Allergy to auto-polymerized acrylic resin in an orthodontic patient

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This article reports on a 60-year-old woman who had an allergic reaction to methylmethacrylate self-curing acrylic resin during orthodontic treatment. A localized hypersensitive reaction appeared on the palate after an orthodontic retainer was placed. Samples of the acrylic were removed and analyzed with gas chromatography to evaluate the residual monomer level. The residual monomer content was between 0.745% and 0.78%, which did not exceed international standards for this material. Patch tests were performed with several methylmethacrylate resin samples and processed with various techniques; they showed positive reactions. Despite the many alternative products available, self-curing acrylic resin remains widely used because of its low cost, ease of use, and diversity of indications. Orthodontists should be aware that allergic reactions can occur. (Am J Orthod Dentofacial Orthop 2006;129:431-5)

In the last few decades, many substitutes for methylmethacrylate acrylic resins have been developed. Nevertheless, they remain one of the most used materials in dentistry because of their low cost, ease of use, and many applications. Because biocompatibility plays a central role in the development of safe dental materials, allergic reactions, especially to acrylic resins, have been a concern in the dental literature. In contrast, the orthodontic literature contains little information about allergic reactions to this material, although it is widely used.

Nealey and Del Rio1 described stomatitis venenata, a contact allergy caused by a prosthesis constructed of self-curing acrylic resin. McCabe and Basker2 reported 2 cases of sensitivity to acrylic and linked these reactions to the levels of residual monomer (0.233% and 0.186%, analyzed by gas chromatography). Likewise, allergic reaction to methylmethacrylate was shown by Giunta and Zablotsky,3 confirmed by patch testing and histopathologic evaluations.

Devlin and Watts4 cited Fisher, who stated that patch tests in which pressure or trauma is applied to the skin provide false-positive results. The authors also discussed allergic reactions to acrylics, affirming that these are usually type IV allergic reactions, which happen after re-exposing a subject to the allergen. According to those authors, these reactions are normally caused by compounds of low molecular weight called “hamptons,” which can initiate a response only when carried by a protein. For acrylic resins, these would be formaldehyde, benzyl peroxide, methylmethacrylate, and plasticizers such as dibutyl phthalate. The authors also pointed out the importance of a complete evaluation of medical history, because diseases such as anemia and diabetes can render the oral mucosa more susceptible to pathologic effects.

Generally, allergic reactions to acrylic are local manifestations, but there are different clinical presentations. Ruiz Genao et al5 mentioned labial edema in a case of allergy to methylmethacrylate confirmed by patch test. Lunder and Rogl Butina6 reported that chronic urticaria was the only symptom of the allergic reaction and considered it the first case of isolated systemic involvement developed by acrylics.

Many authors agree that residual monomer leaching into the oral environment is a main cause of allergic reactions; therefore, its concentrations have been widely investigated. Stafford and Brooks7 verified that residual monomer contents are usually about 1.5% to 4.5% in self-curing acrylic resins and about 0.3% in heat-curing resins when submitted to the cycle proposed by Hugget et al.8 Harrison and Hugget9 referred to British Standard Specifications for self-curing orthodontic resins; those specifications establish 3.5% as a limit for resid-
ual monomer concentration. Yilmaz et al\textsuperscript{10} mentioned the international patterns of ISO 1567 as a reference. It limits the levels of residual monomer to 2.2\% for heat-cured and 4.5\% for self-curing acrylic resins.

In this article, we report an allergic reaction to the self-curing methylmethacrylate acrylic resin of an orthodontic retainer base plate. Although the content of the residual monomer, verified by gas chromatography, was well below international standards, a localized reaction occurred and was confirmed by skin patch test.

**CASE REPORT**

The patient was a 60-year-old woman who had undergone orthodontic treatment with a fixed standard edgewise appliance (3M Unitek, Monrovia, Calif). The goals of treatment were to correct the posterior vertical collapse and protrusive incisor position, which were consequences of missing teeth and severe periodontal bone loss. Orthodontic treatment took place after the periodontal issues were under control and the patient was in a maintenance program. After removal of the fixed appliance, a removable retainer was constructed of clear self-curing methylmethacrylate acrylic resin and stainless steel clasps. It was used to maintain vertical dimension, thus preventing extrusion of the posterior teeth until titanium implants could be placed and while waiting for osseous integration before reconstructive prosthetic work.

