of Reaction

Patient	Sex	Oral reaction	Skin reaction
1	F	Stomatitis	Perioral dermatitis
2	F	Gingivitis	—
3	M	Red mouth	—
4	F	Recurrent aphthosis	Perioral dermatitis
5	M	Gingivitis, burning mouth	Perioral dermatitis
6	M	Burning mouth	Perioral dermatitis
7	F	Stomatitis	—
8	F	Stomatitis	Perioral dermatitis
9	F	Orofacial granulomatosis	Orofacial granulomatosis
10	M	Gingivitis	Perioral dermatitis
11	F	Stomatitis	Perioral dermatitis
12	M	Gingivitis	—
13	F	Orofacial granulomatosis	Perioral dermatitis
14	M	Gingivitis	Perioral dermatitis

F = female; M = male.

Wiron 88 and 99 (Bego) had been used in the fabrication of the FPDs. Symptoms presented as slight irritations in the neighborhood of the FPD. The duration of the disease ranged from 4 to 22 weeks before referral to a dermatology clinic. The presented oral complications included gingivitis, stomatitis, swelling, erythema, blisters, papules, and ulcerative lesions (Table 1). Patients were patch-tested with standard testing substances (Chemotechnique Diagnostics) authorized by the International Contact Dermatitis Research Group. Dental screening sets were used to test the contact hypersensitivity at the Department of Dermatology, Istanbul University.³ The patients demonstrated hypersensitivity to the most common allergens used in prosthodontics (Table 2). They were then referred to the Department of Maxillofacial Prosthodontics for prosthodontic treatment.

The diagnosis of metal allergy was based on an evaluation of patient history, clinical examination, and results from epicutaneous tests. A careful examination of the face, lips, oral tissues, and teeth gave information on hypersensitivity reactions, but to determine the potential allergens, patients were tested using a standard series. These tests are preferred when Type I and Type IV reactions are noted. However, determining the exact degree of oral tissue changes requires histopathologic identification. In the present study, patch tests had already been performed, and patients

had been diagnosed with metal allergies before applying to the Department of Maxillofacial Prosthodontics for restoration replacement. Therefore, further histopathologic examination was not performed.

After informed consent was obtained and before definitive prosthodontic treatment began, all prosthetic restorations were removed. All patients demonstrated good oral hygiene. No patient had amalgam or composite fillings. Metal-free provisional restorations were fabricated from composite provisional material (Protemp II, 3M ESPE) and cemented using a eugenol provisional luting agent (TempBond NE, Kerr) for 11 patients. Three patients were allergic to acrylics so they received all-ceramic provisional prostheses (IPS Empress Esthetic, Ivoclar Vivadent). Oral symptoms and skin reactions disappeared completely within 3 weeks.

The definitive treatment plan was the fabrication of single crowns or FPDs with zirconia frameworks (Table 3). Computer-aided design/computer-assisted manufacture technology was used to fabricate the frameworks (Everest System, KaVo), and a feldspathic porcelain (Vita Zahnfabrik) that was compatible to the thermal expansion coefficient of zirconia was used.

After delivery of the FPDs with zirconia frameworks, patients were followed closely and received routine follow-up examinations every 2 months for 3 years.

Table 2 Patch Test Results*

Allergen	Patient													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Methyl methacrylate				++		++				+			+++	
Triethyleneglycol dimethacrylate														
Urethane dimethacrylate				++										
Ethyleneglycol dimethacrylate					++									
bis-GMA														
N,N-dimethyl-4-toluidine														
2-hydroxy-4-methoxy-benzophenone														
1,4-butanediol dimethacrylate														
bis-MA		++		++										
Potassium dichromate							++							
Mercury		++			+++									
Cobalt chloride	++	++			+++	++		++	+	++		++		
2-hydroxyethyl methacrylate						++								
Gold sodium thiosulphate		++	+++		++			+		++	++			+
Nickel sulfate	+++	IR	+++	++	+++	+++	+++	+++	++	++	++	+++	++	+++
Eugenol														
Colophony														
N-ethyl-4-toluenesulfonamide														
Formaldehyde														
4-tolyldiethanolamine														
Copper sulfate	++	++	+++	++	+++	++	++	+	+++	++	+	++	++	++
Methylhydroquinone	+++	++												
Palladium chloride	++	++		++		++	+++	+			+++	++	++	++
Aluminium chloride hexahydrate														
Camphoroquinone														
N,N-dimethylamino-ethyl methacrylate														
2(2-hydroxy-5-methyl-phenyl) benzoate mazo														
Tetrahydrofurfuryl methacrylate														

*Patch tests were applied with IQ Chambers (Chemotechnique) to the upper back of the patients for 2 days.

The results were evaluated according to the standard scoring system (+ = weak positive reaction [erythema, infiltration, possibly discrete papules], ++ = strong positive reaction [erythema, infiltration, papules, vesicles], +++ = extreme positive reaction [erythema, infiltration, confluent vesicles], IR = irritant reaction [different types of reactions]).

Table 3 Distribution of FPDs

Restoration	Maxilla		Mandible	
	Anterior	Posterior	Anterior	Posterior
Single crowns	3	2	—	—
Two-unit FPD	4	1	3	5
Three-unit FPD	3	1	4	—
Four-unit FPD	2	—	2	—

FPD = fixed partial denture.

Results

In total, 30 restorations were replaced in 14 patients. Of those 14 patients, 100% showed positive reactions against nickel, 71.43% reacted against palladium, 57.14% reacted against cobalt, and 50% reacted against gold (Tables 1 and 2). In addition to caries and occlusal wear, oral symptoms including stomatitis, gingivitis, lichenoid reactions, burning-mouth syndrome, cheilitis, lip swelling, and skin reactions were evaluated. No hypersensitivity lesions in the mouth or on the skin were reported or observed. No restoration had to be removed or replaced because of pulpal irritation or secondary caries. Some prosthodontic complications were encountered, such as FPD decementation after 16 months (1 patient, 7.14%) and minor chipping of the veneering material after 22 months (2 patients, 14.28%).

Discussion

In the present report, zirconia-containing restorations were used in metal allergy patients with a documented hypersensitivity to dental metals and alloys. Zirconium-based frameworks did not cause any type of allergic reaction. The null hypothesis was therefore rejected. These results are promising and suggest that zirconia may be used in metal allergy patients safely.

Efforts have been made to develop alternative prosthodontic materials that are more bioinert and have enough mechanical strength to carry masticatory loads. In the case of metal allergies, finding a replacement for the dental material is not often easy. In this situation, all-ceramic restorations may be

first considered. Due to their mechanical properties, all-ceramic restorations cannot always be used for multiple-unit FPDs, especially in patients suffering from bruxism. This was the main reason why all-ceramic FPDs were not solely used in the current study. Of the replaced restorations, 30% were located in the posterior segment, and two patients reported having nocturnal bruxism. An alternative material may be titanium. Titanium demonstrates excellent biocompatibility, corrosion resistance, and mechanical properties comparable to other metal alloys.⁴ However, difficulties in the fabrication process and high fabrication costs make it less preferable. Furthermore, it can cause allergic reactions at a rate of 0.6%.⁵

Conclusion

Within the limitations of this report, it can be concluded that zirconia may be used safely as a framework substitute for patients with metal allergies.

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