Thirty days after placement of the retainer, she returned for a regular appointment, complaining of a burning sensation on the palate, a bitter taste in the mouth, hypersalivation, and difficulty swallowing when wearing the appliance. A well-delineated erythema could be seen on the hard palate, marking the retainer contours exactly (Fig 1). At this appointment, part of the retainer’s acrylic plate was removed (Fig 2) with a stainless steel bur under refrigeration to analyze the levels of residual monomer by using the technique described by Sadamori et al.\textsuperscript{11}

Two portions of acrylic weighing 0.2 g were sampled and stored in test tubes containing 5 mL methyl-ethyl-ketone. The test tubes were sealed and stored in a dark place at 4°C for 48 hours. Then they were centrifuged at 2000 rpm for 15 minutes, and 1 µL of the supernatant was removed with a microsyringe. The sample was immediately injected into an auto-sampling gas chromatographer (Auto System XL, Perkin Elmer, [Wellesley, Mass]), equipped with a PE-WAX (Perkin Elmer) column, 30 m long and 0.25 mm in cross section, with polyethylene glycol as stationary phase and nitrogen as carrier gas. The device was callipered with
different concentrations of a 99% pure grade methylmethacrylate pattern solution (Merck-Schuchardt, Hohenbrunn, Germany), to build a calibration curve used to calculate the concentrations in the samples and also as a control. Residual methylmethacrylate monomer levels were verified at 0.745% and 0.78%.

At the same appointment, the patient was referred to a dermatologist, who prescribed triancinolone acetonide for oral use. It did not relieve her symptoms and was replaced by hydrocortisone, which gave partial relief. A skin patch test was conducted with 10 samples of the same acrylic resin as in her retainer (JET-Clássico, São Paulo, Brazil), combining various polymerization and polishing techniques, described in Table I. These combinations were shown to contain the highest and lowest concentrations of residual monomer for self-curing acrylic resin.

With the patch test on her arm, the patient was instructed not to wet or scratch the area and to call the physician if a reaction occurred. The first evaluation was scheduled for 48 hours later. A classification of clinical signs of reactions to materials was used, as did Menezes et al12 (Table II).

After 48 hours, the patient’s reactions were scored as 2, with erythema alone. No differences were observed in terms of scores for the samples. Some pressure from the patch test was noticed on the skin, and the area was left clear for 24 hours. Another evaluation was made 72 hours after the first application. This time the reaction was exacerbated, with erythema, edema, and papules, and rescoring as 3. Although various techniques were used to polymerize and polish the acrylic samples, no differences could be seen in the reactions. The patient was then instructed to apply flurandrenolide on her skin, but, after 15 days, signs of the allergic reaction could still be seen on the patch test site.

The objective of the removable retainer was to maintain vertical dimension and prevent extrusion of the posterior teeth while waiting for implant-supported prosthetic rehabilitation. When this stage of treatment was completed, a bonded fixed retainer was placed to prevent relapse of the periodontally compromised anterior teeth.

**DISCUSSION**

Acrylic resins are widely used in dentistry, especially in orthodontics and prosthodontics. Increasing concerns about the biocompatibility of this material were evident a decade ago, when reactions were described in the literature.1-3 According to Kusy,13 although metal allergies, particularly to nickel, are the main cause of hypersensitivity reactions in orthodontics, methylmethacrylate is also a key etiologic agent, especially in women. Although reactions to this kind of allergen are rare,14 awareness of local and systemic manifestations is important in orthodontic practice when a patient’s general health is concerned.5,6

This patient had an allergic reaction to a retainer made of self-curing acrylic resin. Local clinical signs, such as palatal erythema delineating the contact area, were evident. Burning sensations and difficulty in swallowing also occurred, raising concerns about systemic involvement.

Other authors have studied residual monomer contents in heat-cured acrylic resins,15 and many have tried to determine the most effective polymerization cycle, reaching very low levels of unpolymerized monomer.8,9 Self-curing resins have a great disadvantage in this aspect. Without a heat source to provide energy that could overcome binding forces to a stabilizer, the material needs a chemical activator. As a result, there are significantly higher levels of unpolymerized content, which vary among commercial brands and processing techniques.

Samples of the retainer were analyzed by gas chromatography. The resulting levels were acceptable, well below international standards.7,9,10 Comparisons with results of other studies should be made carefully. Other authors might have used other types of resins (McCabe and Basker2 experimented with heat-cured resins) and also because of different extraction methods (eg, the aforementioned authors’ use of methanol). We
used methyl-ethyl-ketone as the solvent in a technique shown to be the most effective by Sadamori et al.\textsuperscript{11}

When a patient is hypersensitive, removal of the etiologic agent is always called for. This patient was also treated with oral medication, triacginolone acetanide, and later with hydrocortisone, which gave only mild relief. Complete remission of symptoms was achieved only after the retainer was removed. A skin patch test for the acrylic resin, with several samples of the same material processed by various techniques, was conducted to determine whether altering the processing method could improve biocompatibility. Methods generally suggested to lower the residual monomer content, such as 24-hour immersion in water and hot-water baths, were also tested. No difference was noticed in the reactions to any sample. In this patient, the slightest amount of unpolymerized methylmethacrylate was sufficient to start a reaction. This agrees with the findings of Kusy,\textsuperscript{13} who stated that the effect caused by everyday substances depends on concentration, but, when the concentration exceeds a specified level, it can become harmful. Each patient has a different chemical profile, so that what is optimal concentration for 1 patient might cause an allergic response in another; this explains why such a low level of residual monomer caused the reaction in this patient.

Fernström et al\textsuperscript{16} suggested that only the unpolished surface of the resin contained allergenic substances. However, the patch test verified that even polished resin samples caused an allergic reaction of the same intensity. As found by Fowler,\textsuperscript{17} the allergic reaction peaked in 72 hours and lasted for more than 2 weeks. This observation refuted the possibility of a traumatic reaction to the patch test from pressure or scratching and confirmed the allergic reaction type IV diagnosis.\textsuperscript{4}

Overcoming allergic reactions in denture patients sensitized by methylmethacrylate might require, according to Kanerva et al,\textsuperscript{18} 1 of 6 possibilities: cover the prosthesis with light polymerized methyl methacrylate, cover it with ultraviolet polymerized urethane acrylate, cover it with ultraviolet polymerized methacrylate, use a polycarbonate prosthesis, use vulcanite, or use titan associated to ceramic teeth. A patient allergic to methylmethacrylate was shown to also have positive patch test results to polysulfone and polycarbonate, leaving urethane dimethacrylate as the only choice.\textsuperscript{19}

Therefore, the treatment of allergic reactions to dental materials should be individualized. Suspicious changes should be investigated by a dermatologist and, whenever possible, confirmed by patch testing. Because an allergic reaction is not dose-dependent, but related to the patient’s sensitivity,\textsuperscript{13} it could eventually become life-threatening.\textsuperscript{20}

With hydrocortisone, this patient experienced enough relief of symptoms to continue supervised use of her retainer. This was a temporary situation necessary to maintain the vertical dimension and prevent extrusion of the posterior teeth until reconstructive implant-supported prosthetic work was finished. The retainer was then discontinued, and a wire was bonded with a bis-GMA composite resin to prevent relapse of the periodontally compromised incisors. No reactions or discomfort was associated with that appliance.

**CONCLUSIONS**

Awareness of reactions that can occur with dental materials is important to the orthodontist. Acrylic resins based on methylmethacrylate can produce type IV hypersensitivity reactions. Diagnosis and treatment should include a multidisciplinary team. In all instances, the patient’s well-being should guide treatment decisions, and general health—not just oral health—should be the goal.

**REFERENCES**


